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Proposed Use of Floating Production, Storage, and Offloading Systems On the Gulf of Mexico Outer Continental Shelf

Western and Central Planning Areas

Final Environmental Impact Statement

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Cover

Turret-moored FPSO in a tandem offloading configuration with shuttle tanker (illustration courtesy of Advanced Production and Loading AS, 1999).

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EXECUTIVE SUMMARY

The United States Department of Interior (DOI) Minerals Management Service (MMS) has prepared this Final Environmental Impact Statement (FEIS) to evaluate potential environmental effects of the proposed use of Floating Production, Storage, and Offloading (FPSO) Systems in the deepwater portions (i.e., in areas >650 feet [200 meters] in depth) of the Outer Continental Shelf (OCS) in the Central and Western Planning Areas of the Gulf of Mexico (GOM). This EIS has been prepared in accordance with the National Environmental Policy Act (NEPA), as amended, 42 U.S.C.§§ 4321-4370(d)(1994), and MMS implementation guidelines.

This Environmental Impact Statement (EIS) is a programmatic document to examine the concept of, and fundamental issues associated with, the petroleum industry's proposed use of FPSOs on the OCS of the GOM. Therefore, this EIS addresses the proposed action generically and does not constitute a review of any site-specific development proposal. In addition, the EIS addresses only the NEPA review process: subsequent site-specific FPSO proposals would be subject to established MMS and United States Coast Guard (Coast Guard) review and decision processes (addressing engineering, oil spill, air quality, water quality, and site-specific documentation under NEPA); U.S. Environmental Protection Agency (USEPA) water quality permitting; and any applicable review by states for coastal zone consistency.

The proposed use of FPSOs on the GOM OCS would provide industry with a deepwater production and transportation option in lease areas that are beyond the reach of current oil pipeline infrastructure and possibly technically and/or economically beyond the reach of existing means for extending oil pipeline infrastructure into these lease areas. Offshore leases in areas that present technological and/or economic barriers to development (e.g., great distances from existing infrastructure, extreme depth, highly irregular ocean bottom terrain, fields with marginal production potential, etc.) could potentially become viable candidates for development with the use of FPSOs.

Proposed Action and Alternatives

Alternative A (Conceptual Approval of FPSOs [The Proposed Action]) is the implementation of a policy accepting the conceptual use of the base-case FPSO system in the deepwater OCS areas of the Western and Central Planning Areas of the GOM within the range of design and operational variations considered in the EIS. Under this alternative, FPSOs would be considered an acceptable deepwater development technology for use in the GOM.

Alternative B (Conditional Approval of FPSOs [The Proposed Action with General Restrictions or Conditions]) is the implementation of a policy accepting the conceptual use of the base case FPSO system and range of options in the GOM OCS with general restrictions on the design, operation, or geographic location as conditions of approval. Certain restrictions were identified for consideration based on existing regulatory requirements and the findings of the risk assessment and/or impact assessment performed for this EIS. These restrictions or conditions are analyzed as variations of Alternative B and are described as follows: *Alternative B-1* considers that FPSOs would be prohibited in the portions of the project area in which lightering-prohibited areas have been established by Coast Guard (under 33 CFR Part 156 Subpart C). *Alternative B-2* considers that FPSOs would not be permitted in the Corpus Christi or Port Isabel map protraction areas. *Alternative B-3* considers the exclusion of FPSOs from lease areas near the Mississippi Delta, specifically the Viosca Knoll and Mississippi Canyon map protraction areas. *Alternative B-4* considers the requirement for an attendant vessel to be present during offloading operations, as a measure to enhance safety and provide a level of immediate oil spill response capability.

Alternative C (No Action) is that the concept of using FPSOs in the GOM OCS would not be accepted based on this EIS.

Summary Comparison of Environmental Impacts

Alternative A, the proposed action, would generally have limited adverse impacts on most environmental resources, although significant impacts could occur under certain circumstances. Resources that could be significantly impacted by Alternative A include air quality, water and sediment quality, offshore environments, marine mammals, sea turtles, and commercial fisheries. As discussed in table 2-3, these significant impacts would only occur under specific conditions, most of which can be protected against by project planning and regulatory restrictions. In addition, the proposed action would result in some beneficial effects on fishery resources and localized socioeconomic conditions.

Alternatives B-1, B-2, and B-3 would have less impact than the proposed action on some of the resources due to the exclusion of FPSO operations from areas near sensitive resources. Under Alternative B-3, the potential for significant impacts on air quality in Breton Sound NWA would be eliminated by excluding FPSOs from nearby areas. Alternatives B1, B-2, and B-3 would have greater impacts (both beneficial and adverse) on fishery resources and commercial fishing than those projected for Alternative A due to limiting locations for FPSO operations.

Alternative B-4 (requiring an attendant vessel) would have greater adverse impacts than Alternative A on air quality, water quality, offshore environments, marine mammals, sea turtles, commercial fisheries, the socioeconomic environment, and other uses. However, most of these increased impacts are negligible or minor.

Alternative C would have negligible impacts on environmental resources, though it has the potential to cause a significant adverse impact on the socioeconomic environment along the Gulf coast if the absence of FPSOs leads to an industry downturn. If individual FPSOs were permitted under Alternative C, adverse impacts similar in nature to those described for Alternative A would occur.

Mitigation and Risk-Reducing Measures

Mitigation measures that are identified as potentially applicable to the proposed use of FPSOs on the GOM OCS include those that would address potential impacts associated with FPSO installation and routine operations; the incorporation of risk-reducing measures that would (1) lessen the potential for accidents that could result in an oil spill, or (2) minimize the volume of an oil spill should an accident occur; and mitigation measures for ensuring appropriate and timely oil spill response, should a spill occur.

FPSO Installation and Routine Operations. The analysis for considering potentially significant air quality impacts determined that the potential effects are largely location-dependant. A permanently moored FPSO/shuttle tanker offloading operation in the northeast quadrant of the Mississippi Canyon protraction area would generate sulfur dioxide emissions that could exceed Class I standards in the Breton Sound National Wilderness Area (NWA) in offshore Louisiana. The use of low sulfur fuels for these operations may be an effective measure for reducing sulfur dioxide emissions to levels that are below Class I standards. In the event that a dynamic positioning system is employed, short-term flaring is conducted, or more than one production facility is established within the vicinity, use of low sulfur fuels for operation of vessels and equipment may not achieve the necessary reduction in sulfur dioxide concentrations for meeting the Class I criteria at Breton Sound NWA. It should be noted that the selection of Alternative B-3 would exclude the use of FPSOs in the Mississippi Canyon lease area, in effect mitigating the potential for significant impacts on air quality at Breton Sound NWA that would be attributed to FPSOs and their support activities. The area considered under Alternative B-3 is very large and emissions from FPSO and shuttle tanker operations in a location away from the northeast quadrant may not exceed Class I standards in the Breton NWA.

Selection of Alternative B-3 would provide mitigation for potential impacts of FPSO activities on local deepwater marine mammal species in the Viosca Knoll and Mississippi Canyon lease areas. These waters are considered to support a resident population of endangered sperm whales.

The potential for impacts on commercial fisheries brought on by the abandonment of debris and facilities on the sea floor would be mitigated through MMS's site clearance and verification processes. Lessees are required to remove all devices, works, structures, and related underwater obstructions from their Federal OCS leases within one year after the lease is terminated or relinquished. Economic relief from entanglement with oil- and gas-related debris is available through the fisherman's contingency fund.

Risk-reducing Measures. An oil spill frequency analysis, addressing the proposed use of FPSOs on the GOM OCS, was completed in conjunction with this EIS. The results and conclusions of the frequency analysis are summarized in the EIS. This analysis considered that a variety of design and operational scenarios may be considered by operators for the OCS. It included identifying measures for reducing the risk of accidents, and for potentially minimizing the volume of oil released, should an accident occur. There are a number of variations in system design, configuration and operation that, alone or in combination, could be employed to minimize the risk of an oil spill. An extensive list of potentially applicable risk-reducing measures was developed as part of the risk assessment effort, and is provided in Section 4.4.1 of the EIS. In addition, it should be noted that the selection of Alternative B-4 would represent a risk-reducing measure for providing an additional level of safety during FPSO/shuttle tanker offloading, and for on-site first-response capability in the event of an oil spill. An attendant vessel is the only “active” system available to intervene and potentially prevent a collision and any resulting fire, explosion or oil spill.

Mitigation for Oil Spill Response Readiness. Several different response methods are currently available for offshore oil spills, including application of oil dispersants, mechanical containment and recovery, and *in-situ* burning. Each of these response methods represents, in effect, available mitigation that may serve to reduce or eliminate oil spill-related impacts. The critical time period for spill response (i.e., mobilization of spill response manpower, transportation, materials, and supplies) is within the first one or two days following an accidental release of oil. The extent and location of a spill (and the relative location of potentially sensitive shoreline or offshore resources) are important considerations that influence the nature of a spill response. While it is recognized that the MMS and Coast Guard will require limited spill response capability on site (e.g., spill response plans for the FPSO and shuttle tankers, limited supplies for cleanup of small spills), it may also be possible to pre-position spill equipment and supplies as mitigation. Section 4.4.3 considered current spill response capability for the GOM region, recognizing that there is no reliable method of estimating what resources may be available when the first FPSO begins operation. Further, there is no reliable means of determining what spill response contractual arrangements may be in place when the first FPSO is installed in the GOM. It is recommended that pre-positioning of supplies be considered on a project-by-project basis, considering the proposed FPSO location, shuttle tanker routes, and sensitive offshore and coastal resources. Under the proper circumstances, the enhanced readiness afforded through pre-positioning for an accidental release of oil may provide sufficient mitigation to protect sensitive resources from significant impacts.

Application of these mitigation and risk-reducing measures is an option available to the Secretary of the Interior.

Action Scenarios Analyzed

The petroleum industry proposes the use of FPSOs as a viable technological and operational means of producing hydrocarbon resources on the U.S. portion of the GOM OCS. This EIS describes “a most likely configuration” of an FPSO system that would operate in these deepwater areas of the Western and Central Planning Areas of the GOM. Hence, the base-case scenario for consideration in this EIS is a generic FPSO system that incorporates the components, configuration, and types and level of activities that would reasonably be expected to represent industry’s intended applications of these systems. The major components of the base-case scenario FPSO generally fall within a range of potentially viable design choices and configurations. The range of potential options for the main components of FPSO systems that would operate in the GOM also are identified and discussed in the EIS. The base-case scenario was defined in sufficient detail so that (1) a quantitative risk assessment (including a hazard analysis and accident frequency analysis) could be conducted, (2) environmental impact-producing factors could be identified, and (3) an environmental impact assessment could be completed. The potentially applicable range of options for FPSO system components and configuration was analyzed to the point that risks and impacts could be gauged relative to the base-case scenario.

Consideration of the proposed action is limited to a 10-year period, 2001 through 2010. A 10-year period was chosen for the analysis time frame because rapidly changing technologies make projections beyond that time frame very uncertain. During the 10-year planning period for consideration of the proposed action, the MMS projects that five FPSOs could be incrementally deployed by industry within the geographic area of consideration. The first FPSO could be deployed as early as 2001, and then, with the addition of one FPSO approximately every other year beyond 2001, five FPSOs could be operating in the geographic area of consideration by 2010.

The cumulative analysis considers environmental impacts that potentially could result from the incremental contribution of the proposed action for FPSOs when combined with past, present, and reasonably foreseeable future actions, including other OCS hydrocarbon development activities, other OCS activities and uses, maritime transport, and coastal activity.

Major Issues

The major issues of concern considered and/or analyzed in this EIS include many of the same issues identified during scoping for previous MMS's NEPA documents covering OCS oil and gas development, as well as issues identified specifically for FPSOs in this EIS scoping process. The following sources were used to focus more specifically on issues of concern related to use of FPSOs for deepwater development: public scoping for this EIS; MMS's Gulf of Mexico *Deepwater Operations and Activities Environmental Assessment (Deepwater EA)*; and the FPSO workshop co-sponsored by MMS and DeepStar on April 16, 1997.

Many of the issues identified in the *Deepwater EA* are related to impact-producing activities or risk factors generally associated with deepwater oil and gas activities, including production operations. As noted in the *Deepwater EA*, many of these issues have been analyzed in previous NEPA documents, and these analyses are referenced where appropriate. Only issues unique to FPSO-based production systems were selected for detailed analysis in this EIS. Most of these issues are associated with the following unique aspects of FPSO operations: offshore storage of large volumes of OCS-produced crude oil; off-loading of OCS-produced crude oil offshore; and transport of OCS-produced crude oil via surface vessel (versus transport via marine pipeline). Issues of concern relate to: potential impact-producing factors associated with FPSO operations and support activities; sensitive environmental resources that could be impacted by FPSO installation, operation, decommissioning, and associated transportation and support activities; and socioeconomic activities that could be affected by FPSO–related activities.

The environmental resources that are potentially vulnerable to impacts from construction, installation, operation, and decommissioning of FPSOs in the GOM are: air quality; water and sediment quality; coastal habitats; benthic communities; marine mammals; sea turtles; coastal and marine birds; fish; commercial and recreational fisheries; social and economic conditions; recreational resources and beach use; cultural resources; and other uses.

Impact Conclusions – FPSO Installation, Routine Operations and Decommissioning

A summary of the potential impacts on each environmental resource and the conclusion of the analyses is presented in Section 2.3, as well as in Sections 4.3 through 4.5 of this EIS. Below is a general summary of the potential impacts resulting from the proposed action and alternatives.

Air Quality. Under the proposed action, emissions from routine operations may result in a long-term significant impact in air quality at Breton Sound NWA due to exceedances of the SO_2 standard. The installation of up to five geographically dispersed FPSOs may adversely affect air quality, depending upon location and proximity to shore and one another. In the unlikely event that all five FPSOs were placed near sensitive receptors (e.g., in the Mississippi Canyon area) in an area with a 50-km radius, significant air quality impacts are expected from SO_2 emissions. The flaring/venting options for gas disposal also could have significant impacts on air quality.

Alternatives B-1 and B-2 would have negligible impact on ambient air quality. Alternative B-3 would effectively mitigate the significant impact of FPSO emissions in the northeastern portion of the Mississippi Canyon lease area, specifically impacts on the Breton NWA. Alternative B-4 would have an incremental increase in impact above that projected for Alternative A (i.e., significant impacts from SO_2 emissions in the Mississippi Canyon area). For operations in the northeastern part of the Mississippi Canyon area, any air quality impacts could be further exacerbated by the presence of an attendant vessel under Alternative B-4.

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Water and Sediment Quality. The proposed action would have an adverse, but not significant impact on water quality. Support vessel traffic from the shorebase(s) to the FPSO site(s) would produce adverse but not significant impacts on coastal water and sediment quality. If vessel traffic is concentrated in one or a few ports, then significant, localized impacts on water quality and sediment quality could be realized. Anchoring installation/emplacement activities would produce localized, short-term impacts on offshore sediment quality. During routine production operations at the FPSO, produced water discharges and wastewater discharges from the FPSO and support vessels would produce localized impacts on offshore water quality, an adverse but not significant impact.

Alternatives B-1 through B-3 would have negligible impact on coastal and offshore water and sediment quality, relative to Alternative A. Alternative B-4 would have an incremental impact on water quality, however, impacts are expected to remain adverse but not significant.

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Coastal Environments. The proposed action would have generally negligible impacts on coastal environments (i.e., coastal barrier beaches, dunes, wetlands, and seagrass beds). However, adverse but not significant impacts on beaches, coastal wetlands and seagrass habitats could occur due to incremental increases in vessel traffic, depending upon the location of operations and the nature of adjacent coastal resources. These impacts would result from incremental increases in erosion rates, sediment re-suspension, and turbidity caused by vessel transits in coastal areas.

Alternative B-1 is expected to produce negligible impacts on coastal barrier beaches and associated dunes, particularly if exclusions from the lightering-prohibited areas concentrated shuttle tanker traffic to specific ports. Alternative B-2 would have negligible impact on coastal barrier beaches and associated dunes. Alternative B-3 would have no effect on proposed operations elsewhere in the deepwater area and thus no effects on the impacts associated with shuttle tanker traffic discussed under Alternative A. Alternative B-4 would have similar impacts on coastal environments as those projected for Alternative A.

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Offshore Environments. The proposed action would have generally negligible, localized impacts on offshore environments (encompassing plankton and deep benthic communities and topographic features). Anchoring, structure emplacement, and pipelaying would produce adverse but not significant impacts on soft-bottom benthic communities. Recolonization of disturbed areas is expected during the first several years following FPSO installation and operation. With proper avoidance, impacts on chemosynthetic communities from installation activities would be negligible. However, if chemosynthetic communities were damaged during installation, such damage to chemosynthetic communities would represent a significant, long-term impact. Bottom-founded structures may provide hard substrate for epifaunal attachment, possibly a beneficial impact. Use of either suction pile or driven pile anchoring techniques (instead of drag anchoring) may slightly reduce impacts on the benthos by reducing the total amount of seafloor area affected.

Alternatives B-1, B-2, and B-3 would have no impact on offshore resources. Alternative B-4 may produce a slight increase in impact on both water column and deep benthic environments. This incremental increase in discharges is minor, and impacts on plankton would remain negligible. If a dedicated anchor is required, additional, minor anchor impacts are predicted. Impacts on benthic communities would remain adverse but not significant.

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Marine Mammals. Normal operations under the proposed action would cause localized adverse impacts on marine mammals, primarily from noise and/or visual disturbances from helicopters, service vessels, and shuttle tankers. Expected increases in service vessel and shuttle tanker traffic associated with normal operations may also increase the probability of collisions between these vessels and marine mammals. Although the risk of collisions may vary, any collision with a marine mammal that is listed as an endangered species, such as the sperm whale, would constitute a significant impact. A collision with a non-listed species would be considered adverse, but not locally or regionally significant. Ingestion of, or entanglement with, any solid debris accidently lost overboard would produce a negligible impact on marine mammals.

Alternatives B-1 and B-2 would have similar impacts on marine mammals, as those projected for Alternative A. Alternative B-3 may mitigate potential impacts of FPSO activities on local deepwater marine mammal species, especially the endangered sperm whale. Alternative B-4 has the potential for greater impacts on marine mammals than Alternative A, however, the impacts from additional noise or discharges from an attendant vessel are not considered to be significant.

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five

FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Sea Turtles. Under the proposed action, installation and operation of an FPSO would have generally negligible impacts on sea turtles, although collisions with service vessels and shuttle tankers and installation of OCS pipelines may produce adverse or significant impacts. Expected increases in vessel traffic associated with installation may also increase the probability of collisions between these vessels and sea turtles. Although the risk of collisions may vary, any collision with a single sea turtle that causes death would constitute a significant impact, as all species are currently listed as endangered or threatened species. Destruction of shallow water habitats and beaches as a result of the installation of OCS pipelines may produce adverse but not significant impacts on sea turtles through loss of nesting habitat.

Alternatives B-1, B-2, and B-3 would have the same impacts on sea turtles as described in Alternative A. Alternative B-4 has the potential for increased impact on sea turtles from additional subsea mechanical noise and additional discharges. Impacts on sea turtles resulting from these sources are considered to be adverse but not significant.

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Coastal and Marine Birds. The proposed action would produce negligible or adverse impacts on coastal and marine birds. Installation of new OCS pipeline landfalls, if required, could cause adverse impacts on coastal birds due to the associated destruction or alteration of coastal habitat and related disturbance from installation operations. However, with appropriate placement (and avoidance of sensitive avian habitat), impacts are not expected to be significant. Helicopter and service vessel traffic related to normal operations would produce only a negligible impact on coastal and marine birds.

Alternatives B-1 through B-4 would have similar impacts on coastal and marine birds as those described under Alternative A.

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Fish Resources. The proposed action would produce negligible or beneficial impacts on fish resources, except for potentially adverse impacts on highly migratory fish. Anchors and other bottom-founded structures would serve as fish attracting devices (FADs), a beneficial impact on species preferring bottom relief. Highly migratory fish species could be diverted from traditional migratory routes and, consequently, from traditional spawning or feeding areas. Such disruptions in migration patterns could result in short- or long-term effects on the feeding behavior in deepwater fishes, an adverse but not significant impact. In situ abandonment of bottom-founded structures would create a permanent FAD effect for benthic fishes, which could have adverse or beneficial effects on fish populations, although significant impacts are not expected.

Alternative B-1 may have a beneficial impact on shallow-water fish resources greater than that of Alternative A. The impacts of Alternative B-2 on fish resources would not be appreciably different than those caused by Alternative A. Alternative B-3 would have less beneficial impact than that of Alternative A due to the elimination of FPSO structures in lease areas nearest to the Mississippi Delta. Alternative B-4 would have an incrementally greater adverse impact on fish resources than that projected for Alternative A, but the impact would still be negligible.

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Commercial Fisheries. The proposed action would produce negligible to adverse, localized, long-term impacts on commercial fisheries. The presence of FPSOs, pipelines, and vessel traffic would preclude deepwater trawling and longlining in relatively small areas surrounding these structures and activities, causing an adverse but not significant impact. The placement of FPSOs in water depths of greater than 1,000 feet would greatly lessen the chance for conflicts with trawling and bottom longlining. If optional scenarios involve shallower waters (e.g., along the 600-foot isobath), then the potential for impact would increase, but would only be significant if the FPSO was located on or near a known fishing area. Partial structure abandonments on the seafloor would cause permanent loss of relatively small fishing areas, resulting in a negligible impact on commercial bottom fisheries.

Alternative B-1 and B-2 would have less of an impact on demersal fisheries (i.e., bottom longlining and trawling) than that of Alternative A, particularly for lightering prohibited areas located in water depths between 600 and 1,500 feet. Alternative B-1 and B-2 would, however, produce an incremental increase (over Alternative A effects) in space-use conflicts with the surface longline fishing, causing an adverse but not significant impact. Alternative B-3 would have less impact than Alternative A on the royal red shrimp fishery, which generally occurs in the proposed exclusion area (i.e., within water depths of 600 to 1,500 feet). However, this exclusion area would cause adverse but not significant impacts by slightly increasing the space-use conflicts elsewhere in the deepwater areas where surface longlining occurs. Alternative B-4 would have impacts on commercial fisheries similar to those projected for the Alternative A.

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Socioeconomic Environment. The proposed action could have short-term socioeconomic benefits along the Gulf coast during construction phases, but impacts of normal FPSO and shuttle tanker operations on the socioeconomic environment would be negligible. In the event five FPSOs were placed in proximity to one another, it is possible that one or two port facilities would realize the bulk of the socioeconomic impact, resulting in a localized, adverse but not significant impact. The storage capacity and production rates associated with five FPSOs would produce a slightly greater impact on socioeconomic resources, but still result in a negligible socioeconomic impact.

Alternative B-1 would have negligible impacts on social and economic outcomes, similar to those of Alternative A. Alternatives B-2 and B-3 would also have negligible social and economic impact overall, however, the beneficial effects of FPSO-related offshore employment (of workers residing along coastal areas adjacent to the exclusion zones) may be dampened slightly. Alternative B-4 would have a slightly greater adverse impact on socioeconomic environment than that projected for Alternative A, but the impact would still be negligible.

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Recreational Resources and Beach Use. The proposed action would have negligible, localized, adverse impacts on recreational resources and beach use. No impacts on recreational resources and beach use are expected in association with perceived water quality degradation. Slight increases in the number of vessel and helicopter transits would produce minor, incremental impacts on viewsheds in the vicinity of transit routes. Options for increased storage capacity and increased production rates would further increase tanker traffic but still result in negligible impacts, given the amount of tankering activity currently being conducted at Gulf ports.

Alternatives B-1, B-2, B-3, and B-4 would have negligible impacts on recreational resources and beach use similar to those caused by Alternative A.

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Other Uses. The proposed action would have negligible impacts on other uses of the GOM, such as commercial and military uses. Incremental increases in vessel traffic, helicopters, and shuttle tankering would produce the potential for increased conflicts with other uses of surface, airspace, and underwater areas, but these impacts are expected to be negligible.

Alternatives B-1, B-2, and B-3 would have less impact than Alternative A on other uses due to the exclusion of FPSOs from designated areas. Alternative B-4 would have a minor incremental impact on other uses above that projected for Alternative A, but this would still represent a negligible impact.

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Risk of Oil Spill

In conjunction with preparation of the EIS, a quantitative risk assessment was performed by Det Norske Veritas (DNV, Offshore Department, Risk and Reliability Services Division, Houston, Texas) based on the specifications defined for the base-case FPSO. DNV prepared and submitted to MMS a detailed report on the methodology and results of the risk assessment (DNV, January 2000).

The risks from FPSO operations were compared to those of accepted deepwater technologies for oil production to identify risk factors unique to FPSO operations. These risks were measured by examining each accidental event considered and comparing its frequency or outcome against that of the corresponding operation on a tension leg platform (TLP), which is taken to be representative of accepted deepwater technology for the GOM OCS. The results of this comparison were used to predict the risks unique to FPSO operation. The study quantified common risks to both FPSOs and TLPs and risks unique to FPSOs, but it did not address risks unique to TLPs.

The results of the risk assessment indicate that for risks unique to FPSO operation:

- The frequency of FPSO-unique oil releases greater than 1,000 barrels is 0.037 per billion barrels produced for FPSO-related failures, and 1.2 per billion barrels transported for shuttle tanker-related failures. (The production rate is assumed to be 150,000 barrels of oil per day.)
- Approximately 94.4 percent of the volume of potential FPSO-unique spills is likely to be due to the transfer of oil from the FPSO to the shuttle tanker and from the shuttle tanker transit to shore.
- Approximately 53.6 percent of the volume of potential FPSO-unique spills is likely to be from shuttle tankers near port.
- Approximately 39.0 percent of the volume of potential FPSO-unique spills is likely to be from shuttle tankers in transit to port.
- Approximately 1.8 percent of the volume of potential FPSO-unique spills is likely to be from the transfer of oil from the FPSO to the shuttle tanker. However, this volume is comprised entirely of the smaller spill sizes (<1,000 barrels).
- Process releases are the single largest FPSO-unique risk for releases on the FPSO.
- For events on the FPSO, accidents that escalate to the cargo area (which comprises escalation consequences from most of the hazard categories in table 4-25) represent the largest FPSO-unique risk. The cumulative frequency of these events is on the order of 1×10^{-3} per year.
- Collisions with passing merchant vessels are low-frequency events but account for 1.2 percent of all the FPSO-unique oil released due to the potential for large-volume spills.

The assessment of oil spill risks performed for this study should be regarded as generic to the concept of using FPSOs in deep water. More detailed analysis would accompany the evaluation of specific FPSO permit applications. At that time, the locations of a proposed FPSO and associated tanker routes would be more defined, and the risk from transportation routes closer to shore would be evaluated.

Based on the risk assessment, the risk of spills unique to FPSOs operations in the GOM is low. Of spill risk on the FPSO itself, excluding offloading and shuttle tanker transport, FPSO-unique spill risk comprises only 5% of the total risk. The remaining 95% of spills are not unique to FPSO operations and would be equally likely and have similar outcomes on a TLP or other deepwater production alternative.

Furthermore, risk of oil spills during offloading from the FPSO to the shuttle tanker is similar to that for lightering operations in the GOM, where there is a history of low spill frequency and small spill volumes. The risk of shuttle tanker transport spills should be compared with the risk of spills from oil transport by offshore pipeline. Based on analysis of MMS's database of oil spills in U.S. waters (Anderson and LaBelle, 1994), it is estimated that for pipeline transport there will be 1.32 spills with volumes greater than 1,000 bbls for every billion bbls transported, and for tanker transport there will be 1.21 spills with volumes greater than 1,000 bbls for every billion bbls transported. Therefore, the oil spill risk for shuttle tanker transport is comparable to and slightly less than that of pipeline transport.

The risk of shuttle tanker transport spills used in this assessment was derived from a database of tanker spills in U.S. waters with incidents extending back to the 1970s. This incident database covers a large range of years and provides a wide experience base for determining what the historic risk of tanker transport spills has been. However, the large range of years covered also means that recent regulatory and other risk-reducing measures are not well represented in the predicted risk of tanker transport spills. It is expected that these mitigative actions should result in improved tanker performance in the future over the performance predicted using this database. Therefore, the risk of shuttle tanker transport spills predicted in this assessment may well be conservative

Oil Spill Impacts

A summary of the potential impacts on each environmental resource and the conclusion of the analyses is presented in Section 4.4 through 4.5 of this EIS. Below is a general summary of the potential impacts resulting from an accident that would result in an oil spill.

Air Quality. On a regional basis, oil spills from FPSO operations are expected to produce adverse but not significant impacts on ambient air quality. Impacts will be relatively short term (i.e., duration of the spill). During the first few days, localized significant impacts may be realized, depending upon spill location and relative position of sensitive onshore receptors (e.g., Class I areas).

Water and Sediment Quality. On a regional basis, oil spills from FPSO operations are expected to produce adverse but not significant impacts on ambient water quality. Impacts will be relatively short term (i.e., duration of the spill). On a regional basis, oil spills from FPSO operations are expected to produce adverse but not significant impacts on sediment quality. Only significant impacts would be realized if oil was ignited prior to release (i.e., where spilled oil density greatly exceeds that of seawater), resulting in sinking oil reaching the benthos where it will affect sediment quality.

Coastal Barrier Beaches. On a local basis, oil spills from FPSO operations will produce either adverse (but not significant) or significant impacts on coastal barrier beaches, depending upon spill size, the nature of the oil coming ashore (e.g., highly vs. lightly weathered) and location and the characteristics of the barrier beach. Impacts may be long term, depending upon spill location and relative position of sensitive resources. Spill frequencies are low (i.e., probability of large, nearshore spills is low). At all offshore locations modeled, smaller spills are not predicted to reach shore.

Wetlands. On a local basis, oil spills from FPSO operations will produce either adverse (but not significant) or significant impacts on wetlands, depending upon spill size, the nature of the oil coming ashore (e.g., highly vs. lightly weathered) and location of the wetland. Impacts may be long term, depending upon several factors including spill location, degree of oil weathering, and organic content of marsh sediments. Spill frequencies are low (i.e., probability of large, nearshore spills is low). At all offshore locations modeled, smaller spills are not predicted to reach wetlands.

Seagrass Beds. On a local basis, oil spills from FPSO operations are not expected to produce either adverse or significant impacts on seagrass beds. Probabilities for spilled oil reaching Florida seagrass beds are very low. Smaller spills from FPSO locations offshore are not predicted to reach shore.

Offshore Environments. Oil spills from FPSO operations will produce either negligible or adverse but not significant impacts on offshore environments, including state offshore waters, menhaden spawning grounds, and topographic features. Oil will not reach topographic features, while oil reaching state offshore waters or menhaden spawning grounds will be weathered. Any impacts are projected to be short term.

Marine Mammals. Mysticetes (baleen whales) are considered more likely to be affected by an oil spill than odontocetes due to feeding mechanisms and their preferred prey. Small oil spills are unlikely to produce significant impacts on marine mammals. While larger spills are very rare, should they occur, impacts are potentially significant, of regional importance, and long term. Spill frequencies for larger spills are very low, reducing the risk of impact on marine mammals from an oil spill.

Sea Turtles. If exposed to oil or tar balls, sea turtles are at high risk of suffering serious injury or death, a significant impact given the listed status of all Gulf sea turtle species. The probability of exposure to oil from accidents on FPSOs and shuttle tankers is low. Thus, risk of significant impact is correspondingly low. Small oil spills are unlikely to produce significant impacts on sea turtles located well inshore of FPSO operations. While larger spills are very rare, should they occur, impacts are potentially significant (i.e., affecting adults in coastal waters, smothering nests on nesting beaches), of regional importance, and long term. Spill frequencies for larger spills are very low, reducing the risk of impact on sea turtles from an oil spill.

Coastal and Marine Birds. If exposed to oil, coastal and marine birds might realize significant impacts. Large congregations, rookeries, and foraging areas are particularly sensitive. Endangered waterbirds and shorebirds are extremely susceptible to oil in the coastal and intertidal zones, where oil contact resulting in serious injury or mortality is a significant impact. The probability of exposure to oil from accidents on FPSOs and shuttle tankers is low. Thus, risk of significant impact is correspondingly low. Small oil spills are unlikely to produce significant impacts on coastal and marine birds located inshore of FPSO operations. While larger spills are very rare, should they occur, impacts are potentially significant, of regional importance, and long term. Spill frequencies for larger spills are very low, reducing the risk of impact on birds from an oil spill.

Fish Resources. Because pelagic eggs and larvae of Gulf fishes are vulnerable to oil exposure, the loss of large numbers of embryos and larvae is an adverse but not significant impact, localized and short term in nature. Impacts on adults from oil exposure are not as severe. The probability of exposure to oil from accidents on FPSOs and shuttle tankers is low. Thus, risk of significant impact is correspondingly low.

Commercial Fisheries. Nearshore waters and estuarine environments are important habitat to commercially-important species. While pelagic eggs, larvae, and juveniles of commercially important fishery species are vulnerable to oil exposure, there are no apparent impacts on adult, harvestable stocks of those species where early life stages have been exposed to spilled oil. Similarly, recruitment does not appear to be affected by oil exposure. Contamination of tissues of select fish species has minimal impact on health risk. Impacts on commercial fisheries from oil spills are adverse but not significant. These impacts are expected to be localized and short term in nature. The probability of exposure to oil from accidents on FPSOs and shuttle tankers is low. Thus, risk of significant impact is correspondingly low. Impacts on commercial fisheries associated with closure of a local fishery by state agencies following an oil spill are adverse but not significant, localized, and of relatively short duration.

Socioeconomic Environment. Of the 13 labor market areas (LMAs) evaluated, only the Brazoria area has a high potential for adverse but not significant impacts on oil spill-sensitive employment sectors. Oil spills are expected to have only negligible impacts on other LMAs. In the absence of definitive data regarding the extent and location of oiling along Gulf coast, impacts upon local infrastructure from cleanup operations is expected to be adverse but not significant, relatively short term, and localized.

Recreational Resources and Beach Use. On a local basis, oil spills from FPSO operations will produce negligible, adverse (but not significant), or significant impacts on recreational resources located along coastal barrier beaches and within protected embayments and wetlands of the western and central Gulf coast. Impact severity will depend upon spill size, the nature of the oil coming ashore (e.g., highly vs. lightly weathered), the location and characteristics of the recreational resource, season, the nature and extent of cleanup operations, and the amount of time a particular recreational area is closed due to cleanup and/or restoration activities. Impacts may be long term, depending upon spill location and relative sensitivity of the recreational resource affected (e.g., impacts on affected wetlands are generally greater than similar spill exposure on a barrier beach). Spill frequencies are low (i.e., probability of large, nearshore spills is low). At all offshore locations modeled, smaller spills are not predicted to reach shore.

Cultural Resources. An oil spill driven by wind and currents may be deposited on a section of the coast containing various historical properties. This deposition may have an adverse effect on historical resources (e.g., historical piers, esplanades, boardwalks, landings, port structures, etc.). Furthermore, an oil spill may severely affect archaeological sites, particularly fragile prehistoric shell midden sites that frequently occur along the Gulf coast.

Other Uses. Oil spills from FPSO operations will produce negligible to adverse (but not significant) impacts on other uses (e.g., other GOM oil and gas activities, commercial shipping, and military testing and training operations), primarily through limited preclusion of offshore waters prompted by the presence of the oil spill and oil spill response equipment. Such impacts are expected to be localized and relatively short term.

Cumulative Impacts

Installation, routine operations, and decommissioning activities for the above FPSO components and activities would involve impacts on air quality and the marine and coastal environment, and potentially could affect commercial fisheries. However, these impacts are expected to be minimal in magnitude, and localized and/or of short duration (e.g., during periods of installation and decommissioning activities), and therefore less than significant. Approximately 55 deepwater production startups are projected for the GOM OCS by the end of 2000, and an additional 88 deepwater startups are projected during the 10-year period of 2001 through 2010. Of these projected total 143 deepwater production facilities anticipated to be installed on the OCS during this time period, up to five, or 3.5 percent, would be FPSO systems. Consequently, the incremental contribution of installation, decommissioning and routine operations for the above FPSO components and activities toward any cumulative adverse impacts in the Gulf region is not expected to be significant.

The degree to which the emissions from between one and five FPSOs would be significant and/or could potentially contribute to a significant and adverse cumulative impact is likely to be location-dependant. For example, the use of one or more dynamically positioned and/or moored FPSOs in Viosca Knoll Area, or in the northern portion of the Mississippi Canyon lease Area, alone or in combination with other offshore activities, may generate emissions that cumulatively exceed Class I air quality standards (under the Wilderness Act of 1964) in the Breton Sound NWA. The degree to which a cumulative effect would be observed depends on several factors, including meteorological conditions, fuel characteristics, horsepower, emissions controls, FPSO location, distance from sensitive receptors, and the emissions associated with other activities in the region.

FPSO operations would incrementally contribute to the demand for support services and, therefore, to the cumulative beneficial and adverse impacts that could be realized at locations for ports and service bases serving deepwater developments.

The potential for any incremental encroachment upon military use areas would not exist because each of the developments that may be proposed (as many as five FPSOs) would have to satisfy DoD requirements prior to proceeding.

Transport of OCS-produced oil to inshore or shore-side facilities would be accomplished with shuttle tankers rather than oil pipelines. Therefore, oil pipeline-installation vessel emissions (potentially high but of short duration) would not occur. Without an oil export pipeline, FPSOs would involve less bottom disturbance activities, and water quality and marine life impacts, although these effects would otherwise to a great extent be temporary and of short duration. The need for oil pipeline maintenance and repair, use of flow assurance chemicals, line replacement activities, the potential occurrence of leaks and spills, and the eventual abandonment issues, would be significantly reduced. Consequently, an incremental increase in OCS oil production would be achieved without otherwise contributing to the cumulative impacts associated with GOM oil pipeline infrastructure expansion.

Combined with the emissions of FPSO routine operations, the emissions that occur during offloading may represent a significant incremental contribution to cumulative adverse impacts on air quality. Furthermore, additional on-site sources that would potentially include dynamic-positioning (DP) stationkeeping, use of attendant vessels during offloading and/or any MMS-approved flaring, would cause additional emissions that could exacerbate the degree to which FPSO operations contribute to cumulative impacts on air quality. The potential for any significant contribution to a cumulative adverse impact on air quality would be highly dependant on the location of FPSOs on the OCS, and their proximity to each other, as well as their proximity to other emissions sources, orientation to sensitive receptors, and meteorological conditions. In remote areas of the OCS that are distant from the Gulf coast, it is expected that FPSOs would not result in significant incremental impacts on air quality, because the emissions would disperse into a substantial volume of the atmosphere. Given the degree to which offshore development has occurred, and is projected to continue to occur, in the Mississippi delta area, it is possible that one or more FPSO operations located in the region could play a role in contributing significantly to cumulative air quality impacts. For example, the use of one or more FPSOs in the northern portion of the Mississippi Canyon Area could result in a significant incremental impact on air quality in the Breton Sound NWA, a Class I area under the Wilderness Act of 1964.

Given the projected increases of imported crude oil and products that will pass through Gulf ports during the ten-year analysis period, foreign and domestic tanker transits at these ports may increase from the current 16,334 port transits to between 20,000 and 22,000 port transits annually by 2010. If approved by MMS, the use of five FPSOs on the OCS would be expected to generate between 365 and 685 shuttle tanker transits to GOM ports in 2010, and would represent between 1.8 and 3.4 percent of all tanker transits in that year.

It is expected that infrastructure and services demands and impacts of routine operations would increase relative to the total number of expected tanker transits in the GOM and its ports. The shuttle tanker transits associated with up to five FPSO operations on the OCS would represent a small percentage of annual tanker transits into Gulf ports during the ten-year period of 2001 through 2010. Consequently, the incremental impact of routine operations for FPSO shuttle tankers is not expected to be a significant portion of the potential cumulative effects.

The projected increase in tanker traffic activity, both in terms of vessel transits and the total volume of petroleum to be transported in the GOM on an annual basis during the 2001 through 2010 period, brings with it an increased potential for accidents and associated oil spills. The projected increase in demand for petroleum products is expected to continue, and the increase in imports required to meet that demand will be the principal controlling factor in determining the degree to which oil will be transported to U.S. refinery ports and terminals by tankers. The annual production rate in the GOM is expected to remain relatively flat during the ten-year period. FPSO and shuttle tanker risks are comparable to the existing deepwater production structure and oil pipeline risks, and, therefore, the net gain in risk would be negligible. Consequently, increases in oil imports, in the form of increased tanker transits into GOM refinery ports and terminals, will drive the cumulative increase for risk of oil spills.

Table of Contents

Section		Page

Table of Contents (Cont.)

Section **Page**

Table of Contents (Cont.)

Section **Page**

Table of Contents (Cont.)

Section **Page**

Table of Contents (Cont.)

Section **Page**

Table of Contents (Cont.)

Section **Page**

Table of Contents (Cont.)

Section **Page**

Appendices

Table of Contents (Cont.)

Section **Page**

Appendices

List of Tables

Table **Page**

List of Tables (Cont.)

Table **Page**

List of Tables (Cont.)

List of Tables (Cont.)

List of Tables (Cont.)

Table **Page**

List of Tables (Cont.)

Table **Page**

List of Tables (Cont.)

Table **Page**

List of Tables (Cont.)

List of Illustrations

List of Illustrations (Cont.)

Figure **Page**

List of Illustrations (Cont.)

Figure **Page**

List of Illustrations (Cont.)

Figure **Page**

List of Illustrations (Cont.)

Figure **Page**

List of Illustrations (Cont.)

Figure **Page**

ABBREVIATIONS AND ACRONYMS

ACAA	Alabama Coastal Area Act
ACAMP	Alabama Coastal Area Management Plan
ADECA	Alabama Department of Economic and Community Affairs
ADEM	Alabama Department of Environmental Management
ANWR	Aransas National Wildlife Refuge
APD	Application for Permit to Drill
API	American Petroleum Institute
ARZ1	Archeological Resource Zone 1
ATB	articulated tug barges
BACT	best available control technology
BAST	best available and safest technology
Bbbl	billion barrels
BBO	billion barrels of oil
Bcf	billion cubic feet
BEA	Bureau of Economic Affairs
BOP	blowout preventer
B.P.	before present
Call	Call for Information and Nominations
CCA	Coastal Coordination Act (Texas)
CD	Consistency Determination
CEI	Coastal Environments, Inc.
CEQ	Council on Environmental Quality
CER	Categorical Exclusion Review
cf.	compare, see
CFDL	Coastal Facilities Designation Line (Texas)
CFR	Code of Federal Regulations
CNRA	Coastal Natural Resources Area
Coast Guard	U.S. Coast Guard
COD	chemical oxygen demand
COE	Corps of Engineers (U.S. Army)
CPA	Central Planning Area
CRA	Comparative Risk Assessment
CSA	Continental Shelf Associates
CWA	Clean Water Act
CWPPRA	Coastal Wetlands Protection, Planning & Restoration Act
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DEIS	Draft Environmental Impact Statement
DNV	Det Norske Veritas
DOCD	Development Operations Coordination Document
DOD	Department of Defense (U.S.)
DOI	Department of the Interior (U.S.) (also: USDOI)
DOT	Department of Transportation (U.S.) (also: USDOT)
DP	dynamic positioning
DWOP	Deepwater Operations Plan
dwt	dead weight tonnage
E & E	Ecology and Environment, Inc.
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIA	Energy Information Administration (USDOE)
EIS	Environmental Impact Statement
EP	Exploration Plan
EPA	Eastern Planning Area
ESP	Environmental Studies Plan
et al.	and others
et seq.	and the following
EWTA	Eglin Water Test Area
FAA	Federal Aviation Administration
FCF	Fishermen's Contingency Fund
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FMC	Fishery Management Council
FMP	Fishery Management Plan

FONSI	Finding of No Significant Impact
FPS	floating production system
FPSO	floating production, storage, and offloading system
FR	*Federal Register*
FSO	floating storage and offloading
FWPCA	Federal Water Pollution Control Act of 1972
FWS	Fish and Wildlife Service
FY	fiscal year
G&G	geological and geophysical
GIS	geographical information system
GIWW	Gulf Intracoastal Waterway
GMAQS	Gulf of Mexico Air Quality Study
GMFMC	Gulf of Mexico Fishery Management Council
GOM	Gulf of Mexico
GTFP	Green Turtle Fibropapillomatosis
HMWHC	high molecular weight hydrocarbons
IPF	impact-producing factor
ITB	integrated tug barges
ITL	Information to Lessees and Operators
ITM	Information Transfer Meeting
LATEX	Texas-Louisiana Shelf Circulation and Transport Process Program (MMS-funded study)
LCRP	Louisiana Coastal Resources Program
LDNR	Department of Natural Resources (Louisiana)
LLD	lower limit of detection
LOOP	Louisiana Offshore Oil Port
LSU	Louisiana State University
LTL	Letter to Lessees and Operators
MAFLA	Mississippi, Alabama, and Florida
MARPOL	International Convention for the Prevention of Pollution from Ships
MCP	Mississippi Coastal Program
MFCMA	Magnuson Fishery Conservation and Management Act of 1976
Mmbbl	million barrels
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act of 1972
MMS	Minerals Management Service
MPPRAC	Marine Plastic Pollution Research and Control Act of 1987
MSA	Metropolitan Statistical Area
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act (of 1996)Mta
MOU	Memorandum of Understanding
NAAQS	National Ambient Air Quality Standards
NACE	National Association of Corrosion Engineers
NARP	National Artificial Reef Plan
NAS	National Academy of Sciences
n.d.	no date
NEPA	National Environmental Policy Act
NERBC	New England River Basins Commission
NFEA	National Fishing Enhancement Act
NGVD	National Geodetic Vertical Depth
NHAP	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent to Prepare an EIS
NORM	naturally occurring radioactive material
NOW	nonhazardous oil-field waste
NPDES	National Pollution and Discharge Elimination System

NRC	National Research Council
NST	National Status & Trends Program (NOAA)
NTL	Notice to Lessees and Operators
NVIC	Navigation and Vessel Inspection Circular
NWA	National Wilderness Area
OCD	Offshore and Coastal Dispersion model
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OPEC	Organization for Petroleum Exporting Countries
OSCP	Oil Spill Contingency Plan
OSIR	Oil Spill Intelligence Report
OSRA	Oil Spill Risk Analysis
P.L.	Public Law
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PINC	Potential Incidence of Noncompliance
PINS	Padre Island National Seashore
PM_{10}	particulate matter smaller than 10 microns
ppm	parts per million
ppt	parts per thousand
PSD	Prevention of Significant Deterioration
RCRA	Resource Conservation and Recovery Act
RPA	representative of the proposed action
RD	Regional Director
RTR	Rigs-to-Reef
SEIS	supplemental environmental impact statement
SEFSC	Southeast Fisheries Science Center
SIC	Standard Industrial Classification
SIP	state implementation plan
sp.	species
spp.	multiple species
SSP	Strategic Studies Plan
Stat.	Statutes
TAMU	Texas A&M University
tcf	trillion cubic feet
TCMP	Texas Coastal Management Plan
TED	turtle excluder device
THC	total hydrocarbon content
TLP	tension leg platform
TSP	total suspended particulate matter
TWC	treatment, workover, and completion
U.S.	United States
U.S.C.	United States Code
USCG	U.S. Coast Guard
USCOE	U.S. Corps of Engineers
USDOC	U.S. Department of Commerce
USDOE	U.S. Department of Energy
USDOI	U.S. Department of the Interior (also: DOI)
USEPA	U.S. Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VOC	volatile organic compound
WBNP	Wood Buffalo National Park
WPA	Western Planning Area

1. PROPOSED ACTION

1.1 Introduction

The United States Department of Interior (DOI) Minerals Management Service (MMS) has prepared this Final Environmental Impact Statement (FEIS) to evaluate potential environmental effects of the proposed use of Floating Production, Storage, and Offloading (FPSO) Systems in the deepwater portions (i.e., in areas >650 feet [200 meters] in depth) of the Outer Continental Shelf (OCS) in the Central and Western Planning Areas of the Gulf of Mexico (GOM). This DEIS has been prepared in accordance with the National Environmental Policy Act (NEPA), as amended, 42 U.S.C.§§ 4321-4370(d)(1994), and MMS implementation guidelines.

This Environmental Impact Statement (EIS) is a programmatic document to examine the concept of, and fundamental issues associated with, the petroleum industry's proposed use of FPSOs on the OCS of the GOM. Therefore, this EIS addresses the proposed action generically and does not constitute a review of any site-specific development proposal. In addition, the EIS addresses only the NEPA review process: subsequent site-specific FPSO proposals would be subject to established MMS and Coast Guard review and decision processes (addressing engineering, oil spill, air quality, water quality, and site-specific documentation under NEPA); U.S. Environmental Protection Agency (USEPA) water quality permitting; and any applicable review by states for coastal zone consistency.

Section 1.2, Purpose and Need for Action, describes the basis for industry's proposed use of FPSOs in the Western and Central Planning Areas of the OCS of the GOM. Section 1.3 provides the basis for preparing the EIS, including the regulatory authority and procedure for implementing completion of the EIS process; a description of the Federal Government's obligation to address potential significant environmental impacts that could result from decisions that are to be made; and the possible decision outcomes with respect to the proposed use of FPSOs. Section 1.4 describes the proposed action, including the general location and ocean depths in which FPSO operations would occur; the FPSO system, system components, and configurations that would most likely be used; and FPSO installation, routine operations, and decommissioning activities. Section 1.5 describes the regulatory and administrative framework applicable to the approvals for use of FPSOs on the OCS, including MMS and Coast Guard regulatory authorities. Section 1.6 describes the measures that have been taken by MMS to ensure public involvement in the EIS preparation process.

1.2 Purpose and Need for Action

Offshore operators have inquired about the potential use of FPSOs in the deepwater portions of the Western and Central Planning Areas of the GOM OCS. If approved for use in the GOM, FPSOs would result in increased accessibility to remote leases and improved cycle time on developing some discoveries, which could increase the cumulative oil and gas production potential of the OCS. Measures that increase the potential for domestic oil production, such as the use of FPSOs on the OCS, would also potentially allow opportunity for displacement of crude oil imports to the U.S.

During the past 15 years, the petroleum industry has extended exploration and production activity from the edge of the Continental Shelf (200 meters [650 feet] depth) in the GOM southward into the deep waters of the OCS (figure 1-1). In recent years, there has been a surge in deepwater leasing in the Central and Western Planning Areas of the GOM OCS, and operators have spent billions of dollars in obtaining these leases. As of the end of 1997, the remaining proved reserves in the GOM OCS Western and Central Planning Areas, in water depths greater than 200 m, are 1.877 billion barrels of oil equivalent (BBOE), and MMS estimates unproved reserves to be 1.034 BBOE (USDOI, MMS, 2000b). The deepwater portion of the GOM is, at present, the most active province for hydrocarbon exploration in the United States OCS (USDOI, MMS, 2000b). The large number of 100-million-barrel (bbl) fields discovered beyond the 1,000-foot depth contour, and the emergence of enabling technologies, have secured the future of GOM oil and gas operations and extended the reach of offshore exploration, production, and pipelining into unprecedented water depths (USDOI, MMS, 2000b).

The floating production systems that have been used in the deepwater GOM in the 1990s, such as large tension leg platforms (TLPs), spars, and semi-submersibles, may not be the best technologies for use in remote offshore leases. Deepwater environments have subjected industry to new sets of challenges, and techniques for drilling, production, and transportation must be adapted, altered, and/or reinvented to respond to the physical constraints imposed by working at great depths and at locations increasingly distant from onshore support and infrastructure. In response to the challenges posed by the production and transportation of crude oil in such areas, industry proposes to use FPSO systems as a means of augmenting the available options for deepwater development methods in the GOM. Some of the potential advantages FPSOs have over other development options include: shorter cycle time (time from first oil discovery to first oil production), lower construction costs, reusability of equipment, and the flexibility to transport crude oil to the refining center of choice.

FPSOs are floating production systems that store crude oil in tanks located in the hull of the system and offload the crude to shuttle tankers or ocean-going barges for transport to shore. Historically, most FPSOs have been either “purpose-built” or “converted” ship-shaped tanker vessels. In a few cases, non-ship-shaped hulls have been used as FPSOs. Purpose-built FPSOs are designed and constructed specifically for the purpose of operating as FPSOs. Most converted FPSOs were vessels originally designed and constructed as ocean-going oil tankers that have been structurally modified and equipped for FPSO service. FPSOs have onboard production and processing equipment, storage facilities for produced hydrocarbons, and the capability to offload hydrocarbons to shuttle tankers, which can subsequently transport the cargo to terminals and deepwater ports. An FPSO is either moored to the seafloor or dynamically positioned (using thrusters) at a production site. In terms of transporting crude oil from the offshore development site to terminals or refinery ports, FPSO systems differ from the conventional method of transporting crude oil by pipeline in that they involve temporary storage of crude oil on location, and offloading of the oil to shuttle tankers for transport to the terminal or refinery destinations.

FPSO systems have never been used in the U.S. GOM, but there is growing experience in the use of these systems in other areas of the world, including Southeast Asia, the South China Sea, the Indian Ocean off Northwest Australia, the South Atlantic Ocean off West Africa and Brazil, the Mediterranean Sea, the North Sea, and the East Coast of Canada. The earliest applications of FPSO systems were by Shell and Petrobras off of the coasts of Spain and Brazil, respectively, during the late 1970s. (USDOI, MMS, 2000a)

To date there has been one example of a production facility on the U.S OCS being used for crude oil storage and offloading and shuttle tanker transport. The Offshore Storage and Treatment (OS&T) vessel serving the Hondo Field and Platform Hondo (located in 490 feet of

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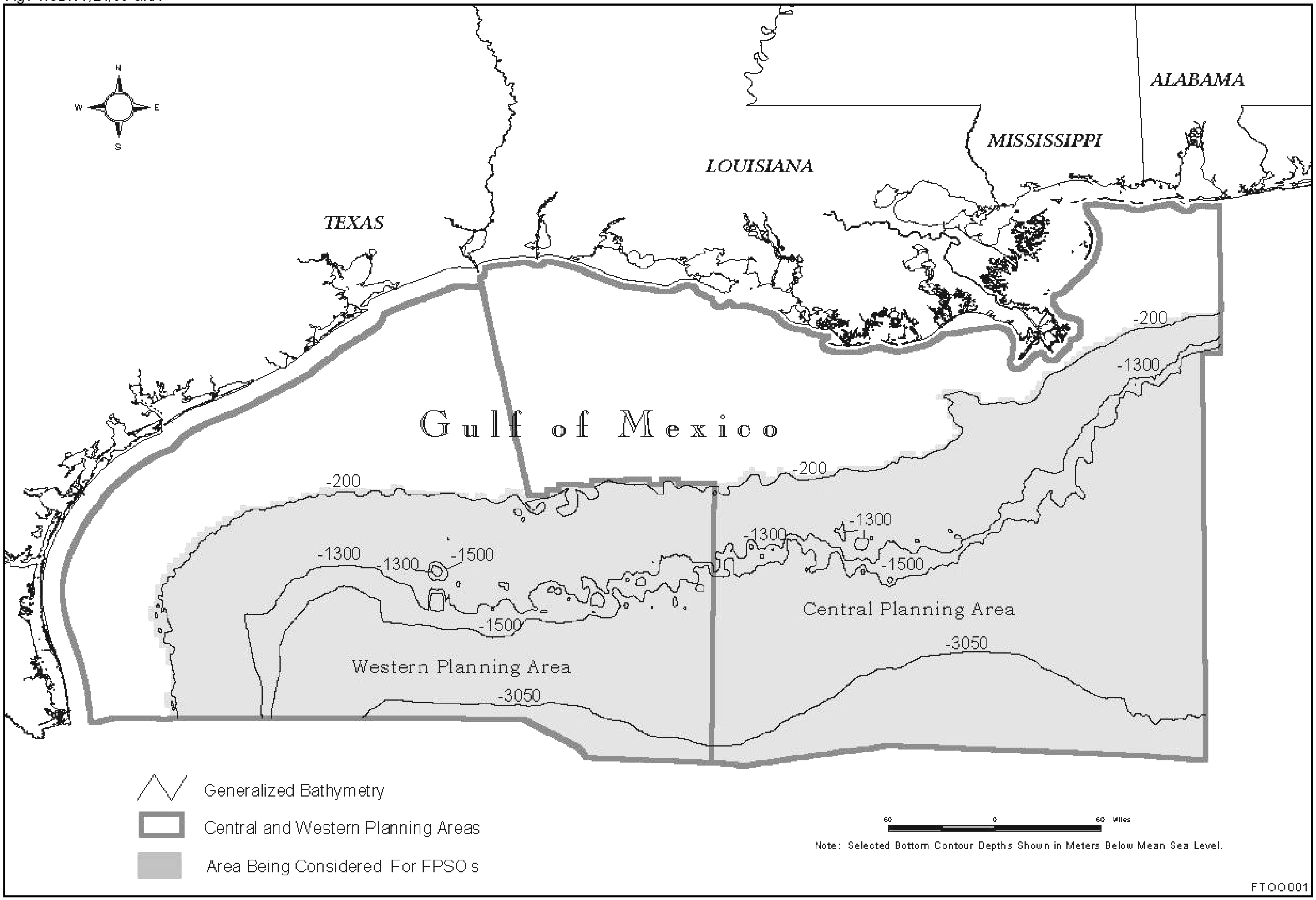

Source: MMS 2000

Figure 1-1 OUTER CONTINENTAL SHELF OF THE U.S. GULF OF MEXICO. GENERALIZED BATHYMETRY (CENTRAL AND WESTERN GULF OF MEXICO) SELECTED BOTTOM DEPTH CONTOURS CITED IN EIS SECTION 1. DEPTHS REFERENCED IN SCENARIO AND IN "DESCRIPTION OF PROPOSED ACTION"

water on the Pacific OCS, 3.5 miles off Santa Barbara County, California) resembled some aspects of FPSO operations. The vessel was a converted single-hull oil tanker with a total storage capacity of 210,000 barrels of crude oil. The OS&T operated at the production site between 1981 and 1994, and no major spills resulted from this activity. A total of 19 minor spills occurred, averaging 1.8 gallons in volume. The two largest spills, both of which were 15-gallon crude oil spills that occurred during offloading to shuttle tankers, were subsequently cleaned up using on-site response capabilities. Following decommissioning from the site in 1994, the vessel was reassigned for similar service in Indonesia.

The world's fleet of FPSOs (not including those decommissioned prior to 1999) includes 71 vessels that are in service or under construction. Twenty-nine of the FPSOs are purpose-built, and 42 are converted oil tankers. Four of the 71 FPSOs are idle, and one was decommissioned in 1999. As of 1999, 10 of the FPSOs were reported to be under construction and are scheduled for completion by 2000. Approximately 44 of the 71 FPSOs were installed between 1995 and 1999 and are operating in all major offshore oil-producing regions of the world except the U.S. GOM (McNeely *et al.*, 1999). A floating storage and offloading (FSO) system is presently being used in the Cantarel field, Bay of Campeche, Mexico.

The ability to transport crude oil has always been an important factor in the successful development of both onshore and offshore oil fields. Historically, pipelines have been the most common means used to transport crude oil produced in the GOM OCS. The technology and methods involved in pipeline transport of product from offshore oil and gas fields located in the shallower waters of the GOM OCS have evolved to the level of routine and commonplace. The current extent of oil pipeline infrastructure in the GOM is shown on figure 1-2. Much of the same technology and methods would be employed in the deep waters beyond the edge of the continental slope; however, the operating environment for deepwater pipelines differs from the operating environment of pipelines on the shelf. Unlike the gradual sloping of the shelf seafloor, the seafloor beyond the shelf is extremely irregular. This means that suitable routes for pipeline routes are fewer and more difficult to identify. The irregularity of the seafloor topography in the deepwater OCS can result in greater "span" distances (i.e., length of unsupported pipeline above the irregularities of the seafloor), which in turn could lead to bending stresses.

Compared with shallow water pipelines, pipelines located in deep water endure greater physical stresses (e.g., extreme depths and strong currents) on pipe and equipment during installation; higher hydrostatic pressures (i.e., water pressure at depth); and colder water and sediment temperatures. The rugged seafloor environment may also cause terrain-induced pressures within the pipe that can be operationally problematic, as the oil must be pumped up and down steep slopes.

The greater pressures and colder temperatures in the deepwater OCS present industry with difficulties with respect to maintaining the flow of crude oil through pipelines. Under these conditions, the physical and chemical characteristics of the produced hydrocarbons (i.e., product containing crude oil and gas fractions and water) lead to the accumulation of gas hydrate, paraffin, and other substances within the pipeline that can restrict and eventually block flow if not successfully prevented and/or abated. There are physical and chemical techniques that can be applied to manage this accumulation of flow-inhibiting substances. These measures include forcing plunger-like "pigging" devices through the pipeline to scrape the pipe walls clean and the continuous injection of flow-assurance chemicals (e.g., methanol or ethylene glycol) into the pipeline system to minimize the formation of flow-inhibiting substances. However, the greater water depths of the OCS and the increased length of pipelines needed to reach shoreside facilities

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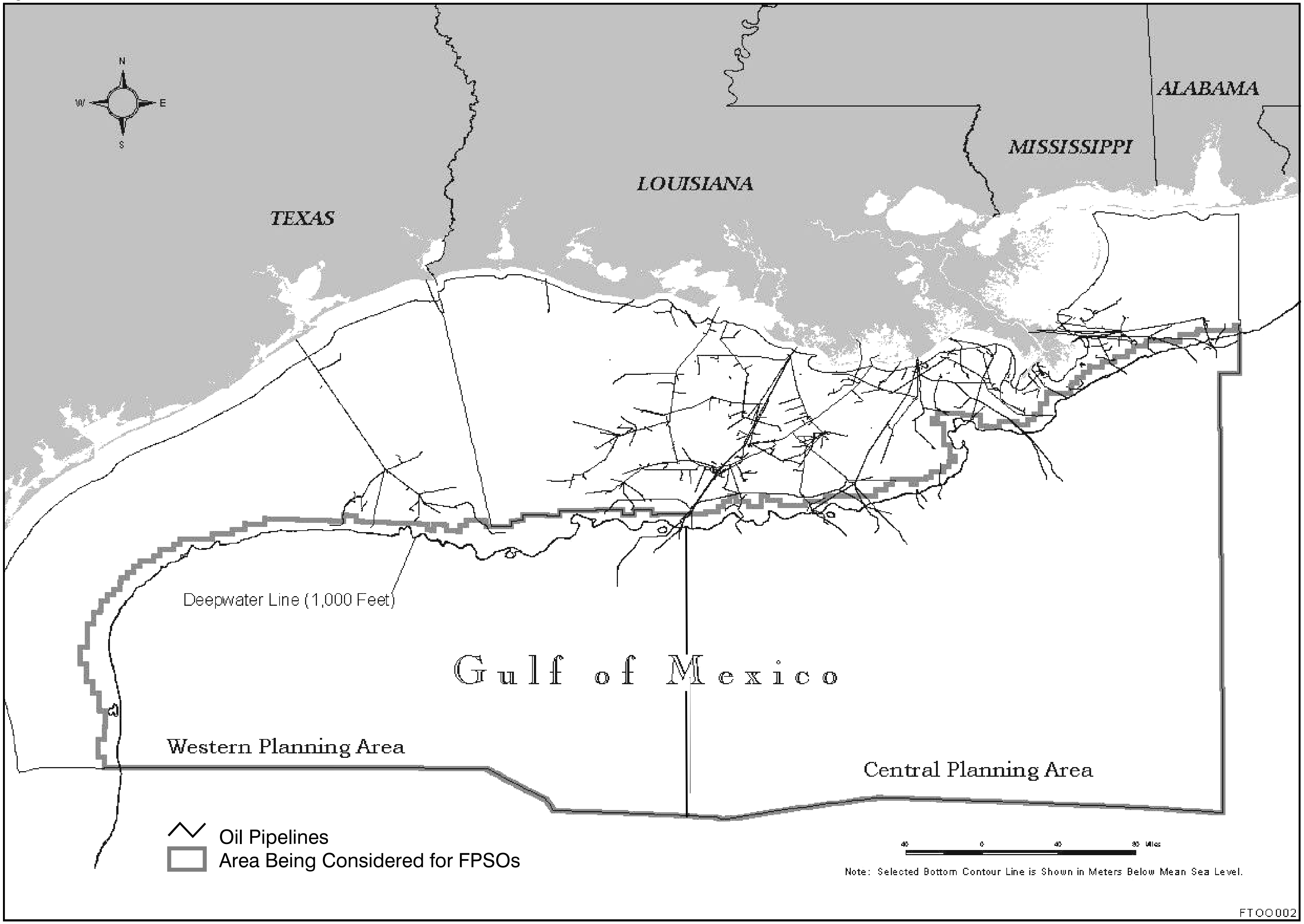

Source: MMS 2000.

Figure 1-2 EXTENT OF OIL PIPELINE INFRASTRUCTURE IN THE U.S. GULF OF MEXICO (CENTRAL AND WESTERN PLANNING AREAS)

make these flow-assurance measures more difficult to implement and can significantly increase the cost to produce and transport product. Consequently, measures for installing oil pipelines, maintaining pipeline integrity, and maintaining crude oil transport in these deep, rugged, cold, and distant seafloor environments would require overcoming technological challenges, and the high costs involved would present economic constraints on development in the deep water of the OCS. (USDOI, MMS, 2000b). Installation of pipelines for transmission of natural gas and operation of these facilities in deepwater is usually more feasible than for oil pipelines. Natural gas pipelines are of a smaller diameter and installation is less complicated. Additionally, the flow assurance issues associated with oil pipelines are not applicable to the transmission of processed natural gas.

The proposed use of FPSOs on the GOM OCS would provide industry with a deepwater production and transportation option in lease areas that are beyond the reach of current oil pipeline infrastructure. Offshore leases in areas that present technological and/or economic barriers to development (e.g., great distances from existing infrastructure, extreme depth, highly irregular ocean bottom terrain, fields with marginal production potential, etc.) could potentially become viable candidates for development with the use FPSOs. Some of the advantages that industry anticipates would be realized if FPSOs were approved for use on the OCS include the following:

- The ability to transport crude oil from deepwater leases on the OCS where conventional pipeline transport options would not be viable from technology and/or economic standpoints;
- Reduced cycle time of development (i.e., the period between the first discovery of oil and the commencement of production). FPSOs can be fabricated and installed faster than other development options, thereby allowing an operator to enhance the economics of a project by initiating production and obtaining a return on capital investment sooner than could be done with other development options;
- The use of FPSO shuttle tankers to transport product rather than a long export oil pipeline may significantly reduce the tariffs and initial capital investment required for a development project.

Industry maintains that FPSOs offer increased flexibility for meeting the economic justifications for developing fields on the OCS that otherwise may not be developed. The following are areas where the economic benefits of that flexibility are sought:

- Transporting oil from an FPSO by shuttle tanker would give the operator flexibility in directing the cargo to the refinery of choice, and thus allow the operator to obtain the most competitive price for the product.
- Unlike other deepwater production facilities, an FPSO does not need to be totally amortized against a single development project; a FPSO can be moved and reused in other development projects.
- FPSOs can be leased by operators, allowing for financing flexibility and reduced up front capital investment.
- FPSOs typically have more deck space than other offshore structures, and processing equipment can more easily be accommodated and re-sized for increased production if wells produce at higher rates than anticipated, or if other fields are discovered nearby.

The use of FPSO systems during the past 20-plus years has evolved to incorporate advancing material and design technologies, as well as increasing experience in conducting successful operations at greater ocean depths, in harsh environments, and at remote locations. In 1999, Intec Engineering, Inc., completed a survey and compilation of worldwide FPSO historical data for DeepStar (an oil industry consortium for addressing deepwater development issues). This Intec survey represents the only known and available recent attempt at compiling a comprehensive world-wide history of FPSO operational activities that includes a record of oil spill events associated with these operations. Given that the survey involved contacting many different parties, including foreign companies and governments, and that timely and thorough response to questionnaires was strictly voluntary, the oil spill historical information obtained by Intec is limited. Appendix A of the survey (FPSO Database), which reviewed the use of FPSOs since the late 1970s, identified 97 ongoing or completed FPSO operations. These operations represent a combined total of 413 years of FPSO service and processed an estimated 5.9 billion barrels of crude oil. Of the 97 FPSO operations identified in the Intec survey, historic oil spill information was obtained for 28. These 28 operations represent a combined total of 121 years of FPSO service and produced a total of 2.0 billion barrels of oil. The survey results indicate that these 28 FPSO operations experienced a combined total of 194 reported oil spills totaling 5,407 barrels of oil. This amount equates to 2.7 barrels spilled for every 1 million barrels produced. The largest reported oil spill, which occurred in the North Sea, was 3,900 barrels. During startup of the *Captain FPSO*, an overboard dump valve was inadvertently left open. The cause of the spill was considered to be operational rather than hardware related (Intec Engineering, Inc., 1999). An accident such as this could be considered as not necessarily FPSO specific, since this type of human error could potentially occur during the startup of any new production system.

Since 1980, GOM OCS operators have produced about 5.5 billion barrels of crude oil, while the amount of oil spilled offshore totaled about 61,500 barrels, or 11.2 barrels spilled for every 1 million barrels produced. (Anderson, 1997). There were no spills of greater than 1,000 barrels from production platforms during this period. There have been six spills of greater than 1,000 barrels from oil pipelines since 1981. Given the technological advances and accumulated operational experience regarding the use of FPSO systems, the oil industry considers FPSOs to be an appropriate and viable means for developing the deepwater areas of the GOM OCS.

1.3 Basis for Preparing the EIS

In 1996, operators and FPSO builders began seriously discussing with MMS the possibility of using FPSOs in the GOM. Recognizing the increasing interest in the use of FPSOs and shuttle tankers, MMS and DeepStar co-sponsored an FPSO workshop in April 1997 to identify technical, safety, and environmental issues and information needs related to FPSOs. Subsequently, MMS and DeepStar have worked together to identify the potential role of FPSOs in the development of the GOM and to address the various technical, safety, and environmental issues related to the use of FPSOs and shuttle tankers in the GOM. In June 1998, MMS expressed its willingness to prepare an EIS, under the implementing regulations of NEPA, that would address the issues associated with the proposed use of FPSOs in the Western and Central Planning Areas on the OCS. In July 1998, DeepStar agreed to provide the necessary funding required for MMS procurement of a contractor to complete the EIS process. In addition, DeepStar cooperated with MMS to define a representative base-case scenario (as well as the potential range of variations in system components, configuration, and operation) for the use of an FPSO on the OCS.

As described in Section 1.2, the proposed use of FPSO systems in the GOM OCS has the potential to enhance industry's capabilities to develop oil and gas reserves in deepwater areas that otherwise would challenge or exceed the limits of current deepwater production and transportation infrastructure and technologies. However, FPSO systems would be a departure from the conventional transportation methods used for U.S. offshore oil development. This new approach would involve large volumes of oil being temporarily stored at sea at locations distant from on-shore support and emergency response systems. Rather than moving the oil to shore via pipeline, FPSO operations involve offloading crude oil to shuttle tankers for transport.

Prior to any decisions made by the Federal Government regarding the proposed use of FPSOs in the GOM, the risk of oil spills and the potential consequences of any such spills must be evaluated. NEPA requires the preparation of a detailed EIS for any major federal decision that may have a significant impact on the environment. Given that this large-volume storage and transport method would be new to the U.S. GOM, and the potential exists for significant adverse impacts, the consideration of, and decisions regarding, the proposed use of FPSO systems on the OCS constitutes a major federal action. Consequently, in accordance with NEPA, as well as in accordance with its mission as a federal agency, MMS is proceeding with the preparation of this EIS for the proposed use of FPSOs on the GOM OCS.

This document was prepared as a programmatic EIS. It is programmatic in that it addresses the fundamental concepts and issues associated with the proposed use of FPSOs on the Western and Central Planning Areas of the GOM OCS. The MMS has taken this approach as the first step in developing an understanding of the benefits and risks that may be associated with FPSO systems, and to allow an opportunity for public involvement in this process prior to considering approval of individual applications for site-specific FPSO systems. The MMS believes that the development of a programmatic EIS will assist: (1) the government in making informed decisions, (2) the public in playing a role in shaping these decisions, and (3) industry by obtaining feedback in the fundamental issues and concerns that must be addressed as part of any application for approval of a proposed site-specific FPSO operation.

In order to consider the proposed use of FPSOs in the programmatic sense, a generic FPSO system and operation is defined in this document that represents a likely scale and configuration of what would be anticipated to be deployed on the OCS during the course of the next 10 years (i.e., the base-case scenario). An attempt was also made by the EIS authors to identify a range of technical variations that conceivably could be proposed by industry as part of various site-specific design scenarios.

It is expected that the outcome of this programmatic EIS process will result in one of three basic decisions by the federal government: (1) conceptual approval of FPSOs, (2) conceptual approval of FPSOs under certain pre-conditions, or (3) a decision for no action (i.e., no conceptual approval by the government). In accordance with the requirements of NEPA, the government's decision will be detailed in a Record of Decision (ROD) and published in the *Federal Register*. Regardless of the decision outcome, it is intended that this programmatic EIS (including the resulting ROD) serve as a planning document and reference tool for "tiering" any subsequent NEPA actions regarding site-specific proposals for use of FPSOs in the GOM

The President's Council on Environmental Quality (CEQ) considers tiering appropriate for NEPA documentation when the sequence of statements or analyses is to proceed from broad-scale and/or regional statements (i.e., programs, plans, or policy) to lesser, more focused, statements (e.g., site-specific plans). "Tiering in such cases is appropriate when it helps the lead agency to focus on the issues which are ripe for decision, and exclude from consideration issues already decided or not yet ripe." (CEQ Implementation Regulations Part 1502.28)

No approval for a site-specific proposal to use FPSO systems in the GOM will be granted as a result of the ROD for this EIS. Rather, proposals for use of a site-specific FPSO system would be considered by the government, and appropriate NEPA documentation would be prepared, by tiering from this programmatic EIS. In addition, operators would still be required to submit Deepwater Operations Plans (DWOP; Notice to Lessees and Operators [NTL] 98-8N) for technical review, as well as required project-specific development plans for technical, safety and environmental review.

1.4 Description of the Proposed Action

The petroleum industry proposes the use of FPSOs as a viable technological and operational means of developing hydrocarbon resources on the U.S. portion of the GOM. This section describes "a most likely configuration" of an FPSO system that would operate in these deepwater areas of the Western and Central Planning Areas of the GOM. Hence, the base-case scenario for consideration in this EIS is a generic FPSO system that incorporates the components, configuration, and types and level of activities that would reasonably be expected to represent industry's intended applications of these systems. The major components of the base-case scenario FPSO generally fall within a range of potentially viable design choices and configurations. The range of potential options for the main components of FPSO systems that would operate in the GOM also are identified and discussed below.

Although FPSO systems have been used at a number of locations around the world over the past 20 years, they have not been used in the GOM. Both industry and MMS have expended efforts to assess the various types of FPSO systems being employed in other regions of the world in concert with identifying the issues, limitations, and basic design factors that could be involved in applying this technology to the GOM OCS environment. The MMS prepared a compendium reference document for supporting its preparation of an Environmental Assessment for deepwater development. This reference document is titled *MMS 2000-015, Deepwater Development: A Reference Document for the Deepwater Environmental Assessment, Gulf of Mexico OCS (1998 through 2007).* The document provides a component-based summary of deepwater technology and operations and identifies trends and issues associated with deepwater development in the U.S. GOM. It includes a section, based on industry inputs provided primarily by DeepStar, describing a prototypical FPSO for the GOM. This document served as the starting point for development of a base-case scenario for this EIS.

Upon commencing the NEPA process for this EIS, the project team used a step-wise approach to build upon the prototype FPSO presented in the MMS deepwater development reference document and further define a likely configuration of an FPSO operation in the GOM. Working with industry feedback and concurrence, the objectives of this work were to (1) determine the range of potentially relevant and applicable options for FPSO system components, configuration, and operations; and (2) identify within the identified range of possibilities the most likely configuration of an FPSO system that would be used in the GOM, otherwise known as the base-case scenario. The base-case scenario was then defined in sufficient detail so that (1) a quantitative risk assessment (including a hazard analysis and accident frequency analysis) could be conducted, (2) environmental impact-producing factors could be identified, and (3) an environmental impact assessment could be completed. The potentially applicable range of options for FPSO system components and configuration was analyzed to the point that risks and impacts could be gauged relative to the base-case scenario.

Consideration of the proposed action is limited to a 10-year period, 2001 through 2010. A 10-year period was chosen for the analysis time frame because rapidly changing technologies make projections beyond that time frame very uncertain. During the 10-year planning period for consideration of the proposed action, MMS projects that five FPSOs would be incrementally deployed by industry within the geographic area of consideration. The first FPSO would be deployed as early as 2001, and then, with the addition of one FPSO approximately every other year beyond 2001, five FPSOs would be operating in the geographic area of consideration by 2009. (Aker, 1999; Regg, 2000a).

1.4.1 Location

The area being considered in this EIS for the proposed use of FPSOs encompasses the deepwater portions of the Central and Western Planning Areas of the GOM OCS (figure 1-3). Specifically, the geographic area of consideration includes the following map protraction areas within the aforementioned planning areas: Corpus Christi, Port Isabel, East Banks, Alaminos Canyon, Garden Banks, Keathley Canyon, NG 15-8, Ewing Banks, Green Canyon, Walker Ridge, NG 15-9, Viosca Knoll (southern portion), Mississippi Canyon, Atwater Valley, Lund, and NG 16-7.

Within the geographic area of consideration, FPSOs would potentially be deployed in areas having water depths ranging from 600 feet to 12,500 feet (figure 1-1). Industry has indicated that FPSOs would be needed primarily in waters greater than 1,000 feet deep and that the greatest potential for use of FPSOs would be in waters between 4,000 and 10,000 feet deep. The base-case scenario for this EIS considers an FPSO deployed in water 5,000 feet deep.

1.4.2 FPSO System Components and Configuration

The proposed use of an FPSO system in the geographic area of consideration would involve the following basic components:

- Double-hulled, purpose-built FPSO,
- Permanently moored turret,
- Subsea system (wells, flowlines, manifolds, and risers),
- Processing,
- Gas export pipeline,
- Crude oil storage,
- Crude oil offloading,
- Manning and accommodations,
- Other auxiliary component, and
- Shuttle tankers for transporting produced oil.

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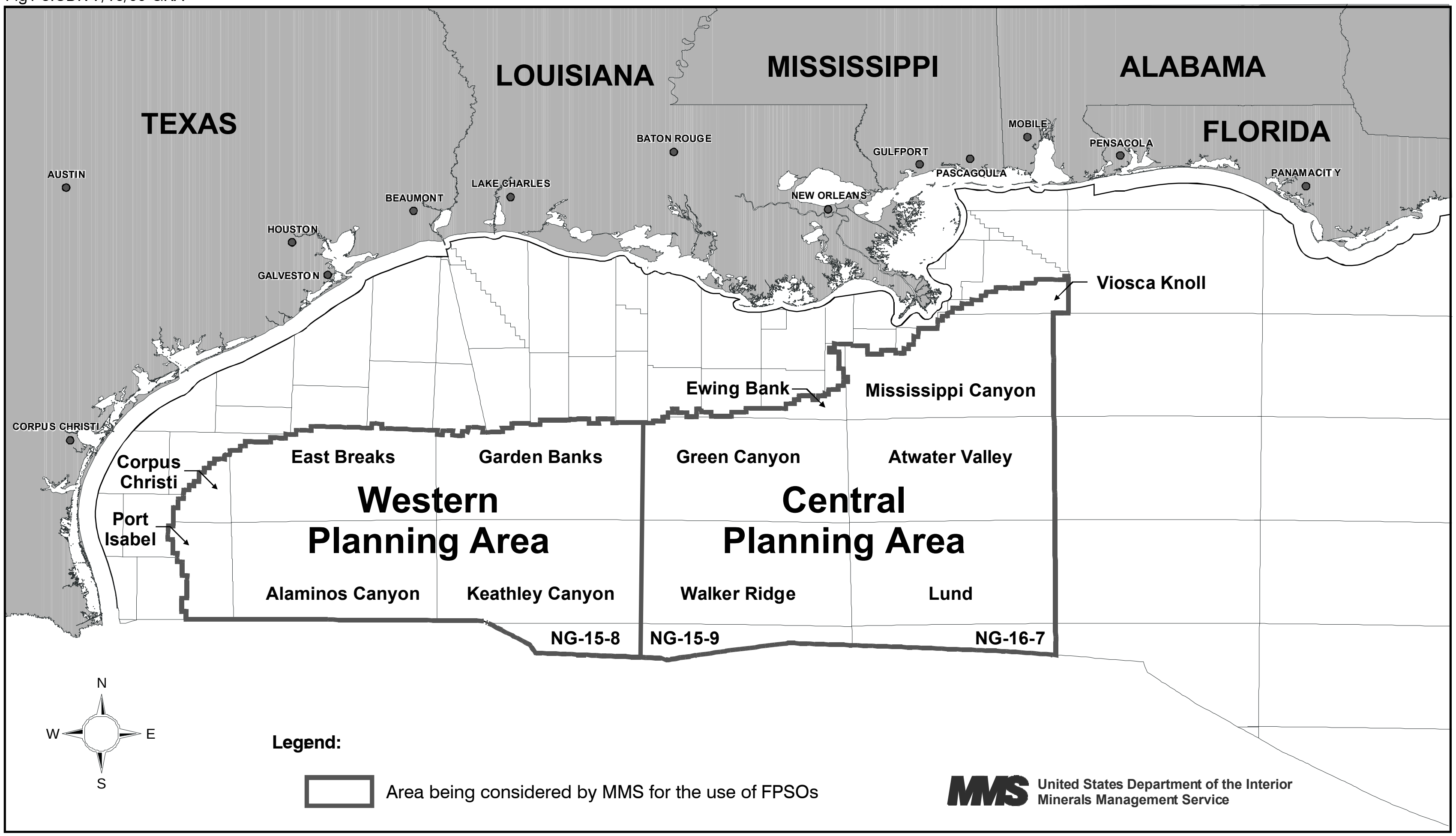

Figure 1-3 AREAS UNDER CONSIDERATION FOR USE OF FPSOs

These components and their configuration for FPSO systems, including the base-case scenario and the potential range of variations, are discussed below.

1.4.2.1 FPSO Description

The hull of an FPSO is either ship-shaped or non-ship-shaped in configuration (figures 1-4 and 1-5). A non-ship-shaped FPSO could be a spar or other purpose-built, floating facility equipped with oil storage facilities. The base-case scenario for this EIS considers a purpose-built FPSO having a ship-shaped hull. The base-case scenario FPSO would be a double-hulled vessel, including both double sides and double bottom. However, some operators may consider, and propose, a single hull or double-sided/single-bottomed hull, depending upon the applicability of the Oil Prevention Act of 1990 (OPA, 90) requirements. Although FPSOs may be designed to incorporate a propulsion system, the base-case scenario for this EIS considers an FPSO without propulsion or thruster assist.

The oil storage capacity of FPSOs operating in the deepwater areas of the GOM could range from as little as 100,000 barrels (bbls) to as much as 2.3 million bbls. The base-case scenario for this EIS considers an FPSO with an oil storage capacity of 1 million bbls (figure 1-6).

The typical existing ship-shaped FPSO can be characterized as a tanker-like vessel with dimensions ranging as follows: 600 to 1,000 feet in length; 100 to 200 feet in width; and 60 to 100 feet in height. For the base-case scenario considered in this EIS, the 1-million-bbl ship-shaped FPSO would have an overall length of 730 feet, a maximum width of 150 feet, and a height of 100 feet. In addition, the base-case FPSO would have a full-load draft of approximately 70 feet.

The FPSO vessel would be designed and constructed to comply with Coast Guard regulations. The production facilities would be designed and constructed to comply with MMS regulations.

1.4.2.2 Mooring and Stationkeeping

There are two options for FPSO stationkeeping at a deepwater production site. FPSOs would be either moored to the seafloor with mooring lines and anchors, or dynamically positioned over the production site by servo-activated thrusters and a geographic positioning system (GPS). The vast majority of existing FPSO systems employ a fixed mooring system using anchors and anchor lines (figure 1-7), and few rely on dynamic positioning systems. The base-case scenario for this EIS considers a fixed mooring system as a most likely configuration for FPSOs on the OCS.

Fixed mooring systems can be further described as either disconnectable or permanent. A few existing FPSO systems have been designed to be disconnectable under impending severe weather circumstances or approaching icebergs. However, experience has shown that both the FPSO and permanent mooring systems can be designed to withstand severe weather such as hurricanes. Consequently, most FPSOs employed to date are permanently moored, i.e., they are designed to remain at the location throughout all anticipated environmental (weather and current) conditions, including hurricanes. When considering the choice of mooring system for an FPSO, the relative risks and design requirements take into account such factors as company experience

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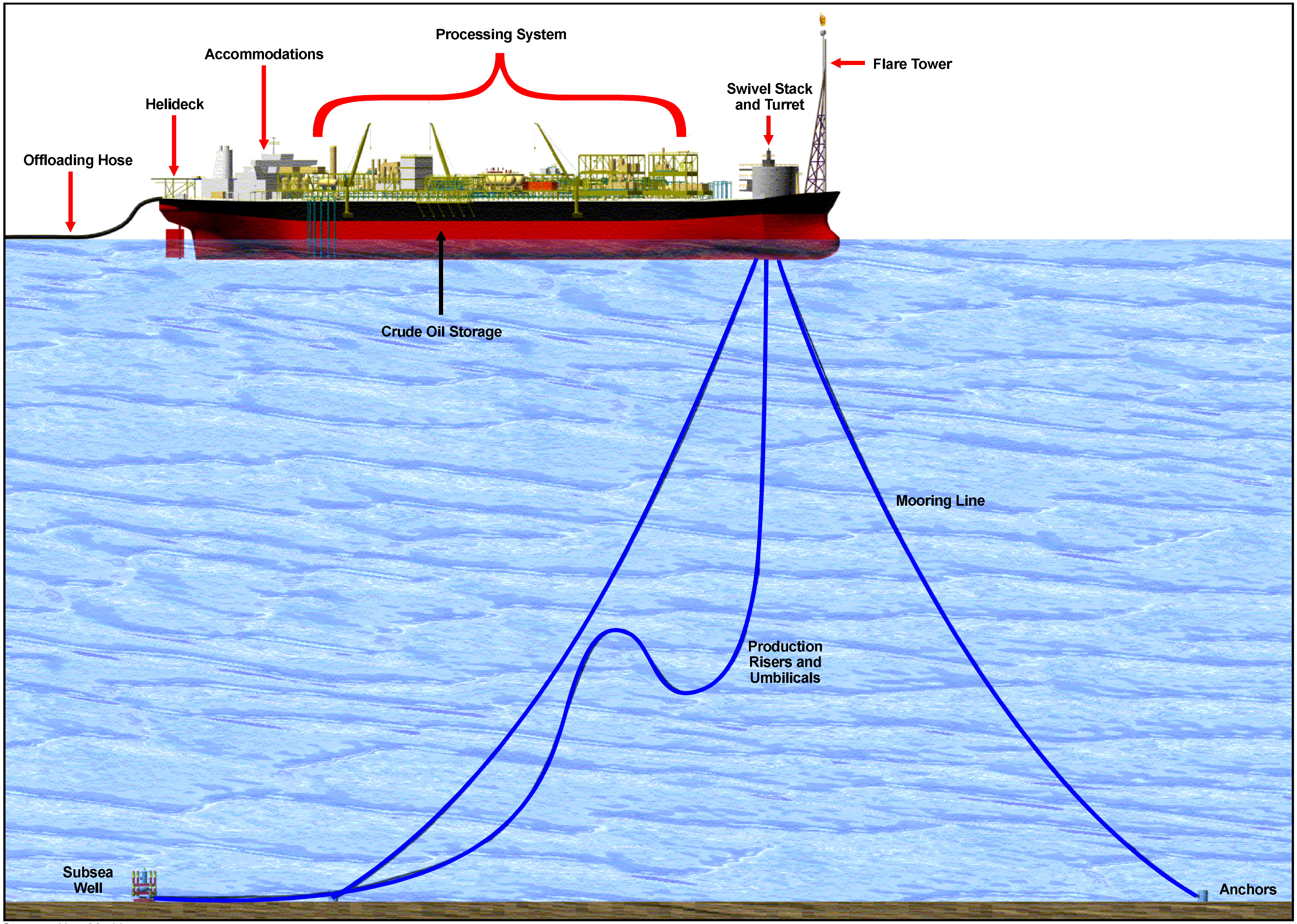

Source: Aker Maritime 2000

Figure1-4 EXAMPLE OF A SHIP-SHAPED FPSO WITH AFIXED MOORING SYSTEM

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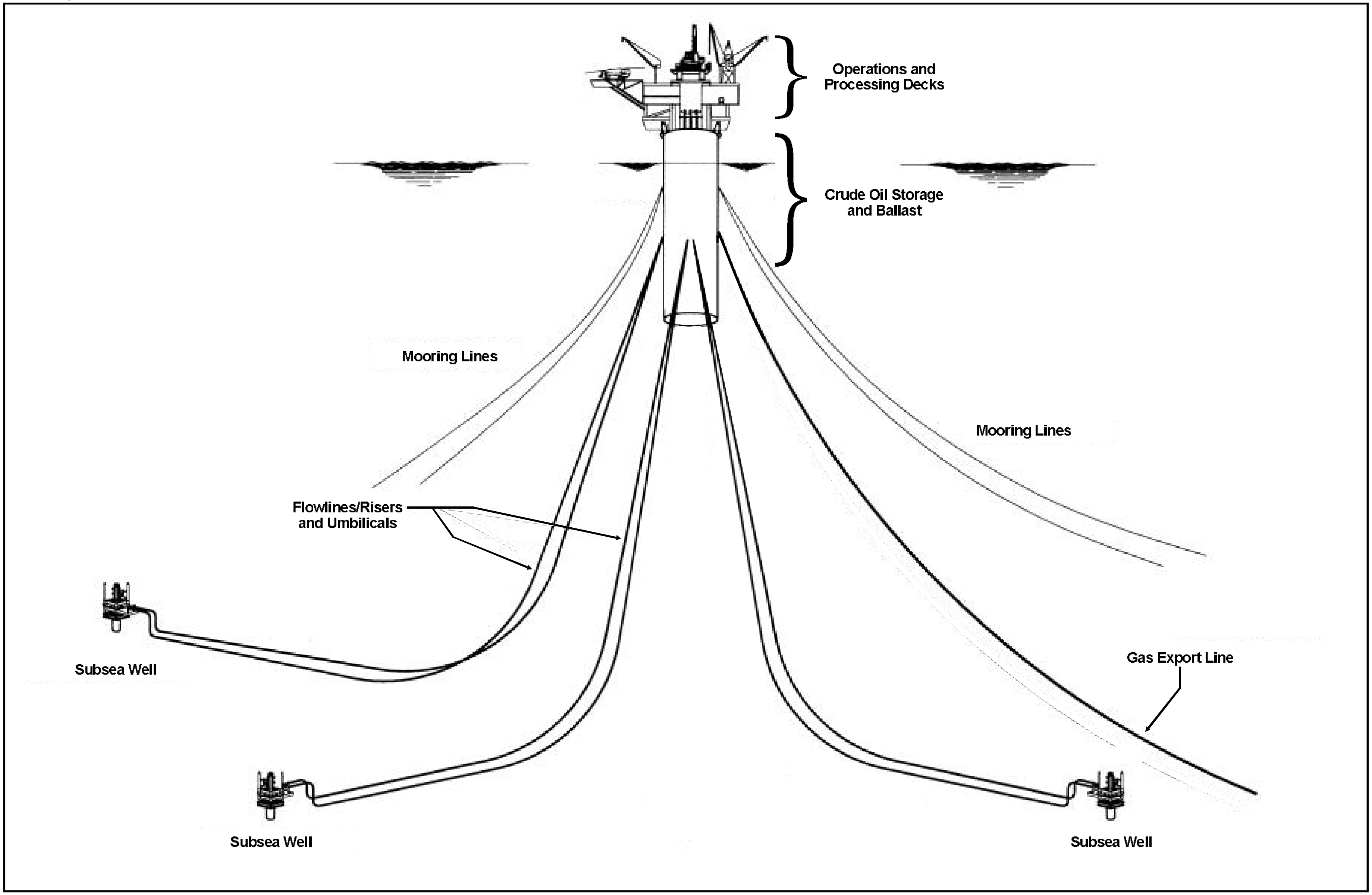

Source: Aker Maritime 2000

Figure 1-5 EXAMPLE OF A SPARE FPSO

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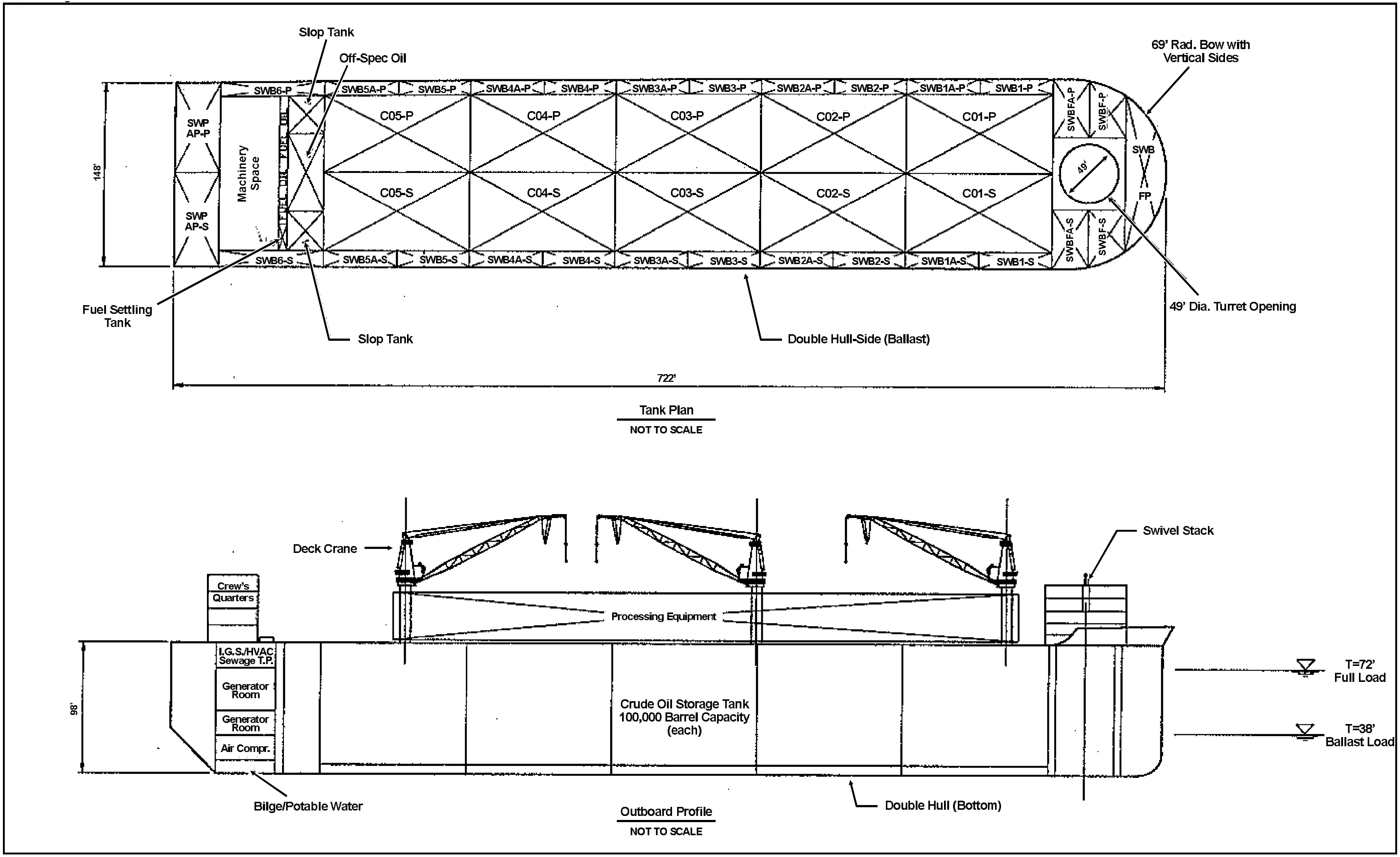

Source: Aker Maritime 2000.

Figure1-6 SCHEMATIC OF BASE-CASE SCENARIO FPSO

SOURCE: APL 1999.

Figure 1-7 EXAMPLE OF A TURRET-MOORED FPSO SYSTEM CONFIGURATION

and preferences in stationkeeping and mooring methods, water depth, environmental criteria (weather and currents), distance from shore, and economics.

Some weather systems forming in the GOM may not allow adequate time for an orderly disconnection from the mooring system and transit of the vessel to waters outside of the severe weather track. An FPSO and its moored turret system could be designed to withstand severe weather conditions and remain on station. Thus, the permanently moored turret system is considered as a most likely configuration in the base-case scenario. Nevertheless, some operators may propose a disconnectable mooring system.

FPSOs can be moored directly to the seafloor (spread-moored) or they can be moored to the seafloor from a turret that is mounted to, or integrated into, the hull of the vessel. Spread mooring has limited applications and is not considered within the range of potential mooring configurations on the OCS since there is an absence of a mild, unidirectional environment. A turret mooring system provides the means for the FPSO vessel to “weathervane,” essentially allowing the ship to pivot on the mooring system and take the position of least resistance with respect to the prevailing wind, waves, and current. In this manner, weathervaning minimizes the loading of forces imposed by the physical environment upon the vessel. While the FPSO turret mooring system provides for mooring of the vessel to the production site, it also serves as the junction point for the marriage of the production risers to the FPSO vessel.

The configurations of FPSOs deployed in the GOM could involve either a turret that is disconnectable from the FPSO vessel or a turret that is permanently integrated into the vessel. The base-case scenario for this EIS considers a turret mooring system that is permanently integrated into the FPSO vessel.

The turret of a mooring system can be located either internally or externally to the FPSO vessel (figure 1-8). For example, on some systems, the turret is mounted externally to the bow of the FPSO. The location of the turret depends on a number of factors, including the segregation of process equipment, offloading configuration, and environmental loads. As is the case with the base-case scenario for this EIS, internal turret systems are typically located just forward of midships to facilitate weathervaning.

The turret mooring system considered in the base-case scenario in this EIS provides for passive weathervaning, which allows the vessel to freely pivot according to prevailing winds, waves, and currents. Passive weathervaning of the FPSO vessel is the predominant industry practice; however, active weathervaning (using thrusters) or a combination of passive weathervaning with thruster assist may be considered an appropriate measure under certain environmental conditions and design-imposed circumstances.

Under the base-case scenario, the permanently integrated turret mooring system with passive weathervaning would enable the FPSO to remain on site in all metocean (i.e., weather and ocean) conditions up to and including 100-year return period maximum events, including:

- The 100-year wave with associated wind and current, and
- The 100-year current with associated wave and wind.

1.4.2.3 Subsea Systems

The subsea systems associated with FPSOs would be essentially the same as those associated with other deepwater production activities presently occurring on the OCS (e.g., subsea tiebacks to a fixed or floating host facility such as compliant towers, spars, or tension leg platforms). As

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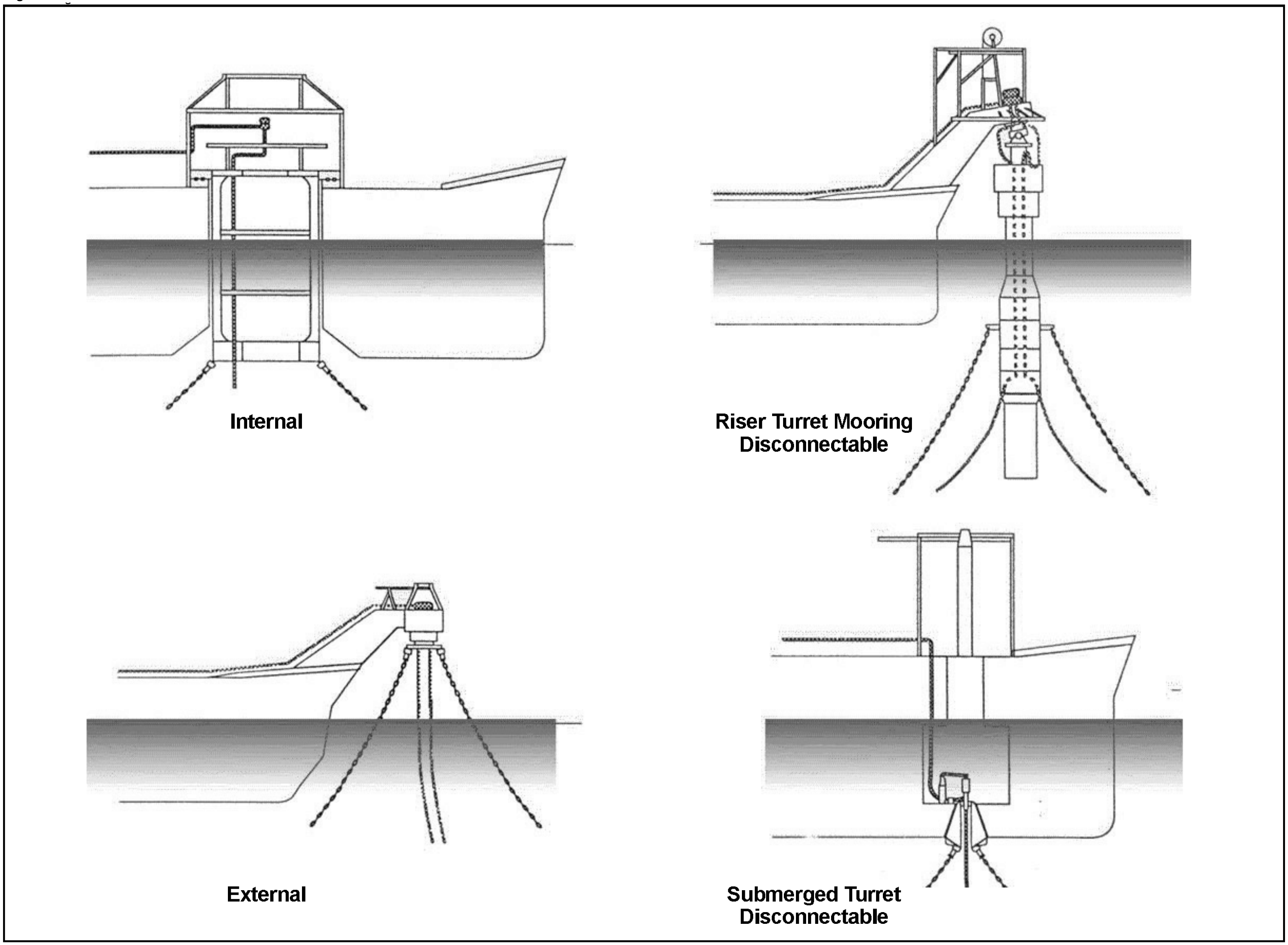

Source: Aker Maritime 2000.

Figure 1-8 EXAMPLES OF VARIOUS FPSO TURRET CONFIGURATIONS

shown on figure 1-9, the basic components of the subsea system include subsea wellhead equipment, well jumper lines, and a central subsea manifold. The well jumper lines serve to pipe hydrocarbons from individual wellheads to the central subsea manifold. The manifold, in turn, serves to connect the subsea system to the FPSOs riser system; the riser system provides the conduit to transfer produced hydrocarbons upward to the FPSO. Control umbilicals extend from the FPSO to the subsea system, allowing for operations and monitoring of the equipment on the seafloor.

For a turret-moored FPSO system, the riser is connected to the system at the turret, allowing for weathervaning of the vessel while maintaining the integrity of the riser system. The riser system would consist of production piping to transfer hydrocarbons from the subsea production equipment to the vessel, export piping to transfer produced natural gas, conduits to allow for the delivery of flow-assurance chemicals to be injected into the subsea production system piping, and control umbilicals to supply electrical and hydraulic power and to maintain and monitor subsea operations. The various piping and umbilical conduits are typically bundled within a protective, insulated casing.

1.4.2.4 Processing Systems

The processing systems and facility design for an FPSO would be essentially the same as those found on other existing deepwater production systems having a similar production rate (e.g., spars and tension leg platforms). Processing facilities are located on a raised deck above the vessel's weatherdeck (figures 1-4 and 1-6). Fluids are transferred to the processing plant from the risers through a stacked swivel transfer system on the FPSO turret. The processing plant separates the produced oil, water, and gas to obtain export-quality oil and gas. Produced water is treated to sufficient quality for discharge overboard.

Based on the assumed parameters and physical setting of a generic production field and its physical setting on the GOM OCS, a representative peak production scenario was developed as part of the base-case scenario that considers:

- 150,000 barrels of oil per day (BOPD),
- 200 million cubic feet per day (MMCFD) gas production, and
- 70,000 barrels of water per day (BWPD).

Actual field characteristics will vary from location to location. The above peak production rates are considered to be within the range of typical oil, gas, and water production rates for deepwater development on the OCS.

A swivel stack assembly at the top of the turret allows for the transfer of hydrocarbons from the risers to the processing plant on the deck of the FPSO (figure 1-10). The export gas line and control umbilicals (for subsea equipment operations) also are routed through the swivel and down through the turret to the subsea equipment. The swivel stack system prevents twisting of the pipe conduits and cables at the turret, as the FPSO may pivot more than 360 degrees as it weathervanes with the prevailing winds and currents.

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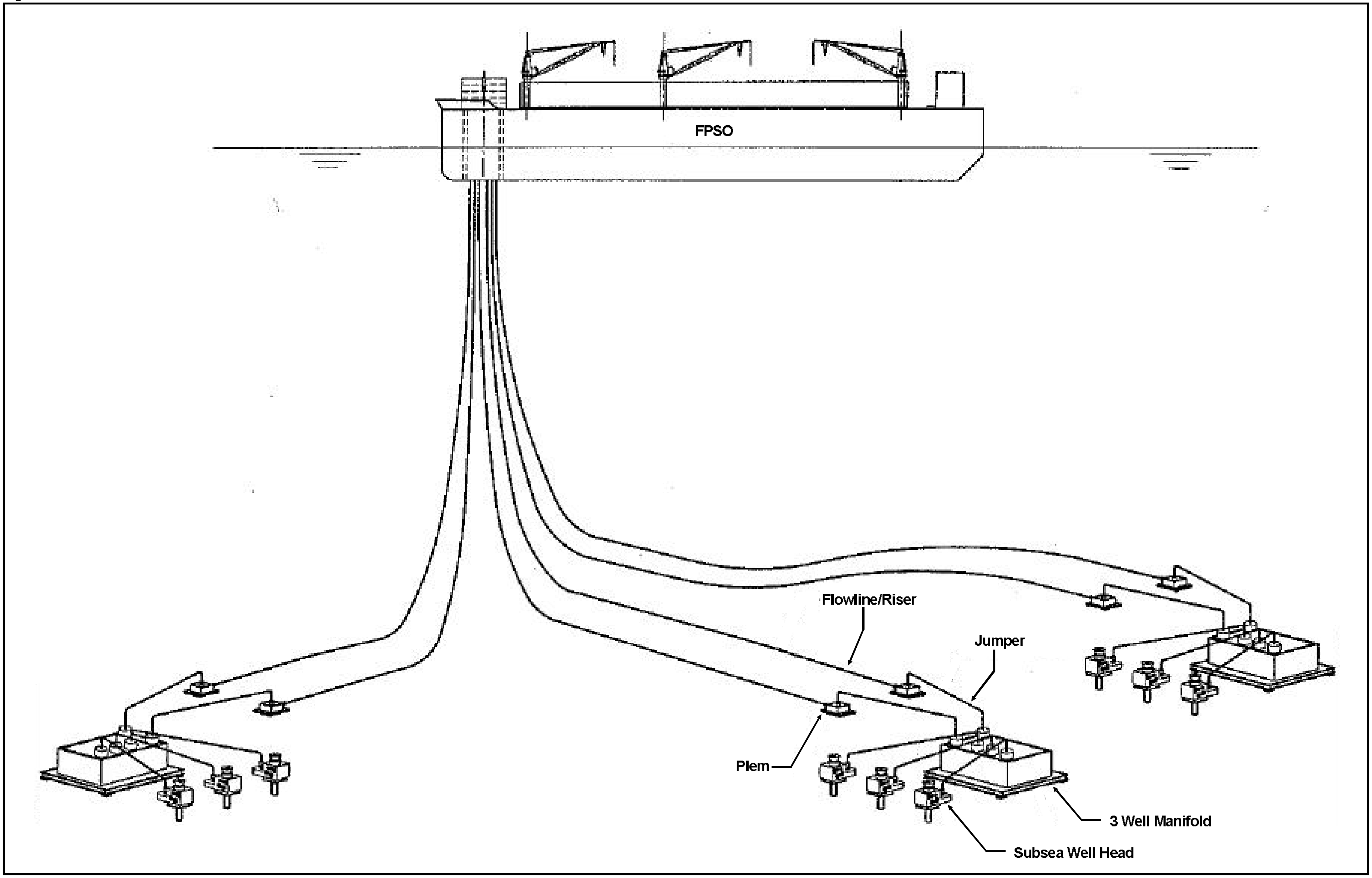

Source: Aker Maritime 2000.

Figure 1-9 SCHEMATIC OF BASE-CASE SUBSEA SYSTEM

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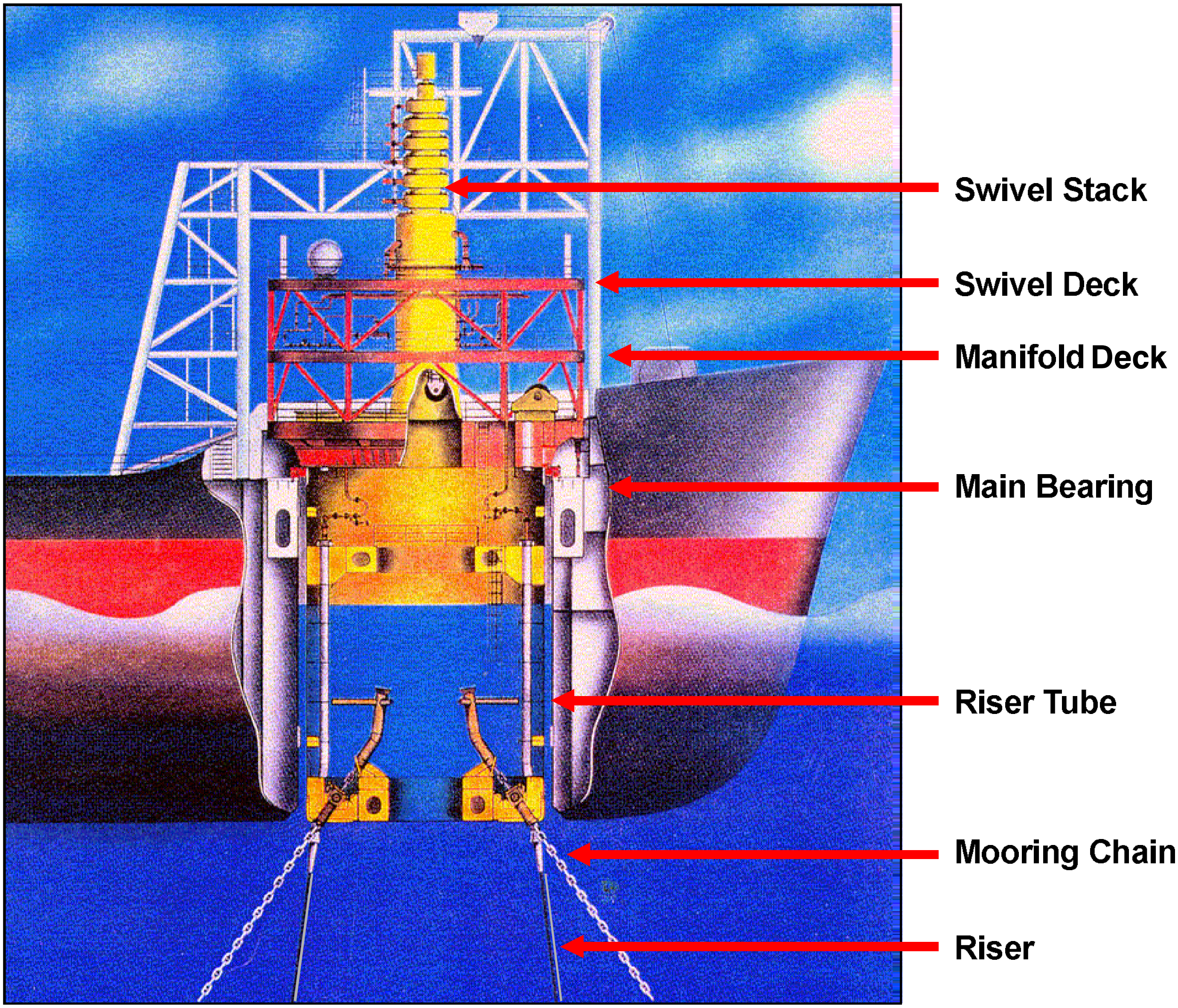

Source: Aker Maritime 2000.

Figure 1-10 DETAILED ILLUSTRATION OF EXAMPLE TURRET AND SWIVEL STACK ASSEMBLY

The base-case scenario processing systems would include a variety of components such as the following:

- Pressure vessels
- Storage tanks
- Pumps
- Generators
- Piping
- Electrical systems
- Boilers
- Compressors
- Separators
- Treatment units
- Maintenance equipment

Processed gas would be compressed and exported through piping via the swivel and riser to the export pipeline system on the seafloor for pipeline transport to shore-side processing facilities. With approval of MMS, gas may be re-injected into the formation during the FPSO operation start-up period (generally less than a year) until natural gas pipeline infrastructure is in place. Also pending MMS approval, gas may be re-injected into the formation during maintenance and repair periods (typically several days or weeks). A gas-flare system would be installed on the FPSO. Some gas volumes may be flared for shore-term periods (typically 2 to 14 days). This short-term gas flaring, when justified and approved by MMS, would be conducted as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the well bore and to provide sufficient reservoir data for the operator to justify development in the high-cost, deepwater environment. In unique circumstances with detailed justification, approval of flaring by MMS would be considered for 6- to 12-month periods. As part of routine operations, a part of the produced natural gas would be filtered and used as fuel gas for the turbine-powered generators and other equipment on the FPSO vessel.

Prior to being discharged overboard, produced water would be treated to achieve sufficient quality as to be in compliance with applicable permit requirements under Section 402 of the Clean Water Act (i.e., wastewater discharge criteria under a National Pollution Discharge Elimination System [NPDES] permit).

The drain system on the processing deck would consist of both open and closed drain systems. The open drain system would collect storm water and washdown water in the processing area and direct it to collection tanks for oil/water separation. Oil would then be routed to the slop oil tank for recycling through the processing facility. The decanted water would be discharged in accordance with NPDES requirements.

The closed drain system would collect oily fluids from various points in the processing area. The fluids would then be pumped to a slop tank for eventual recycling.

1.4.2.5 Storage Systems

FPSO vessels include storage facilities for produced and processed oil, hence the structural and visual resemblance of ship-shaped FPSO vessels to an oil tanker. The sizing of storage capacity for an FPSO depends on several factors, including the characteristics of one or more fields where operations are anticipated, the expected rate of production, and other design factors and operator preferences. The storage capacity of FPSOs operating in the GOM could, from a design standpoint, range from approximately 100,000 bbls to 2.3 million bbls. The base-case scenario for this EIS considers a ship-shaped FPSO with a capacity of 1 million bbls divided among ten 100,000-barrel storage tanks within the hull of the FPSO (figure 1-6). The base-case scenario also considers the following components and operational characteristics of an FPSO storage system as a likely scenario for GOM operations:

- Processed oil would be transferred from the processing facility to storage tanks via an on-deck loading manifold. The manifold would have drop lines dedicated to the receiving oil tanks and a connection to an in-tank suction header. Export-quality (on-spec) oil can be transferred to any of the 10 oil storage tanks using cargo pumps and the on-deck loading header, if required, for load distribution.
- Non-export-quality (off-spec) oil would be transferred to a dedicated off-spec oil storage tank via the on-deck loading header.
- Off-spec water would be transferred to an off-spec water storage tank. A separate loading line would be installed, as there may be on-spec oil produced simultaneously with the off-spec water.
- Slop tank(s) for storage of oily waste materials would be located at the aft end of the cargo compartment.
- Off-spec oil and off-spec water will be re-run through the processing facilities to achieve on-spec products. Additional pumps would be installed to transport the off-spec products from the storage tanks to the processing system.
- The cargo system would be designed to enable isolation of any tanks for inspection and repair.
- All cargo tanks and the fuel storage tanks would be capable of being maintained in an inert, pressurized condition at all times except when the need to enter a tank arises. The inert-gas system and ventilation system would be designed to allow for gas freeing of any cargo tank while production is maintained.
- The cargo transfer piping would be arranged to enable transfer of cargo between any cargo tanks while production is maintained. Production would continue during offloading operations.
- Provisions would be made for flushing the offloading hose with seawater, discharging into the shuttle tanker, after completion of offloading operations.

Because Coast Guard considers FPSOs to be tank vessels, OPA 90 double-hull requirements are incorporated as part of the base-case scenario (discussed further in Section 1.5.3).

1.4.2.6 Offloading Systems

FPSOs temporarily store processed oil on location until the cargo can be transferred to a shuttle tanker. The objective is to transfer, safely and efficiently, the oil cargo of an FPSO to a shuttle tanker that is equipped, capable, and of the appropriate size and draft for safely entering terminals and refinery ports along the U.S. GOM coast.

For FPSO operations, offloading configurations can vary depending upon the FPSO stationkeeping method, environmental conditions, and other design factors. In the GOM, potential FPSO/shuttle tanker offloading configurations include tandem, side-by-side, and remote buoy-based offloading systems. In tandem offloading, the shuttle tanker is positioned at a safe distance with its bow generally in line with the stern of the FPSO. Side-by-side offloading puts the FPSO and shuttle tanker in a parallel orientation. Buoy-based systems involve extending the offloading pipeline from the FPSO to a moored buoy station at a distant location, which in turn provides a fixed offloading point of operations for shuttle tankers. In the GOM, and for the weathervaning FPSO associated with the moored-turret configuration in the base-case scenario, the tandem offloading is the most likely configuration. In effect, the entire operation, including both vessels, would weathervane from the same moored-turret system (figure 1-11).

Based on the assumptions used to determine generic field development, production rate estimates, and FPSO fluid processing and storage capacities, the base-case scenario for this EIS considers the following to be a likely offloading configuration in the GOM:

- The tandem offloading system would be capable of offloading 50,000 barrels per hour (BPH) to a shuttle tanker moored to the stern of the FPSO. Offloading frequency would range from once in 10 days to as high as once every three days during peak production.
- Cargo oil would be offloaded by the FPSO's main cargo pumps through a deck line to a stern offloading station, and then through a retractable hose to the loading manifold of the shuttle tanker. The shuttle tanker would be moored to the bow, approximately 80 meters (260 feet) astern of the FPSO by means of a single hawser.
- Safety features such as marine break-away offloading hoses and emergency shut-off valves would be incorporated in order to minimize the potential for, and size of, oil spills.
- In accordance with Coast Guard regulations, a detailed design of the offloading assembly and the site-specific offloading procedure would be submitted for approval.

1.4.2.7 Shuttle Tankers

As described above, shuttle tankers are used to transport processed crude oil produced by FPSO systems. Under the Jones Act and OPA 90 requirements, shuttle tankers would be required to be double hulled. Shuttles can have internal propulsion systems, or they may use other propulsion system configurations, such as an articulated tug barge (ATB). ATBs involve the connectable/disconnectable integration of a tug-type vessel to a recess in the stern of a large-capacity barge. Shuttle tankers also vary in size. In the GOM, the maximum size of shuttle tankers is limited primarily by the 34- to 47-foot water depths of U.S. Gulf coast refinery ports. Due to these depth limitations, shuttle tankers larger than 500,000 bbls in cargo capacity would likely be limited by physical constraints for port access. The base-case scenario for this EIS considers a 500,000-bbl capacity shuttle tanker as a likely means of transporting oil cargo in GOM FPSO operations.

Shuttle tankers operating in conjunction with FPSOs in the GOM could maintain their station during FPSO offloading operations using several techniques. These include side-by-side mooring to the FPSO, use of a hawser mooring system with or without thruster assist, or by use of a dynamic positioning system that maintains the vessel's station by use of thrusters rather than mooring lines. As described in the previous section, the base-case scenario for this EIS considers hawser mooring systems used in a tandem offloading configuration (shown in figure 1-11) as the most likely scenario for FPSO operations in the GOM. During the FPSO offloading procedure, the shuttle tanker would continue to operate its engines in an idle mode so that any necessary maneuvers of the vessel could be promptly executed.

The shuttle tanker design and systems would be in compliance with Coast Guard regulations. The MMS assumes that shuttle tankers would be constructed in the United States in compliance with the Jones Act.

The base-case scenario considers the following refinery ports as being likely destinations for shuttle tankers transporting crude oil cargo from FPSO operations in the U.S. GOM: Corpus Christi, Freeport, Port Arthur/Beaumont, and Houston/Galveston, Texas; and Lake Charles, the lower Mississippi River, and the Louisiana Offshore Oil Port, Louisiana.

1.4.2.8 Manning and Accommodations

The likely configuration of an FPSO operating in the GOM as defined for the base-case scenario for this EIS would require a compliment of 40 crew and operations personnel. Table 1-1 provides a breakdown of the personnel and onboard duties. Personnel would be rotated to shore by helicopter every 14 days.

Accommodations for shipboard personnel, including central operations and living space, would be located either fore or aft of the processing deck systems and turret, swivel, and flare tower systems. For the base-case scenario, permanent accommodations would be provided for 70 personnel at the aft end of the vessel (figures 1-4 and 1-6). Quarters and living space would be provided for the normal manning level of 40 personnel and for 30 temporary service personnel and visitors. Monitoring and control of the cargo and ballast tanks would be done from within the accommodations.

1.4.2.9 Other Systems

The Central Control Center (CCC) would be located within the accommodations block and includes the process control and monitoring systems, fire and gas panels, and other systems essential to process operations. The CCC would be equipped with alarms and a manually initiated gas system for fire situations. The CCC and its process control system are considered part of the Temporary Safe Refuge (TSR).

The TSR would be integrated with the personnel accommodations and would provide sufficient space within which the full compliment of personnel onboard the FPSO can obtain temporary refuge during emergencies such as those associated with fire or gas releases. The TSR would provide a breathable air supply, access to lifeboats, lifesaving equipment, communications equipment, gas detectors, firefighting gear, and other necessary features. All emergency facilities would be in accordance with Coast Guard requirements.

Lifesaving equipment onboard the FPSO, including lifeboats and davits, rescue boats, liferafts, lifesaving appliances, and fire protection, would be in accordance with Coast Guard requirements.

Fire-fighting systems onboard the FPSO would be in accordance with Coast Guard requirements and would consist of the following:

- Fire water main (sea water),
- Fire pumps and hose stations,
- Foam fire fighting systems,
- Fixed gaseous fire fighting systems,
- Fire walls and breaks,

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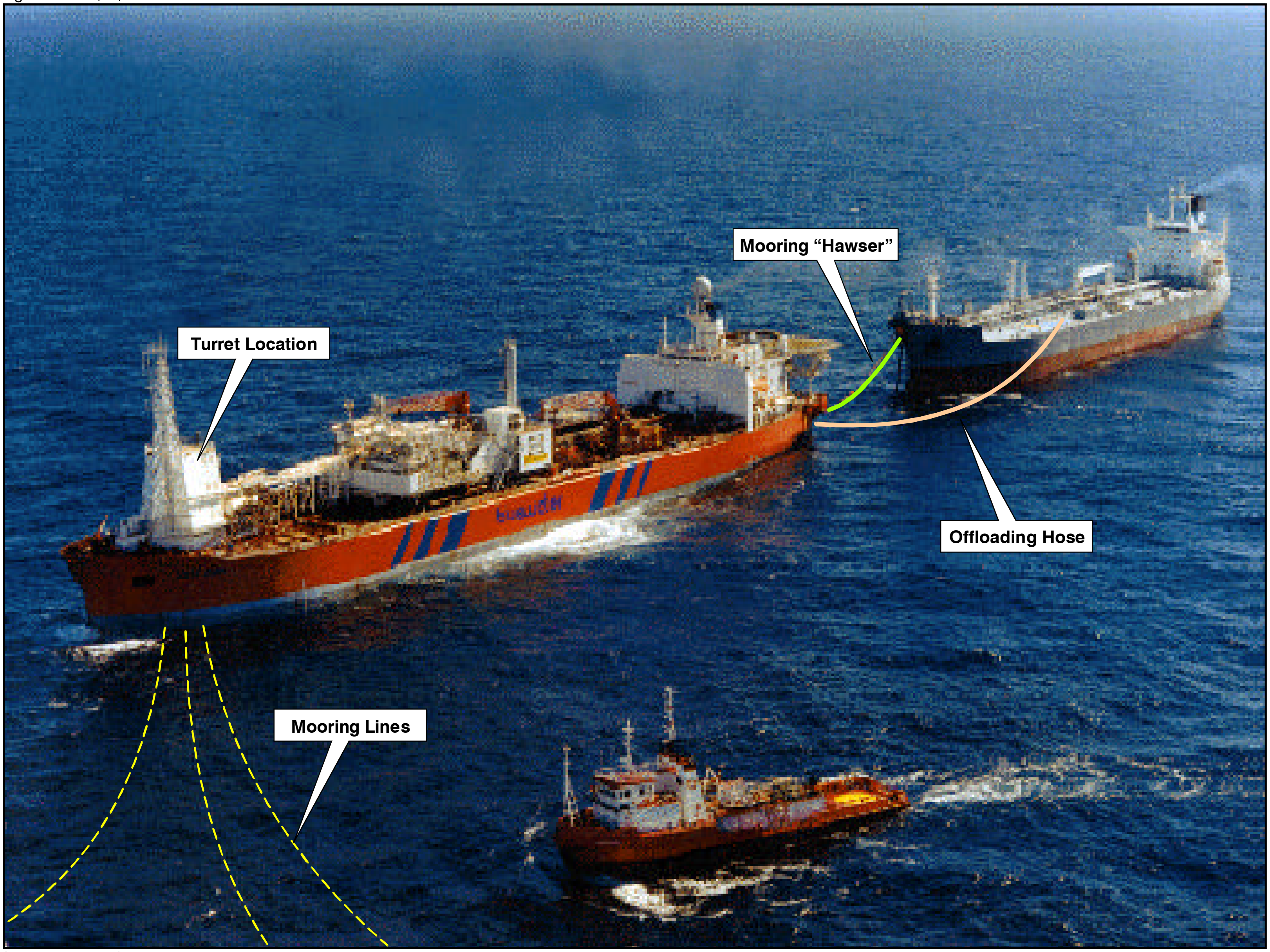


Source: Adapted from Bluewater 1999.

Figure 1-11 FPSO TANDEM OFFLOADING CONFIGURATION

Table 1-1

Manning of the Base-case Scenario FPSO

Operation /Job	Number of Personnel
Offshore Installation Manager	1
Operations Coordinator	1
Operations Personnel	11
Multi-skill Personnel (Operations and Marine)	9
Marine Operations Personnel	8
Housekeeping	6
Shore-base Duties	4
Temporary Personnel/Visitors	30
Total Personnel	70

- Portable fire-fighting appliances,
- Helideck fire-fighting system,
- Accommodations sprinkler system, and,
- Process deluge system.

Deck cranes and hoists would be installed on the deck of the FPSO for the loading and unloading of materials and equipment, and to support maintenance operations onboard the vessel.

A helideck able to accommodate a Sikorsky S-61N or comparable helicopter would be located on the FPSO, likely directly aft of accommodations. The helideck would be designed in accordance with Coast Guard requirements.

1.4.3 Operations

1.4.3.1 Installation

Installation of an FPSO system at a production site on the OCS would involve a series of separate but interrelated steps. The subsea wells would be drilled, and wellheads, manifolds, flowlines, umbilicals, and other subsea production equipment would be installed. The array of mooring system anchors and anchor lines would be emplaced. The FPSO would then be towed to the production site and connected to the mooring system. The flowline risers, umbilicals, and gas export line would be connected to the FPSO at the turret.

For purposes of identifying and describing the impact-producing factors associated with FPSO installation activities, Section 4.1.1 presents a more detailed description of the installation activities that would occur for the base-case scenario FPSO system.

1.4.3.2 Routine Operations

Operation of an FPSO system involves the following:

- Monitoring and operating subsea wells for the production of hydrocarbons;
- On-board processing of the produced oil, gas, and water;
- On-board temporary storage of the processed crude oil;
- Export of the produced gas by pipeline to inshore terminals or processing plants;
- Treatment of produced water to NPDES permit standards for overboard discharge;
- Offloading of crude oil from FPSO storage tanks to shuttle tankers; and,
- Shuttle tanker transport of oil to deepwater terminals or refinery ports.

Section 1.4.2 describes each of the FPSO system components for the base-case scenario, including their configurations and operation. Many aspects of an FPSO operation are essentially the same as those associated with other deepwater production facilities (i.e., spars, large tension-leg platforms and semi-submersibles) in the GOM. However, unlike other deepwater production facilities, FPSOs involve onboard storage of large volumes of crude oil, offloading of crude oil to shuttle tankers, and shuttle tanker transport (as opposed to pipeline transport) of crude oil to terminals and refinery ports.

Well maintenance and workover activities would be expected to occur on a periodic basis, just as they would with other deepwater production facilities. Workover and well-maintenance operations would be conducted from a separate floating drilling unit or some type of intervention vessel.

Section 4.1.2 presents a detailed discussion of the base-case scenario FPSO system's routine operations for purposes of identifying and describing the impact-producing factors associated with those routine operations.

1.4.3.3 Decommissioning

Decommissioning an FPSO system involves removal or in-place abandonment of all production site structures and equipment, including removing the FPSO vessel from the field, either for salvage or for reuse at another field. Components such as jumpers, risers, mooring lines, anchors, manifolds, and some wellhead equipment (subsea trees) would be retrieved for salvage. Flowlines, pipelines, and umbilicals would be cleaned, capped, and abandoned on the sea floor. Subsea wells would be plugged and abandoned in accordance with MMS regulations.

Section 4.1.3 presents a detailed discussion of the base-case scenario FPSO decommissioning activities for purposes of identifying and describing the impact-producing factors associated with these activities.

1.5 Regulatory and Administrative Framework

1.5.1 Applicable Federal Laws and Policies

The Outer Continental Shelf Lands Act

Under the Outer Continental Shelf Lands Act (OCSLA), the Department of the Interior is required to:

- Manage the orderly leasing, exploration, development, and production of oil and gas resources on the Federal OCS;
- Ensure the protection of the human, marine, and coastal environments;
- Ensure that the public receives a fair and equitable return for these resources; and
- Ensure that free-market competition is maintained.

Within the U.S. Department of Interior, MMS is charged with the responsibility of managing and regulating the development of OCS oil and gas resources in accordance with the provisions of the OCSLA. The MMS operating regulations are presented in Chapter 30, Code of Federal Regulations (CFR), Part 250. The MMS responsibilities and procedures in this regard are described in Section 1.5.2.

In accordance with the OCSLA (43 U.S.C. 1354) and the Export Administration Act of 1969 (50 App U.S.C. 2405(d), oil that is produced on the U.S. OCS must go to a U.S. port.

The National Environment Policy Act and the Council on Environmental Quality

NEPA requires all Federal agencies to use a systematic, interdisciplinary approach to protection of the human environment. Such an approach ensures the integrated use of natural and social sciences in any planning and decision making that may have an impact on the environment. The NEPA also requires the preparation of a detailed EIS on any major Federal action that may have a significant impact on the environment. The EIS must address any adverse environmental effects that cannot be avoided or mitigated, alternatives to the proposed action, the relationship between short-term resources and long-term productivity, and irreversible and irretrievable commitments of resources.

In 1979, the Council on Environmental Quality (CEQ) established uniform procedures for implementing the procedural provisions of NEPA. These regulations provide for the use of the NEPA process to identify and assess reasonable alternatives to proposed actions that avoid or minimize adverse effects of these actions upon the quality of the human environment. AScoping@ is used to identify the scope and significance of important environmental issues associated with a proposed Federal action through coordination with Federal, State, and local agencies; the general public; and any interested individual or organization prior to the development of an impact statement. The process also identifies and eliminates from further detailed study issues that are not significant or that have been covered by prior environmental review.

The Marine Mammal Protection Act

Under the Marine Mammal Protection Act (MMPA) of 1972, the Secretary of Commerce is responsible for the protection of all cetaceans and pinnipeds (except walruses) and has delegated authority for implementing the MMPA to the National Marine Fisheries Services (NMFS). The Secretary of the Interior is responsible for walruses, polar bears, sea otters, manatees, and dugongs and has delegated responsibility to USFWS for providing overview and advice to the responsible regulatory agencies on all Federal actions bearing upon the conservation and protection of these marine mammals.

The MMPA established a moratorium on the taking of marine mammals in waters under U.S. jurisdiction. The Act defines Atake@ to mean “hunt, capture, or kill or attempt to harass, hunt, capture, or kill any marine mammal.@ “Harassment@ is defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild (level A); or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (level B). The moratorium may be waived when the affected species or population stock is within its optimum sustainable population range and would not be disadvantaged by the authorized taking, e.g., be reduced below its maximum net productivity level, which is the lower limit of the optimum sustainable population range. The Act directs the Secretary, upon request, to authorize the unintentional taking of small numbers of marine mammals incidental to activities other than commercial fishing (e.g., offshore oil and gas exploration and development) when, after notice and opportunity for public comment, the Secretary finds that the total of such taking during the 5-year (or less) period would have a negligible impact on the affected species.

The Act also specifies that the Secretary shall withdraw, or suspend for a specified period of time, permission to take marine mammals incidental to oil and gas production, and other activities if the applicable regulations regarding methods of taking, monitoring, or reporting are not being complied with, or the taking is having, or may be having, more than a negligible impact on the affected species or stock.

In 1994, a new subparagraph (D) was added to Section 101(a)(5) to simplify the process of obtaining Asmall take@ exemptions when unintentional taking is by incidental harassment only. Specifically, the incidental take of small numbers of marine mammals by harassment can now be authorized for periods of up to one year without rulemaking, as required by Section 101(a)(5)(A), which remains in effect for other authorized types of incidental taking.

In October 1995, NMFS issued regulations authorizing and governing the taking of bottlenose and spotted dolphins incidental to the removal of oil and gas drilling and production structures in state waters on the GOM OCS for a period of 5 years. Letters of authorization must be requested by and issued to individual applicants to conduct the activities (platform removals) pursuant to the regulations.

To ensure that activities on the OCS adhere to MMPA regulations, MMS must actively seek information concerning impacts of OCS activities on local species of marine mammals.

Since 1986, MMS, the U.S. Army Corp of Engineers, and OCS operators have been following strict NMFS recommendations to prevent adverse impacts on endangered marine turtles and avoid the incidental taking of marine mammals.

The Magnuson - Stevens Act of 1976

The Magnuson - Stevens Act of 1976 (MFCMA) (16 U.S.C. 1801-1882) established and delineated an area from the States= seaward boundary to approximately 200 nautical miles (nmi) out as a fisheries conservation zone for the United States and its possessions. The Act created eight regional Fishery Management Councils (FMCs) and mandated a continuing planning program for marine fisheries management by the FMCs. The Act, as amended, requires that a Fishery Management Plan (FMP) based upon the best available scientific and economic data be prepared for each commercial species (or related group of species) of fish that is in need of conservation and management within each respective region.

The Act was reauthorized by Congress through passage of the Sustainable Fisheries Act of 1996. The reauthorization implements a number of reforms and changes, including some that are specific to the GOM. Three new standards were added to the seven existing standards. These new standards consider fishing communities, by-catch, and human safety at sea. Changes specific to the GOM concern the red snapper fishery: the previously approved individual transfer quota system is repealed; preparation of any information or plan pertaining to any individual transfer quota system is prohibited; and the stock=s assessment and associated information will receive a number of independent peer reviews.

When Congress reauthorized the Act in 1996, several reforms and changes were realized. For example, one change required the NMFS to designate and conserve Essential Fish Habitat (EFH) for species managed under an existing FMP. The intentions of such changes are to minimize, to the extent practicable, any adverse effects on habitat caused by fishing or nonfishing activities and to identify other actions to encourage the conservation and enhancement of such habitat. The phrase “essential fish habitat” as defined in the Sustainable Fisheries Act encompasses “those waters and substrate necessary to fishes for spawning, breeding, feeding, or growth to maturity.”

EFH present within the central and western GOM fall under the jurisdiction of the Gulf of Mexico Fishery Management Council (GMFMC). In addition to this regional council, the NMFS Highly Migratory Species Management Division, Office of Sustainable Fisheries, manages Atlantic tunas, swordfish, and sharks within a broad geographic region that encompasses the GOM (NMFS, 1999b). Both documents were reviewed for this characterization and assessment.

To date, nine FMPs have been implemented in the GOM. The FMP for shrimp was implemented in 1981; for stone crab, in 1982; for spiny lobster, in 1982; for coastal pelagic fish, in 1983; for coral, in 1984; for reef fish, in 1984; for swordfish, in 1985; for red drum, in 1987; and for sharks, in 1982 (Justen, 1992). FMPs are amended and updated as new information from studies and public input is received and assessed.

MMS will enter into formal consultation with NMFS for EFH as part of this EIS process.

The Endangered Species Act

The Endangered Species Act of 1973, as amended, establishes protection and conservation of threatened and endangered species and the ecosystems upon which they depend. The Act is administered by FWS and NMFS. Section 7 of the Act governs interagency cooperation and consultation. The MMS formally consults with NMFS and FWS to ensure that activities on the OCS under MMS jurisdiction do not jeopardize the continued existence of threatened or endangered species and/or result in adverse modification or destruction of their critical habitat. As a part of the process for developing this EIS, MMS will complete Section 7 consultation with both FWS and NMFS regarding the proposed use of FPSOs in the Western and Central Planning Areas of the GOM OCS.

The FWS and NMFS make recommendations regarding modifications of oil and gas operations to minimize adverse environmental impacts; however, it remains the responsibility of MMS to ensure that proposed actions do not impact threatened or endangered species

The Marine Protection Research, and Sanctuary Act

The Marine Protection, Research, and Sanctuaries Act of 1972 established the National Marine Sanctuary Program, which is administered by the National Oceanic and Atmosphere Administration (NOAA) of the Department of Commerce. The Flower Garden Banks National Marine Sanctuary (NMS) was designated in 1992. The Department of the Interior has taken action to protect the biological resources of the blocks wholly underlain by the Flower Garden Banks (Blocks A-375 and A-398 in High Island Area, East Addition, South Extension, which are excluded from leasing). The MMS has also established a ANo Activity Zone@ around the Flower Garden Banks and has established other operations restrictions as described in the Topographic Features Stipulation. Stetson Bank was added to the Flower Garden Banks NMS in 1996 and is currently protected by a ANo Activity Zone.@

The Oil Pollution Act

OPA 90 establishes a single uniform Federal system of liability and compensation for damages caused by oil spills in U.S. navigable waters. OPA 90 requires removal of spilled oil and establishes a national system of planning for and responding to oil spill incidents. OPA 90 includes provisions to (1) improve oil-spill prevention, preparedness, and response capability; (2) establish limitations on liability for damages resulting from oil pollution; (3) provide funding for natural resource damage assessment; (4) implement a fund for the payment of compensation for such damages; and (5) establish an oil pollution research and development program. The Secretary of Interior is given authority over offshore facilities and associated pipelines (except deepwater ports) for all Federal and State waters, including responsibility for spill prevention, oil-spill contingency plans, oil-spill containment and clean-up equipment, financial responsibility certification, and civil penalties. The Coast Guard is responsible for enforcing vessel compliance with OPA 90.

The Clean Water Act

The Federal Water Pollution Control Act (FWPCA) of 1972, as amended, commonly referred to as the Clean Water Act (CWA), authorizes the USEPA to issue National Pollutant Discharge Elimination System (NPDES) permits to regulate discharges into waters of the United States. On March 4, 1993, the USEPA issued revised Effluent Limitations Guidelines and New Source Performance Standards that set more restrictive conditions than were previously applied to discharges on the OCS. These limitations and standards are now being incorporated into GOM NPDES permits, which in turn, place further conditions on discharges to reduce biological impacts.

USEPA, Region 6, has jurisdiction for NPDES permitting in the area being considered for the proposed use of FPSOs. Region 6 issued its Final NPDES permit for new and existing sources in offshore waters of the western portion of the GOM in November 1998 (63 FR 58722), and a subsequent modification was issued on April 19, 1999 (64 FR 19156). Under this permit, new sources (in the offshore subcategory of the oil and gas extraction point source category) are allowed to discharge produced water. Limits based on ocean discharge criteria are included in the permit to ensure compliance with Section 403(c) of the Clean Water Act. For the proposed use of FPSOs, produced water discharges will be regulated either under the general NPDES permit current at the time or under an individual NPDES permit (this is to be determined by USEPA).

The Clean Air Act

The Clean Air Act (CAA), as amended, delineates jurisdiction of air quality between the USEPA and DOI. For OCS operations in the GOM, those west of 87.5EW. longitude are subject to MMS air quality regulations; operations east of 87.5EW. longitude are subject to USEPA air quality regulations.

Under the CAA, the Secretary of the Interior is required to consult with the Administrator of the USEPA onshore areas "to assure coordination of air pollution control regulations for OCS emissions and emissions in adjacent onshore areas." The MMS established 30 CFR 250.302, 250.303, and 250.304 to comply with the CAA. The regulated pollutants include carbon monoxide, particulates, sulfur dioxide, nitrogen oxides, and volatile organic compounds (as a precursor to ozone). In areas where hydrogen sulfide may be present, operations are regulated by 30 CFR 250.67. The above regulations allow for the collection of information about potential sources of pollution for the purpose of determining whether the projected emissions of air pollutants from a facility could result in ambient onshore air pollutant concentrations above maximum levels provided in the regulations. These regulation also stipulate appropriate emissions controls deemed necessary to prevent accidents and air quality deterioration.

MMS expects that the general conformity rule at 40 CFR Part 93, Subpart B would be applicable for approval of site specific development proposals involving shuttle tanker offloading of crude oil in GOM refinery ports and terminals. The rule requires that responsible agencies (Federal agencies conducting or permitting an action) must ensure that proposed activities do not interfere with state(s) implementation plan(s) (SIP[s]) for air quality attainment. As this EIS is a programmatic document addressing a generic FPSO system, the MMS believes that a conformity analysis is not appropriate at this programmatic stage. If an OCS Plan for an FPSO with tankering of OCS-produced oil to a port or ports affected by a SIP is submitted to the MMS, a conformity analysis will be required in support of the MMS review and decision process. Consultation and coordination with the affected state(s) would occur in conjunction with the conformity analysis.

The Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) provides a framework for the safe disposal and management of hazardous and solid wastes. Most oil-field wastes have been exempted from coverage under RCRA=s hazardous waste regulations. Any hazardous wastes generated on the OCS that are not exempt must be transported to shore for disposal at a hazardous waste facility. Exempt wastes taken from the GOM OCS for disposal are regulated in Texas, Louisiana, and Mississippi.

The Marine Plastic Pollution Research and Control Act

The Marine Plastic Pollution Research and Control Act (MPPRCA) of 1987 implements Annex V of the International Convention of the Prevention of Pollution from Ships (MARPOL). The GOM has received ASpecial Area@ status under MARPOL, thereby prohibiting the disposal of all solid waste into the marine environment. Fixed and floating platforms, drilling rigs, manned productions platforms, and support vessels operating under a Federal oil and gas lease are required to develop Waste Management Plans and to post placards reflecting discharge limitations and restrictions.

The Coastal Zone Management Act

Pursuant to the Coastal Zone Management Act (CZMA) and the Coastal Zone Reauthorization Amendments of 1990, all Federal activities must be consistent to the maximum extent practicable with the enforceable policies of each affected State=s coastal zone management (CZM) program. Each State=s CZM program sets forth objective, policies, and standards regarding public and private use of land and water resources in the coastal zone.

A State with an approved CZM plan reviews Development Operations Coordination Documents (DOCDs) to determine whether the proposed activities are consistent with that State's CZM plan. The MMS may not issue a permit for activities described in a plan unless the State concurs, or is conclusively presumed to have concurred, that the plan is consistent with its CZM plan.

The MMS:s GOM OCS Region sends copies of DOCDsCincluding the consistency determination and other necessary informationCto the designated State CZM agency. If no State-agency objection is submitted by the end of the review period, MMS shall presume consistency concurrence has been received from the State. The MMS:s Gulf Region may then approve any permit for activities describe in the plan. If the Gulf Region receives a written objection from the State, the Region will not approve any permit for the activity until consistency of the activity with the State's CZM is achieved. The Gulf Region does not impose or enforce additional State conditions when issuing permits, but it can require modification of a plan if the operator has agreed to requirements requested by the State.

Ports and Waterways Safety Act

The Ports and Waterways Safety Act (33 U.S.C. 1223) authorizes Coast Guard to designate safety fairways, fairway anchorages, and traffic separation schemes (TSSs) to provide unobstructed approaches through oil fields for vessels using GOM ports. The Coast Guard provides listings of designated fairways, anchorages, and TSSs in 33 CFR 166 and 167, along with special conditions related to oil and gas production in the GOM. In general, no fixed structures such as platforms are allowed in fairways. Temporary underwater obstacles such as anchors and attendant cables or chains attached to floating or semisubmersible drilling rigs may be placed in a fairway under certain conditions. Fixed structures may be placed in anchorages, but the number of structures is limited.

A TSS is a designated routing measure designed to separate opposing streams of traffic by appropriate means and by the establishment of traffic lanes (33 CFR 167.5). The Galveston Bay approach TSS and precautionary areas is the only TSS established in the GOM.

Merchant Marine Act of 1920 (Jones Act)

The Merchant Marine Act of 1920, commonly referred to as the Jones Act (P.L. 66-261) regulates coastal shipping between U.S. ports and inland waterways. The Act provides that "no merchandise shall be transported by water, or by land and water…between points in the United States…in any other vessel than a vessel built in and documented under the laws of the United States and owned by persons who are citizens of the United States... "

Therefore, the Act requires that all goods shipped between different ports in the U.S. or its territories must be:

- Carried on vessels built and documented (flagged) in the U.S.,
- Crewed by U.S. citizens or legal aliens licensed by Coast Guard, and
- Owned and operated by U.S. citizens.

The rational behind the Jones Act and earlier Cabotage laws was that the United States needed a merchant marine fleet to ensure that its domestic waterborne commerce remains under government jurisdiction for regulatory, safety, and national defense considerations. The same general principles of safety regulations are applied to other modes of transportation in the United States. While other modes of transportation can operate foreign-built equipment, these units must comply with U.S. standards. However, many foreign-built ships do not meet the standards required of U.S.-built ships and thus are excluded from domestic shipping.

The U.S. Customs Service has determined that facilities fixed or attached to the OCS for the purpose of oil exploration as described under Section 1333(a) of Title 43, United States Code, are considered points within the U.S. Therefore, OCS oil facilities are considered U.S. sovereign territory and fall under the requirements of the Jones Act. This carries the implication that all shipping to and from these facilities related to oil exploration on the OCS can only be conducted by vessels meeting the requirements of the Jones Act. Therefore, shuttle tankering of oil that is produced at OCS facilities can only be legally provided by U.S.-registered vessels and aircraft that are properly endorsed for coastwise trade under the laws of the U.S.

Executive Order 12898: Environmental Justice

The environmental-justice policy, based on Executive Order 12898, requires agencies to incorporate into NEPA documents analysis of the environmental effects of their proposed programs on minorities and low-income populations and communities. Scoping and review for the EIS is an open process that provides an opportunity for all participants, including minority and low-income populations, to express concerns that can be addressed in the EIS.

1.5.2 MMS Regulatory Authority

The MMS is charged with responsibility for managing and regulating the development of OCS oil and gas resources in accordance with the provisions of OCSLA (described in Section 1.5.1). MMS operating regulations are provided in 30 CFR, Chapter 250. The MMS's established regulatory framework (including review, evaluation, and decision-making processes) is applicable to all activities considered in this EIS.

The MMS procedures for managing and regulating OCS development activities, including those applicable to floating production systems such as FPSOs, are summarized below.

The MMS is responsible for regulating and monitoring the oil and gas operations and activities on the Federal OCS. The MMS has established operating regulations and procedures to ensure that proposed activities are orderly, safe, and pollution-free. These regulations include technical and environmental reviews and evaluations by the MMS to ensure all operations are conducted in a safe and environmentally sound manner. The focus of the regulations is to reduce the risks associated with actions conducted in the offshore environment. The lessee or operator has the primary responsibility for ensuring all operations meet or exceed MMS's regulatory requirements.

The MMS operating regulations, 30 CFR 250, are designed to, ". . . regulate all operations conducted under a lease, right of use and easement, or right-of-way to promote orderly exploration, development, and production of mineral resources and to prevent unreasonable harm or damage to, or waste of, any natural resource (including any mineral deposits in areas leased or not leased), any life (including fish and other aquatic life), property, or the marine, coastal, or human environment." The operating regulations provide requirements and guidance on each phase of offshore operations. The operating regulations incorporate by reference numerous industry practices, methods, codes, and measurements that are accepted as standards in conducting offshore operations. This allows the integration of the most current practices into all aspects of offshore work.

Prior to commencing exploration, development, or production activities on a lease, operators must submit detailed plans of these activities for MMS review, evaluation, and decision. No activities may occur until approval has been granted by MMS. Proposed activities are evaluated through established technical, safety, and environmental review processes. Specific requirements must be addressed in these plans relative to operating conditions and environmental considerations. Supporting environmental information required may include archaeological, biological, and geohazards surveys and reports. If a plan is approved, operators must still submit applications for specific operations for review and approval prior to commencing operations. Upon approval of activities, lessees must comply with all lease stipulations, operational regulations, permit requirements, mitigation measures, and other applicable Federal laws and regulations

All proposed operations must meet or exceed the safety standards set by MMS. The MMS requires use of the Best Available and Safest Technology (BAST) for OCS operations, which include state-of-the-art drilling technology, production safety systems, completion of oil and gas wells, oil-spill response plans, pollution-control equipment, and specifications for platform/structure designs.

The MMS completes a technical and safety review of all proposed production facility designs and installation procedures. All proposed facilities in the GOM Region are reviewed for structural integrity. These detailed classical engineering reviews entail an intense evaluation of all operator proposals for fabrication, installation, modification, and repair of all mobile and fixed structures in the GOM Region.

To ensure that new structures are designed, fabricated, and installed using standardized procedures to prevent structural failures, MMS uses third-party (a Certified Verification Agent) expertise and technical input in the verification process. All surface production facilities, including separators, treaters, compressors, headers, and flowlines, must be designed, installed, and maintained in a manner that provides for efficiency, safety of operations, and protection of the environment. Safety systems utilized for drilling, well workover activities, and production operations on the OCS must be designed, installed, used, maintained, and tested in a manner to ensure the safety and protection of the human, marine, and coastal environments. All tubing installations open to hydrocarbon-bearing zones below the surface must be equipped with safety devices that automatically shut off the flow from the well in the event of an emergency (unless the well is incapable of flowing). New technologies for deepwater activities are evolving rapidly. Most of the MMS operating regulations were written prior to the rapid increase in deepwater activities, and advancements in technology typically outpace the regulatory revision process. As a result, MMS has seen and is expecting to see more operator requests for alternative technologies and departures from the regulations. The uniqueness of deepwater operations and its environment compared to traditional shelf activities necessitates flexibility in the regulations to permit these development operations to proceed in deepwater areas of the GOM. To ensure that MMS continues to meet its mandates for orderly development, safety, and environmental protection, additional review processes have been established for proposed deepwater operations and for all proposed subsea developments.

Notice to Leesees and Operators (NTL) 98-8N requires operators to submit for early technical review by MMS a Deepwater Operations Plan (DWOP) for operations in deep water and for all projects using subsea production technologies. A DWOP is intended to address the different functional requirements of production equipment in deep water, particularly the technological requirements associated with subsea production systems, and the complexity of deepwater production facilities. A DWOP provides MMS with information specific to deepwater equipment issues to demonstrate whether a deepwater project is being developed in an acceptable manner as mandated in the OCSLA, as amended, and the MMS operating regulations (30 CFR 250). The MMS reviews deepwater development activities from a total system perspective, emphasizing operational safety, environmental protection, and conservation of natural resources.

For MMS to grant alternative compliance approvals, the operator must demonstrate an equivalent or increased degree of protection. Comparative analysis with other approved systems, equipment, and procedures is another tool that MMS can use to assess the adequacy of protection provided by an alternative. Actual in-service experience with an alternative compliance measure must be demonstrated by the lessee or operator before MMS will consider it a proven operational technology. An example of this philosophy is the evolution from the traditional vertical bore production tree to the horizontal tree currently being used in deepwater applications. A departure can be granted when necessary if the operator can demonstrate that an acceptable level of protection exists. The MMS's case-by-case technical and engineering evaluations of departure requests may involve a qualitative risk assessment and a review of the operations and equipment.

The MMS evaluates the design, fabrication, installation, and maintenance of pipelines. Proposed pipeline routes are evaluated for potential geologic hazards and other natural or man-made seafloor or subsurface features or conditions that could have an adverse impact on the pipeline. Routes are also evaluated for potential impacts on archaeological resources and biological communities. Operators are required to periodically inspect pipeline routes, and monthly overflights are conducted to inspect pipeline routes for leakage.

The Oil Pollution Act of 1990 (OPA, 90) requires removal of spilled oil and establishes a national system for planning for and responding to oil-spill incidents. MMS mandates that the operator of a lease possess a pro-active spill prevention program, a current viable oil-spill contingency plan, financial responsibility certification, and a system to ensure that the operator can obtain oil-spill containment and clean-up equipment quickly. The MMS regulations (30 CFR 254) require all owners and operators of oil processing and handling, storage, or transportation facilities located seaward of the coastline to submit an Oil Spill Response Plan (OSRP) for approval before an owner/operator can use a facility. Owners or operators of offshore pipelines are required to submit a plan for any pipeline that carries oil, condensate, or liquid known to be detrimental to the environment. Pipelines carrying essentially dry gas do not require a plan.

A response plan must be submitted before an owner/operator can use a facility. To continue operations, the facility must be operated in compliance with the approved plan. All MMS-approved OSRPs are required to be reviewed and updated every two years.

A Certificate of Financial Responsibility (COFR Program) is required for every GOM Region drilling, workover, production, and pipeline operation that may involve the accidental release of hydrocarbon liquids into the environment. The MMS determines the amount of financial responsibility required for offshore facilities as prescribed by OPA 90. The OPA agency analysis applies an assessment protocol to estimate the operator's likely liability for a worst-case spill from a facility or class of facility. The responsible party must demonstrate to MMS (or state) that sufficient funds for cleanup and damage liability would be available if needed.

The MMS's regulations provide for the collection of information about potential sources of pollution. This information is used to determine whether projected emissions of air pollutants from a facility may result in ambient onshore air pollutant concentrations above USEPA significance levels and to identify appropriate emissions controls to prevent accidents and air quality deterioration. Regulated pollutants include carbon monoxide, suspended particulates, sulfur dioxide, nitrogen oxides, total hydrocarbons, hydrogen sulfide, and volatile organic compounds (as a precursor to ozone).

All operators on the OCS involved in production of sour hydrocarbons that could result in atmospheric hydrogen sulfide concentrations above 20 parts per million (ppm) are required to file a contingency plan for hydrogen sulfide that includes procedures to ensure the safety of the workers on the production facility. All operators are required to adhere to National Association of Corrosion Engineers (NACE) *Standard Material Requirement MRO75-97 for Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment* (NACE, 1990). The American Petroleum Institute (API) has also developed "Recommended Practices for Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide" (API, 1995). The MMS issued an NTL titled "Hydrogen Sulfide (H_2S) Requirements" to provide guidance on sensor location, sensor calibration, respirator breathing time, measures for protection against hydrogen sulfide, requirements for classifying an area for the presence of hydrogen sulfide, requirements for flaring and venting of gas containing hydrogen sulfide, and other issues pertaining to operations that involve hydrogen sulfide.

The MMS has pollution prevention and control regulations (30 CFR 250.300) to ensure lessees do "…not create conditions that will pose an unreasonable risk to public health, life, property, aquatic life, wildlife, recreation, navigation, commercial fishing, or other uses of the ocean…" during offshore oil and gas operations. Control and removal of pollution is the responsibility of the lessee and is performed at the expense of the lessee. Operators are required to install curbs, gutters, drip pans, and drains on structures and deck areas in a manner necessary to collect all contaminants and debris not authorized for discharge. Disposal of any solid waste into the marine environment is prohibited. Fixed and floating structures, drilling rigs, manned production platforms/structures, and support vessels operating under a Federal oil and gas lease are required to develop Waste Management Plans and to post placards reflecting discharge limitations and restrictions. Operational discharges such as produced water, drilling fluids, and cuttings are regulated by USEPA through the NPDES program; MMS may restrict the rate of drilling fluid discharge or prescribe alternative discharge methods.

The MMS administers an active civil penalties program. This program provides a high-profile compliance and enforcement tool. A civil penalty in the form of substantial monetary fines may be issued against any operator that commits a violation that may constitute a threat of serious, irreparable, or immediate harm or damage to life, property, or the environment. The MMS may make recommendations for criminal penalties if a willful violation occurs. In addition, the regulation in 30 CFR 250 directs MMS to suspend any operation in the GOM Region if the lessee has failed to comply with a provision of any applicable law, regulation, or order or provision of a lease or permit. Furthermore, the Secretary may invoke his authority under 30 CFR 250 and cancel a lease.

The MMS conducts both announced and unannounced on-site inspections of all production facilities and monthly inspections of all drilling and workover facilities to ensure compliance with lease terms, NTLs, and approved plans, and to ensure that safety and pollution-prevention requirements of regulations are met. These inspections focus primarily on the facility's safety equipment and on the records the operator maintains that reflect the periodic testing required by the Operating Regulations. Inspectors may require the activation of some safety equipment on a facility to ensure it is working properly.

The MMS encourages all operators to participate in the Safety and Environmental Management Program (SEMP) that is detailed in the American Petroleum Institute's Recommended Practice, API RP 75. This comprehensive environmental and safety program addresses all facets of oil and gas operations.

Lessees/operators must notify MMS 30 days before removal of a structure and provide the following information: complete identification of the structure; size of the structure (number and size of legs and pilings); removal technique to be employed (if explosives are to be used, the amount and type of explosive per charge); and the number and size of well conductors to be removed and the removal technique. At present, if a structure removal involves the use of explosives, an environmental assessment is prepared and an Endangered Species Section 7 Consultation is initiated with NMFS. The NMFS issued a "standard" Biological Opinion on July 25, 1988, which covers removal operations that meet specified criteria pertaining to the size of explosive charge used, detonation depth, and number of blasts per structure grouping. The use of explosives to cut offshore oil/gas structure legs/pilings for removal could cause injury or death to protected marine mammals and endangered sea turtles. Mitigation measures have been developed to decrease the likelihood of impact on these protected species. Although NMFS has the responsibility to enforce protection of the majority of marine mammals in the GOM, MMS and NMFS have conferred extensively in the development of platform removal precautions and have employed data resulting from equations found in Connor (1991). The MMS, NMFS, and lessees are cooperating in an observer/monitoring program to determine whether marine mammals and/or sea turtles are present in the vicinity of the structure removals. The NMFS sends approved observers to every structure removal where explosives are used. Since the NMFS protective observer program began in 1986, only one sea turtle is known with certainty to have been harmed. Others have been removed from the area of platform removal prior to detonation. If cetaceans are observed in the vicinity of a removal site, detonations are postponed until the animals have vacated the area.

Under MMS operating regulations and lease agreements, lessees must remove objects and obstructions from the seafloor upon termination of a lease. The MMS requires lessees to submit a procedural plan for site clearance verification. Lessees must ensure that all objects related to their activities are removed following termination of their lease. NTL 98-26 established site clearance verification procedures that included trawling the cleared site over 100 percent of the established clearance radii by a licensed shrimper. Lessees are required to file reports on the results of their site clearance activities.

1.5.3 Coast Guard Regulatory Authority

Primary responsibility for the enforcement of U.S. maritime laws and regulations in GOM waters falls upon Coast Guard. The Coast Guard's responsibilities for regulating activities on the OCS, the continental shelf, and in ports and harbors, as applicable to the proposed action, are presented in Title 33 CFR, chapters 1-199; Title 43 U.S.C. section 1331; Title 46 U.S.C., Part A and B; and OPA 90. The Coast Guard is responsible for managing and regulating provisions for safe navigation of vessels in U.S. waters, as well as the enforcement of environmental and pollution prevention regulations. As such, Coast Guard provides for the regulation and enforcement of hazardous working conditions on the OCS, for the management and regulation of measures for pollution prevention in territorial waters, and for ensuring that the provisions of OPA 90 and the MPPRCA (i.e., MARPOL Annex V) are implemented.

The Coast Guard's regulatory position with regard to proposed use of FPSOs includes the following specific points:

- Coast Guard considers any FPSO to be a "vessel" based on the definition of vessels as set forth in Title 46 U.S.C. '2101 (45), referencing 1 U.S.C. '3.
- Crude oil produced from a subsea installation by an FPSO is "cargo" per the definition of "cargo" in the tank vessel regulations in Title 46 CFR, Section 30.10-5. The crude that is produced and stored aboard any FPSO, regardless of the FPSO's mode of propulsion type or connection to the riser, is considered cargo. Therefore, cargo tanks aboard an FPSO are subject to the tank vessel requirements in Title 33 CFR, Part 157, and the double-hull provisions of OPA 90.
- The Coast Guard considers the offloading operations associated with FPSOs to be lightering operations; therefore, the lightering regulations in 33 CFR, Part 156, are applicable. In line with this, Coast Guard considers the establishment of designated lightering zones (33 CFR, Part 156.225) and lightering-prohibited areas (33 CFR, Part 156.310) as applicable to FPSO offloading operations.
- Because FPSOs are considered to be tank vessels, FPSOs must comply with OPA 90 double-hull requirements presented in Title 46 U.S.C., Section 3703a. According to this section, tank vessels constructed after June 30, 1990, are, with limited exception, required to have double hulls. However, the Act allows existing single-hull tank vessels to be operated until they reach their mandatory retirement age. These retirement dates vary depending upon the age of the vessel and hull configuration. All non-OPA-90 compliant vessels will be retired by the year 2015.
- Based on Coast Guard's weighing of the risk for any particular FPSO operation, the cognizant District Commander has the authority to establish a safety zone of 500 meters around an FPSO operation in accordance with the regulations presented in 33 CFR, Part 147.
- Coast Guard regulations presented in 33 CFR, Subchapter N, pertain to Coast Guard responsibility in governing OCS activities and pollution prevention measures on the OCS. Various aspects of operations plans, vessel designs, safety systems, and contingency plans are subject to Coast Guard review, inspection, and approval (Coast Guard, written communication, November 16, 1998).
- The OCS Lands Act (43 U.S.C.) provides Coast Guard with extensive authority to monitor, inspect and regulate occupational safety and health provisions of facilities on the OCS. Specifically, 43 U.S.C. 1347 (c) provides Coast Guard with the authority to promulgate regulations or standards applying to unregulated hazardous working conditions related to activities on the OCS.

The Coast Guard reviewed the DEIS, as well as relevant agency and public review comments on the DEIS that were received by MMS. Coast Guard comments are provided in Appendix B. In this written correspondence, Coast Guard reiterates its position regarding FPSOs as "tank vessels", and the applicability of OPA 90 requirements for FPSOs. In addition, Coast Guard addresses its regulatory authority over the use of ATBs (a.k.a. integrated tug barges [ITBs]), regulatory requirements for use of federally licensed pilots on U.S. flag tanker vessels calling on U.S. ports, concerns regarding the need for minimum requirements for oil spill response capability, and broad concerns regarding the need for cooperative efforts by all parties in planning and coordinating vessel traffic schemes.

1.5.4 Memorandum of Understanding (MOU) Between MMS and Coast Guard

On December 16, 1998, MMS and Coast Guard updated and signed a Memorandum of Understanding (MOU) concerning responsibilities for offshore facilities on the OCS. Given the overlap in jurisdictions of MMS and Coast Guard regarding some issues, the MOU delineates lead responsibilities for managing OCS activities in accordance with OCSLA and OPA 90.

Because of jurisdictional overlap and the large array of regulatory provisions pertaining to activities on the OCS, MMS and Coast Guard have established a formal Memorandum of Understanding (MOU) that defines their respective roles. The MOU, dated August 1989 and updated December 1998 (and published in the Federal Register on January 15, 1999), defines the responsibilities of both agencies regarding the management of oil and gas activities in the OCS. The MOU is designed to minimize duplication and promote consistent regulation of facilities under the jurisdiction of both agencies.

The MOU assigns both agencies with responsibility for the various aspects of the design, implementation, and operation of OCS facilities, including floating facilities such as FPSOs. Generally, the MOU identifies MMS as the lead agency for matters concerning the equipment and operations directly involved in the production of oil and gas. These include among others: design and operation of risers, permanent mooring foundations of the facility, drilling and well production and services, inspection and testing of all drilling-related equipment, and platform decommissioning. Issues regarding the safe operation of the facility, its systems, and the equipment needed to support all operations on board generally fall under the jurisdiction of Coast Guard. These include among others: design of vessels, their seakeeping characteristics, propulsion and dynamic positioning systems, supply and lightering procedures and equipment, utility systems, safety equipment and procedures, and pollution prevention and response procedures.

Both agencies will continue to be responsible for accident investigations and will coordinate to minimize duplication of efforts. For those incidents where both agencies have an investigative interest in the systems involved, one agency will assume lead investigative responsibility, with supporting participation provided by the other agency.

The MOU between MMS and Coast Guard is provided in Appendix A.

1.6 Public Involvement

The MMS Notice of Intent (NOI) to prepare an EIS was published in the *Federal Register* on June 10, 1999 (Appendix C). Under NEPA, the publishing of an NOI by the lead Federal agency formally initiates public scoping and the EIS process. The notice provided information on the type of action being proposed, the geographic area of the proposed action, and the preliminary set of alternatives to be considered. The NOI solicited involvement of interested parties and initiated the 45-day comment period during which issues and concerns regarding the proposed action could be presented to MMS for consideration in the EIS process. The NOI also incorporated the announcement of formal public scoping meetings, including dates, locations, and meeting times.

Scoping

Scoping is an integral and required early step in the preparation of an EIS under NEPA. Federal and local government agencies and the public are introduced to the proposed action and notified of a Federal agency's intent to prepare an EIS. Issues and concerns regarding the proposed action are received and considered by the lead Federal agency to ensure that the analysis of the proposed action and its potential environmental consequences is inclusive and appropriately focused. Scoping meetings are held in locations that are accessible to stakeholders and provide a forum where the interested public can be briefed on the nature of the proposed action and on the process and schedule for the EIS activities and document availability. Most importantly, the scoping meetings allow the public to express any issues or concerns about the proposed action and to ask questions about the EIS process prior to the preparation of the EIS.

A scoping notification letter, dated June 10, 1999, was sent to 883 interested parties identified on the MMS project mailing list to inform them of the upcoming scoping meetings and the purpose of the project.

Notices announcing the scoping meetings and MMS's intent to prepare an EIS were published in advance in the local newspapers in cities where the meetings were held. The public scoping meetings were held on June 21, 1999, in Corpus Christi, Texas; June 22, 1999, in Houston, Texas; June 23, 1999, in Beaumont, Texas; June 24, 1999, in Lake Charles, Louisiana; and June 28, 1999, in Kenner, Louisiana.

Written comments in response to the NOI, newspaper notices, and the scoping meetings were received through July 26, 1999. A total of six written responses were received from the public in response to the EIS scoping notifications that were published and mailed, and as a result of the scoping meetings. Written correspondence expressing issues and concerns were received from: Port Fourchon, located in Galliano, Louisiana; the U.S. FWS; Shell Offshore, Inc.; the LA 1 Coalition, a public interest group located in Louisiana; the State of Louisiana, Department of Wildlife and Fisheries; and one citizen from Marrero, Louisiana.

A summary of the comments received during the scoping period for the preparation of the EIS is provided in table 1-2.

Public Review and Comment on the DEIS

The Notice of Availability for the DEIS was published in the *Federal Register* on August 15, 2000. Document distribution commenced on August 11, 2000. The MMS distributed the DEIS to interested parties for review and comment, and the document was also made available at public library repositories. Comments on the DEIS were solicited from the public in the forum of public hearings, as well as in written correspondence. A public hearing notice was advertised in the *Federal Register* in advance of hearings, and the location, date, and time of hearings was advertised in local newspapers for the communities where hearings took place. The public hearings for receiving public comments on the DEIS were held in Houston, Texas; Lake Charles and New Orleans, Louisiana; and Mobile, Alabama. Notices and advertisements regarding availability of the DEIS and public hearing information also provided instructions for submitting written comments and identify the closing date for receiving public comments. The details regarding the public forums that were conducted for the preparation of this EIS, as well as public comments received, and MMS responses to these comments are provided in Sections 5.3 through 5.5.

Table 1-2

Issues Identified During the Public Scoping Period for the EIS

Issue	Number of Comments Received						
	Number of Comments Received During the Public Scoping Meetings					Number of Written Comments	Total Comments Received
	Corpus Christi, TX	Houston, TX	Beaumont, TX	Lake Charles, LA	Kenner, LA		
Storms/ Hurricanes	1				1		2
Safety/ Lightering	1			1	1	1	4
Double Hull Versus Single Hull Vessels	1	1		1			3
Alternative Technologies for Retrieving Hydrocarbon Resources	1	1		1	1		4
Topographic Features	1						1
Potential for Damage to Natural Resources	1			2	1	1	5
Regulations and Requirements for U.S. Flagged Vessels		1				1	2
Potential for Impact to Infrastructure					1	1	2
Potential for Endangered species Disturbance					1		1
Potential for FPSOs Resulting in Benefits to Local Communities					1	1	2
Potential for Systems Failures on FPSOs Resulting in Spills					1		1
Concerns for U.S. Coast Guard Lightering Prohibited Areas				1	1	1	3
Need for Meetings in Other States/ Mississippi and Alabama					1		1
Potential for Having to Respond to Multiple Concurrent Accidents in Gulf of Mexico				1			1
Liability for Oil Spills				1			1
Need for Oil Spill Response Plans				1			1
Potential for Terrorist Attacks on FPSOs				1			1
Use of Pipelines for Transport of Hydrocarbons		1					1

2. ALTERNATIVES

2.1 Background

The scoping process discussed in Section 1.5, as well as other forums hosted by MMS and DeepStar (Section 2.1.2), resulted in the identification of alternatives, issues of concern, and potential mitigation measures, each of which is summarized in the following sections.

2.1.1 Identification of Alternatives

As this is a programmatic EIS, alternatives represent broad, agency policies concerning the potential use of FPSOs in the GOM. Reasonable alternatives to the proposed action were identified within the bounds of MMS's existing jurisdictional authority to regulate development of petroleum hydrocarbons on the OCS. Only alternatives involving the use of FPSOs on the GOM OCS were considered; alternative development technologies are evaluated in MMS's *Deepwater Environmental Assessment* (USDOI, MMS 2000a) and GOM OCS lease sale EISs, and are not considered in this EIS.

2.1.1.1 Alternatives Analyzed

The alternatives analyzed in this EIS are briefly described below and further discussed in Section 2.2.

Alternative A – Conceptual Approval of FPSOs (The Proposed Action)

Alternative A is the implementation of a policy accepting the conceptual use of the base case FPSO system in the deepwater areas of the Western and Central Planning Areas of the GOM within the range of design and operational variations considered in the EIS. Under this alternative, FPSOs would be considered an acceptable deepwater development technology for use in the GOM.

Alternative B – Conditional Approval of FPSOs (The Proposed Action with General Restrictions or Conditions)

Alternative B is the implementation of a policy accepting the conceptual use of the base case FPSO system and range of options in the GOM OCS with general restrictions on the design, operation, or geographic location as conditions of approval. Certain restrictions were identified for consideration based on existing regulatory requirements and the findings of the risk assessment and/or impact assessment performed for this EIS. These restrictions or conditions are analyzed as variations of Alternative B and are described in Section 2.2.2.

Alternative C – No Action

Under the No Action alternative, the concept of using FPSOs in the GOM OCS would not be accepted based on this EIS.

2.1.1.2 Alternatives Considered But Not Analyzed

Only programmatic alternatives involving the use of FPSOs on the GOM OCS were considered in the preparation of this EIS; alternative technologies were not considered. Project-specific mitigation alternatives also were not considered; alternatives based on mitigation measures are best evaluated by project-specific NEPA documents. No additional alternatives were proposed during the scoping process.

A non-ship-shape FPSO, such as a spar with storage capacity, was considered as an alternative but not analyzed. Such an FPSO deviates dramatically from other FPSOs in its feasibility, installation, operations, and decommissioning. Therefore, a proposal for a non-ship-shape FPSO would be subject to a separate NEPA review.

Any specific proposal for use of an FPSO submitted to the MMS will go through a site-specific/project-specific environmental review process. An Environmental Assessment (EA) tiered off of this EIS will be prepared for any FPSO proposal within the range of parameters evaluated within this EIS. An EA will likely take several months to complete. If a proposal is submitted to MMS for a non-ship-shaped FPSO (e.g., a spar-shaped FPSO) or for an FPSO with design or operational parameters outside the ranges evaluated in this EIS, an EA and/or a Supplemental EIS will prepared. If the findings of the EA indicate the potential for significant impacts that were not evaluated in this EIS, a supplemental EIS will be prepared to address those specific issues. If the proposed activities pose obviously different risks or impacts, or if the proposed activities are highly controversial, a supplement EIS may be initiated without an EA being prepared first. Preparation of a supplemental EIS, including the formal public input opportunities, will likely take approximately one year to complete.

2.1.2 Issues

The major issues of concern considered and/or analyzed in this EIS include many of the same issues identified during scoping for previous MMS's NEPA documents covering OCS oil and gas development, as well as issues identified specifically for FPSOs. The following sources were used to focus more specifically on issues of concern related to use of FPSOs for deepwater development:

$ Public scoping for this EIS;
$ MMS's *Deepwater Environmental Assessment*; and
$ The FPSO workshop co-sponsored by MMS and DeepStar on April 16, 1997.

Many of the issues identified in the *Deepwater EA* are related to impact-producing activities or risk factors generally associated with deepwater oil and gas production. As noted in the *Deepwater EA*, many of these issues have been analyzed in previous NEPA documents, and these analyses are referenced where appropriate. Only issues unique to FPSO-based development systems were selected for detailed analysis in this EIS. Most of these issues are associated with the following unique aspects of FPSO operations:

$ Offshore storage of large volumes of OCS-produced crude oil,
$ Off-loading of OCS-produced crude oil offshore, and

- $ Transport of OCS-produced crude oil via surface vessel (versus transport via marine pipeline).

2.1.2.1 Issues Analyzed

Issues of concern relate to: potential impact-producing factors associated with FPSO operations and support activities; sensitive environmental resources that could be impacted by FPSO construction, installation, operation, decommissioning, and associated transportation and support activities; and socioeconomic activities that could be affected by FPSO–related activities. The issues judged to warrant analysis in this EIS are identified in table 2-1.

Resources of Concern

The environmental resources that are potentially vulnerable to impacts from construction and operation of FPSOs in the GOM are:

- $ Air quality
- $ Water and sediment quality
- $ Coastal habitats
- $ Benthic communities
- $ Marine mammals
- $ Sea turtles
- $ Coastal and marine birds
- $ Fish
- $ Commercial and recreational fisheries
- $ Social and economic conditions
- $ Recreational resources and beach use
- $ Cultural resources
- $ Other uses

The issues of concern identified above are analyzed under these resource topics in Section 4.

2.1.2.2 Issues Considered But Not Analyzed

Numerous other issues related to deepwater OCS production that were considered were determined not to be unique to FPSO-based development; therefore, they are not analyzed in this EIS. These issues are summarized in table 2-2.

2.1.3 Mitigation Measures

Many of the issues identified in table 2-1 have been analyzed in previous NEPA documents and, in some cases, mitigation measures were developed through the NEPA process. Many of the mitigation measures have been established by MMS operating regulations or

Table 2-1

Issues Analyzed

Topic	Issues
Oil spills	$ Potential effects of oil spills on marine mammals, other endangered and threatened species, commercial fishing, recreation and tourism, water quality, and wetlands
	$ Storage of large volumes of oil in deepwater locations
	$ Potential for catastrophic failure of one or more FPSO systems
	$ Fate and behavior of deepwater oil spills, fate and effects of oil spills related to tanker transport
	$ Oil spill contingency planning and response capabilities
	$ Availability and adequacy of oil-spill containment and cleanup technologies
	$ Oil spill cleanup strategies
	$ Impacts of various oil-spill cleanup methods
	$ Effects of winds and currents on the transport of spilled oil
	$ Toxicological effects of fresh and weathered oil, and air pollution from spilled oil
	$ Short- and long-term impacts of oil on wetlands
Use of Chemicals	$ Use and fate of chemicals in deepwater production
Air emissions	$ Emissions associated with deepwater operations
	$ Emissions from extended well testing and early production systems
	$ Emissions associated with increased support services (e.g., service vessels, anchor handling vessels, helicopters)
	$ Emissions related to oil and oil-product transfer operations
	$ Emissions from shuttle tankers
	$ Consumption of the Class I Area maximum allowable increments
	$ Emissions from in situ burning (alternative oil spill cleanup method)
Biological communities	$ Potential impacts on benthic communities (including chemosynthetic communities), marine mammals, sea turtles, and fish resources
	$ Potential impacts on essential habitats
	$ Potential impacts on coastal marshes
	$ Potential impacts on essential fish habitats
Socioeconomic and sociocultural conditions	$ Safety of the deepwater workforce
	$ Loss of GOM coastal jobs
	$ Multiple-use conflicts with commercial and recreational fisheries
	$ Effects on coastal resources of other GOM countries (transboundary effects)
FPSO operations	$ Timing and scale of operations
	$ Facility decommissioning and site clearance
	$ Alternative transportation of produced fluids
	$ Disposition of produced gas
Support services, activities, and infrastructure	$ Potential impacts of increased dredging to support deepwater activities (if new ports or expansion/modification of existing ports to capture the shuttle tanker business is anticipated)
	$ Increased erosion along channels traveled by shuttle tankers

Table 2-2

Issues Considered But Not Analyzed

Topic	Issues
Oil spills	$ Fate and effects of oil released by loss of control of a subsea well $ Chemical composition of specific deepwater crude oils
Socioeconomic and sociocultural conditions	$ Increased economic and industrial activity in the coastal zone $ Increased risk of terrorist attacks $ Historic archaeological resources (shipwrecks)
Pipelines	$ Deepwater pipelaying and pipeline technologies $ Wetland impacts due to increased numbers of pipeline land-falls $ Unsupported pipeline spans (e.g., fisheries conflicts) $ Geologic hazards
Support services, activities, and infrastructure	$ Compatibility of current coastal infrastructure with anticipated larger support vessels $ Additional service vessel and helicopter traffic (except for air emissions) $ Increased use of coastal infrastructure, including traffic on existing roadways $ Increased demand for fresh water and other consumables $ Competition with other port users $ Increased demand for multipurpose ports $ Potential locations of additional onshore service bases

Notices to Lessee (NTLs). Established mitigation measures are identified and discussed in Section 4 (Environmental Consequences).

All of the suggested new mitigation measures presented in this EIS are environmentally viable and have been evaluated for technological and economic viability, expected benefits, and potential impacts. Measures that were determined to be environmentally, technologically, and economically viable and to offer net environmental benefits will be recommended for implementation. Implementation may be through MMS operating regulations (30 CFR 250), NTLs, or project-specific requirements.

2.2 Description of Alternatives

2.2.1 Alternative A – Conceptual Approval of FPSOs (The Proposed Action)

Alternative A is the implementation of a policy approving the concept of using FPSOs in the deepwater areas of the Western and Central Planning Areas of the GOM. Under this alternative, FPSOs within the range of options defined for the base case in this EIS would be considered acceptable development technology for use in the deepwater areas of the Western and Central Planning Areas of the GOM. Operators would still be required to submit Deepwater Operations Plans (DWOP; NTL 98-8N) for technical review of the concept and subsequent project-specific development plans (Development Operations Coordination Documents; DOCD) for site-specific technical, safety, and environmental review.

Proposals for use of FPSOs in the GOM that consist of locations, system design variations, or operational options not defined under the base case description or range of options in Section 1.3 would not be conceptually approved under this alternative.

2.2.2 Alternative B – Conditional Approval of FPSOs (The Proposed Action with General Restrictions or Conditions)

Alternative B is the implementation of a policy accepting the conceptual use of FPSOs in the deepwater areas of the Western and Central planning areas of the GOM with certain restrictions on the operation or geographic location as conditions of approval. Certain restrictions have already been identified for consideration under this alternative by MMS; others may be identified as a result of the risk assessment and/or impact assessment currently being performed. These restrictions or conditions are analyzed as choices under Alternative B.

2.2.2.1 Geographic Exclusion Areas

Alternative B-1 No FPSOs in Designated Lightering-Prohibited Areas

Under Alternative B-1, FPSOs would be prohibited in the portions of the project area in which lightering-prohibited areas have been established by Coast Guard (under 33 CFR Part 156 Subpart C) (figure 2-1). The Coast Guard designated these prohibited areas to protect the Flower Garden Banks and other ecologically sensitive topographic features from anchoring damage, direct impact of accidental releases of oil or chemical compounds, and ecological hazards of a sunken vessel in the vicinity of these areas.

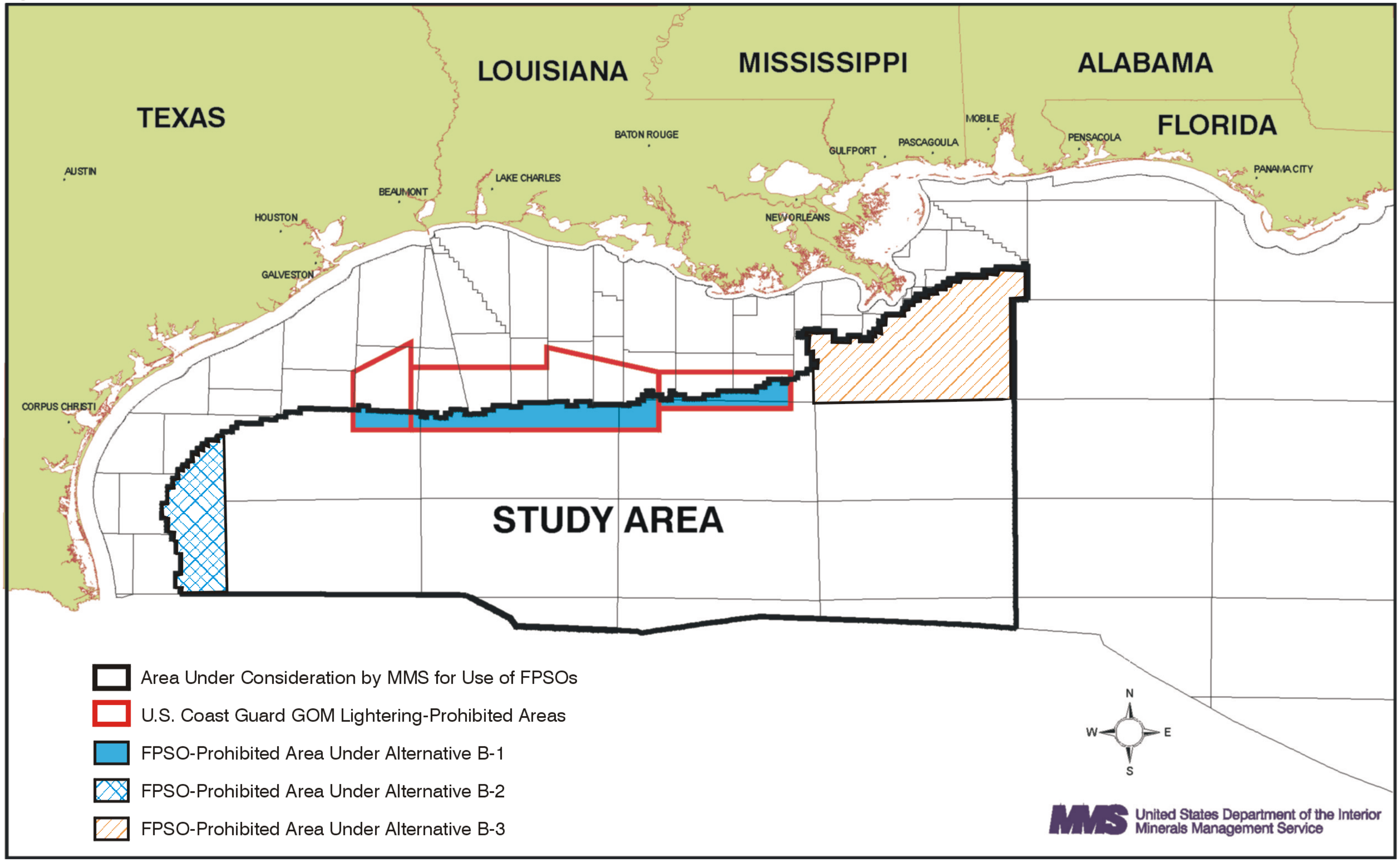


Figure 2-1 LIGHTERING-PROHIBITED AREAS IN THE GULF OF MEXICO

Alternative B-2 No FPSOs in Lease Areas Nearest South Texas

Under Alternative B-2, FPSOs would not be permitted in the Corpus Christi or Port Isabel map protraction areas, which are the lease areas located nearest to shore. This alternative is intended to mitigate potential increased risk of oil spill impacts on coastal areas and the shorter time to implement response actions before oil spills reach the coast that might be posed by FPSOs deployed in this area.

Alternative B-3 No FPSOs in Lease Areas Nearest the Mississippi Delta

Similar to Alternative B-2, this alternative would exclude FPSOs from lease areas near the Mississippi Delta, specifically the Viosca Knoll and Mississippi Canyon map protraction areas. Given the proximity of the Viosca Knoll and Mississippi Canyon lease blocks to sensitive coastal and nearshore habitats of the Mississippi Delta, the presence of FPSOs in these areas could result in an increased risk of oil spills reaching these areas before spill containment could be implemented.

2.2.2.2 Stipulations on FPSO Operations

Alternative B-4 Requirement for Attendant Vessel During Offloading Operations

Under Alternative B-4, MMS would require that an attendant vessel be present during offloading operations. The purpose of the attendant vessel would be to:

$ Assist in offloading activities (e.g., transfer of offloading hose),
$ Maintain designated safety distance between marine traffic and the FPSO/shuttle tanker by warning or fending off other vessels, and
$ Carry oil spill response equipment and provide first response in the event of an oil spill.

The presence of an attendant vessel would decrease the risk of an oil spill occurring from a collision between the FPSO or shuttle tanker and a stray vessel, and enhance the response capability and time should an oil spill occur. An attendant vessel is the only “active” system available to intervene and potentially prevent a collision and any resulting fire, explosion, or oil spill.

2.2.3 Alternative C – No Action

Under the No Action Alternative of this EIS, the general concept of using FPSOs in the GOM OCS would not be accepted. This alternative, however, would not necessarily prohibit the use of FPSOs in the GOM.

Three potential scenarios for deepwater development could occur under this alternative:

$ Operators could submit FPSO proposals for consideration through the established MMS review and decision process, including project-specific review under NEPA;

- $ Development of deepwater oil fields could occur through the use of other deepwater production technologies (e.g., spars, TLPs, semi-submersibles); or
- $ Some fields may not be developed, or development may be delayed, if FPSOs are not approved and other technologies are determined not to be economically or technologically viable.

2.3 Comparison of Environmental Impacts

The environmental impacts of each alternative are discussed in detail in Section 4.3. A resource-by-resource comparison of environmental impacts of the alternatives is presented in table 2-3. The most notable impacts and differences between the alternatives are discussed below.

Alternative A, the proposed action, would generally have limited adverse impacts on most environmental resources, although significant impacts could occur under certain circumstances. Resources that could be significantly impacted by Alternative A include air quality, water and sediment quality, offshore environments, marine mammals, sea turtles, and commercial fisheries. As discussed in table 2-3, these significant impacts would only occur under specific conditions, most of which can be protected against by project planning and regulatory restrictions. In addition, the proposed action would result in some beneficial effects on fishery resources and localized socioeconomic conditions.

Alternatives B-1, B-2, and B-3 would have less impact than the proposed action on some of the resources due to the exclusion of FPSO operations from areas near sensitive resources. Under Alternative B-3, the potential for significant impacts on air quality in Breton Sound NWA would be eliminated by excluding FPSOs from nearby areas. Alternatives B1, B-2, and B-3 would have greater impacts (both beneficial and adverse) on fishery resources and commercial fishing than those projected for Alternative A due to limiting locations for FPSO operations.

Alternative B-4 (requiring an attendant vessel) would have greater adverse impacts than Alternative A on air quality, water quality, offshore environments, marine mammals, sea turtles, commercial fisheries, the socioeconomic environment, and other uses. However, most of these increased impacts are negligible or minor.

Alternative C would have negligible impacts on environmental resources, though it has the potential to cause a significant adverse impact on the socioeconomic environment along the Gulf coast if the absence of FPSOs leads to an industry downturn. If individual FPSOs were permitted under Alternative C, adverse impacts similar in nature to those described for Alternative A would occur.

Table 2-3

Comparison of Environmental Consequences of Alternatives

Resources	Alternatives		
	A	**B**	**C**
Air Quality	Emissions from routine operations may result in a long-term significant impact on air quality at Breton Sound NWA due to exceedances of the SO_2 standard. Additionally, the installation of up to five geographically dispersed FPSOs may adversely affect air quality, depending upon location and proximity to shore and one another. If the five FPSOs were placed near sensitive receptors (e.g., Mississippi Canyon) in an area with a 50-km radius, significant air quality impacts are expected from SO_2 emissions. The flaring/venting options for gas disposal also could have significant impacts on air quality.	Alternatives B-1 and B-2 would have negligible impact on ambient air quality. Alternative B-3 would effectively mitigate the significant impact of FPSO emissions in the northeastern portion of the Mississippi Canyon lease area. Alternative B-4 would have an incremental increase in impact above that projected for Alternative A (i.e., significant impacts from SO_2 emissions in the Mississippi Canyon lease area).	Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or Alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.
Water and Sediment Quality	The proposed action would have an adverse but not significant impact on water quality. Support vessel traffic from the shorebase(s) to the FPSO site(s) would produce adverse but not significant impacts on coastal water and sediment quality. If vessel traffic is concentrated in one or a few ports, then significant, localized impacts to water quality and sediment quality could be realized. Anchoring installation/emplacement activities would produce localized, short- term impacts on offshore sediment quality. During routine production operations at the FPSO, produced water discharges and wastewater discharges from the FPSO and support vessels would produce localized, adverse but not significant impacts on offshore water quality.	Alternatives B-1 through B-3 would have negligible impact on coastal and offshore water and sediment quality, relative to Alternative A. Alternative B-4 would have an incremental impact on water quality; however, impacts are expected to remain adverse but not significant.	Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or Alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Table 2-3

Comparison of Environmental Consequences of Alternatives

Resources	Alternatives		
	A	B	C
Coastal Environments	The proposed action would have generally negligible impacts on coastal environments (i.e., coastal barrier beaches, dunes, wetlands, and seagrass beds). However, adverse but not significant impacts on beaches, coastal wetlands and seagrass habitats could occur due to incremental increases in vessel traffic, depending upon the location of operations and the nature of adjacent coastal resources. These impacts would result from incremental increases in erosion rates, sediment resuspension, and turbidity caused by vessel transits in coastal areas.	Alternative B-1 is expected to produce negligible impacts on coastal barrier beaches and associated dunes. Alternative B-2 would have negligible impact on coastal barrier beaches and associated dunes. Alternative B-3 would have no effect on proposed operations elsewhere in the deepwater area and thus would have no effect on the impacts associated with shuttle tanker traffic discussed under Alternative A. Alternative B-4 would have similar impacts on coastal environments as those projected for Alternative A.	Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or Alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.
Offshore Environments	The proposed action would have generally negligible, localized impacts on offshore environments (encompassing plankton and deep benthic communities and topographic features). Anchoring, structure emplacement, and pipelaying would produce adverse but not significant impacts on soft bottom benthic communities. Recolonization of disturbed areas is expected during the first several years following FPSO installation and operation. With proper avoidance, impacts on chemosynthetic communities from installation activities would be negligible. However, if chemosynthetic communities were damaged during installation, such damage to chemosynthetic communities would represent a significant, long-term impact. Bottom-founded structures may provide hard substrate for epifaunal attachment, possibly a beneficial impact. Use of either suction pile or driven pile anchoring techniques (instead of drag anchoring) may slightly reduce impacts on the benthos by reducing the total amount of seafloor area affected.	Alternatives B-1, B-2, and B-3 would have no impact on offshore resources. Alternative B-4 may slightly increase impacts on both water column and deep benthic environments. This incremental increase in discharges is minor, and impacts to plankton would remain negligible. If a dedicated anchor is required, additional, minor anchor impacts are predicted. Impacts to benthic communities would remain adverse but not significant.	Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or Alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Table 2-3

Comparison of Environmental Consequences of Alternatives

Resources	Alternatives		
	A	B	C
Marine Mammals	Normal operations under the proposed action would cause localized adverse impacts to marine mammals, primarily from noise and/or visual disturbances from helicopters, service vessels, and shuttle tankers. Expected increases in service vessel and shuttle tanker traffic associated with normal operations may also increase the probability of collisions between these vessels and marine mammals. Although the risk of collisions may vary, any collision with a marine mammal that is listed as an endangered species, such as the sperm whale, would constitute a significant impact. A collision with a nonlisted species would be considered adverse, but not locally or regionally significant. Ingestion of, or entanglement with, discarded solid debris associated with normal operations would produce a negligible impact on marine mammals.	Alternatives B-1 and B-2 would have similar impacts on marine mammals as those projected for Alternative A. Alternative B-3 may effectively mitigate potential impacts of FPSO activities on local deepwater marine mammal species, especially the endangered sperm whale. Alternative B-4 has the potential for greater impacts on marine mammals than Alternative A; however, the impacts from additional noise or discharges from an attendant vessel are not considered to be significant.	Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or Alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.
Sea Turtles	Installation and operation of an FPSO would have generally negligible impacts on sea turtles, although collisions with service vessels and shuttle tankers and installation of OCS pipelines may produce adverse or significant impacts. Expected increases in vessel traffic associated with installation may also increase the probability of collisions between these vessels and sea turtles. Although the risk of collisions may vary, any collision with a single sea turtle that causes death would constitute a significant impact, as all species are currently listed as endangered or threatened species. Destruction of shallow water habitats and beaches as a result of the installation of OCS pipelines may produce adverse but not significant impacts on sea turtles through loss of nesting habitat.	Alternatives B-1, B-2, and B-3 would have the same impacts on sea turtles as described in Alternative A. Alternative B-4 has the potential for increased impact on sea turtles from additional subsea mechanical noise and additional discharges. Impacts on sea turtles resulting from these sources are considered to be adverse but not significant.	Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or Alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Table 2-3

Comparison of Environmental Consequences of Alternatives

Resources	Alternatives		
	A	B	C
Coastal and Marine Birds	The proposed action would produce negligible to adverse impacts on coastal and marine birds. Installation of new OCS pipeline landfalls, if required, could cause adverse impacts on coastal birds due to the associated destruction or alteration of coastal habitat and related disturbance from installation operations. However, with appropriate placement (and avoidance of sensitive avian habitat), impacts are not expected to be significant. Helicopter and service vessel traffic related to normal operations would produce only a negligible impact to coastal and marine birds.	Alternatives B-1 through B-4 would have similar impacts on coastal and marine birds as those described under Alternative A.	Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or Alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.
Fish Resources	The proposed action would produce negligible or beneficial impacts to fish resources, except for potentially adverse impacts to highly migratory fish. Anchors and other bottom-founded structures would serve as fish attracting devices (FADs), a beneficial impact on species preferring bottom relief. Highly migratory fish species could be diverted from traditional migratory routes and, consequently, from traditional spawning or feeding areas. Such disruptions in migration patterns could result in short- or long-term effects on the feeding behavior of deepwater fishes, an adverse but not significant impact. In situ abandonment of bottom-founded structures would create a permanent FAD effect for benthic fishes, which could have adverse or beneficial effects on fish populations, although significant impacts are not expected .	Alternative B-1 may have a greater beneficial impact on shallow water fishery resources than would Alternative A. The impacts of Alternative B-2 on fishery resources would not be appreciably different than those caused by Alternative A. Alternative B-3 would have less beneficial impact than would Alternative A due to the elimination of FPSO structures in lease areas nearest to the Mississippi Delta. Alternative B-4 would have an incrementally greater adverse impact on fishery resources than would for Alternative A, but the impact would still be negligible.	Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or Alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Table 2-3

Comparison of Environmental Consequences of Alternatives

Resources	Alternatives		
	A	B	C
Commercial Fisheries	The proposed action would produce negligible to adverse, localized, long-term impacts on commercial fisheries. The presence of FPSOs, pipelines, and vessel traffic would preclude trawling and longlining in relatively small areas surrounding these structures and activities, causing an adverse but not significant impact. The placement of FPSOs in water depths of greater than 1,000 feet would greatly lessen the chance for conflicts with bottom longlining. If optional scenarios involve shallower waters (e.g., along the 600-foot isobath), then the potential for impact would increase, but would only be significant if the FPSO were located on or near a known fishing area. Structures abandoned on the seafloor would cause permanent loss of relatively small fishing areas, resulting in a negligible impact to commercial bottom fisheries.	Alternatives B-1 and B-2 would have less impact on demersal fisheries (i.e., bottom longlining and trawling) than would Alternative A, particularly in lightering-prohibited areas located in water depths between 600 and 1,500 feet. Alternatives B-1 and B-2 would, however, produce an incremental increase, relative to Alternative A, in space-use conflicts with surface longline fishing, causing an adverse but not significant impact. Alternative B-3 would have less impact than Alternative A on the royal red shrimp fishery, which generally occurs in the proposed exclusion area (i.e., within water depths of 600 to 1,500 feet). However, this exclusion area would cause adverse but not significant impacts by slightly increasing the space-use conflicts elsewhere in the deepwater areas where surface longlining occurs. Alternative B-4 would have impacts on commercial fisheries similar to those projected for Alternative A.	Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or Alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.
Social and Economic Environments	The proposed action could have short-term socioeconomic benefits along the Gulf Coast during construction phases, but impacts of normal FPSO and shuttle tanker operations on the socioeconomic environment would be negligible. In the event five FPSOs were placed in proximity to one another, it is possible that one or two port facilities would realize the bulk of the socioeconomic impact, resulting in a localized, adverse but not significant impact. Increased storage capacity and increased production rates would produce a slightly greater impact on socioeconomic resources, but still result in a negligible socioeconomic impact.	Alternative B-1 would have negligible impacts on social and economic outcomes, similar to those of Alternative A. Alternatives B-2 and B-3 would also have negligible social and economic impact overall; however, the beneficial effects of FPSO-related offshore employment (of workers residing along coastal areas adjacent to the exclusion zones) may be somewhat less. Alternative B-4 would have a slightly greater adverse impact on the socioeconomic environment than that projected for Alternative A, but the impact would still be negligible.	Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or Alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

Table 2-3

Comparison of Environmental Consequences of Alternatives

Resources	**Alternatives**		
	A	**B**	**C**
Recreational Resources and Beach Use	The proposed action would have negligible, localized, adverse impacts on recreational resources and beach use. No impacts on recreational resources and beach use are expected in association with perceived water quality degradation. Slight increases in the number of vessel and helicopter transits would produce minor, incremental impacts on viewsheds in the vicinity of transit routes. Options for increased storage capacity and increased production rates would further increase tanker traffic, but still result in negligible impacts given the amount of tankering activity currently being conducted at Gulf ports.	Alternatives B-1, B-2, B-3, and B-4 would have negligible impacts on recreational resources and beach use, similar to those projected for Alternative A.	Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or Alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.
Other Uses	The proposed action would have negligible impacts on other uses of the GOM such as commercial and military uses. Incremental increases in vessel traffic, helicopters, and shuttle tankering would produce the potential for increased conflicts with other uses of surface, airspace, and underwater areas, but these impacts are expected to be negligible.	Alternatives B-1, B-2, and B-3 would have less impact than Alternative A on other uses due to the exclusion of FPSOs from designated areas. Alternative B-4 would have a minor incremental impact on other uses above that projected for Alternative A, but this would still represent a negligible impact.	Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or Alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central Planning Areas of the OCS.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Physical Elements of the Environment

3.1.1 Geology

Substantial engineering and geological constraints must be overcome if hydrocarbon resources on the continental slope (i.e., waters >200 m [656 ft]) off Texas and Louisiana are to be recovered economically. To accomplish this will require novel geological and geophysical surveys and engineering methods. Substantial seafloor engineering problems in deep waters (i.e., >200 m [656 ft]) include both short-term (i.e., slump) and long-term (i.e., creep) slope instabilities, pipeline spanning problems, mass transport from unknown causes, and unusual stiffness and strength conditions (Hooper and Dunlap, 1989). The geohazards, or engineering and geologic constraints, present in and on the continental slope off Texas and Louisiana are numerous and are mainly due to the interactions between salt tectonics and rapid rates of sedimentation.

The main geohazards on the continental slope and their principal results are as follows:

$ Faults – sediment tectonics, halokinesis;
$ Slope stability – slope steepening, slumps, creep, debris flow;
$ Gassy sediments – strength reduction, hydrates, liquefaction;
$ Fluid and gas expulsion features – strength reduction, liquefaction;
$ Diapiric structures – salt, mud, hydrates;
$ Seafloor depressions – blowouts, pockmarks;
$ Seafloor features – sediment waves, differential channel fill, brine-low channels, sea-bed furrows;
$ Shallow waterflow (SWF) – strength reduction, liquefaction; and
$ Deep, high-velocity currents – mega-furrows, seabed erosion.

The GOM is classified as a passive continental margin (i.e., a continental boundary formed by rifting). The northwest margin of the GOM, particularly the continental slope off Texas and Louisiana, has a complex evolutionary history involving prograding and regressing continental shelves, delta systems, and cyclic sea-level fluctuations. The processes that determined the topography and morphology of the upper and lower continental slope (i.e., 200 to 2,000 m [656 to 6,562 ft] and 2,000 to 3,000 m [6,562 to 9,843 ft], respectively) and the distribution of sediments within these areas are almost completely dominated by halokinesis involving allochthonous and autochthonous salt.

Bathymetric charts of the continental slope of the northwestern GOM (Bryant *et al.*, 1990; NOAA, 1990; Bouma and Bryant, 1995, Liu and Bryant, 1999) reveal the presence of over 105 intraslope basins with relief in excess of 150 m [492 ft], 28 mounds, and five major and three minor submarine canyons. The intraslope basins occupy much of the area of the continental slope. Intraslope-interlobal and intraslope-supralobal basins occupy the upper and lower continental slope, respectively. The coalescing of salt canopies forms intraslope-interlobal basins, while supralobal basins are formed by downbuilding into the salt canopy (formerly termed a salt nappe).

The middle and lower portions of the continental slope contain a canopy of salt that has moved down-slope in response to updip extension. The Sigsbee Escarpment is the southern edge of the salt canopy within the study area (figure 3-1). The intraslope basins of the slope are essentially Holocene- and Pleistocene-age sediment depocenters. Fewer basins are found on the uppermost continental slope. In general, these basins have lower-gradient slopes. The structure of this area is affected more by the seaward progradation of deltas during the Pleistocene-age sea-level lowstands and less by salt tectonics, except on a local scale. The lower continental slope contains eight submarine canyons and a large escarpment, each feature evolving from, in part, the coalescing and migration of salt canopies, an unusual process for the formation of submarine canyons.

The geology and topography of the near-surface continental slope (i.e., upper 500 to 1,000 m [1,640 to 3,281 ft] of sediments, the area of greatest concern with regard to submarine slope stability) off Texas and Louisiana are functions of the interplay between episodes of rapid shelf edge progradation and contemporaneous modification of the depositional sequence by diapirism and mass-movement processes. Many slope sediments have been uplifted, folded, fractured, and faulted by diapiric action. Oversteepening on the basin flanks and subsequent mass movements have resulted in the appearance of highly overconsolidated sediments underlying extremely weak pelagic sediments. The construction of the Mississippi Canyon is in part a function of sidewall slumping and pelagic draping of low- shear-strength sediments. In contrast, slope oversteepening and subsequent mass movement have resulted in high pore pressures in rapidly deposited debris flows on the upper slope and on basin floors, resulting in unexpected decreased shear strengths. Biogenic and thermogenic gas induces the accumulation of hydrates and underconsolidated gassy sediments, which are common on the upper slope. On the middle and lower slope, gassy sediments are also encountered, particularly in basins that do not have a salt base, such as Beaumont Basin; the salt canopy restricts the upward movement of gas from below.

Holocene and Pleistocene sediment cores recovered from the continental slope off Texas and Louisiana from conventional piston coring and from Deep Sea Drilling Project activities indicate the presence of unconsolidated gassy clays, silty clays, sands, and clayey sands, many containing gas hydrates. Most samples of Pleistocene sediments recovered from the slope indicate a hemipelagic origin, along with lesser amounts of turbidites and debris flow material. Holocene hemipelagic sediments on the middle and lower portions of the slope are usually less than a meter thick, and are up to several meters thick on the upper slope (Silva *et al.*, 1999).

Water depths over the intraslope–intralobal basins located on the upper slope range from 1,500 to 2,200 m (4,922 to 7,218 ft). The bathymetry of the Central and Western Planning Areas is shown on figure 3-2. The bathymetry of the upper to middle continental slope area consists of relatively flat ridges and basin floors separated by intraslope escarpments. The intraslope basin escarpments have relief up to 700 m (2,297 ft), with slopes generally ranging from 5^{o} to 30^{o} and in some locations up to 50^{o}. Ridges that rim the basins correspond to late, laterally spreading, flat-topped salt tongues overlain by a thin sediment cover (Bryant *et al.*, 1992).

The deeper portions of intraslope-intralobal basins are salt free and exhibit a dissected topography consisting of a multitude of small submarine canyons along the walls. Cores taken on the walls of some basins indicate that as much as 3 m (10 ft) of sediment has been removed by slumping. The intraslope-supralobal basin on the lower continental slope, where the physiography is comparatively smooth (figure 3-2), shows that relief exists mainly as a rounded depression. The slopes of these basin walls generally range from 4 and 8^{o}, but in some areas are

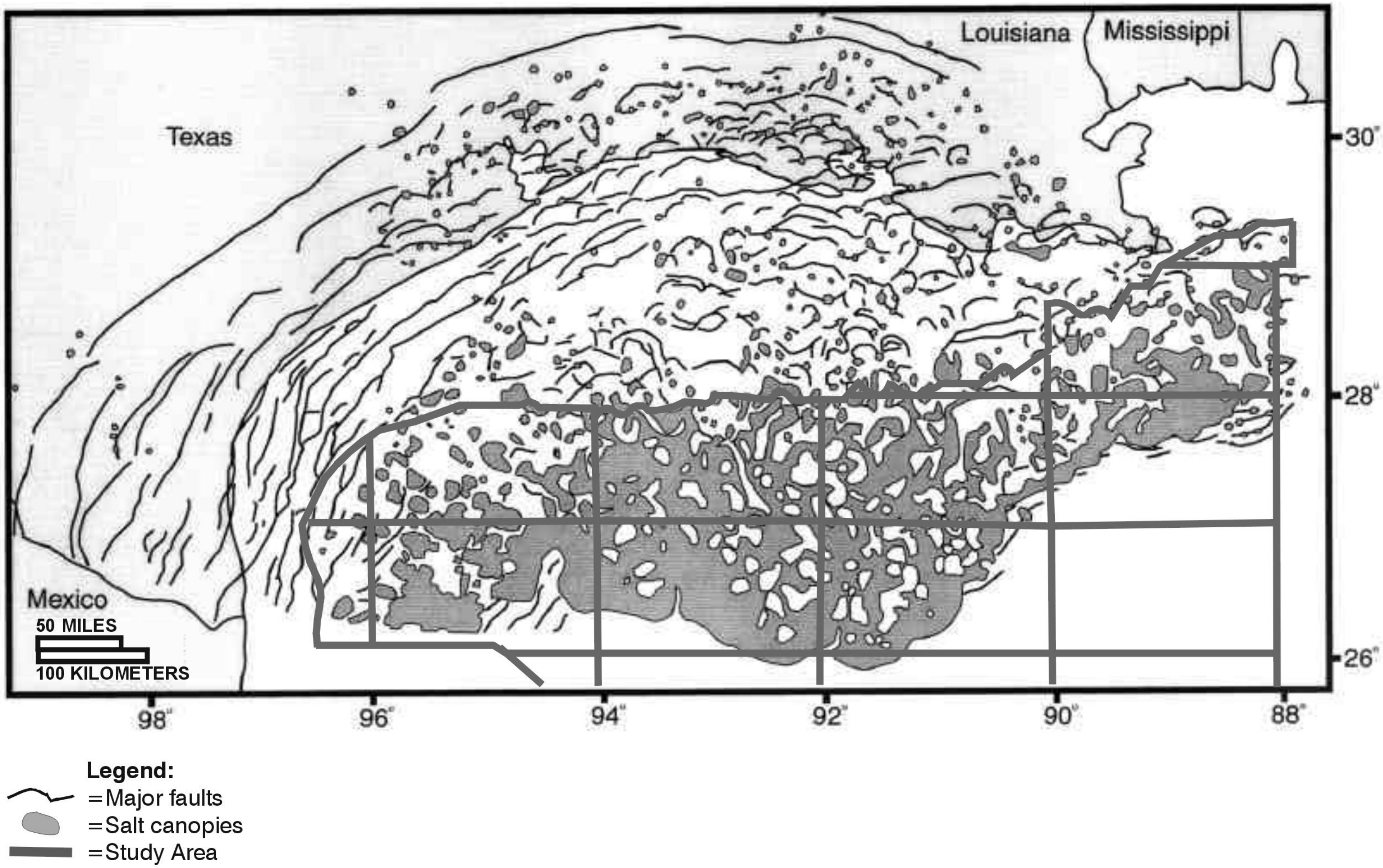


Figure 3-1 **LOCATION OF SALT AND MAJOR FAULTS ON THE CONTINENTAL MARGIN, NORTHWESTERN GULF OF MEXICO (MODIFIED FROM: RAWAN *ET AL.*,1999).**

as much as 15^o. Basins form on the lower slope, where subsidence is due to evacuation of underlying salt (i.e., salt withdrawal). This process is particularly evident in basins such as Vaca Basin, where initial basin subsidence appears to have been relatively slow and accompanied by the accumulation of relatively concordant strata (Bryant and Simmons, 1992). A possible scenario for the creation of intraslope supralobal basins is that subsidence of the basin was initially controlled by differential loading caused by lateral variations in sediment thickness, while the sediments were still relatively buoyant compared to the salt.

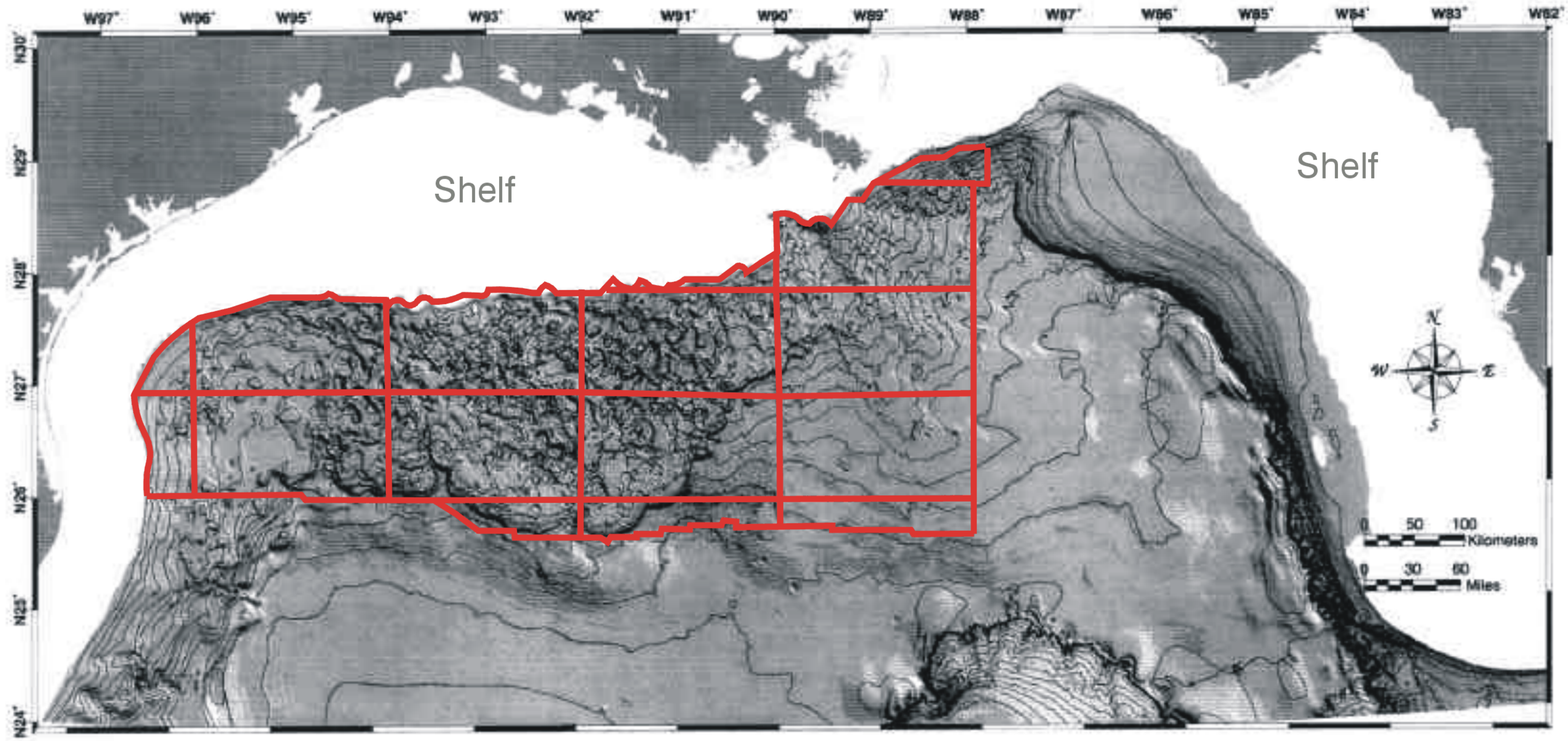
The submarine canyons along the Sigsbee Escarpment (i.e., Alaminos, Keathly, Bryant, Cortez, Farnella, and Green Canyons) are the result of the coalescing of salt canopies, the migration of the salt over the abyssal plain, and erosion of the escarpment during periods of sea-level lowstands (Bryant and Simmons, 1992). The bathymetry of the canyons is illustrated in figure 3-2. In addition to these large submarine canyons, numerous small submarine canyons and gullies and large slumps occur along the escarpment. Submarine fans of various sizes extend seaward of the canyons onto the continental rise. Slopes along a substantial portion of the canyon walls and the escarpment range from 5^o to 10^o, although slopes in excess of 15^o occur. This is supported by large slope failures in the Green Canyon area.

The major faults on the continental slope, referred to as growth faults, are extensional faults that form contemporaneously with rapid accumulation of massive volumes of sediments. Growth faults are found primarily on the upper continental slope, where sediment accumulation is thickest. The most common type of fault on the middle and lower continental slope has been interpreted as "groups of geometrically classified fault families and fault welds that are kinematically and genetically linked to each other and to associated salt bodies and welds. Linked fault systems can contain extensional, contractional, and strike-slip components. Extensional fault families are formed by basinward translation, subsidence into salt, or folding. Those fault families that accommodate basinward translation are balanced by salt extrusion or contractional fault families" (Rowan *et al*., 1999).

Faulting resulting from the formation of salt diapirs is the most common type of faulting on the upper slope. On the middle and lower continental slope, faulting related to salt-stock canopies and salt canopies is the most common type of faulting. Extensive faulting is present on the rim of most intraslope-intralobal and supralobal basins on the middle and lower continental slope. These faults are extensional faults caused by the upward movement of salt resulting from pressures created by sediment accumulation within basins. This type of faulting results in the occurrence of a large number of small faults in the area of the seafloor undergoing extension. In some areas of the slope, the upward migration of salt results in the seafloor being extensively fractured (i.e., faulted) and continuously displaced.

Portions of some of the submarine canyons (e.g., Bryant Canyon) are being filled with salt. Turbidity current flows that are active during times of sea-level lowstands create the canyons. Subsequently, sediments that accumulate on the margins of the canyon differentially load the salt, causing the salt to migrate upward, forming the canyon. The migration of salt into the canyon can occur at a rate of centimeters per year.

On the middle and lower continental slope, salt may occur very close to the seafloor. For example, on the salt plug called "Green Knoll," salt is exposed at the seafloor and is being dissolved by seawater, resulting in the collapse of the cap of the knoll. In intraslope-intralobal Orca Basin, salt is exposed at the bottom of the northern portion of the basin, forming a famous brine pool. In areas where salt is close to the seafloor, the emplacement of structures that require foundation piles will require new engineering methods to accommodate such structures.



Contour Interval: 200meters
Sun Shading: azimuth 45º, elevation 45º

Datum: NAD83
Projection: Albers Equal Area
First Standard Parallel: 29º12'00"N
CentralMeridian: 91ºW

Data Source:
SeaBeam (NGDC;TAMU)
and Petty-Ray Seismics (Bryant *et al*.,1990; NGOC)

Legend:
=Study Area

Figure 3-2 BATHYMETRY MAP OF THE DEEPWATER PORTION OF THE NORTHWESTERN GULF OF MEXICO (MODIFIED FROM: BRYANT *ET AL*.,1990)

Water currents can be a problem for structures on the continental slope, but they may be a major problem to structures such as platforms, bottom assemblies, and pipelines at the base of the Sigsbee Escarpment, starting in water depths as shallow as 1,200 m (3,937 ft) and as deep as 3,300 m (10,827 ft). Recent studies have revealed the presence of large mega-furrows at the base of the Sigsbee Escarpment. These large bedforms, measuring 20 to 30 m (66 to 98 ft) wide and as deep as 10 m (33 ft), occur along the base of the escarpment and extend southward for 20 km (12.4 mi). They result from high-velocity (i.e., up to 103 cm/s [2 knots]) bottom currents occurring along the base of the Sigsbee Escarpment. The mega-furrows have been found extending from long. 90° to 92.5° W., and possibly as far west as Alaminos Canyon.

Shallow waterflow, also known as geopressured sands, is the uncontrolled flow of sand and water that can create substantial sediment pile up (e.g., at a wellhead). Shallow waterflow is the result of compaction disequilibrium, or differential compaction. This process usually occurs at 360 to 530 m (1,181 to 1,739 ft) below the seafloor and is more likely to occur on the upper and middle slope than above the salt canopy, as the tabular salt prevents the escape of overpressures from below.

Properties related to geohazards of the upper, middle, and lower continental slopes, intraslope basins, lower slope canyons, and the Sigsbee Escarpment are summarized in table 3-1.

3.1.2 Meteorology

Air quality in the study area is affected by several meteorological conditions, including temperature, wind speed and direction, and precipitation. Surface temperature affects the amount of convection that occurs in the lower part of the atmosphere. Scientists refer to the upper boundary of convective mixing as the mixing height. While the mixing height over water is more stable due to relatively constant surface temperatures, the mixing height over coastal regions varies both diurnally and seasonally. The mixing height is important in determining how well emissions disperse in the atmosphere.

Wind speed and direction are also important in determining dispersion of emissions. Higher wind speeds tend to disperse pollutants more rapidly than calm winds. Winds that blow from a constant direction for an extended period of time can cause localized emission impacts. Areas near the coast are subject to the land breeze/sea breeze phenomena. Waters of the GOM absorb large amounts of the sun’s energy, which means very little radiative energy is returned to the atmosphere. The sun’s heating of soils in coastal areas returns substantially more radiative heat to the atmosphere; thus, air temperatures over coastal areas are warmer during the daytime hours. At night, land areas lose their heat more rapidly than water areas, so the coastal temperatures are cooler than those found over water. This differential heating and cooling effect manifests itself in land breeze/sea breeze circulation in which winds travel onshore during the day and offshore at night.

Consider the morning profiles from Corpus Christi. It is not uncommon to see a weak surface-based inversion both in temperature and moisture (i.e., dew point temperature). While open water areas of the Gulf typically do not lose sufficient heat overnight to set up a temperature or dew point inversion, there are occasions where offshore inversions are created when warm air is advected over colder water. For example, offshore inversions occur in the winter and spring months near the Mississippi River delta. Temperature inversions (which cause fog) can also cause extreme cases of localized pollution.

Table 3-1

Engineering Constraints and Possible Geohazards of Intraslope Basins and Canyons

Upper to Middle Slope Intraslope-Interlobal Basins -

- Steep sidewalls average 10 to 20 degrees, maximum 50 degrees
- Small submarine canyons and gullies dissect basin escarpments
- Basin wall sediments may be unstable and undergoing modification by creep and slump processes
- Low shear strength debris flow sediments present on basin floors
- Basin floors subject to debris flows from side wall slumping
- Stiff sediments on highly faulted ridges between basins
- Hydrates, gas seeps, carbonate bioherms, and chemosynthetic organisms may be present
- Basins may contain low shear strength, gassy, anoxic sediments
- Isolated basins subject to formation of brine pools
- Basin sediments underconsolidated at shallow subbottom depths

Lower Slope Intraslope-Supralobal Basins -

- Elevated faulted ridges between basins
- Elevated ridge along basin rim
- Basins are bowl shaped with low angle basin floor
- Soft surficial sediments within basin
- Structures on basin floor subject to debris flow
- Basin sediments underconsolidated at shallow subbottom depths

Lower Slope Canyons and Escarpments -

- Side walls average 10 to 15 degrees, maximum 30 degrees
- Small submarine canyons and gullies dissect escarpment and smaller canyon escarpments
- Canyons and escarpment structurally active from effects of halokineses
- Very rugged topography
- Slump deposits and slope failure common
- Small submarine fans on canyon floor formed from debris flows and turbidity currents
- Characteristically located in very deep water
- Sediments underconsolidated at shallow subbottom depths
- High velocity bottom currents and mega-furrows present at base of Sigsbee Escarpment

Precipitation is an important part of the natural cycle for cleansing the atmosphere. Particulate matter is often the base particle on which water vapor coalesces to form the tiny droplets of water that form clouds. Molecules of other pollutants (e.g., SO_2, NO, CO) adhere to the water droplets and are eventually returned to earth in precipitation. While many modern dispersion models contain sophisticated algorithms to assess the wet deposition of pollutants, this feature is not accepted in most regulatory applications and will not be used in determining impacts in this analysis. In addition, the current modeling effort will not address dry deposition.

Emissions from a source may be dispersed from or confined to a local area depending on weather conditions. Thus, meteorological conditions play an important role in assessing the air quality impacts of a proposed action. The remainder of this section describes the meteorology for both the offshore and coastal areas.

General Climatology

The study area covers a substantial portion of the north-central and northwestern GOM. For most of the year (late spring, summer, and fall), weather in the eastern portion of the study area is influenced by the large, subtropical, high-pressure system known as the Bermuda High. The western portion of the study area is influenced by the Mexican Low as well as the Bermuda High. Because the winds circulate clockwise around the Bermuda High and counter-clockwise around the Mexican Low, winds are predominately from the south-southeast across the study area from April to early November. From November to April, winds occasionally shift to the northwest with the passage of mid-latitude frontal systems. In the summer and early fall, high pressure persists aloft over the study area. Most days exhibit a fairly featureless pressure pattern above the surface, with coastal circulation falling under land/sea breeze effects.

On occasion, a weak low-pressure system aloft may move into the area and can remain over the region for several days. A weak upper-level low usually helps to destabilize the air mass and retain moisture to greater depths than normal. On such days, a more than normal number of scattered showers and thunderstorms may develop. These thunderstorms will occur mainly during the hottest part of the day (i.e., from mid-afternoon through the early evening).

During the mid- and late summer, forecasters track easterly waves, tropical depressions, tropical storms, and hurricanes from the eastern Atlantic Ocean to the GOM. The Atlantic/Gulf region typically experiences six to nine named storms during the hurricane season, which extends from June 1st to November 30th. Tropical storms and hurricanes can produce strong winds, thunderstorms, and occasional tornadoes.

Onshore Climatology

Data from the National Climatic Data Center have been evaluated for several locations onshore of the study area, including Corpus Christi, Galveston, Lake Charles, and New Orleans. The years reviewed extended from 1961 through 1990. Based on this analysis, the annual average maximum and minimum daily temperatures along the coastal region of the study area are 77.5 ^{o}F and 60.9 ^{o}F, respectively, with an average daily temperature of 69.2^{o}F. July is normally the hottest month for Lake Charles and New Orleans, with an average high temperature of 90.6 ^{o}F. August is the hottest month for Corpus Christi and Galveston, with average highs of 93.4 ^{o} and 87.6 ^{o}F, respectively. Overall, winters in these areas are relatively mild: January is the coldest month, with an average low temperature of 43.7 ^{o}F. The average annual rainfall for this region is 121 cm (47.6 in). The wettest month is May for Lake Charles, July for New Orleans, and September for Galveston and Corpus Christi. The driest months are February-March for Corpus Christi, Galveston, and Lake Charles, and October for New Orleans. Table 3-2 summarizes climatic data for these four coastal cities located inshore of the study area. Figure 3-3 indicates the location of these coastal cities in relation to the study area.

Mixing heights in coastal regions vary diurnally and seasonally. Winter mixing heights range from 300 to 500 m (984 to 1,640 ft) AGL during the early morning hours, and from 800 to 1,050 m (2,625 to 3,445 ft) AGL by late afternoon. Transient mid-latitude cold fronts can occasionally bring mixing heights below 100 m (328 ft) during frontal passage. Summer mixing heights over coastal areas typically range from 400 to 600 m (1,312 to 1,969 ft) AGL at the beginning of the day, lifting to a range of 1,150 to 2,450 m (3,773 to 8,038 ft) AGL by early evening.

Offshore Climatology

While the offshore climate is affected by the same features (e.g., Bermuda High, Mexican Low) as the coastal environments, there is less daily temperature variation. In July, for example, the daily high and low temperatures in New Orleans vary by an average of 17.5^{o}F, whereas offshore temperatures vary by approximately 6.3^{o}F. Seasonal temperature variability is similar for both onshore and offshore areas. Table 3-3 summarizes climatic data for four weather buoys in or near the study area. Figure 3-3 indicates the location of the buoys.

Mixing heights offshore are quite shallow, generally 1,100 m (3,609 ft) ASL or less. Mixing heights offshore have less diurnal variability than coastal areas because daily temperatures offshore do not vary as much as they do onshore. Transient cold fronts can have an impact on the mixing heights, with some of the lowest heights occurring with frontal passage.

3.1.3 Air Quality

The Clean Air Act (CAA) of 1970, 42 USC 7401 *et seq.*, amended in 1977 and 1990, is the basic Federal statute governing air pollution. The MMS is responsible for implementing the CAA in the study area. It accomplishes this largely through regulations found in 30 Code of Federal Regulations (CFR) Part 250, which ensures that new or modified offshore sources will not substantially affect onshore air quality by requiring that sources are in compliance with state and National Ambient Air Quality Standards (NAAQS). The U.S. EPA developed the Prevention of Significant Deterioration (PSD) program [40 CFR Part 51] to ensure that areas already in compliance with the NAAQS do not deteriorate air quality to levels at or above those standards. Such areas, depending upon the quality of their air in a baseline year, must control the emissions of certain pollutants such that the concentrations of those pollutants increase no more than the allowable increment as set forth in the CAA.

The CAA designates six pollutants as criteria pollutants for which NAAQS are promulgated. The NAAQS for sulfur dioxide (SO_2), nitrogen dioxide (NO_2), respirable particulates (PM_{10}, particulates <10 microns in diameter), carbon monoxide (CO), ozone (O_3), and lead (Pb) were set to protect human health (primary standards) and welfare (secondary standards). The NAAQS standards are provided in table 3-4. The proposed action is located in an area presumed to be in attainment with applicable ambient standards.

The coastal areas near the proposed action area are currently designated as “attainment” for all NAAQS-regulated pollutants except ozone. As required by Title I of the CAA Amendments of 1990, USEPA designated several areas in the Gulf Coast states as "nonattainment" for ground-level ozone (a primary constituent of smog) as shown in figure 3-4. Nonattainment areas are classified as marginal, moderate, serious, severe, or extreme.

Table 3-2

Coastal Gulf Climate Data

City	Average Maximum Temperature (°F)	Average Minimum Temperature (°F)	Average Rainfall (inches)	Average Morning Mixing Height (m)	Average Afternoon Mixing Height (m)
Corpus Christi, TX	81.0	62.1	30.1	368	1,812
Galveston, TX	74.3	64.9	42.3	NA	NA
Lake Charles, LA	77.2	58.1	55.8	473	1,116
New Orleans, LA	77.5	58.5	62.2	552	1,150

Source: Temperatures derived from NCDC Cooperative Stations 1961-1990 Normals. Precipitation derived from data for years between 1954 and 1995. Mixing heights derived for variable periods for each station between 1965 and 1998.

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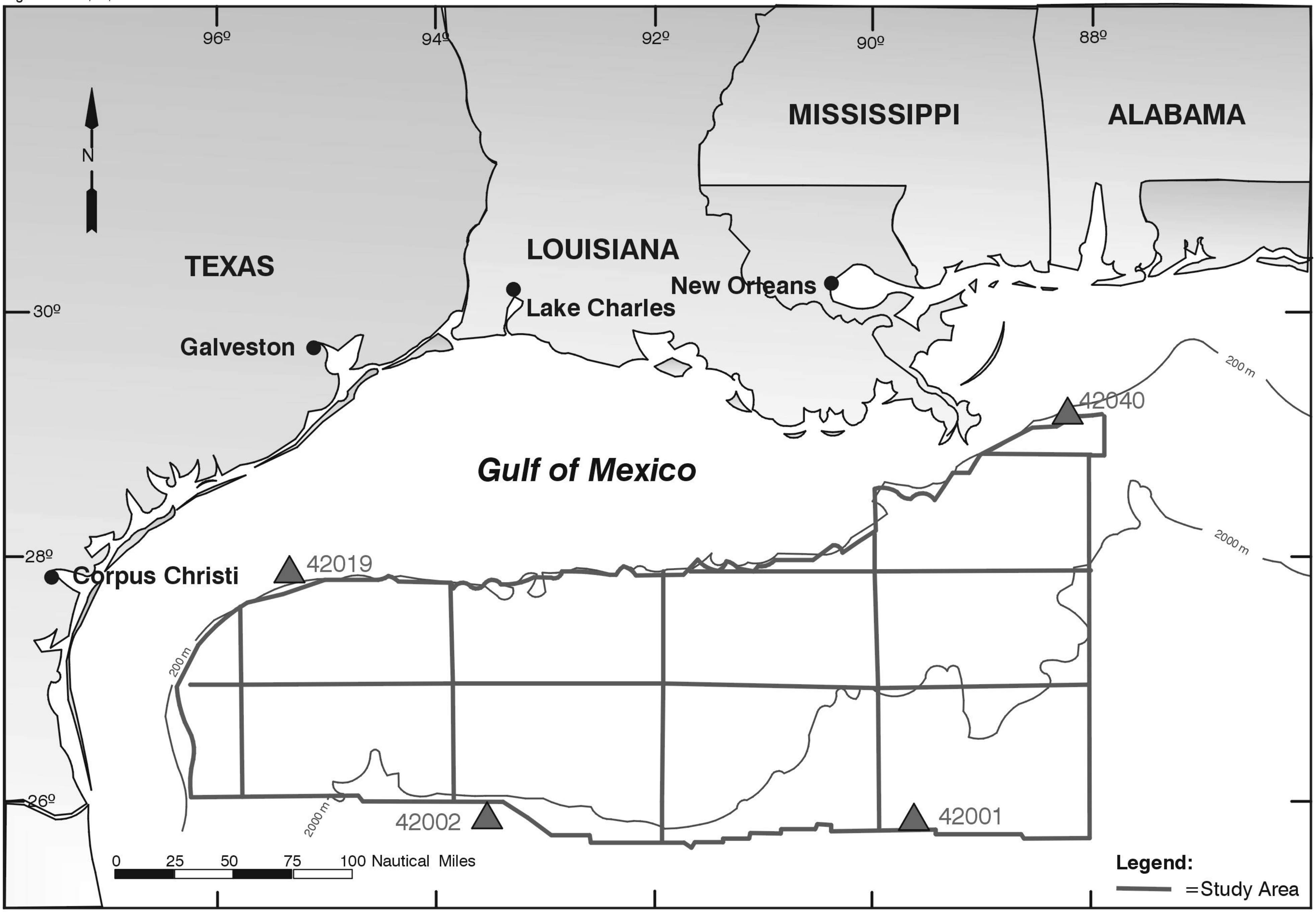

Figure 3-3 COASTAL AND OFFSHORE WEATHER DATA POINTS DISCUSSED IN TEXT.

Table 3-3

Gulf Offshore Buoy Data

Station ID	Average Maximum Temperature (°F)	Average Minimum Temperature (°F)	Average Annual Sea Temperature (°F)	Average Wind Speed (knots)
42019	78.7	69.8	76.8	11.8
42002	79.2	71.7	73.9	12.0
42001	79.3	72.2	78.6	11.4
42040	76.5	67.5	76.1	10.9

Source: Derived from available station data for variable periods at each buoy between 1973 and 1997.

Table 3-4

National Ambient Air Quality Standards (NAAQS), PSD Increments, PSD Significant Emission Rates, and Modeling Significance Levels

	National Ambient Air Quality Standards (NAAQS)[a]						PSD Increments ($\mu g/m^3$)		PSD Significant Emission	Modeling Significance	FLM Modeling Significance
	Averaging	Primary		Secondary			Class		Rates[b]	Levels	Levels
Pollutant	**Period**	**($\mu g/m^3$)**	**(ppm)**	**($\mu g/m^3$)**	**(ppm)**	**Form** (i.e., How Standard is Applied)	**I**	**II**	**(tons/year)**	**($\mu g/m^3$)**	**($\mu g/m^3$)**
PM_{10}	Annual	50[c]	--	50[c]	--	Annual arithmetic mean, averaged over 3 years	4	17	15	1	0.16
	24-hour	150[c]	--	150[c]	--	99th percentile of concentrations in a given year, averaged over 3 years	8	30		5	0.32
$PM_{2.5}$	Annual	15[c]	--	15[c]	--	Annual arithmetic mean from single or multiple monitors, averaged over 3 years	PSD Increments and Significant Emission Rates have not yet been established for $PM_{2.5}$				
	24-hour	65[c]	--	65[c]	--	98th percentile of concentrations in a given year, averaged over 3 years					
SO_2	Annual	(80)	0.03	--	--	Annual arithmetic mean	2	20	40	1	0.1
	24-hour	(365)	0.14	--	--	Not to be exceeded more than once per calendar year	5	91		5	0.2
	3-hour	--	--	(1,300)	0.5	Not to be exceeded more than once per calendar year	25	512		25	1
NO_2	Annual	(100)	0.053	(100)	0.053	Annual arithmetic mean	2.5	25	40 of NO_X	1	0.1
Ozone	8-hour	(157)[c]	0.08[c]	(157)[c]	0.08[c]	3-year average of annual 4th highest daily maximum 8-hour concentrations	--	--			
	1-hour	(235)[c]	0.12[c]	(235)[c]	0.12[c]	Not to be exceeded more than 3 times in 3 consecutive years	--	--	40 of VOC	--	
CO	8-hour	(10,000)	9	--	--	Not to be exceeded more than once per calendar year	--	--	100	500	
	1-hour	(40,000)	35	--	--	Not to be exceeded more than once per calendar year	--	--		2,000	
Lead	Calendar Quarter	1.5	--	1.5	--	Maximum arithmetic mean	--	--	0.6	--	

[a] NAAQS are expressed in $\mu g/m^3$ for particulate matter (and lead) and in parts per million (ppm) for the other pollutants. For reference, corresponding equivalent standards are shown in parentheses.

[b] Lower Significant Emission Rates apply in certain nonattainment areas for nonattainment new source review. Sources within 10 km of Class I areas can trigger PSD if impacts exceed 1 $\mu g/m^3$ (24-hour average).

[c] PM2.5 and Ozone 8-Hour Standards are suspended pending litigation. See 40 CFR Part 50 for information regarding the implementation of the new $PM_{2.5}$ and ozone standards and the interim treatment of the existing standards.

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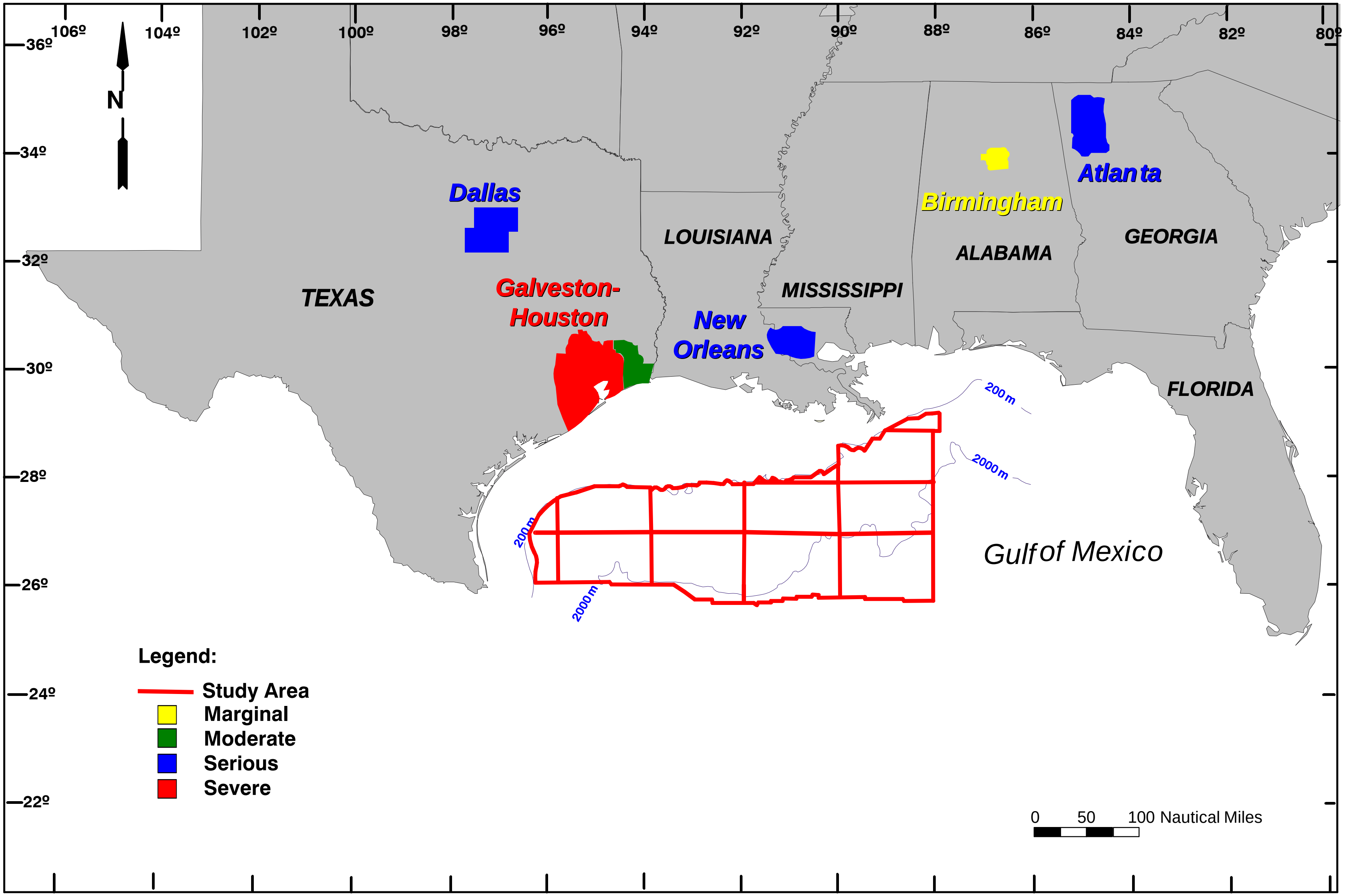

Figure 3-4 CLASSIFIED OZONE NONATTAINMENT AREAS WHERE THE ONE-HOUR STANDARD STILL APPLIED AS OF JULY 1999

The MMS reviews proposed new or modified pollutant sources located in OCS waters to evaluate potential impacts of the proposed source on onshore air quality, especially noting whether the source will contribute to any violation of the NAAQS.

Modeling Significance Levels

The MMS has codified modeling significance levels in 30 CFR Part 250.303 (1999) to determine compliance with the NAAQS and PSD requirements. New facilities are required to model impacts using an approved model to determine whether the projected emissions of those air pollutants from the facility result in an onshore ambient air concentration above the modeling significance levels. The MMS modeling's significant impact levels are set at the same concentrations as the current EPA significance levels for new or modified major PSD sources affecting attainment areas. The MMS modeling significance levels are shown in table 3-5.

Class I Areas

Many areas of unique natural qualities have been designated as Class I areas under the Wilderness Act of 1964. These Federally designated areas are to remain "unimpaired" for future use and enjoyment as wilderness. As such, Class I areas have the lowest increment of permissible deterioration, which essentially precludes development near these areas. The Breton National Wilderness Area, located approximately 113 km (70 mi) east of Chalmette, Louisiana, is the nearest Class I area to the study area. Other Class I areas located closest to the Gulf region are shown in figure 3-5.

3.1.4 Physical Oceanography

Background

Few hydrographic surveys of the entire GOM have been conducted during the past several decades. Examples of data sources include a series of cruises in the 1960s (e.g., Hidalgo 62-H-3, Geronimo cruises, and Kane). The limited available data, however, can be combined to obtain nearly synoptic descriptions of the general circulation in the Gulf. The resulting patterns are similar. The general circulation pattern based on the Hidalgo cruise completed in 1962 is illustrated in figure 3-6 (after Nowlin, 1972). The contours in figure 3-6 represent the flow paths (streamlines) of the geostrophic surface currents calculated relative to the 1,000-m (3,281-ft) reference surface. These currents reflect the medium- to large-scale distributions of temperature and salinity, and thus density. This pattern also is characteristic of time-averaged outputs from numerical models of the circulation in the Gulf (e.g., see Hurlbert and Thompson, 1980, 1982). This pattern most closely approximates the time-averaged, or background, circulation in the Gulf, not instantaneous currents.

The streamlines entering the Gulf through the Yucatan Channel, turning clockwise, and then exiting the Gulf into the Straits of Florida, represent the Loop Current, which is a part of the western boundary current system of the North Atlantic. This is the principal current and source of energy for the circulation in the Gulf. The Loop Current may be confined to the southeastern GOM or it may extend well into the northeastern or north-central Gulf, with intrusions of Loop

Table 3-5

Significant Impact Levels for Air Emissions

Pollutant	Averaging Period	MMS Significant Impact Levels[a] ($\mu g/m^3$)	FWS Significant Impact Levels[b] ($\mu g/m^3$)
Nitrogen Dioxide (NO_2)	Annual	1.0	0.1
Sulfur Dioxide (SO_2)	Annual	1.0	0.1
	24-Hour	5.0	0.2
	3-Hour	25	1.0
Particulates (PM_{10} or TSP)	Annual	1.0	0.16
	24-Hour	5.0	0.32
Carbon Monoxide (CO)	8-Hour	500	N/A
	1-Hour	2,000	N/A

[a] 30 CFR Chapter II, Minerals Management Service, Department of the Interior, Section 250.303(e); 30 CFR Chapter II, Minerals Management Service, Department of the Interior, Section 250.45(e).

[b] Update and clarification of Guidance Document For the Review of Offshore Air Pollutant Emissions Sources, FWS, September 1997.

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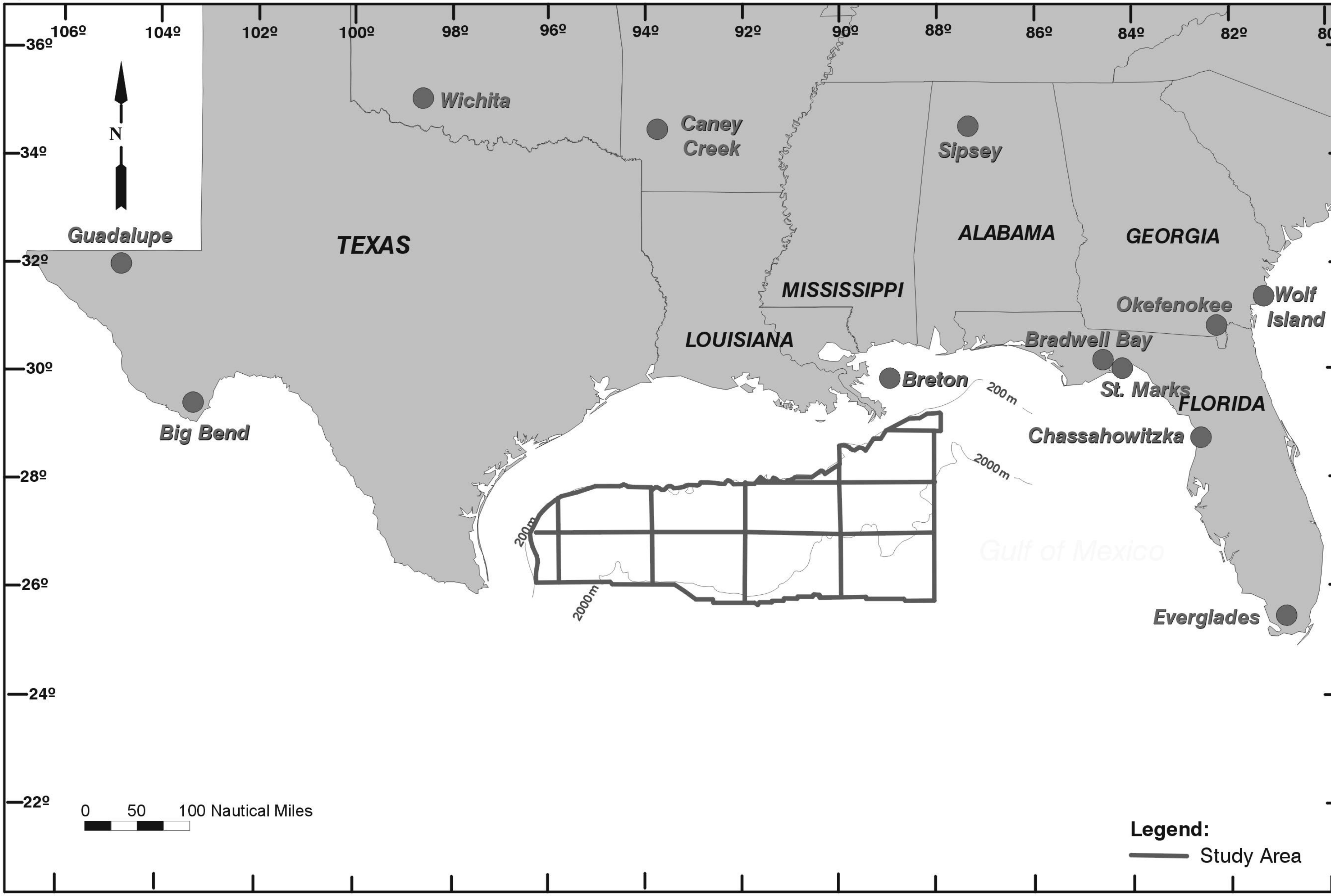

Figure 3-5 CLASS I AIR QUALITY AREAS IN PROXIMITY TO THE U.S. GULF COAST (MODIFIED FROM: USFWS, 2000).

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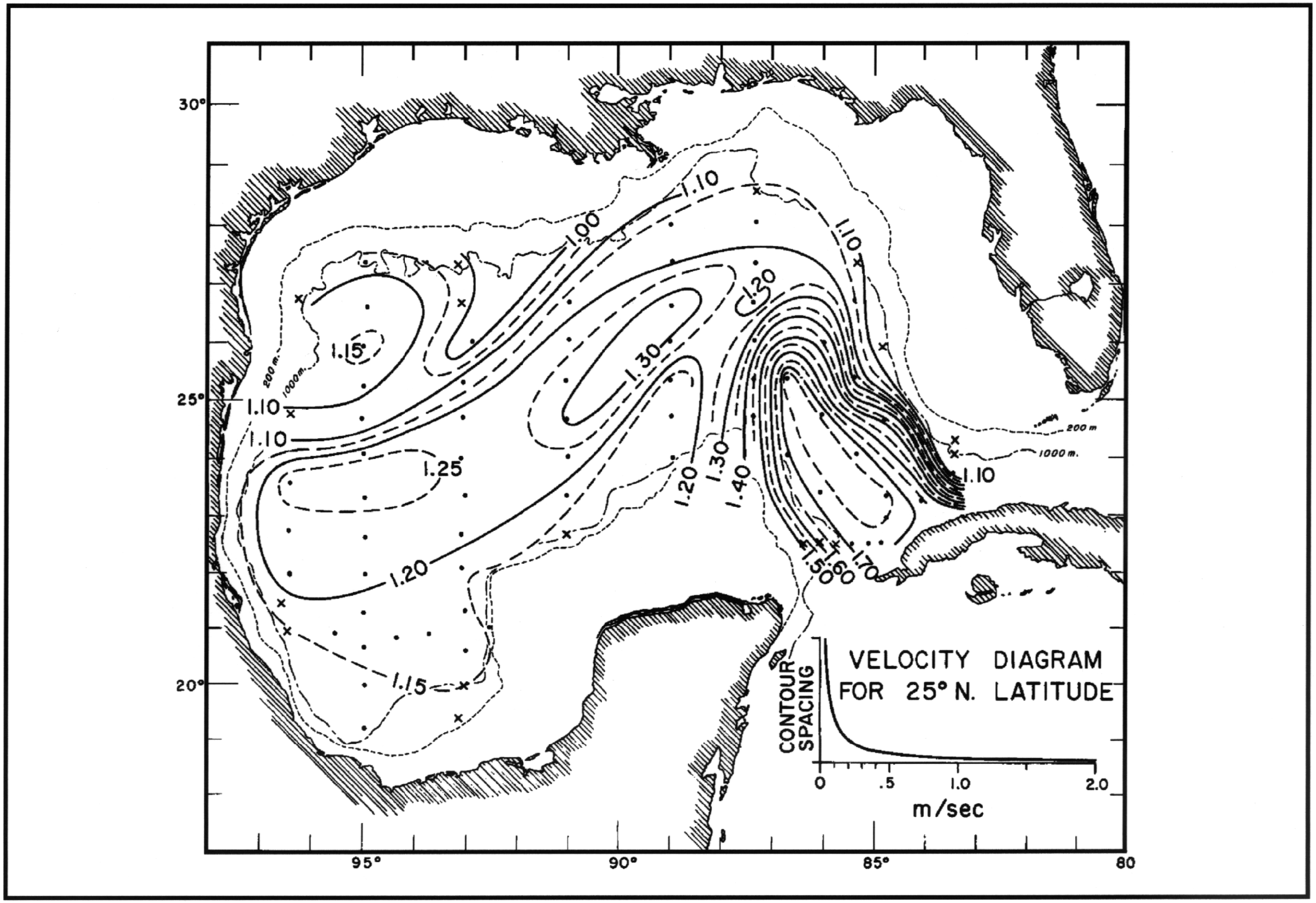

Fig. 3-6. Geopotential anomaly (dynamic m) of the sea surface relative to the 1000-db surface, constructed from *Hidalgo* cruise 62-H3 data collected February-March 1962.

Current water even to the shelf edge along Louisiana and the Florida panhandle (e.g., Huh *et al.*, 1981; Paluszkiewicz *et al.*, 1983).

Closed rings of clockwise-rotating (i.e., anticyclonic) water, called Loop Current Eddies (LCEs), separate periodically from the Loop Current. Studies on the frequency of Loop Current intrusions into the eastern Gulf and of the frequency of LCE separation (Sturges, 1992, 1994; Sturges *et al.*, 1993; Vukovich, 1988, 1995) clearly show these to be chaotic processes.

Currents associated with the Loop Current and its eddies extend at least to depths of 800 m (2,625 ft), the sill depth of the Florida Straits, and geostrophic shear is observed to extend to the sill depth of the Yucatan Channel (2,000 m; 6,562 ft). These features may have surface speeds of 150 to 200 cm/s (2.9 to 3.9 kn) or more; speeds of 10 cm/s (0.2 kn) are not uncommon at a depth of 500 m (1,640 ft) (Cooper *et al.*, 1990). Anticyclonic eddies separate from the Loop Current with frequency peaks at 8 to 9 months and at 13 to 14 months (Sturges, 1994). These Loop Current eddies can have lifespans of one year or more (Elliot, 1982). Therefore, their effects can persist at one location for long periods - weeks or even months (e.g., Nowlin *et al.*, 1998).

The major large-scale permanent circulation feature present in the Western and Central Planning Areas is an anticyclonic (clockwise rotating) feature oriented about ENE-WSW with its western extent near lat. 24^{o} N. off Mexico. There has been debate regarding the mechanism for this anticyclonic circulation and the possible associated western boundary current along the coast of Mexico. Elliott (1979) attributed LCEs as the primary source of energy for the feature, but Sturges (1993) argued that wind stress curl over the western Gulf is adequate to drive an anticyclonic circulation with a western boundary current. Sturges (1993) found annual variability in the wind stress curl corresponding to the strongest observed boundary current in July and the weakest in October. Based on ship drift data, Sturges (1993) showed the maximum northward surface speeds in the western boundary current were 25 to 30 cm/s (0.49 to 0.58 kn) in July and about 5 cm/s (0.1 kn) in October; the northward transport was estimated to vary from 2.5 to 7.5×10^{6} m^{3}/s (8.83×10^{7} to 2.65×10^{8} ft^{3}/s). He reasoned that the contribution of LCEs to driving this anticyclonic feature must be relatively small. Others have attributed the presence of a northward flow along the western Gulf boundary to ring-slope-ring interactions (Vidal *et al.*, 1999).

Stratification

Table 3-6 gives the names, depth ranges, densities, and identifying features of the remnants of the principal water masses, excluding the highly variable surface waters, as observed in 1) the eastern GOM by Morrison and Nowlin (1977) and Nowlin and McLellan (1967); and 2) the western GOM by Morrison *et al.* (1983) and Nowlin and McLellan (1967). Extrema in water mass properties are closely associated with specific density surfaces. All of these subsurface waters derive from outside the Gulf and enter from the Caribbean Sea through the Yucatan Channel, which has a sill depth of approximately 2,000 m (6,562 ft). Below that depth, horizontal distributions of temperature and salinity within the Gulf are essentially uniform.

Figure 3-7 presents composite plots of temperature vs. salinity, temperature vs. depth, and salinity vs. depth for the winter cruise 62-H-3 that covered the entire Gulf. Evident in these plots is the wide range of near-surface values, especially because sampling extended over the shelves. Also seen are rather wide ranges of depths at which specific values of temperature or salinity are found in the main pycnocline and very narrow ranges at depth.

Table 3-6

Water Masses in the Gulf of Mexico, Associated Property Extremes, and Potential Densities

	Eastern Gulf of Mexico			Western Gulf of Mexico		
Water Mass	Depth (m)	Feature(s)	Sigma-theta (mg/cm^3)	Depth	Feature(s)	Sigma-theta (mg/cm^3)
SUW-LC	150-250	S_{max}	25.40	NA	NA	NA
SUW	150-250	S_{max}	25.40	0-250	S_{max}	25.40
18C W	200-400	O_{2max}	26.50	NA	NA	NA
TACW	400-700	O_{2min}	27.15	250-400	O_{2min}	27.15
AAIW	NA	NA	NA	500-700	NO_{3max}	27.30
AAIW	700-900	PO_{4max}	27.40	600-800	PO_{4max}	27.40
AAIW	800-1,000	S_{min}	27.50	700-800	S_{min}	27.50
		S_iO_{2max}	NA		S_iO_{2max}	NA
UNADW	900-1,200	S_iO_{2max}	27.70	1,000-1,100	S_iO_{2max}	27.70

Key:

18C W	=	18 degree C Sargasso Sea Water
AAIW	=	Antarctic intermediate water
NO_{3max}	=	nitrate maximum
O_{2max}	=	dissolved oxygen maximum
O_{2min}	=	dissolved oxygen minimum
PO_{4max}	=	phosphate maximum
S_iO_{2max}	=	silicate maximum
S_{max}	=	salinity maximum
S_{min}	=	salinity minimum
SUW	=	subtropical underwater in the Gulf but outside Loop Current
SUW-LC	=	subtropical underwater in Loop Current and new Loop Current eddies
TACW	=	tropical Atlantic central water
UNADW	=	mixture of upper North Atlantic deep water and high silicate Caribbean mid-water

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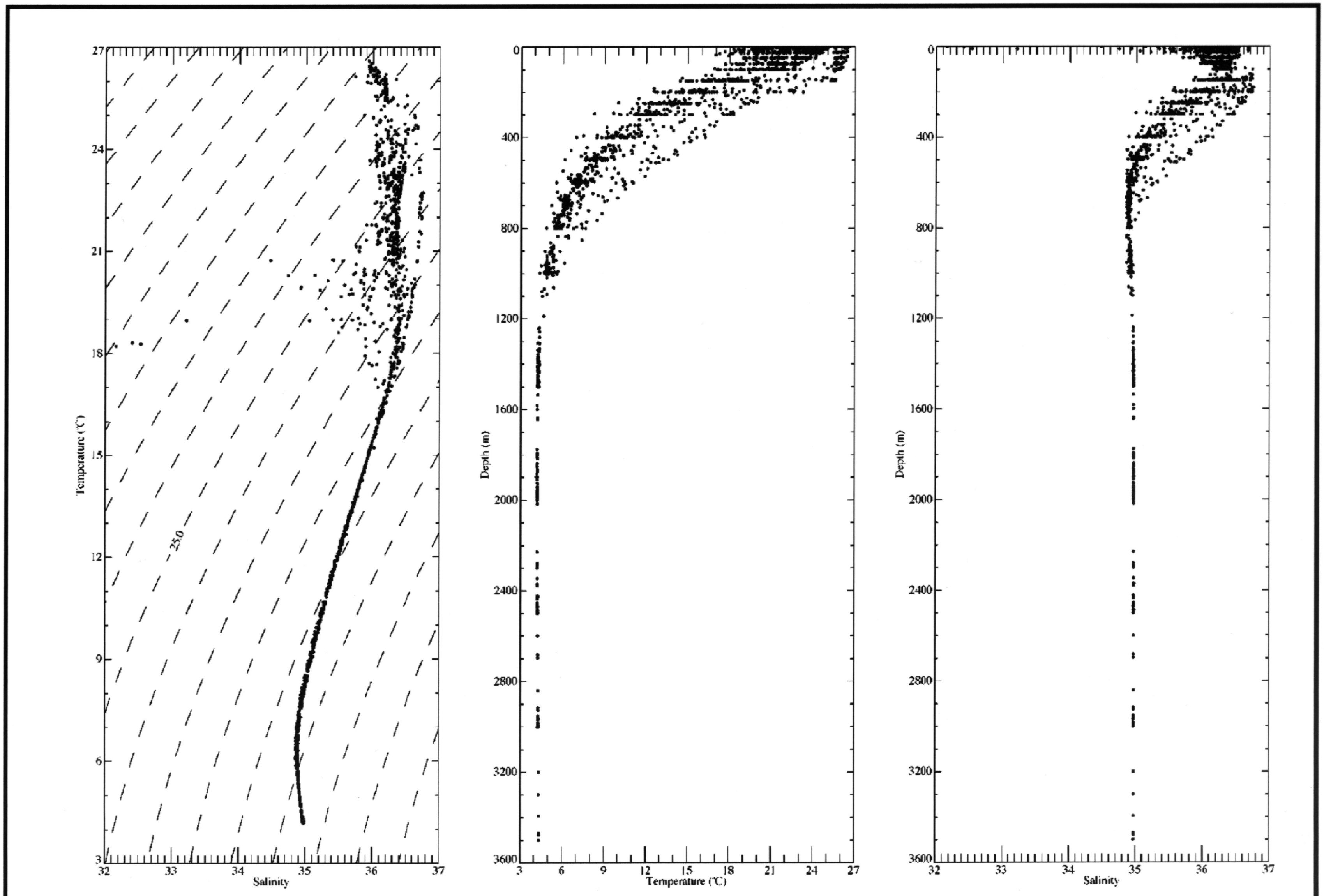

Fig. 3-7. Temperature vs. salinity, temperature vs. depth, and salinity vs. depth based on all data collected during *Hidalgo* cruise 62-H3, February-March 1962.

Figure 3-8 better illustrates upper layer waters with two different distributions. Caribbean-type water with a high maximum salinity marking the core of the Subtropical Underwater is found within the region enclosed by the Loop Current and LCEs, illustrated in the figure by station 215, which was within an older LCE found in the northwestern Gulf. The second type of distribution is illustrated in the figure by station 165, which was located within a cyclone in the northwestern Gulf; at that station, the salinity maximum at the Subtropical Underwater core is much reduced by vertical mixing (characteristic of open Gulf waters outside of the Loop Current and of LCEs), and temperatures and salinities are found higher in the water column than within the LCEs.

Robinson (1973) describes the seasonal variability of the upper waters of the Gulf in terms of the monthly mean temperatures of the surface and upper 150 m (492 ft) and the depth to the top of the thermocline. Contoured fields of temperature at six levels and the depth of the thermocline are presented. Also shown are time series of temperatures averaged for each 2.5^{o} by 2.5^{o} square.

Principal Energetic Currents

At least five classes of phenomena occur in the study area that can cause energetic currents of potential concern to those involved with offshore oil and gas production and transportation. Descriptions of these phenomena are provided below.

- Currents resulting from energetic, episodic, or regular atmospheric events (e.g., cold-air outbreaks, extratropical cyclones, and tropical cyclones such as hurricanes);
- Surface-intensified currents arising from major surface circulation features (the Loop Current, the anticyclonic LCEs derived there, and both cyclonic and anticyclonic eddies spun up in the Gulf);
- Currents extending from about 1,000 m (3,281 ft) through the deeper water column with little depth variation (e.g., those believed to be associated with topographic Rossby waves), sometimes with bottom intensification;
- High-speed, subsurface-intensified currents or jets; and
- Currents responsible for large, linear furrows discovered along the base of the continental slope in some locations of the western and central Gulf.

The remaining subsections of this discussion of the physical oceanography of the Gulf provide overviews of these phenomena.

Currents Caused by Energetic Atmospheric Events

Perhaps the currents of greatest concern are those resulting from strong, episodic wind events such as tropical cyclones (especially hurricanes), extratropical cyclones, and cold-air outbreaks. Such wind events can result in extreme waves and cause currents with speeds of 100 to 150 cm/s (1.9 to 2.9 kn) over the continental shelves. Additional information on wave spectra and wave kinematics is provided in the last section of the physical oceanography discussion. Recent examples for the Texas-Louisiana shelf and upper slope are given in Nowlin *et al.* (1998). Other researchers (e.g., Brooks, 1983, 1984; Molinari and Mayer, 1982) have measured

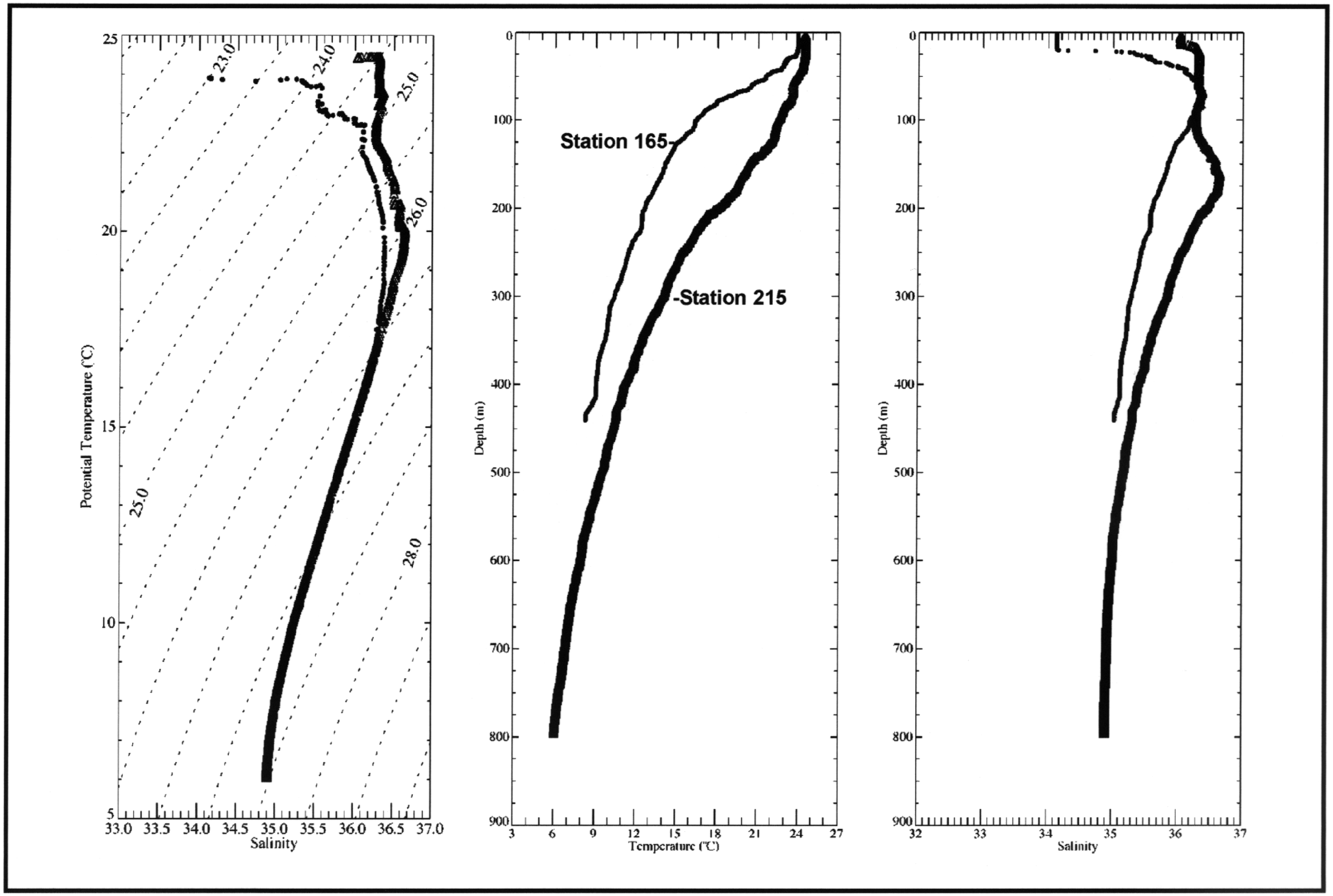

Fig. 3-8. Temperature vs. salinity, temperature vs. depth, and salinity vs. depth for two stations made in early May 1993 over the continental slope off Texas.

the effects of such phenomena down to depths of 700 m (2,296 ft) and 980 m (3,215 ft), respectively, over the continental slopes in the northwestern and northeastern Gulf.

There are many studies of hurricane effects on the underlying ocean. Most of these focus on surface wind waves or storm surges. However, an increasing number of studies have considered the effects on currents and thermal (and density) structures in deep water. Among those with a focus on hurricanes in the GOM are Leipper (1967), O'Brien and Reid (1967), O'Brien (1967), Forristall (1974), Forristall (1980), and Cooper and Thompson (1989a, 1989b). Sanford *et al.* (1987) and Price *et al.* (1994) convey the results of a study of direct current observations within hurricanes accompanied by model hindcasting and comparisons. Although the hurricanes studied were out of the immediate study area (i.e., Hurricane Norbert, off western Mexico at lat. ~20°N in September 1984; Hurricanes Josephine and Gloria, off the southeast Atlantic coast at lat. ~30°N in October 1984 and September 1985, respectively), the results should be equally applicable to the GOM for hurricanes exhibiting similar characteristics. These authors measured upper ocean (200 m; 656 ft) currents by deploying aircraft expendable current profilers (AXCP) in a pattern through each hurricane; AXCP deployment was made possible through use of a weather reconnaissance plane from which meteorological observations were also taken. The oceanic reaction to a severe storm can be separated into the initial "forced response" with the arrival of the storm and the "relaxation stage response" with the passage and retreat of the storm. AXCP measurements were analyzed to separate surface mixed layer and surface wave currents. The maximum vertically-uniform currents in the surface mixed layer (i.e., from the surface to ~50 m [165 ft]) in the three storms were found to be 73, 110, and 170 cm/s (1.4, 2.1, and 3.3 kn), with the largest currents measured in each storm's right quadrant. The vertical shear measurements of the mixed layer currents were on the order 20 to 30 cm/s (0.4 to 0.6 kn). Maximum surface currents from combining both mixed layer and surface wave components were estimated at 133 to 346 cm/s (2.6 to 6.7 kn). These results were consistent with model results. Models accounted for 35 to 90 percent (average: 85 percent) of the variance of the mixed layer currents, and agreement increased with increasing current speed. Mixed layer currents showed patterns of divergence centered behind the eyes of the storms; these lead to upwelling at the base of that layer and a lowering of sea level above. Mixed layer divergence and associated distortion of the thermal and density fields occur on near inertial periods, giving rise to inertial waves with wave lengths of several hundred km and decay scales of 5 to 10 days (e.g., see Brooks 1983).

Tropical conditions normally prevail over the Gulf from May or June until October or November. The nominal hurricane season is 1 June through 30 November. Figure 3-9 shows horizontal current vectors (i.e., hourly values from 3-hr low-passed records) during late August 1992 from two locations off Louisiana at approximately long. 90.5^{o} W. on the shelf edge and upper slope. Moorings 13 and 12 were located in water depths of 200 and 504 m (656 and 1,654 ft), respectively. Current meter depths are indicated. The eye of Hurricane Andrew passed on a northeastward track about 85 km (53 mi) north of mooring 13 at 0000 UTC on 26 August. Near-surface instruments recorded a large surge of water directed to the left of the storm's track just before the passage of the eye; maximum values at 10 m (32.8 ft) on mooring 13 reached 163 cm/s (3.2 kn). Following the initial surge, an oscillation with near inertial period was set up that penetrated, with diminished amplitude, to the deepest instrument on mooring 13 approximately 24 hours after the initial surge. Some time delay and considerable decrease in amplitude with depth is seen, although the maximum speed at 190 m (623 ft) exceeded 100 cm/s (1.9 kn). There was a weak coherent response at 490 m (1,607 ft) at mooring 12 (note the change in velocity scale). The inertial oscillation continued with diminishing amplitudes for about one week.

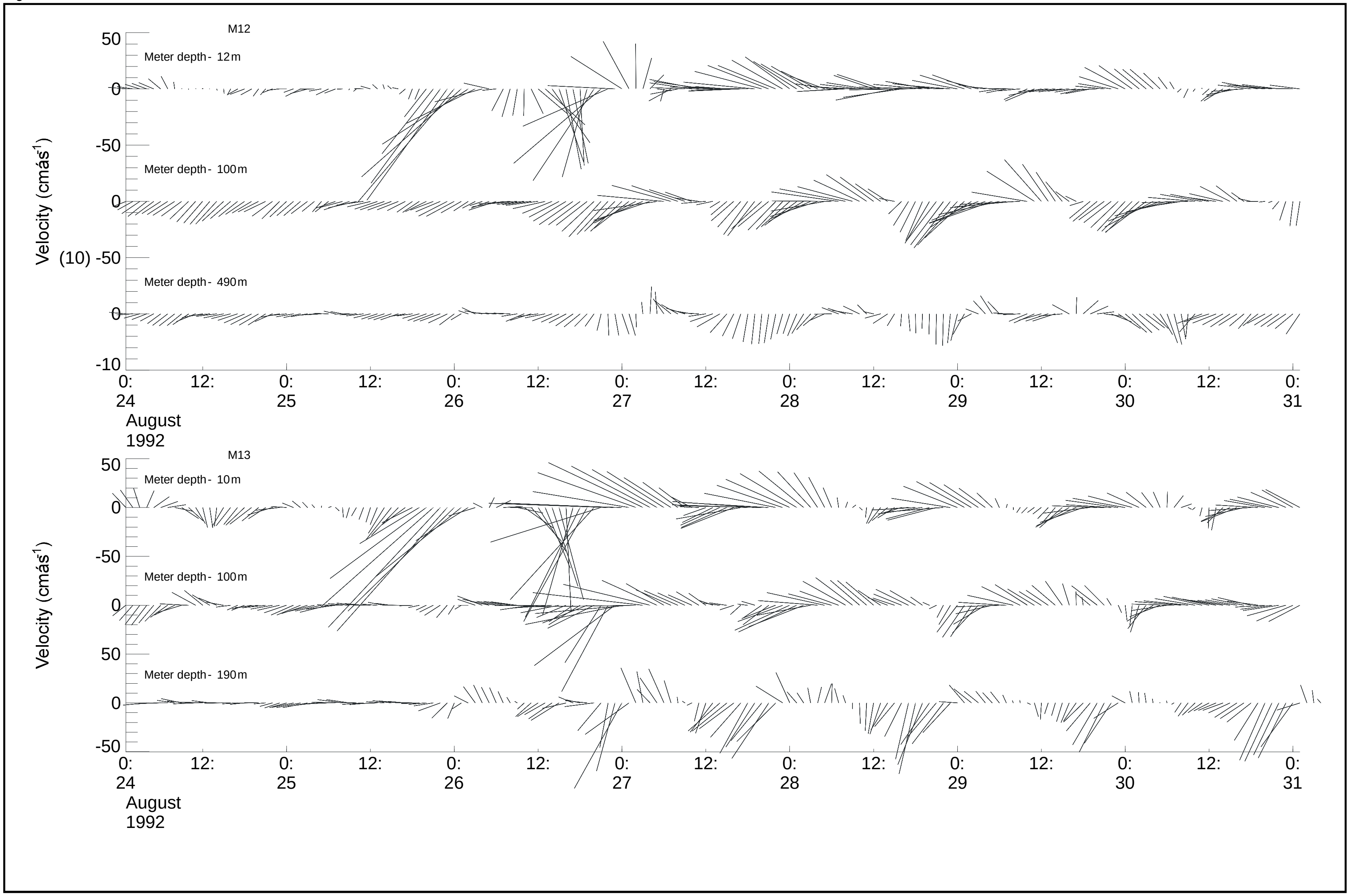

Figure 3-9 HORIZONTAL CURRENT VECTORS (HOURLY VALUES FROM 3-HR LOW-PASSED RECORDS) DURING LATE AUGUST 1992 FROM TWO LOCATIONS (200 M AND 504 M) OFF LOUISIANA AT APPROXIMATELY LONG.90.5° W ON THE SHELF EDGE AND UPPER SLOPE

Figure 3-10 shows hourly current components (u positive to the east and v positive to the north) measured at indicated depths from 200 to 700 m (656 to 2,297 ft) on moorings S (lat. 26^o N., long. 96^{o}10' W.) and C (55 km [34 mi] north of S). Both moorings were approximately on the 730-m (2,395-ft) isobath. At approximately 0000 UTC on 10 August 1980, the eye of Hurricane Allen passed about 65 km (40.4 mi) west-southwest of mooring S on a track toward the north-northwest. The effects of the hurricane passage were reported by Brooks (1983). Currents were stronger at mooring C than at S, although currents at both were affected, even to within 20 m (66 ft) of the bottom. The observed forced stage response to the storm was a strong southward, alongshore current that occurred with the landward passage of the hurricane; maximum speeds exceeded 90 cm/s (1.7 kn) in the thermocline at 200 m (656 ft) and 15 cm/s (0.3 kn) at 700 m (2,296 ft). This surge triggered a series of internal waves with near inertial period as the relaxation stage response; these elliptical motions had maximum speeds along shore that reached 50 cm/s (1.0 kn) within about three days and then lasted for about five days with decreasing amplitudes. These oscillations were coherent over the scale of mooring separation (55 km; 34 mi) and with depth.

From October or November until March or April, the Gulf experiences intrusions of cold, dry continental air masses. These result in the formation of extratropical cyclones and cold-air outbreaks, both of which can cause highly energetic surface currents. On average, about 10 to 12 extratropical cyclones are formed over the northern Gulf per year; the number of frontal passages varies from one to two per month in summer to over 10 per month in winter. To illustrate the effects of an extreme extratropical cyclone, figure 3-11 shows eastward (u) and northward (v) components of currents (i.e., hourly values from 3-hr low-passed records) from two moorings located off Louisiana at approximately long. 90.5^o W. Moorings 13 and 12 were in water depths of 200 m (656 ft) and 504 m (1,654 ft), respectively. On 12 March 1993, a Class 5 extratropical cyclone moved from west to east across the Texas-Louisiana shelf with its center approximately over the 1,500-m (4,922-ft) isobath. Initially, the flow over the outer shelf and slope was toward the northeast as part of an induced cyclonic circulation over the Texas-Louisiana shelf. Following the passage of the storm out of the area on 13 March, a surge occurred to the southwest, followed by a period (14-17 March) of strong motion toward the northeast, with diurnal modulation. This was followed by an energetic near-inertial oscillation with decreasing amplitude lasting over a week. The maximum observed speeds associated with this event were 65, 22, 67, 41, and 35 cm/s (1.3, 0.4, 1.3, 0.8, and 0.7 kn) at moorings 12 (upper, 12 m; 39.37 ft), , 12 (lower; 100 m; 328 ft), 13 (upper; 10 m; 33 m), 13 (mid; 100 m; 328 ft), and 13 (lower; 190 m; 623 ft), respectively.

During the MMS-sponsored LATEX program of the early 1990s, a class of energetic surface currents previously unreported in the GOM were found over the Texas and Louisiana shelves (Nowlin *et al.*, 1998). To illustrate these currents, figure 3-12 shows eastward (u) and northward (v) components of currents from 3- to 40-hr band-passed records made in July and December 1992 at mooring 10 located off Louisiana (lat. 27.94^o N., long. 92.75^o W.) in water depths of 200 m (656 ft). The July sequence shows maximum amplitudes of 40 to 60 cm/s (0.8 to 1.2 kn) at a depth of 12 m (39 ft) for the situation of light winds. The period of diminished amplitudes followed an atmospheric frontal passage. These are near-circular, clockwise-rotating oscillations with a period near 24 hours. They seem to be an illustration of thermally induced cycling (Price *et al.*, 1986) in which high-amplitude rotary currents can exist in thin mixed layers typical of summer. By contrast, the December sequence shown in figure 3-12 evidences no such behavior. Many examples of such currents, in phase at distinct locations, exist for the Texas-

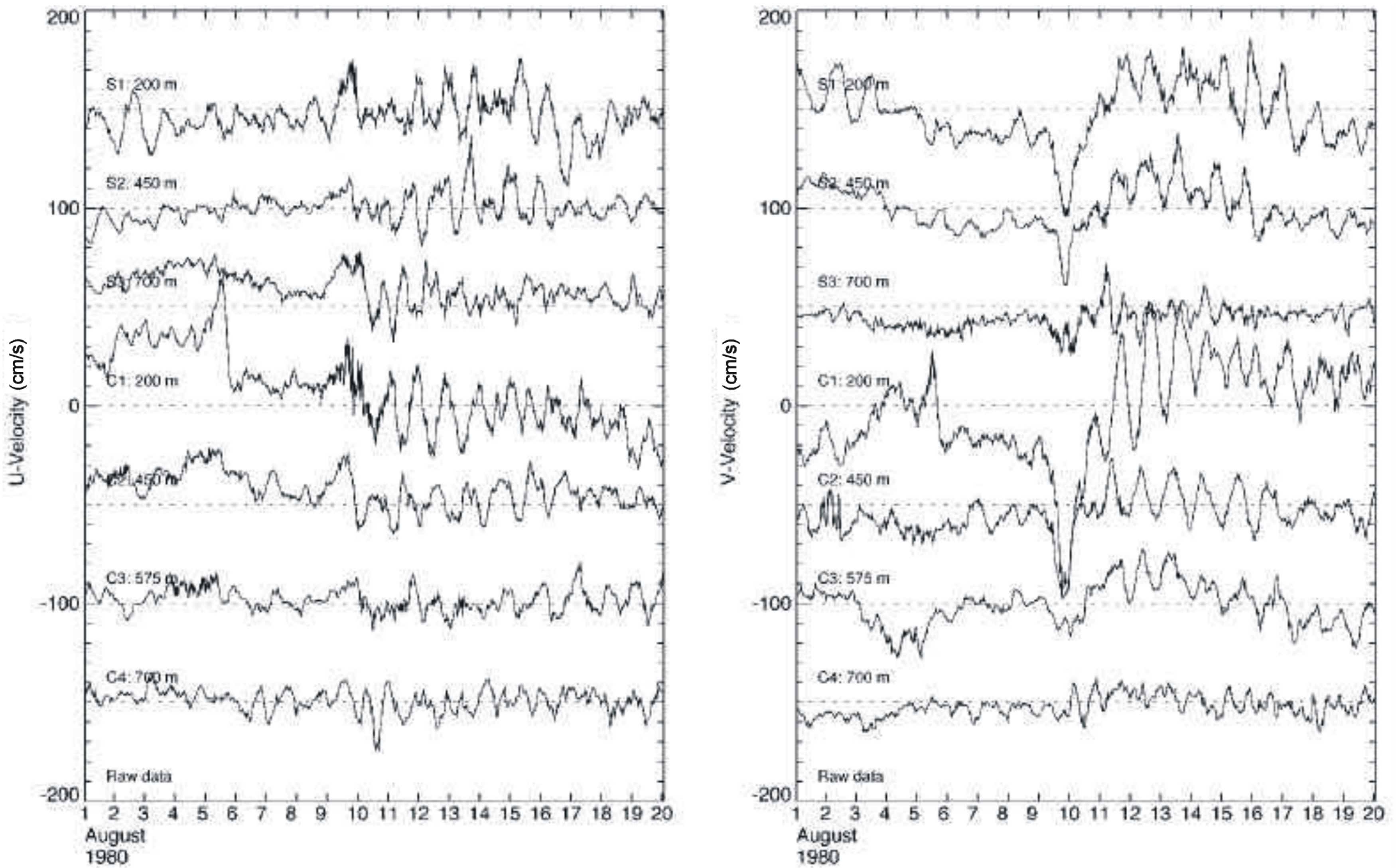

Figure 3-10 COMPONENTS (U POSITIVE TO THE EAST AND V POSITIVE TO THE NORTH) OF HOURLY CURRENTS MEASURED AT INDICATED DEPTHS ON MOORINGS S (LAT.26°N, LONG.96°10'W) AND C (55KM NORTH OF S), WITH BOTH MOORINGS AT APPROXIMATELY 730-M WATER DEPTH

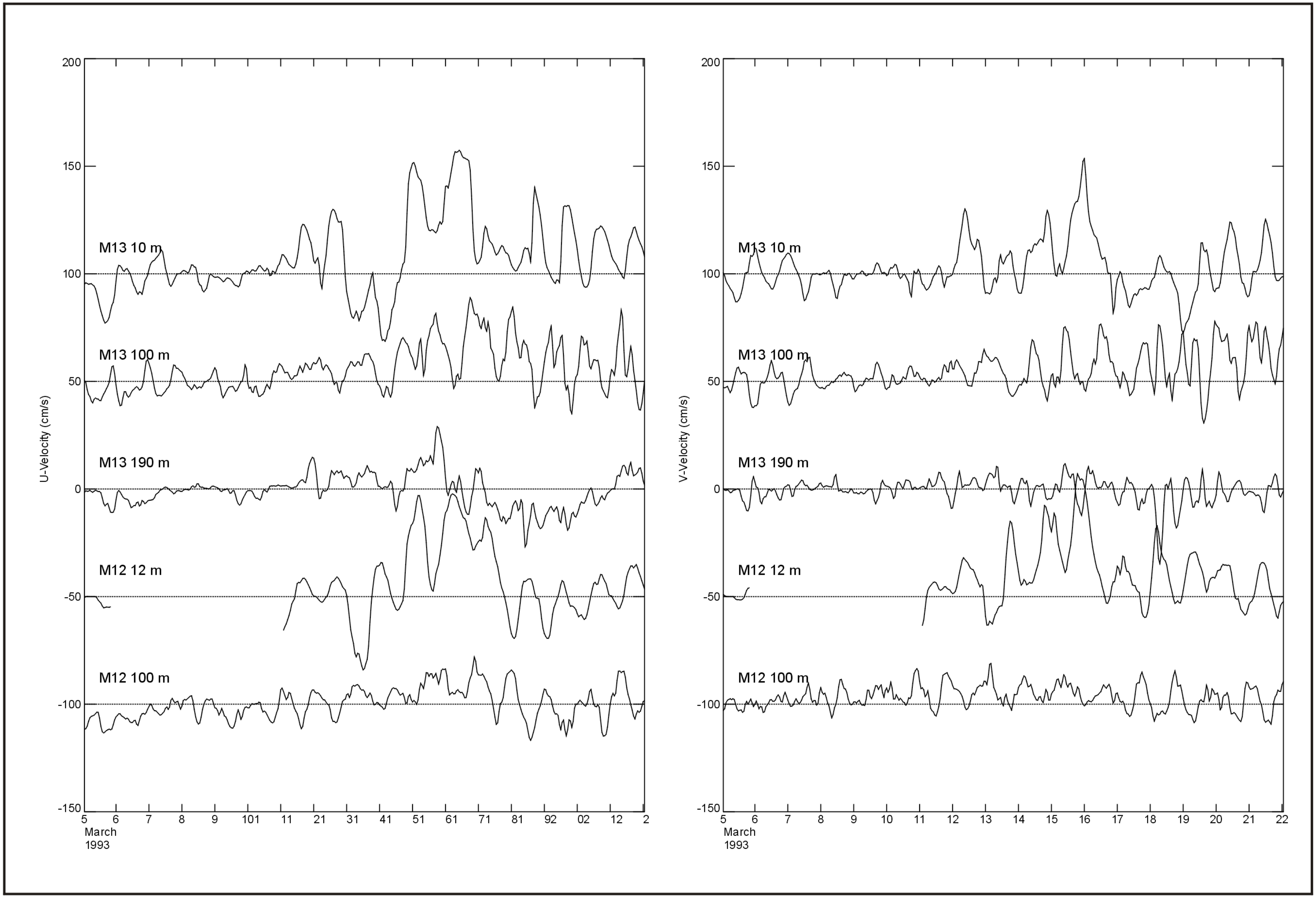

Figure 3-11 EASTWARD (U) AND NORTHWARD (V) COMPONENTS OF CURRENTS (HOURLY VALUES FROM 3-HR LOW-PASSED RECORDS) WERE FROM MOORINGS LOCATED OFF LOUISIANA AT APPROXIMATELY LONG. 90.5°W. MOORINGS 12 AND 13 WERE LOCATED IN WATER DEPTHS OF 504 AND 200 M, RESPECTIVELY.

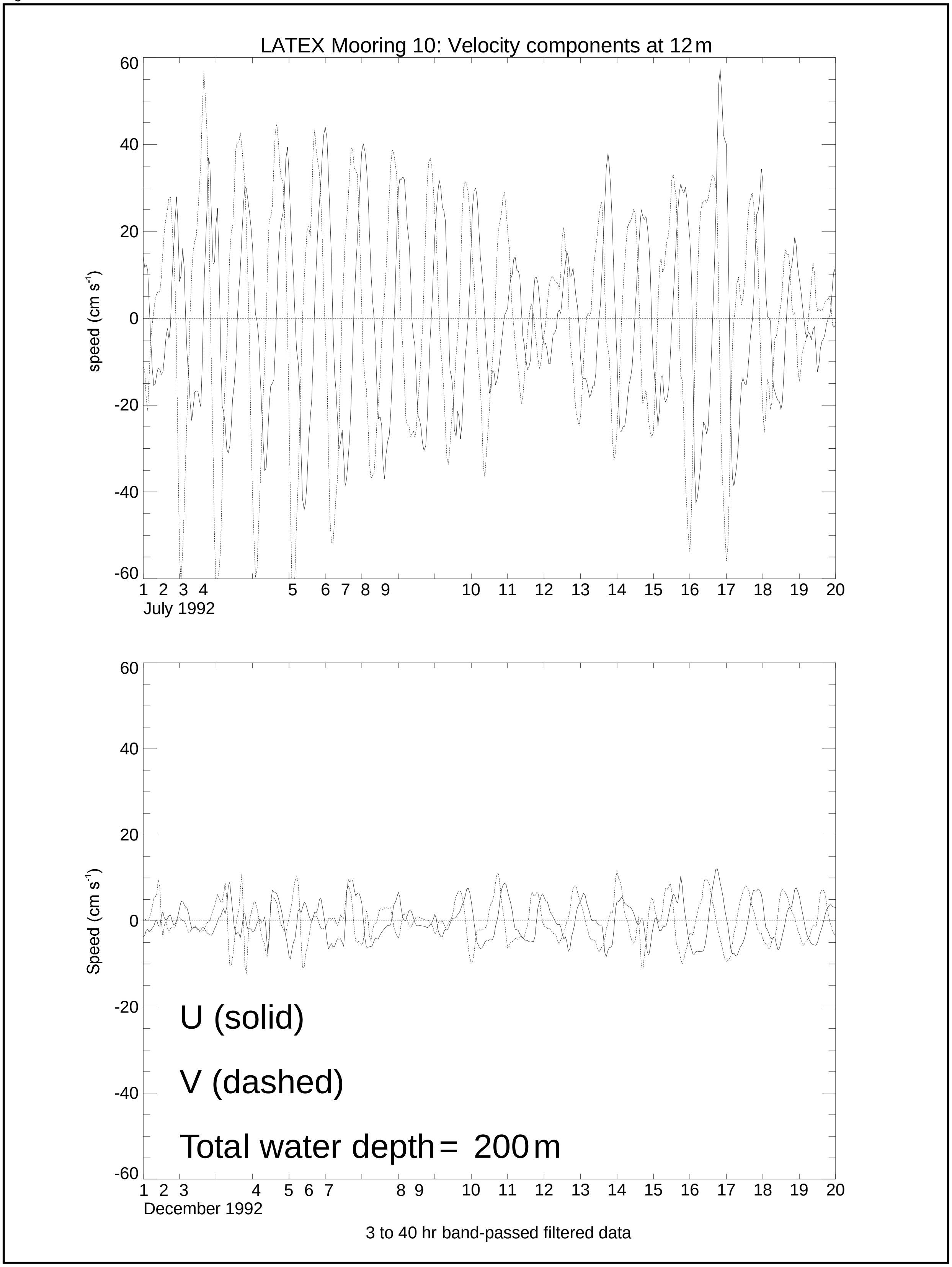

Fig. 3-12. **EASTWARD (u) AND NORTHWARD (v) COMPONENTS OF CURRENTS FROM 3- TO 40- HR BAND-PASSED RECORDS MADE IN JULY AND DECEMBER 1992 AT MOORING 10, LOCATED OFF LOUISIANA AT LAT. 27.94°N, LONG. 92.75°W.**

Louisiana shelf and, by implication, further offshore. Currents at a depth of 1 m (3.3 ft) have been observed to reach 100 cm/s (1.9 kn).

Clearly episodic wind events can cause major currents in the deep waters of the Gulf. The initial currents give rise to inertial oscillations with decreasing amplitudes, which last for up to about 10 days and are superimposed on longer period signals.

Surface-intensified Circulation Features

The phenomena of most concern in the past to deepwater operators in the GOM were surface-intensified currents associated with the Loop Current (LC), LC eddies (LCEs) detached from the LC, and other eddies (both anticyclonic and cyclonic). Currents associated with the LC and LCEs extend into the water column to as deep as 1,000 m (3,281 ft), and, in the case of the LC itself, perhaps to depths approaching the sill depth of the Yucatan Channel (2,000 m; 6,560 ft). Periods between LC detachments vary from 4 to 16 months (Sturges, 1994). Initially, these features have diameters greater than 250 km (155 mi), with typical values closer to 350 km (217 mi), which decrease by 45 percent within 150 days and 70 percent within 300 days (Elliot, 1982). These currents can have surface speeds of 150 to 200 cm/s (2.9 to 3.9 kn) or more; speeds of 10 cm/s (0.2 kn) are not uncommon at 500 m (1,640 ft) (Cooper *et al.*, 1990). Additional details regarding water mass distribution in the study area are provided in table 3-6.

After separating from the LC, LCEs move into the western Gulf at an average translation speed of 5 km (3.1 mi) per day (range of 1 to 20 km/day, or 0.6 to 12.4 mi/day), and in the process may interact with other eddies or with the continental margins to form additional eddies (e.g., see Smith, 1986). They have typical lifetimes of 350 to 400 days (Elliott, 1982) and decay by interactions with boundaries, ring shedding, and ring-ring interactions. The net result is that at almost any given time, the Gulf is populated with numerous eddies, which are interacting with one another and with the margins. As an example, figure 3-13 shows sea surface height anomaly (in cm) relative to a mean sea surface for 9 May 1993. It is based on satellite altimeter gridded data by R. Leben, Colorado Center for Astrodynamics Research, as described in Biggs *et al.* (1996). Clearly seen is the Loop Current, one semi-detached anticyclonic feature, the remnants of two LCEs, and many cyclonic features of various strengths. Many of these separated anticyclonic and cyclonic features would be expected to have surface currents exceeding 50 cm/s (1.0 kn) and perhaps as high as 100 cm/s (1.9 kn).

Although the LC and LCEs have been studied since the early 1960s, details of their velocity distributions and variability remain virtually unknown. Only a few estimates of three-dimensional velocity fields have been reported (e.g., Cooper *et al.*, 1990; Forristall *et al.*, 1992). As an example, figure 3-14 shows components of velocity (cm/s) normal to a section extending from approximately lat. 27.4^{o} N., long. 90.6^{o} W. (station 64) to lat. 24.8^{o} N., long. 89.4^{o} W. (station 78). Measurements were made with a lowered Neil Brown acoustic current meter by Forristall *et al.* (1992); ship motion was estimated using Loran-C and motion of the instrument relative to the ship was measured with an ultra-short baseline acoustic system. This section crossed the LCE Fast Eddy during August 1985 and components are taken to represent azimuthal swirl speeds of the eddy. Positive components are directed toward 65^{o}. Surface currents exceeded 160 cm/s (3.1 kn) on one side of this LCE and 120 cm/s (2.3 kn) on the other side. Speeds at 200 m (656 ft) reached 100 cm/s (1.9 kn) in this young LCE located in the north-central Gulf.

To illustrate currents produced by LCEs in the northwestern Gulf, and at somewhat greater depths, figure 3-15 shows 40-hr, low passed current components from the same moorings

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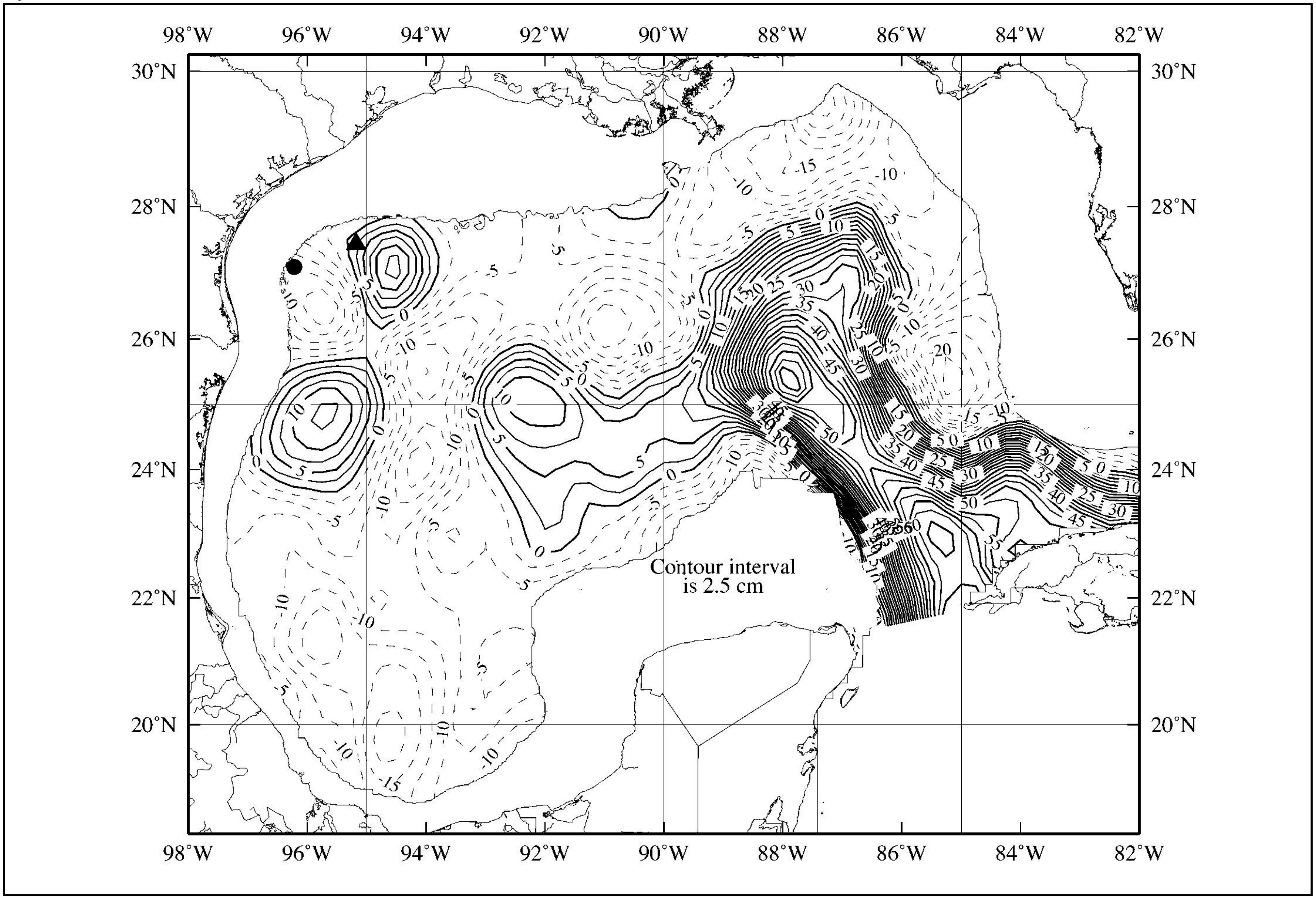

Figure 3-13 **SEA SURFACE HEIGHT ANOMALY (CM) FROM SATELLITE ALTIMETER DATA FOR 9 MAY 1993 (ADAPTED FROM: BIGGS *ET AL.*, 1996).**

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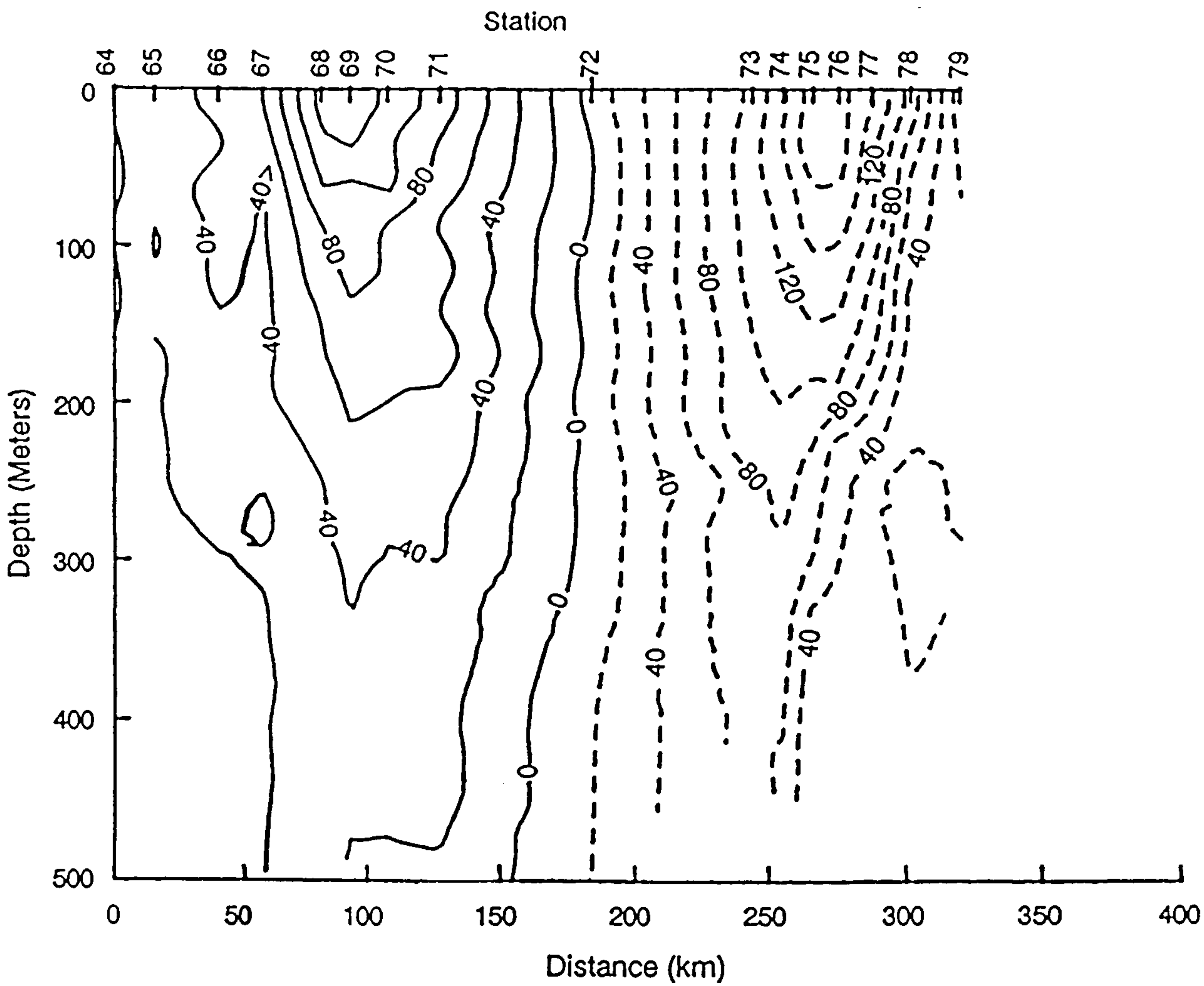

Figure 3-14 COMPONENTS OF VELOCITY (CM/SEC) NORMAL TO A SECTION EXTENDING FROM APPROXIMATELY LAT. 27.4°N, LONG. 90.6°W (STATION 64) TO LAT. 24.8°N, LONG. 89.4°W (STATION 78).

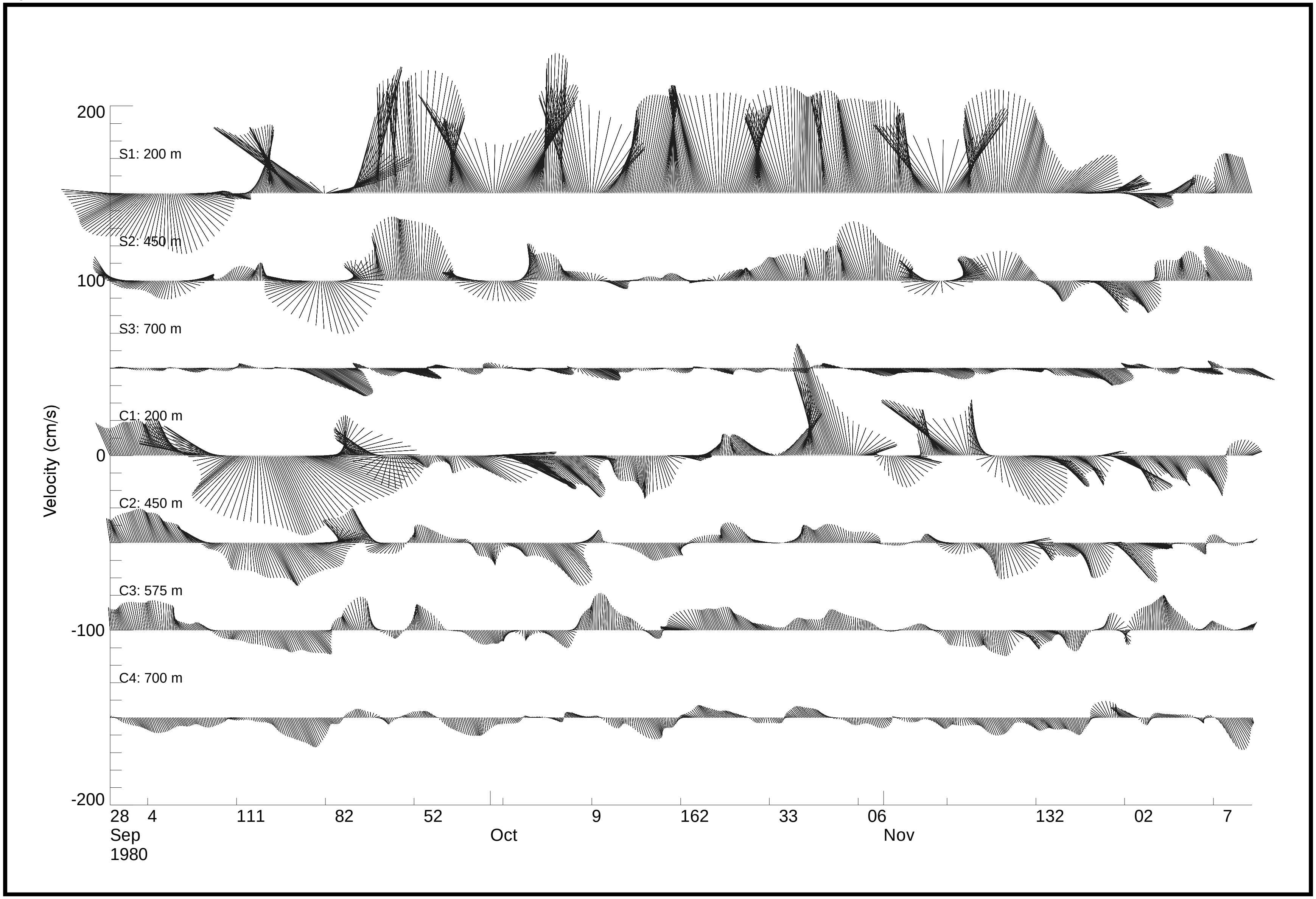

Figure 3-15 COMPONENTS (U POSITIVE TO THE EAST AND V POSITIVE TO THE NORTH) OF 40-HR, LOW-PASSED CURRENTS MEASURED AT INDICATED DEPTHS ON MOORINGS S (LAT. 26°N, LONG. 96°10'W) AND C (55 KM NORTH OF S), WITH BOTH MOORINGS AT APPROXIMATELY 730-M WATER DEPTH.

C and S discussed in connection with hurricane effects (figure 3-10). At mooring S, large northward components, accompanied by reversing east-west components, are seen at the upper instrument commencing in late September and continuing into early November. During this period, northward speeds at a depth of 200 m (656 ft) averaged about 50 cm/s (1.0 kn), with bursts exceeding 70 cm/s (1.4 kn). This period of high-speed flow resulted because of the presence in the area of a clockwise-rotating remnant of an LCE (Brooks, 1984). The vector velocities (not shown) reveal that the current varied in direction from northwest to northeast several times during this period; the implication is that the western edge of the eddy repeatedly moved north and south over the mooring during the period. Maximum speeds associated with this LCE at 200 m (656 ft) reached 60 cm/s (1.2 kn); speeds at 450 m (1,476 ft) were considerably lower but nevertheless noteworthy, with values in excess of 35 cm/s (0.7 kn). Even near the bottom, at depths of 700 m (2,296 ft), speeds reached 10 cm/s (0.2 kn) Velocities at mooring C were not correlated with those at mooring S. A cyclonic eddy (also noted to be in the area by Brooks, 1984) was situated between moorings C and S from about 10 through 20 September, as seen by the northwestward flow at S and southeastward flow at C.

Figure 3-16 shows horizontal current vectors (hourly values from 3-hr low-passed records) from moorings located approximately equidistant along the 200-m (656-ft) isobath at the edge of the Texas continental shelf. Mooring 6 was at lat. 27.71^o N., long. 95.66^o W.; mooring 9 was at lat. 27.81^o N., long. 93.50^o W. The influence of Loop Current Eddy V over the shelf edge is seen as it moves generally eastward past each mooring, beginning at mooring 6, from 22 July to 9 August. Maximum speeds at the upper instruments (~10 m; 32 ft) ranged from 50 to 100 cm/s (1.0 to 1.9 kn); those at mid-depth instruments (100 m; 328 ft) approached or exceeded 50 cm/s (1.0 kn). It should be noted that this LCE remnant was only the northern portion of an old ring that had been separated into two parts by interaction with another eddy.

Energetic, high-frequency currents have been reported to occur as LCEs flow past structures, but they are not well documented; such currents would be of concern to offshore operators because they could induce structural fatigue of materials.

Only limited information is available concerning the velocity fields within cyclonic and ancillary anticyclonic eddies; salient references include Vukovich and Maul (1985), Forristall *et al.* (1992), and notably Hamilton (1992) and Berger *et al.* (1996). Hamilton (1992) reports the existence in the central Gulf and over the Louisiana continental shelf of cold cyclones with the following characteristics: upper layer current velocities of 30 to 50 cm/s (0.6 to 1.0 kn), little surface temperature expression, largest isotherm displacements in the depth range 200 to 800 m (656 to –2,624 ft), diameters of 100 to 150 km (62 to –93.2 mi), and long lifetimes.

Based on LATEX-C (i.e., Louisiana/Texas Shelf Physical Oceanography Program: Eddy Circulation Study), Berger *et al.* (1996) reported the existence over the continental slope and offshore of numerous eddies smaller than LCEs. Three small types of eddies can be identified from the results of that study: cyclonic eddies, anticyclonic eddies, and a submesoscale coherent vortex. The cyclones are probably the same features described over the slope by Hamilton (1992) and mentioned by Hamilton *et al.* (1999). These features are seen to affect the thermal fields to diameters of 150$^+$ km (93.2 mi), although the observed radii of solid body rotation seems to extend only to 25 to 50 km (15.5 to 31.1 mi). Maximum currents are 30 to 50 cm/s (0.6 to 1.0 kn) and occur somewhat beneath the surface (e.g. around 200 m [656 ft]). Velocities extend into the water column to depths of 800 to 1,000 m (2,625 to –3,281 ft). Isotherms are sometimes observed to be depressed in the surface waters with the doming found in cyclones beginning around 200 m (656 ft) and increasing with increasing depth down to at least 1,500 m (4,922 ft), conso-

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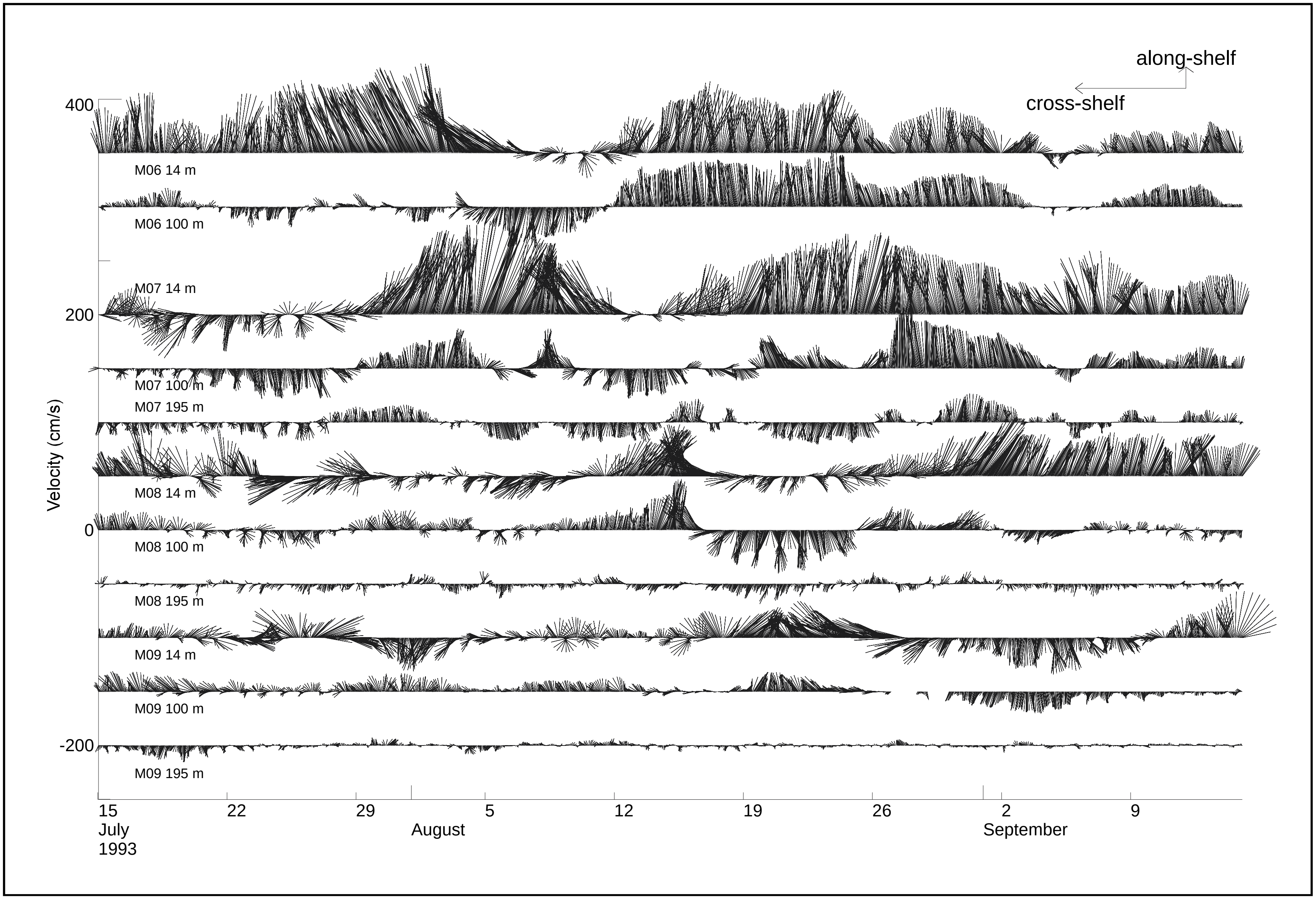

Figure 3-16 **HORIZONTAL CURRENT VECTORS (HOURLY VALUES FROM 3-HR LOW-PASSED RECORDS) FROM MOORINGS LOCATED APPROXIMATELY EQUIDISTANT ALONG THE 200-M ISOBATH AT THE EDGE OF THE TEXAS CONTINENTAL SHELF.**

nant with the occurrence of maximum currents near 200 m (656 ft). The secondary anticyclones observed over the continental slopes of Texas and Louisiana appear to have horizontal extents as small as, or smaller than, the cyclones. However, such secondary anticylones are numerous and are often found over the upper slope. Unlike the cyclones, secondary anticyclones have their maximum thermal expression in the surface layers. There exist only minimal measurements of the velocity structure in these features, although it is speculated that maximum velocities are ≤50 cm/s (≤1.0 kn). On one occasion in October 1993, Berger *et al.* (1996) observed over the slope (near long. 92.5°W) an eddy not previously observed in the GOM, a submesoscale coherent vortex as generally described by McWilliams (1985). This eddy had a thermal structure that was raised and lowered, respectively, above and below a subsurface level of about 350 m (1,148 ft).

Deep Barotropic Currents

During the mid-1980s, deep currents were observed to exist in the Gulf from depths near 1,000 m (3,281 ft) to the bottom. Hamilton (1990) described such currents at three locations (i.e., in deepwater portions of the eastern, central, and western Gulf). These deep currents were seen to be essentially depth-independent, though with some energy intensification with increasing depth near bottom. These currents were observed to have spectral peaks near 25 days and from 40 to 100 days. Hamilton (1990) concluded that such currents result from topographic Rossby waves and estimated that the wavelengths range from 150 to 250 km (93 to 155 mi). Hamilton (1990) speculated that these Rossby waves may be generated by low-frequency fluctuations of the Loop Current, and particularly on separation of LCEs. Propagation speeds into the western Gulf for these waves were found to be greater (perhaps 9 km/day [5.6 mi/d]) than the average propagation speeds of the separated LCEs (5 km/day [3.1 mi/d]). This means that these deep barotropic Rossby waves likely become independent of the upper layer LCEs relatively rapidly. Sturges *et al.* (1993) observed similar phenomena from numerical model results for the Gulf. They showed the seemingly distinct propagation of the deep waves and the surface intensified LCEs from eastern to western Gulf. Deep circulation patterns distinct from those associated with the surface-intensified eddies have also been seen in numerical model studies by Hurlbert and Thompson (1982) and Inoue and Welsh (1997). Public and proprietary measurements have indicated such barotropic currents have maximum speeds from near 40 cm/s (0.8 kn) to 100 cm/s (1.9 kn). This class of barotropic currents, with possible bottom intensification, is of high interest to offshore operators attempting oil production in water depths of 1,000 m (3,281 ft) and greater; measurements are ongoing in the Western and Central Planning Areas by MMS and offshore operators.

High-speed, Subsurface-intensified Currents

Several deep water oil and gas operators have observed very high-speed, subsurface-intensified currents lasting as long as a day at locations over the upper continental slopes (i.e., water depths of 700 m [2,296 ft] or less). Such currents may have vertical extents of less than 100 m (328 ft), and they generally occur within the depth range of 100 to 300 (328 to 984 ft) m. Maximum speeds exceeding 150 cm/s (2.9 kn) have been reported.

Examining data from locations in depths of 1,200 to 1,500 m (3,937 to –4,922 ft), scientists at Texas A&M (W. Nowlin, 1999, personal communication) have observed currents with maximum subsurface speeds of 50 cm/s (1.0 kn) lasting for about one day, with bursts of speed peaking at more than 100 cm/s (1.9 kn). The higher-speed currents appear to propagate upward, characteristic of baroclinic waves (either sub- or super-inertial). It seems possible that such phenomena could be intensified near topography. Causal mechanisms are being sought.

Model results also show short-period, subsurface-intensified currents over the Gulf slopes, but with maximum speeds approaching only 50 cm/s (1.0 kn). More evidence for this phenomenon is being sought in observations and in model results.

Currents Responsible for Furrows

In early 1999, W. Bryant of Texas A&M University (1999, personal communication) discovered and mapped, using a deep-towed acoustic system, a previously unexplored bedform just offshore of the Sigsbee Escarpment in the northwestern GOM. These are large, long furrows eroded into the Holocene deposits blanketing this region. These furrows, which are spaced on the order of 100 m apart, have depths of 5 to 10 m (16 to –33 ft), widths of several tens of meters, and extend unbroken for distances of tens of kilometers or more. Generally, these furrows are oriented nearly along depth contours. Bryant has observed them in the region of long. 90^{o} W. just off the Sigsbee Escarpment and near the Bryant Fan, south of Bryant Canyon, from long. 91^{o} W. to 92.5^{o} W. Depths in those regions range from 2,000 to 3,000 m (6,562 to –9,843 ft). The existence of these features recently has been corroborated, and they have been mapped more extensively in the area of Green's Knoll by offshore oil and gas operators.

It appears that the processes responsible for these furrows are presently active. Based on the change in character of these features from offshore toward the escarpment, and on the rather good agreement of that change with changes observed in published laboratory studies of submarine erosion (e.g., Dzulynski, 1965; Allen, 1969), the tentative conclusion is that bottom currents responsible for these features are oriented along isobaths and increase in strength toward the escarpment. It is difficult to extrapolate from the laboratory experiments to the real world, but speculation is that near-bottom speeds of currents responsible for the inshore furrows might be 50 cm/s (1.0 kn), and possibly in excess of 100 cm/s (1.9 kn). These currents might be sporadic or quasi-permanent. The furrows and the currents responsible for them may also exist over a considerable part of the yet unexplored base of the continental slope in the GOM.

The implications of these furrows and currents for oil and gas production are manifold. These currents may represent a distinctly different phenomenon, and thus different set of problems, than the other classes of currents observed to date and presently under consideration.

Overview of Deepwater Currents

Many observations of the effects of energetic wind events have been reported; however, only a limited number of measurements of wind-driven energetic currents have been reported for the study area. Representative examples have been discussed previously; others examples are discussed in Nowlin *et al.* (1998).

Figure 3-17 presents a schematic of design currents in the deepwater region of the GOM for three classes of phenomena: topographic Rossby waves, LCEs, and subsurface-intensified, high-speed jets (shown by gray domain). Currents associated with anticyclonic eddies have been the most often measured or estimated; those associated with cyclonic eddies, though less well

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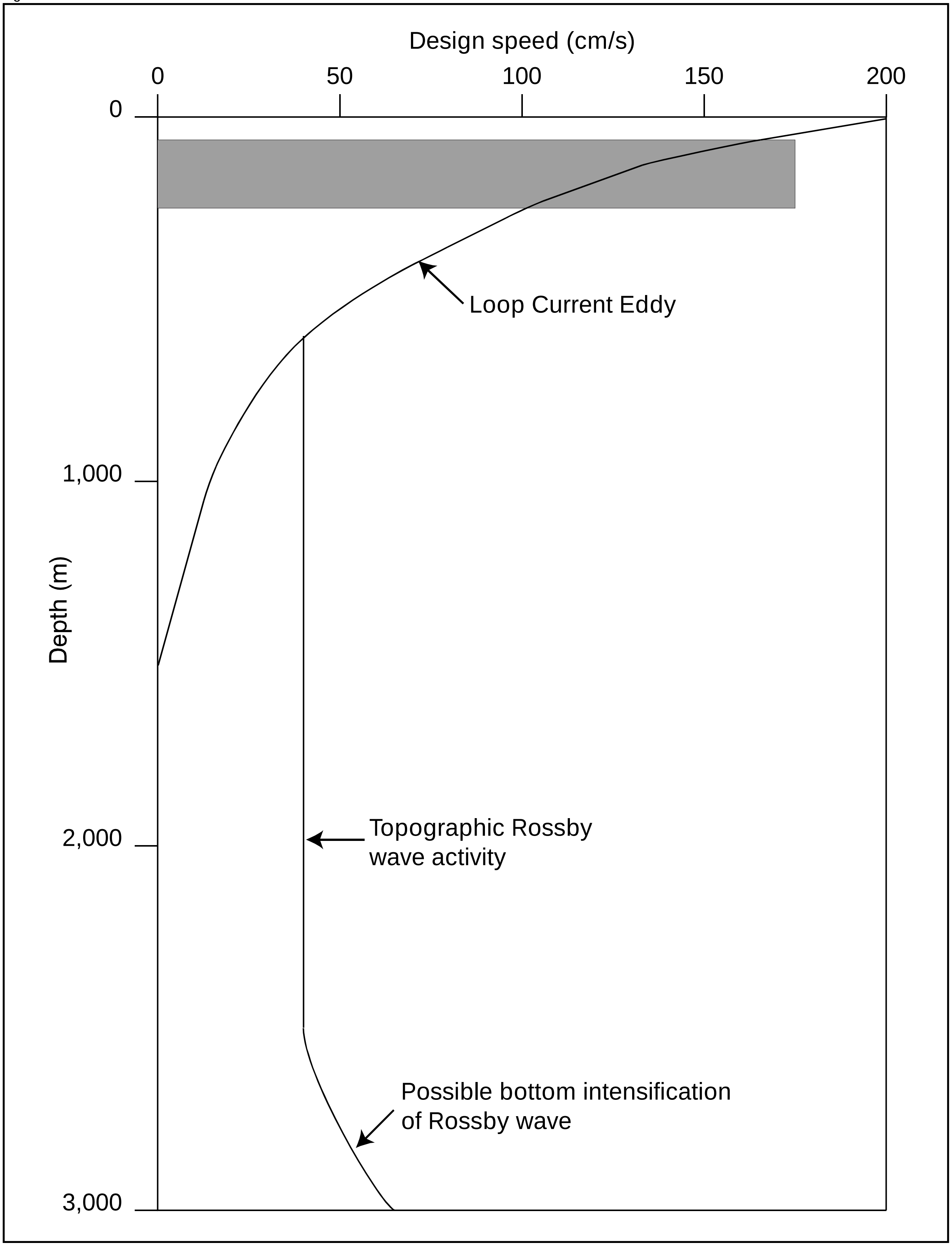

Figure 3-17 SCHEMATIC SHOWING DESIGN CURRENTS IN DEEPWATER GULF OF MEXICO FOR THREE CLASSES OF PHENOMENA, INCLUDING: 1) TOPOGRAPHIC ROSSBY WAVES; 2) LOOP CURRENT EDDIES; AND 3) SUBSURFACE-INTENSIFIED, HIGH-SPEED JETS (SHOWN BY GRAY DOMAIN).

surveyed, are assumed to be of the same or lesser magnitudes than their anticyclonic counterparts. The phenomena of deep barotropic currents, perhaps with bottom intensification, have been observed and reported in the open literature on one occasion, but are only substantiated by model results and proprietary measurements. Subsurface-intensified, high-speed jets have now been documented in many data sets, but they have not yet been reported in the open literature. The physical mechanisms responsible for those jets are not yet identified.

The class of currents responsible for the newly found furrows near the Sigsbee Escarpment is even less well understood. Speculation regarding currents responsible for bottom furrows in the literature is based partly on laboratory experiments. Such work attributes the furrows to rows of counter-rotating helical currents generally directed along the furrows with rising parts of the helixes over the furrows. No direct measurements have yet been reported in the literature.

Surface Wind Waves

Oceanic surface gravity waves with periods of 1 to 30 s contain large amounts of surface wave energy. Surface wind waves are produced by the action of the wind at the air-sea interface and have gravity as the restoring force. They consist of two types: sea and swell (U.S. Army Corps of Engineers, 1984). Seas (also referred to as wind waves) have typical periods of 0.2 to 9 s and are generated by local winds; swell, with periods of 9 to 30 s, consist of waves that have propagated from another region in which they were generated (Pond and Pickard, 1983; LeBlond and Mysak, 1978).

Summarizing the wave climatology over the Texas-Louisiana shelf, Kelly (1988) noted that winds from the southeast and south typically had low to moderate speeds. Therefore, although the fetch (i.e., the distance over which the wind blows) is relatively large, waves generated by these winds were in the range of only 0.5 to 1.5 m (1.6 to 4.9 ft). Winds from the north, often strong winds associated with cold air outbreaks, have short fetch near coast, increasing offshore. The cold air outbreaks typically resulted in 2- to 3-m (6.6 to 9.8 ft) waves nearshore and 4- to 6-m (13.1 to 19.7 ft) waves over the outer shelf; wave periods were 4 to 6 s. The extreme hurricane wind speeds produced higher waves (7 to 10 m [23 to 33 ft]) with longer periods (9 to 13 s).

Using ship observations taken prior to 1977, Quayle and Fulbright (1977) determined wave heights over the slope and shelf of the northern GOM. They found average wave heights of 1 m (3.3 ft) throughout the northern Gulf, with approximately 94 percent of the wave heights being 2 m (6.6 ft) or less, but ranging up to 9.5 m (31.2 ft). They also noted that their data were biased toward good weather conditions because ships tended to avoid bad weather when possible. Because the fetch in the GOM is limited, waves having large amplitudes and long periods (i.e., 10 s or greater) are rare (McGrail and Carnes, 1983, and references therein) and are generally associated with extreme episodic weather events such as hurricanes (National Data Buoy Center, 1990).

The National Data Buoy Center (NDBC) of the National Oceanic and Atmospheric Administration maintains meteorological buoys in the GOM. Three of these are located along approximately lat. 26°N in waters with depths near 3,200 m (10,500 ft). Between 1973 and 1993, one or more of the buoys have provided data used by NDBC to compute significant wave height and wave period. Wave data are calculated by NDBC by applying spectral analysis to data from accelerometers or inclinometers that measure the heave acceleration or vertical displacement of the buoy hull during the wave acquisition time (Steele and Mettlach, 1993). The significant wave height is calculated as the average of the highest one-third of all the wave heights measured during a 20-minute sampling period. The average wave period is the average period of all waves during the sampling period. The dominant wave period is the period with the maximum wave energy. NDBC data for monthly and annual means of significant wave height, average wave period, and dominant wave period for the four buoys are available at the NDBC website (www.ndbc.noaa.gov). Throughout the deep water areas of the GOM, the patterns of significant wave height and wave period are similar. The monthly mean significant wave heights average 1.1 m (3.6 ft) and range from 0.6 m to 1.5 m (2 to 5 ft) and the average wave period ranges from 4.1 to 5.2 s with a mean of 4.8 s. Approximately 92 to 94 percent of the wave heights were 2 m (6.6 ft) or less at the deep water buoys, while the patterns evident in shallow water were similar (i.e., 92 percent of the wave heights were 2 m [6.6 ft] or less).

The mean significant wave heights and wave periods for the three deep water buoys were averaged to obtain general seasonal patterns. Higher mean significant wave heights and longer average and dominant wave periods occur between November and March. As expected, the lowest heights and shortest periods occur in summertime, when fewer frontal passages or other storms occur (Nowlin *et al.*, 1998).

Maximum monthly significant wave heights for the deep water buoys range from 2.9 to 10.7 m (9.5 to 35.1 ft). Although the maxima for the period of record (1973 to 1993) are smallest from April to July, there is less regular seasonal pattern for the maximum heights than for the mean heights. This is because the maxima are associated with the energetic, episodic wind events, such as hurricanes, which occur between June and November, or cyclogenesis events, which occur mainly between November and May (Nowlin *et al.*, 1998). With sufficiently long records, it is likely that the maximum significant wave height would increase to 9 m (29.5 ft) or more for all months since strong storms could occur in any month; but, because extreme events are rare, the mean significant wave height likely would remain similar.

The energetic events, which produce the larger waves, are of great concern in the design of offshore structures. Considerable effort has been spent to estimate these waves, both directional spectra and kinematics, from meteorological data through the use of hindcast modeling and to validate such models (e.g., Cardone *et al.*, 1976; Forristall *et al.*, 1978, 1980). As part of model validation, Ward *et al.* (1978) developed a hurricane climatology covering the period 1900 through 1974 based on wave data from 48 GOM storms with a central pressure of 980 mb or less. While they found maximum significant wave heights ranging from 4.6 to 15.5 m (15.1 to 50.9 ft), with an average of 9.7 m (31.8 ft), more than half of the storms evaluated (i.e., 27 of 48) were characterized by maximum significant wave heights greater than 10 m (32.8 ft). Using the Cardone *et al.* (1976) wave hindcast model validated by Ward *et al.* (1978), Haring and Heideman (1978) estimated rare wave heights associated with 22 severe hurricanes occurring in the GOM between 1900 and 1977. They found the model results varied little between the three sectors studied off the coasts of south Texas, east Texas-west Louisiana, and east Louisiana-Mississippi-Alabama. They found 100-yr significant wave heights of 12 to 13 m (39.4 to 42.7 ft) in water depths of 70 to 700 m (230 to 2,297 ft) and 11 to 12 m (36.1 to –39.4 ft) in shallower waters; the dominant spectral wave periods were 14 to15 s in all water depths studied. Maximum 100-yr wave heights were estimated to be 20 to 22 m (65.6 to 72.2 ft).

The Waterways Experiment Station (WES) has a Wave Information Study series (WIS) that examines the wave statistics of the GOM and compares the result of the WES wave hindcast model to observations. Tracy and Cialone (1996) presented the results of the WIS 1995 GOM wave hindcast. They reported that, during Hurricane Opal, which was an intense category 4 hurricane in October 1995, the observed maximum significant wave height and maximum peak period in the deepwater areas of the central and eastern GOM reached 10 m (32.8 ft) and 13 s at buoy 42001, near which Opal passed by, and 8 m (26.2 ft) and 22 s at buoy 42003. In shallow water (53 m; 174 ft) over the northeastern Gulf, one buoy measured maximum significant wave heights of 8 m (26.2 ft) and peak period of 18 s. Tracy and Cialone (1996) compared their hindcast model results with these observations and concluded they matched very well.

In August 1992, Hurricane Andrew, which was within 2 mb of becoming a category 5 hurricane, generated substantial surface waves that were well documented over both the deep water and the Texas-Louisiana shelf. Stone *et al.* (1993) and Breaker *et al.* (1994) reported on measurements made at buoys 42003, which was ~50 km (31 mi) southwest of the hurricane at its closest, and buoy 42001, which was ~240 km (149 mi) southwest. Prior to the hurricane, seas at 42003 had wave heights of less than 1 m (3.3 ft) and wave periods of 4 to 8 s. As the hurricane passed near the buoy, seas reached a maximum significant wave height of over 6 m (19.7 ft) and peak wave periods of 17 s. Measurements from buoy 42001 also showed the influence of Hurricane Andrew with a time lag of approximately 9 hrs (Stone *et al*., 1993). The significant wave height increased from less than 2 m (6.6 ft) before the hurricane to over 4 m (13.1 ft), while the wave period increased from ~7 s to 17 s. Waves at buoy 42003 were generated primarily by the hurricane until it passed by; waves at buoy 42001, however, were primarily swell (Breaker *et al.*, 1994). DiMarco *et al.* (1995) examined the conditions over the Texas-Louisiana shelf during passage of Hurricane Andrew. They found the maximum significant wave height was 9.09 m (29.8 ft) and the peak wave period was 10.7 s as the hurricane passed within ~30 km (18.6 mi) of a mooring in 21 m (68.9 ft) of water. At the mooring located farthest from the wave generation zone (approximately 1,400 km [870 mi] away), the maximum significant wave height was 1.6 m (5.2 ft) with a peak period of 16 s.

Hurricanes, however, are not the only intense storms that can generate substantial waves. Approximately 10 times each year, winter cyclones develop over the GOM in a process called cyclogenesis (Hsu, 1988; Johnson *et al*., 1984). On 12 March 1993, an intense extratropical cyclone, comparable to a category 1 hurricane, developed off the south Texas coast (Nowlin *et al*., 1998). From 0600 to 1800 UTC on 12 March, it moved eastward along the Texas shelf edge before turning to the northeast. At about 0900 UTC 13 March, it exited the Gulf over Florida at about long. 85°W (Shumann *et al.*, 1995). Time series of the significant wave height, average wave period, and dominant wave period were developed from buoy measurements; maxima for these parameters were, respectively, 9.2 m (30.2 ft), 9.7 s, and 14.3 s at eastern buoy 42003, 9.1 m (29.9 ft), 9.8 s, and 12.5 s at central buoy 42001, and 7.8 m (25.6 ft), 9.1 s, and 12.5 s at western buoy 42002. The peaks in height and period progress in time from the western to eastern buoys. The significant wave heights are greater further east, reflecting typical conditions for cyclones – maximum wave heights occur to the right of the path of forward movement of a storm system (U.S. Army Corps of Engineers, 1984). The buoys in the central and eastern Gulf were on the right side of the storm for a longer time than was the buoy on the west. On the shelf at buoy 42020, off the south Texas coast, the maximum significant wave height was 6.1 m (20.0 ft), the average wave period was 7.8 s, and the dominant wave period was 10.0 s. The maximum record-length significant wave heights at buoys 42001 and 42020 were associated with this cyclone.

3.1.5 Water and Sediment Quality

Oil and gas production activities in the Western and Central Planning Areas have historically been conducted predominantly in the shelf area (i.e., in water less than 200 m deep). However, the current trend, aided by new technologies, is to produce oil and gas from areas in ever increasing water depths. For example, MMS production figures for the GOM indicate that deepwater production (>300 m; 984 ft) of both oil and gas increased from 6 percent in 1985 to 36 percent in 1998, and from less than one percent of the total production of oil and gas in 1985 to 11 percent of production in 1998. This trend is likely to continue. The major chemical constituents of concern in the GOM are salinity, nutrients, trace metals, hydrocarbons, and synthetic organics. The discussion of salinity and nutrients is included as part of the general description of the water masses in deep waters. The discussion of trace elements, hydrocarbons, and synthetic organics is of special interest in evaluating marine pollution resulting from human activities (e.g., oil and gas operations).

The search for and production of offshore oil requires drilling operations. Drilling operations produce by-products, including cuttings (rock fragments), drilling muds, and produced water. Drilling muds and cuttings are routinely discharged during drilling activities and may be released in limited amounts during well workover operations. By comparison, produced water is normally released in limited amounts during drilling operations, but may be discharged in moderate to large volumes during production, depending upon the nature of the oil and gas being produced. Drilling muds fulfill a variety of functions and are formulated according to type of drilling (e.g., deviation from vertical) and geological conditions at the drill site. Many different mud formulations are often used in drilling a single well. The fate and effects of discharged cuttings and associated drilling muds and produced waters have been studied. Generally, the area around a platform where these materials are deposited, and where observable effects on the ecosystem could be established, were confined to within 1 to 3 km of the drilling platform (Neff *et al.*, 1985; Neff, 1997).

Generally, human impacts on the environment are greatest in the immediate vicinity of the activity of concern, with impacts generally decreasing in severity with increasing distance from the impact source. Natural processes, however, can transport chemical contaminants great distances, affecting ecosystems far removed from the area of input. One such area where natural processes have the potential to affect such transport is the offshore GOM. Understanding the potential for human activities to affect remote areas therefore requires an understanding of these natural processes. There is considerable information regarding how nearshore environments have been impacted by human activities, but only sparse information of this type is available for offshore areas. As humans move their activities, such as oil production, farther offshore, the information we have developed for nearshore areas, coupled with our understanding of natural transport processes, can be used to place limits on the extent of potential impacts in offshore areas. Due to the connection between nearshore and offshore contamination, human activities that can degrade nearshore and/or offshore environments are discussed in the following sections.

3.1.5.1 Coastal Waters

Though the use of FPSOs is projected for deepwater regions of the central and western Gulf, support operations (i.e., shuttle tankers carrying FPSO-produced oil, crew and supply vessels) will traverse coastal waters adjacent to Gulf ports. In addition, the potential for accidents and oil spills from FPSO operations may have ramifications for nearshore coastal waters. The following description of the Gulf's coastal water environment has been developed with these considerations in mind.

The coastal waters of the GOM encompass numerous bays and estuaries, which provide important feeding, breeding, and/or nursery habitat for many fish, invertebrate, bird, and mammal species. The biological characteristics of estuarine and wetland areas of the Gulf are described in detail in Section 3.2.1. In general, estuaries are highly productive ecosystems, where marine waters pushed via tidal action mix with riverine (freshwater) outflow. It has been estimated that more than 95 percent of the commercial fishery harvest from the Gulf is comprised of estuarine-dependent species, while most fishery species of recreational importance rely on estuaries during some portion of their life cycle (USEPA, 1999). For example, commercially important menhaden, shrimp, oyster, and blue crab all rely heavily on a healthy estuarine environment.

Estuarine systems of the Gulf fall into one of two biogeographic provinces – the West Indian Province, extending from Tampa Bay to the Florida Keys, and the Louisianian Province, extending from the Rio Grande region in Texas to Anclote Key, Florida. The latter province is of primary concern to this assessment. USEPA (1999) identifies 13 major estuarine systems (i.e., surface area >280 km^2 [>108 mi^2]) within the Louisianian Province, including nine located inshore of the Central and Western Planning Areas. From west to east, they are Corpus Christi Bay, Galveston Bay, Sabine Lake, Vermilion-Atchafalaya Bay, Terrebonne Bay, Barataria Bay, Breton Sound, Lake Pontchartrain, and Mobile Bay. In addition, hundreds of smaller estuaries line the Gulf Coast inshore of the study area. USEPA (1999) provides detailed information on each estuary, with characterizations pertinent to 18 separate measures of estuarine quality (i.e., total surface and drainage area; average depth; average daily freshwater inflow; salinity; silt-clay percentage; percentage of areas with low water clarity, high total dissolved nitrogen, high chlorophyll, hypoxia, anoxia, low dissolved oxygen, and sediment contamination; areas of coastal wetlands and submerged aquatic vegetation; percentage of area with degraded benthos, percentage of fish with pathology, and percentage of acreage with harvest limited shellfish beds).

Four primary habitat characteristics affect the composition and natural functioning of an estuary (i.e., water depth, salinity, temperature, and sediment type). According to USEPA (1999), the following are prominent characteristics of the Louisianian Province estuaries of the GOM:

- Average estuarine water depth is 3 m (9.8 ft), with maximum depths (i.e., >10 m [32.8 ft]) found within dredged channels and the Mississippi River;
- Half of the estuaries are polyhaline (i.e., bottom salinity >18 parts per thousand [ppt]), while 23 and 27 percent of the remaining estuaries exhibit salinities of <5 ppt and 5 to 18 ppt, respectively;
- Shallow Gulf estuaries are highly subject to temperature fluctuations, given their relatively shallow depth; water temperatures can range from 4 to 32 degrees C over the course of a year; and
- Sediment types for estuaries inshore of the Central and Western Planning Areas are primarily mud (i.e., >80 percent silt-clay) or mixed mud-sand (i.e., 20 to 80 percent silt-clay).

USEPA (1999) has compiled the most recent assessment of water quality within estuaries and coastal waters of the GOM, based on data collected by individual Gulf states in 1996. Estuaries are classified based on their designated beneficial uses (e.g., aquatic life support, fish consumption, recreation). Results indicate that 1) 78 percent of the Gulf's estuaries have been surveyed, representing a total of 39,666 km^2 (15,315 mi^2) and 2) of the estuaries surveyed, slightly less than two-thirds (65 percent) have good water quality and support their designated uses, while the remainder are considered "impaired" due to nutrient enrichment, the influx of pathogens, increases in oil and grease concentrations, alteration of habitat, salinity and/or chloride intrusion, siltation, or organic enrichment. In Louisiana, all seven of these factors have to some extent adversely affected between 5 and 20 percent of the estuaries. Pathogen indicators are also present in a limited number of estuaries in Alabama, Mississippi, and Texas, while organic enrichment and nutrient enrichment have been documented in several estuaries in Mississippi and Texas.

The primary activities occurring along the Gulf Coast that have contributed, or are still contributing, to the degradation of coastal water conditions include the petrochemical industry; agricultural; power plants; pulp and paper mills; fish processing; municipal wastewater treatment; maritime shipping; and dredging. The petrochemical industry along the Gulf Coast is the largest in the U.S. This industry includes extensive onshore and offshore oil and gas development operations, tanker and barge transport of both imported and domestic petroleum into the Gulf region, and petrochemical refining and manufacturing operations.

More than 3,700 point sources of contamination flow into the GOM (Weber *et al.*, 1992). Point sources contribute contaminants through discharges and accidental releases. About 460 of these point source inputs discharge directly into the waters of the Gulf or its estuaries. Of this total, 113 are municipalities discharging more than a billion gallons (more than 3.8 billion liters, or 1.0 billion gallons) per day of sewage effluent into Gulf coastal waters (Weber *et al.*, 1992). Of the remaining industrial sources, 192 are in Texas, 79 are in Louisiana, 30 are in Mississippi, 29 are in Alabama, and 17 are in Florida. Most are petroleum refineries and petrochemical plants.

Vessel traffic is another major point source of contamination to Gulf waters. Vessels contribute bilge and waste discharges, spills, and leaching of tributyltin from ship hulls. Four of the ten busiest ports in the U.S. are located on the Gulf Coast. Adding to vessel traffic from commercial shipping is the largest commercial fishing industry in the U.S. and a large recreational boating industry.

Hydrodynamics modification, including channelization, wetland dredge and fill modifications, and natural subsidence, can also alter the Gulf's coastal water quality. These activities can result in sediment deficit and saltwater intrusion, particularly in the Louisiana coastal areas. Saltwater intrusion is defined as the inland movement of offshore saline waters into more brackish and fresh waters. About 9 to 10 million m^3 (310 to 353 million ft^3) of material are estimated to be dredged every year to support oil and gas projects in Louisiana. Most material dredged from the extensive navigation channel network is dumped at the 27 dredged-material disposal sites located along the Gulf coastline. In total, an average of 25 million m^3 (883 million ft^3) of sediments is disposed of at these sites annually. Dredged material disposal results in temporarily increased turbidity and resuspension and may release sediment contaminants into coastal waters. Point sources have been regulated, reducing contamination of coastal waters. Non-point sources, which are difficult to regulate, currently have the greatest impact on the GOM coastal water quality. Non-point pollutant sources include agriculture, forestry, urban runoff, marinas, recreational boating, and atmospheric deposition. Waterways draining into the GOM transport wastes from 75 percent of U.S. farms and ranches, 80 percent of U.S. cropland, hundreds of cities, and thousands of industries located upstream of the GOM coastal zone. Urban and agricultural runoff contributes large quantities of pesticides, nutrients, and fecal coliform bacteria.

More than 4.5 thousand metric tons (10 million pounds) of pesticides were applied within the GOM coastal area in 1987, making it the top user of pesticides in the country (USDOC, NOAA, 1992a). The GOM ranked highest in the use of herbicides (3 thousand tons [6.6. million pounds]) and fungicides, and a close second in the use of insecticides. The Atchafalaya/Vermilion Bays, the Lower Laguna Madre, and Matagorda Bay ranked in the top ten estuarine drainage areas in the U.S. for carrying pesticides to coastal waters. Although ranking high based on inputs, when pesticide risk to estuarine organisms is estimated (USDOC, NOAA, 1992a), only Tampa Bay and the Lower Laguna Madre drainage basins were in the top ten.

An excess of nutrients, found primarily in river runoff, is one of the greatest concerns regarding GOM coastal waters. Excessive nutrient enrichment can lead to noxious algal blooms, decreased seagrasses, fish kills, and oxygen-depletion events. Nitrogen and phosphorus loadings in the Mississippi River and GOM coastal waters have risen dramatically over the last three decades (Rabalais, 1992). The Nutrient Enrichment Subcommittee of the GOM Program estimated that more than 172 metric tons (379,000 pounds) of phosphorus and more than 848 metric tons (1.87 million pounds) of nutrient nitrogen are discharged into the GOM on an average day, with 90 percent of both elements coming from the Mississippi River system (Lovejoy, 1992). Excessive nutrient enrichment has been a particular problem for the Lower and Upper Laguna Madre in Texas; Lake Pontchartrain, the Mississippi River mouth, and Barataria Bay in Louisiana; Mississippi Sound, Pascagoula Bay, and Biloxi Bay in Mississippi; and Perdido, Pensacola, Choctawhatchee, and St. Andrews Bays in Florida (Rabalais, 1992).

A good indicator of coastal and estuarine water quality is the frequency of fish kill events and closures of commercial oyster harvesting. Of the ten most extensive fish kills reported in the U.S. between 1980 and 1989, five occurred in Texas (three in Galveston County, one in Harris County, and one in Chambers County; USDOC, NOAA, 1992b). Because oysters are bottom-dwelling filter feeders, they concentrate pollutants and pathogens. The oyster industry is a good indicator of impacts from septic tank runoff pollution. About one-half of the harvestable shellfish beds in Louisiana are closed annually because of *E. coli* bacteria contamination. Most of the productive oyster reefs in GOM estuaries are in conditionally approved areas or areas where shellfish harvesting may be affected by pollution. In the late fall of 1993 and again in 1994, there were multi-state outbreaks of viral gastroenteritis in humans associated with consumption of oysters contaminated with fecal material (Herrington, 1996). Effluents from a coastal oil rig operating in Louisiana Bay were most likely responsible in one outbreak.

Since its creation in 1984, the National Oceanic and Atmospheric Administration's (NOAA) National Status and Trends (NS&T) Program has monitored the concentrations of synthetic chlorinated compounds such as DDT, chlordane, polychlorinated biphenyls (PCBs), tributyltin, polynuclear aromatic hydrocarbons (PAHs), and trace metals in bottom-feeding fishes, shellfish, and sediments at coastal and estuarine sites along the U.S. coast, including the GOM (Texas A&M University, 1988; USDOC, NOAA, 1992c; Daskalakis and O'Connor, 1994; O'Connor and Beliaeff, 1995). Sites were selected to represent general conditions of estuaries and nearshore waters away from point source inputs. Eighty-nine sites were sampled for bivalves and sediments along the Gulf Coast and compared with more than 300 sites located throughout the U.S. coastal areas.

Contaminants were measured in mussels and oysters taken from U.S. coastal areas, including oysters from Gulf coastal waters, from 1986 to 1999 as part of NOAA's NS&T Mussel Watch Program. Nationally, the highest chemical contamination consistently occurred near large urban/industrial areas. Fewer sites along the Gulf were contaminated compared to other U.S. coastal areas, probably because urban centers along the Gulf are farther inland than urban centers along other coasts. Of the six U.S. urbanized areas showing highest levels of organic compound contamination in shellfish, Mobile, Alabama, was the only Gulf Coast site in this group. Of the 21 sites identified as exhibiting both a "high" concentration for one or more of the contaminant compounds and a temporal trend of increasing concentration for that same compound, eight sites were located along the Gulf, including three in Florida, two in Louisiana, and one each in Alabama, Mississippi, and Texas. This implies that the source for the high levels of these compounds continue to be bioavailable in these areas. Sites located along the Gulf having oysters containing at least three compounds with "high" concentrations include Tampa Bay, St. Andrews Bay, and Choctawhatchee Bay, Florida; Mobile Bay, Alabama; Lake Pontchartrain, Lake Borgne, and Breton Sound, Louisiana; and Galveston Bay, Brazos River, Matagorda, and Corpus Christi, Texas (O'Connor and Beliaeff, 1995). The highest concentrations of chlorinated hydrocarbons in GOM oysters were observed along the Mississippi to northern Florida coasts and at stations in Galveston Bay and Tampa Bay. Mercury concentration were found to be very high in Matagorda Bay, Texas, and were attributed to a major discharge of this element from a chloralkali operation in the area (USDOC, NOAA, 1992c). Choctawhatchee Bay, Florida, continues to be one of the most contaminated areas in the U.S., having lead levels exceeding Food and Drug Administration guidelines and high concentrations of four trace metals--cadmium, copper, mercury, and selenium; three chlorinated pesticides--total DDT, total dieldrin, and total chlordane; PAHs; and butyltin compounds.

Sediment data were also collected and examined (O'Connor, 1990). Higher levels of sediment contamination were associated with highly populated/industrialized areas, and, in general, sites in the GOM had lower concentrations of toxic contaminants than the rest of the country. The likely reason for this finding was that sampling sites in the GOM coastal area were further removed from urban areas, which typically have large numbers of point-source discharges. The distribution of organochlorine loadings in sediments followed those observed in oysters. Contaminant concentrations that ranked in the top 20 highest for the entire U.S. were Florida (17), Mississippi (1), and Texas (1) (USDOC, NOAA, 1992c). Florida was one of four states that had contaminant concentrations in the top 20 nationally for all selected compounds. Mississippi's site ranked in the top 20 only for PAHs, and the Texas site ranked in the top 20 only for total DDT. Sediments with chemical concentrations exceeding high levels were identified in Tampa Bay, Panama City, St. Andrew Bay, and Choctawhatchee Bay, Florida; Biloxi Bay, Mississippi; and Galveston Bay, Texas.

The NOAA NS&T distribution of PAHs, which are toxic components of petroleum, indicates that in spite of more extensive oil production in the GOM, concentrations are within the range of those found in East and West coast samples (Jackson *et al.*, 1994). The distribution of PAHs indicates chronic contamination from combustion sources in coastal estuaries with additional insults from occasional small-scale petroleum spills.

3.1.5.2 Marine Waters (Offshore)

The chemical oceanography of the GOM is influenced by the Gulf's configuration, water circulation, and the large volumes of land runoff it receives. The GOM is a semi-enclosed water body: oceanic input is through the Yucatan Channel and the principal outflow is through the Straits of Florida. Freshwater from approximately two-thirds of the U.S. and more than half of Mexico comes into the GOM via the Mississippi River and other major rivers. This large amount of runoff, with its nonoceanic composition, mixes into the nearshore surface water of the GOM, making the chemistry of parts of this system quite different from that of the offshore areas. Sea-surface salinities along the northern GOM vary seasonally. During months of low freshwater input, salinities near the coastline range between 29 and 32 ppt. High freshwater input during the spring and summer months result in strong horizontal salinity gradients, with salinities of less than 20 ppt on the inner shelf. The mixed layer in the open Gulf, extending to a depth of approximately 100 to 150 m, is characterized by salinities ranging from 36.0 to 36.5 ppt (Barnard and Froelich, 1981). Dissolved oxygen values in the mixed layer average about 4.6 milliliters/liter (mL/L), with certain seasonal variations, particularly a slight lowering during the summer months, decreasing with depth to about 3.5 mL/L (Barnard and Froelich, 1981). Vertical profiles of temperature, salinity, oxygen, and phosphate identify five major water masses down to 1,000 m (3,281 ft). The principal nutrients—phosphate, nitrate, and silicate—generally are depleted in the surface mixed layer. Phosphates range from 0. 25 part per million (ppm), averaging 0.21 ppm; silicates predominantly range from 0.048 to 1.9 ppm; and nitrates range from 0.0031 to 0.14 ppm, averaging 0.014 ppm.

There are several water masses in the central/western GOM. These water masses can be identified by their different chemical signatures based on salinity, dissolved oxygen, nitrate, phosphate, and silicate concentrations. These water masses are related to potential density surfaces (Morrison *et al.*, 1983). Depth variation of potential density surfaces and related water mass characteristics are closely related to the current regime. In the western/central GOM, there are no important variations in the water mass property/potential density relationship at depths greater than 250 m (Morrison *et al.*, 1983).

The water masses are identified as GOM water (0 to 250 m; 0 to 820 ft), tropical Atlantic central water (250 to 400 m; 820 to 1,312 ft), Antarctic intermediate (phosphate maximum) water (500 to 700 m; 1,641 to 2,297 ft), Antarctic intermediate (salinity maximum) water (600 to 860 m; 1,969 to 2,822 ft), mixed upper North Atlantic deep and Caribbean mid water (1,000 to 1,100 m; 3,281 to 3,609 ft).

The depth distribution of nutrients and dissolved oxygen (DO) in the deep GOM are similar to those of the Atlantic deep ocean. The DO has a surface maximum due to exchange with the atmosphere and production from photosynthesis. The DO concentration decreases with depth as decomposition of organic matter (respiration) depletes the oxygen. The DO concentration increases again at water depths where water masses from colder climates with low productivity and therefore have higher DO concentrations.

The nutrient profiles are the opposite of the DO profile. Their concentration in surface water is very low because they are being used up to produce plant matter. In deeper waters, nutrient concentrations increase as organisms die and decay. Nutrient concentrations are highest in deeper water. The GOM deep water is similar to ocean waters, and the major chemical constituents are not affected, to any measurable extent, by anthropogenic inputs.

Two unusual water types are present in the GOM: hypersaline basins and midshelf freshwater vents. Two basins containing hypersaline waters have been identified. Salinities are as high as 196 ppt at a small pool on the East Flower Garden topographic high and 250 ppt in the Orca Basin (Addy and Behrens, 1980; Barnard and Froelich, 1981). The southwest Florida shelf contains a number of submarine freshwater springs found in association with extensive karst topography.

A common phenomenon in the Gulf, especially on the shelf, is the local presence of greatly elevated levels of suspended material (i.e., greater than one ppm). Termed the nepheloid layer, this near-bottom turbid water is separated from the overlying water by a sharp discontinuity in suspended particulate matter. These nepheloid layers may be associated with resuspension of sediments by bottom currents, internal waves, intense at-depth biological activity, or a complex combination of these factors. These features appear to occur naturally at nearly all locations on the shelf and upper slope environment, except within the upper portions of substantial topographic highs (Brooks *et al.*, 1981). The nepheloid layer may be part of a process of transport of materials, including contaminants, from nearshore to offshore.

The Mississippi River outflow has a considerable effect on the chemistry and water quality of the GOM. During the summer of 1993, extreme flooding resulted in unusually high freshwater outflows from the Mississippi and Atchafalaya Rivers. Not only were lower salinities and increased nutrient loadings measured on a considerable portion of the GOM, there were also increased loadings of agricultural chemicals and sediments (Dowgiallo, 1994). The effects of freshwater inflow into the GOM were detected not only in the northern Gulf but also in the Florida Keys and along the U.S. East Coast.

A recently completed study funded by MMS provides further indications of the significance of the Mississippi River plume (Murray and Donley, 1996). Data collected during research trips in 1993 and 1994 show that the temperature and salinity characteristics of the plume are measurable over a broad area reaching just east of Galveston Bay. East of Galveston Bay, the distributions of these parameters are typical of regions receiving large amounts of freshwater, while westward distributions are typical of areas that receive low amounts of freshwater.

Degradation of the GOM marine waters is associated with coastal runoff discharges, riverine inputs, and, to a smaller extent, effluent discharges from offshore activities, primarily OCS oil and gas development and marine transportation. Not only do the river systems, particularly the Mississippi River, bring freshwater to the GOM, they carry large volumes of contaminants from the extensive agricultural activities, hundreds of cities, and thousands of industries. The most apparent offshore water quality problems are floating debris, hypoxic (oxygen-depleted) conditions, and toxic and pathogen contamination.

In 1993, approximately 300 million barrels (MMbbl) of crude oil and 4.6 tcf of gas were produced on the OCS and shipped to shore by pipeline. Although such activity seems extensive, the maritime industry’s use of GOM waters is even greater. Approximately 1.5 billion barrels (Bbbl) of crude oil was imported through GOM waters by tanker in 1993, about five times the volume piped from domestic production. In addition, about 236 MMbbl of petroleum products was imported in GOM waters and 175 MMbbl was exported. Although petroleum, both crude oil and petroleum products, is the most common commodity shipped through Gulf waters, vessel traffic associated with other commodities is extensive; the GOM has four of the top ten busiest ports in the U.S. All of these offshore activities discharge some form of treated wastewater into the GOM and have resulted in accidental spills of both oil and other chemicals.

Oxygen-depleted, or hypoxic waters, have been identified in a large area of the northern GOM near the mouth of the Mississippi River. Often called the “dead zone,” the areal extent of the oxygen-depleted waters has reached up to 16,500 km^2 (6,371 mi^2) of bottom waters on the inner continental shelf from the Mississippi River delta to the Texas coast, as far south as Freeport (Murray and Donley, 1996). Although the Mississippi/Alabama inner shelf has the potential for bottom-water hypoxia, and low oxygen concentrations have been documented, such events are not considered frequent or widespread (Rabalais, 1992). Although primarily a summer phenomenon, the zone off the Mississippi River has been identified as early as February and as late as October and may affect more than the bottom waters. Researchers have expressed concern that this zone may be increasing in frequency and intensity. Although the causes of this hypoxic zone have yet to be conclusively determined, high summer temperatures combined with freshwater runoff carrying large amounts of excess nutrients from the Mississippi River have been implicated.

Hypoxic conditions in the GOM vary spatially and seasonally depending on the flow of the Mississippi River discharge and are affected by physical features such as water circulation patterns, saltwater and freshwater stratification, wind mixing, tropical storms, and thermal fronts (Meier, 1996). Efforts are underway, facilitated by the GOM Program, to reduce the runoff and discharge of nutrients coming from the upper and lower Mississippi River watersheds and the Ohio River watershed (Meier, 1996). Impacts on phytoplankton and benthic ecosystems are being documented. Benthic fauna studied within the area exhibited a reduction in species richness, abundance, and biomass that was much more severe than has been documented in other hypoxia-affected areas (Rabalais *et al.*, 1996).

Red tides, which are blooms of single-cell algae that produce potent toxins harmful to marine organisms and humans, are a natural phenomenon in the GOM, occurring primarily off southwestern Florida and Mexico. These can result in severe economic and public health problems and are associated with fish kills and invertebrate mortalities. The first documented case of a red tide in the GOM occurred in 1972. In 1996, there was a particularly widespread outbreak. Starting in May and spreading northwest from southwestern Florida, red tides were reported in the waters of Alabama, Mississippi, Louisiana, and Texas. Beaches and oyster beds were closed. There are ongoing studies to determine whether human activity that increases nutrient loadings to GOM waters contributes to the frequency and intensity of red tides.

Information on elevated levels of organic compounds of environmental concern that have been measured in northern GOM offshore waters was summarized by Kennicutt *et al.* (1988). Volatile organic compounds (VOCs) were generally more abundant in coastal and nearshore waters near point sources, and generally decreased with distance from shore. Chlorinated VOCs were generally restricted to nearshore waters, whereas petroleum-related VOCs were detected at offshore locations. Major sources of high-molecular-weight hydrocarbons (HMWHC) include biological production, natural seepage, offshore petroleum production, shipping activities, coastal and riverine run-off, and atmospheric exchange and fallout. The highest levels of HMWHC were measured near point sources in coastal environments and near natural seeps. Large areas of the Gulf off Florida and southern Texas appear to be relatively pristine, whereas areas off northern Texas, Louisiana, and Alabama show detectable levels of petroleum hydrocarbons, likely from natural seepage. Organochlorine residues appear to exist in many marine species. Higher concentrations of pollutants were generally found in organisms from the Mississippi Delta than in offshore biota (Kennicutt *et al.*, 1988).

There has been relatively little evaluation of anthropogenic inputs to the GOM slope area (depths >200 m [656 ft]). This is due to the distance of the slope area from potential input sources and the fact that processes that would transport contaminants that far would likely spread the contamination over a large area (dilution). Exceptions are atmospheric transport and deposition of contaminants, oil production operations, and shipping operations. Oil production and shipping activities normally would affect only a relatively small proportion of the slope area with the exception of catastrophic accidents such as platform "blow outs" or shipping spills of hazardous materials such as oil.

Trace elements are natural components of marine waters and sediments, and many metals are required for healthy growth of organisms. Human activities, however, can increase the concentration and species of metals in the environment, and exposure to elevated concentrations of metals can be toxic to organisms.

Limited data are available regarding trace element concentrations in the deepwater GOM. Most data produced before the 1980s were biased high by a factor of ten to 1,000. Many metals have been shown to behave in a manner similar to nutrients (Bruland, 1983). Reliable average concentrations of cadmium (0.0005 ppb), copper (0.082 ppb), and nickel (0.11 ppb) for deepwater GOM surface waters have been reported (Boyle *et al.*, 1984). Nearshore average concentrations for a limited number of samples in the Mississippi River plume for cadmium (0.02 ppb), copper (0.5 ppb), and nickel (0.5 ppm) were higher than offshore concentrations, as expected (Boyle *et al.*, 1984). Metal concentrations increased with depth in deep water, likely as a result of organic matter degradation similar to nutrient release (Boyle *et al.*, 1984). While limited, the deepwater GOM trace element data suggest minimal anthropogenic inputs when compared to nearshore waters.

Marine sediments are considered to be the ultimate sink for trace metals added to the ocean. This is certainly true once sediments are buried a meter or more below the surface. Before burial to this depth, organism uptake and porewater metal diffusion may lead to metal removal from the sediments, and anthropogenic trace elements may still have adverse toxic effects on benthic and bottom-dwelling organisms. Most studies of offshore GOM sediments report metal concentrations that are not elevated compared to contaminated sites. Exceptions to this general conclusion are in areas where high concentrations of drill cuttings and drill muds are found. In these areas, barium, a major component of drilling mud cuttings, can be elevated. Other trace metals that reported to be elevated in these areas include chromium, nickel, and vanadium. Chromium is associated with the drilling muds/cuttings, while the nickel and vanadium are associated with the produced oils. The concentrations of all these metals, with the exception of barium, return to natural background levels normally within ~1 to 3 km (~0.6 to 1.9 mi) of the production platform (Neff, 1985). Studies by Boothe and Presley (1985; 1987) indicate this may not be the case for barium. The mass balance for barium indicated that only one percent of the barium for nearshore operations and 12 percent of the barium for offshore operations was present in the vicinity of the drill site. The remainder is likely spread over large areas of the GOM. Current studies do not provide enough information to determine the extent of the area where high barium concentrations exist. However, based on benthic ecology studies near drilling platforms, it is unlikely the anthropogenic barium in these sediments is producing a measurable ecological effect.

Hydrocarbons in the marine environment can be classified as coming from terrestrial organisms, marine organisms, and/or petroleum. Hydrocarbons are only slightly soluble in seawater, and seawater-dissolved hydrocarbon concentrations are rarely measured. Due to their low solubility, hydrocarbons tend to associate with particles in the water and are found in sediment deposits. The major inputs of petroleum to the offshore GOM include natural seepage, offshore petroleum production and drilling operations, transportation activities, atmospheric deposition, and sediment transport from coastal areas.

Hydrocarbons in sediments from the GOM continental slope are a mixture of terrigenous, petroleum, and planktonic hydrocarbons (Kennicutt *et al.*, 1987). Hydrocarbon concentrations ranged from 5 to 86 ng/g. The relative importance of these inputs varies as a function of location and water depth. The hydrocarbon concentrations are generally lower than those reported on the shelf and much lower than in many coastal areas of the GOM. The influence of land-derived biogenic hydrocarbons decreases from the central to the western slope, and is even lower in the eastern slope. Petroleum inputs were measurable at all sites sampled. Natural seepage is considered to be a major source of these petroleum hydrocarbons. Hydrocarbon concentrations vary by one to two orders of magnitude above a given isobath due to sediment texture and hydrocarbon inputs. Variability along isobaths is as great or greater than those seen for a depth range of 300 to 3,000 m (984 to 9,843 ft) along a single transect. Aromatic hydrocarbon concentrations are less than 5 ppb, but their presence is inferred from spectrophotometric analyses, confirming the presence of petroleum-related hydrocarbons at all sites. Aromatic hydrocarbons at these low concentrations are not thought to adversely affect biota (Long and Morgan, 1990).

3.2 Biological Resources

3.2.1 Coastal Environments

Coastal environments include coastal barrier beaches and associated dunes and wetlands. The following discussion focuses on coastal environments located inshore of the area of interest for future FPSO operations (i.e., Central and Western GOM Planning Areas). However, because of concerns about possible FPSO-related oil spills and the transport of oil throughout the Gulf, limited discussion of coastal features inshore of the Eastern GOM Planning Area has also been provided.

3.2.1.1 Coastal Barrier Beaches and Associated Dunes

Inshore of the Central and Western GOM OCS Planning Areas

Coastal barrier landforms inshore of the Central and Western Gulf Planning Areas consist of the islands, spits, and beaches that extend in an irregular arch from Baldwin County, Alabama, westward to the U.S./Mexico border in Cameron County, Texas. These elongated, narrow landforms are composed of sand and other unconsolidated course sediments that have been transported to their present location by rivers, waves, currents, storm surges, and winds. Coastal landforms are transitory in nature and are constantly being sculpted and modified by the same forces that led to their original deposition.

Sea level rise since the end of the last glacial period approximately 10,000 years ago has greatly affected the coastal landforms seen in the Gulf today. Present barrier landforms are relatively young, having been formed between 5,000 and 6,000 years ago when the main continental ice sheets melted and sea level rise began to stabilize.

The accumulation and movement of the sediments making up barrier islands, sand spits, and beaches are often described in terms of "transgressive" or "regressive" sequences. A transgressive sequence is one in which the shoreline is moving landward and marine deposits rest on top of terrestrial deposits. A regressive sequence is one in which terrestrial sediments are being deposited on top of marine sediments and the shoreline is being extended out into the sea. Transgressive barrier islands are usually undergoing active erosion. They characteristically have a predominately low-profile morphology characterized by narrow widths, low, sparsely vegetated, discontinuous dunes and numerous active washover channels. Regressive landforms are undergoing accretion or active sediment deposition and characteristically have high-profile morphologies, broad widths, and high, continuous, well-vegetated dunes. Regressive landforms have few, if any, washover channels.

Barrier landforms (i.e., barrier islands, major bars, sand spits) in the central and western GOM can be divided into four major classifications based on location, including: 1) the Mississippi Sound Landform Complex; 2) the Mississippi Deltaic Landform Complex; 3) the Chenier Plain Landform Complex; and 4) the Texas Barrier Island Landform Complex. Table 3-7 identifies the islands, bars, and beaches seen in each of these complexes and gives their current status as transgressive, regressive, or subsiding sediment deposits.

Inshore of the Central GOM Planning Area, barrier islands and landforms occur in three settings. From east to west these settings are: 1) the Mississippi Sound barrier islands; 2) the Mississippi River deltaic barrier islands; and 3) the beaches of Chenier Plain, Louisiana.

The Mississippi Sound barrier islands have formed over the last three to four thousand years as a result of westward sand migration resulting in shoal and sand bar growth (Otvos, 1980). Geologically these features are quite young. The islands are separated from each other by fairly wide, deep channels. Ebb and flood tide deltas and shoals are associated with these channels and contribute to the sediment budget and sand transfer processes characteristic of this system. All islands within this setting are generally regressive or stable features with high beach ridges and prominent sand dunes. They are well vegetated, showing a southern maritime forest climax community of pine and palmetto. Although some of these islands may experience washover during major storms, washover channels are not common. Most of these islands show no trend toward erosion or thinning, although they do migrate westward in response to the westward moving longshore current. Dauphin Island is an exception to this generality in that the island is a long, narrow, transgressive sand deposit which is frequently overwashed by storms. The eastern end of the island is apparently migrating toward the mainland.

Barrier islands found along the Mississippi River Deltaic Plain were built and have been sustained by the series of overlapping river deltas that have extended onto the continental shelf over the last 6,000 years. Barrier island transgression or regression along the deltaic plain of the Mississippi River depends upon what stage of the cycle the nearby land mass is experiencing. If the nearby delta is in the expanding stage, the deposits being pushed out onto the shelf are regressive. Once the river channel changes, subsidence and sea-level rise begin to convert these sediments in transgressive deposits as waves and washover channels form and divide barrier islands.

The coast of Chenier Plain is composed of sand beaches and coastal mudflats. The extensive mudflats seen in this area are the result of fine particle deposition from both the Mississippi and the Atchafalaya Rivers, where mud and fine particles are carried westward by the prevailing coastal current. In some cases, this fluid-saturated mud extends several hundred meters seaward from the edge of the salt marsh communities found along the shore, absorbing

Table 3-7

Type and Status of Coastal Landforms Seen in the Central and Western Gulf of Mexico

State	Feature	Status
Mississippi Sound Barrier Islands and Landforms Complex		
Alabama	Fort Morgan / Mobile Bay Sand Spit	Regressive feature with sand deposition coming from the east.
Alabama	Dauphin Island	Stable regressive core at the eastern end, with a transgressive bar-like landform forming its western extension. This transgressive area is migrating towards the mainland.
Mississippi	Petit Bois Island	Regressive, stable barrier island feature.
Mississippi	Horn Island	Regressive, stable barrier island feature.
Mississippi	Gulf Island	Regressive, stable barrier island feature.
Mississippi	Ship Island	Primarily a regressive deposit, but there is a large, transgressive washover area in the center of this barrier island.
Mississippi	Cat Island	Regressive, stable barrier island feature.
Mississippi Deltaic Landforms Complex		
Louisiana	North Island	Transgressive deposit from the old Mississippi River delta currently being eroded away.
Louisiana	Chandeleur Islands	Chain of low-relief islands marking the easternmost extension of a previous Mississippi River delta. Currently, these sand deposits are transgressive and are being eroded away.
Louisiana	The Mississippi River "Bird's Foot" Delta	Current delta of the Mississippi River. Regressive deposits laid down in the very recent past. Experts agree that this delta has reached its maximum expansion and would already have begun to erode away if the course of the Mississippi River had not been stabilized.
Louisiana	Grand Terre Island	Transgressive deposit from an old Mississippi River delta currently undergoing erosion and subsidence.
Louisiana	Grand Island	Transgressive deposit from an old Mississippi River delta currently undergoing erosion and subsidence.
Louisiana	Timbalier Island	Transgressive deposit from an old Mississippi River delta currently undergoing erosion and subsidence.
Louisiana	Isles Dernieres	Transgressive deposit from an old Mississippi River delta currently undergoing erosion and subsidence.
Louisiana	Marsh Island	Transgressive deposit from an old Mississippi River delta currently undergoing erosion and subsidence.
Chenier Plain Landform Complex		
Louisiana	Beaches and coastal mud flats west of Marsh Island	Regressive mud and sand deposits from the Mississippi and Atchafalaya Rivers. There are areas along this coastline undergoing erosion but overall these deposits are regressive and relatively stable.
Texas	Beaches from the Louisiana border to Rollover Pass north of Galveston Bay.	While this area is a physiographic continuation of the Chenier Plain, the sediments in this area are transgressive, migrating landward over tidal marshes.
Texas Barrier Islands Landforms Complex		
Texas	Galveston Island and the Bolivar Peninsula	Transgressive sediment deposits that are currently experiencing net erosion.
Texas	Matagorda Peninsula	Transgressional sediment deposits with a predominately erosional shoreline.
Texas	Matagorda Island	Transgressional barrier island that has been breached frequently by hurricanes and lesser storms. Washover sediments now overlie the inactive deltaic tidal sediments.
Texas	San Jose Island	Transgressional barrier island.
Texas	Mustang Island	Transgressional barrier island.
Texas	Padre Island	Transgressional barrier island.

wave energy and helping to protect these coastal wetland communities. Beaches in the Chenier Plain area are thin sand deposits present along the seaward edge of the marsh. The coastline of the Chenier Plain is relatively stable at this time.

Coastal barrier landforms inshore of the Western GOM Planning Area extend from the Texas-Louisiana border to Bolivar Peninsula, just north of Galveston Bay. The Texas coastline represents a continuation of the Chenier Plain; however, the beaches and shoreline sediments present in this region are in a state of transgression. Thin accumulations of sand, shell, and caliche nodules form beaches that are migrating landward over tidal marshes. These beaches have poorly developed dunes and numerous washover channels.

From Galveston Bay southward to the Mexican border, the coast of Texas is a barrier island coast. Barrier islands and sand spits present in this region along the Texas coast were formed from sediments supplied by three major deltaic headlands: 1) Trinity River delta, in the Galveston Bay area; 2) the Brazos-Colorado-San Bernard Rivers delta complex, in Matagorda County; and 3) the Rio Grand delta complex, in Cameron County.

Barrier islands in this region are arranged symmetrically around old, eroding delta headlands. Such islands tend to be narrow and sparsely vegetated, exhibiting a low profile with numerous washover channels.

Barrier islands and sand spits protect the bays, lagoons, estuaries, salt marshes, and seagrass beds located behind them from the direct impacts of the open ocean. By separating the coastal waters from the open ocean, these landforms contribute to and increase the amount of available estuarine habitat. They also provide protection for the coastal wetlands, which provide habitat to a large number of bird and other animal species, including several species that are endangered or threatened (e.g., see Section 3.2.5.2).

Inshore of the Eastern GOM OCS Planning Area

Though the use of FPSOs is projected for deepwater regions of the central and western Gulf, support operations (i.e., shuttle tankers carrying FPSO-produced oil, crew and supply vessels) will traverse coastal waters adjacent to Gulf ports. Thus, there is a need to characterize coastal environments of the Central and Western Planning Areas. In addition, the potential for accidents and oil spills from FPSO operations may have ramifications for nearshore coastal waters throughout the GOM. The following description of the coastal environment of the eastern GOM has been developed with these considerations in mind.

The barrier islands and mainland beaches of the Florida panhandle typically are stable, with broad, high-profile beaches backed by high dunes. These beaches are some of the most beautiful seen along the GOM and represent a major economic asset to the State of Florida and the region in general. Throughout the Big Bend area east of Cape San Blas, the coast curves inward, away from the Gulf proper. The coastline in this area is one of the lowest energy coastlines in the world (Continental Shelf Associates, Inc., and Martel Laboratories, Inc., 1986). Typical barrier islands and beaches are not seen along this coast, and forested wetlands occur down to the water’s edge. Typical barrier features appear again in Anclote Key in Pasco and Pinellas Counties, Florida, and continue southward through Cape Romano, just north of Everglades National Park and Florida Bay. The Florida Keys to the south of Florida Bay are a unique coastal feature not seen elsewhere along the U.S. GOM coast. They form a line of cemented limestone islands, which provide unique habitats for a variety of flora and fauna (USDOI, MMS, 1996b).

3.2.1.2 Wetlands

Inshore of the Central and Western GOM OCS Planning Areas

Wetland habitats inshore of the Central and Western Planning Areas consist of seagrass beds; mangroves; fresh, brackish, and salt marshes; mudflats; forested wetlands of hardwoods; and cypress-tupelogum swamps. Wetland habitats may occupy only narrow bands along the shore, or they may cover vast expanses of the coastline. Seagrass beds, if present, are seen offshore in shallow water, while mangroves and marshes interface between marine and terrestrial habitats, and forested wetlands are found inshore, away from direct contact with the water.

High organic productivity, high detritus production, and extensive nutrient recycling characterize coastal wetlands. The wetlands environment provides habitat for a vast number of invertebrate, fish, reptile, bird, and mammal species. Two-thirds of the high-value fishes caught in the GOM spend at least some portion of their life cycle in the nearshore seagrass beds or salt marshes (USDOI, MMS, 1990a).

Table 3-8 identifies the bays, estuaries, lagoons, sounds, and coastal wetlands present inshore of the Central and Western Planning Areas. Under the “Category” classification in table 3-8, bays are defined as semi-enclosed embayments of primarily open seawater with little freshwater input. Estuaries are defined as embayments with substantial freshwater input from rivers and streams and consequently lower and more variable salinities. Estuaries represent mixing zones where continental freshwater runoff mixes with higher salinity ocean water. Lagoons are long narrow bodies of water that occur where nearshore water is prevented from entering the open sea by nearshore barrier islands. Salinities are typically higher in lagoons than in estuaries or bays, and in some cases, such as Laguna Madre, may exceed open-ocean salinity. Sounds are large embayments of essentially open-ocean water that have been cut off from the open sea by barrier islands located quite far from shore. Because of variable influx of fresh water, salinities in sounds rarely exceed open ocean waters.

Coastal wetlands, as indicated in table 3-8, refer to those areas where the salt marsh or wetland community fronts directly on the open sea with very little protection from barrier islands and very little beach. All of these enclosed, semi-enclosed, and open coastal wetlands provide unique habitats that are of critical importance to both the adjacent terrestrial and continental shelf ecosystems.

Inshore of the Central GOM Planning Area, mainland marshes behind Mississippi Sound occur as discontinuous wetlands associated with estuarine environments. In Alabama, most of the wetlands are located in Mobile Bay and along the northern side of Mississippi Sound. The most extensive coastal wetland areas in Mississippi are seen in the eastern part of the state, near the mouth of the Pearl River and in Pascagoula Bay. The marshes in Mississippi are more stable than those of either Alabama to the east or Louisiana to the west, reflecting a more stable substrate and continued active sedimentation in the marsh areas. Major causes of marsh loss in Alabama have included industrial development, navigational dredging, natural succession, and erosion-subsidence (Roach *et al.*, 1987).

A majority of the coastal wetlands present around the GOM are found in Louisiana, where they occur in two physiographic provinces: 1) the Mississippi River Deltaic Plain; and 2) the Chenier Plain. Existing wetlands in the Mississippi Deltaic Plain have formed over the last 6,000 years atop of a series of overlapping riverine deltas. These wetlands developed in shallow areas that received flow and sediments from the Mississippi River. The effects of sea level rise

Table 3-8

Bays, Estuaries, Lagoons, Sounds, and Coastal Wetlands of the Central and Western Gulf of Mexico

State	Feature	Category
Alabama	Mobile Bay	Estuary
Alabama and Mississippi	Mississippi Sound	Sound
Mississippi	Pascagoula Bay	Bay
Mississippi	Biloxi Bay	Estuary
Mississippi	St. Louis Bay	Estuary
Louisiana	Lake Borgne	Sound
Louisiana	Chandeleur Sound	Sound
Louisiana	Breton Sound	Sound
Louisiana	Barataria Bay	Coastal Wetland
Louisiana	Timbalier Bay	Coastal Wetland
Louisiana	Terrebonne Bay	Coastal Wetland
Louisiana	Caillou Bay	Coastal Wetland
Louisiana	Atchafalaya Bay	Coastal Wetland
Louisiana	Blanche Bay	Coastal Wetland
Louisiana	Vermillion Bay	Coastal Wetland
Texas	Galveston Bay	Estuary
Texas	West Bay	Lagoon
Texas	Matagorda Bay	Lagoon
Texas	Espiritu Santo Bay	Lagoon
Texas	San Antonio Bay	Estuary
Texas	Copano Bay	Estuary
Texas	Aransas Bay	Lagoon
Texas	Corpus Christi Bay	Estuary
Texas	Baffin Bay	Estuary
Texas	Upper Laguna Madre	Lagoon
Texas	Lower Laguna Madre	Lagoon

Note: Categorization of the features noted above is founded on the following definitions. Estuaries, bays, sounds, and lagoons are designated primarily on the amount of fresh water present. Estuaries are defined by riverine input. These habitats are subject to rapid salinity fluctuations. Bays are generally open to coastal shelf water but do not have the fresh water input of estuaries. Their salinity range is more constant. Sounds are large bodies of water separated from the open ocean by a chain of barrier islands. In this regard, they are similar to lagoons; however, sounds are larger and deeper and generally have more and larger openings to coastal shelf waters. Their salinity remains fairly constant. Lagoons as seen in the Gulf of Mexico are long, narrow, shallow bodies of water. They have few inlets connecting them to open coastal waters, and they can become hypersaline during periods of high evaporation. Lagoons are characterized by having very little fresh water input.

and high, natural subsidence of these organically rich sediments are continually impacting these wetlands (van Beek and Meyer-Arendt, 1982). Wetland areas located near the active channel of the Mississippi tend to expand, whereas those formed by older, abandoned channels tend to erode and subside. Louisiana has the most rapidly retreating shoreline in the nation, with some estimates reaching as high as an average of 3.96 m (13 ft) per year (U. S. Geological Survey, 1988). The most rapid rate of shoreline retreat is seen along the Mississippi River Deltaic Plain (Williams *et al.*, 1992).

The Chenier Plain, located to the west of Atchafalaya Bay, is a series of sand and shell ridges formed as sand dunes during the last ice age. These ridges are now separated by progradational mud flats, marshes, and open water. Localized sedimentation conditions have favored deposition in the Chenier Plain area.

In the 1980s, Louisiana, Alabama, and Mississippi contained 35,536, 10,725, and 17.7 km^2 (8,784,000, 2,651,000, and 4,365 acres) of wetlands, respectively. During the following ten years, Louisiana lost 1,990 km^2 (491,904 acres), while Alabama and Mississippi lost 165.8 and 0.8 km^2 (40,976 and 200 acres) of wetlands, respectively (Hefner *et al.*, 1994).

Deterioration of wetlands, particularly along the Louisiana coastline, is an issue of concern (USDOI, MMS, 1997b). Several factors have contributed to the loss of wetlands in coastal Louisiana. Levee construction and efforts to conserve topsoil have reduced the Mississippi River's sediment load by 50 percent since the 1950s. Construction of ring levees has allowed drainage and development of vast wetland acreage. Development activities in low areas outside levees have caused wetlands to be filled in. Canals built for navigation and shoreline access have raised spoil banks where wetlands once existed. Canals have allowed greater impacts of tidal flushing in the fresh and brackish water marshes, resulting in wetland loss, shifts in species composition, and habitat deterioration (Turner and Cahoon, 1988; Britsch and Kemp, 1990).

Inshore of the Western GOM Planning Area, the portion of the Texas coast from the Louisiana border to the Bolivar Peninsula (just north of Galveston Bay) is physiographically part of the Chenier Plain. Estuarine marshes along the rest of the Texas coast occur in discontinuous bands around the bays and lagoons and on the inner sides of the barrier islands. Salt marshes, composed primarily of smooth cordgrass, are evident nearest to the mouths of bays and lagoons, in areas of higher salinities. Brackish water marshes are seen farther inland, and freshwater marshes occur along the major rivers and tributaries (White *et al.*, 1986).

Seagrasses grow on sand bottoms in sallow, relatively clear water in areas with low wave energy. There are over 29,990 km^2 (7,413,000 acres) of seagrass in the GOM, approximately 98.5 percent of which is on the west Florida shelf. Inshore of the Central and Western GOM Planning Areas, the coastal waters of Mississippi and Alabama contain approximately 200 km^2 (74,000 acres) of seagrass growing along the inner edges of the barrier islands of Mississippi Sound and along the shorelines of prominent bays. To the west, Texas nearshore waters contain approximately 150 km^2 (37,000 acres) of seagrass beds, most of which are located in the Laguna Madre and the Copano-Aransas Bay complex (Shew *et al.*, 1981; USDOI, MMS, 1998a).

Seagrass beds are an extremely productive marine habitat and support a tremendously complex ecosystem, providing nursery grounds for vast numbers of commercially and recreationally important fisheries species, including shrimp, black drum, snappers, groupers, spotted sea trout, southern flounder, and many others.

Seagrass distributions inshore of the Central and Western GOM Planning Areas have declined over the last several decades due to a number of natural and man-made factors, including recent hurricanes, flooding, dredging, trawling, dredge material disposal, water quality degradation, and levee construction, which has diverted freshwater away from wetlands.

Inshore of the Eastern GOM OCS Planning Area

Approximately 98.5 percent of the seagrass beds in the GOM are located in the eastern Gulf, off the coast of Florida (USDOI, MMS, 1996b). In addition to this submerged aquatic vegetation, the Big Bend, Northern Everglades, and Florida Bay all have extensive coastal wetland communities that front directly on the open waters of the Gulf. Plant communities dominating these wetlands range from salt marshes and coastal hardwoods in the north to mangrove forests in the south (Continental Shelf Associates, Inc, and Martel Laboratories, Inc., 1986; Continental Shelf Associates, Inc. 1990, 1991).

3.2.2 Offshore Environments

3.2.2.1 Water Column

The GOM is a subtropical ocean basin located within the circulation regime that is often called the Intra-Americas Sea (IAS). The near-surface circulation pattern of the eastern GOM is dominated by the anticyclonic flow of the Loop Current (LC). East of long. 90^{o} W., upper layer flow enters through the Yucatan Channel and leaves through the Florida Straits. Since this current enters from the Caribbean, it acts as a biological conveyor belt to maintain the exchange of pelagic species between the Caribbean and the GOM. This conveyor does not fertilize downstream plant plankton, however, since LC surface waters are among the most oligotrophic in the world ocean. Nitrate, phosphate, and other essential plant nutrients are usually below the analytical detection limit (i.e., <0.05 µM/l) in LC inflow water from the surface to depths of approximately 80 to 90 m. The extinction coefficient, "k", that describes how rapidly irridiance decreases with depth (according to the exponential equation $I_z = I_o * e^{-kz}$) is usually <0.05 in LC surface water. As a consequence, the LC inflow is almost "swimming pool" clear and therefore deep blue in color.

In the central and western deepwater GOM as well, the standing stocks and biological productivity of the plant and animal communities living in the upper part of the water column are in general those that might be expected in a nutrient-limited ecosystem. In 1970, as part of a review of primary (planktonic) productivity of the world ocean, Soviet scientists characterized the deepwater GOM by mean primary productivity of just 100 to 150 mg C/m^3/d (Koblenz-Mishke *et al.*, 1970). A few years later, extensive surveys of phytoplankton chlorophyll and primary production that span the period 1964 to 1971 were summarized by El-Sayed *et al.* (1972) in atlas format as averages within 2^{o} squares of latitude and longitude. These atlas maps show that surface chlorophyll-a generally ranges from 0.06 to 0.32 mg/m^3 in areas of deep water of the central and western GOM, equivalent to just 3 to 21 mg/m^2 when integrated from the surface to the base of the photic zone. Low values of primary production (<0.25 mg C/m^3/hr) characterize the majority of the oceanic stations in this atlas, equivalent to <10 mg C/m^2/hr when integrated from the surface to the base of the photic zone. With an annual average of 12 hours of sunlight per day, this rate is equivalent to <120 mg C/m^2/d, in good agreement with the summary by Koblenz-Mishke *et al.* (1970). Allowing for primary production to proceed 365 days a year in the GOM because of its subtropical climate, this rate of primary productivity is <50 g C/m^2/yr. Consequently, the deepwater GOM falls at the low end of the estimated range of 50 to 160 g

C/m^2/yr that is generally accepted for the annual primary production in open-ocean ecosystems (Smith and Hollibaugh, 1993).

In fact, data collected by survey expeditions to the GOM in the 1960's and 1970's remain the basis for the general paradigm that standing stocks and annual productivity of plankton are both quite low seaward of the shelf-slope break. Research carried out since then supports this description of the mean state, but recent research also indicates that "hot spots" in primary production occur when/where nutrient availability is locally enhanced (Biggs and Sanchez, 1997; Lohrenz *et al.*, 1990, 1999; Gonzalez-Rodas, 1999). In addition, even in a subtropical ocean there are seasonal changes. Pigment concentration at the surface in the deepwater GOM undergoes a well-defined seasonal cycle that is generally synchronous throughout the region. Muller-Karger *et al.* (1991) reviewed monthly climatologies of near-surface phytoplankton pigment concentration from multi-year series of coastal zone color scanner (CZCS) images for the period 1978 to 1985. They reported that the highest surface concentrations of chlorophyll occur between December and February, and lowest values occur between May and July. However, there is only about three-fold variation between the lowest (~0.06 mg/m^3) and highest (0.2 mg/m^3) surface pigment concentrations. Model simulations show that the single most important factor controlling the seasonal cycle in surface pigment concentration is the depth of the mixed layer (Walsh *et al.*, 1989). Muller-Karger *et al.* (1991) concluded that, because of this dependence, annual cycles of algal biomass are usually out of phase relative to the seasonal SST cycle.

Since essential plant nutrients are limiting, any process that increases the nutrient concentrations available to the phytoplankton in the deepwater GOM will increase their primary productivity. It is well known that freshwater inputs carry high nutrient loads. However, in the GOM these high nutrient inputs are usually measurable only in proximity to rivers and estuaries (Lohrenz *et al.*, 1994). The exceptions occur when surface currents set up an off-shelf flow that carries the river water seaward past the shelf-slope break and into deepwater. Biggs and Muller-Karger (1994) combined CZCS data with ship data to document that high-chlorophyll "plumes" do form in the western GOM when a seaward-moving surface flow confluence is created by deepwater cyclone-anticyclone circulation pairs. Analogous to a pair of anticlockwise-rotating and clockwise rotating gears, these circulations entrain coastal water from the western and central GOM and draw this offshore when the cyclone (i.e., anticlockwise circulation) lies immediately to the north or east of the anticyclone (i.e., clockwise circulation).

Recent fieldwork has shown that these mesoscale oceanographic features have additional impacts upon deepwater plankton and micronekton communities, for locally high nutrient levels are also introduced to the surface of deepwater ocean regions at eddy edges where there is enhanced vertical mixing. In fact, the periphery region of high-velocity surface currents that surrounds both the cyclonic and the anticyclonic eddies are zones of locally high vertical shear. In the CZCS ocean color climatology from 1978 to 1985 and in imagery from the current generation ocean color sensor (i.e., Sea Wide-Field Scanner, or SeaWiFS; in orbit since November 1997), the periphery of the LC and of the anticyclonic Loop Current eddies (LCEs) of diameter 200 to 300 km (124 to 186 mi) that are shed from the LC are often seen to be outlined by surface pigment concentrations that are two- to three-fold higher than the extremely low concentrations (i.e., 0.04 to 0.06 mg/m^3) in the interior of these circulations.

The presence of multiple cyclonic and anticyclonic features in the GOM can set up strong frontal gradients between these features. Lee *et al.* (1991) have shown that meanders and eddies in the Gulf Stream are often marked by local aggregations of phytoplankton. Elevated fish stocks appear to concentrate in such areas (Atkinson and Targett, 1983). Since 1982, the Southeast Area Management and Assessment Program (SEAMAP) has made over 2,000 deepwater collections of zooplankton and micronekton in the GOM to survey for icthyoplankton (i.e., eggs and larvae of commercially important fish species). Data reports for the SEAMAP program were produced each year, but there has been no summary of the interannual or decadal variability of the data. Recently, Lamkin (1997) used six years of SEAMAP data (1983 to 1988) in an investigation of the frontal zones associated with the northern excursions of the LC. Lamkin (1997) found a positive correlation between the abundance of larval nomeid fishes (i.e., drift fishes such as man-of-war fish) and the location of the northern edge of the LC. In particular, *Cubiceps pauciradiatus* has adult spawning grounds and larval habitats closely related to sharp temperature gradients. Other fish larvae also appear to vary in abundance in relation to mesoscale hydrographic features (Richards *et al.*, 1993). Larvae of apex predators like bluefin and yellowfin tuna seem to be most abundant along LC frontal zones and within eddy peripheries (Richards *et al.*, 1989) and the adults, as well, can be caught in such frontal zones.

Because the interiors of the anticyclones are areas of convergence, the upper 100 m (328 ft) or so of the water column in both LC and LCEs are areas in which surface waters are infrequently renewed and thus are impoverished in nitrogen and phosphorus nutrients (Biggs, 1992). The interiors of these regions of convergence are generally regarded as biological “ocean deserts.” However, the cyclonic cold-core eddies (i.e., local areas of divergence) that are frequently associated with these anticyclones represent areas of higher biological productivity. Both types of these mesoscale features can be detected by the topography of the 15°C isotherm; this is domed upward in the cyclones, and pushed locally deep within the anticyclones. Both types of features can now be located with satellite altimetry since GOM cold-core eddies (i.e., 15°C isotherm domed) show up as 10 to 20 cm (3.9 to 7.9 in) local depressions in sea surface height, whereas warm-core eddies (i.e., 15°C isotherm pushed locally deep) show up as 20 to 70 cm (7.9 to 27.6 in) local elevations in sea surface height (Leben *et al*., 1993).

Subsurface sampling of these GOM eddies from ships showed there was a highly predictable negative first-order relationship between temperature <22°C and nitrate concentration. Temperature could thus be used as a proxy for nitrate concentration, and in particular the depth of the 19°C isotherm was a good estimation of the depth of the 10 µM nitrate concentration (Biggs *et al.*, 1988). Within one cyclone sampled in 1996, the nitracline was domed 40 to 60 m (131 to 197 ft) shallower than within the LCE that was sampled concurrently (Zimmerman and Biggs, 1999, figure 6). Because this doming facilitated a higher flux of new nitrogen into surface waters in cyclone than in anticyclone, the deep chlorophyll maximum (DCM) was locally shallower and chlorophyll reached higher maximum concentration in the cyclone than in the LCE. Because this resulted in higher standing stocks of chlorophyll in the upper 100 m (328 ft) in the cyclone, the cyclones are regarded as biological "oases," while the interior of the LCEs are biological "deserts." During the recently completed GulfCet II research program, which was co-sponsored by the U.S. Geological Survey and MMS, trawling and bioacoustic survey work showed the cyclone but not the LCE had locally higher standing stocks of zooplankton and nekton (Chapter 3 in Davis *et al*., 2000).

In summary, when and where anticyclonic and cyclonic hydrographic features occur over areas of deep water in the western and central GOM, they will play an important role in determining biogeographic patterns and controlling population ecology in the Gulf. The potential for increased fisheries biomass within cyclones and along the frontal zones of both types of eddies is becoming better understood now that these have been identified as deepwater concentrating mechanisms for higher trophic levels and apex predators. Continued study and assessment of zooplankton and nekton abundance within these mesoscale circulation features is warranted, as these organisms ultimately serve as food stocks for higher trophic levels. Acoustic sampling should play an important role in future applied research on eddies, for the hundreds of kilometers in diameter spatial size of these mesoscale circulation features and the fact that most persist for many months demands they be surveyed and sampled in an efficient manner in order to maximize the multidisciplinary value of data collected on their water column biology.

3.2.2.2 Deep Benthic Communities

Soft Bottom Benthos

The benthic communities in the western and central areas of the GOM are typical of most temperate continental slope assemblages at depths ranging from approximately 300 m (984 ft) to just over 3,000 m (9,843 ft). The total community can be subdivided by organism size: 1) megafauna (large animals typically caught in shrimp trawls and visible to the naked eye), 2) macrofauna (species defined on the basis of their capture on 0.25- to 0.5-mm sieving screens), 3) meiofauna (smaller invertebrates consisting mostly of nematode worms, defined by separation on 63-µm-mesh sieving screens), and 4) microfauna (composed of protists and bacteria). In the present description, the communities will be described on the basis of their structure (e.g., biomass, diversity, etc.), their function (e.g., metabolism, growth rates, etc.) and the environmental factors that affect both structure and function.

Environmental Factors

Depth is an important environmental factor affecting the benthos within the study area, including the outer margin of the shelf (at depths of about 200 m [656 ft]) and extending into the slope (slightly above 3 km [9,843 ft]) at the southern boundary at the EEZ with Mexico. The geology and topography of the region (Section 3.1.1) is characterized by numerous basins and rises that are tens of kilometers across and often more than several hundred meters deep. The entire region is draped in a blanket of fine-grained silt-clay sediments about 2 m (6.6 ft) thick that dates from the Holocene transgression. The organic content, however, is modest, with few if any values above 1 to 2 percent organic carbon. This reflects the generally low productivity of the surface waters (Section 3.2.2.1) and the dilution of organics by terrigenous particulate matter carried offshore by the Mississippi River. It might be expected that organic matter in sediments could be higher due to fertilization from oil and gas seeps, but such influences so far appear to be limited to the immediate vicinity of a seep.

The oceanic oxygen minimum at depths of 200 to 400 m (656 to 1,312 ft) reaches values between 2.5 and 3 ml/l, levels that are low enough to have an impact on indigenous fauna. This condition of "near-hypoxia" is not related to the seasonal hypoxia normally observed on the continental shelf under the Mississippi River plume.

Temperatures, which are known in general to have substantial influences over animal distributions, are stable below depths of the permanent thermocline, except when influenced by a warm eddy. Small variations are known to occur as deep as 1.2 km (3,937 ft), but not deeper. The constant, deepwater temperature reflects the temperature of the source, the Antarctic Intermediate Water. It has a temperature of 4.3^{o}C and a salinity of 34.9 psu. Thus, temperature and salinity variations have minimal effects on the fauna, with the exception of the upper continental slope environment when it is influenced by a warm eddy.

An alteration of “normal” communities might be expected in the numerous small basins lining the slope if they are characterized by underlying salt or fossil organics that have seeped into the basin. If the basin retains this subbottom material because of its density, then the communities in the immediate proximity of this "lake" will be highly altered. Although this is known to occur (MacDonald, 1998), its frequency is so far unknown.

Community Structure

To a large degree, the oligotrophic nature of the open GOM (Section 3.2.2.1) is reflected in the structure of the deep Gulf benthos. It is well established that the density and biomass of the macrofauna declines precipitously with depth from about 5,000 individuals/m^2 in lower shelf and upper slope environments down to several hundred individuals/m^2 on the abyssal plain (Rowe and Menzel 1971, Rowe *et al.* 1974; see figure 3-18). A decline in densities with depth has also been observed in the megafauna and the meiofauna (Pequegnat *et al.*, 1990). A mid-depth maximum was observed on the upper slope in the macrofauna in some locations (Pequegnat *et al.*, 1990), and it is inferred that this occurs in regional sediment “depocenters” of organically rich particulate matter. Megafauna densities, composed principally of echinoderms and crustaceans, amount to as many as 600 individuals/ha, but these are in less abundance than at similar depths on the Florida Escarpment of the eastern Gulf.

It has been suggested that the communities are zoned with depth (Pequegnat 1983). The upper slope has been designated the Shelf/Slope Transition Zone and extends from about 100 m (328 ft) down to approximately 500 m (1,641 ft). This zone is populated by echinoderms, crustaceans, and several abundant bottom fishes, all of which feed on the smaller invertebrates on or near the bottom. Below the Shelf/Slope Transition Zone are two Archibenthal Zones (Horizons A and B) at 500 to 775 m (1,641 to 2,543 ft) and 800 to 1,000 m (2,625 to 3,281 ft), respectively. Within these zones, galatheid crabs are abundant, along with rat tail fishes. Large sea cucumbers and sea stars are abundant as well in the upper horizon.

A peculiar inhabitant of the Gulf is the giant isopod crustacean, *Bathynomus giganteus*. While many of the dominant species mentioned below are common to the U.S. East Coast at more or less similar depths, *B. giganteus* is not. In the second zone, the fishes, echinoderms, and crustaceans decline. This zone is characterized by the red crab, *Chaceon quinquedens*. The Upper Abyssal Zone extends from 1 km (3,281 ft) down to 2.2 km (7,218 ft) depth. It is much broader than the zones noted previously, but the number of fish species declines. However, the invertebrate species appear to increase. Common echinoderms are the sea cucumbers *Mesothuria lactea* and *Benthodytes sanguinolenta*. Galatheid crabs are characterized by 12 species of the familiar deep-sea genera *Munida* and *Munidopsis*. Although the galatheids, which are common deep-living decapods, remain speciose, the shallow-living brachyuran crabs decline.

Below this stratum is the Mesoabyssal Zone from 2.3 to 3.2 km (7,546 to 10,500 ft) depth. This crosses over the steep Sigsbee Escarpment, demarcating the lower slope and the upper rise. Fishes are depauperate, and the echinoderms continue to dominate the megafauna. The Lower Abyssal Zone (3.2 to 3.8 km [10,500 to 12,468 ft]) stretches out onto the abyssal plain of the Sigsbee Deep, which extends into the Mexican EEZ. The most common megafauna species at these greatest depths in the Gulf is the large asteroid *Dytaster insignis.* The designations for zones noted above are similar to those used previously by Menzies *et al.* (1973)

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Fig3-18.CDR-7/14/00-GRA

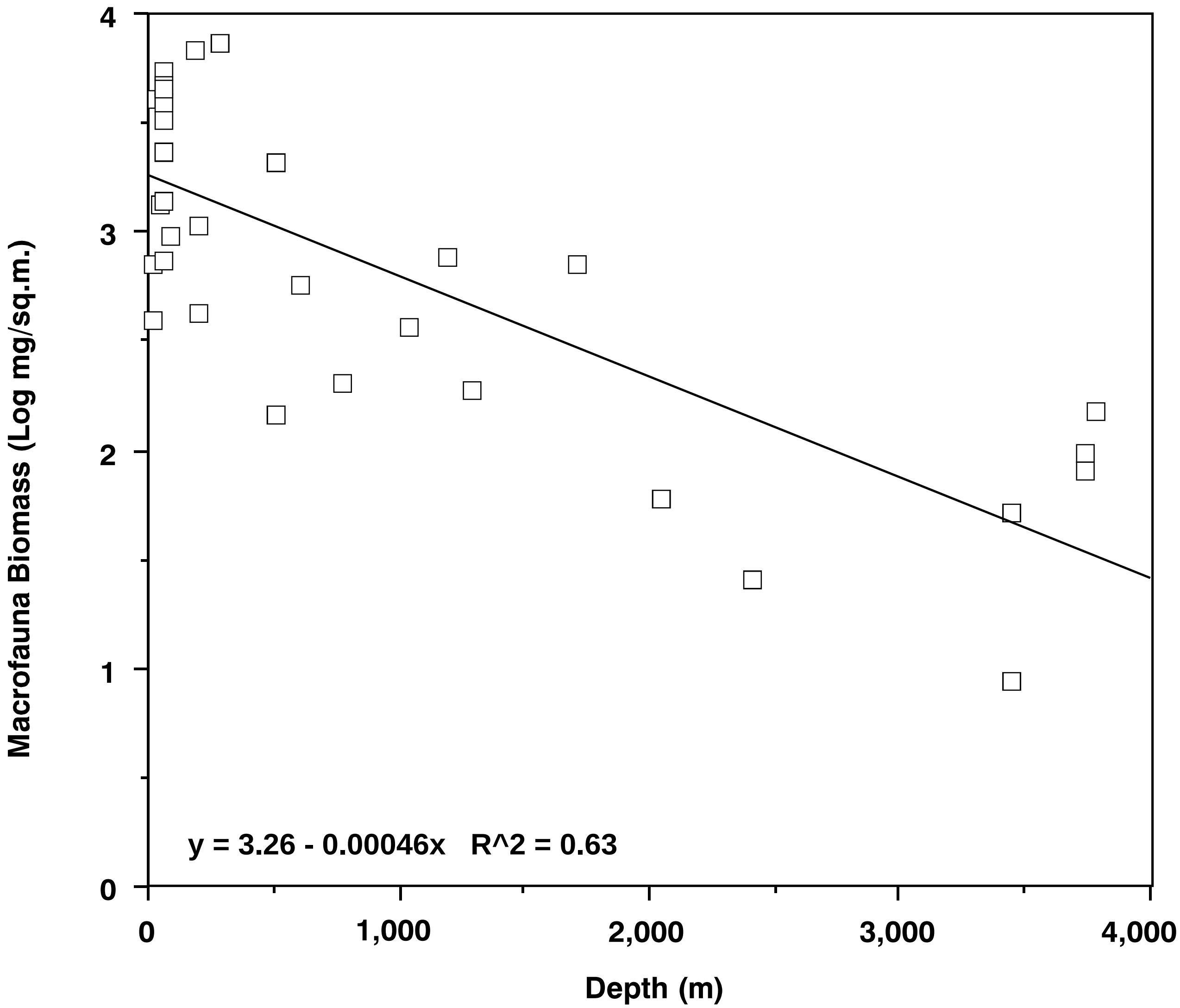

Figure 3-18 BIOMASS OF MACROFAUNA RELATIVE TO DEPTH IN THE GULF OF MEXICO, IN MG (WET WEIGHT) PER SQUARE METER (FROM: ROWE AND MENZEL, 1971; ROWE ET AL., 1974; ROWE, PERSONAL COMMUNICATION, 1999).

for other oceanic margins, including the northwest Atlantic, but the species composition is usually different.

Macrofaunal species diversity is high on the continental slope, as would be expected from other studies worldwide. However, the pattern in diversity relative to depth is somewhat different. While diversity in the major ocean basins appears to increase down the continental margin out to depths of 2 to 3 km (6,562 to 9,843 ft), and then decline further offshore at greater depths, the Gulf has a slightly different pattern. Based on a recent review of available data compiled by Lohse (1999), highest diversity values occur on the upper continental slope and the outer continental shelf at depths of 100 to 1,000 m (328 to 3,281 ft), with a decline from 1,000 m (3,281 ft) and deeper along the continental slope. This shoaling of the diversity maximum may be due to variability from phenomena such as warm eddies or fossil hydrocarbon seeps, or it could be a function of the limitation of larval transport at great depths by the sill across the Yucatan Straits.

Community Function

Community function refers to the rates of dynamic processes such as respiration, predation, recruitment, excretion, growth, and reproduction. Much less is known about these processes than is known about community structure, especially for deep-sea communities such as those on continental slopes. Community total oxygen consumption (SOC), which can be interpreted as the combined respiration of the sediment-dwelling biota (i.e., macrofauna, meiofauna, bacteria), has been measured at numerous locations on the continental shelf adjacent to the study area, but few measurements have been made offshore at slope depths. Available rates presented in figure 3-19 provide a comparison of bay, shelf, slope, and abyssal plain values. While rates are highly variable, SOC (determined using log SOC in ml $O_2/m^2/hr$) conforms to a statistically significant decline when plotted with log depth as the independent variable on the x axis. High values on the slope above the regression line are probably due to the occurrence of “depocenters” and fossil hydrocarbon seeps. This line allows for a prediction of the turnover of organic matter by the community and illustrates that the amount of recycling of organic matter by the benthos declines rapidly with depth in a manner parallel to the decline in biomass.

Slope macrofauna are dominated by polychaete annelid worms, whose densities vary in time on the upper slope (figure 3-20). Such temporal variability suggests that seasonality may be important in determining total biomass and the dynamic aspects of the communities present. Note that the densities vary by a factor of two between fall and spring samples (Hubbard, 1995); such variation in time also appears to diminish with depth.

Steady-state budgets of “carbon cycling” in bottom-community food webs have been constructed for a number of continental margins in the North Atlantic and associated basins, including the GOM (Cruz-Kaegi, 1998), as depicted in figure 3-21. This budget, which represents mean values for the stocks and metabolic rates at depths between 300 and 3,000 m (984 to 9,843 ft), illustrates that the communities of the slope are dominated by smaller organisms, namely the meiofauna and the bacteria. Bacterial communities of the slope exhibit standing stocks that are more than ten times greater than co-occurring meiofauna and macrofaunal communities. Megafaunal assemblages are extremely limited in these environments, exhibiting standing stocks that are less than two percent (by organic carbon content) of meiofaunal and macrofaunal assemblages and only a fraction of a percent of bacterial standing stocks. This is characteristic of deep-ocean assemblages where the input of organic

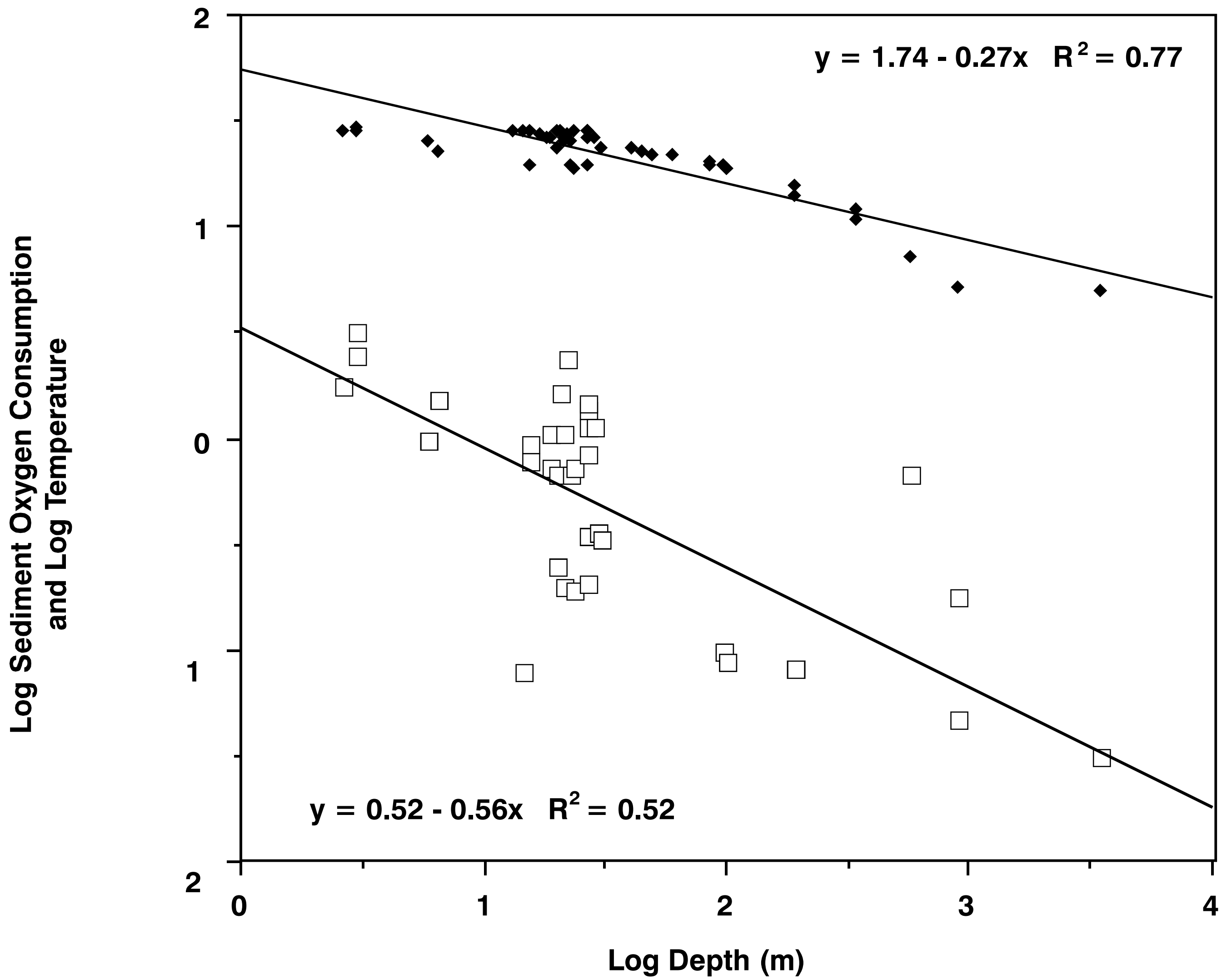

Figure 3-19 RELATIONSHIP BETWEEN SEDIMENT OXYGEN CONSUMPTION AS A FUNCTION OF DEPTH (FROM: ROWE, PERSONAL COMMUNICATION, 1999).

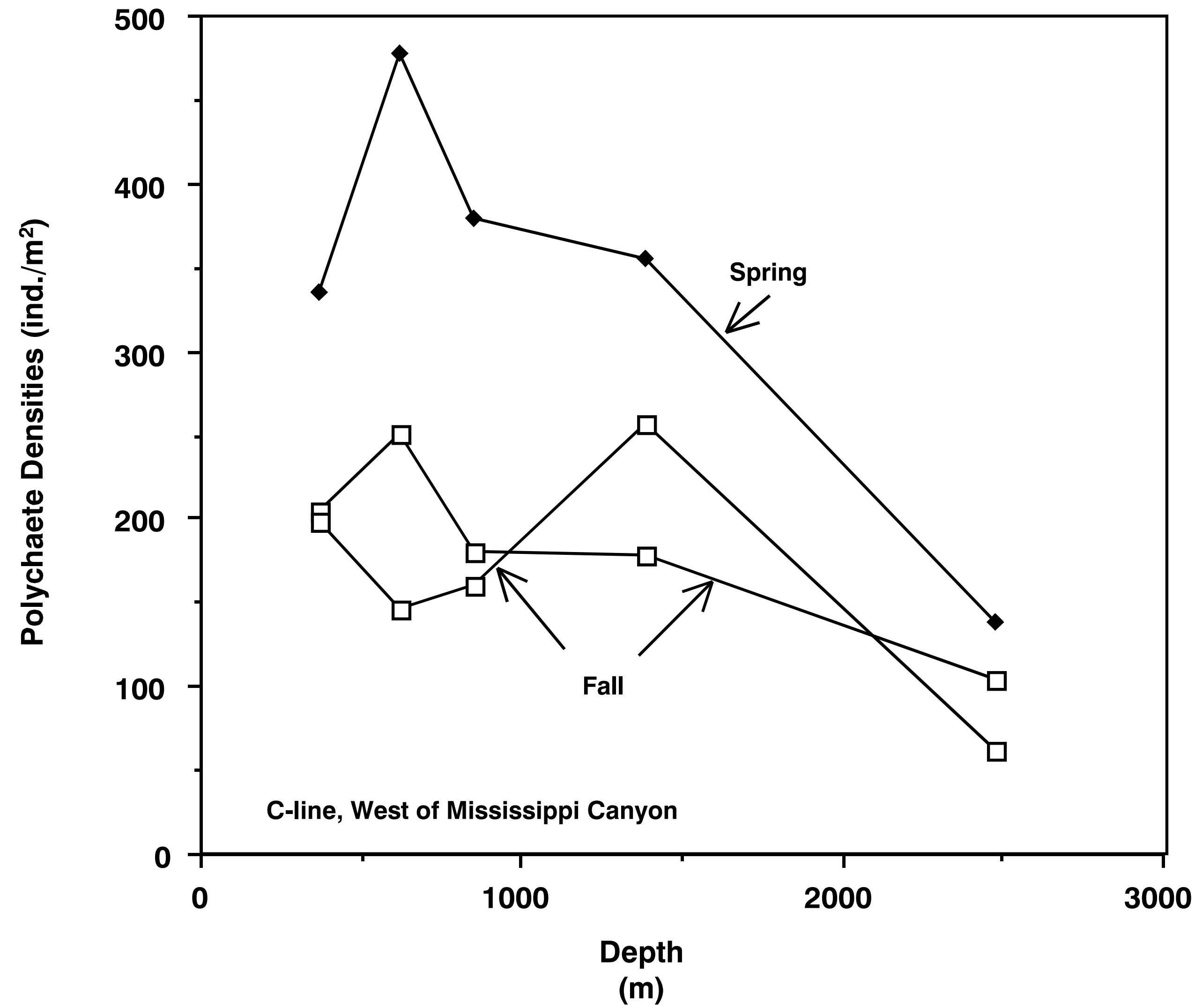

Figure 3-20 VARIATIONS IN DENSITIES OF POLYCHAETE ANNELIDS IN THE CENTRAL REGION OF THE NORTHERN GULF OF MEXICO SHOWING SPRING DENSITIES HIGHER THAN FALL DENSITIES. EACH POINT REPRESENTS THE MEAN OF THREE TO FIVE SAMPLES (ADAPTED FROM: HUBBARD, 1995).

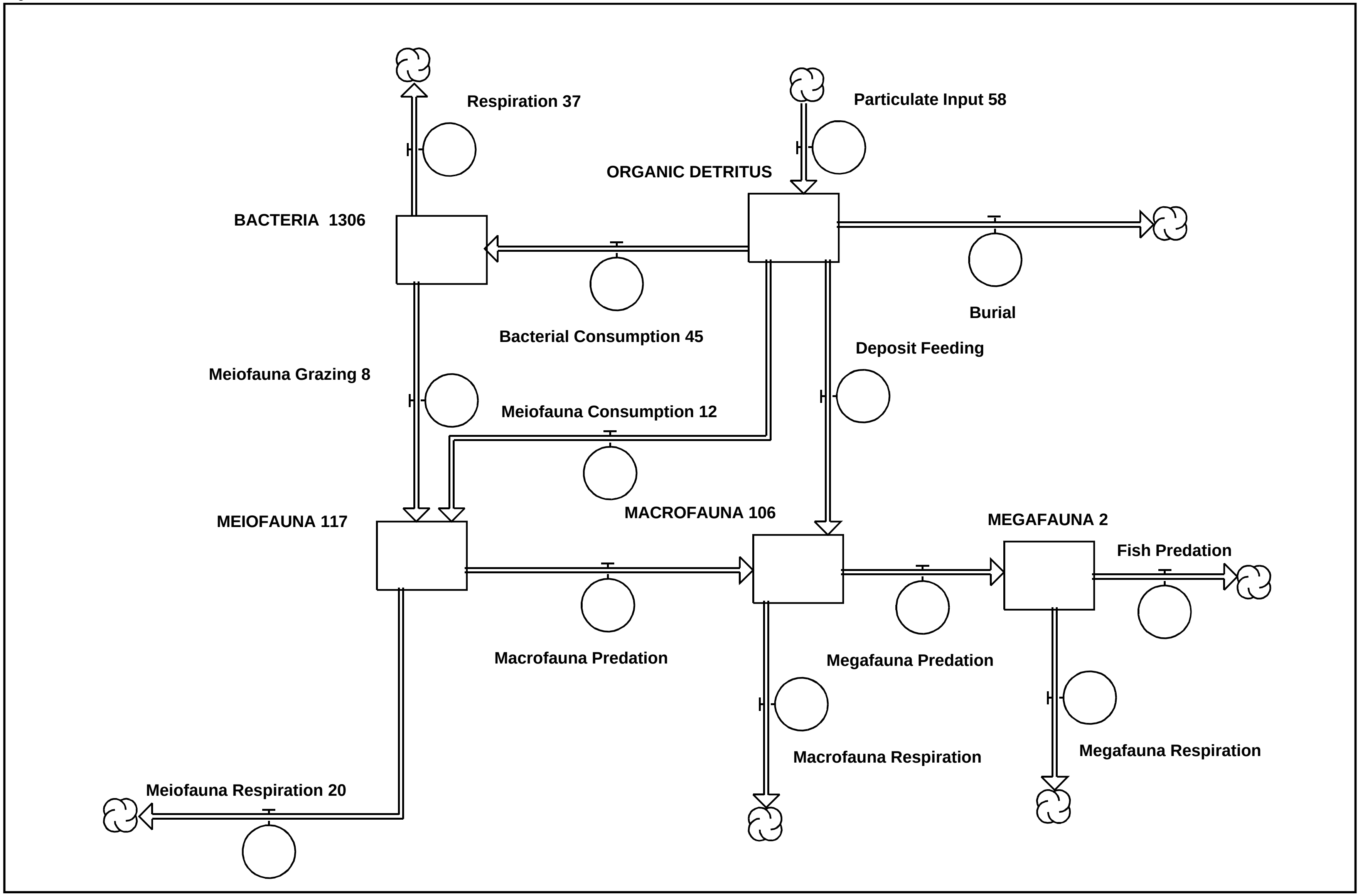

Figure 3-21 STANDING STOCKS OF MAJOR COMPONENTS OF THE BENTHIC COMMUNITY (REPRESENTED AS THE MEAN OF STANDING STOCKS AND FLUXES) IN UNITS OF ORGANIC CARBON PER SQUARE METER (STOCKS) AND FLUXES BETWEEN STOCKS (MG C/M2/DAY). LARGEST FLUXES ARE RESPIRATION RATES, WHILE HIGHEST STANDING STOCKS ARE THE SMALLER FORMS (E.G., BACTERIA, MEIOFAUNA) (ADAPTED FROM: CRUZ-KAEGI, 1998).

matter is meager and of poor quality as food. It also suggests that the deep Gulf benthos is food-limited and harbors few organisms of relatively high biomass (i.e., tens of grams), with the aexception of areas in and immediately adjacent to hydrocarbon seeps. There is no expectation, based on such findings, that the deep slope fauna at depths greater than about 1.5 km (4,922 ft) will ever be utilized as a commercial or recreational fishery or that they constitute a food source for other organisms higher up the food chain that might be an important resource.

Chemosynthetic Communities

Background

Chemosynthesis is a mode of life practiced by numerous groups of bacteria that are able to oxidize simple compounds such as hydrogen sulfide (H_2S) and methane (CH_4) (Jannasch, 1989). The sulfide-oxidizing forms use energy released by the oxidation process to drive the cellular machinery of carbon fixation. Starting with the basic building blocks of nutrients and water, these bacteria produce carbohydrates, proteins, and other complex organic compounds. Like photosynthetic plants, chemosynthetic bacteria are thus able to form new organic compounds at the base of the food chain.

Ecologically, chemosynthetic bacteria differ from plants because they do not need light and require free oxygen. In their free-living forms, chemosynthetic bacteria are found where a substrate is enriched with H_2S or CH_4. Such conditions often occur in the anaerobic sediments of marshes or sewage treatment ponds, where the decomposition of organic matter produces these chemically reduced compounds in abundance. Because they require the means for oxidizing their chemical nutrient source, chemosynthetic bacteria typically live at the interface between reduced sediments and oxygenated water. A common form is *Beggiatoa*, which form long filaments that form pale-colored mats on sediment surfaces (Larkin *et al*., 1994). In shallow aquatic habitats, chemosynthetic bacteria are one component of complex systems comprising numerous pathways for producing and recycling organic matter.

Below the photic zone, in depths of 300 m (984 ft) or more, photosynthesis is no longer possible and nutrient limits sharply constrain the possibilities for complex community structure. Where seepage of hydrocarbons, venting of hydrothermal fluids, or other geological processes supply abundant reduced compounds, chemosynthesis becomes the dominant component of the ecosystem. In the northern GOM, these conditions are met where oil and gas seep into seafloor sediments at depths of about 400 m (1,312 ft) and greater. Although chemosynthesis remains an exclusively microbial process at the cellular level, chemosynthetic communities in the deep sea achieve prominence because of symbiotic partnership between chemosynthetic bacteria and invertebrate hosts (Fisher, 1990).

Symbiosis with Invertebrates

Free-living chemosynthetic bacteria are limited to interfaces because they simultaneously require oxygen and reduced compounds that would spontaneously oxidize in the presence of oxygen. Symbiotic partnership with invertebrate hosts greatly extends the possible habitat for the chemosynthetic mode of life. Specific adaptations vary, but the basic arrangement is that the bacteria live within specialized cells in the host organism. The host physiology supplies oxygen and chemosynthetic substrates to the bacteria, often by means of specialized blood chemistry, and exploits the resulting bacterial productivity. Major groups from the GOM are briefly described below, including vestimentiferan tube worms, seep mussels, vesicomyid and lucinid clams, and specialized polychaete worms.

Vestimentiferan Tube Worms

These highly adapted polychaetes lack mouth, gut, and anus. They live in a tough polysaccharide tube, typically 1 cm (0.39 in) in diameter and up to 2 m (6.6 ft) long. Gas exchange and oxygen uptake is via a vascularized plume (red in color), which extends 1 to 2 cm (0.39 to 0.79 in) from the anterior tube end. The tube is often held 1 m (3.3 ft) or more above the seafloor. Their symbionts utilize H_2S, which the tube worm absorbs from root-like structures that extend below the buried portions of the tubes. Buried tube length may be as much as one-third the body length. Two species are common to the GOM: *Lamellibrachia* n. sp. cf. *barhami* and *Escarpia* n. sp. *Lamellibrachia*, the larger animal, typically forms bush-like clusters of several hundred individuals. These animals grow at rates typically less than 1 cm/yr (0.39 in/yr), so that a large adult may be 200+ years old. A single large cluster marks a location where hydrocarbon seepage has continued unabated for several hundred years or more (Fisher *et al.*, 1997).

Seep Mussels

These deep-sea mussels possess methanotrophic oxidizing symbionts, which live in the linings of greatly enlarged gills (Childress *et al.*, 1986). Methane and oxygen are supplied to the symbionts through the ventilation of the gills. The mussels retain functional feeding grooves and gut. Excess bacteria are sloughed out of the gills and digested normally. Because the requirement is for dissolved CH_4, seep mussels are restricted to locations where CH_4 concentrations are high, for example near active gas vents. At such sites, mussels may completely cover the seafloor in mats that are bound together by byssal threads and extend for several meters or more. The maximum length of an adult is 12 to 13 cm (4.7 to 5.1 in). The growth rates are slow, with juveniles requiring possibly 20 years to reach maturity and large adults frequently surviving 40 years (Nix *et al.*, 1995). The most common species is *Bathymodiolus childressi*.

Vesicomyid Clams

These are surface-dwelling bivalves that plow long, curving furrows across the seafloor (Rosman *et al.*, 1987). The foot is thrust forward and down into anoxic soils while the siphon is extended into the bottom water with the exposed portion of the shell. This allows the animal to absorb H_2S across the foot epithelium, from where it is transported to symbiont-lined gills via specialized blood chemistry. Adults are 75 to 90 cm (29.5 to 35.4 in) long, with a deep, heavy shell. The two species known from the GOM are *Calyptogena ponderosa* and *Vesicomya cordata*. Nothing is known of the growth rates, but deep-sea bivalves are typically long lived. Accumulations of dead shells with clusters of live individuals suggest persistent occupation of active seep sites. These aggregations have been found on the flow-fields where expulsion of oil-rich mud generates shallow anoxic layers.

Lucinid Clams

Although these are possibly the most ubiquitous chemosynthetic invertebrates in the GOM, living adults are almost never seen in photo-surveys. These animals live in deep, U-shaped burrows and manipulate the oxygen tension in their burrows by moving up and down in the passage to the surface. Accumulations of dead shells are often seen in photo-surveys. The chalky shells are subcircular, shallow, and have a small but distinct beak at the hinge. Symbionts live in enlarged gills and utilize H_2S. Growth rates and life-spans are unknown. Common species in the GOM are *Lucinoma atlantis* and *Thiasira oleophila* (Callender and Powell, 1997).

Polychaete "Ice Worms"

This polychaete, *Hesiocaeca methanicola*, received attention in the press following its discovery in 1997, but relatively little is published about its life history or ecology (Desbruyeres and Toulmond, 1998). The worm inhabits shallow depressions on the surface of shallow gas hydrate deposits. It does not possess chemosynthetic symbionts, but the stable carbon isotope ratios of its tissue are consistent with a diet derived from chemosynthetic production.

Types of Chemosynthetic Communities in the Northern GOM

Roberts and Carney (1997) distinguish among slowly seeping oil and gas seeps, rapid, mud-prone expulsion features (mud volcanoes), and quiescent, mineral-prone seeps. Reilly *et al.* (1996) categorize complex communities, which comprise a mixture of tube worms and seep mussels, and simple communities, which consist of a single species—usually seep mussels or vesicomyid clams. MacDonald *et al.* (1998a) and MacDonald *et al.* (in press) identify brine-pooling and sediment diffusion habitats, noting that so-called simple and complex communities can occur in close proximity. At slow oil and gas seeps, fluids migrate to the seafloor from deep (i.e., 3,000 to 5,000 m [9,843 to 16,405 ft] subbottom) reservoirs that are broadly distributed across the continental slope. Near the seafloor, a layer of unconsolidated hemipelagic sediment forms that is several hundred meters thick. The upper sediment column diffuses and retains oil and gas over areas considerably larger than the fault axis (Reilly *et al.*, 1996). In the upper meter or so of the sediments, microbial degradation of the labile carbon in the oil and gas depletes available oxygen and reduces seawater sulfate to H_2S. This provides chemosynthetic substrates for invertebrates with sulfide-oxidizing symbionts, notably vestimentiferan tube worms. Increased alkalinity due to microbial productivity causes extensive precipitation of carbonate. Accumulating fluid and carbonate produces low mounds with basal diameters of 10 m (3.3 ft) to over 500 m (1,641 ft) and slopes of 10 percent or greater. At localized vents, methane bubbles through near-bottom waters and generates sufficient local concentrations to support seep mussels. Gas hydrates form where free gas is trapped beneath layers of rock or other shallow obstructions. The result is often a patchwork of tube worm clusters and carbonate boulders extending over the surface of the seep, with the greatest concentrations along fault axes.

At mud volcanoes, formation of chemosynthetic communities is controlled by the intensity and frequency of mud discharge. Rapid fluid flux often includes abundant hydrocarbons, but burial of slow-growing fauna will limit community formation at active sites. Because the fluid flux is associated with shallow salt in most cases, halite dissolution produces concentrated brines and the increased density of these briny fluids tends to create pools or channels with distinct, stable interfaces. Seep mussels can colonize the stable edges of mud-filled craters or channels. Repeated burial over thousands of years of activity is indicated by recovery of mussels shells in cores taken at mud-prone sites.

Mineral-prone seeps occur with decreased rates of venting and formation of surface domes capped with lithified layers. Lithification greatly reduces sediment porosity and limits seepage to faults and fissures in the crust. Layers of bivalve shell may remain over large areas for many years after most seepage and all chemosynthetic production has ceased.

Dependence upon seeping hydrocarbons places GOM chemosynthetic fauna in a deep-sea locality that may be affected by human activities. Expansion of the offshore energy industry has experienced several expansive episodes in the past twenty years. All of these have increased activities at ever greater depths. The amount of seafloor influenced by seepage is quite small compared to the extent of the subbottom hydrocarbon system, and industry engineers generally strive to avoid the unstable substrate at seeps (Reilly *et al.*, 1996). Current interest lies in improving the capacity to predict where seep communities will occur and in understanding processes that contribute to either stability or change in this environment so that anthropogenic changes could be distinguished from natural processes. Type cases of "typical" chemosynthetic communities are given below.

Bush Hill

The "Bush Hill" site (lat. 27°47' N., long. 91°30.4 'W.) described by MacDonald *et al.* (1989) was the first hydrocarbon seep community to be sampled from a submersible. Reilly *et al.* (1996) describe it as the type-example of a complex chemosynthetic community. The Conoco tension leg work platform (TLWP) was installed <2 km (1.2 mi) west-southwest of the mound and began producing oil in the late 1980s. The major seep area is a 300-m (984-ft; E-W) by 500-m (1,641-ft; N-S) mound with a crest depth of 570 m (1,870 ft), rising about 40 m (131 ft) above the surrounding seafloor, and composed of mud, carbonate, and shallow gas hydrate. The N-S axis of the mound is situated along the surface trace of a west-dipping fault that is the conduit by which oil and gas reaches the surface from deposits located at approximately 1,200 m (3,937 ft) subbottom depth. Surface sediments contain, by weight, up to 10 percent liquid hydrocarbons, which Kennicutt *et al.* (1988b) described as having fingerprints identical to oil produced by the TLWP wells. However, reservoirs tapped by TLWP wells were located at subbottom depths of 3,000 m (9,843 ft) or greater (Cook and D'Onfro, 1991), suggesting that the field comprises a complex of many reservoirs that are charged from a common source but seep only from the shallowest strata. Sulfide concentrations in shallow sediments (<10 cm [3.9 in]) associated with tube worm clusters have been measured in the 100 to 250 μM range with use of micro-electrode technique (Escorcia *et al.*, 1999). Methane concentrations in near-bottom waters are 30 to 60 μM in the vicinity of active gas vents and below 1 μM elsewhere (MacDonald *et al.*, 1989; Nix *et al.*, 1995). Shallow gas hydrates have been recovered by coring at Bush Hill (Brooks *et al.*, 1986). Layers of gas hydrate breach the sediment layer near the highest point of the mound (MacDonald *et al.*, 1994). Tube worm clusters extend over much of the mound crest, while mussels are confined to the active gas vents.

Brine Pool NR1

The focus of this chemosynthetic community is a small (190 m^2 [2,044 ft^2]) pool of brine (salinity 121.35 psu) found near lat. 27°43.4' N. and long. 91°16.5' W. at a water depth of 650 m (2,133 ft) (MacDonald *et al*., 1990). Brine fills a crater at the center of an approximately 100-m (328-ft)-wide mound. The mound rises about 6 m (19.7 ft) above the surrounding seafloor, but the crater and its diatreme extend at least 30 m (98 ft) below the surface. The brine contains microbial methane ($\delta^{13}C$ = -63.8) in concentrations that are supersaturated at standard temperature and pressure. Streams of CH_4 bubbles emanate continually from the center of the pool. The pool is ringed by a large (540 m^2 [5,810 ft^2]) bed of seep mussels (MacDonald and Fisher, 1996). Mussels settled on the "shoreline" of the pool include numerous juveniles, whereas the periphery of the bed comprised a single settlement class without juveniles. Sulfide levels are below levels of detection in the pool, but rise sharply in fluids collected beneath the surrounding mussel bed (Fisher, 1999, personal communication). The bed of seep mussels comprises a striking example of a mono-specific aggregation of chemosynthetic fauna, but numerous other species of heterotrophic animals are also commonly observed at the site (MacDonald, 1992; MacDonald and Fisher, 1996). Recent findings challenge the Reilly *et al.* (1996) designation that Brine Pool NR1 is a "simple" community, because small but noteworthy clusters of vestimentiferans are known to occur to the south of the pool (MacDonald *et al.*, in press).

Garden Banks 386

Located at depths of 580 m (1,903 ft) near lat. 27° 36.9' N. and long. 92° 15.5' W., this flat-topped mound is described as a mud volcano by Reilly *et al.* (1996), but active seepage in the form of gas venting and mud or fluid discharge does not occur over the mound (Reilly *et al*., 1996; Lee *et al.*, 1999). A rubble-strewn crust of authigenic carbonate extends over the entire approximately 600-m (1,969 ft)-wide area of the upper mound. Bivalve shells are common, but no living seep mussels or clams have been recovered from the site, and tube worms are restricted to stunted individuals lining small fractures in the rocky substratum (MacDonald *et al*., 1995). Because active mud volcanoes of similar morphology are common in the region, and because of the accumulation of dead bivalve shells, one can surmise that this site was previously more active in terms of fluid expulsion and biological productivity. Mineral-prone seeps probably do not generally represent aggregations of biological activity requiring extensive protection. It would require careful study, however, to distinguish a mineral-prone, relatively inactive seep and biological assemblage like the mound in Garden Banks 386 from more active features.

Distribution of Chemosynthetic Communities in the Northern GOM

Seeps and chemosynthetic communities can be detected with seismic survey methods by looking for migration conduits—also called seismic wipe-outs—that coincide with surface mounds and low-angle faults (Reilly *et al*., 1996; Roberts and Carney, 1997). Side-scan sonar has also shown promise and may be more cost-effective in some applications (Sager *et al.*, 1999). As the discussion above indicates, the timing of migration and seepage is not necessarily predicted by structures that are detected with seismic data. The geochemistry of hydrocarbon seeps has been thoroughly described (Anderson *et al.*, 1983; Brooks *et al.*, 1984; Brooks *et al.*, 1986; Kennicutt *et al.*, 1987; Kennicutt *et al.*, 1988a) and will reliably predict regional occurrence of chemosynthetic communities for at least the so-called "lush" communities of most concern for resource managers (USDOI, MMS, 1988). However, brine-pooling communities like Brine Pool NR1 are not always associated with thermogenic hydrocarbons in the surface sediments. Submersible and photo-surveys have been executed haphazardly and with a definite bias toward sites less than 1,000 m (3,281 ft) deep due to the cost and depth limitations of available submersibles. Surveys of chemosynthetic communities need to be evaluated critically, therefore, with an eye to the underlying limits of the data and the motivating goals of the survey. The following briefly summarizes different evidence for the regional distribution of chemosynthetic communities in the GOM.

Evidence from Energy Prospecting

Sassen *et al.* (1993) demonstrated that, where data permit comparison, many major seeps and associated chemosynthetic communities are correlated with major oil fields in the deepwater GOM. Recent exploration and production have not been thoroughly documented by submersible observations, and there is some question about community development in water depths between 1,000 and 2,000 m (3,281 and 6,562 ft) where data are lacking (MacDonald, 1998b). However, these authors and other researchers (Abrams, 1996; Kaluza and Doyle, 1996) note that salt tectonism generates migration conduits across the entire GOM slope. All hydrocarbon fields are therefore highly susceptible to leakage. A map of oil discovery and production could be used to predict many of the *general* localities where chemosynthetic communities might be found. Direct observations are required to confirm community occurrence at scales of 1 km or less.

Evidence from Direct Observation

Table 3-9, reproduced from MacDonald *et al.* (1996), compiles direct observations of chemosynthetic communities in the northern GOM. As is evident in the table, the vast majority of documented chemosynthetic communities in the central and western Gulf occur in the Green Canyon and Garden Banks lease block areas (21 and 12 sites, respectively). Five or fewer chemosynthetic community sites have been noted for Alaminos Canyon, East Banks, Mississippi Canyon, Ewing Bank, and Viosca Knoll lease block areas.

3.2.2.3 Topographic Features

A number of topographic features occur on and at the edge of the continental shelf of the western and central GOM (figure 3-22), inshore of the study area. Given the potential sensitivity of these features to oil and gas operations, including shuttle tankering associated with FPSO operations, their characteristics have been detailed in the following section.

Topographic features, sometimes called "topographic highs" because they are elevated above the surrounding seafloor, support a variety of hard-bottom benthic organisms. The habitats that these topographic features provide are important to the GOM continental shelf system for a number of reasons. Many of the features support hard-bottom communities that have high biomass, high diversity, and high species richness. Large numbers of commercially and recreationally important fish species are also associated with these features. A number of the features, particularly the East and West Flower Garden Banks (figure 3-22) are sufficiently

Table 3-9

Sites Where Chemosynthetic Megafauna Have Been Collected
in the Central and Western Gulf of Mexico

Fauna	Latitude (North)	Longitude (West)	MMS Lease Block	Depth (m)	Observation Method	Data Source
VM	26°21.20'	94°29.80'	AC0645	2,200	Sub	1
M	27°23.50'	94°29.45'	EB0602	1,111	Trl	2
PG	27°27.55'	93°08.60'	GB0500	734	Trl	2
VC	27°30.05'	93°02.01'	GB0458	757	Trl	2
M	27°31.50'	92°10.50'	GB0476	750	Sub	3
MC	27°33.40'	92°32.40'	GB0424	570	Sub	3
V	27°35.00'	92°30.00'	GB0425	600	Sub	3
VC	27°34.50'	92°55.95'	GB0416	580	Sub	3
VC	27°36.00'	94°46.00'	EB0376	776	Sub	3
PG	27°36.15'	94°35.40'	EB0380	793	Trl	2
MC	27°36.50'	92°28.94'	GB0382	570	Sub	3
VC	27°36.60'	94°47.35'	EB0375	773	Trl	2
VC	27°36.82'	92°15.25'	GB0386	585	Sub, Trl	2, 3
VC	27°37.15'	92°14.40'	GB0387	781	Sub, Trl	2, 3
V	27°37.75'	91°49.15'	GC0310	780	Trl	2
VC	27°38.00'	92°17.50'	GB0342	425	Trl	2
C	27°39.15'	94°24.30'	EB0339	780	Trl	2
VC	27°39.60'	90°48.90'	GC0287	994	Sub, Trl	2
C	27°40.45'	90°29.10'	GC0293	1,042	Trl	2
VC	27°40.50'	92°18.00'	GB0297	589	Trl	2
VMC	27°40.88'	91°32.10'	GC0272	720	Sub, Trl	2, 3, 4
VC	27°42.65'	92°10.45'	GB0300	719	Trl	2
V	27°43.10'	91°30.15'	GC0229	825	Trl	2
VM	27°43.30'	91°16.30'	GC0233	650	Sub	5
VMC	27°43.70'	91°17.55'	GC0233	813	Trl	2
VM	27°44.08'	91°15.27'	GC0234	600	Sub	3, 6
VM	27°44.30'	91°19.10'	GC0232	807	Sub	3
VM	27°44.80'	91°13.30'	GC0234	550	Sub	3, 7
VC	27°45.00'	90°16.31'	GC0210	715	Sub	3
C	27°45.50'	89°58.30'	GC0216	963	Sub, Photosl	8, 2
VMC	27°46.33'	90°15.00'	GC0210	796	Sub	3
VM	27°46.65'	91°30.35'	GC0184/5	580	Sub, Trl	2, 3, 9
VM	27°46.75'	90°14.70'	GC0166	767	Sub, Trl	2, 3
VM	27°49.16'	91°31.95'	GC0140	290	Sub	10
V	27°50.00'	90°19.00'	GC0121	767	Sub	3
VM	27°53.56'	90°07.07'	GC0081	682	Photosl	11
VC	27°54.40'	90°11.90'	GC0079	685	Trl	2
VM	27°55.50'	90°27.50'	GC0030	504	Sub	3
VPG	27°56.65'	89°58.05'	GC0040	685	Trl	2
C	27°57.10'	89°54.30'	MC0969	658	Trl	2
V	27°57.25'	89°57.50'	EW1010	597	Sub, Trl	2, 3
V	27°58.70'	90°23.40'	EW1001	430	Sub, Trl	2, 3
VC	29°11.00'	88°00.00'	VK0826	545	Sub, ROV, Trl	3, 4, 12

Notes:
Fauna indicates type of chemosynthetic megafauna found at site: V=vestimentiferan tube worms, M=seep mytilids, C=vesicomyid or lucinid clams, PG=pogonophoran tube worms.
Lease block designators follow MMS standard abbreviations.
Observation methods include trawl (Trl) and submarine (Sub), or definitive photography via submarine, remotely operated vehicle (ROV), or photosled (Photosl).
Data sources give precedence to observations published in open literature. Data sources: 1–Brooks *et al*. (1989), 2–Kennicutt *et al*. (1988a,b), 3–GERG unpubl. data, 4-Callender *et al.* (1990), 5–MacDonald *et al*. (1990b), 6–MacDonald *et al*. (1990b), 7–MacDonald *et al*. (1990a), 8–Rosman *et al*. (1987), 9–MacDonald *et al*. (1989), 10–Roberts *et al*. (1990), 11–Boland 1986, 12–Boss (1968), Gallaway *et al*. (1990), Volkes (1963).

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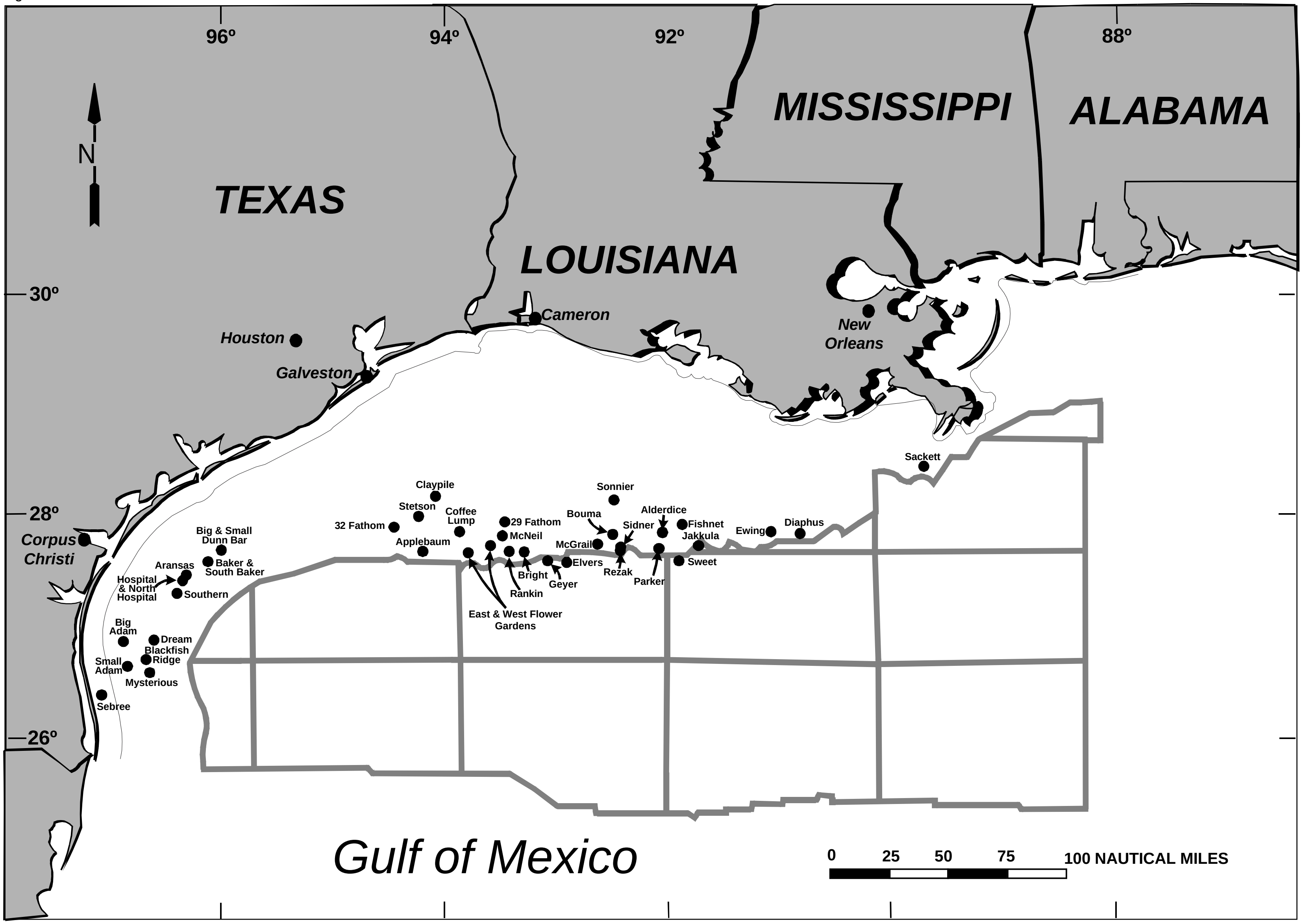

Figure 3-22 LOCATIONS OF TOPOGRAPHIC FEATURES IN THE WESTERN AND CENTRAL PLANNING AREAS (ADAPTED FROM: MINERALS MANAGEMENT SERVICE, 1998A).

elevated above the surrounding seafloor that there is sufficient light to support the growth of hermatypic coral species.

Seven distinct biotic zones have been identified on the topographic features, as detailed in table 3-10. These zones have been divided into four categories based on the level of reef-building activity in a particular zone (Rezak *et al.*, 1983). Major reef building and primary production occurs in four zones: 1) the *Diploria-Montastraea-Porites* Zone, a high-diversity coral reef zone; 2) the *Madracis* Zone; 3) the *Stephanocoenia-Millepora* Zone, a low-diversity coral reef zone; and 4) the Algal-Sponge Zone. Minor reef building occurs in the *Millepora*-Sponge Zone, and minor to negligible reef building occurs in the Antipatharian Zone. No reef building occurs in the Nepheloid Zone.

The *Diploria-Montastraea-Porites* Zone is only found at the East and West Flower Garden Banks at depths shallower than 36 m (118 ft). This zone is characterized by the presence of 18 hermatypic coral species. Coral cover in the *Diploria-Montastraea-Porites* Zone has been estimated at 49 to 50 percent at the East Flower Garden Bank and 45 to 48 percent at the West Flower Garden Bank (Continental Shelf Associates, Inc., 1997c). *Montastraea franksi* is the dominant coral species, comprising about one-half the living coral cover. Other important coral species, in order of decreasing dominance, are *Diploria strigosa*, *Montastraea cavernosa*, *Colpophyllia* spp., and *Porites astreoides.* Commercially important fishes occurring in this zone include groupers and hinds (*Mycteroperca* spp. and *Epinephelus* spp.), amberjacks (*Seriola* spp.), barracuda (*Sphyraena barracuda*), red snapper (*Lutjanus campechanus*), vermilion snapper (*Rhomboplites aurorubens*), cottonwick (*Haemulon melanurum*), and porgies (*Calamus* spp.). Spiny lobsters (*Panulirus argus*) and shovel-nose lobsters (*Scylliarides aequinoctialis*) also inhabit the high-diversity coral reef.

On the outer edges of the coral reef zone in depths ranging from 28 to 46 m (92 to 151 ft), large areas occur that are completely covered by the small branching coral *Madracis mirabilis*. This is referred to as the *Madracis* Zone, where large amounts of carbonate sediment are produced. Lush assemblages of leafy algae, including *Stypopodium*, *Caulerpa*, *Dictyota*, *Chaetomorpha*, *Pocockiella*, *Rhodymenia*, *Valonia*, and *Codium* occur in places on the gravel substratum produced by the *Madracis* population. These areas are referred to as the Leafy Algae Zone.

A relatively less diverse assemblage characterized by the presence of 12 hermatypic species occurs between 36 and 52 m (118 to 171 ft). This is known as the *Stephanocoenia-Millepora* Zone. Hermatypic coral species living in this zone include *Stephanocoenia michelinii*, *Millepora* sp., *Montastraea cavernosa*, *Colpophyllia* spp., *Diploria* sp., *Agaricia* spp. , *Mussa angulosa*, and *Scolymia* sp. Compared to the high- diversity coral reef, considerably less extensive coral cover exists in the *Stephanocoenia-Millepora* Zone, and fish populations also are less diverse. Crustose coralline algae are the predominant encrusting forms covering dead coral rock. Considerable numbers of American thorny oysters (*Spondylus americanus*) are present.

An Algal-Sponge Zone is present at a number of continental shelf-edge banks between 55 and 85 m (180 to 279 ft). This zone covers the largest area of the major reef-building zones. Coralline algae are the dominant organisms in this zone and the most important producer of carbonate nodules within the zone. *Lithothamnium* and *Lithoporella,* along with the encrusting foraminiferan *Gypsina plana,* form these algal nodules, which range between <1 to >10 cm (<0.39 to >3.9 in) in diameter and typically cover 50 to 80 percent of the seafloor in this zone. The nodules serve as a habitat for diverse infauna and epifauna assemblages. Most of the leafy algae occurring on the banks is found within the Algal-Sponge Zone, and these algae contribute

Table 3-10

Biotic Zones on Topographic High Features in the Gulf of Mexico

Bank	Zone Diploria-Montastraea-Porites	Madracis	Stephanocoenia-Millepora	Algal-Sponge	Millepore-Sponge	Antipatharian	Nepheloid
East Flower Garden	X	X	X	X		X	X
West Flower Garden	X	X	X	X		X	X
Bright			X	X		X	X
McGrail			X	X		X	X
Geyer				X	X	X	X
Rankin				X		X	X
Alderdice				X		X	X
Rezak				X		X	X
Sidner				X		X	X
Ewing				X		X	X
Jakkula				X		X	X
Bouma				X		X	X
Elvers				X		X	X
Parker				X		X	X
MacMeil				X		X	X
Sackett				X		X	X
Diaphus						X	X
Sweet				X		X	X
Applebaum				X		X	X
Phleger						X	X
Claypile					X		X
32 Fathom						X	X
Coffee Lump						X	X
Sonnier					X		X
Stetson					X		X
29 Fathom						X	X
Fishnet						X	X
Sebree							X
Big Dunn Bar						X	X
Small Dunn Bar						X	X
Big Adam						X	X

Table 3-10

Biotic Zones on Topographic High Features in the Gulf of Mexico

Bank	Zone: Diploria-Montastraea-Porites	Madracis	Stephanocoenia-Millepora	Algal-Sponge	Millepore-Sponge	Antipatharian	Nepheloid
Small Adam						X	X
Blackfish						X	X
Mysterious						X	X
Baker						X	X
Aransas						X	X
Southern						X	X
North Hospital						X	X
Hospital						X	X
South Baker						X	X
Dream						X	X

large amounts of food to the surrounding communities. The calcareous green algae *Halimeda* and *Udotea* and several species of hermatypic corals (including *Helioseris cucullata* and *Agaricia* sp.) are major contributors to the substrate. *Neofibularia nolitangere* is the most distinctive and prominent sponge present. Echinoderms are prominent within the Algal-Sponge Zone, with sizeable numbers of comatulid crinoids and asteroid species being very common. A large number of gastropods and pelecypods, the largest of which is the American thorny oyster (*Spondylus americanus*), occur in this zone. Characteristic fishes of this zone are yellowtail reef fish (*Chromis enchrysurus*), sand tilefish (*Malacanthus plumieri*), cherubfish (*Centropyge argi*), and orangeback bass (*Serranus annularis*).

Partly drowned coral reefs also occur within the Algal-Sponge Zone. These are structures that are predominantly covered by crustose coralline algae with occasional small colonies of hermatypic corals such as *Agaricia* spp., *Helioceris cuculata*, and *Montastraea cavernosa*. Large anemones, large comatulid crinoids, basket stars, and *Millepora* also occur on the partly drowned reefs.

One zone of minor reef building is associated with three mid-shelf banks (the Claypile, Sonnier, and Stetson Banks) and one shelf-edge bank (the Geyer Bank). This zone, the Millepora-Sponge Zone, occurs at depths that are comparable to the depths of occurrence of the *Diploria-Montastraea-Porites* Zone at the East and West Flower Garden Banks. This zone is characterized by the presence of the hydrozoan coral *Millepora* and sponges.

The Antipatharian Zone is a transition between the lower Algal-Sponge Zone and the deep Nepheloid Zone, where there is no reef building. This zone generally occurs along the lower portions of the banks down to about 90 m (295 ft) and is identifiable based on the increased occurrence of the bedspring antipatharian (*Cirripathes*) with the algal sponge assemblage. This assemblage is less diverse than the other shallower zones and is characterized by comatulid crinoids, antipatharians, thin to sparse coralline algae, and few leafy algae. Fish species present in this zone include yellowtail reeffish (*Chromis enchrysurus*), queen angelfish (*Holacanthus ciliaris*), blue angelfish (*Holacanthus bermudensis*), and spotfin hogfish (*Bodianus pulchellus*).

The Nepheloid Zone occurs at all of the topographic high features, beginning at the limit of the Antipatharian Zone and extending to the surrounding soft bottom. There is high turbidity, sedimentation, and resuspension in this zone, and the rocks and drowned reefs are covered with a veneer of sediment. The most conspicuous of the sparse epifauna are comatulid crinoids, octocoral whips and fans, antipatharians, encrusting sponges, and solitary ahermatypic corals. Fishes present in this zone include red snapper (*Lutjanus campechanus*), Spanish flag (*Gonioplectrus hispanus*), snowy grouper (*Epinephelus niveatus*), bank butterflyfish (*Chaetodon aya*), scorpionfishes, and roughtongue bass (*Holanthias martinicensis*).

3.2.3 Marine Mammals

Twenty-nine species of marine mammals are known to occur in the GOM, as detailed in table 3-11 (Davis *et al*., 2000). The Gulf's marine mammals are represented by members of the taxonomic order Cetacea, which is divided into the suborders Mysticeti (i.e., baleen whales) and Odontoceti (i.e., toothed whales, dolphins, and their allies), as well as the order Sirenia, which is comprised of the manatee and the dugong. Within the GOM, there are 28 species of cetaceans (seven mysticete and 21 odontocete species) and one sirenian species, the manatee, which is further split into two subspecies (Jefferson *et al*., 1992).

Table 3-11

Marine Mammals of the Gulf of Mexico

Order Cetacea	
Suborder Mysteceti (baleen whales)	
Family Balaenidae	
Northern right whale (*Eubalaena glacialis*)	(E)
Family Balaenopteridae	
Minke whale (*Balaenoptera acutorostrata*)	
Sei whale (*Balaenoptera borealis*)	(E)
Bryde's whale *(Balaenoptera edeni*)	
Blue whale (*Balaenoptera musculus*)	(E)
Fin whale (*Balaenoptera physalus*)	(E)
Humpback whale (*Megaptera novaeangliae*)	(E)
Suborder Odontoceti (toothed whales)	
Family Physeteridae	
Pygmy sperm whale (*Kogia breviceps*)	
Dwarf sperm whale (*Kogia simus*)	
Sperm whale (*Physeter macrocephalus*)	(E)
Family Ziphiidae	
Sowerby's beaked whale (*Mesoplodon bidens*)	
Blainville's beaked whale (*Mesoplodon densirostris*)	
Gervais' beaked whale (*Mesoplodon europaeus*)	
Cuvier's beaked whale *(Ziphius cavirostris*)	
Family Delphinidae	
Pygmy killer whale (*Feresa attenuata*)	
Short-finned pilot whale (*Globicephala macrorhynchus*)	
Risso's dolphin (*Grampus griseus*)	
Fraser's dolphin (*Lagenodelphis hosei*)	
Killer whale (*Orcinus orca*)	
Melon-headed whale (*Peponocephala electra*)	
False killer whale (*Pseudorca crassidens*)	
Pantropical spotted dolphin (*Stenella attenuata*)	
Rough-toothed dolphin (*Steno bredanensis*)	
Clymene dolphin (*Stenella clymene*)	
Striped dolphin (*Stenella coeruleoalba*)	
Atlantic spotted dolphin (*Stenella frontalis*)	
Spinner dolphin (*Stenella longirostris*)	
Bottlenose dolphin (*Tursiops truncatus*)	
Order Sirenia	
Family Trichechidae	
Florida manatee (*Trichechus manatus latirostris*)	(E)
Antillean manatee (*Trichechus manatus manatus*)	(E)

Key:

(E) = Currently listed as an endangered species under the Endangered Species Act of 1973.

Though the use of FPSOs is projected for deepwater regions of the central and western Gulf, support operations (i.e., shuttle tankers carrying FPSO-produced oil, crew and supply vessels) will traverse coastal waters adjacent to Gulf ports. In addition, the potential for accidents and oil spills from FPSO operations may have ramifications for nearshore waters. Therefore, the following description of the Gulf's marine mammal community, while emphasizing deepwater species, also considers shallow water species.

3.2.3.1 Non-Threatened and Non-Endangered Species

Two of the seven species of mysticetes known to occur in the Gulf are not currently listed as threatened or endangered. With the exception of the sperm whale, none of the odontocetes known to occur in the Gulf are currently listed as endangered or threatened.

Cetaceans - Mysticetes

The minke whale (*Balaenoptera acutorostrata*) is widely distributed from tropical to polar seas. Minke whales may be found offshore but appear to prefer coastal and inshore waters. Their diet consists of invertebrates and fishes (Leatherwood and Reeves, 1983; Stewart and Leatherwood, 1985; Jefferson *et al.*, 1993; Whrsig *et al.*, 2000). Sighting data suggest that minke whales either migrate into Gulf waters in small numbers during the winter or, more likely, that sighted individuals represent strays from low-latitude breeding grounds in the western North Atlantic (Jefferson and Schiro, 1997; Davis *et al.*, 1998, 2000).

The Bryde's whale (*Balaenoptera edeni*) is generally confined to tropical and subtropical waters (i.e., between lat. 40° N. and lat. 40° S.). Unlike a few other baleen whales, it does not have a well-defined breeding season in most areas; thus, calving may occur throughout the year. The Bryde's whale is represented by more sighting records than any other species of baleen whale in the Gulf. All Bryde's whale sightings made during the GulfCet I and II programs were from the continental shelf edge in the vicinity of DeSoto Canyon and along the 100-m (328-ft) isobath in the north-central Gulf. These data suggest that the Gulf may represent at least a portion of the range of a dispersed, resident population of Bryde's whale (Jefferson and Schiro, 1997; Davis *et al.*, 1998, 2000). Bryde's whales feed on both fishes and invertebrates (Leatherwood and Reeves, 1983; Cummings, 1985; Jefferson *et al.*, 1993).

Cetaceans - Odontocetes

<u>Pygmy and Dwarf Sperm Whales</u>

The pygmy sperm whale (*Kogia breviceps*) and its congener, the dwarf sperm whale (*K. simus*) are known from deep waters in tropical to warm temperate zones (Jefferson and Schiro, 1997). They appear to be most common on the continental slope and along the shelf edge, although field identification and differentiation of the two species is problematic. Little is known of their natural history. Data collected from stomach contents of stranded individuals suggest that these species feed on cephalopods, fishes, and crustaceans in deep water (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993). *Kogia* has been sighted throughout the Gulf across a wide range of depths and bottom topographies, though they may be more commonly associated with water mass fronts along the continental shelf edge break and upper slope (Baumgartner, 1995).

Beaked Whales

Two genera and four species of beaked whales are known to occur in the GOM. These encompass 1) three species in the genus *Mesoplodon* (i.e., Sowerby's beaked whale [*M. bidens*], Blainville's beaked whale [*M. densirostris*], and Gervais' beaked whale [*M. europaeus*]), and 2) one species in the genus *Ziphius*, Cuvier's beaked whale (*Ziphius cavirostris*). Generally, beaked whales appear to prefer deep water, though little is known of their respective life histories. Stomach content analyses suggest that these whales feed primarily on deepwater cephalopods, although they will also take fishes and some benthic invertebrates (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993). In the Gulf, beaked whales have been sighted at depths between approximately 700 and 2,000 m (2,297 and 6,562 ft). Cuvier's beaked whale is probably the most common beaked whale in the Gulf (Jefferson and Schiro, 1997; Davis *et al.*, 1998, 2000).

Delphinids

All remaining species of non-endangered and non-threatened cetaceans found in the Gulf are members of the taxonomically diverse family Delphinidae. The pygmy killer whale (*Feresa attenuata*) is apparently widely distributed in tropical waters, though little is known of its biology or life history. Its diet includes cephalopods and fishes, though reports of attacks on other delphinids have been reported (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993). The pygmy killer whale does not appear to be commonly found in the GOM. Sightings of this species have been at depths of 500 to 1,000 m (1,641 to 3,281 ft) (Jefferson and Schiro, 1997; Davis *et al.*, 1998, 2000).

The short-finned pilot whale (*Globicephala macrorhynchus*) is found in warm temperate to tropical waters of the world. Short-finned pilot whales feed primarily on cephalopods and fishes. In the Gulf, it is most commonly sighted along the continental slope at depths of 250 to 2,000 m (Jefferson and Schiro, 1997; Davis *et al.*, 1998, 2000).

The Risso's dolphin (*Grampus griseus*) is a pantropical species that inhabits deep oceanic and continental slope waters. Risso's dolphins feed primarily on cephalopods and secondarily on fish and crustaceans (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993; Baumgartner, 1997; Whrsig *et al.*, 2000). In the Gulf, its distribution appears to be widespread at depths of 150 to 2,000 m (492 to 6,562 ft), with aggregations sighted in areas along the upper continental slope with steep bottom topography (Baumgartner, 1995).

The Fraser's dolphin *(Lagenodelphis hosei*) has a pantropical distribution in oceanic waters and nearshore in areas where deep water approaches the coast. Fraser's dolphins feed on fishes, cephalopods, and crustaceans (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993; Jefferson and Schiro, 1997). Fraser's dolphins have been sighted in the western and eastern Gulf at depths of around 1,000 m (3,281 ft) (Leatherwood *et al.*, 1993; Jefferson and Schiro, 1997; Davis *et al.*, 2000).

The killer whale (*Orcinus orca*) is one of the most cosmopolitan of all of the delphinids. Generally, they appear to prefer nearshore, cold temperate to subpolar zones. Killer whales feed on marine mammals, marine birds, fishes, sea turtles, and cephalopods (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993). In the Gulf, most sightings of killer whales have been along the continental slope, within a broad area of the north-central Gulf (Jefferson and Schiro, 1997; O'Sullivan and Mullin, 1997).

The melon-headed whale (*Peponocephala electra*) is a deepwater, pantropical species. It is known to feed on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993; Mullin *et al.*, 1994c; Jefferson and Schiro, 1997). Sightings of this species in the Gulf have been primarily in continental slope waters west of the Mississippi River (Jefferson and Schiro, 1997; Davis *et al.*, 1998, 2000).

The false killer whale *(Pseudorca crassidens*) is found in tropical to warm temperate zones in deep offshore waters. It feeds on primarily fishes and cephalopods, although it has been known to also feed on cetaceans (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993). In the Gulf, most sightings of false killer whales have occurred along the continental slope, although some have been sighted in shallower shelf waters (Davis *et al.*, 1998).

The pantropical spotted dolphin (*Stenella attenuata*) is a tropical species known from the Atlantic, Pacific, and Indian Oceans. It is known to feed on epipelagic fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993). The pantropical spotted dolphin is the most common and abundant cetacean on the slope, especially outer slope waters of the Gulf at depths greater than 1,200 m (3,937 ft) (Davis and Fargion, 1996; Jefferson and Schiro, 1997).

The rough-toothed dolphin (*Steno bredanensis*) is a circumtropical and subtropical species that feeds on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993). In the Gulf, they are sighted almost exclusively west of the Mississippi River at depths of 900 to 2,000 m (2,953 to 6,562 ft), and occur year-round (Davis *et al.*, 1998; Jefferson and Schiro, 1997).

The Clymene dolphin (*Stenella clymene*) is endemic to the Atlantic and found only in tropical and subtropical waters. This species appears to feed on fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993; Mullin *et al.*, 1994a). Data suggest that Clymene dolphins are widespread within deeper Gulf waters (i.e., shelf edge and slope) (Davis *et al.*, 2000; Whrsig *et al.*, 2000).

The striped dolphin (*Stenella coeruleoalba*) is primarily a tropical species, though it may also range into temperate seas. Striped dolphins are known to feed on cephalopods and fishes. In the Gulf, they are found offshore of the shelf edge, at depths of >200 m (<656 ft) (Jefferson and Schiro, 1997; Davis *et al.*, 2000; Whrsig *et al.*, 2000).

The Atlantic spotted dolphin (*Stenella frontalis*) is endemic to the Atlantic within tropical to temperate waters. They are known to feed on a wide variety of fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993). The Atlantic spotted dolphin is the only other species of cetacean (other than the bottlenose dolphin) that commonly occurs on the continental shelf of the GOM (Davis and Fargion, 1996; Jefferson and Schiro, 1997). Previous Gulf surveys sighted the Atlantic spotted dolphin primarily on the continental shelf and shelf edge at depths less than 250 m (820 ft), although some individuals were sighted along the slope at depths of up to approximately 600 m (1,969 ft) (Davis *et al.*, 1998).

The spinner dolphin (*Stenella longirostris*) is a pantropical species (Jefferson and Schiro, 1997). Spinner dolphins appear to feed on fishes and cephalopods (Whrsig *et al.*, 2000). In the Gulf, most sightings of spinner dolphins have been east of the Mississippi River at depths of 500 to 1,800 m (1,641 to 5,906 ft) (Jefferson and Schiro, 1997; Davis *et al.*, 2000).

The bottlenose dolphin (*Tursiops truncatus*) is a common inhabitant of the continental shelf and upper slope waters of the Gulf. Sightings of this species in the Gulf are rare beyond approximately 1,200 m (3,937 ft) (Mullin *et al.*, 1994b; Jefferson and Schiro, 1997; Davis *et al.*, 2000). Opportunistic feeders, they prey on a wide variety of species (Davis and Fargion, 1996;

Jefferson and Schiro, 1997). Current data suggest that there are genetically discrete inshore and offshore populations of bottlenose dolphins.

3.2.3.2 Threatened and Endangered Species

Five mysticete (or baleen) whales (the northern right, blue, fin, sei, and humpback), one odontocete (or toothed) whale (the sperm whale), and two subspecies of one sirenian (the West Indian manatee) occur or have been reported in the GOM and are currently listed as endangered species. No listed mysticetes (baleen whales) normally occur in the Gulf (Jefferson and Schiro, 1997). Sperm whales are common and perhaps a resident species in certain deepwater areas of the Gulf. The West Indian manatee (*Trichechus manatus*) inhabits only coastal marine, brackish, and freshwater habitats.

Cetaceans - Mysticetes

The northern right whale (*Eubalaena glacialis*) inhabits primarily temperate and subpolar waters. The western North Atlantic population ranges between the Maritime Provinces of eastern Canada to northeastern Florida. Right whales forage primarily on subsurface and localized concentrations of zooplankton such as calanoid copepods (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993). Sparse, historical sightings and stranding records suggest that this species is not a normal inhabitant of the GOM. Records that do exist are considered to be those of extralimital strays from their wintering grounds off the southeastern United States (Jefferson and Schiro, 1997).

The sei whale (*Balaenoptera borealis*) is an oceanic species that is not commonly sighted near the coast. They occur from the tropics to polar zones in both hemispheres, but appear to be more common in mid-latitude temperate zones. Sei whales feed on localized concentrations of zooplankton, small fishes, and cephalopods (Gambell, 1985; Jefferson *et al.*, 1993). Sparse sighting data in the GOM suggest that their presence there is rare, or of accidental occurrence (Jefferson and Schiro, 1997).

The blue whale (*Balaenoptera musculus*) is an oceanic species that moves into shallower habitats to feed. Blue whales are distributed from the equator to polar regions of both hemispheres. Blue whales feed almost exclusively on localized concentrations of zooplankton (Yochem and Leatherwood, 1985; Jefferson *et al.*, 1993). Their presence in the GOM is considered to be very rare, as sighting records consist of two stranded individuals on the Texas coast and two non-confirmed sightings (Jefferson and Schiro, 1997).

The fin whale (*Balaenoptera physalus*) is also an oceanic species of both hemispheres, and may be found from the tropics to polar zones. They are sighted near the coast in certain areas where deep water approaches the coast. Fin whales feed on localized concentrations of zooplankton, fishes, and cephalopods (Leatherwood and Reeves, 1983; Jefferson *et al.*, 1993). Their presence in the GOM is considered to be uncommon to rare. Sparse sighting data on this species suggest that individuals in the Gulf may be extralimital strays from their western Atlantic population (Jefferson and Schiro, 1997; Whrsig *et al.*, 2000).

The humpback whale (*Megaptera novaeangliae*) feeds and breeds in coastal waters and migrates from its tropical breeding areas to polar or sub-polar regions. Humpback whales feed on localized concentrations of zooplankton and fishes (Winn and Reichley, 1985; Jefferson *et al.*, 1993). Humpback whales sighted in the GOM may be extralimital strays during their breeding season or during their migrations (Whrsig *et al.*, 2000).

Cetaceans - Odontocetes

The sperm whale (*Physeter macrocephalus*) is the largest toothed whale and is distributed from the tropics to polar zones in both hemispheres. They are deep-diving mammals and inhabit oceanic waters, although they may come close to shore in certain areas where deep water approaches the coast. Sperm whales are known to feed on cephalopods, demersal fishes, and benthic invertebrates (Rice, 1989; Jefferson *et al*., 1993). The sperm whale is the only great whale that is considered to be common in the GOM (Jefferson and Schiro, 1997). Sighting data suggest a Gulf-wide distribution on the slope. Congregations of sperm whales are commonly found in waters over the shelf edge in the vicinity of the Mississippi River delta in water depths of 500 to 2,000 m (1,641 to 6,562 ft). From these consistent sightings, it is believed that there is a resident population of sperm whales in the Gulf consisting of adult females, calves, and immature individuals (Mullin *et al*., 1994b; Davis and Fargion, 1996; Sparks *et al.*, 1996; Jefferson and Schiro, 1997; Davis *et al.*, 2000). Recent minimum population estimates of sperm whales in the entire GOM totaled 411 individuals, as cited in the NMFS stock assessment report for 1996 (Waring *et al*., 1997). Subsequent abundance estimates of sperm whales in the "oceanic northern GOM" survey area totalled 387 individuals (Davis *et al*., 2000).

Sirenians

The West Indian manatee (*Trichechus manatus*) is the only sirenian found in tropical and subtropical coastal waters of the southeastern United States, GOM, Caribbean Sea, and Atlantic coast of northern and northeastern South America (Reeves *et al*., 1992; Jefferson *et al*., 1993; O'Shea *et al*., 1995). There are two subspecies of the West Indian manatee: the Florida manatee (*T. m. latirostris*), which ranges from the northern GOM to Virginia; and the Antillean manatee (*T. m. manatus*), which ranges from northern Mexico to eastern Brazil, including the islands of the Caribbean Sea. The West Indian manatee typically ranges no further north than the Suwanee River in northwest Florida, though individuals are occasionally found as far west as Texas. West Indian manatees are herbivorous, feeding on aquatic plants.

Distributions of Cetaceans within Offshore Waters of the Northern GOM

Factors that may influence the spatial and temporal distribution and abundance of cetaceans may be environmental, biotic, or anthropogenic. Environmental factors encompass those that are physiochemical, climatological, or geomorphological. Biotic factors include the distribution and abundance of prey, inter- and intra-specific competition, reproduction, natural mortality, catastrophic events (e.g., die offs), and predation (Davis *et al*., 1998). Anthropogenic factors include such items as historical hunting pressure (in some species), pollution, habitat loss and degradation, shipping traffic, recreational and commercial fishing, oil and gas development and production, and seismic exploration (USDOI, MMS, 1997b).

Within the northern GOM, many of the aforementioned environmental and biotic factors are strongly influenced by various circulation patterns. These patterns are generally driven by river discharge, wind stress, and the Loop Current. The major river system in this area is the Mississippi-Atchafalaya. Most of the river discharge into the northern Gulf is transported to the west and along the coast. Circulation on the continental shelf is largely wind-driven, with localized effects from fresh water (i.e., riverine) discharge. Beyond the shelf, mesoscale circulation is largely driven by the Loop Current in the eastern Gulf. Meanders of the Loop Current create warm-core anticyclonic eddies (anticyclones) once or twice annually that migrate westward. The anticyclones in turn spawn cold-core cyclonic eddies (cyclones). Together, anticyclones and cyclones govern the circulation of the continental slope in the central and western Gulf. The Loop Current and anticyclones are dynamic features that transport large quantities of high-salinity, nutrient-poor water across the near-surface waters of the northern Gulf. Cyclones, in contrast, contain high concentrations of nutrients and stimulate localized production. The combination of input of nutrients into the Gulf from river outflow and mesoscale circulation features enhances productivity, and thus the abundance, of cetacean prey species such as fishes and cephalopods within the Gulf. The dynamics of these oceanographic features in turn affect the spatial and temporal distribution of prey species and ultimately influence cetacean diversity, abundance, and distribution (Mullin *et al.*, 1994b; Davis *et al.*, 2000).

Studies conducted during the GulfCet I program demonstrated correlation of cetacean distribution patterns with certain geomorphic features such as bottom depth or topographic relief. These studies suggested that bottom depth was the most important variable in habitat partitioning among cetacean species in the northern Gulf (Baumgartner, 1995; Davis *et al.*, 1998). For example, GulfCet I surveys, along with other surveys (such as the subsequent GulfCet II program) and opportunistic sightings of cetaceans within the U.S. GOM, found that only the Atlantic spotted dolphin and the coastal form of the bottlenose dolphin were common inhabitants of the continental shelf. The remaining species of cetaceans known to regularly occur in the Gulf (with possible exception of the Bryde's whale) were sighted on the continental slope (Mullin *et al.*, 1994b; Jefferson, 1995; Davis *et al.*, 1998, 2000). During the GulfCet II program, the most commonly sighted cetaceans on the continental slope were bottlenose dolphins (pelagic form), pantropical spotted dolphins, Risso's dolphins, and dwarf/pygmy sperm whales. The most abundant species on the slope were pantropical spotted and spinner dolphins. Sperm whales sighted during GulfCet II surveys were found almost entirely in the north-central and northeastern Gulf, and near the 1,000-m (3,281-ft) isobath on the continental slope (Davis *et al.*, 2000).

An objective of the GulfCet II program was to correlate a number of environmental parameters such as selected hydrographic features with cetacean sighting data in an effort to characterize cetacean habitats in the GOM (Davis *et al.*, 2000). From GulfCet II surveys, sightings of cetaceans along the slope were concentrated in cyclones where production (in this case, measured chlorophyll concentration) was elevated; increased primary production within these cyclonic features enhances secondary production, including preferred prey items. Sightings of these deepwater species, however, were much less frequent in water depths greater than 2,000 m (6,562 ft) and in anticyclones. Sperm whales tended to occur along the mid-to-lower slope, near the mouth of the Mississippi River and, in some areas, in cyclones and zones of confluence between cyclones and anticyclones. From these data, it was suggested that the greater densities of cetaceans sighted along the continental slope, rather than abyssal areas, of the northern Gulf probably result from localized conditions of enhanced productivity, especially along the upper slope, and as a result of the collisions of mesoscale eddies with the continental margin (Davis *et al.*, 2000).

In the north-central Gulf, the relatively narrow continental shelf south of the Mississippi River delta may be an additional factor affecting cetacean distribution, especially in the case of sperm whales (Davis *et al.*, 2000). Outflow from the Mississippi River mouth transports large volumes of low salinity, nutrient-rich water southward across the continental shelf and over the slope. River outflow may also be entrained within the confluence of a cyclone-anticyclone eddy pair and transported beyond the continental slope. In either case, this input of nutrient-rich water leads to a localized deepwater environment with enhanced productivity and may explain the presence of a resident population of sperm whales within 50 km (31 mi) of the Mississippi River delta in the vicinity of the Mississippi Canyon.

Temporal variability in the distribution of cetaceans in the northern GOM may also be primarily dependent upon the extent of river discharge and the presence and dynamic nature of mesoscale hydrographic features such as cyclones. Consequently, the distribution of cetacean species will change in response to the movement of prey species associated with these hydrographic features. GulfCet I and II survey data determined that most of the cetacean species that were routinely or commonly sighted in the northern Gulf apparently occur in these waters throughout the year, although seasonal abundance of certain species or species assemblages in slope waters may vary at least regionally (Baumgartner, 1995; Davis *et al.*, 1998, 2000).

3.2.4 Sea Turtles

Of the seven or eight extant species of sea turtles, five are known to inhabit the waters of the GOM (Pritchard, 1997): the green turtle, the loggerhead, the hawksbill, the Kemp's ridley, and the leatherback (table 3-12).

As a group, sea turtles possess elongated, paddlelike forelimbs that are substantially modified for swimming and shells that are depressed and streamlined (Marquez, 1990; Ernst *et al.*, 1994; Pritchard, 1997). They depend on land only during the reproduction period, when females emerge to nest on sandy beaches. They are long-lived and slow-maturing. Generally, their distributions are primarily circumtropical, although the various species differ widely in their seasonal cycles, geographical ranges, and behavior. There are also considerable differences in behavior among populations of the same species (Marquez, 1990).

Most sea turtles (except perhaps the leatherback) exhibit differential distributions among their various life stages - hatchling, juvenile, and adult (Marquez, 1990; Musick and Limpus, 1997; Hirth, 1997). After reaching the sea, hatchling turtles actively swim directly away from the nesting beach until they encounter zones of water mass convergence and/or sargassum rafts that are rich in prey and provide shelter (NMFS and USFWS, 1991a,b; NMFS and USFWS, 1992a; Hirth, 1997). Most then undergo a passive migration, drifting pelagically within prevailing current systems such as oceanic gyres. After a period of years (the number varies among species), the juveniles actively move into neritic developmental habitats. When approaching maturity, subadult juvenile turtles move into adult foraging habitats, which in some populations are geographically distinct from their juvenile developmental habitats (Musick and Limpus, 1997).

All sea turtle species that inhabit the Gulf are listed as either endangered or threatened under the authority of the Endangered Species Act of 1973 (Pritchard, 1997). It is believed that human activities are the cause of the collapse of sea turtle numbers. These activities impact every stage of their life cycle and encompass 1) the loss of nesting beach and foraging habitats; 2) harvesting of eggs and adults for consumption; 3) incidental mortalities at sea through pelagic and ground fishing practices; and 4) harm or mortality from increasing loads of non-biodegradable waste and pollutants (Lutcavage *et al.*, 1997).

The loggerhead (*Caretta caretta*) is a large sea turtle that inhabits the continental shelves and estuaries of temperate and tropical environments of the Atlantic, Pacific, and Indian Oceans.

Table 3-12

Sea Turtles of the Gulf of Mexico

Family Cheloniidae	
Loggerhead turtle (*Caretta caretta*)	(T)
Green turtle (*Chelonia mydas*)	(T)/(E*)
Hawksbill turtle (*Eretmochelys imbricata*)	(E)
Kemp's ridley turtle (*Lepidochelys kempi*)	(E)
Family Dermochelyidae	
Leatherback turtle (*Dermochelys coriacea*)	(E)

Key:

(E) = Currently listed as endangered under the Endangered Species Act of 1973.
(T) = Currently listed as threatened under the Endangered Species Act of 1973.
(E*) = Listed as endangered in the State of Florida.

This species typically wanders widely throughout the marine waters of its range and is capable of living in varied environments for a relatively long time (Marquez, 1990; NMFS and USFWS, 1991b; Ernst *et al.*, 1994). They may remain dormant during winter months, buried in moderately deep, muddy bottoms (Marquez, 1990). Loggerheads are carnivorous and, though considered primarily predators of benthic invertebrates, are facultative feeders over a wide range of food items (Ernst *et al.*, 1994). Loggerheads are considered to be the most abundant sea turtle in the GOM (Dodd, 1988). Loggerhead nesting along the Gulf Coast occurs primarily along the Florida panhandle, although some nesting also has been reported from Texas through Alabama (NMFS and USFWS, 1991b). The loggerhead is currently listed as a threatened species.

The green turtle (*Chelonia mydas*) is the largest hardshell turtle and considered to be a circumglobal species. They are commonly found throughout the tropics and as stragglers in a far more extensive area, generally between lat. 40° N. and lat. 40° S. (NMFS and USFWS, 1991a; Hirth, 1997). In the continental U.S., they are found from Texas to Massachusetts. Green turtles are omnivorous; adults prefer feeding on plants, but juveniles and hatchlings are more carnivorous (Ernst *et al.*, 1994; Hirth, 1997). The adult feeding habitats are beds or pastures of seagrasses and algae in relatively shallow, protected waters; juveniles may forage in areas such as coral reefs, emergent rocky bottom, sargassum mats, and in lagoons and bays. Movements between principal foraging areas and nesting beaches can be extensive, with some populations regularly carrying out transoceanic migrations (NMFS and USFWS, 1991a; Ernst *et al.*, 1994; Hirth, 1997). Green turtles occur in some numbers over grass beds along the south Texas coast and the Florida Gulf Coast. Reports of nesting along the GOM coast are infrequent, and the closest important nesting aggregations are along the east coast of Florida and the Yucatan Peninsula (NMFS and USFWS, 1991a). The green turtle is currently listed internationally as a threatened species and as an endangered species in the State of Florida.

The hawksbill (*Eretmochelys imbricata*) is a small to medium-sized sea turtle that occurs in tropical to subtropical seas of the Atlantic, Pacific, and Indian Oceans. In the continental U.S., the hawksbill has been recorded in all the Gulf States and along the Atlantic coast from Florida to Massachusetts, although sightings north of Florida are rare. They are considered to be the most tropical of all sea turtles and the least commonly reported sea turtle in the GOM (Marquez, 1990; Hildebrand, 1995). Coral reefs are generally recognized as the resident foraging habitat for juveniles and adults. Adult hawksbills feed primarily on sponges and demonstrate a high degree of selectivity, feeding on a relatively limited number of sponge species, primarily demosponges (Ernst *et al.*, 1994). Nesting within the continental U.S. is limited to southeastern Florida and the Florida Keys. Juvenile hawksbills show evidence of residency on specific foraging grounds, although some migrations may occur (NMFS and USFWS, 1993). Some populations of adult hawksbills undertake reproductive migrations between foraging grounds and nesting beaches (Marquez, 1990; Ernst *et al.*, 1994). The hawksbill is presently listed as an endangered species.

The Kemp's ridley (*Lepidochelys kempi*) is the smallest sea turtle. This species occurs mainly in the GOM and along the northwestern Atlantic coast as far north as Newfoundland. Juveniles and adults are typically found in shallow areas with sandy or muddy bottoms, especially in areas of seagrass habitat. Kemp's ridleys are carnivorous and feed primarily on crabs, though they also feed on a wide variety of other prey items as well (Marquez, 1990; NMFS and USFWS, 1992a; Ernst *et al.*, 1994). The major Kemp's ridley nesting area is near Rancho Nuevo, along the northeastern coast of Mexico (Tamaulipas), although scattered nests have also been reported in other areas of Mexico and in Texas (e.g., within the Padre Island

National Seashore), Colombia, Florida, and South Carolina (NMFS and USFWS, 1992a; Ernst *et al.*, 1994). Adult Kemp's ridleys exhibit extensive internesting movements but appear to travel near the coast, especially within shallow waters along the Louisiana coast. The Kemp's ridley is currently listed as an endangered species.

The leatherback (*Dermochelys coriacea*) is the largest and most distinctive living sea turtle. This species possesses a unique skeletal morphology, most evident in its flexible, ridged carapace, and in cold water maintains a core body temperature several degrees above ambient. They also have unique deep-diving abilities. This species is also the most pelagic and most wide-ranging sea turtle, undertaking extensive migrations from the tropics to boreal waters. Though considered pelagic, leatherbacks will occasionally enter the shallow waters of bays and estuaries. Leatherbacks feed primarily on gelatinous zooplankton such as jellyfish, siphonophores, and salps, though they may, perhaps secondarily, ingest some algae and vertebrates (Ernst *et al.*, 1994). Data from analyses of leatherback stomach contents suggest that they may feed at the surface, nocturnally at depth within deep scattering layers, or in benthic habitats. Florida is the only site in the continental U.S. where the leatherback regularly nests (NMFS and USFWS, 1992b; Ernst *et al.*, 1994; Meylan *et al.*, 1995). The leatherback is currently listed as an endangered species.

Distributions of Sea Turtles in the Offshore Waters of the Northern GOM

Surveys conducted during the GulfCet I and II programs represent the most recent assessments of sea turtle distribution and abundance within the oceanic northern GOM (Davis *et al.*, 1998, 2000). During these surveys, only three species of sea turtles were sighted: loggerheads, Kemp's ridleys, and leatherbacks.

GulfCet I and II surveys found the abundance of sea turtles in the GOM to be considerable higher on the continental shelf and within the eastern Gulf, east of Mobile Bay (Lohoefener *et al.*, 1990; Davis *et al.*, 2000). Kemp's ridleys were sighted only along the shelf. The number of sightings of loggerheads were also found to be considerably higher on the continental shelf than the slope. There were also sightings of individual loggerheads over very deep waters (>1,000 m). The importance of the oceanic Gulf to loggerheads was not clear from these surveys, though it was suggested that they may transit through these waters to distant foraging sites or while seeking warmer waters during winter (Davis *et al.*, 2000). From historic sighting data, leatherbacks appear to spatially utilize both shelf and slope habitats in the GOM (Fritts *et al.*, 1983a,b; Collard, 1990; Davis *et al.*, 1998). GulfCet I and II surveys suggested that the region from Mississippi Canyon to DeSoto Canyon, especially near the shelf edge, appears to be an important habitat for leatherbacks (Davis *et al.*, 2000).

Seasonally, loggerheads were widely distributed across the shelf during both summer and winter, though their abundance on the slope was considerably higher during winter surveys than summer (Davis *et al.*, 2000). Temporally, variability in leatherback distribution and abundance suggest that specific areas may be important to this species, either seasonally or for short periods of time. Overall, leatherbacks occurred in substantial numbers during both summer and winter surveys, and the high variability in the relative numbers of individual leatherbacks sighted within specific areas suggest that their distribution patterns were irruptive in nature (Davis *et al.*, 2000).

3.2.5 Coastal and Marine Birds

The distributions and populations of birds in offshore waters (i.e., outer continental shelf, slope, and abyssal areas) of the central and western GOM are not well known, whereas coastal and nearshore distributions have been studied more extensively. Generally, offshore waters are inhabited by seabird species, both resident and migratory. The area is also seasonally traversed by a diverse and sizeable array of migratory coastal bird and landbird species.

3.2.5.1 Non-Threatened and Non-Endangered Species

Three taxonomic orders of seabirds (defined as species that spend a large portion of their lives on or over seawater) are found in the offshore waters of the central and western GOM: 1) Procellariiformes (albatrosses, petrels, shearwaters, and storm-petrels); 2) Pelicaniformes (frigatebirds, tropicbirds, gannets, and boobies); and 3) Charadriiformes (phalaropes, skuas and jaegers, gulls, and terns) (Clapp *et al.*, 1982a,b,c; Harrison, 1983; Warham, 1990; Olsen and Larsson, 1995; Peake *et al.*, 1995; Harrison, 1996; Olsen and Larsson, 1997; National Geographic Society, 1999). Species known to occur in these areas of the Gulf are listed in table 3-13.

GOM seabirds were categorized by Fritts and Reynolds (1981) according to their seasonal and geographic presence and their migratory or resident status. Major categories encompass summer migrant pelagics, summer residents, winter marine species, and permanent residents. Summer migrant pelagic species are present in the Gulf during the summer but primarily breed elsewhere. Examples include shearwaters, storm-petrels, boobies, tropicbirds, and black terns. Summer residents (i.e., seabirds that breed in the Gulf) include sooty terns, least terns, and sandwich terns. Wintering marine birds include northern gannet, herring gulls, and jaegers. Permanent residents include laughing gulls, royal terns, bridled terns, and magnificent frigatebirds.

In contrast, near-coastal and inner continental shelf waters of the central and western Gulf support a larger, more diverse compliment of bird species than offshore waters. These encompass seabirds; shorebirds (i.e., members of the Order Charadriiformes, which outside of their specific migratory pathways are generally restricted to coastline margins); wading birds (i.e., herons and egrets, ibises and spoonbills, and cranes); rails; and waterfowl (Clapp *et al.*, 1982a,b,c; Harrison, 1983; Olsen and Larsson, 1995; Peake *et al.*, 1995; Harrison, 1996; Olsen and Larsson, 1997; National Geographic Society, 1999). Many of these birds are migrants that seasonally inhabit coastal waters, beaches, flats, sandbars, and wetland habitats.

The GOM is an important pathway for migratory birds. Most of the migrant birds (especially passerines) that overwinter in the neotropics and breed in eastern North America either directly cross the GOM or traverse the Gulf Coast or the Florida peninsula (Hagan and Johnston, 1992). Radar studies indicate that the flight pathway of the majority of trans-Gulf migrant birds during spring is directed toward the coastlines of Louisiana and eastern Texas. An ongoing study conducted by Louisiana State University's Museum of Natural Science (LSUMNS) is studying the use of offshore oil and gas production platforms by migrating birds (other than seabirds) for rest or temporary shelter to avoid inclement weather. It is believed that these platforms may serve as artificial islands for these species during their migrations (Bob Russell, LSUMNH, pers. comm, 7 September 1999). These data are updated regularly and published via email or on selected website addresses, including: 1) migrants@msn.com; 2) migrants@hotmail.com; and 3) www.geocities.com/NapaValley/8596/).

Table 3-13

Seabirds of the Offshore Waters of the Gulf of Mexico (from: Clapp *et al*., 1983; Harrison, 1992, 1996; Olsen And Larsson, 1995, 1997; National Geographic Society, 1999)

Order Procellariiformes
Family Diomedeidae
Yellow-nosed albatross (*Diomedea chrysostoma)*
Family Procellariidae
Cory's shearwater (*Calonectris diomedea)*
Black-capped petrel (*Pterodroma hasitata)*
Greater shearwater (*Puffinus gravis)*
Sooty shearwater (*Puffinus griseus)*
Audubon's shearwater (*Puffinus lherminieri)*
Manx shearwater (*Puffinus puffinus)*
Family Hydrobatidae
Wilson's storm-petrel *(Oceanites oceanicus)*
Band-rumped storm-petrel (*Oceanodroma castro)*
Leach's storm-petrel (*Oceanodroma leucorhoa)*
Order Pelicaniformes
Family Fregatidae
Magnificent frigatebird *(Fregata magnificens)*
Family Phaethontidae
Red-billed tropicbird (*Phaethon aethereus)*
White-tailed tropicbird (*Phaethon lepturus)*
Family Sulidae
Northern gannet (*Morus bassanus)*
Masked booby (*Sula dactylatra)*
Brown booby (*Sula leucogaster)*
Red-footed booby (*Sula sula)*
Order Charadriiformes
Family Scolopacidae
Red phalarope (*Phalaropus fulicaria)*
Red-necked phalarope (*Phalaropus lobatus)*
Family Laridae
Black noddy (*Anous minutus)*
Brown noddy (*Anous stolidus)*
Black tern (*Chlidonias niger)*
Herring gull (*Larus argentatus)*
Laughing gull (*Larus atricilla)*
Ringed-bill gull (*Larus delwarensis)*
Lesser black-backed gull (*Larus fuscus)*
Glaucous gull (*Larus hyperboreus)*
Great black-backed gull (*Larus marinus)*
Bonaparte's gull (*Larus philadelphia)*
Franklin's gull (*Larus pipixcan)*
Parasitic jaeger (*Stercorarius parasiticus)*
Long-tailed jaeger (*Stercorarius longicaudus)*
Pomarine jaeger (*Stercorarius pomarinus)*
Bridled tern (*Sterna anaethetus)*
Least tern (*Sterna antillarum)*
Caspian tern (*Sterna caspia)*
Roseate tern (*Sterna dougallii)*
Forster's tern (*Sterna forsteri)*
Sooty tern (*Sterna fuscata)*
Common tern (*Sterna hirundo)*
Royal tern (*Sterna maxima)*
Gull-billed tern (*Sterna nilotica)*
Sandwich tern (*Sterna sandvicensis)*

3.2.5.2 Threatened and Endangered Species

Most species of coastal and marine birds that occur in the central and western GOM and are currently listed as endangered or threatened inhabit or frequent coastal areas and waters of the inner continental shelf. These include the sandhill crane (Gulf Coast race) (*Grus canadensis pulla*), piping plover (*Charadrius melodus*), eskimo curlew (*Numenius borealis*), brown pelican (*Pelicanus occidentalis*), and bald eagle (*Haliaeetus leucocephalus*) (USFWS, 1998). Because of their normal coastal or inner continental shelf ranges, these species are not expected to occur in deepwater portions of the central and western GOM.

Distributions of Seabirds in Offshore Waters of the Northern GOM

Systematic survey data collected during the GulfCet I and II programs represent the most recent contributions toward the understanding of seabird distributions and abundances in the offshore waters of the GOM (Davis *et al.*, 1998, 2000). GulfCet I surveys were conducted between the Alabama-Florida and Texas-Mexico borders, between the 100- and 2,000-m (328- and 6,562-ft) isobaths. GulfCet II surveyed the oceanic northern Gulf, the previous GulfCet I survey area, and along the continental slope of the eastern Gulf.

Fourteen species represented over 99 percent of the total sightings made during the GulfCet I survey program. In descending order of abundance, the principal species sighted were terns, storm-petrels, jaegers, and laughing gulls (*Larus atricilla*). GulfCet I surveys found that species groups and individual species of seabirds present in the GOM varied spatially and seasonally, and that water depth appeared to substantially influence their distributions in the central and western Gulf (Davis *et al.*, 1998).

Subsequent GulfCet II surveys measured several environmental parameters along with correlated sightings in an effort to analyze the affinities of seabird species for various hydrographic environments (Davis *et al.*, 2000). For example, certain seabird species groups tended to be associated with oceanographic conditions of higher or, in some cases, lower sea surface productivity. Further, all seabird groups generally tended to concentrate at fronts defined by steep temperature gradients (Ribic *et al.*, 1997). Generally, species diversity was highest within cyclonic eddies and lowest on the continental shelf. Analysis of GulfCet I and II data showed that seabird groups and individual species present in the GOM exhibited seasonal patterns of shifting species abundances. Seasonally, survey data showed that species diversity was greatest in spring and lowest in winter and fall, and that the sighting rate, or numbers of bird sightings per day, was highest in summer and lowest in fall (Davis *et al.*, 1998, 2000).

3.2.6 Fish Resources

Beyond the 200-m (656-ft) isobath, fish broadly associate with the pelagic or benthic realms. Pelagic fishes may be further subdivided by their preferred position in the water column, which leads to three primary groups: epipelagic, mesopelagic, and bathypelagic.

Epipelagic fishes inhabit the upper 200 m (656 ft) of the water column and include several shark species (mako, silky, oceanic whitetip, and whale shark), billfishes (marlins, sailfish, and swordfish), herrings, flyingfish, halfbeaks, opahs, oarfish, bluefish, scads, jacks, pilotfish, dolphin, remoras, pomfrets, tunas, butterfish, and tetraodontiform fishes (molas and triggerfish). A number of these species, including dolphin, sailfish, white marlin, blue marlin, and tunas, are important to commercial and recreational fisheries. Information on commercial fisheries is provided in Section 3.3.1; this section also addresses Essential Fish Habitat (EFH), a regulatory and legal requirement that has ramifications on select, managed fishery resources.

Epipelagic fishes in the Gulf are reportedly associated with mesoscale hydrographic features such as fronts and eddies. Fishermen contend that yellowfin tuna aggregate near sea surface temperature boundaries or frontal zones; however, Power and May (1991) found no correlation between longline catches of yellowfin tuna and sea surface temperature in the GOM. The occurrence of bluefin tuna larvae in the GOM associated with the Loop Current boundary and the Mississippi River discharge plume is evidence that these species spawn in the Gulf (Richards *et al.*, 1989). All of the epipelagic species are migratory, but specific patterns are not well understood. Many of the oceanic species associate with flotsam, which provides forage areas and/or nursery refuge.

Floating sea weed (*Sargassum*), jellyfishes, siphonophores, and driftwood attract juvenile and adult epipelagic fishes. Many species will associate with drifting objects. Larger predators forage around flotsam. As many as 54 fish species are closely associated with floating *Sargassum* at some point in their life cycle, but only two spend their entire lives there: the sargassum fish and the sargassum pipefish (Adams, 1960; Dooley, 1972; Bortone *et al.*, 1977). Most fishes associated with *Sargassum* are temporary residents such as juvenile forms of species that reside in shelf or coastal waters as adults (Dooley, 1972; Bortone *et al.*, 1977; Moser *et al.* 1998). However, several larger species of recreational or commercial importance, including dolphinfish, yellowfin tuna, blackfin tuna, skipjack tuna, Atlantic bonito, little tunny, and wahoo, feed on the small fishes and invertebrates attracted to *Sargassum* (Manooch *et al.*, 1983; Manooch and Mason, 1984; Morgan *et al.*, 1985).

Mesopelagic fishes assemblages in the GOM are numerically dominated by myctophids (lanternfish), with gonostomatids (bristlemouths) and sternoptychids (hatchetfish) common but less abundant in collections. Myctophids are small silver fishes that can be extremely abundant, often responsible for the deep scattering layer in sonar images of the deep sea. Assemblages have only been studied in the eastern GOM by Backus *et al.* (1977), Hopkins and Lancraft (1984), Gartner *et al.* (1987), Sutton and Hopkins (1996), and Hopkins *et al.* (1997). Lanternfish were most common in the catches by Backus *et al.* (1977) and Hopkins and Lancraft (1984). Backus *et al.* (1977) analyzed lanternfish distribution in the western Atlantic Ocean and recognized the GOM as a distinct zoogeographic province. Species with tropical and subtropical affinities were most prevalent in the GOM lanternfish assemblage. This was particularly true for the eastern Gulf, where Loop Current effects on species distribution were most pronounced.

Gartner *et al.* (1987) sampled three stations in the northeastern Gulf, including one near De Soto Canyon (29101#N, 87101#W). Forty-two of the 49 lanternfish species collected from all stations were taken from the northeastern stations. The most abundant were similar to those for the entire eastern Gulf. Ichthyoplankton collections from oceanic waters yielded higher numbers of mesopelagic larvae than larvae of other species (Richards *et al.*, 1989). Lanternfish of the eastern Gulf generally spawn year-round, with peak activity in spring and summer (Gartner, 1993). Some lanternfish were reported by Darnell and Kleypas (1987) in trawl collections from near the rim of De Soto Canyon.

Members of the mesopelagic group spend the daytime in depths of 200 to 1,000 m, migrating vertically at night into food-rich, near-surface waters. Mesopelagic fishes, while less commonly known, are important ecologically because they transfer substantial amounts of energy between mesopelagic and epipelagic zones over each daily cycle. The lanternfishes are important prey for meso- and epipelagic predators, particularly the mesopelagic group of stomiids (Hopkins *et al.*, 1997).

Deeper-dwelling bathypelagic fishes occur in the water column at depths greater than 1,000 m and seldom migrate to shallower waters. This group is composed of bizarre, little known species such as snipe eels, slickheads, deep-sea anglers, bigscales, and whalefish (Helfman *et al.* 1997; McEachran and Fechhelm, 1998). Most species are capable of producing and emitting light (i.e., bioluminescence) to aid in communicating in an environment devoid of sunlight.

Fishes inhabiting the benthic realm are referred to as demersal because of their close association with the substrate. Within the study area, the substrate is typically silty and featureless offshore of the continental shelf of the GOM. Cutthroat eels, grenadiers, and cusk-eels numerically dominate fish assemblages within this habitat. Deepwater trawling investigations indicate that species assemblages segregate with water depth along the continental slope and rise (Pequegnat, 1983; Gallaway and Kennicut, 1988; Pequegnat *et al.*,1990). Pequegnat *et al.* (1990) established the following six depth zones for the megafauna (i.e., demersal fishes and large invertebrates) of the deep GOM:

- Shelf/slope transition Zone (118 to 475 m [387 to 1,558 ft]);
- Archibenthal Zone-Horizon A (500 to 775 m [1,641 to 2,543 ft]);
- Archibenthal Zone-Horizon B (800 to 975 m [2,625 to 3,199 ft]);
- Upper Abyssal Zone (1,000 to 2,275 m [3,281 to 7,464 ft));
- Mesoabyssal Zone (2,300 to 3,225 m [7,546 to 10,581 ft]);
- Lower Abyssal Zone (3,250 to 3,850 m [10,663 to 12,632 ft]).

The fish assemblage found in each zone is characterized by one or several common species. In the Shelf/slope Transition Zone, the goby flathead (*Bembrops gobioides*), a batfish (*Dibranchus atlanticus*), a grenadier (*Coelorhincus caribbaeus*), and a flatfish (*Poeceliopsetta beani*) were most common. The Archibenthal Zone-Horizon A was characterized by two grenadiers (*Coelorhincus coelorhincus* and *Bathygadus macrops*), whereas, the Archibenthal Zone-Horizon B supported high numbers of two additional grenadier species (*Nezumia aequalis* and *Bathygadus melanobranchus*). In the Upper Abyssal Zone, the dominant fish species was *Gadomus longifilis.* The Mesoabyssal Zone supported a depauperate fish assemblage consisting of only five species, including *Dicrolene kanazawai* and *Basozetus normalis*. The Lower Abyssal Zone was depauperate, but supported a unique fish assemblage represented by *Barathronus bicolor* and *Bathytroctes macrolepis*.

3.3 Other Relevant Activities and Resources

3.3.1 Commercial Fisheries

Commercial fisheries are very important to the economies of the Gulf coastal states (Browder *et al.*, 1991). In 1998, commercial fishery landings in the GOM, which includes the waters off western Florida, Alabama, Mississippi, Louisiana, and Texas, totaled over 1.5 billion pounds and were worth over $700 million (NMFS, 1999a). Of the individual states, Louisiana led in total landings and value in 1998 with 1.1 billion pounds landed worth $291 million (NMFS, 1999a). Mississippi was second with landings exceeding 210 million pounds worth $48 million, followed by Texas with landings of 89 million pounds worth $183 million, Florida with 87 million pounds worth $148 million, and Alabama with 30 million pounds worth $46 million. Most of these landings were of fishes and invertebrate species caught in estuarine, coastal, and shelf waters of the region.

Commercial fishing in deeper waters (i.e., >200 m [656 ft]) of the GOM targets fewer species and produces landings that historically contribute less than one percent of the regional total weight and dollar value. These deepwater fisheries are specialized, involving gear and methods that differ somewhat from their shallow-water counterparts. Species sought by deepwater commercial fishers can be divided into three basic groups—epipelagic fishes, reef fishes, and invertebrates. The subsections below describe the target species, fishing activities, and recent landings trends.

Target Species

Epipelagic fishes found in the commercial catch include dolphin, sharks (i.e., mako, silky, and thresher), snake mackerels (i.e., escolar and oilfish), swordfish, tunas (i.e., bigeye, blackfin, bluefin, and yellowfin), and wahoo. These species are widespread in the oceanic waters of the Gulf and are generally found in the upper 200 m (656 ft) of the water column. Sharks, swordfish, and tunas are the most important fishery species and are currently managed as a unit (Highly Migratory Species) by the NMFS (1999b).

Reef fishes typically caught in deepwater include groupers (snowy, Warsaw, and yellowedge), snappers (queen and silk), and tilefish (blueline tilefish, goldface tilefish, and tilefish). Tilefishes are not true reef fishes, given that they prefer level, clayey bottoms in 80 to 450 m (1,476 ft) water depths, not reefs or hard bottoms; however, tilefish have been classified in this analysis according to GOM Fishery Management Council (GMFMC, 1981) guidelines. These guidelines place tilefish within the Council's reef fishes management unit. Deepwater snappers and groupers associate with hard-bottom outcrops in water depths ranging from 80 to 600 m (262 to 1,969 ft).

Deepwater invertebrates important to commercial fisheries in the GOM include royal red shrimp and golden crab. Royal red shrimp occur over specific substrata in different areas of the Gulf, including the blue-black terrigeneous silts and silty clays found off the Mississippi Delta and the calcareous muds found off the Dry Tortugas (Roe, 1969; GMFMC, 1996). Peak abundances of royal red shrimp in the GOM occur in depths ranging from 250 to 500 m (820 to 1,641 ft) (Roe, 1969). Golden crab occur in a similar depth range but prefer hard bottoms and outcroppings such as the Florida Escarpment (Lindberg and Lockhart, 1993).

Types of Activity

Epipelagic fishes are primarily caught with drifting longlines fished in the upper water column. Longlines consist of a monofilament mainline suspended in the water column by regularly spaced buoys. Buoy lines are used to adjust the fishing depth of the mainline. Leaders with baited hooks are attached along the length of the mainline as it is being deployed. Mainlines range from 8 to 64 km (5 to 40 mi) in length and have 32 to 48 hooks per km (20 to 30 hooks per mile) (Berkeley *et al.*, 1981; NMFS, 1999b). Longlines are often set near oceanographic features such as fronts or areas of downwelling, often with the aid of sophisticated onboard temperature sensors, depth finders, and positioning equipment.

From 1994 to 1998, permitted longlines set in the GOM ranged from 40 to 103 km (25 to 64 mi) and averaged 60 km (37 mi). The number of sets per month ranged from 77 to 502 and averaged 322. In 1998, the number of sets ranged from 77 to 391 and averaged 259. This year-round fishery typically targets yellowfin tuna. The primary homeports for longline vessels are Dulac and Venice, Louisiana, and Destin, Madiera Beach, and Panama City, Florida (Tanaguchi, 1987; NMFS, 1999b).

Deepwater demersal/reef fishes are caught with bottom longlines, traps, and hook-and-line, with most of the landings being produced by bottom longlines. Bottom longlines are similar to surface longlines except that bottom longlines are anchored to the seafloor and are much shorter (usually <2 km [1.2 mi]) than surface longlines (GMFMC, 1981).

Shrimp trawling is one of the most important commercial endeavors in the GOM. However, most of the shrimp grounds lie well inshore of the 200-m (656-ft) isobath. Most trawling for royal red shrimp occurs in water depths of 400 to 500 m (1,312 to 1,641 ft) offshore of Florida, Alabama, and Texas (GMFMC, 1996). The trawling gear used to catch royal red shrimp is very similar to that used to catch shallow-water shrimp. However, all components, including winches, trawl doors, lines, and vessels must be heavier to accommodate the greater depths involved. Golden crab gear consists of rectangular wire mesh traps attached in a series along a weighted mainline (Otwell *et al*., 1984). Most of the Gulf fishing for golden crab occurs offshore of western Florida.

Commercial Landings

Epipelagic fishes comprised most of the value and weight of deepwater landings in the GOM during 1998 (NMFS, 1999c; tables 3-14 and 3-15). Yellowfin tuna represented 55 percent of the value and 47 percent of the weight of all deepwater species landed. Swordfish, dolphin, and wahoo collectively accounted for another 19 percent of the value and 21 percent of the weight. Louisiana and Florida led Gulf coastal states in terms of value and weight of epipelagic species landed, followed by Texas. Alabama and Mississippi reported no landings of epipelagic fishes in 1998 (NMFS, 1999c).

Yellowedge grouper, which accounted for 9.7 percent of the value and 8.8 percent of the weight of deepwater species landed in 1998, dominated reef fish landings (NMFS, 1999c). Two tilefish species and snowy grouper contributed another five percent of the value and seven percent of the weight, respectively, for deepwater species reported in 1998. Most 1998 catches of reef fishes were landed in Louisiana and Florida. Alabama and Texas contributed little to these landings, and Mississippi did not report any deepwater reef fish landings in 1998.

Invertebrate landings for the Gulf Coast waters were restricted to specific states. A majority of the royal red shrimp were landed off Alabama, where total 1998 landings weighed 123.5 metric tons (272,317.5 lbs) and were valued at $586,575 (NMFS, 1999c). Florida and Texas reported only small fractions of this amount during 1998. Florida was the only Gulf Coast state to report catches of golden crab in 1998, landing 133 metric tons (293,265 lbs) valued at $205,000 (NMFS, 1999c).

Table 3-14

Dollar Value of Deepwater Species Landed off Gulf Coast States in 1998

Species	State[a] Alabama	Florida	Louisiana	Texas	Grand Total	Percent
Epipelagic Fish						
Tuna, yellowfin		1,233,884	7,338,444	691,142	9,263,470	55.4
Swordfish		924,546	1,335,696	166,690	2,426,932	14.5
Dolphin		494,432	71,054	5,595	571,081	3.4
Wahoo		67,432	143,740	4,611	215,783	1.3
Tuna, bluefin		7,316	113,605		120,921	0.7
Escolar		21,105	96,643		117,748	0.7
Tuna, bigeye		24,545	71,281		95,826	0.6
Tuna, blackfin		26,374	22,425	5,864	54,663	0.3
Shark, shortfin mako		15,315	32,911		48,226	0.3
Oilfish		11,855	22,332		34,187	0.2
Tuna,unc			23,555		23,555	0.1
Shark, silky		3,177			3,177	0.0
Tuna, albacore			3,079		3,079	0.0
Shark, longfin mako				2,256	2,256	0.0
Shark, thresher		1,055			1,055	0.0
Tuna, skipjack		466			466	0.0
Reef Fishes						
Grouper, yellowedge		1,277,115	254,121	93,160	1,624,396	9.7
Tilefish		269,540	53,062	38,725	361,327	2.2
Grouper, snowy		252,151	14,809		266,960	1.6
Snapper, silk		216,501	3,064		219,565	1.3
Grouper, warsaw		48,663	67,973	35,603	152,239	0.9
Tilefish, blueline		112,586			112,586	0.7
Speckled hind		85,537			85,537	0.5
Snapper, queen		37,801	23,181		60,982	0.4
Brotula, bearded	276	14,799	9,570		24,645	0.1
Barrelfish		6,194			6,194	0.0
Hake, Atlantic, red and white			1,715		1,715	0.0
Tilefish, goldface			1,439		1,439	0.0
Bass, longtail			591		591	0.0
Invertebrates						
Shrimp, royal red	586,575	30,778		5,068	622,421	3.7
Crab, deepsea golden		205,440			205,440	1.2
GRAND TOTAL	586,851	5,388,607	9,704,309	1,048,714	16,728,481	

Source: National Marine Fisheries Service, 1999c.

[a] No landings of deepwater species were reported by Mississippi.

Table 3-15

Weight (metric tons) of Deepwater Species Landed off Gulf Coast States in 1998

Species	States[a] Alabama	Florida	Louisiana	Texas	Grand Total	Percent
Epipelagic Fish						
Tuna, yellowfin		237.6	1,341.8	137.4	1,716.8	47.0
Swordfish		162.1	306.2	41.2	509.5	14.0
Dolphin		157.8	30.7	2.4	190.9	5.2
Wahoo		17	62.6	2	81.6	2.2
Escolar		8.5	51.1		59.6	1.6
Shark, shortfin mako		6.1	35.8		41.9	1.1
Tuna, blackfin		12.4	20.9	2.9	36.2	1.0
Oilfish		4.8	10.1		14.9	0.4
Tuna, bluefin		1.3	12.2		13.5	0.4
Tuna, bigeye		4.4	8.9		13.3	0.4
Tuna,unc			5.7		5.7	0.2
Tuna, albacore			2.6		2.6	0.1
Shark, silky		2.3			2.3	0.1
Shark, longfin mako				1.4	1.4	0.0
Shark, thresher		1			1	0.0
Tuna, skipjack		0.5			0.5	0.0
Reef Fish						
Grouper, yellowedge		252.7	46.2	20.8	319.7	8.8
Tilefish		104.6	17.1	14.4	136.1	3.7
Grouper, snowy		58.9	3.1		62	1.7
Tilefish, blueline		58.5			58.5	1.6
Snapper, silk		46.8	0.7		47.5	1.3
Grouper, warsaw		13.7	15.1	9.9	38.7	1.1
Speckled hind		22.6			22.6	0.6
Snapper, queen		8.5	5.4		13.9	0.4
Brotula, bearded		5.9	4.7		10.6	0.3
Barrelfish		1.7			1.7	0.0
Hake, Atlantic, red and white			0.9		0.9	0.0
Tilefish, goldface			0.6		0.6	0.0
Bass, longtail			0.2		0.2	0.0
Invertebrates						
Shrimp, royal red	123.5	9.7		1.2	134.4	3.7
Crab, deepsea golden		113			113	3.1
GRAND TOTAL	123.5	1,312.4	1,982.6	233.6	3,652.1	

Source: National Marine Fisheries Service, 1999c.

[a] No landings were reported for Mississippi.

Essential Fish Habitat

Regulatory Framework for Essential Fish Habitat (EFH)

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1801-1882) established regional Fishery Management Councils and mandated that Fishery Management Plans (FMPs) be developed to responsibly manage exploited fish and invertebrate species in Federal waters of the U.S. When Congress reauthorized the Act in 1996, several reforms and changes were realized. For example, one change required the NMFS to designate and conserve Essential Fish Habitat (EFH) for species managed under an existing FMP. The intentions of such changes are to minimize, to the extent practicable, any adverse effects on habitat caused by fishing or nonfishing activities and to identify other actions to encourage the conservation and enhancement of such habitat.

The phrase "essential fish habitat" as defined in the Magnuson-Stevens Act encompasses "those waters and substrate necessary to fishes for spawning, breeding, feeding, or growth to maturity." The interim final rules promulgated by the NMFS in 1997 (50 CFR Sections 600.805 - 600.930) further clarify EFH with the following definitions.

- **Waters.** Aquatic areas and their associated physical, chemical, and biological properties that are used by fishes and may include aquatic areas historically used by fishes where appropriate;
- **Substrate.** Sediment, hard bottom, and structures underlying the waters, as well as associated biological communities;
- **Necessary.** Refers to the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and
- **Spawning, breeding, feeding, or growth to maturity.** Refers to stages representing a species' full life cycle.

EFH Presence in the Central and Western GOM

EFH present within the central and western GOM fall under the jurisdiction of the Gulf of Mexico Fishery Management Council (GMFMC). In addition to this regional council, the NMFS Highly Migratory Species Management Division, Office of Sustainable Fisheries, manages Atlantic tunas, swordfish, and sharks within a broad geographic region that encompasses the GOM (NMFS, 1999b). Both documents were reviewed for this characterization and assessment.

The FMP for the GOM was recently amended to address EFH for managed species (GMFMC, 1998). This document was reviewed and has been summarized pertinent to EFH for deepwater portions (i.e., >200 m [656 ft]) of the central and western GOM. The FMP provides maps and tabular information on the geographical distribution of various life stages of managed species.

Table 3-16 lists species and life stages for each EFH that might be present both inshore and beyond water depths of 200 m (656 ft) in the central and western GOM. For each species, the table also indicates whether the habitat for the appropriate life stage is pelagic (i.e., water column), soft bottom benthic, or hard bottom benthic. EFH designations are pending for several species (e.g., royal red shrimp, golden crab, several grouper species) and have been established

Table 3-16

Managed Species for Which Essential Fish Habitat has been Identified in the Central and Western Gulf of Mexico (from Gulf of Mexico Fishery Management Council, 1998; National Marine Fisheries Service, 1999b).

Species	Life Stages (Reproductive Activity)	Habitat and Depth Range(s)
Invertebrates		
Shrimp:		
Brown shrimp	Adults	Soft bottom; <200 m
White shrimp	Adults	Soft bottom; <200 m
Pink shrimp	Adults	Soft bottom; <200 m
***Crabs*:**		
Stone crab	Adults	Hard bottom; <200 m
Fish [a]		
Sharks:		
Blacknose shark (*Carcharhinus acronotus*)	Adults	Pelagic; < 200 m
Silky shark (*Carcharhinus falciformis*)	All life stages	Pelagic; $\geq$200 m
Bull shark (*Carcharhinus leucas*)	All life stages	Pelagic; <200 m
Blacktip shark (*Carcharhinus limbatus*)	All life stages	Pelagic; <200 m
Tiger shark (*Galeocerdo cuvier*)	Adults; Late juveniles/subadults	Pelagic; <200 m
Lemon shark (*Negaprion brevirostris*)	Adults	Pelagic; <200 m
Atlantic sharpnose shark (*Rhizoprionodon terraenovae*)	Adults; Late juveniles/subadults	Pelagic; <200 m
Longfin mako shark (*Isurus paucus*)	All life stages	Pelagic; $\geq$200 m
Bonnethead (*Sphyrna tiburo*)	All life stages	Pelagic; <200 m
Scalloped hammerhead (*Sphyrna lewini*)	Adults	Pelagic; <200 m
Sea basses:		
Red grouper (*Epinephelus morio*)	Adults	Hard bottom; <200 m
Gag (grouper) (*Mycteroperca microlepis*)	Adults	Hard bottom;<200 m
Scamp (*Mycteroperca phenax*)	Adults	Hard bottom; <200 m
Tilefishes:		
Tilefish (*Lopholatilus chamaeleonticeps*)	All life stages	Soft bottom; $\geq$200 m
Cobias:		
Cobia (*Rachycentron canadum*)	All life stages	Pelagic;<200 m

Table 3-16

Managed Species for Which Essential Fish Habitat has been Identified
in the Central and Western Gulf of Mexico
(from Gulf of Mexico Fishery Management Council, 1998;
National Marine Fisheries Service, 1999b).

Species	Life Stages (Reproductive Activity)	Habitat and Depth Range(s)
Jacks:		
Greater amberjack (*Seriola dumerili*)	All life stages	Pelagic/Hard bottom; <200 m; ≥200 m
Dolphins:		
Dolphin (*Coryphaena hippurus*)	All life stages (spawning area)	Pelagic; <200 m; ≥200 m
Snappers:		
Red snapper (*Lutjanus campechanus*)	Adults; juveniles/subadults	Hard bottom; <200 m; ≥200 m
Gray snapper (*Lutjanus griseus*)	Adults	Hard bottom; <200 m
Lane snapper (*Lutjanus synagris*)	Adults	Hard bottom; <200 m
Drums:		
Red drum (*Sciaenops ocellatus*)	Adults	Soft bottom; <200 m
Mackerels:		
Skipjack tuna (*Katsuwonus pelamis*)	All life stages (spawning area)	Pelagic; ≥200 m
King mackerel (*Scomberomorus cavalla*)	Adults	Pelagic; <200 m; ≥200 m
Spanish mackerel (*Scomberomorus maculatus*)	Adults	Pelagic; <200 m
Yellowfin tuna (*Thunnus albacares*)	All life stages (spawning area)	Pelagic; ≥200 m
Bluefin tuna (*Thunnus thynnus*)	Adults; Larvae and eggs (spawning area)	Pelagic; <200 m; ≥200 m
Swordfishes:		
Swordfish (*Xiphias gladius*)	Adults; larvae and eggs (spawning area)	Pelagic; <200 m; ≥200 m
Leatherjackets:		
Gray triggerfish (*Balistes capriscus*)	Adults	Hard bottom; <200 m

[a] Fish species are listed in phylogenetic order.

Note: GMFMC continues to gather information on habitat requirements for managed deepwater species, which are expected to be included under EFH provisions in the near future (e.g., royal red shrimp, *Pleoticus robustus*; golden crab, *Chaceon quinquedens*; yellowedge grouper, *Epinephelus flavolimbatus*; Warsaw grouper, *E. nigritus*; snowy grouper, *E. niveatus*).

for 32 other fish and invertebrate species (GMFMC, 1998). For highly migratory species, EFH was recognized for silky shark, tunas, and swordfish (NMFS, 1999b). For those species with current EFH designations, the three shrimp species, tilefish, and red drum are soft bottom benthic species with variable depth distributions (i.e., shrimp and red drum <200 m [656 ft]; tilefish $\geq$200 m [$\geq$656 ft]). Stone crab, groupers, scamp, gray triggerfish, and snappers are benthic species associated with hard-bottom habitats; depth ranges for these species is typically <200 m (<656 ft); however, red snapper may be found in deeper water. Remaining fish species (e.g., sharks, cobia, mackerels) are pelagic species with varying depth distributions.

3.3.2 Social and Economic Environment

Geographic Considerations

The MMS Western and Central GOM Planning Areas are adjacent to coastal Texas, Louisiana, and Mississippi. An important task in the socioeconomic analysis is selection of meaningful spatial units of analysis. Counties and county equivalents such as the parishes of Louisiana are obvious candidates because they are recognized spatial units that are relatively autonomous in political terms. In socioeconomic terms, however, counties can be less than satisfactory choices because they rarely provide boundaries for socioeconomic behavior. In this analysis, sets of counties were grouped in a very meaningful way: the extent of intercounty commuting patterns. These labor market areas (LMAs) are commuting zones identified by Tolbert and Sizer (1996). County-to-county flows of commuters from the 1990 Census were analyzed with a hierarchical cluster algorithm. The results of the cluster analysis were used to identify 741 commuting zones, or groups of counties, with strong commuting ties. Thirteen commuting zones that span the Gulf Coast from the southern tip of Texas to easternmost Mississippi and Alabama were used in this socioeconomic analysis. The LMAs characterized are Brownsville, Corpus Christi, Victoria, Brazoria, Houston-Galveston, Beaumont-Port Arthur, Lake Charles, Lafayette, Baton Rouge, Houma, New Orleans, Biloxi-Gulfport, and Mobile Bay. The LMAs encompass both the large urban center counties and surrounding hinterland counties, as indicated in figure 3-23. In this way, they represent regional economies bounded by journey-to-work patterns.

3.3.2.1 Oil and Gas

The GOM region exhibits one of highest concentrations of oil and gas activity in the world. Given the dynamic and often volatile nature of oil and gas exploration and development activities, oil and gas consumption rates, and international politics and finance, the domestic oil and gas industry has realized moderate to severe fluctuations over the past several decades. EISs developed for several recent MMS lease sales for the central and western Gulf region provide abbreviated, concise synopses of historical trends in mobile rig utilization, leased acreage, and oil and gas wellhead prices for the period 1974 to 1995, as well as OCS oil and gas production figures for offshore Texas and Louisiana for the period 1954 to 1995 (USDOI, MMS, 1997b, 1998b). At present, industry streamlining (e.g., company reorganization, corporate acquisitions) coupled with royalty relief and new exploration and extraction technologies has resulted in renewed interest in offshore reserves. Most of the recent offshore activity has occurred off the

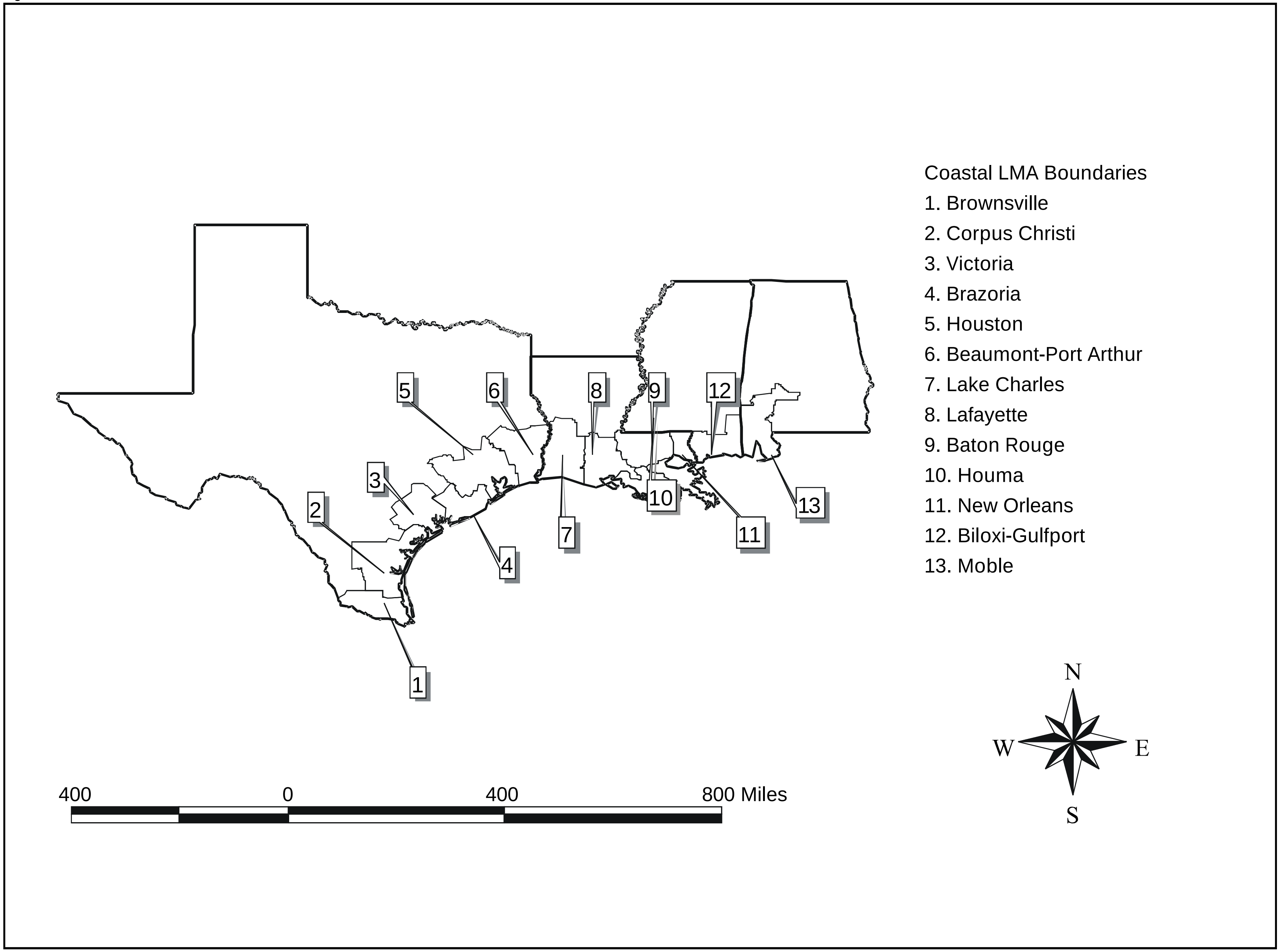

Figure 3-23 GULF COAST LABOR MARKET AREAS.

coasts of Texas and Louisiana, while it is projected that most of the future activity will occur in deeper OCS waters (e.g., >300 m [984 ft]) throughout the GOM (USDOI, MMS, 2000b).

The high level of oil and gas activity on the OCS and nearshore state or territorial waters is supported by an extensive network of onshore support and service facilities. Refining, separation, and processing facilities are present to handle natural gas and crude oil produced offshore or tankered into Gulf Coast ports or via LOOP. Offshore infrastructure includes oil and gas platforms, pipelines, and terminals, which route their production to onshore facilities. Support facilities include pipecoating and storage yards, support bases and airports, and platform and ship fabrication yards. It is expected that future deepwater operations (including FPSOs) will utilize, to the greatest extent possible, the existing infrastructure of support and service facilities, as well as the extensive onshore transport, refining, and processing capabilities of the Gulf Coast region.

3.3.2.2 Population, Labor, and Employment

The following section summarizes past historical trends in population, labor, and employment for the Gulf Coast region of interest (i.e., Alabama, Louisiana, Mississippi, Texas), with an emphasis on descriptions and socioeconomic profiles of the 13 LMAs. Consideration is also given to regional trends as a basis for comparison. The historical discussion of population, labor, and employment is followed by an analysis of future projections for these socioeconomic components for the 2000 to 2020 time period.

Table 3-17 provides a basic population overview since the 1970 decennial population census for the 13 LMAs employed in the current analysis. The bottom row of the table presents total population figures for the Gulf Coast region. This is an area that saw a 27 percent population increase between 1970 and 1980. This was followed by much more modest increase of 10 percent between 1980 and 1990. Since the 1990 decennial census, the Bureau of the Census estimates that the region's population had grown 13 percent as of 1998, yielding a total of nearly 11 million persons. Table 3-17 also shows overall population figures for the 13 LMAs along the Gulf Coast. The areas exhibiting the most growth across the period are Brownsville, Brazoria, and Houston-Galveston. Much of this growth is driven by expansion of the Hispanic population in these areas. Other labor market areas exhibit slower growth; some even show population declines between 1980 and 1990. This coincides with a major contraction in oil and gas industry activity along the Gulf Coast. As the activity began to pick up again in the 1990s, population expansion resumed yet again in the region.

Table 3-18 provides a general socioeconomic profile of the Gulf Coast region as a whole, outlining age structure, race and ethnic composition, education, and employment by industrial sector and occupational group. In the U.S., it is typically the case that population age structures reflect the prevailing presence of the Baby Boom generation. This is only somewhat the case for the Gulf Coast region. Population growth has kept the lower age groups relatively constant in size. While some aging of the population structure is evident, the increase from 1980 to 1990 in the youngest cohort (i.e., ages 0 to 5) suggests that further growth is in the offing for the area.

A more distinctive trend is the changing race and ethnic composition of the region, which has a longstanding tradition of cultural heterogeneity (Freudenburg and Gramling, 1994). While the African-American population has remained relatively constant over time, the Hispanic population nearly doubled (11 percent in 1970 versus 19 percent in 1990), and the white population declined by nearly 10 percent. In terms of education, the region has exhibited a

Table 3-17

Decennial Census Population Figures and Percent Change for Coastal Commuting Zones

Coastal Commuting Zone	1970	1980	Percent Change	1990	Percent Change	1998	Percent Change
Brownsville	355,180	537,717	51.4	701,888	30.5	924,181	31.7
Corpus Christi	389,905	441,121	13.1	465,297	5.5	511,342	9.9
Victoria	125,896	144,833	15.0	149,963	3.5	162,403	8.3
Brazoria	172,954	247,657	43.2	268,590	8.5	308,433	14.8
Houston-Galveston	2,112,332	3,001,402	42.1	3,601,782	20.0	4,251,578	18.0
Beaumont-Port Arthur	409,262	460,162	12.4	453,230	-1.5	493,961	9.0
Lake Charles	280,639	313,284	11.6	321,386	2.6	328,434	2.2
Lafayette	407,042	476,339	17.0	496,579	4.2	535,059	7.7
Baton Rouge	533,221	672,081	26.0	709,562	5.6	770,723	8.6
Houma	225,396	263,213	16.8	263,681	0.2	274,047	3.9
New Orleans	1,186,117	1,348,007	13.6	1,328,455	-1.5	1,352,504	1.8
Biloxi-Gulfport	296,851	368,852	24.3	388,725	5.4	440,657	13.4
Mobile	435,958	502,814	15.3	534,425	6.3	591,388	10.7
Total	6,930,753	8,777,482	26.6	9,683,563	10.3	10,944,710	13.0

Table 3-18

General Socioeconomic Profile of the Gulf Coast Region

Gulf Coast Summary	1970	1980	1990	1998
Population	6,494,795	8,274,668	9,149,138	10,944,710
Age Structure (%)				
0 - 5	9.5	8.6	9.9	
6 - 15	22.5	17.5	16.5	
16 - 17	6.2	5.6	3.1	
18 - 24	11.7	13.7	10.3	
25 - 34	12.7	17.6	17.9	
35 - 44	11.5	11.3	15.2	
45 - 54	10.4	9.5	9.9	
55 - 64	8.0	7.9	7.6	
65 +	7.4	8.3	9.6	
Race and Ethnic Composition (%)				
African American	21.3	20.7	20.7	
Hispanic	10.8	14.7	18.8	
White	68.0	64.7	60.5	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	34.3	22.3	15.4	
9 - 11 years schooling	20.7	16.2	16.2	
High School graduates	24.8	30.0	29.0	
13 -15 years schooling	10.0	15.4	19.9	
College graduates	10.2	16.2	19.5	
Labor Force Size				
Civilian	2,404,436	3,759,135	4,115,971	
Military	59,969	37,350	43,269	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	6.4	7.4	5.1	
Construction	8.3	11.4	7.7	
Business Services	3.2	5.2	5.2	
Communications, Utilities	3.1	3.5	2.9	
Nondurable Manufacturing	17.0	19.2	13.7	
Durable Manufacturing	7.7	9.6	6.3	
Finance, Insurance, Real Estate	4.3	6.3	6.0	
Services	12.8	13.4	13.3	
Wholesale, Retail Trade	20.2	24.0	22.1	
Transportation	4.2	5.9	4.7	
Employment by Occupation Group (%)				
Management, Professional	10.3	12.1	14.1	
Technical	1.8	4.0	4.9	
Sales	8.6	12.7	15.3	
Clerical	19.2	19.9	19.0	
Precision Craft	18.1	19.4	15.6	
Operative, Transportation	12.7	8.0	6.2	
Service, except household	16.1	14.1	16.4	
Farming, Fishing, Forestry	3.1	2.5	2.6	
Household Service	3.2	1.0	0.9	
Laborers	7.0	6.3	5.1	

steady upgrading of skill levels, such that the number persons having attended or graduated from college doubled between 1970 and 1990.

The civilian labor force in the region expanded substantially from 1970 to 1980 and more modestly from 1980 to 1990. The largest industry sectors in terms of employment are services and wholesale/retail trade. The most notable change in the occupation distribution is the increased share for management and professional occupations. These overall trends vary substantially from one labor market area to another. Profiles for each coastal LMA are analyzed in the following sections.

Brownsville Labor Market Area

Situated with its sister city Matamoros, Mexico, in the rich, agricultural area known as the Rio Grande Valley, Brownsville developed in the early part of this century as a major processing and shipping point for agricultural products (figure 3-23). More recently, with the impetus of NAFTA, it has become a growth center for manufacturing employment.

As indicated in table 3-19, the Brownsville area has nearly tripled in population since 1970. Its age structure reflects a robust, growing area with youthful cohorts of constant sizes. Distinctive in its racial and ethnic composition, Brownsville has the lowest proportion of African-American residents of any of the coastal LMAs in this analysis. Moreover, as the only border area, it has by far the highest Hispanic proportion. The Brownsville population exhibits lower education levels than other coastal LMAs. Yet, its labor force more than doubled between 1970 and 1990. While the largest industrial sectors across time are wholesale/retail trade and services, the manufacturing sector shows absolute growth from 1970 to 1990, which has been vastly accelerated since with the advent of free trade in the 1990s. Over this same period, manufacturing employment declined substantially on a national basis and to a certain extent across the Gulf Coast area.

Net migration estimates have been derived from Bureau of the Census county data on population estimates, births, and deaths. Combining this information provides an estimate of net migration for the Gulf Coast LMAs. Figure 3-24 depicts these estimates for the Brownsville LMA. As the fastest growing of the coastal LMAs, Brownsville exhibits positive net migration throughout the 1970 to 1998 period. Obviously, many more persons are moving into the area than are leaving.

Corpus Christi Labor Market Area

The largest city directly on the Texas Gulf Coast, Corpus Christi, developed as a processing and distribution point for agricultural products (figure 3-23). Just offshore is Padre Island, the longest barrier island off the U.S. and a major tourist attraction.

Table 3-20 provides a socioeconomic profile of the Corpus Christi labor market area, which has a population of more than one-half million according to 1998 estimates. In terms of racial and ethnic composition, this south-Texas area exhibited a 10 percent increase in its Hispanic population from 1970 to 1990. Conversely, the white population declined by 11 percent over the same period. Education attainment in this area by 1990 was slightly below overall Gulf Coast region education levels. By the end of the 20-year period, the decennial census data show the labor force approaching 200,000. Employment by industry sector in Corpus Christi parallels that of the overall Gulf Coast region except that local manufacturing

Table 3-19

Socioeconomic Profile of the Brownsville Labor Market Area

Brownsville Labor Market Area	1970	1980	1990	1998
Population	355,180	537,717	701,888	924,181
Age Structure (%)				
0 - 5	10.9	10.4	11.1	
6 - 15	25.8	22.0	20.9	
16 - 17	7.4	6.5	4.3	
18 - 24	10.9	11.8	11.2	
25 - 34	10.0	14.5	14.6	
35 - 44	10.4	9.4	12.8	
45 - 54	9.0	8.6	8.1	
55 - 64	7.5	7.4	6.9	
65 +	8.1	9.3	10.0	
Race and Ethnic Composition (%)				
African American	0.2	0.2	0.2	
Hispanic	42.0	49.4	52.3	
White	57.8	50.4	47.5	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	57.3	48.1	41.4	
9 - 11 years schooling	11.1	10.7	13.3	
High School graduates	16.5	19.3	20.2	
13 -15 years schooling	7.9	11.5	13.4	
College graduates	7.2	10.3	11.7	
Labor Force Size				
Civilian	100,435	180,414	225,208	
Military	338	435	406	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	17.9	13.6	7.8	
Construction	6.4	8.4	6.3	
Business Services	2.7	4.3	4.8	
Communications, Utilities	3.1	3.3	2.1	
Nondurable Manufacturing	8.6	15.8	11.2	
Durable Manufacturing	1.8	5.9	4.5	
Finance, Insurance, Real Estate	3.1	5.1	4.4	
Services	11.8	16.1	14.9	
Wholesale, Retail Trade	26.3	29.5	25.1	
Transportation	2.9	3.9	3.5	
Employment by Occupation Group (%)				
Management, Professional	10.4	9.1	10.2	
Technical	0.5	2.3	2.6	
Sales	8.6	13.2	15.9	
Clerical	15.3	16.9	16.9	
Precision Craft	12.2	14.9	12.8	
Operative, Transportation	12.6	10.0	8.1	
Service, except household	13.7	15.4	17.9	
Farming, Fishing, Forestry	16.6	10.1	8.0	
Household Service	2.4	1.1	1.2	
Laborers	7.6	7.0	6.3	

Table 3-20

Socioeconomic Profile of the Corpus Christi Labor Market Area

Corpus Christi Labor Market Area	1970	1980	1990	1998
Population	389,905	441,121	465,297	511,342
Age Structure (%)				
0 - 5	9.6	9.2	9.9	
6 - 15	23.1	18.3	17.4	
16 - 17	6.6	5.9	3.2	
18 - 24	12.5	13.3	9.9	
25 - 34	11.8	16.0	16.5	
35 - 44	11.2	10.4	14.2	
45 - 54	10.3	9.6	9.8	
55 - 64	8.0	8.3	8.3	
65 +	6.8	9.0	10.7	
Race and Ethnic Composition (%)				
African American	2.6	2.5	2.5	
Hispanic	29.1	36.8	40.6	
White	68.3	60.7	56.9	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	37.3	29.2	20.2	
9 - 11 years schooling	18.1	15.5	16.5	
High School graduates	24.3	26.5	26.3	
13 -15 years schooling	10.9	15.5	21.1	
College graduates	9.4	13.3	15.9	
Labor Force Size				
Civilian	128,670	179,121	185,443	
Military	7,573	4,066	3,079	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	11.3	12.0	7.6	
Construction	9.2	11.9	9.0	
Business Services	3.3	5.1	4.9	
Communications, Utilities	3.6	3.9	3.1	
Nondurable Manufacturing	10.0	13.3	9.3	
Durable Manufacturing	4.0	5.8	3.1	
Finance, Insurance, Real Estate	4.3	6.0	5.1	
Services	14.8	15.8	16.8	
Wholesale, Retail Trade	22.5	25.3	22.6	
Transportation	3.4	4.4	3.8	
Employment by Occupation Group (%)				
Management, Professional	10.8	10.7	11.6	
Technical	1.4	3.4	4.0	
Sales	8.2	11.8	14.3	
Clerical	17.9	18.3	17.0	
Precision Craft	18.2	20.8	18.2	
Operative, Transportation	10.8	6.6	4.7	
Service, except household	17.0	15.8	19.8	
Farming, Fishing, Forestry	4.9	4.0	3.8	
Household Service	3.6	1.3	1.2	
Laborers	7.1	7.1	5.2	

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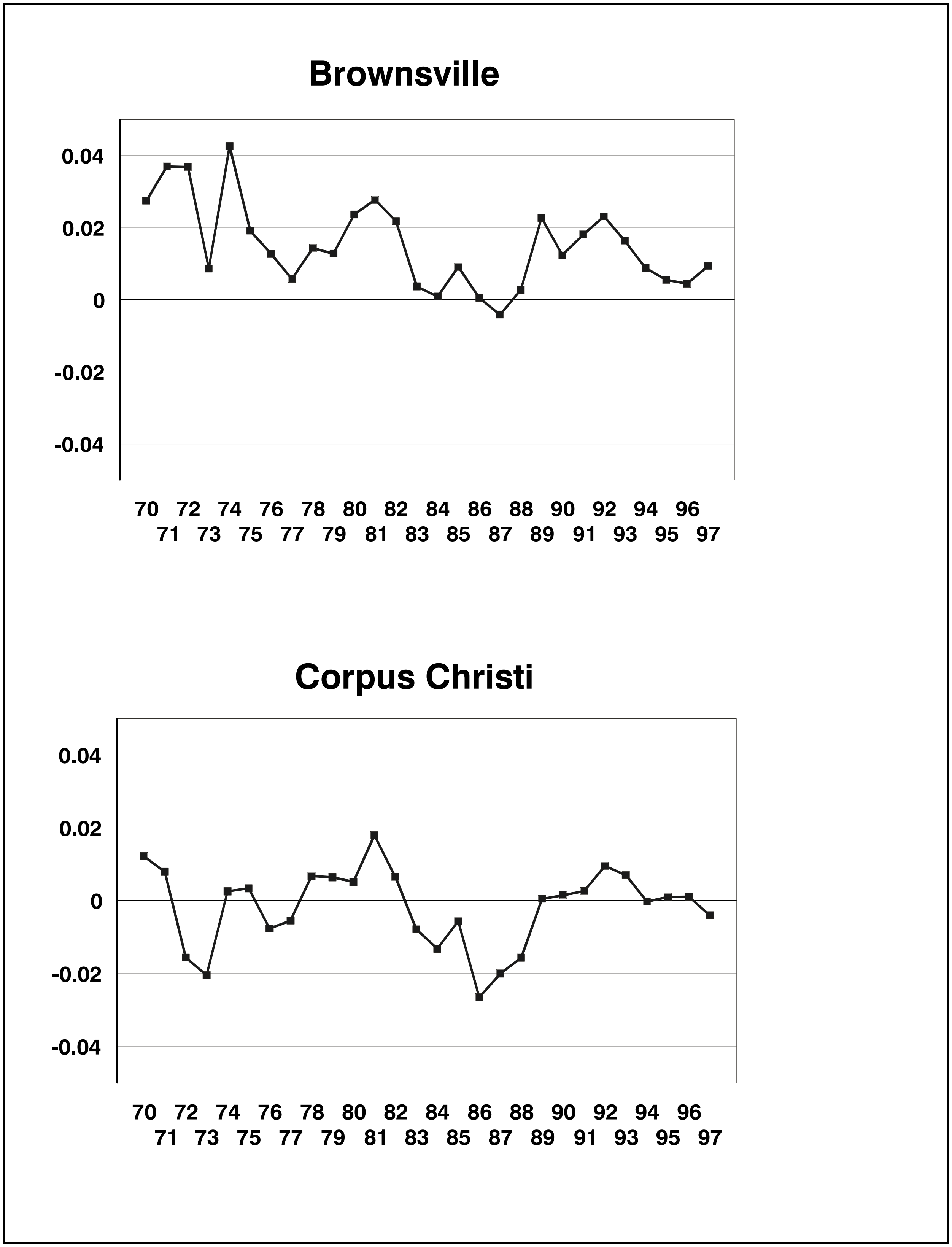

Figure 3-24 NET MIGRATION PATTERNS FOR BROWNSVILLE AND CORPUS CHRISTI, TEXAS 1970-1997.

employment is somewhat lower. Occupational distributions, however, show a higher share of precision craft and skilled jobs in Corpus Christi.

Figure 3-24 displays net migration data for the Corpus Christi labor market area. Two periods of negative net migration (i.e., more out-migration than in-migration) are evident. One occurred very early on in the 1970s. The other and more protracted episode of negative net migration occurred between 1982 and 1988, coincident with a major contraction in oil and gas industry activity along the Gulf Coast. The Corpus Christi area clearly recovered, as values are mostly positive since 1989.

Victoria Labor Market Area

Like its neighboring labor market areas to the south, Victoria has a rich cultural tradition rooted in its proximity to Mexico (figure 3-23). Modern Victoria, however, adds to this Hispanic influence a growing petrochemical industry presence. Coupled with the development of these industries is development of the deepwater port at Port Lavaca-Point Comfort and highway expansion.

The socioeconomic profile of the Victoria labor market area in table 3-21 puts the estimated 1998 population at just over 160,000. The higher age intervals indicate that the population of the area is older on average than is the norm for the balance of the Gulf Coast labor market areas (e.g., compare to table 3-18). Barring new substantial in-migration, this portends a slower rate of growth in the near-term for the Victoria labor market area.

The Victoria area's racial composition is also somewhat at variance with the typical composition of the Gulf Coast labor market areas. Though strikingly constant over time, the percent of African-American residents is lower than the overall coastal figures. The percentage of Hispanic residents is higher than the norm, as is the percentage of white residents. A relatively larger agriculture, forestry, and mining sector is evident, though it has declined somewhat over time. The largest occupational group at all decennial census time points is precision craft. This signals the importance of skilled, blue-collar employment in the local economy.

As figure 3-25 indicates, net migration into the Victoria labor market area was generally positive from 1970 through 1997. The mid-1980s represent a clear exception, however, as negative values were apparent from 1982 through 1988. Like Corpus Christi, these migration data show a shift that coincides with an episode of contraction in the oil and gas industry.

Brazoria Labor Market Area

The Brazoria labor market area encompasses a local economy driven by the petrochemical industry. Situated between the Houston area and the less densely populated Victoria labor market area (figure 3-23), the Brazoria area serves as a transition to the highly urbanized labor markets of southeast Texas.

A socioeconomic profile of the Brazoria labor market area can be found in table 3-22. Brazoria was a high-growth area over the 1970 to 1998 period relative to most other coastal labor market areas. Its age structure mirrors the overall age structure for the coastal region (e.g., compare to table 3-18). Table 3-22 shows that the racial and ethnic composition of Brazoria exhibits fewer African-Americans and more whites than the typical coastal labor market area, while Brazoria's education levels typify the Gulf Coast region. Indicative of the presence of the

Table 3-21

Socioeconomic Profile of the Victoria Labor Market Area

Victoria Labor Market Area	1970	1980	1990	1998
Population	125,896	144,833	149,963	162,403
Age Structure (%)				
0 - 5	8.3	8.3	9.2	
6 - 15	22.3	16.6	16.6	
16 - 17	6.2	5.5	3.1	
18 - 24	9.1	12.0	7.9	
25 - 34	10.7	14.9	15.1	
35 - 44	11.1	10.3	14.2	
45 - 54	11.3	9.9	10.1	
55 - 64	9.7	9.7	9.2	
65 +	11.3	12.6	14.6	
Race and Ethnic Composition (%)				
African American	7.1	6.4	6.1	
Hispanic	18.6	22.4	24.7	
White	74.3	71.2	69.2	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	43.2	31.7	19.9	
9 - 11 years schooling	19.6	17.9	18.0	
High School graduates	21.9	27.5	31.0	
13 -15 years schooling	8.1	12.9	18.8	
College graduates	7.1	10.1	12.3	
Labor Force Size				
Civilian	44,175	62,514	62,741	
Military	222	43	125	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	13.7	14.9	10.7	
Construction	8.7	12.9	8.7	
Business Services	2.4	3.1	4.0	
Communications, Utilities	3.1	3.2	2.9	
Nondurable Manufacturing	16.3	18.6	15.8	
Durable Manufacturing	6.3	8.4	5.7	
Finance, Insurance, Real Estate	3.2	4.7	5.1	
Services	13.8	13.9	14.0	
Wholesale, Retail Trade	19.9	23.8	21.6	
Transportation	2.2	3.2	2.9	
Employment by Occupation Group (%)				
Management, Professional	8.2	8.3	9.6	
Technical	1.5	3.5	4.2	
Sales	7.0	11.8	14.4	
Clerical	13.2	14.8	15.1	
Precision Craft	18.4	24.0	19.3	
Operative, Transportation	15.4	8.5	7.8	
Service, except household	16.5	14.5	16.7	
Farming, Fishing, Forestry	9.5	6.5	6.7	
Household Service	3.9	1.4	1.0	
Laborers	6.5	6.7	5.2	

Table 3-22

Socioeconomic Profile of the Brazoria Labor Market Area

Brazoria Labor Market Area	1970	1980	1990	1998
Population	172,954	247,657	268,590	308,433
Age Structure (%)				
0 - 5	9.4	8.3	10.1	
6 - 15	21.6	16.8	15.7	
16 - 17	6.0	5.2	2.9	
18 - 24	11.4	13.8	10.3	
25 - 34	14.3	20.2	19.9	
35 - 44	12.4	12.4	16.7	
45 - 54	10.7	9.5	10.1	
55 - 64	7.7	7.2	6.9	
65 +	6.5	6.5	7.4	
Race and Ethnic Composition (%)				
African American	11.9	9.4	9.4	
Hispanic	9.7	14.6	18.0	
White	78.4	76.0	72.7	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	31.3	21.0	13.0	
9 - 11 years schooling	21.7	18.4	16.6	
High School graduates	26.8	30.9	31.1	
13 -15 years schooling	11.1	17.0	24.1	
College graduates	9.1	12.7	15.2	
Labor Force Size				
Civilian	62,604	111,721	118,376	
Military	111	84	179	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	11.2	9.4	6.3	
Construction	11.1	18.1	10.1	
Business Services	2.9	4.6	4.4	
Communications, Utilities	2.4	3.0	4.1	
Nondurable Manufacturing	21.6	24.3	20.8	
Durable Manufacturing	5.3	7.2	6.3	
Finance, Insurance, Real Estate	2.6	3.9	4.1	
Services	12.9	12.3	12.9	
Wholesale, Retail Trade	17.3	20.2	19.6	
Transportation	2.6	3.7	3.6	
Employment by Occupation Group (%)				
Management, Professional	8.7	9.0	11.5	
Technical	2.5	4.5	5.8	
Sales	5.5	10.4	11.8	
Clerical	14.2	15.8	17.0	
Precision Craft	21.8	26.7	21.1	
Operative, Transportation	14.7	9.2	7.1	
Service, except household	15.6	13.1	15.5	
Farming, Fishing, Forestry	6.5	4.3	4.1	
Household Service	3.5	0.9	0.7	
Laborers	7.0	6.1	5.4	

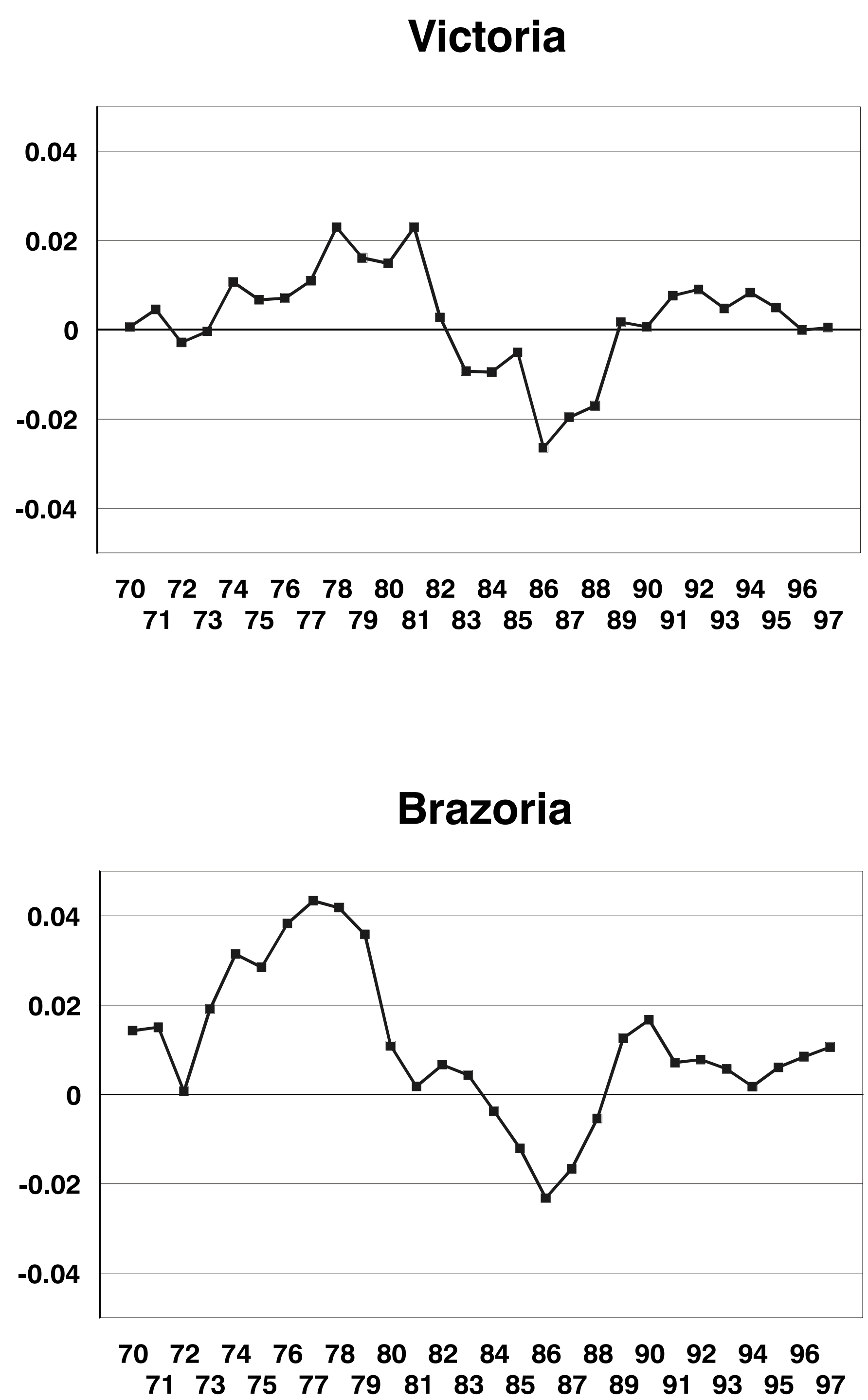

Figure 3-25 NET MIGRATION PATTERNS FOR VICTORIA AND BRAZORIA, TEXAS 1970-1997.

petrochemical industry, the Brazoria market has a much higher share (20 percent in 1990) of nondurable manufacturing workers than is generally the case for the Gulf Coast (13 percent). Further, there is a corresponding larger share of precision craft jobs.

Like the Victoria labor market area, net migration in the Brazoria labor market shows clear out-migration during the oil and gas industry downturn of the mid-1980s (figure 3-25). Prior to that, and unlike Victoria, Brazoria showed high in-migration that peaked about 1976, followed by out-migration from 1984 to 1987. Positive net migration resumed in 1988 and continued through the data series.

Houston-Galveston Labor Market Area

The Houston-Galveston labor market area (figure 3-23) has by far the largest population of any of the Gulf Coast labor markets, as reflected in table 3-17. With the exception of the Brownsville area, Houston-Galveston also exhibits the highest rate of population growth. Though the local economy was driven for much of this century by industries related to oil and gas exploration and production, the economy has diversified recently. Emerging sectors include high technology (e.g., National Aeronautics and Space Administration), medical research and health care delivery, and international exporting and importing. Recent data indicates that the Port of Houston ranks as high as eighth in global shipping tonnage and leads all U.S. ports in international tonnage.

Table 3-23 provides a socioeconomic profile for the Houston-Galveston labor market area. Because this labor market represents nearly one-half of the coastal population being analyzed, any departures from the overall trend indicate distinctive aspects of the Houston-Galveston area. The core of the population age structure is in the middle years of the local distribution. This is especially evident in a comparison of the 55 and over age groups for Houston-Galveston (i.e., 14 percent of the population) and for the combined coastal labor market areas (i.e., 19 percent). This younger population structure should fuel continued growth.

The racial and ethnic composition of the Houston labor market area, however, does more closely parallel the overall coastal makeup. With respect to education levels, Houston-Galveston diverges from the coastal norm to some extent. This is especially apparent among individuals with some college and those who are college graduates. Major industrial sectors in the Houston-Galveston area largely parallel those of the coast as a whole. In terms of occupation groups, the area shows a higher percentage of management and professional occupations, especially in 1980 and 1990. This reflects the centralization of headquarter operations, the expansion of the massive medical center complex, and the development of opportunities for engineers, scientists, and technical personnel.

It is expected that a major metropolitan area with a robust growth rate would exhibit positive net migration in most years. The Houston-Galveston labor market area is no exception, as reflected in figure 3-26. Only five years out of 27 show negative net migration. Those years reflect the now familiar pattern observed in other coastal labor market areas: a sharp downturn coinciding with a contraction in the oil and gas industry. For Houston, however, the recovery was striking, and an upward trend in 1990s was a distinctive feature.

Table 3-23

Socioeconomic Profile of the Houston-Galveston Labor Market Area

Houston-Galveston Labor Market Area	1970	1980	1990	1998
Population	2,112,332	3,001,402	3,601,782	4,251,578
Age Structure (%)				
0 - 5	9.4	8.3	10.1	
6 - 15	21.6	16.8	15.7	
16 - 17	6.0	5.2	2.9	
18 - 24	11.4	13.8	10.3	
25 - 34	14.3	20.2	19.9	
35 - 44	12.4	12.4	16.7	
45 - 54	10.7	9.5	10.1	
55 - 64	7.7	7.2	6.9	
65 +	6.5	6.5	7.4	
Race and Ethnic Composition (%)				
African American	18.6	17.8	17.3	
Hispanic	8.5	13.5	19.2	
White	73.0	68.7	63.5	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	26.1	15.5	11.8	
9 - 11 years schooling	23.3	15.4	14.7	
High School graduates	24.4	29.0	25.4	
13 -15 years schooling	12.6	18.4	22.5	
College graduates	13.5	21.7	25.7	
Labor Force Size				
Civilian	845,504	1,491,443	1,739,758	
Military	2,930	1,801	2,896	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	3.9	6.0	4.6	
Construction	8.3	11.5	8.1	
Business Services	3.9	6.1	6.1	
Communications, Utilities	2.9	3.4	2.8	
Nondurable Manufacturing	17.8	19.7	13.2	
Durable Manufacturing	9.6	11.7	6.9	
Finance, Insurance, Real Estate	5.0	7.2	6.9	
Services	11.5	11.3	12.2	
Wholesale, Retail Trade	20.1	23.2	21.8	
Transportation	4.2	5.9	5.0	
Employment by Occupation Group (%)				
Management, Professional	10.4	14.3	16.8	
Technical	2.2	4.6	5.4	
Sales	9.9	13.3	15.7	
Clerical	22.4	22.2	19.9	
Precision Craft	18.0	18.4	14.3	
Operative, Transportation	11.9	7.4	5.3	
Service, except household	15.3	12.3	15.4	
Farming, Fishing, Forestry	1.2	1.2	1.5	
Household Service	2.6	0.8	0.9	
Laborers	6.2	5.5	4.9	

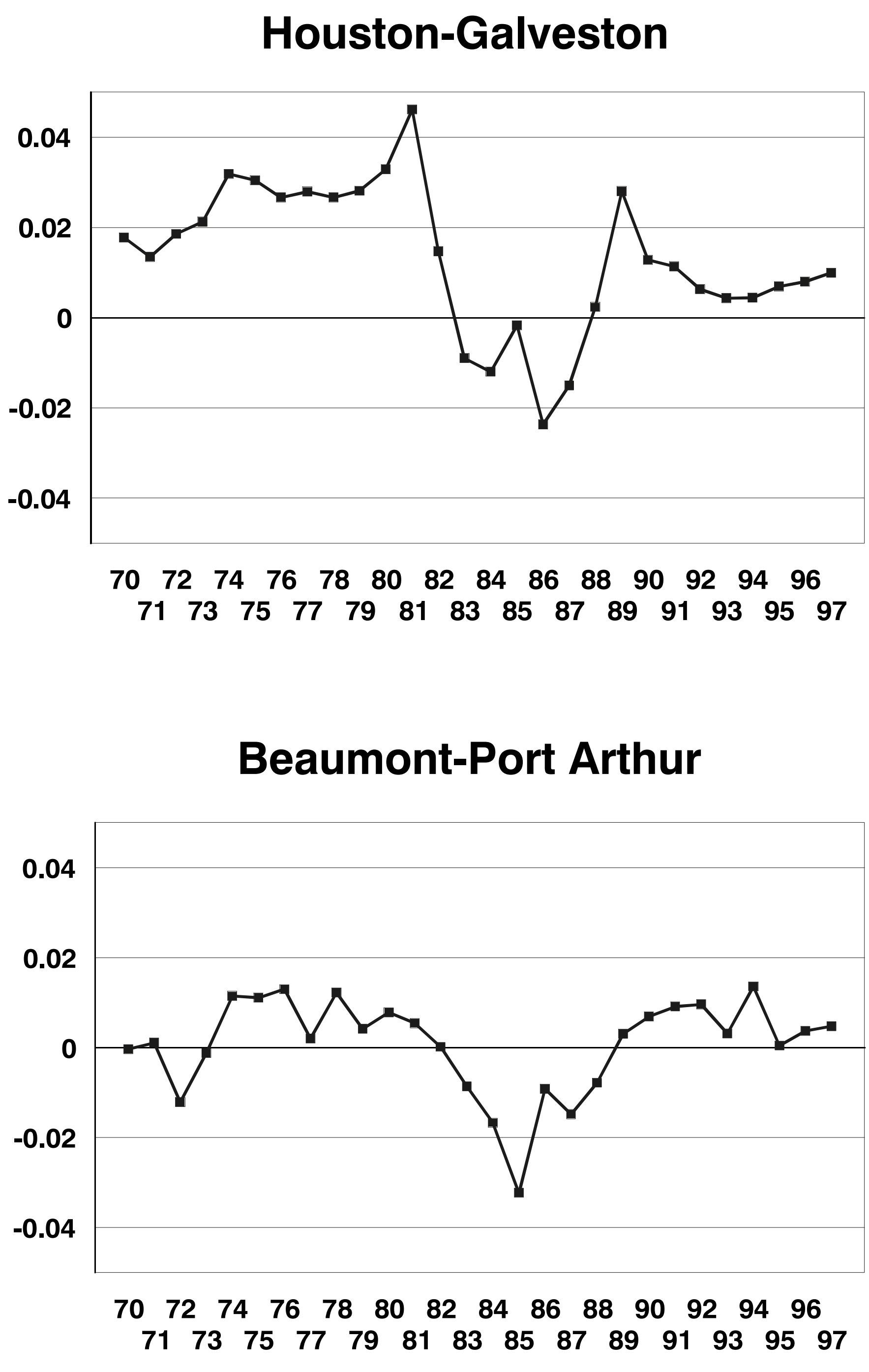

Fig. 3-26. Net migration patterns for Houston-Galveston and Beaumont-Port Arthur, Texas 1970-1997.

Beaumont-Port Arthur Labor Market Area

The Beaumont-Port Arthur area (figure 3-23) is one of only two labor markets to show a decline in population between 1980 and 1990 (table 3-17). Since 1990, however, population estimates indicate a substantial rebound in growth. The nearby Spindletop oilfield dates to 1901, signaling a longstanding presence of the oil and gas industry in the area. Today, industrial employment is anchored by large petrochemical and refining operations. Beaumont also has one of the busiest Texas ports as measured by shipping tonnage. Industrial diversification is also evident in newer plants specializing in precision manufacturing and medical equipment. This latter development is undoubtedly reflected in population growth since 1990.

A socioeconomic profile of the Beaumont-Port Arthur labor market area is contained in table 3-24. Age structure information indicates that this area has a relatively older population relative to the norm for all coastal areas (e.g., compare to table 3-18). While this suggests that natural population growth will slow in the years to come, such a reduction in growth can be offset by in-migration to the area.

The racial and ethnic composition of the Beaumont-Port Arthur area includes fewer Hispanics than is typically the case in Gulf Coast labor market areas. Local education levels are slightly higher than average for the coastal region, especially in terms of high school graduates. Manufacturing employment for this labor area is distinctive by Gulf Coast standards. Both nondurable and durable manufacturing sectors show larger shares of the Beaumont-Port Arthur labor market area than elsewhere along the coast. Similarly, there are more precision craft workers locally than observed at nearly all other Gulf Coast labor market areas (table 3-24).

Figure 3-26 shows net migration in and out of the Beaumont-Port Arthur area since the early 1970s. Most years show more in-migration than out-migration, with the usual exception of the mid-1980s. The rebound in migration is especially strong after 1990.

Lake Charles Labor Market Area

Lake Charles, a major petrochemical center in coastal Louisiana (figure 3-23), has experienced only modest growth since 1980, as reflected in table 3-17. As most other coastal labor markets were recovering from twin downturns in the chemical and oil and gas industries, Lake Charles experienced closure of a major Boeing manufacturing facility in 1992. That loss has since been ameliorated by the addition of another large aerospace concern.

As the socioeconomic profile in table 3-25 indicates, the Lake Charles labor market area’s age structure closely parallels the overall age distribution of the Gulf Coast region. The racial and ethnic composition exhibits proportionately fewer Hispanics and more whites than is the coastal norm. The industrial composition of the Lake Charles area is also distinctive in terms of somewhat higher manufacturing employment. Similarly, Lake Charles has a higher share of precision craft production occupations than do other coastal labor market areas (table 3-25).

The Lake Charles labor market area is also distinctive in the extent of out-migration since 1970, where negative net migration is evident for more than half of the years in the data series (figure 3-27). Further, migration patterns for this area are more volatile than most other coastal labor market areas. Of particular importance are the episodes of out-migration that do not correspond to the oil and gas industry downturn in the mid 1980s.

Table 3-24

Socioeconomic Profile of the Beaumont-Port Arthur Labor Market Area

Beaumont-Port Arthur Labor Market Area	1970	1980	1990	1998
Population	409,262	460,162	453,230	493,961
Age Structure (%)				
0 - 5	8.3	8.0	8.7	
6 - 15	22.0	16.5	15.8	
16 - 17	6.0	5.4	3.0	
18 - 24	10.3	12.4	8.7	
25 - 34	11.2	15.1	15.4	
35 - 44	12.1	10.8	13.7	
45 - 54	11.6	10.7	10.6	
55 - 64	9.5	9.9	10.0	
65 +	9.1	11.2	14.0	
Race and Ethnic Composition (%)				
African American	20.6	20.8	21.8	
Hispanic	3.0	3.0	3.8	
White	76.4	76.2	74.4	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	30.8	19.9	11.8	
9 - 11 years schooling	26.0	20.3	18.7	
High School graduates	26.0	33.6	36.5	
13 -15 years schooling	9.2	14.9	19.9	
College graduates	8.1	11.3	13.2	
Labor Force Size				
Civilian	143,269	186,611	179,825	
Military	790	324	517	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	3.4	3.7	2.7	
Construction	7.6	10.6	8.3	
Business Services	2.5	3.9	4.5	
Communications, Utilities	3.0	4.1	3.7	
Nondurable Manufacturing	27.1	29.4	19.3	
Durable Manufacturing	8.8	11.4	7.0	
Finance, Insurance, Real Estate	2.9	4.6	4.0	
Services	12.4	13.9	14.4	
Wholesale, Retail Trade	18.4	23.0	21.5	
Transportation	3.4	5.4	4.3	
Employment by Occupation Group (%)				
Management, Professional	8.8	9.0	10.9	
Technical	1.9	3.9	4.9	
Sales	7.8	12.2	14.0	
Clerical	15.7	16.1	17.1	
Precision Craft	22.6	24.0	19.4	
Operative, Transportation	15.5	9.7	7.4	
Service, except household	15.6	14.8	17.6	
Farming, Fishing, Forestry	1.1	1.8	2.2	
Household Service	2.8	0.9	0.7	
Laborers	8.2	7.7	5.8	

Table 3-25

Socioeconomic Profile of the Lake Charles Labor Market Area

Lake Charles Labor Market Area	1970	1980	1990	1998
Population	280,639	313,284	321,386	328,434
Age Structure (%)				
0 - 5	8.9	9.0	10.0	
6 - 15	21.4	17.1	16.6	
16 - 17	6.2	5.7	3.1	
18 - 24	17.6	15.5	11.7	
25 - 34	11.4	15.7	17.3	
35 - 44	10.6	10.6	13.7	
45 - 54	9.4	9.4	9.3	
55 - 64	7.5	8.1	8.2	
65 +	7.0	8.8	10.1	
Race and Ethnic Composition (%)				
African American	18.6	19.6	20.7	
Hispanic	1.6	2.0	2.1	
White	79.8	78.3	77.3	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	37.5	24.8	15.1	
9 - 11 years schooling	18.1	18.6	16.7	
High School graduates	28.7	33.3	37.5	
13 -15 years schooling	7.8	11.8	17.8	
College graduates	7.8	11.5	12.8	
Labor Force Size				
Civilian	78,064	114,148	112,762	
Military	26,238	11,081	14,676	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	9.0	11.0	6.2	
Construction	10.0	13.8	8.6	
Business Services	2.4	3.6	3.8	
Communications, Utilities	3.4	3.5	2.9	
Nondurable Manufacturing	16.9	19.4	16.7	
Durable Manufacturing	4.6	5.8	5.1	
Finance, Insurance, Real Estate	3.3	4.5	4.3	
Services	14.2	15.0	14.2	
Wholesale, Retail Trade	21.0	23.8	20.8	
Transportation	3.8	5.2	5.1	
Employment by Occupation Group (%)				
Management, Professional	9.8	9.4	11.1	
Technical	1.3	3.2	4.1	
Sales	7.0	11.4	13.5	
Clerical	16.5	16.2	17.4	
Precision Craft	19.9	23.6	20.0	
Operative, Transportation	13.0	8.4	6.4	
Service, except household	16.7	15.3	17.1	
Farming, Fishing, Forestry	4.1	3.5	3.5	
Household Service	3.8	1.0	0.6	
Laborers	7.8	8.0	6.2	

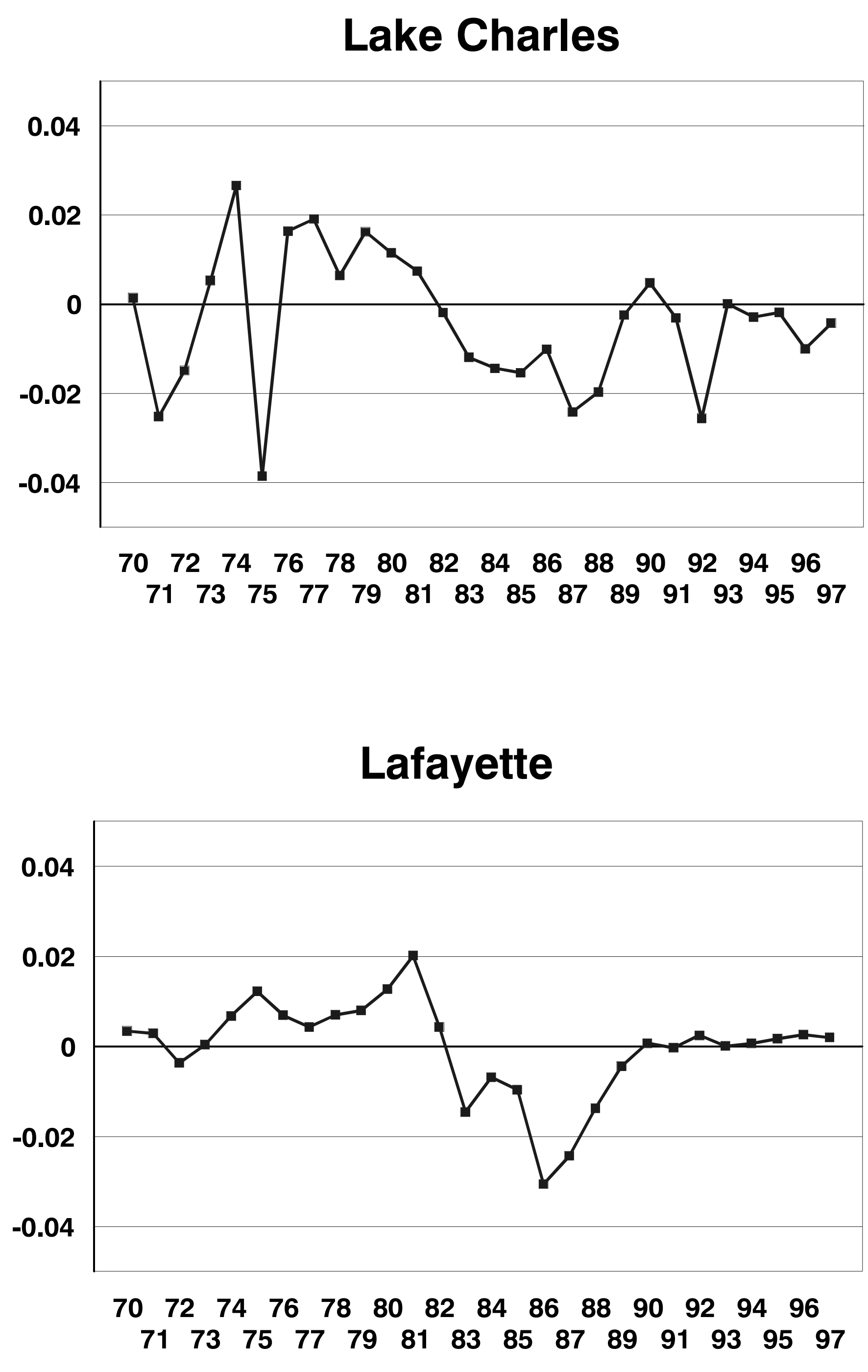

Figure 3-27 NET MIGRATION PATTERNS FOR LAKE CHARLES AND LAFAYETTE, LOUISIANA 1970-1997.

Lafayette Labor Market Area

The Lafayette labor market area anchors the Acadian region of coastal Louisiana (figure 3-23), sustaining a rich cultural tradition and an economy intricately tied to the oil and gas industry. Of the Louisiana labor market areas described in table 3-17, Lafayette ranks second in growth since 1980. This growth has occurred despite a major downturn in the oil and gas industry during the mid-1980s.

Table 3-26 presents a socioeconomic profile for the Lafayette area. The age structure of the Lafayette area exhibits a slightly younger population than most coastal market areas, suggestive of a potential for future natural population growth. The racial and ethnic makeup of the Lafayette labor market area shows a higher percentage of African-Americans, fewer Hispanics, and more whites than is the norm along the Gulf Coast. Education levels are strikingly lower in Lafayette than elsewhere. Laska *et al.* (1993) contend that students cannot pass up the high pay in the oil industry and consequently drop out of school. Indicative of the presence of the oil and gas industry, employment in mining industries is double that of the typical coastal labor market area. Though the industrial mix in the Lafayette area is distinctive, its occupational distribution is much closer to the typical Gulf Coast labor market area.

Migration patterns since 1970 for the Lafayette area are presented in figure 3-27. Most years show net in-migration with the clear exception of the oil and gas downturn years of the mid-1980s. Coupled with the likely natural increase in population, this reasonably constant in-migration suggests that the area can anticipate growth in the years to come.

Baton Rouge Labor Market Area

Home to Exxon's massive refinery complex, the Baton Rouge labor market area (figure 3-23) is buttressed by employment strength in three large sectors: industrial, government, and education. As a state capital and home to two large universities (LSU and Southern), the area exhibits a distinctive white-collar labor force paired with its industrial labor force. The Baton Rouge labor market area exhibits the most growth of any of the coastal Louisiana labor markets. This is largely due to the inclusion of two of the three fastest growing Louisiana parishes--Ascension and Livingston--in the labor market.

Table 3-27 summarizes the socioeconomic profile of the Baton Rouge labor market area. The local age structure shows slightly smaller proportions in the highest age intervals than does the summary Gulf Coast profile (table 3-18). Further, there are fewer Hispanic residents than is the norm elsewhere along the coast. This is balanced by the presence of 10 percent more African-Americans and seven percent more whites. Baton Rouge exhibits higher educational levels with fewer non-high-school graduates than most coastal market areas.

The most distinctive aspect of the local industrial distribution is the relatively larger service component that contains education and government workers. The occupation composition of Baton Rouge closely mirrors the general coastal job distribution pattern.

Figure 3-28 graphs net migration in and out of the Baton Rouge labor market area since 1970. While most years are positive, it is clear that most of the higher positive rates of migration occurred before the chemical industry and oil and gas industry downturns of the mid-1980s. The fact that two of the parishes in the market areas are state leaders in population growth in the 1990s is obviously a product of internal realignment due to suburban development.

Table 3-26

Socioeconomic Profile of the Lafayette Labor Market Area

Lafayette Labor Market Area	1970	1980	1990	1998
Population	407,042	476,339	496,579	535,059
Age Structure (%)				
0 - 5	10.3	9.0	10.3	
6 - 15	24.2	18.4	17.6	
16 - 17	6.5	6.0	3.1	
18 - 24	11.0	14.3	10.2	
25 - 34	11.4	15.4	17.0	
35 - 44	10.8	10.4	13.6	
45 - 54	9.9	9.4	9.6	
55 - 64	8.2	8.0	8.0	
65 +	7.8	9.1	10.5	
Race and Ethnic Composition (%)				
African American	26.6	24.3	26.1	
Hispanic	1.0	2.1	1.2	
White	72.4	73.7	72.7	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	51.3	34.8	22.6	
9 - 11 years schooling	15.5	16.0	17.1	
High School graduates	19.8	26.9	32.6	
13 -15 years schooling	6.4	10.4	14.0	
College graduates	7.0	11.9	13.7	
Labor Force Size				
Civilian	119,699	184,668	184,670	
Military	130	145	461	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	18.0	18.8	12.6	
Construction	9.0	10.7	6.4	
Business Services	3.0	4.6	4.2	
Communications, Utilities	3.2	2.9	2.4	
Nondurable Manufacturing	8.1	12.2	11.1	
Durable Manufacturing	2.9	4.8	4.0	
Finance, Insurance, Real Estate	3.2	4.6	4.7	
Services	15.6	13.8	13.4	
Wholesale, Retail Trade	21.6	24.5	23.0	
Transportation	3.6	5.5	4.0	
Employment by Occupation Group (%)				
Management, Professional	10.3	10.2	11.2	
Technical	1.4	3.5	4.4	
Sales	7.4	12.4	15.6	
Clerical	13.5	16.9	16.4	
Precision Craft	14.9	21.9	17.4	
Operative, Transportation	13.4	7.9	8.4	
Service, except household	18.1	14.6	16.3	
Farming, Fishing, Forestry	8.7	4.2	3.9	
Household Service	5.3	1.4	1.1	
Laborers	7.0	6.9	5.3	

Table 3-27

Socioeconomic Profile of the Baton Rouge Labor Market Area

Baton Rouge Labor Market Area	1970	1980	1990	1998
Population	533,221	672,081	709,562	770,723
Age Structure (%)				
0 - 5	9.6	8.7	9.6	
6 - 15	22.6	17.4	16.3	
16 - 17	6.4	5.6	3.0	
18 - 24	13.5	15.9	12.3	
25 - 34	12.4	17.6	17.5	
35 - 44	10.8	10.7	15.2	
45 - 54	9.8	8.7	9.6	
55 - 64	7.7	7.5	7.2	
65 +	7.3	7.9	9.5	
Race and Ethnic Composition (%)				
African American	31.9	30.8	31.8	
Hispanic	1.3	1.7	1.3	
White	66.8	67.5	66.9	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	34.0	20.3	11.7	
9 - 11 years schooling	19.2	16.8	16.8	
High School graduates	25.7	31.5	33.0	
13 -15 years schooling	9.8	14.4	18.7	
College graduates	11.3	17.0	19.9	
Labor Force Size				
Civilian	170,446	267,900	293,749	
Military	243	298	588	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	5.0	4.6	2.9	
Construction	10.9	13.6	8.6	
Business Services	2.8	4.5	4.4	
Communications, Utilities	2.9	3.8	3.1	
Nondurable Manufacturing	17.4	20.5	14.0	
Durable Manufacturing	4.3	5.4	3.9	
Finance, Insurance, Real Estate	4.3	6.9	6.3	
Services	15.1	16.1	13.6	
Wholesale, Retail Trade	18.2	24.4	21.6	
Transportation	2.6	4.6	3.8	
Employment by Occupation Group (%)				
Management, Professional	10.0	11.8	13.7	
Technical	2.0	4.6	5.1	
Sales	7.2	11.9	14.9	
Clerical	18.0	19.7	19.7	
Precision Craft	19.4	19.7	16.1	
Operative, Transportation	10.8	7.5	5.7	
Service, except household	18.2	15.6	16.4	
Farming, Fishing, Forestry	3.7	2.1	2.4	
Household Service	4.4	1.1	0.8	
Laborers	6.3	6.0	5.0	

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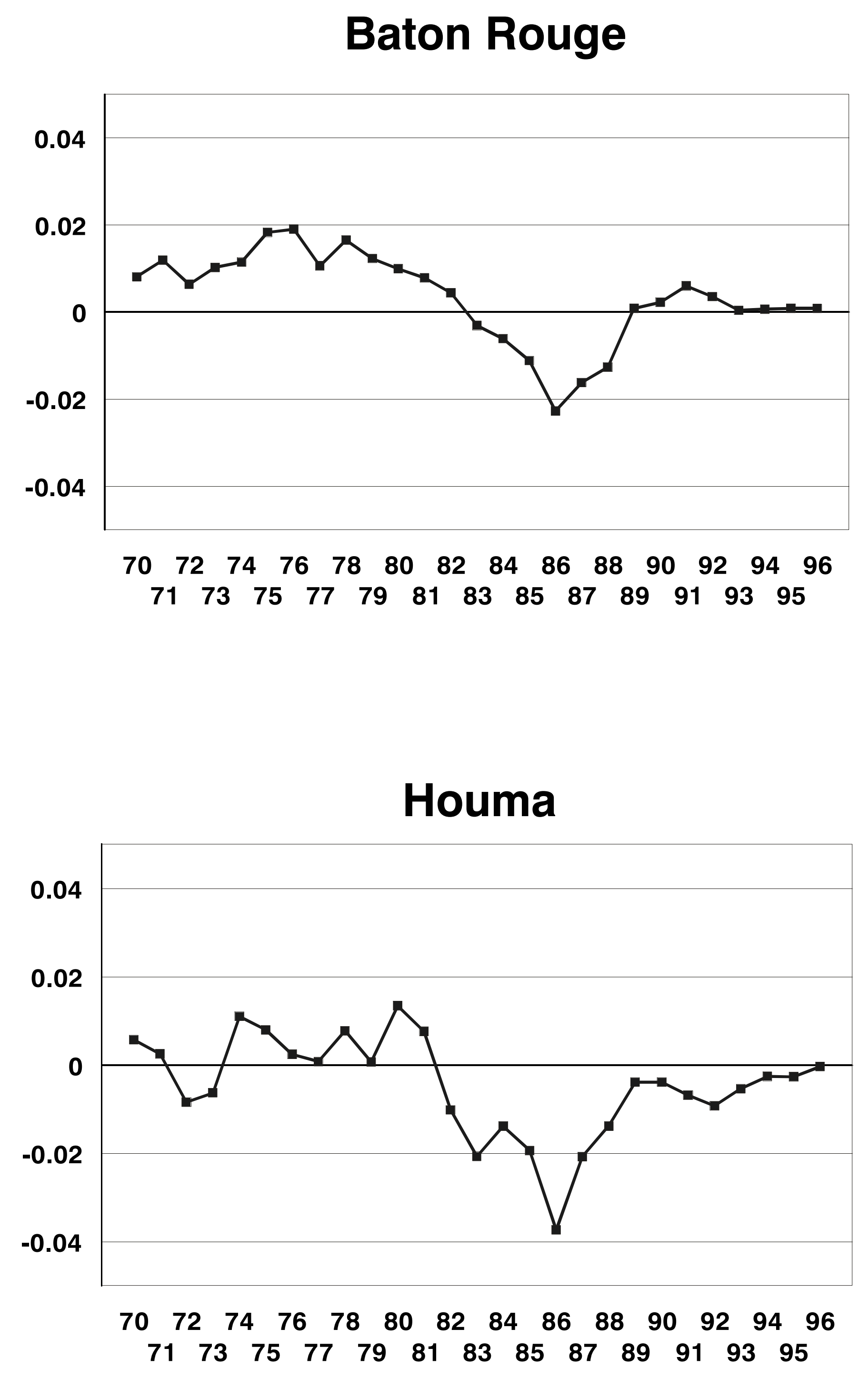

Figure 3-28 NET MIGRATION PATTERNS FOR BATON ROUGE AND HOUMA, LOUISIANA 1970-1997

Houma Labor Market Area

The economy of the Houma labor market area (figure 3-23) is based on agriculture, seafood, mining (especially oil and gas extraction and related services), and services (e.g., medical, education). The area is rich in natural resources. The Houma area is a state leader in terms of onshore production of natural gas and condensate. It also serves as a staging area for offshore services. Port Fuchon in La Fourche Parish is one of the few deepwater ports along the Gulf Coast. Since the mid-1990s, the port has become a major center for launching deepwater oil and gas activities. Despite its industrial character, the Houma area has exhibited only modest population growth since 1970 (table 3-17).

The socioeconomic profile of the Houma labor market area is provided in table 3-28. With larger population components at younger age intervals, the Houma area is clearly destined for natural population growth over the next decade. Fewer Hispanics in the local population are offset by relatively more whites than is typical for Gulf Coast labor market areas. Education levels in Houma are distinctly lower than is the norm, as 42 percent of the population in 1990 had not graduated from high school. However, the strength of the agricultural and mining components in the local economy is evident by the fact that 12 percent of the labor force is employed in those sectors, more than double the typical proportion along the Gulf Coast. Fewer managerial and professional occupations are offset by proportionally more precision craft jobs.

The net migration data reflected in figure 3-28 suggest that the Houma labor market area has not quite recovered from a substantial exodus that coincided with the decline of chemical and oil and gas activities of the mid-1980s. In the later 1990s, however, the net migration rate for Houma shows an upward trend that suggests in-migration may soon surpass out-migration in the area. Coupled with the natural population growth potential noted above, this pending positive net migration signals likely growth ahead.

New Orleans Labor Market Area

In similar fashion to the Houston-Galveston area, the New Orleans labor market area (figure 3-23) exhibits the complexity and heterogeneity associated with a very large urban area. The service sector dominates the area's economy, accounting for as much as one-third of earnings generated in the area. The oil and gas industry has had a major presence in the New Orleans area. Recently, however, the industry has consolidated managerial and professional positions in the Houston area, resulting in a downsizing of administrative operations in New Orleans that will not show up in census data until 2000. Though St. Tammany Parish is the fastest growing county-equivalent in Louisiana, its presence in the New Orleans labor market area is not sufficient to offset a weak area growth rate of 2 percent since 1990 and an actual population decline between 1980 and 1990 (table 3-17).

The socioeconomic profile of the New Orleans labor market area presented in table 3-29 indicates one reason for slow growth: an aging population relative to other coastal labor market areas (e.g., compare the age interval percentages to the summary presented in table 3-18). A smaller Hispanic component in the area is almost entirely offset by a larger African-American component. New Orleans sports fewer persons with only grade-school education than do most other coastal labor market areas. Other aspects of education are similar to other coastal areas. The industry mix in the New Orleans labor area is skewed more toward services and wholesale

Table 3-28

Socioeconomic Profile of the Houma Labor Market Area

Houma Labor Market Area	1970	1980	1990	1998
Population	225,396	263,213	263,681	274,047
Age Structure (%)				
0 - 5	11.8	9.5	10.3	
6 - 15	24.8	19.4	18.1	
16 - 17	6.9	6.3	3.2	
18 - 24	11.6	14.7	10.7	
25 - 34	13.0	16.2	17.3	
35 - 44	10.7	11.0	13.9	
45 - 54	9.0	9.0	9.8	
55 - 64	6.4	6.9	7.6	
65 +	5.8	7.0	9.1	
Race and Ethnic Composition (%)				
African American	19.1	18.8	20.2	
Hispanic	2.4	2.1	1.6	
White	78.6	79.2	78.2	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	49.8	34.7	24.9	
9 - 11 years schooling	16.6	16.5	18.8	
High School graduates	22.4	30.3	35.1	
13 -15 years schooling	5.7	9.1	11.8	
College graduates	5.5	9.3	9.4	
Labor Force Size				
Civilian	67,981	103,337	96,409	
Military	143	100	195	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	18.3	16.2	12.6	
Construction	7.2	11.6	7.3	
Business Services	3.1	4.9	4.8	
Communications, Utilities	2.8	3.0	2.7	
Nondurable Manufacturing	13.1	16.1	12.5	
Durable Manufacturing	6.8	10.2	7.6	
Finance, Insurance, Real Estate	2.6	4.1	4.0	
Services	11.9	11.6	12.0	
Wholesale, Retail Trade	18.7	21.7	21.3	
Transportation	6.7	8.5	6.9	
Employment by Occupation Group (%)				
Management, Professional	12.6	10.1	10.4	
Technical	1.4	2.8	3.5	
Sales	6.2	11.3	13.7	
Clerical	12.5	16.5	15.9	
Precision Craft	18.3	24.3	21.0	
Operative, Transportation	18.4	10.7	9.1	
Service, except household	14.5	12.8	15.2	
Farming, Fishing, Forestry	4.4	3.8	4.2	
Household Service	3.4	1.0	0.6	
Laborers	8.2	6.8	6.5	

Table 3-29

Socioeconomic Profile of the New Orleans Labor Market Area

New Orleans Labor Market Area	1970	1980	1990	1998
Population	1,186,117	1,348,007	1,328,455	1,352,504
Age Structure (%)				
0 - 5	9.3	8.2	9.4	
6 - 15	22.1	16.9	15.7	
16 - 17	6.1	5.5	3.0	
18 - 24	11.2	13.5	10.1	
25 - 34	12.4	17.5	17.5	
35 - 44	11.3	11.1	15.2	
45 - 54	10.9	9.5	10.1	
55 - 64	8.4	8.7	8.1	
65 +	8.2	9.2	11.0	
Race and Ethnic Composition (%)				
African American	30.4	31.9	34.3	
Hispanic	3.2	3.7	3.9	
White	66.4	64.4	61.8	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	35.2	21.6	12.6	
9 - 11 years schooling	19.7	16.1	17.0	
High School graduates	26.1	32.1	30.6	
13 -15 years schooling	9.0	14.4	19.9	
College graduates	10.0	15.8	19.8	
Labor Force Size				
Civilian	409,009	554,736	547,717	
Military	2,771	4,392	7,534	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	3.8	5.1	3.4	
Construction	7.0	10.0	5.9	
Business Services	3.3	5.0	5.0	
Communications, Utilities	3.7	4.1	3.1	
Nondurable Manufacturing	14.7	14.8	10.3	
Durable Manufacturing	7.1	7.7	5.0	
Finance, Insurance, Real Estate	5.2	6.7	6.8	
Services	13.8	15.8	14.7	
Wholesale, Retail Trade	21.5	25.6	23.1	
Transportation	6.3	8.7	5.9	
Employment by Occupation Group (%)				
Management, Professional	10.7	12.7	14.4	
Technical	1.5	3.8	4.8	
Sales	9.0	13.1	16.2	
Clerical	22.5	21.9	21.7	
Precision Craft	16.5	16.8	13.2	
Operative, Transportation	11.5	6.7	4.8	
Service, except household	17.2	16.5	18.2	
Farming, Fishing, Forestry	0.8	1.2	1.7	
Household Service	3.1	1.1	0.9	
Laborers	7.0	6.2	4.3	

and retail trade than most coastal labor markets. The occupation composition shows a larger service occupation share than most other coastal markets.

Net migration has been negative for the New Orleans area since the early 1980s, as reflected in figure 3-29. The trend was clearly exacerbated at about the time of downturns in both the chemical and oil and gas industries. Though migration rebounded in the late 1980s and early 1990s, there has yet to be net in-migration into this labor market area.

Biloxi-Gulfport Labor Market Area

The Biloxi-Gulfport area is Mississippi's only coastal labor market area (figure 3-23). This area exhibits an increasingly diversified local economy that once was based in beach tourism, seafood harvesting, and forestry. While the Biloxi-Gulfport area now has major chemical plants and shipbuilding yards, a major NASA installation and Keesler Air Force base also anchor the local economy. Since 1990, development of the gaming industry has been nothing short of remarkable and is now estimated to employ 15,000 persons (Harrison County Development Commission, 1999, personal communication). Not surprisingly, the growth of the Biloxi-Gulfport area has been robust and rivals the Texas coast labor markets (table 3-17).

As the socioeconomic profile in table 3-30 indicates, the age structure of the Biloxi-Gulfport area mirrors the age structure of the typical coastal labor market area. Smaller African-American and Hispanic proportions are offset by a relatively large white population component. Education levels are higher for Biloxi-Gulfport, especially among high-school and college graduates. While the military component of the Biloxi-Gulfport labor force is proportionately small, it is interesting to note that one quarter of all military employees along the western and central Gulf Coast reside in this labor market area.

The census data presented in table 3-30 do not reflect the service employment growth associated with the gaming industry, which has developed since the census was completed for 1990. However, the 30 percent share of industry employment accounted for by manufacturing is quite distinctive for the Gulf Coast. Even so, the occupational mix is well within the parameters typical of a coastal labor market area.

The net migration data presented in figure 3-29 indicate more in-migration into the Biloxi-Gulfport area than out-migration in most years. Even the mid-1980s dip experienced by virtually all coastal labor market areas is muted in the Biloxi-Gulfport data. Further population growth is quite likely in view of this propensity for in-migration.

Mobile Labor Market Area

The five-county Mobile labor market area in coastal Alabama is distinctive among the Gulf's coastal labor markets due to its large manufacturing sector. Major industries include chemicals, paper, shipyards, and aircraft. According to the Mobile Chamber of Commerce, growth of the local manufacturing sector has accelerated in the 1990s due to major plant expansions and new plant construction. This strong economic component is complemented by a large service sector, which includes a substantial tourism base in nearby Baldwin County (Gulf Shores, Alabama).

Table 3-31 presents a socioeconomic profile of the Mobile labor market area. The age composition information in the table indicates that the Mobile area is typical of Gulf Coast labor market areas. A relatively large cohort of young persons in 1970 moves through time, aging the

Table 3-30

Socioeconomic Profile of the Biloxi-Gulfport Labor Market Area

Biloxi-Gulfport Labor Market Area	1970	1980	1990	1998
Population	296,851	368,852	388,725	440,657
Age Structure (%)				
0 - 5	9.8	8.6	9.2	
6 - 15	22.4	18.1	16.2	
16 - 17	5.9	5.8	3.1	
18 - 24	14.1	14.2	10.8	
25 - 34	13.0	15.6	16.6	
35 - 44	11.0	11.4	14.0	
45 - 54	9.6	9.6	10.5	
55 - 64	7.4	8.2	8.7	
65 +	6.9	8.4	10.9	
Race and Ethnic Composition (%)				
African American	16.1	17.7	18.4	
Hispanic	1.4	1.7	1.3	
White	82.5	80.6	80.3	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	27.2	18.4	11.5	
9 - 11 years schooling	20.9	16.7	18.3	
High School graduates	32.2	36.8	33.4	
13 -15 years schooling	11.0	16.1	21.3	
College graduates	8.6	11.9	15.4	
Labor Force Size				
Civilian	90,726	130,981	151,312	
Military	17,159	12,989	11,122	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	2.6	3.9	2.8	
Construction	9.7	10.3	7.8	
Business Services	2.1	4.3	3.9	
Communications, Utilities	2.8	3.5	2.8	
Nondurable Manufacturing	23.3	26.3	21.4	
Durable Manufacturing	14.9	17.9	14.8	
Finance, Insurance, Real Estate	3.1	5.1	4.5	
Services	11.9	15.8	14.3	
Wholesale, Retail Trade	16.0	24.3	21.3	
Transportation	2.7	4.7	4.0	
Employment by Occupation Group (%)				
Management, Professional	10.6	10.8	11.7	
Technical	1.8	4.2	5.2	
Sales	6.8	11.8	14.1	
Clerical	15.8	16.3	16.2	
Precision Craft	22.3	21.1	18.8	
Operative, Transportation	14.7	9.8	8.9	
Service, except household	15.5	15.9	16.9	
Farming, Fishing, Forestry	1.5	2.6	2.5	
Household Service	2.8	0.8	0.6	
Laborers	8.2	6.6	5.1	

Table 3-31

Socioeconomic Profile of the Mobile Labor Market Area

Mobile Labor Market Area	1970	1980	1990	1998
Population	435,958	502,814	534,425	591,388
Age Structure (%)				
0 - 5	9.2	8.5	9.1	
6 - 15	23.1	17.6	16.0	
16 - 17	6.4	5.7	3.2	
18 - 24	10.6	12.9	9.8	
25 - 34	11.8	15.7	15.9	
35 - 44	10.8	10.7	14.6	
45 - 54	10.6	9.5	10.1	
55 - 64	8.9	8.9	8.7	
65 +	8.6	10.5	12.6	
Race and Ethnic Composition (%)				
African American	31.7	30.5	29.5	
Hispanic	1.8	1.1	0.9	
White	66.5	68.4	69.6	
Education of Persons Age 25+ (%)				
0 - 8 years schooling	35.7	21.4	12.2	
9 - 11 years schooling	23.2	18.9	19.9	
High School graduates	26.7	34.1	33.9	
13 -15 years schooling	7.4	13.8	18.2	
College graduates	7.1	11.9	15.9	
Labor Force Size				
Civilian	143,854	191,541	218,001	
Military	1321	1592	1491	
Employment by Industrial Sector (%)				
Agriculture, Forestry, Mining	3.4	3.5	2.6	
Construction	7.1	10.8	7.9	
Business Services	2.2	4.1	4.6	
Communications, Utilities	2.9	3.5	2.5	
Nondurable Manufacturing	23.2	25	18.3	
Durable Manufacturing	9.7	10.9	8.2	
Finance, Insurance, Real Estate	4.0	6.2	4.9	
Services	13.3	14.3	12.9	
Wholesale, Retail Trade	19.2	24.2	22.6	
Transportation	4.7	5.4	4.6	
Employment by Occupation Group (%)				
Management, Professional	9.1	10.6	12.1	
Technical	1.3	3.4	4.4	
Sales	8.1	12.8	15.7	
Clerical	16.7	17.6	17.8	
Precision Craft	18.2	18.6	16.0	
Operative, Transportation	15.2	10.5	9.1	
Service, except household	16.4	14.8	15.8	
Farming, Fishing, Forestry	2.5	3.1	2.7	
Household Service	4.0	1.3	0.8	
Laborers	8.4	7.3	5.7	

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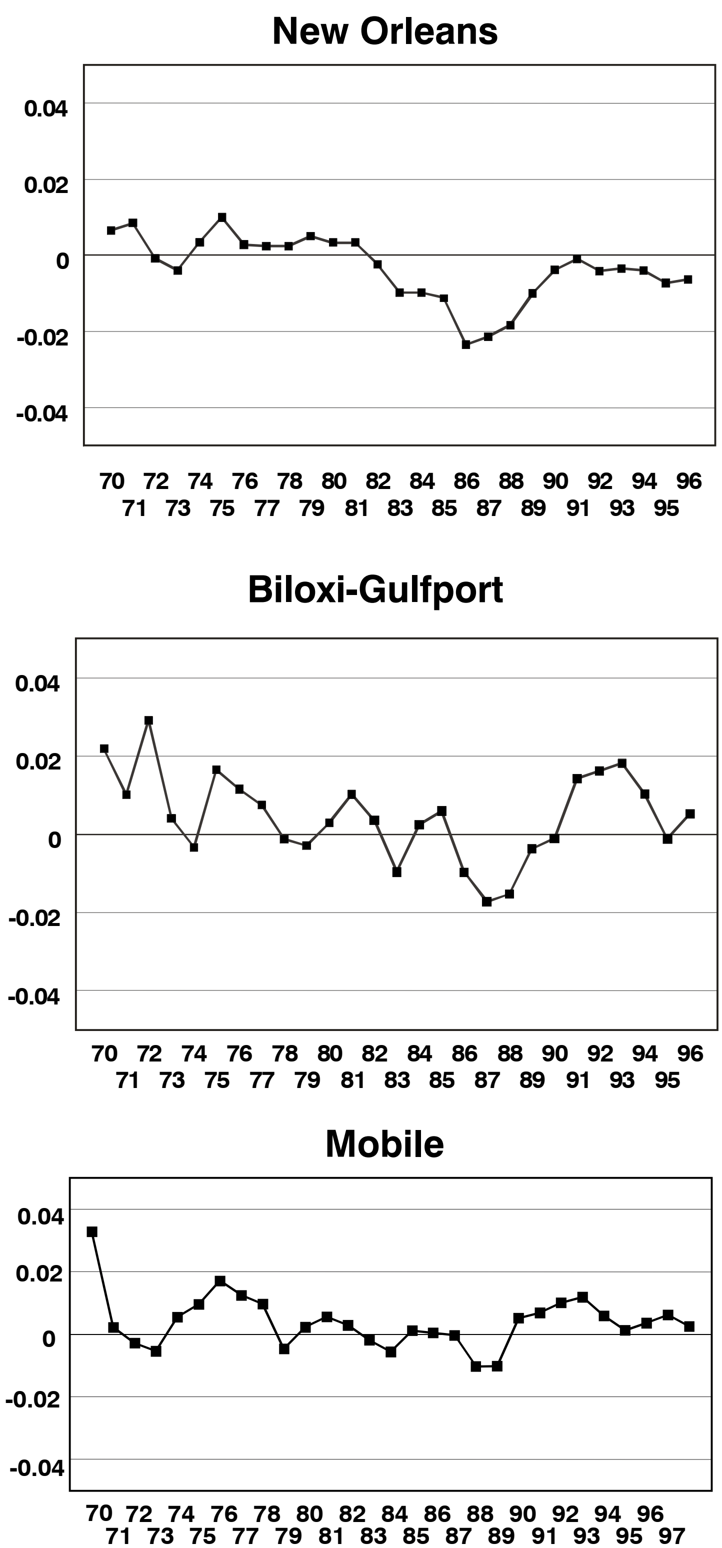

Figure 3-29 NET MIGRATION PATTERNS FOR NEW ORLEANS, LOUISIANA; BILOXI-GULFPORT, MISSISSIPPI; AND MOBILE, ALABAMA; 1970-1997

population. By 1990, the older age groups increase in size, and younger age groups decrease. This aging of the population is a national phenomenon exhibited within other coastal labor market areas. The Mobile area has an above-average over-55 population component. This is likely due to the increasingly popularity of coastal Baldwin County as a retirement destination. As is characteristic of the easternmost coastal labor market areas, Mobile has a relatively larger African-American population component and a relatively smaller Hispanic component than is the case for coastal labor market areas in general. While Mobile sports an above-average percentage of high-school graduates, the area also has a slightly lower percentage of persons who have attended college.

In terms of industry of employment, Mobile exhibits a distinctively high proportion of the labor forced employed in nondurable manufacturing in 1990. The occupational distribution shows slightly fewer white collar workers and slightly more precision craft and operative workers, as would be expected in an area with a large manufacturing presence.

Figure 3-29 depicts net migration since 1970 for the Mobile labor market area. In most years, the net migration estimates are positive, indicating more in-migration and natural population growth as opposed to out-migration. Like the Biloxi area, Mobile's response to the mid-1980s downturn in the oil and gas industry is less exaggerated than coastal labor markets further west.

Future Population Projections

Perhaps the most immediate and discernable impact any new economic activity has on a community is the way that activity alters trends in population growth (Keyfitz, 1981, 1985). Changes in expected growth patterns require altering public planning for school growth, government service activity (such as police and fire protection), for infrastructural growth (i.e., roads, water and sewer systems), among other aspects. Local area projections are built upon the assumption that there are continuities between past patterns of population growth and future patterns. Based upon previously observed relationships, interactions among the components of demographic and economic processes are specified as constants in a model. Such models are then extrapolated forward (as in projection) or are driven by a leading set of indicators (as in estimation). In the present projection series, past county level estimates have been used (i.e., population change, labor force participation, and industrial activity) in conjunction with projections series conducted by the U.S. Census Bureau (Campbell, 1996), U.S. Bureau of Labor Statistics (BLS, 1997a, b), and U.S. Bureau of Economic Analysis (BEA, 1995). Final projections provide an original set of demographic, labor force, and industrial projections that are consistent with the series named above, and provide new information about the coastal communities along the GOM from Alabama to Texas. The basic methodology used to create these projections is shift-share analysis.

Population Projections

Shift-share methodology utilizes direct standardization and decomposition techniques to allocate observed local population or employment growth rates into: 1) the direct share of place population or employment change derived from state growth, 2) the share of change a place experiences due to its unique population composition, and 3) change unique to each place. These three observed components are then applied to state level projection series to allocate state growth among places. In practice, shift-share projection methods applied to small area projections have been shown to be as accurate as, for instance, population cohort component methods.

Shift-share projections for small areas are driven by state level projections in conjunction with information about local areas. In the current projection series, Census Bureau information on county population for 1990 and Census Bureau estimates for 1995 (i.e., each by five-year age groups, race, and sex) were employed. This information was used to adjust the shift-share components and the projection series.

From a series of equations, the population growth rates for a particular location may be decomposed into three distinct components, encompassing: 1) state growth effect, or the amount of population growth in a given group within a select location due to state growth; 2) share effect, or a particular location's additional share in state population growth due the unique population composition of that particular location; and 3) shift effect, or the amount of population growth in a particular location due to that location's unique growth trends. In general, the observed population growth of a particular location is expressed as a function of these three components; that is, the observed rate of growth for a particular location is equal to that place's state growth effect plus its share effect plus its shift effect. Each component of shift-share is expressed as a rate. Components are then converted to absolute population change.

Of the three shift-share components of place growth between 1990 and 1995 described above, two components are entirely determined by state level population change: the state growth effect and the share effect. When future trends in state population growth are projected, these components allocate shares of this population growth differentially among places. The third component, the shift effect, describes unique patterns of population change specific to each place. Such trends are often the result of the competitive advantages or disadvantages specific to local areas

Data Inputs for Population Projections

State level projections provide an important control in the shift-share methodology. In the present analysis, Census Bureau data (i.e., Projections, Series B) are used as controls. The Census Bureau provides two sets of population projections comprised of: 1) a series using a demographically-based time series, and 2) an alternative series using an economically-based set of assumptions. These series differ only in the internal migration assumptions. Series A is a time-series model and uses state-to-state migration observed from 1975 to 1976 through 1993 to 1994. Series B, the Economics Model, uses the BEA employment projections. In this series, state-to-state migration flows are derived from BEA-projected changes in employment.

Census evaluation of Series B indicates that short-term projections in Series B are very nearly as accurate as those of Series A. The long-term projections of Series B show migration patterns consistent with BEA economic projections. Since the projections used in this series focus on certain economic assumptions and utilize BEA employment projections, the present analysis has been conducted using the Series B as control projections on the state level.

From these population projections, two sets of economic projections were derived. First, labor force participation ratios for each age, race, and sex group were derived from BLS. Second, BEA employment projections were used to allocate labor force into industry groups.

From Population to Labor Force Projections

In the BLS labor force series (i.e., 1997 to 2006), the national labor force was determined by projections of the age, sex, and racial composition of the population and by trends in labor force participation rates (i.e., the percent of the specified group in the population who will be working or seeking work). Projections of labor force participation rates for each group were developed by first estimating a trend rate of change, usually based on participation rate behavior during the prior eight-year period. Second, the rate was modified when the time-series projections for the specific group appeared inconsistent with the results of cross-sectional and cohort analyses. Following BLS procedure, the size of the anticipated labor force has been estimated by multiplying the labor force participation for each age, race, and sex group rates by the corresponding group within cited population projections. Labor force participation rates for 2006 have been carried forward to all subsequent years in the current projection models.

From Labor Force to Employment by Industry Projections

Once labor force projections had been derived from the BLS series, BEA employment projections were used to allocate labor force into industry groups. BEA provides industry projections by both individual state and economic area (EA) through 2025. Their employment projection series provides the basis for the Series B census projections developed by the Census Bureau. At the state level, the present population projection series were deemed to be consistent with the BEA employment series. BEA also provides employment by industry projections for sub-state economic areas. However, BEA does not provide demographically detailed projections at the sub-state level. In general, these economic areas cover a much wider geographic area than the commuting zones used in this study. Industrial proportions for each BEA projected year were used to allocate the labor force projections into appropriate industrial categories. The resultant industry projections of commuting zones are consistent with BEA projections for the large sub-state economic areas.

Results

Figures 3-30 and 3-31, as well as table 3-32, present population trends and projections for the four-state region (i.e., Alabama, Louisiana, Mississippi, and Texas) and for the 13 coastal commuting zones of interest from 2000 to 2020. As is evident in figure 3-31, both the Gulf Coast area and the region as a whole are projected to realize increases in population, although this tapers off throughout the projection period. In the 1980s, growth rates for the Gulf Coast area were below that of the four-state region. Notably, with the decline in oil prices and subsequent loss of jobs for oil-dependant areas, the population growth rate between 1985 and 1990 dipped to 1.43 percent (table 3-32), while the region as a whole maintained a much higher population growth rate of 6.75 percent. After the 1985 to 1990 period, five-year growth rates converged in the 1990s, with the coastal area maintaining slightly higher growth rates than the region as a whole. This slight edge in growth is projected to remain over the 2000 to 2020 period.

During this period, both the four-state region and Gulf Coast are projected to experience a considerable shift in age structure. There are three demographic factors at work which creates this change in age composition. First, the bulk of the population of both areas was born during

Table 3-32

Summary of Recent Population Trends (1980-1995) and Population Projections for the Gulf Coastal Commuting Zones and the Four-state Region (2000-2020)

	Age Range and Proportion									
	0-19		20-34		35-64		65+			
Year	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Total	5 Year Rates
All Coastal Commuting Zones										
1980	3,115,160	35.5%	2,410,200	27.4%	2,523,030	28.7%	731,970	8.3%	8,780,360	
1985	3,209,960	33.5%	2,629,890	27.5%	2,908,900	30.4%	823,720	8.6%	9,572,470	9.02%
1990	3,170,670	32.6%	2,439,170	25.1%	3,169,250	32.6%	933,630	9.6%	9,712,720	1.47%
1995	3,390,170	32.2%	2,382,150	22.6%	3,737,200	35.5%	1,024,700	9.7%	10,534,220	8.46%
2000	3,604,830	31.9%	2,350,490	20.8%	4,202,400	37.2%	1,127,790	10.0%	11,285,510	7.13%
2005	3,743,520	31.2%	2,473,110	20.6%	4,536,880	37.9%	1,227,070	10.2%	11,980,580	6.16%
2010	3,899,810	30.7%	2,638,740	20.8%	4,776,930	37.6%	1,383,790	10.9%	12,699,270	6.00%
2015	4,053,270	30.1%	2,836,470	21.1%	4,912,050	36.5%	1,645,580	12.2%	13,447,370	5.89%
2020	4,280,110	30.1%	2,933,890	20.6%	5,026,330	35.4%	1,968,920	13.9%	14,209,250	5.67%
Four-State Region										
1980	8,582,060	34.5%	6,526,570	26.3%	7,220,930	29.1%	2,510,280	10.1%	24,839,840	
1985	8,790,950	32.5%	7,271,150	26.9%	8,223,560	30.4%	2,739,110	10.1%	27,024,770	8.80%
1990	8,816,520	31.6%	7,010,820	25.2%	9,019,790	32.4%	3,027,180	10.9%	27,874,310	3.14%
1995	9,335,640	31.1%	6,841,490	22.8%	10,545,460	35.1%	3,279,270	10.9%	30,001,860	7.63%
2000	9,837,740	30.9%	6,679,900	21.0%	11,800,410	37.0%	3,548,010	11.1%	31,866,060	6.21%
2005	10,181,920	30.2%	6,974,130	20.7%	12,755,110	37.8%	3,828,980	11.3%	33,740,140	5.88%
2010	10,566,810	29.6%	7,395,860	20.7%	13,450,770	37.7%	4,284,090	12.0%	35,697,530	5.80%
2015	10,940,950	29.0%	7,939,110	21.0%	13,831,190	36.6%	5,051,470	13.4%	37,762,720	5.79%
2020	11,527,630	28.9%	8,201,180	20.6%	14,148,880	35.5%	5,996,380	15.0%	39,874,070	5.59%

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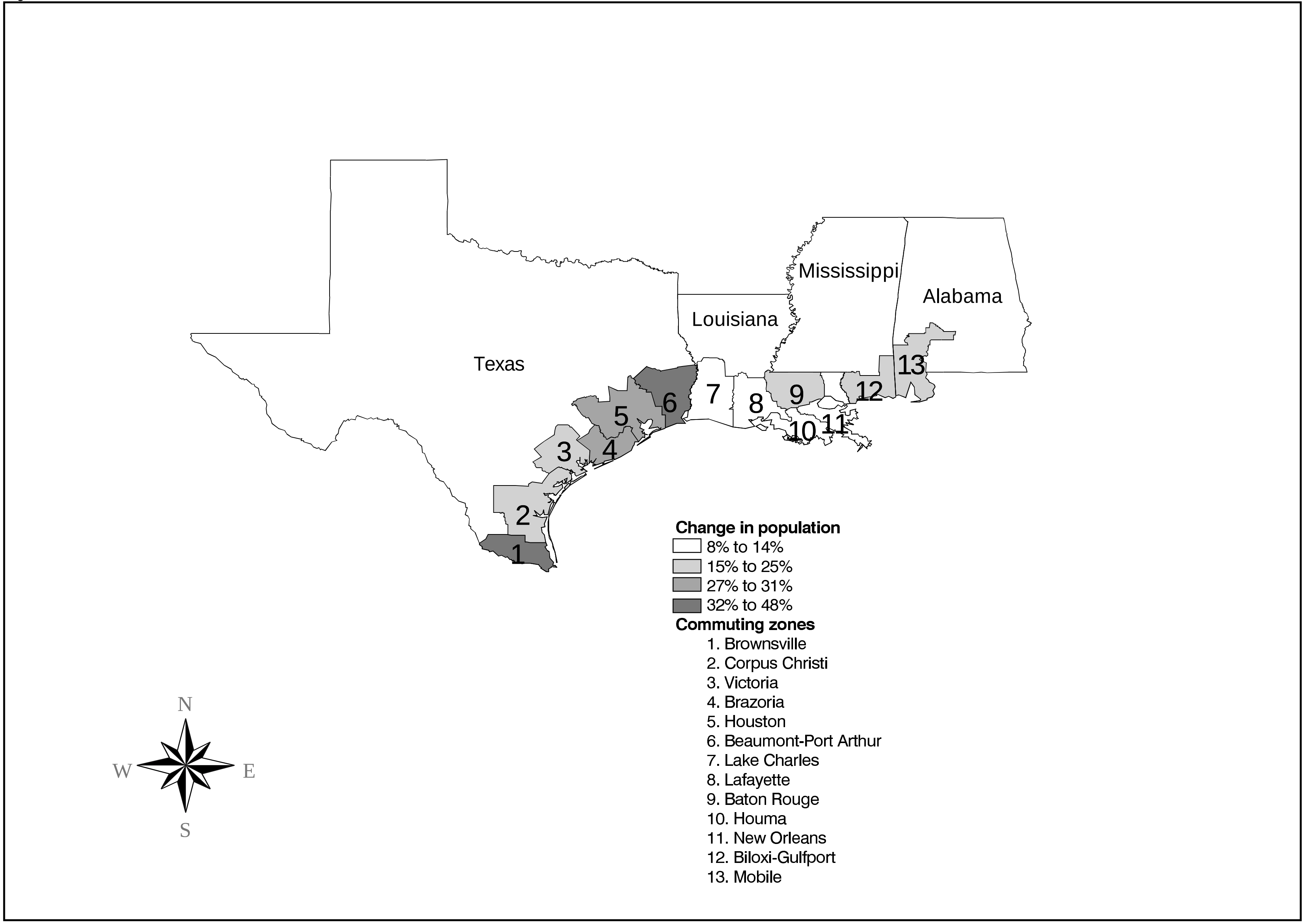

Figure 3-30 POPULATION GROWTH RATES FOR THE GULF COAST, 2000-2020.

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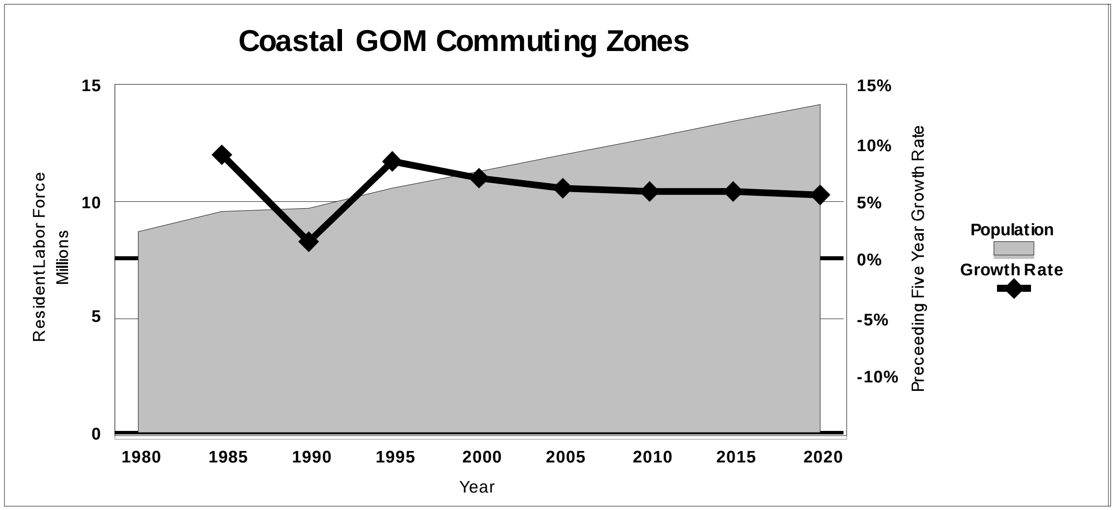

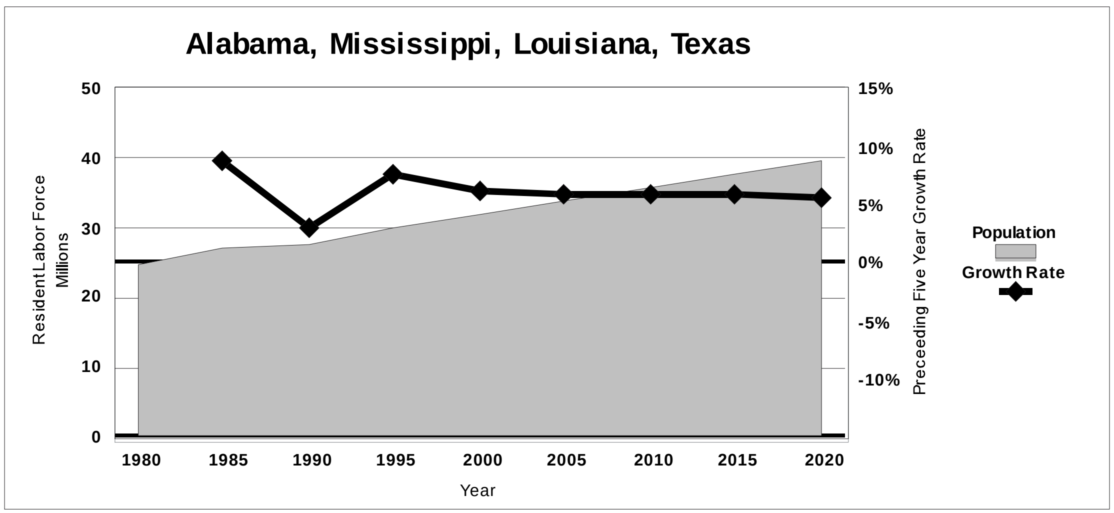

Figure 3-31 HISTORICAL TRENDS AND POPULATION PROJECTIONS FOR GULF COAST COMMUTING ZONES AND THE FOUR-STATE REGION.

the baby-boom years (1946 to 1963). As this cohort ages, the balance of the population correspondingly shifts towards the older groups. Second, the low fertility levels of the late 1960s throughout the 1970s ensured that there were not as many people in the cohorts that followed the Boomers. As Baby Boomers aged, they were not entirely replaced in those age groups by the next cohort. Third, population growth in the nation, the South, and in these areas are likely to slow throughout the next twenty years, since birthrates will remain below death rates, and immigration is not likely to increase from current low levels.

The effect of these factors is seen clearly in table 3-32. Between 1980 and 1995, the proportion of the population less than 20 dropped from 32.5 percent in the region to 29.4 percent. Similarly, within the coastal commuting zones, the percentage of the population at ages less than 20 dropped from 35.5 percent to 32.3 percent. In the age group from 20 to 34, there are greater declines. In the region, this age group drops from 25.3 percent to 22.0 percent. There are absolute declines in this age group between 1985 and 1995, which coincides with the aging of the baby bust cohorts of the 1970s. Similarly there are absolute declines in the coastal area in this age group, corresponding to a proportional decline from 27.6 percent to 22.7 percent.

During the same time period, the older working ages, from 35 to 64, increased proportionally and accounted for much of the region's and coastal area's population increase during this time period. Simply, this meant that the cohort structure of the two regions drove much of the population change between 1980 and 1995. This age composition is likely to continue to drive the patterns and rates of population change to 2020.

Until 2010, when the baby boom begins to retire, the fastest growing age group will continue to be the 35 to 64 year olds. After 2010, the proportion in this age group begins to decline. However the younger age groups (i.e. 0 to 19, 20 to 34) will continue to grow slowly and maintain the same proportion throughout the post-2000 period. The net result is that population growth will moderate around one percent per year by the end of this period and the age structure of the region and coast have shifted toward older age groups.

Differences in age structure, as well as in net migration, among the coastal commuting zone areas could create variations in population growth. As seen in figure 3-32, Texas areas are projected to have the higher population growth rates, exceeding those expected for Louisiana and Mississippi. The highest population growth rates from 2000 to 2020 are projected to be in Brownsville and Beaumont-Port Arthur, followed by Brazoria and the Houston-Galveston area. All have rates above 27 percent for this time period. The lowest population growth rates (under 14 percent) are found in the coastal Louisiana commuting zones of Lake Charles, Lafayette, Houma, and New Orleans. Biloxi-Gulfport, Baton Rouge, Corpus Christi, Mobile, and Victoria are all expected to exhibit low to moderate population growth during this time period.

As seen in figure 3-32, population growth rates are all projected to decline throughout the first two decades of the 21st century. The major difference among the Gulf's coastal commuting zones in final growth levels is set by the apex of population growth projected for the year 2000. Table 3-33 summarizes the recent population trends and future population projections for each of the 13 coastal commuting zones. The local growth rates in the decade between 1995 and 2005 may well be the determining factor for further growth rates in the early 21st century in these areas.

Table 3-33

Recent Population Trends and Future Population Projections for Each of the 13 Coastal Commuting Zones

Coastal Commuting Zone	Age Range and Proportion									
	0-19		20-34		35-64		65+			
Year	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Total	5 Year Rates
Mobile										
1980	177,800	35.4%	124,630	24.8%	147,170	29.3%	52,910	10.5%	502,510	
1985	170,640	32.5%	130,300	24.8%	162,820	31.0%	60,850	11.6%	524,610	4.40%
1990	166,430	31.1%	122,790	22.9%	179,180	33.5%	67,230	12.6%	535,630	2.10%
1995	172,920	30.1%	123,010	21.4%	205,480	35.8%	73,210	12.7%	574,620	7.28%
2000	179,280	29.4%	118,950	19.5%	232,880	38.2%	78,570	12.9%	609,680	6.10%
2005	182,820	28.5%	118,700	18.5%	254,870	39.8%	84,140	13.1%	640,530	5.06%
2010	186,690	27.7%	121,660	18.1%	271,260	40.3%	93,770	13.9%	673,380	5.13%
2015	188,170	26.7%	128,250	18.2%	277,260	39.4%	110,410	15.7%	704,090	4.56%
2020	192,270	26.3%	130,630	17.8%	279,100	38.1%	130,380	17.8%	732,380	4.02%
Biloxi-Gulfport										
1980	135,840	36.9%	93,140	25.3%	107,780	29.3%	31,410	8.5%	368,170	
1985	133,010	34.2%	99,360	25.5%	119,360	30.7%	37,380	9.6%	389,110	5.69%
1990	122,190	31.4%	93,760	24.1%	131,060	33.7%	41,750	10.7%	388,760	-0.09%
1995	131,060	30.7%	96,760	22.7%	151,990	35.6%	46,630	10.9%	426,440	9.69%
2000	142,460	30.1%	100,750	21.3%	178,580	37.7%	52,150	11.0%	473,940	11.14%
2005	148,040	29.2%	103,980	20.5%	197,600	39.0%	57,290	11.3%	506,910	6.96%
2010	152,360	28.4%	106,840	19.9%	213,000	39.7%	65,000	12.1%	537,200	5.98%
2015	154,310	27.3%	113,070	20.0%	219,710	38.9%	77,810	13.8%	564,900	5.16%
2020	158,020	26.8%	116,260	19.7%	222,120	37.7%	93,330	15.8%	589,730	4.40%
New Orleans										
1980	459,700	34.2%	366,470	27.3%	393,360	29.3%	123,880	9.2%	1,343,410	
1985	447,710	32.3%	376,050	27.2%	427,860	30.9%	132,910	9.6%	1,384,530	3.06%
1990	407,960	30.7%	327,630	24.7%	444,900	33.5%	146,720	11.1%	1,327,210	-4.14%
1995	413,150	30.5%	297,390	22.0%	491,060	36.3%	151,920	11.2%	1,353,520	1.98%
2000	410,940	29.8%	282,790	20.5%	526,320	38.2%	159,030	11.5%	1,379,080	1.89%
2005	407,750	28.9%	285,970	20.3%	549,830	39.0%	167,580	11.9%	1,411,130	2.32%
2010	409,140	28.2%	292,620	20.2%	563,480	38.9%	183,320	12.7%	1,448,560	2.65%
2015	411,880	27.6%	301,480	20.2%	566,030	38.0%	211,800	14.2%	1,491,190	2.94%
2020	420,850	27.4%	301,780	19.7%	565,080	36.8%	246,930	16.1%	1,534,640	2.91%
Houma										
1980	102,930	39.2%	70,060	26.7%	70,730	27.0%	18,550	7.1%	262,270	

Table 3-33

Recent Population Trends and Future Population Projections for Each of the 13 Coastal Commuting Zones

Coastal Commuting Zone	Age Range and Proportion									
	0-19		20-34		35-64		65+			
Year	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Total	5 Year Rates
1985	99,380	36.4%	73,900	27.1%	78,700	28.8%	20,980	7.7%	272,960	4.08%
1990	90,180	34.2%	65,980	25.0%	83,400	31.6%	24,060	9.1%	263,620	-3.42%
1995	90,490	33.8%	60,190	22.5%	91,870	34.3%	25,540	9.5%	268,090	1.70%
2000	89,680	32.9%	57,170	21.0%	98,340	36.1%	27,350	10.0%	272,540	1.66%
2005	88,070	31.8%	57,720	20.8%	102,270	36.9%	29,010	10.5%	277,070	1.66%
2010	87,490	31.0%	59,000	20.9%	103,860	36.8%	31,890	11.3%	282,240	1.87%
2015	87,210	30.2%	60,640	21.0%	103,360	35.9%	37,100	12.9%	288,310	2.15%
2020	88,160	29.9%	60,600	20.6%	102,190	34.7%	43,580	14.8%	294,530	2.16%
Baton Rouge										
1980	244,610	36.3%	193,460	28.7%	182,030	27.0%	53,440	7.9%	673,540	
1985	246,230	34.1%	206,560	28.6%	210,880	29.2%	59,460	8.2%	723,130	7.36%
1990	229,080	32.2%	185,750	26.1%	228,490	32.2%	67,160	9.5%	710,480	-1.75%
1995	240,760	32.0%	175,560	23.3%	262,850	34.9%	72,950	9.7%	752,120	5.86%
2000	249,340	31.3%	174,750	21.9%	292,690	36.7%	79,830	10.0%	796,610	5.92%
2005	251,560	30.4%	180,420	21.8%	309,710	37.4%	85,710	10.4%	827,400	3.87%
2010	256,000	29.8%	188,730	21.9%	320,330	37.2%	95,070	11.1%	860,130	3.96%
2015	260,110	29.2%	196,720	22.1%	323,220	36.3%	111,450	12.5%	891,500	3.65%
2020	267,510	29.0%	199,290	21.6%	323,190	35.1%	131,770	14.3%	921,760	3.39%
Lake Charles										
1980	113,950	36.3%	83,640	26.6%	88,450	28.2%	27,850	8.9%	313,890	
1985	112,850	34.2%	90,760	27.5%	96,580	29.3%	29,660	9.0%	329,850	5.08%
1990	104,950	32.6%	83,230	25.9%	100,600	31.3%	32,660	10.2%	321,440	-2.55%
1995	103,000	31.5%	77,620	23.8%	111,300	34.1%	34,720	10.6%	326,640	1.62%
2000	100,560	30.1%	75,780	22.7%	120,350	36.0%	37,480	11.2%	334,170	2.31%
2005	97,950	28.7%	77,880	22.8%	125,990	36.9%	39,930	11.7%	341,750	2.27%
2010	96,820	27.6%	80,510	23.0%	129,220	36.9%	43,900	12.5%	350,450	2.55%
2015	96,160	26.7%	83,440	23.2%	129,580	36.0%	50,760	14.1%	359,940	2.71%
2020	97,100	26.3%	84,180	22.8%	129,150	34.9%	59,280	16.0%	369,710	2.71%
Lafayette										
1980	179,400	37.5%	122,230	25.6%	132,890	27.8%	43,850	9.2%	478,370	
1985	182,410	35.4%	134,700	26.1%	150,410	29.2%	48,310	9.4%	515,830	7.83%
1990	167,000	33.6%	120,920	24.3%	155,980	31.4%	52,760	10.6%	496,660	-3.72%

Table 3-33

Recent Population Trends and Future Population Projections for Each of the 13 Coastal Commuting Zones

Coastal Commuting Zone	Age Range and Proportion									
	0-19		20-34		35-64		65+			
Year	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Total	5 Year Rates
1995	172,570	33.2%	113,700	21.9%	176,790	34.0%	57,200	11.0%	520,260	4.75%
2000	176,090	32.2%	111,260	20.3%	196,620	35.9%	62,980	11.5%	546,950	5.13%
2005	175,960	31.1%	114,300	20.2%	208,210	36.8%	67,570	11.9%	566,040	3.49%
2010	177,480	30.3%	118,450	20.2%	215,290	36.8%	74,510	12.7%	585,730	3.48%
2015	179,010	29.6%	122,950	20.3%	217,350	35.9%	86,310	14.3%	605,620	3.40%
2020	182,880	29.3%	123,770	19.8%	217,700	34.8%	1,850	0.3%	625,200	3.23%
Victoria										
1980	49,710	34.2%	33,560	23.1%	43,710	30.1%	18,450	12.7%	145,430	
1985	50,310	32.4%	35,790	23.0%	49,100	31.6%	20,210	13.0%	155,410	6.86%
1990	47,480	31.6%	30,970	20.6%	49,710	33.1%	21,860	14.6%	150,020	-3.47%
1995	49,900	31.3%	29,170	18.3%	57,250	35.9%	23,000	14.4%	159,320	6.20%
2000	51,750	31.4%	27,170	16.5%	61,830	37.5%	23,980	14.6%	164,730	3.40%
2005	53,120	30.8%	28,060	16.3%	65,930	38.2%	25,480	14.8%	172,590	4.77%
2010	54,650	30.2%	29,500	16.3%	68,650	38.0%	28,090	15.5%	180,890	4.81%
2015	56,430	29.6%	31,570	16.5%	70,340	36.9%	32,420	17.0%	190,760	5.46%
2020	59,490	29.5%	32,050	15.9%	72,140	35.8%	37,700	18.7%	201,380	5.57%
Brownsville										
1980	232,290	42.8%	122,310	22.5%	137,640	25.3%	50,810	9.4%	543,050	
1985	260,430	40.8%	150,080	23.5%	168,710	26.4%	59,130	9.3%	638,350	17.55%
1990	284,200	40.2%	157,360	22.2%	194,940	27.6%	70,890	10.0%	707,390	10.82%
1995	337,980	39.4%	178,140	20.8%	256,150	29.8%	85,930	10.0%	858,200	21.32%
2000	397,590	38.9%	202,900	19.8%	317,890	31.1%	104,170	10.2%	1,022,550	19.15%
2005	434,760	38.0%	232,290	20.3%	358,180	31.3%	108,660	9.5%	1,143,890	11.87%
2010	473,580	37.3%	265,170	20.9%	389,870	30.7%	139,530	11.0%	1,268,150	10.86%
2015	510,220	36.7%	298,620	21.5%	410,130	29.5%	169,530	12.2%	1,388,500	9.49%
2020	554,870	36.7%	320,720	21.2%	430,810	28.5%	25,970	1.7%	1,512,370	8.92%
Corpus Christi										
1980	164,120	37.2%	112,250	25.4%	125,300	28.4%	39,820	9.0%	441,490	
1985	165,920	35.0%	120,830	25.5%	142,450	30.0%	44,900	9.5%	474,100	7.39%
1990	158,680	34.1%	107,950	23.2%	148,760	32.0%	50,180	10.8%	465,570	-1.80%
1995	167,350	33.5%	105,530	21.1%	172,070	34.4%	54,670	10.9%	499,620	7.31%
2000	173,590	33.2%	102,930	19.7%	186,550	35.7%	59,360	11.4%	522,430	4.57%

Table 3-33

Recent Population Trends and Future Population Projections for Each of the 13 Coastal Commuting Zones

Coastal Commuting Zone	Age Range and Proportion									
	0-19		20-34		35-64		65+			
Year	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Total	5 Year Rates
2005	178,210	32.4%	108,930	19.8%	198,540	36.1%	64,190	11.7%	549,870	5.25%
2010	183,900	31.7%	116,810	20.2%	206,560	35.6%	72,270	12.5%	579,540	5.40%
2015	190,390	31.1%	126,400	20.6%	210,970	34.4%	85,200	13.9%	612,960	5.77%
2020	201,090	31.0%	130,780	20.2%	215,800	33.3%	101,000	15.6%	648,670	5.83%
Brazoria										
1980	86,460	34.8%	69,040	27.8%	72,910	29.4%	19,720	7.9%	248,130	
1985	88,960	33.2%	73,440	27.4%	83,800	31.2%	22,130	8.2%	268,330	8.14%
1990	88,410	32.8%	66,490	24.7%	89,340	33.2%	24,990	9.3%	269,230	0.34%
1995	95,720	32.5%	63,060	21.4%	108,060	36.7%	27,250	9.3%	294,090	9.23%
2000	102,530	32.7%	58,440	18.7%	122,650	39.2%	29,560	9.4%	313,180	6.49%
2005	107,120	32.2%	60,150	18.1%	133,250	40.1%	32,090	9.6%	332,610	6.20%
2010	111,890	31.6%	65,010	18.4%	140,810	39.8%	36,100	10.2%	353,810	6.37%
2015	116,780	31.1%	70,120	18.7%	145,870	38.8%	43,010	11.4%	375,780	6.21%
2020	124,060	31.1%	72,060	18.1%	150,790	37.8%	51,620	13.0%	398,530	6.05%
Houston-Galveston										
1980	1015470	33.8%	910,580	30.3%	877,050	29.2%	199,580	6.6%	3,002,680	
1985	1104890	32.2%	1026580	30.0%	1064970	31.1%	230,970	6.7%	3,427,410	14.15%
1990	1165150	32.2%	979,790	27.0%	1208680	33.4%	269,710	7.4%	3,623,330	5.72%
1995	1272860	31.7%	968,060	24.1%	1472970	36.7%	303,030	7.5%	4,016,920	10.86%
2000	1385130	31.9%	946,340	21.8%	1670550	38.5%	339,370	7.8%	4,341,390	8.08%
2005	1466870	31.4%	1007140	21.6%	1816760	38.9%	374,980	8.0%	4,665,750	7.47%
2010	1554680	31.1%	1088160	21.8%	1923650	38.5%	429,670	8.6%	4,996,160	7.08%
2015	1641970	30.7%	1186100	22.2%	1995160	37.3%	523,450	9.8%	5,346,680	7.02%
2020	1763410	30.9%	1239020	21.7%	2062610	36.1%	641,350	11.2%	5,706,390	6.73%
Beaumont-Port Arthur										
1980	152,880	33.4%	108,830	23.8%	144,010	31.5%	51,700	11.3%	457,420	
1985	147,220	31.4%	111,540	23.8%	153,260	32.7%	56,830	12.1%	468,850	2.50%
1990	138,960	30.6%	96,550	21.3%	154,210	34.0%	63,660	14.0%	453,380	-3.30%
1995	142,410	29.4%	93,960	19.4%	179,360	37.0%	68,650	14.2%	484,380	6.84%
2000	145,890	28.7%	91,260	18.0%	197,150	38.8%	73,960	14.6%	508,260	4.93%
2005	150,290	27.6%	97,570	17.9%	215,740	39.7%	80,440	14.8%	544,040	7.04%
2010	155,130	26.6%	106,280	18.2%	230,950	39.6%	90,670	15.6%	583,030	7.17%

Table 3-33

Recent Population Trends and Future Population Projections for Each of the 13 Coastal Commuting Zones

Coastal Commuting Zone	Age Range and Proportion									
	0-19		20-34		35-64		65+			
Year	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Total	5 Year Rates
2015	160,630	25.6%	117,110	18.7%	243,070	38.8%	106,330	17.0%	627,140	7.57%
2020	170,400	25.3%	122,750	18.2%	255,650	37.9%	125,160	18.6%	673,960	7.47%

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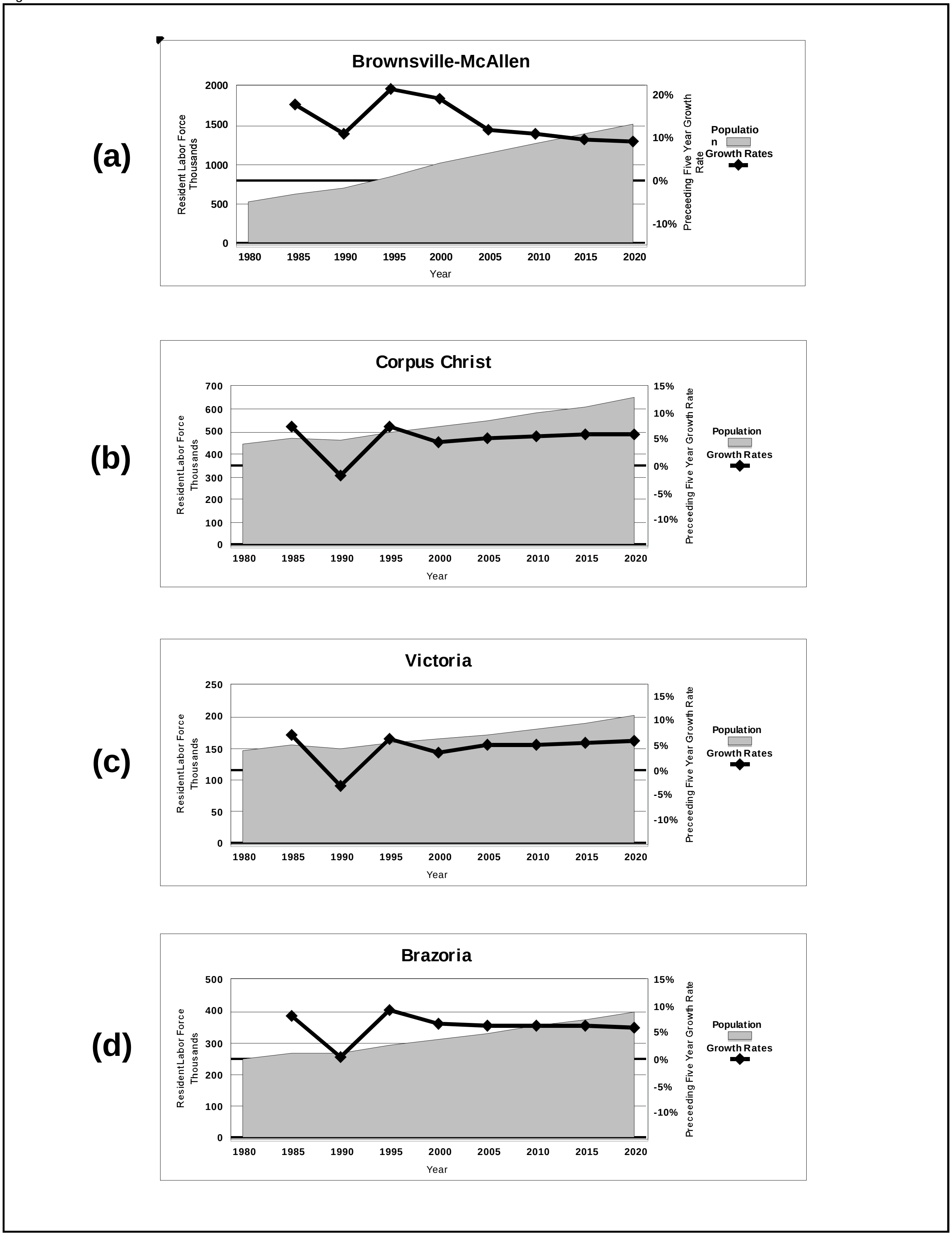

Fig. 3-32. Historical trends and population projections for each of the 13 Gulf coast commuting zones (a-d).

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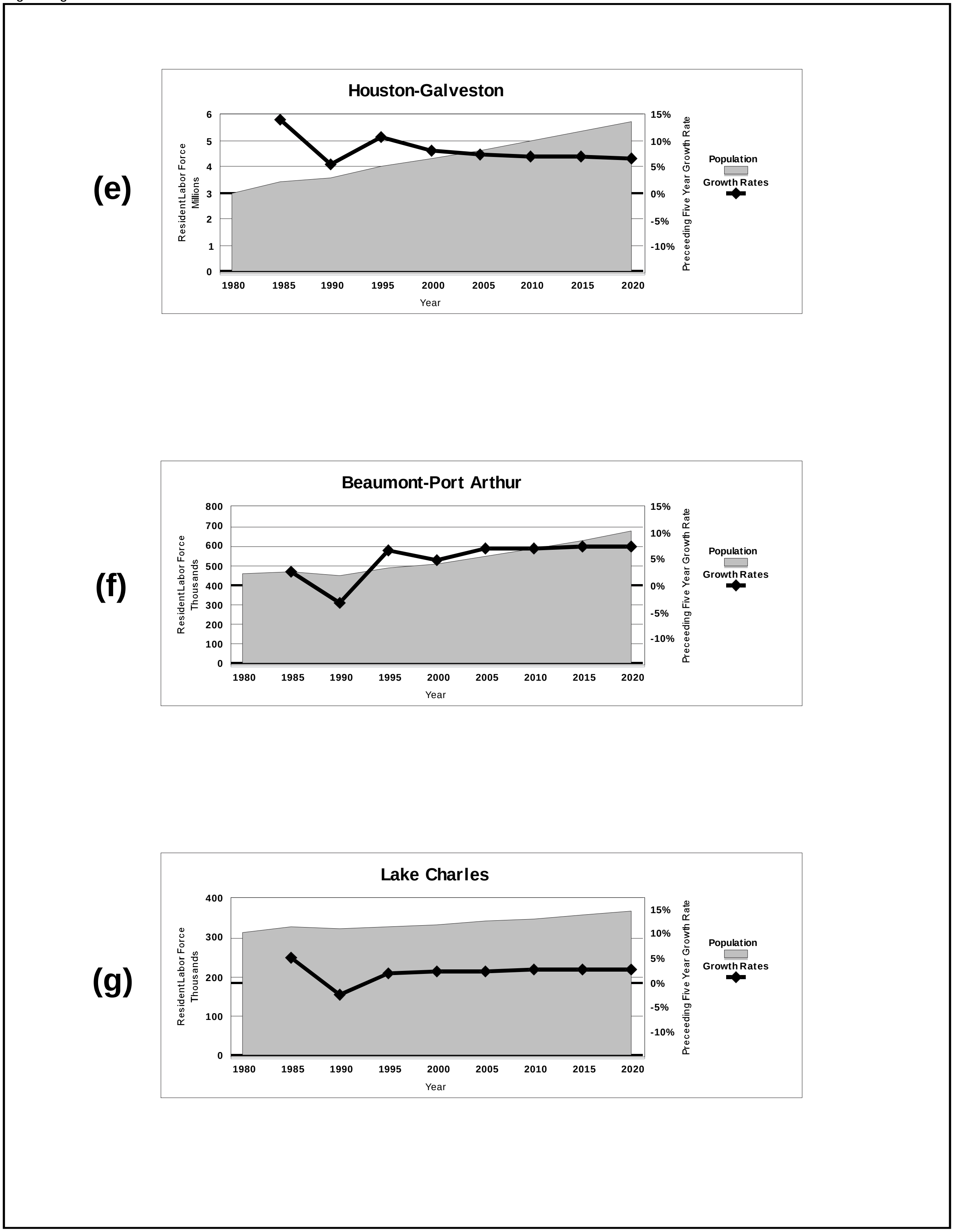

Fig. 3-32. Historical trends and population projections for each of the 13 Gulf coast commuting zones (e-g).

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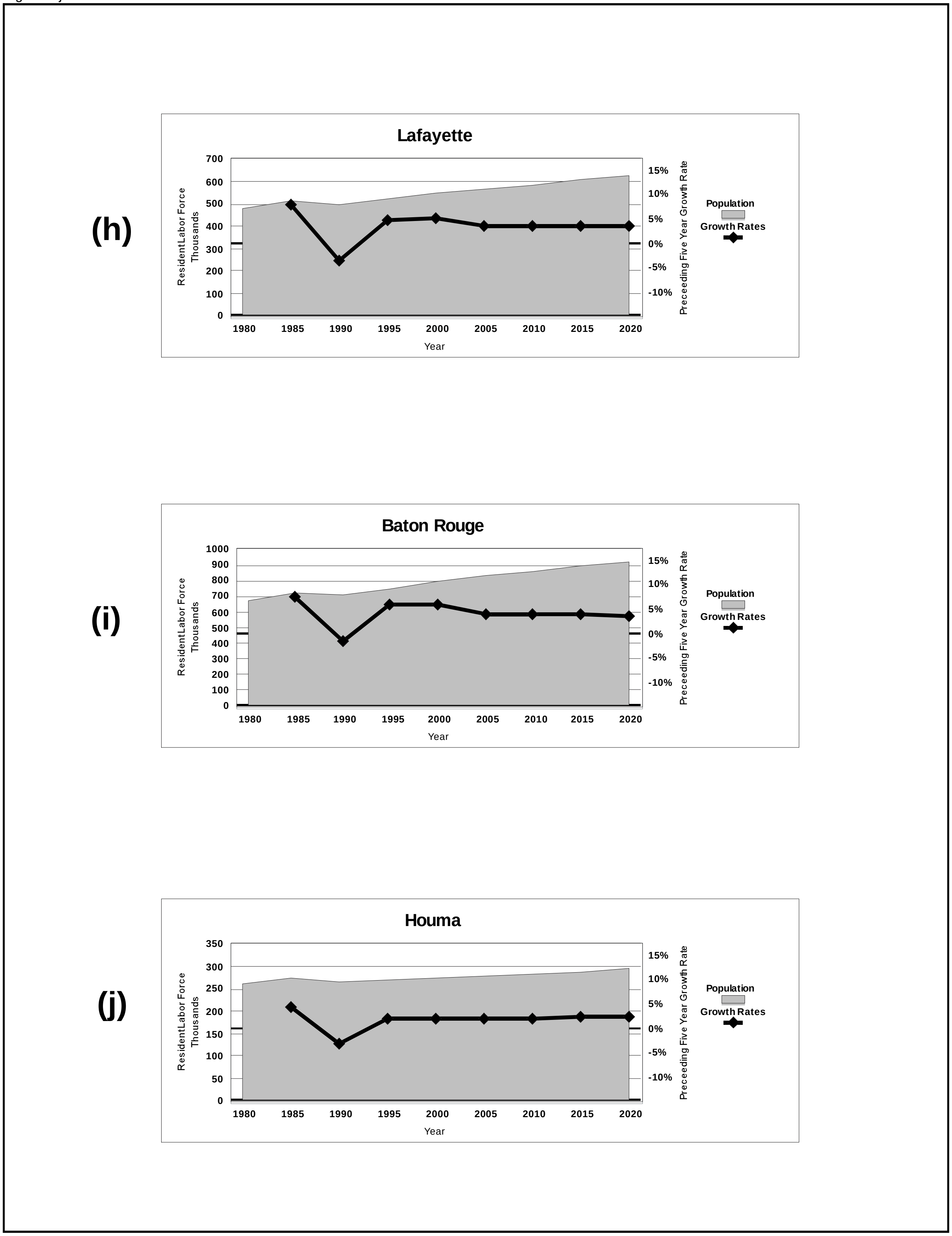

Fig. 3-32. Historical trends and population projections for each of the 13 Gulf coast commuting zones (h-j).

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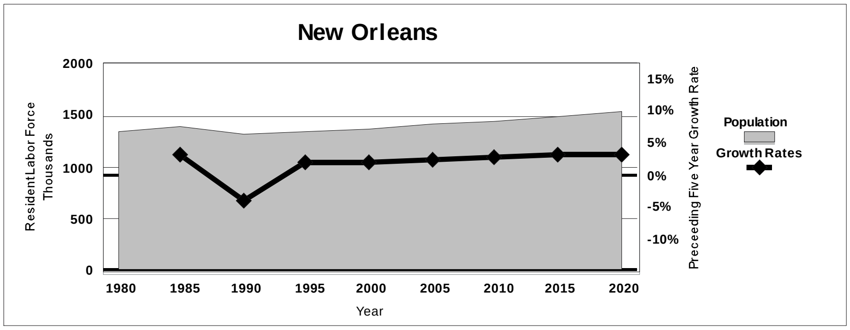
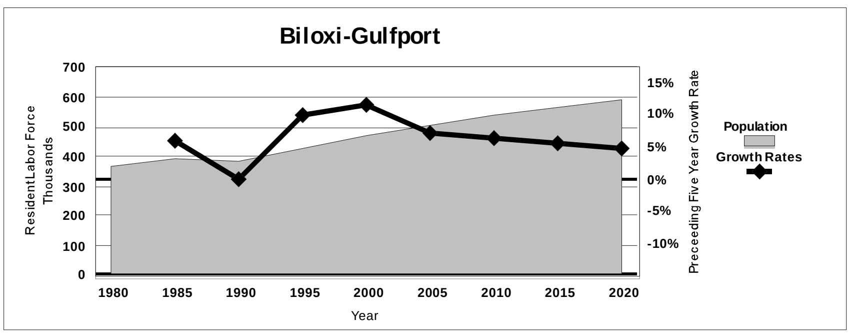
Fig3-32km.CDR-7/14/00-GRA

(k)



(l)



(m)

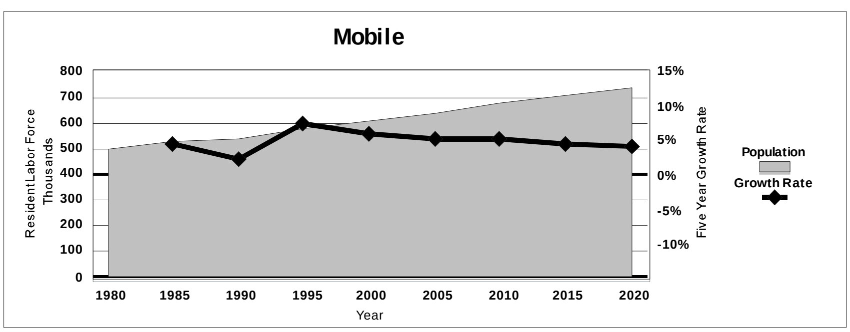


Fig. 3-32. Historical trends and population projections for each of the 13 Gulf coast commuting zones (k-m).

Labor Force Projections

Although labor force changes and population changes are interrelated, trends can and do diverge when much of the change in population is found in the non-working ages. This is the case in both the four-state region and coastal commuting zone, as reflected in table 3-34 and figures 3-33 and 3-34. The divergence in labor force trends and population change is evident in a comparison of figures 3-31 and 3-33, where population changes are expected to generally remain constant while the five year rates for labor force change decrease throughout the projection period.

Once in double digits during the 1980 to 1985 period, labor force change is projected to drop to 2.45 percent for the region and 5.67 percent for the coastal areas by the 2015 to 2020 period. Also note that labor force growth rates drop considerably faster than do population growth rates throughout the first two decades of the 21st century (e.g., compare tables 3-32 and 3-34). This difference between population and labor force is due to the changing age structure of the population.

For the region, the proportion of the labor force in younger ages (i.e., 20 to 34) is projected to stabilize around 33 percent, with a slight rise in proportions in 2015 and 2020. The coastal areas follow the same trend with a slightly higher proportion in this age group than projected for the region. At the same time, the proportion of older workers (i.e., 35 to 64) stabilizes in the region, then declines after 2010. In the coastal areas this decline begins in 2005. This reflects the retirement of the Baby Boom cohorts. As they exit the labor force, growth in this age segment of the labor force slows. Because the 35 to 64 ages comprise the largest category of labor during this time period, this slows overall labor force sooner than population growth rates. By 2020, the Baby Boom will no longer affect labor force changes and the labor force is projected to enter into a period of long-term slow growth.

A review of figure 3-34 indicates that the same geographic pattern for growth exists as for population (i.e., compare to figure 3-30). The coastal Texas commuting zones of Brownsville and Beaumont-Port Arthur have the highest labor force growth rates, followed by Brazoria and the Houston-Galveston area. The coastal Louisiana commuting zones of Lake Charles, Lafayette, Houma, and New Orleans have the lowest growth rates. Moderate labor force growth is projected for Mobile, Biloxi-Gulfport, Baton Rouge, Corpus Christi, and Victoria.

By and large these declines in labor force growth can be explained by the aging of the labor force, as detailed for each of the coastal commuting zones in table 3-35. Graphic presentations of labor force trends for each of the 13 commuting zones are presented in figure 3-35. With the exception of Brownsville (which has the highest overall labor force growth rates), all the commuting zones have more than 50 percent of their labor force in the 35 to 64 age group throughout the projection period.

Also, as with population, the period from 2000 to 2005 is projected to be a critical period for all commuting zones (figure 3-35). With growth rates falling throughout the projection period, cumulative growth for the first two decades of the 21st century is largely set between 2000 and 2005.

Table 3-34

Summary of Recent Labor Force Trends (1980-1995) and Projections for the Gulf Coast Commuting Zones and the Four-state Region (2000-2020)

	Age Range and Proportion									
	0-19		20-34		35-64		65+			
Year	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Total	5 Year Rates
All Coastal Commuting Zones										
1980	677,810	15.1%	1,911,890	42.6%	1,812,341	40.4%	86,860	1.9%	4,488,901	
1985	631,350	12.6%	2,136,310	42.7%	2,147,100	43.0%	82,560	1.7%	4,997,320	11.33%
1990	607,120	11.8%	1,911,890	38.8%	2,436,120	47.4%	102,680	2.0%	5,140,900	2.87%
1995	656,280	11.7%	1,940,370	34.6%	2,888,350	51.6%	115,790	2.1%	5,600,790	8.95%
2000	731,430	12.1%	1,918,020	31.7%	3,288,040	54.3%	122,600	2.0%	6,060,090	8.20%
2005	766,740	11.9%	2,019,390	31.3%	3,538,210	54.8%	135,400	2.1%	6,459,740	6.59%
2010	824,120	12.1%	2,155,930	31.7%	3,669,680	53.9%	158,940	2.3%	6,808,670	5.40%
2015	811,420	11.5%	2,317,800	32.9%	3,726,410	52.8%	199,070	2.8%	7,054,700	3.61%
2020	843,070	11.6%	2,400,310	33.0%	3,787,410	52.1%	239,070	3.3%	7,269,860	3.05%
Four-State Region										
1980	1,919,910	15.3%	5,171,390	41.3%	5,144,110	41.1%	288,180	2.3%	12,523,590	
1985	1,779,530	12.7	5,907,770	42.3%	6,031,630	43.1%	263,850	1.9%	13,982,780	11.65%
1990	1,745,120	11.9	5,741,390	39.0%	6,910,510	47.0%	318,870	2.2%	14,715,890	5.24%
1995	1,842,970	11.6	5,576,460	35.0%	8,137,640	51.1%	355,610	2.2%	15,912,680	8.13%
2000	2,016,240	11.8	5,457,070	32.0%	9,228,390	54.1%	371,050	2.2%	17,072,750	7.29%
2005	2,109,700	11.6	5,701,420	31.4%	9,951,180	54.8%	407,400	2.2%	18,169,700	6.43%
2010	2,270,390	11.9	6,049,780	31.6%	10,339,790	54.0%	475,630	2.5%	19,135,590	5.32%
2015	2,223,310	11.2	6,495,380	32.8%	10,500,180	53.0%	592,560	3.0%	19,811,430	3.53%
2020	2,299,470	11.3	6,719,420	32.9%	10,666,120	52.3%	708,700	3.5%	20,393,710	2.94%

Table 3-35

Summary of Labor Force Historical Trends and Future Projections for the 13 Coastal Commuting Zones

Coastal Commuting Zone	Age Range and Proportion									
	0-19		20-34		35-64		65+			
Year	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Total	5 Year Rates
Mobile										
1980	39,260	15.9%	97,980	39.7%	103,530	41.9%	6,300	2.5%	247,070	
1985	34,730	13.2%	104,760	39.7%	118,080	44.8%	6,040	2.3%	263,610	6.69%
1990	33,490	12.2%	99,450	36.1%	135,310	49.1%	7,190	2.6%	275,440	4.49%
1995	34,240	11.5%	99,210	33.3%	156,210	52.5%	8,020	2.7%	297,680	8.07%
2000	35,230	11.0%	96,460	30.2%	179,440	56.2%	8,310	2.6%	319,440	7.31%
2005	37,260	11.0%	96,390	28.5%	195,930	57.8%	9,150	2.7%	338,730	6.04%
2010	39,790	11.2%	98,810	27.9%	205,210	57.9%	10,690	3.0%	354,500	4.66%
2015	38,730	10.7%	104,210	28.7%	206,910	57.0%	13,350	3.7%	363,200	2.45%
2020	38,590	10.5%	106,320	29.0%	206,300	56.2%	15,820	4.3%	367,030	1.05%
Biloxi										
1980	31,420	16.8%	73,960	39.6%	77,580	41.5%	3,790	2.0%	186,750	
1985	27,760	13.9%	80,800	40.3%	87,890	43.9%	3,850	1.9%	200,300	7.26%
1990	25,380	12.3%	76,920	37.1%	100,050	48.3%	4,760	2.3%	207,110	3.40%
1995	26,840	11.8%	78,830	34.6%	116,610	51.2%	5,560	2.4%	227,840	10.01%
2000	29,160	11.4%	82,410	32.1%	138,810	54.1%	6,020	2.3%	256,400	12.54%
2005	30,790	11.1%	85,210	30.8%	153,450	55.5%	6,840	2.5%	276,290	7.76%
2010	33,660	11.5%	87,500	29.9%	163,070	55.8%	8,070	2.8%	292,300	5.79%
2015	33,030	10.9%	92,500	30.6%	166,260	55.1%	10,120	3.4%	301,910	3.29%
2020	33,270	10.8%	95,180	31.0%	166,890	54.3%	12,070	3.9%	307,410	1.82%
New Orleans										
1980	101,960	14.9%	288,450	42.2%	278,980	40.8%	14,230	2.1%	683,620	
1985	90,400	12.6%	302,110	42.1%	311,830	43.5%	13,150	1.8%	717,490	4.95%
1990	79,390	11.4%	264,530	37.9%	337,290	48.4%	15,900	2.3%	697,110	-2.84%
1995	84,680	11.9%	239,030	33.5%	373,800	52.3%	16,740	2.3%	714,250	2.46%
2000	86,740	11.8%	227,770	30.9%	405,300	55.0%	16,720	2.3%	736,530	3.12%
2005	85,320	11.3%	230,620	30.5%	421,470	55.8%	17,810	2.4%	755,220	2.54%
2010	86,890	11.3%	236,400	30.8%	424,800	55.3%	20,190	2.6%	768,280	1.73%
2015	83,550	10.8%	243,620	31.5%	420,940	54.5%	24,480	3.2%	772,590	0.56%
2020	84,160	10.9%	244,090	31.5%	417,290	53.9%	28,690	3.7%	774,230	0.21%

Table 3-35

Summary of Labor Force Historical Trends and Future Projections for the 13 Coastal Commuting Zones

Coastal Commuting Zone	Age Range and Proportion									
	0-19		20-34		35-64		65+			
Year	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Total	5 Year Rates
Houma										
1980	23,340	17.6%	55,680	42.0%	51,200	38.7%	2,250	1.7%	132,470	
1985	19,890	14.2%	60,030	42.8%	58,220	41.5%	2,140	1.5%	140,280	5.90%
1990	16,590	12.1%	53,870	39.3%	64,000	46.7%	2,650	1.9%	137,110	-2.26%
1995	17,580	12.5%	48,860	34.9%	70,790	50.5%	2,890	2.1%	140,120	2.20%
2000	18,390	12.7%	46,430	32.1%	76,700	53.1%	2,970	2.1%	144,490	3.12%
2005	18,090	12.3%	46,920	31.8%	79,420	53.8%	3,160	2.1%	147,590	2.15%
2010	18,370	12.3%	48,000	32.1%	79,420	53.2%	3,610	2.4%	149,400	1.23%
2015	17,670	11.8%	49,330	33.0%	78,060	52.2%	4,410	3.0%	149,470	0.05%
2020	17,730	11.9%	49,330	33.1%	76,780	51.5%	5,190	3.5%	149,030	-0.29%
Baton Rouge										
1980	57,400	16.6%	152,710	44.1%	129,890	37.5%	6,350	1.8%	346,350	
1985	52,310	13.8%	166,310	43.8%	155,250	40.9%	5,990	1.6%	379,860	9.68%
1990	46,700	12.3%	150,360	39.6%	175,220	46.2%	7,290	1.9%	379,570	-0.08%
1995	51,510	12.8%	141,140	35.0%	202,060	50.2%	8,060	2.0%	402,770	6.11%
2000	55,310	12.8%	140,560	32.6%	227,210	52.7%	8,440	2.0%	431,520	7.14%
2005	55,500	12.4%	145,230	32.3%	239,260	53.3%	9,150	2.0%	449,140	4.08%
2010	57,480	12.4%	152,010	32.8%	243,610	52.5%	10,510	2.3%	463,610	3.22%
2015	56,320	12.0%	158,470	33.7%	242,810	51.6%	12,990	2.8%	470,590	1.51%
2020	57,410	12.1%	160,680	33.8%	241,540	50.8%	15,390	3.2%	475,020	0.94%
Lake Charles										
1980	26,140	16.4%	66,510	41.8%	63,190	39.7%	3,370	2.1%	159,210	
1985	23,090	13.5%	73,840	43.3%	70,680	41.4%	2,990	1.8%	170,600	7.15%
1990	20,580	12.2%	68,300	40.4%	76,580	45.3%	3,530	2.1%	168,990	-0.94%
1995	20,900	12.0%	63,360	36.5%	85,350	49.2%	3,850	2.2%	173,460	2.65%
2000	21,290	11.8%	61,830	34.3%	93,370	51.7%	3,940	2.2%	180,430	4.02%
2005	20,690	11.1%	63,540	34.2%	97,320	52.4%	4,270	2.3%	185,820	2.99%
2010	20,820	11.0%	65,780	34.7%	98,200	51.8%	4,830	2.5%	189,630	2.05%
2015	19,770	10.3%	68,190	35.7%	97,210	50.9%	5,860	3.1%	191,030	0.74%
2020	19,700	10.3%	68,840	35.9%	96,290	50.2%	6,860	3.6%	191,690	0.35%

Table 3-35

Summary of Labor Force Historical Trends and Future Projections for the 13 Coastal Commuting Zones

Coastal Commuting Zone	Age Range and Proportion									
	0-19		20-34		35-64		65+			
Year	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Total	5 Year Rates
Lafayette										
1980	40,870	17.2%	96,590	40.8%	94,280	39.8%	5,240	2.2%	236,980	
1985	36,330	14.0%	108,730	41.9%	109,590	42.2%	4,760	1.8%	259,410	9.46%
1990	30,560	12.1%	98,260	38.9%	118,470	46.9%	5,500	2.2%	252,790	-2.55%
1995	33,310	12.5%	91,850	34.5%	134,900	50.7%	6,090	2.3%	266,150	5.29%
2000	35,760	12.6%	89,870	31.7%	151,690	53.5%	6,380	2.2%	283,700	6.59%
2005	35,670	12.1%	92,380	31.3%	159,990	54.2%	6,890	2.3%	294,930	3.96%
2010	36,680	12.1%	95,830	31.6%	162,740	53.7%	7,900	2.6%	303,150	2.79%
2015	35,570	11.6%	99,450	32.4%	162,150	52.9%	9,610	3.1%	306,780	1.20%
2020	36,000	11.7%	100,200	32.4%	161,470	52.3%	11,320	3.7%	308,990	0.72%
Victoria										
1980	11,080	15.6%	26,810	37.8%	30,950	43.6%	2,080	2.9%	70,920	
1985	9,780	12.8%	29,320	38.3%	35,590	46.5%	1,900	2.5%	76,590	7.99%
1990	8,610	11.6%	25,630	34.5%	37,810	50.9%	2,240	3.0%	74,290	-3.00%
1995	9,180	11.5%	24,090	30.2%	44,170	55.3%	2,440	3.1%	79,880	7.52%
2000	10,290	12.3%	22,470	26.8%	48,560	57.9%	2,480	3.0%	83,800	4.91%
2005	10,830	12.2%	23,220	26.3%	51,710	58.5%	2,660	3.0%	88,420	5.51%
2010	11,740	12.7%	24,460	26.5%	53,040	57.5%	3,060	3.3%	92,300	4.39%
2015	11,540	12.1%	26,150	27.5%	53,630	56.4%	3,710	3.9%	95,030	2.96%
2020	12,110	12.4%	26,600	27.2%	54,570	55.9%	4,380	4.5%	97,660	2.77%
Brownsville										
1980	45,610	18.5%	96,520	39.2%	97,630	39.7%	6,210	2.5%	245,970	
1985	50,220	16.7%	122,410	40.6%	122,960	40.8%	6,020	2.0%	301,610	22.62%
1990	58,090	16.8%	129,920	37.6%	149,230	43.2%	8,020	2.3%	345,260	14.47%
1995	68,200	16.1%	146,680	34.6%	199,270	47.0%	10,180	2.4%	424,330	22.90%
2000	84,630	16.4%	167,480	32.5%	251,780	48.8%	12,070	2.3%	515,960	21.59%
2005	92,840	15.9%	192,240	33.0%	284,050	48.7%	14,130	2.4%	583,260	13.04%
2010	105,360	16.3%	219,740	33.9%	305,260	47.1%	17,380	2.7%	647,740	11.06%
2015	110,370	15.8%	247,590	35.5%	317,830	45.5%	22,140	3.2%	697,930	7.75%
2020	120,780	16.2%	266,390	35.7%	332,160	44.5%	26,990	3.6%	746,320	6.93%

Table 3-35

Summary of Labor Force Historical Trends and Future Projections for the 13 Coastal Commuting Zones

Coastal Commuting Zone	Age Range and Proportion									
	0-19		20-34		35-64		65+			
Year	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Total	5 Year Rates
Corpus Christi										
1980	35,240	16.1%	89,620	40.9%	89,540	40.8%	4,850	2.2%	219,250	
1985	32,440	13.5%	99,200	41.2%	104,330	43.4%	4,540	1.9%	240,510	9.70%
1990	30,480	12.7%	89,530	37.3%	114,160	47.6%	5,630	2.3%	239,800	-0.30%
1995	32,150	12.4%	87,200	33.6%	133,590	51.5%	6,330	2.4%	259,270	8.12%
2000	35,650	13.0%	85,190	31.0%	147,150	53.6%	6,650	2.4%	274,640	5.93%
2005	37,190	12.8%	90,240	31.0%	156,380	53.7%	7,310	2.5%	291,120	6.00%
2010	40,260	13.2%	96,830	31.7%	160,280	52.4%	8,560	2.8%	305,930	5.09%
2015	39,840	12.6%	104,780	33.1%	161,570	51.0%	10,590	3.3%	316,780	3.55%
2020	41,930	12.8%	108,610	33.2%	164,020	50.1%	12,640	3.9%	327,200	3.29%
Brazoria										
1980	18,650	14.3%	55,810	42.9%	53,370	41.0%	2,350	1.8%	130,180	
1985	16,780	11.8%	60,690	42.6%	62,760	44.1%	2,200	1.5%	142,430	9.41%
1990	15,760	11.0%	55,350	38.6%	69,580	48.5%	2,750	1.9%	143,440	0.71%
1995	17,090	10.9%	52,270	33.3%	84,750	53.9%	3,090	2.0%	157,200	9.59%
2000	19,600	11.6%	48,580	28.8%	97,360	57.7%	3,250	1.9%	168,790	7.37%
2005	20,840	11.6%	50,090	27.8%	105,440	58.6%	3,570	2.0%	179,940	6.61%
2010	22,780	11.9%	54,230	28.4%	109,910	57.5%	4,230	2.2%	191,150	6.23%
2015	22,500	11.3%	58,520	29.4%	112,520	56.6%	5,310	2.7%	198,850	4.03%
2020	23,700	11.5%	60,310	29.3%	115,620	56.1%	6,390	3.1%	206,020	3.61%
Houston-Galveston										
1980	212,660	13.3%	725,080	45.3%	640,660	40.0%	23,700	1.5%	1,602,100	
1985	208,300	11.1%	837,700	44.8%	799,730	42.8%	23,370	1.3%	1,869,100	16.67%
1990	215,340	10.8%	804,110	40.4%	942,890	47.3%	30,360	1.5%	1,992,700	6.61%
1995	233,480	10.6%	791,240	35.8%	1151350	52.1%	34,950	1.6%	2,211,020	10.96%
2000	269,410	11.2%	774,530	32.3%	1319550	55.0%	37,500	1.6%	2,400,990	8.59%
2005	289,930	11.2%	823,860	31.9%	1429030	55.3%	41,810	1.6%	2,584,630	7.65%
2010	316,140	11.5%	889,900	32.4%	1490830	54.3%	49,770	1.8%	2,746,640	6.27%
2015	309,810	10.8%	969,770	33.8%	1526970	53.2%	64,040	2.2%	2,870,590	4.51%
2020	324,010	10.9%	1013890	34.0%	1567530	52.5%	78,500	2.6%	2,983,930	3.95%
1980	34,180	15.0%	86,170	37.8%	101,540	44.5%	6,140	2.7%	228,030	

Table 3-35

Summary of Labor Force Historical Trends and Future Projections for the 13 Coastal Commuting Zones

Coastal Commuting Zone	Age Range and Proportion									
	0-19		20-34		35-64		65+			
Year	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Total	5 Year Rates
Beaumont										
1985	29,320	12.4%	90,410	38.4%	110,190	46.8%	5,610	2.4%	235,530	3.29%
1990	26,150	11.5%	78,750	34.6%	115,530	50.8%	6,860	3.0%	227,290	-3.50%
1995	27,120	11.0%	76,610	31.0%	135,500	54.9%	7,590	3.1%	246,820	8.59%
2000	29,970	11.4%	74,440	28.3%	151,120	57.4%	7,870	3.0%	263,400	6.72%
2005	31,790	11.2%	79,450	27.9%	164,760	57.9%	8,650	3.0%	284,650	8.07%
2010	34,150	11.2%	86,440	28.4%	173,310	57.0%	10,140	3.3%	304,040	6.81%
2015	32,720	10.2%	95,220	29.8%	179,550	56.1%	12,460	3.9%	319,950	5.23%
2020	33,680	10.0%	99,870	29.8%	186,950	55.8%	14,830	4.4%	335,330	4.81%

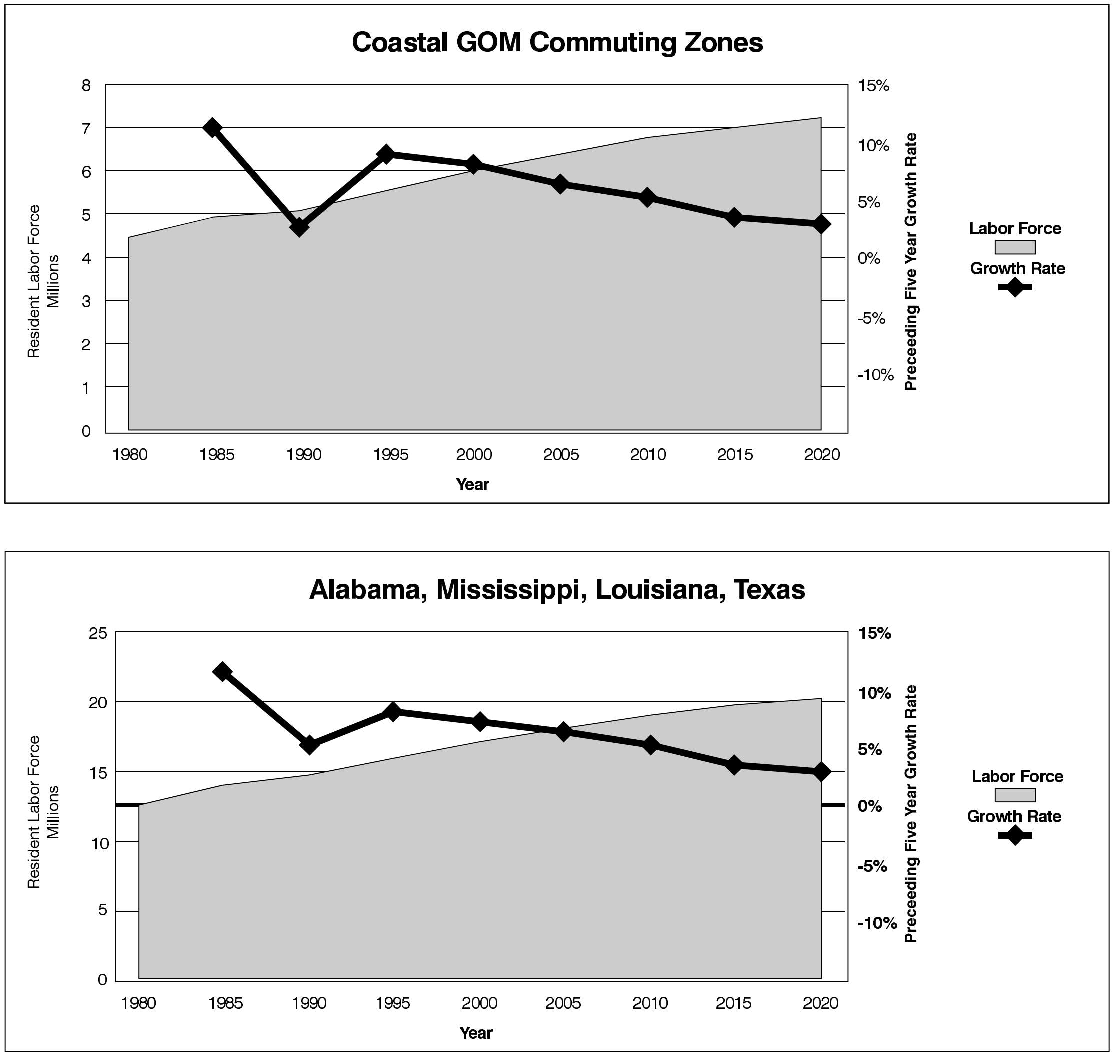


Figure 3-33 **HISTORICAL TRENDS AND LABOR FORCE PROJECTIONS FOR GULF COAST COMMUTING ZONES AND THE FOUR-STATE REGION.**

02:001000_MM01_00_03_90-B0266
Fig3-34.CDR-7/26/00-GRA

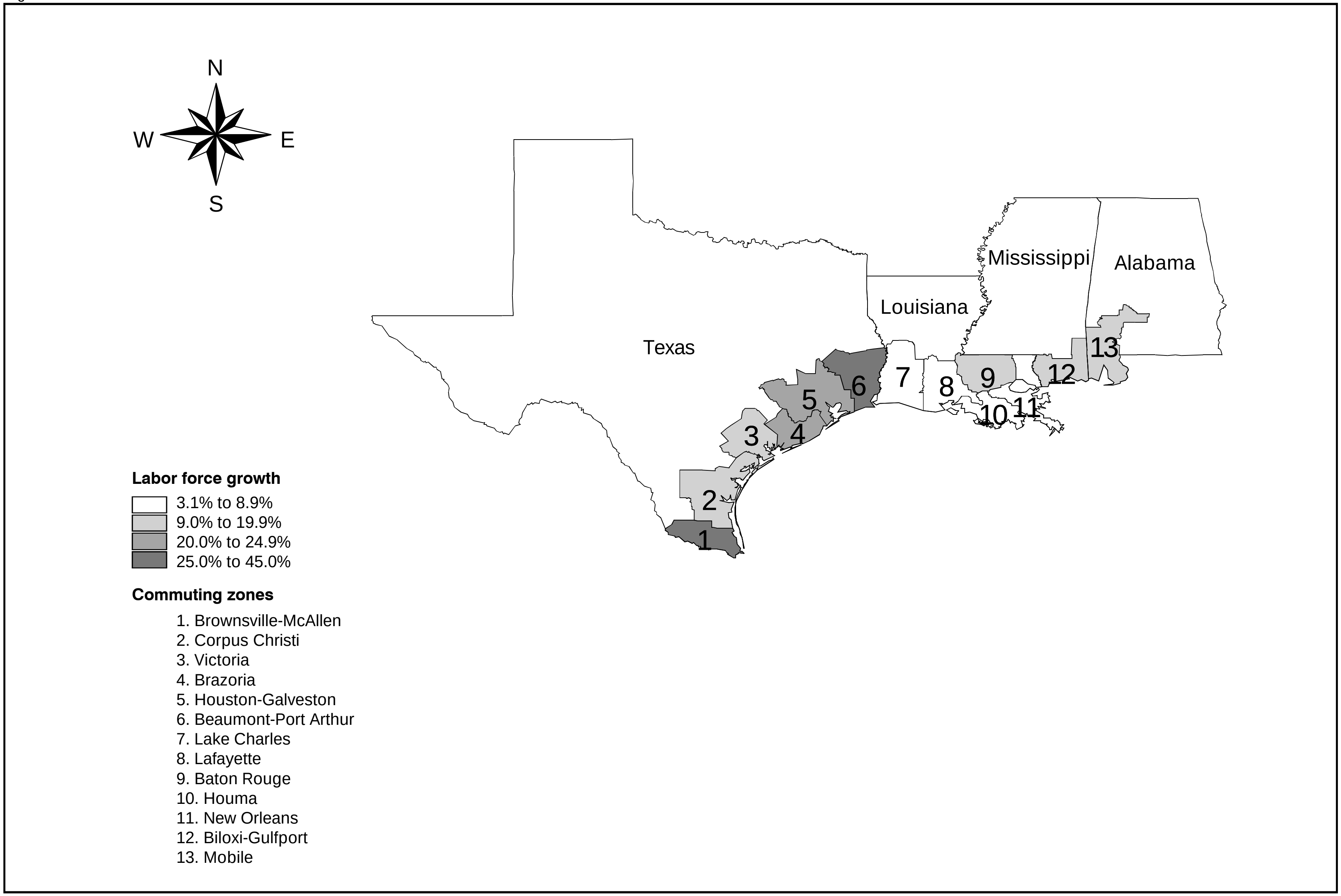


Figure 3-34 HISTORICAL TRENDS AND LABOR FORCE PROJECTIONS FOR EACH OF THE 13 GULF COAST COMMUTING ZONES.

02:001000_MM01_00_03_90-B0266
Fig3-35ad.CDR-7/14/00-GRA

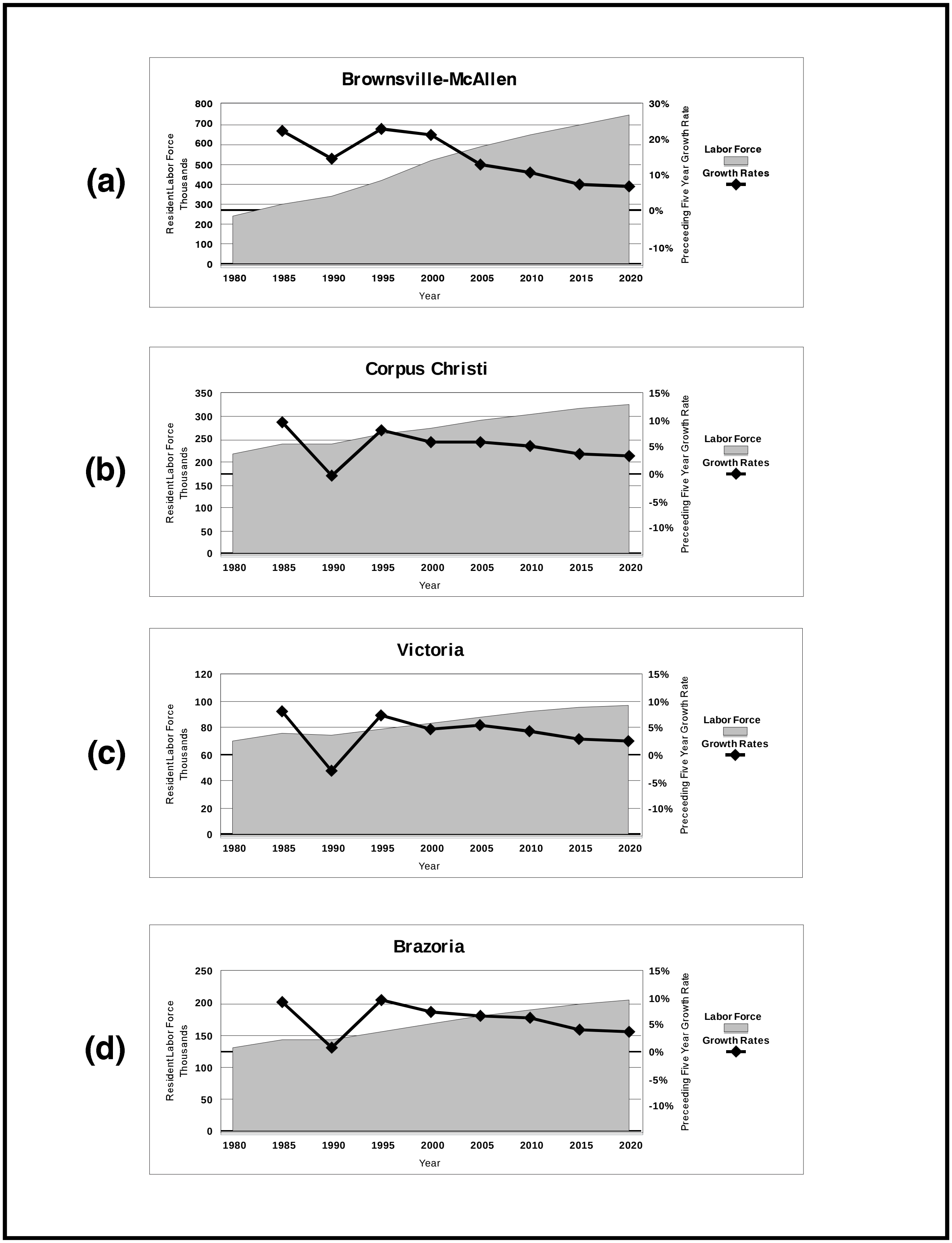


Figure 3-35 LABOR FORCE GROWTH RATES FOR THE GULF COAST, 2000-2020 (A-D).

02:001000_MM01_00_03_90-B0266
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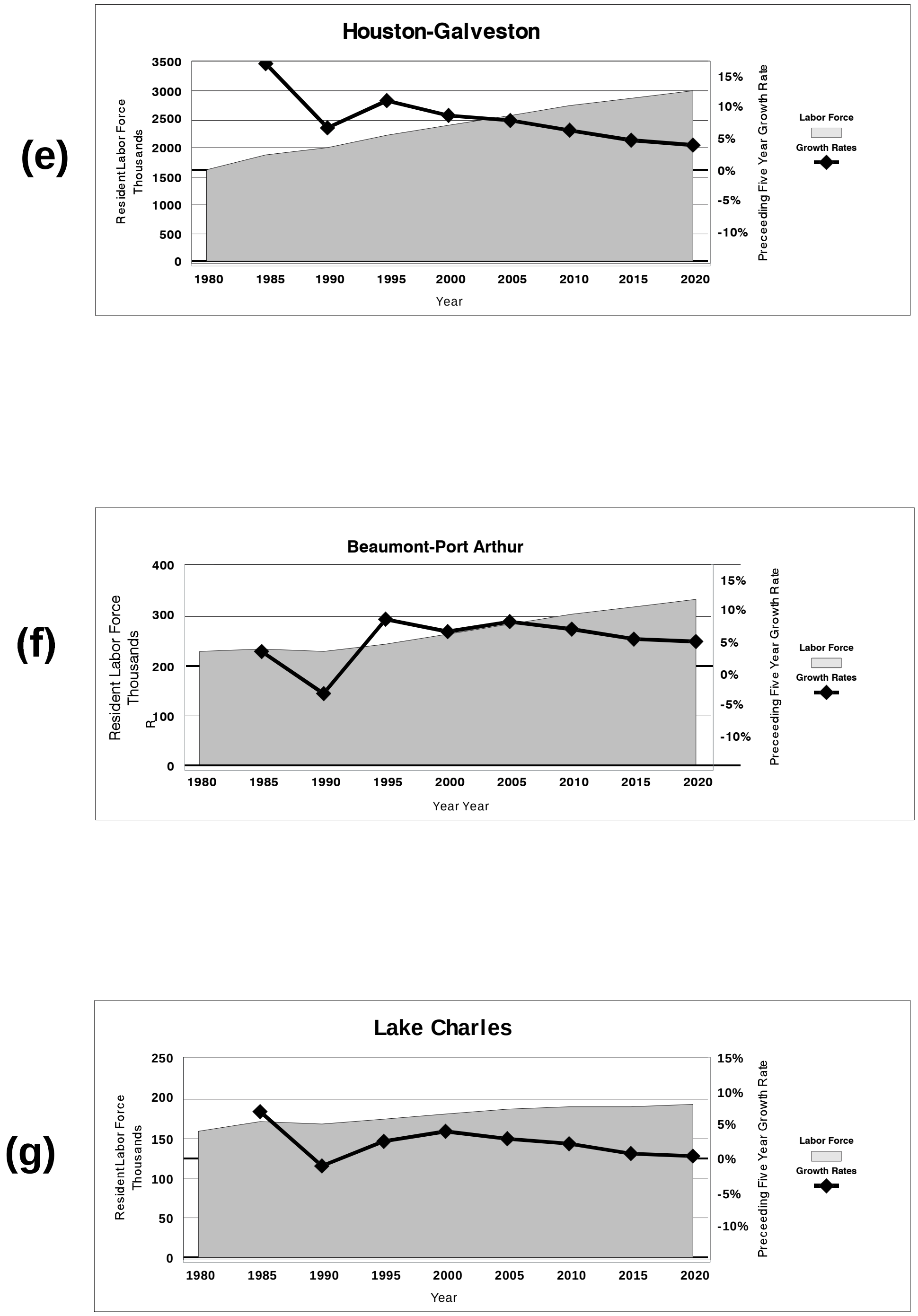
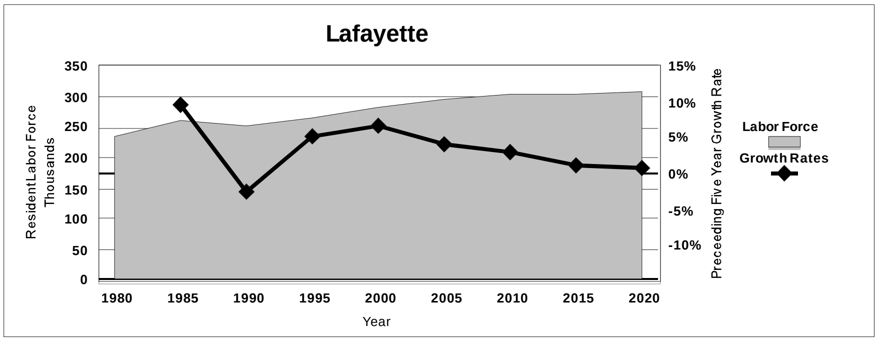


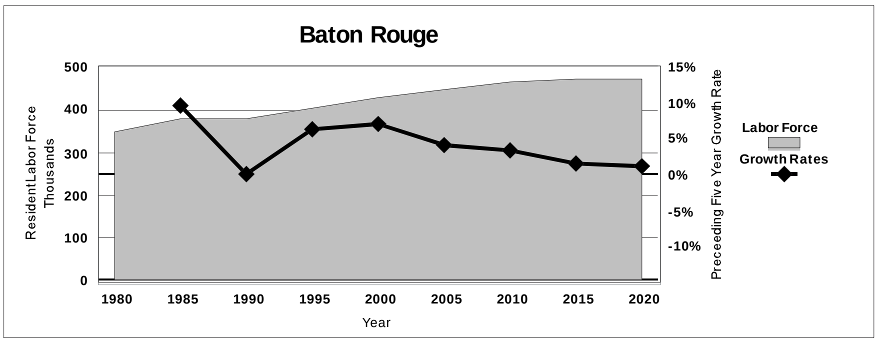
Figure 3-35 LABOR FORCE GROWTH RATES FOR THE GULF COAST, 2000-2020 (E-G).

02:001000_MM01_00_03_90-B0266
Fig3-35hj.CDR-7/14/00-GRA

(h)



(i)



(j)

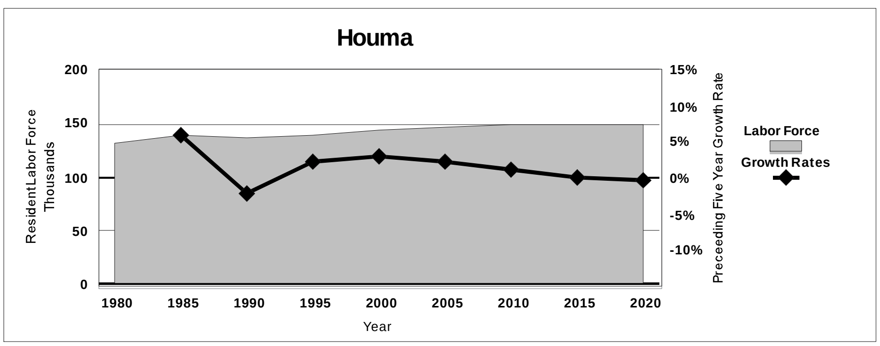


Figure 3-35 LABOR FORCE GROWTH RATES FOR THE GULF COAST, 2000-2020 (H-J).

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Fig3-35km.CDR-7/14/00-GRA

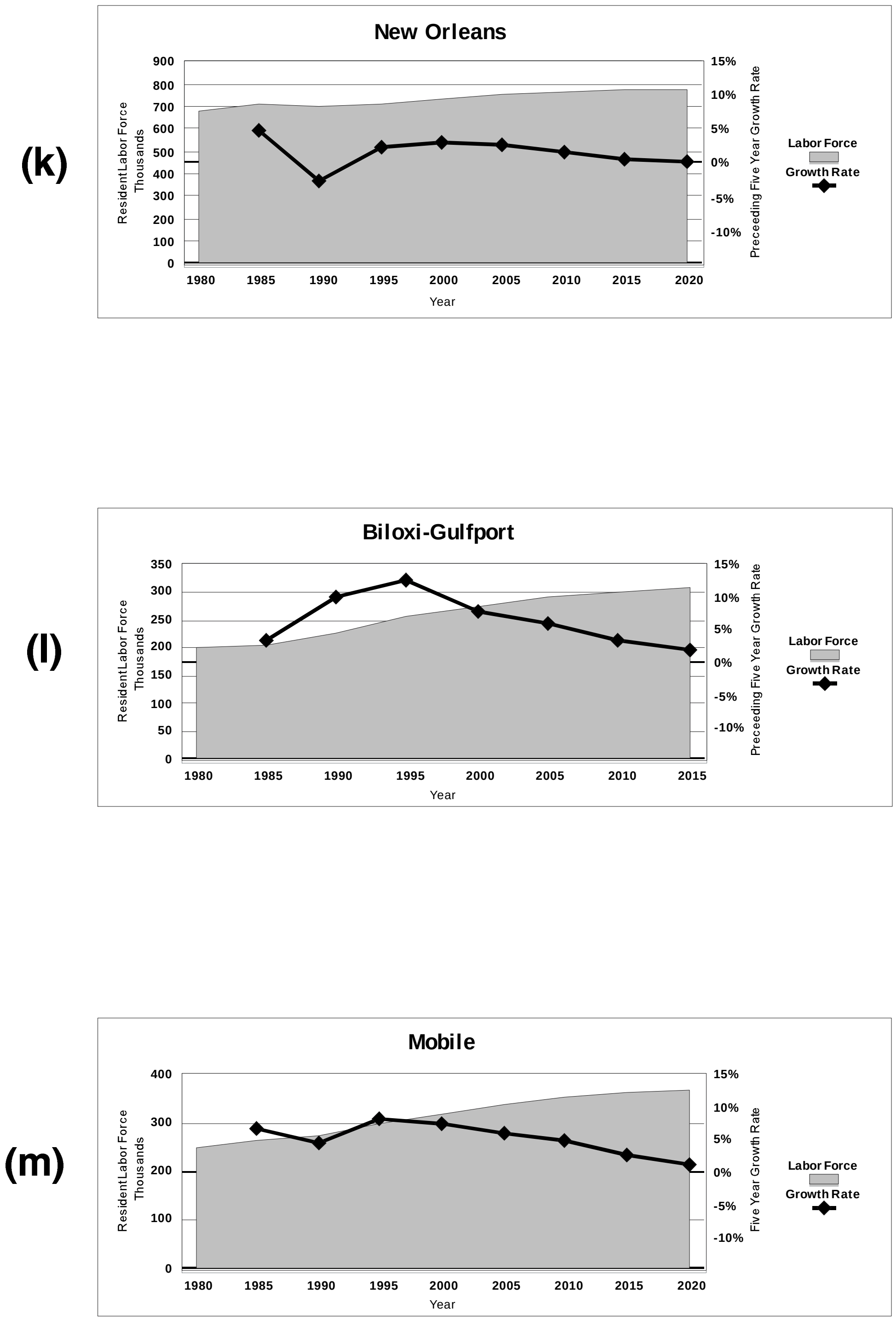

Figure 3-35 LABOR FORCE GROWTH RATES FOR THE GULF COAST, 2000-2020 (K-M).

Employment by Industry Projections

Although the growth of the labor force is projected to slow considerably during the first two decades of the 21st century, these growth rates vary considerably by industry, as seen in table 3-36. For the coastal area noted in the table, the overall change in labor force of 20 percent is primarily driven by retail and services growth (19.65 and 36.71 percent, respectively). While farming is projected to continue its long-term employment decline (-12.64 percent), related activities in agricultural services, forestry, and fisheries are projected to realize an increase in employment (39.28 percent). Total employment in oil and gas is projected to decrease from 134,486 to 108,075. This would constitute a loss of over 19 percent for the coastal commuting zones, irrespective of any proposed FPSO activities.

As seen in figure 3-36, the areas most effected by this loss in oil and gas employment are the Lake Charles and New Orleans commuting zones in Louisiana, and the Beaumont-Port Arthur area in Texas. However, with the exception of Biloxi-Gulfport, all areas are projected to lose employment in this industry. Table 3-37 outlines the projected growth or decline in employment for each of the 13 commuting zones during the period 2000 to 2020. As noted previously, projected declines in oil and gas employment are expected in all but one of the coastal commuting zones, with declines ranging from nearly 16 to more than 32 percent. The sole exception to this trend is evident for the Biloxi-Gulfport area; while employment projections in the oil and gas industry for this area are positive, these projections involve a very small number of jobs (i.e., 356 in 2000, increasing to 363 in 2020).

3.3.2.3 Public Services, Infrastructure, and Land Use Plans

Public services and infrastructure encompass those facilities and services which are routinely or commonly provided to resident and migrant populations, including (but not restricted to) housing, transportation (e.g., public transit, roads and highways), potable water supplies, police and fire protection, educational facilities, recreational and health care facilities, and solid waste disposal and sewage treatment. Coastal parishes and counties along the Gulf Coast from Texas to Mississippi could potentially be affected by future FPSO operations offshore (i.e., from construction and installation activities, FPSO operations, and facility decommissioning) and associated onshore support services.

According to USDOI, MMS (1997b), infrastructure and public service development onshore of the Central and Western GOM OCS Planning Areas has paralleled population growth and community development. Public services and infrastructure are very closely tied to population levels, migration patterns, and employment trends. The oil and gas industry in the GOM is a major factor in the region, one whose influence is well documented during historical boom and bust cycles. While the Gulf Coast region supports diverse agricultural, forestry, and fisheries industries, oil and gas development is recognized as a major factor affecting community infrastructure change.

USDOI, MMS (1997b, 1998a) has summarized the historical trends of offshore oil and gas development during the past 50 years, with emphasis on regional effects of global and domestic oil production and pricing and new extraction technologies. For example, the period of positive net migration and population growth along the Texas, Louisiana, and Mississippi coast

Table 3-36

Summary of Employment by Industry Projections for the Gulf Coast Region, 2000-2020

Employment Sector	2000	2005	2010	2015	2020	Change to 2020
All-Industry Total	6,350,330	6,761,540	7,127,550	7,395,590	7,635,210	20.23%
Farm	114,670	113,450	111,800	108,810	100,170	-12.64%
Non-Farm	6,235,720	6,648,160	7,016,000	7,287,090	7,534,980	20.84%
Private	5,219,480	5,582,960	5,907,660	6,147,740	6,373,660	22.11%
Ag Services, Forestry	85,920	96,420	105,750	112,590	119,670	39.28%
Mining	139,950	133,160	127,570	122,560	113,180	-19.13%
Oil and Gas	134,486	127,671	122,125	117,162	108,075	-19.64%
Construction	421,190	445,010	466,610	481,160	491,800	16.76%
Manufacturing	607,140	617,840	628,490	634,340	629,110	3.62%
Durables	268,460	271,360	273,550	274,670	269,340	0.33%
Nondurables	338,640	346,780	354,480	359,650	359,540	6.17%
Transport. & Utilities	336,130	353,250	368,110	378,420	386,230	14.90%
Wholesale Trade	288,690	302,680	314,030	320,470	323,070	11.91%
Retail Trade	1,086,830	1,154,230	1,218,400	1,262,780	1,300,380	19.65%
F.I.R.E.	364,810	385,020	402,890	416,360	427,510	17.19%
Services	1,889,130	2,095,090	2,275,690	2,418,720	2,582,650	36.71%
Government	1,016,360	1,065,310	1,108,150	1,139,300	1,161,480	14.28%
Federal Civilian	85,670	84,760	83,830	82,670	79,890	-6.75%
Military	92,220	92,370	92,690	92,750	92,350	0.14%
State and Local	838,240	888,000	931,640	963,620	989,130	18.00%

Table 3-37

Summary of Future Projections for Employment Within the 13 Coastal Commuting Zones, 2000-2020

	2000	2005	2010	2015	2020	Change to 2020
Mobile						
All-Industry Total	609,680	640,530	673,380	704,090	732,380	20.13%
Farm	12,050	11,650	11,370	11,160	10,120	-16.02%
Non-Farm	597,810	628,880	662,010	693,110	722,070	20.79%
Private	505,050	533,140	562,800	590,210	616,720	22.11%
Ag Services, Forestry	7,850	8,370	8,800	9,300	9,560	21.78%
Mining	2,370	2,180	2,200	2,230	2,060	-13.08%
Oil and Gas	2,277	2,090	2,106	2,132	1,967	-13.63%
Construction	42,000	43,870	46,030	47,820	49,110	16.93%
Manufacturing	88,740	89,190	90,410	91,730	90,910	2.45%
Durables	38,340	39,130	40,160	41,310	41,610	8.53%
Nondurables	50,580	50,060	50,250	50,430	49,300	-2.53%
Transport. & Utilities	33,050	34,580	36,130	37,590	38,800	17.40%
Wholesale Trade	26,660	27,670	28,790	29,770	30,370	13.92%
Retail Trade	105,720	110,490	116,080	121,130	125,590	18.79%
F.I.R.E.	30,680	31,850	33,190	34,610	35,800	16.69%
Services	168,170	184,750	200,990	216,210	234,320	39.34%
Government	92,760	95,740	99,210	102,710	105,540	13.78%
Federal Civilian	6,210	6,010	5,870	5,950	5,620	-9.50%
Military	11,140	11,100	11,190	11,350	11,430	2.60%
State and Local	75,410	78,630	82,160	85,590	88,480	17.33%
Biloxi-Gulfport						
All-Industry Total	256,400	276,290	292,300	301,910	307,410	19.89%
Farm	1,840	1,880	1,900	1,780	1,640	-10.87%
Non-Farm	254,440	274,410	290,400	300,130	305,770	20.17%
Private	194,780	212,500	227,020	236,190	242,630	24.57%
Ag Services, Forestry	3,550	4,130	4,560	4,960	5,410	52.39%
Mining	370	380	380	380	380	2.70%
Oil and Gas	356	364	364	363	363	2.05%
Construction	13,110	14,130	14,830	15,130	15,220	16.09%
Manufacturing	40,430	41,770	42,590	42,710	41,630	2.97%
Durables	29,520	30,520	31,180	31,140	30,310	2.68%
Nondurables	10,900	11,260	11,410	11,570	11,190	2.66%
Transport. & Utilities	9,680	10,380	11,030	11,310	11,450	18.29%
Wholesale Trade	4,900	5,130	5,320	5,340	5,280	7.76%
Retail Trade	41,770	44,780	47,280	48,690	49,180	17.74%
F.I.R.E.	9,430	9,880	10,390	10,550	10,570	12.09%
Services	71,420	81,920	90,630	96,990	103,390	44.76%
Government	59,780	61,910	63,380	63,940	63,270	5.84%
Federal Civilian	11,270	11,130	11,030	10,810	10,190	-9.58%
Military	20,830	21,260	21,550	21,610	21,380	2.64%
State and Local	27,690	29,520	30,930	31,650	31,820	14.92%
New Orleans						
All-Industry Total	736,530	755,220	768,280	772,590	774,230	5.12%
Farm	4,840	4,570	4,330	4,020	3,580	-26.03%
Non-Farm	731,690	750,650	764,030	768,570	770,650	5.32%
Private	610,040	628,190	641,390	646,630	650,310	6.60%
Ag Services, Forestry	10,000	10,960	11,750	12,140	12,670	26.70%
Mining	16,210	15,060	14,070	13,200	11,920	-26.47%
Oil and Gas	15,577	14,439	13,469	12,619	11,382	-26.93%
Construction	34,530	34,770	34,800	34,450	33,680	-2.46%
Manufacturing	48,730	47,310	46,080	44,770	42,700	-12.37%
Durables	23,560	22,710	21,960	21,170	19,900	-15.53%
Nondurables	25,170	24,600	24,120	23,600	22,730	-9.69%

Table 3-37

Summary of Future Projections for Employment Within the 13 Coastal Commuting Zones, 2000-2020

	2000	2005	2010	2015	2020	Change to 2020
Transport. & Utilities	47,430	47,070	46,700	45,910	44,560	-6.05%
Wholesale Trade	36,380	36,820	36,880	36,500	35,770	-1.68%
Retail Trade	132,700	135,540	137,940	138,480	138,300	4.22%
F.I.R.E.	42,920	43,680	44,150	44,240	44,190	2.96%
Services	241,050	256,970	269,010	276,800	286,520	18.86%
Government	121,650	122,450	122,630	121,940	120,340	-1.08%
Federal Civilian	13,790	13,170	12,600	12,060	11,400	-17.33%
Military	12,100	11,830	11,600	11,380	11,180	-7.60%
State and Local	95,760	97,460	98,430	98,410	97,770	2.10%
Baton Rouge						
All-Industry Total	431,520	449,140	463,610	470,590	475,020	10.08%
Farm	5,180	4,920	4,610	4,300	3,700	-28.57%
Non-Farm	426,340	444,220	459,000	466,290	471,320	10.55%
Private	341,690	358,510	372,450	379,920	386,310	13.06%
Ag Services, Forestry	3,380	3,690	4,010	4,210	4,450	31.66%
Mining	2,220	2,150	2,000	1,960	1,800	-18.92%
Oil and Gas	2,133	2,061	1,915	1,874	1,719	-19.43%
Construction	45,230	46,340	47,280	47,540	47,200	4.36%
Manufacturing	37,200	36,800	36,460	35,800	34,500	-7.26%
Durables	10,250	10,250	10,120	9,980	9,570	-6.63%
Nondurables	26,950	26,550	26,250	25,820	24,930	-7.50%
Transport. & Utilities	19,660	20,200	20,640	20,830	20,760	5.60%
Wholesale Trade	19,130	19,990	20,640	20,830	20,850	8.99%
Retail Trade	64,260	65,820	67,320	67,590	67,200	4.58%
F.I.R.E.	26,420	27,580	28,550	29,050	29,570	11.92%
Services	124,180	135,840	145,550	152,200	160,080	28.91%
Government	84,660	85,810	86,550	86,370	85,010	0.41%
Federal Civilian	3,170	3,080	3,010	2,840	2,750	-13.25%
Military	4,540	4,410	4,310	4,210	4,080	-10.13%
State and Local	76,830	78,220	79,240	79,230	78,190	1.77%
Lafayette						
All-Industry Total	283,700	294,930	303,150	306,780	308,990	8.91%
Farm	7,190	6,830	6,470	6,110	5,370	-25.31%
Non-Farm	276,510	288,100	296,680	300,670	303,620	9.80%
Private	236,700	247,430	255,620	259,660	262,840	11.04%
Ag Services, Forestry	3,250	3,510	3,670	3,820	3,860	18.77%
Mining	17,930	16,970	16,130	15,360	14,130	-21.19%
Oil and Gas	17,230	16,270	15,442	14,683	13,493	-21.69%
Construction	14,190	14,530	14,780	14,880	14,790	4.23%
Manufacturing	30,450	31,400	31,880	32,050	31,740	4.24%
Durables	12,220	12,480	12,560	12,500	12,240	0.16%
Nondurables	18,230	18,920	19,320	19,460	19,490	6.91%
Transport. & Utilities	17,640	18,140	18,450	18,510	18,460	4.65%
Wholesale Trade	13,200	13,650	14,010	14,020	14,030	6.29%
Retail Trade	49,270	51,690	53,710	54,750	55,660	12.97%
F.I.R.E.	13,300	13,950	14,490	14,880	15,260	14.74%
Services	77,550	83,580	88,390	91,390	95,020	22.53%
Government	39,810	40,670	41,060	41,110	40,680	2.19%
Federal Civilian	1,770	1,760	1,740	1,620	1,600	-9.60%
Military	3,550	3,510	3,480	3,430	3,390	-4.51%
State and Local	34,490	35,400	35,940	35,960	35,690	3.48%
Lake Charles						
All-Industry Total	180,430	185,820	189,630	191,030	191,690	6.24%
Farm	5,450	5,210	4,920	4,630	4,150	-23.85%

Table 3-37

Summary of Future Projections for Employment Within the 13 Coastal Commuting Zones, 2000-2020

	2000	2005	2010	2015	2020	Change to 2020
Non-Farm	174,980	180,680	184,710	186,400	187,540	7.18%
Private	133,440	138,920	142,970	145,020	146,740	9.97%
Ag Services, Forestry	2,010	2,180	2,280	2,380	2,470	22.89%
Mining	2,150	1,900	1,800	1,630	1,470	-31.63%
Oil and Gas	2,066	1,822	1,723	1,558	1,404	-32.06%
Construction	13,060	13,730	14,190	14,360	14,450	10.64%
Manufacturing	16,500	16,270	16,130	15,860	15,380	-6.79%
Durables	5,020	4,930	4,780	4,700	4,410	-12.15%
Nondurables	11,410	11,340	11,290	11,160	10,970	-3.86%
Transport. & Utilities	9,250	9,580	9,760	9,800	9,830	6.27%
Wholesale Trade	5,880	6,060	6,160	6,120	6,090	3.57%
Retail Trade	29,560	30,490	31,220	31,510	31,570	6.80%
F.I.R.E.	7,600	7,820	7,890	7,960	7,960	4.74%
Services	47,490	50,980	53,590	55,400	57,520	21.12%
Government	41,540	41,680	41,680	41,380	40,800	-1.78%
Federal Civilian	5,020	4,790	4,640	4,420	4,210	-16.14%
Military	9,760	9,580	9,420	9,260	9,100	-6.76%
State and Local	26,760	27,320	27,620	27,700	27,490	2.73%
Beaumont-Port Arthur						
All-Industry Total	263,400	284,650	304,040	319,950	335,330	27.31%
Farm	3,530	3,660	3,670	3,780	3,640	3.12%
Non-Farm	259,870	280,990	300,370	316,300	331,820	27.69%
Private	224,430	243,380	260,680	275,080	289,330	28.92%
Ag Services, Forestry	3,530	4,150	4,680	5,090	5,670	60.62%
Mining	1,530	1,340	1,260	1,170	1,080	-29.41%
Oil and Gas	1,470	1,285	1,206	1,118	1,031	-29.86%
Construction	24,020	26,250	28,320	30,000	31,700	31.97%
Manufacturing	34,970	35,410	35,900	36,260	35,880	2.60%
Durables	12,830	13,190	13,530	13,830	13,890	8.26%
Nondurables	22,020	22,220	22,380	22,430	21,990	-0.14%
Transport. & Utilities	13,540	14,170	14,790	15,260	15,780	16.54%
Wholesale Trade	8,830	9,520	10,110	10,570	10,930	23.78%
Retail Trade	48,860	52,750	56,380	59,220	61,910	26.71%
F.I.R.E.	10,710	11,360	11,880	12,260	12,540	17.09%
Services	78,540	88,530	97,470	105,000	113,840	44.95%
Government	35,440	37,610	39,570	41,220	42,490	19.89%
Federal Civilian	1,770	1,830	1,900	1,960	1,890	6.78%
Military	1,770	1,830	1,900	1,960	2,020	14.12%
State and Local	31,910	33,950	35,780	37,300	38,580	20.90%
Houston-Galveston						
All-Industry Total	2,400,990	2,584,630	2,746,640	2,870,590	2,983,930	24.28%
Farm	40,890	40,890	40,680	39,810	37,080	-9.32%
Non-Farm	2,360,100	2,543,740	2,705,960	2,830,780	2,946,850	24.86%
Private	2,039,340	2,201,760	2,345,730	2,456,490	2,561,010	25.58%
Ag Services, Forestry	27,460	31,600	35,310	38,170	41,540	51.27%
Mining	68,660	66,290	64,220	62,380	58,130	-15.34%
Oil and Gas	65,979	63,557	61,479	59,632	55,508	-15.87%
Construction	166,170	177,110	186,890	193,810	199,180	19.87%
Manufacturing	210,290	213,970	217,520	219,590	217,640	3.50%
Durables	104,990	105,320	105,760	105,800	103,340	-1.57%
Nondurables	105,300	108,650	111,760	113,870	114,300	8.55%
Transport. & Utilities	135,150	144,890	153,300	159,640	165,150	22.20%
Wholesale Trade	126,280	133,590	139,430	143,260	144,960	14.79%
Retail Trade	389,650	417,650	443,850	462,770	479,170	22.97%

Table 3-37

Summary of Future Projections for Employment Within the 13 Coastal Commuting Zones, 2000-2020

	2000	2005	2010	2015	2020	Change to 2020
F.I.R.E.	162,390	173,010	182,220	189,260	195,190	20.20%
Services	753,300	843,730	923,080	987,530	1,060,050	40.72%
Government	320,760	341,910	360,220	374,290	385,840	20.29%
Federal Civilian	24,990	25,320	25,490	25,630	25,190	0.80%
Military	13,040	13,090	13,170	13,240	13,220	1.38%
State and Local	282,730	303,570	321,570	335,500	347,510	22.91%
Corpus Christi						
All-Industry Total	274,640	291,120	305,930	316,780	327,200	19.14%
Farm	9,060	9,150	9,140	9,080	8,530	-5.85%
Non-Farm	265,580	281,970	296,790	307,700	318,670	19.99%
Private	213,050	227,590	240,680	250,370	260,430	22.24%
Ag Services, Forestry	4,680	5,300	5,950	6,380	6,870	46.79%
Mining	9,570	9,050	8,610	8,220	7,530	-21.32%
Oil and Gas	9,196	8,677	8,243	7,858	7,190	-21.81%
Construction	19,850	21,110	22,320	23,140	23,920	20.50%
Manufacturing	16,900	17,570	18,280	18,710	19,160	13.37%
Durables	4,070	4,160	4,140	4,220	4,210	3.44%
Nondurables	12,830	13,520	14,030	14,490	14,950	16.52%
Transport. & Utilities	10,280	10,610	10,950	11,140	11,290	9.82%
Wholesale Trade	8,860	9,250	9,560	9,730	9,850	11.17%
Retail Trade	47,330	49,700	51,960	53,430	54,590	15.34%
F.I.R.E.	14,760	15,490	16,150	16,660	17,050	15.51%
Services	80,720	89,310	96,910	102,960	110,170	36.48%
Government	52,530	54,380	56,110	57,320	58,240	10.87%
Federal Civilian	7,020	6,860	6,590	6,380	6,090	-13.25%
Military	6,620	6,760	6,910	7,030	7,200	8.76%
State and Local	38,780	40,760	42,510	43,800	44,840	15.63%
Brownsville						
All-Industry Total	515,960	583,260	647,740	697,930	746,320	44.65%
Farm	15,350	15,640	15,930	15,680	14,670	-4.43%
Non-Farm	500,610	567,620	631,980	682,250	731,650	46.15%
Private	392,030	445,310	496,470	536,390	576,020	46.93%
Ag Services, Forestry	15,190	16,960	18,670	19,730	20,390	34.23%
Mining	2,060	1,980	1,880	1,760	1,610	-21.84%
Oil and Gas	1,980	1,898	1,800	1,682	1,537	-22.34%
Construction	24,060	27,160	30,150	32,410	34,530	43.52%
Manufacturing	47,480	52,190	56,880	60,420	63,510	33.76%
Durables	12,820	13,830	14,560	15,330	15,560	21.37%
Nondurables	34,660	38,520	42,140	45,100	47,940	38.32%
Transport. & Utilities	18,830	21,240	23,300	25,010	26,480	40.63%
Wholesale Trade	20,260	22,060	23,640	24,660	25,220	24.48%
Retail Trade	110,790	125,280	139,620	150,440	161,000	45.32%
F.I.R.E.	23,900	26,670	29,290	31,530	33,450	39.96%
Services	129,620	151,780	173,030	190,420	209,840	61.89%
Government	108,570	122,480	135,510	145,860	155,630	43.35%
Federal Civilian	5,860	6,090	6,340	6,520	6,620	12.97%
Military	4,120	4,280	4,450	4,580	4,650	12.86%
State and Local	98,600	111,940	124,550	134,580	144,180	46.23%
Victoria						
All-Industry Total	83,800	88,420	92,300	95,030	97,660	16.54%
Farm	2,760	2,780	2,760	2,730	2,540	-7.97%
Non-Farm	81,040	85,640	89,540	92,300	95,120	17.37%
Private	65,010	69,130	72,620	75,110	77,730	19.57%
Ag Services, Forestry	1,430	1,610	1,800	1,910	2,050	43.36%

Table 3-37

Summary of Future Projections for Employment Within the 13 Coastal Commuting Zones, 2000-2020

	2000	2005	2010	2015	2020	Change to 2020
Mining	2,920	2,750	2,600	2,470	2,250	-22.95%
Oil and Gas	2,806	2,637	2,489	2,361	2,149	-23.43%
Construction	6,060	6,410	6,730	6,940	7,140	17.82%
Manufacturing	5,160	5,340	5,510	5,610	5,720	10.85%
Durables	1,240	1,260	1,250	1,270	1,260	1.61%
Nondurables	3,910	4,110	4,230	4,350	4,460	14.07%
Transport. & Utilities	3,140	3,220	3,300	3,340	3,370	7.32%
Wholesale Trade	2,700	2,810	2,890	2,920	2,940	8.89%
Retail Trade	14,440	15,090	15,680	16,030	16,290	12.81%
F.I.R.E.	4,500	4,710	4,870	5,000	5,090	13.11%
Services	24,630	27,130	29,240	30,890	32,880	33.50%
Government	16,030	16,520	16,930	17,200	17,380	8.42%
Federal Civilian	2,140	2,080	1,990	1,910	1,820	-14.95%
Military	2,020	2,050	2,080	2,110	2,150	6.44%
State and Local	11,830	12,380	12,820	13,140	13,380	13.10%
Houma						
All-Industry Total	144,490	147,590	149,400	149,470	149,030	3.14%
Farm	3,660	3,420	3,190	2,970	2,590	-29.23%
Non-Farm	140,830	144,170	146,210	146,500	146,440	3.98%
Private	120,550	123,820	125,980	126,510	126,770	5.16%
Ag Services, Forestry	1,660	1,760	1,810	1,860	1,860	12.05%
Mining	9,130	8,490	7,950	7,480	6,810	-25.41%
Oil and Gas	8,774	8,140	7,611	7,151	6,503	-25.88%
Construction	7,230	7,270	7,280	7,250	7,130	-1.38%
Manufacturing	15,510	15,720	15,710	15,620	15,310	-1.29%
Durables	6,220	6,250	6,190	6,090	5,900	-5.14%
Nondurables	9,280	9,470	9,520	9,480	9,400	1.29%
Transport. & Utilities	8,980	9,080	9,090	9,020	8,900	-0.89%
Wholesale Trade	6,730	6,830	6,900	6,830	6,770	0.59%
Retail Trade	25,090	25,870	26,470	26,680	26,840	6.97%
F.I.R.E.	6,780	6,980	7,140	7,250	7,360	8.55%
Services	39,500	41,830	43,560	44,520	45,830	16.03%
Government	20,280	20,350	20,230	20,030	19,620	-3.25%
Federal Civilian	900	880	860	790	770	-14.44%
Military	1,810	1,760	1,710	1,670	1,640	-9.39%
State and Local	17,570	17,720	17,710	17,520	17,210	-2.05%
Brazoria						
All-Industry Total	168,790	179,940	191,150	198,850	206,020	22.06%
Farm	2,870	2,850	2,830	2,760	2,560	-10.80%
Non-Farm	165,920	177,090	188,320	196,090	203,460	22.63%
Private	143,370	153,280	163,250	170,160	176,820	23.33%
Ag Services, Forestry	1,930	2,200	2,460	2,640	2,870	48.70%
Mining	4,830	4,620	4,470	4,320	4,010	-16.98%
Oil and Gas	4,641	4,430	4,279	4,130	3,829	-17.50%
Construction	11,680	12,330	13,010	13,430	13,750	17.72%
Manufacturing	14,780	14,900	15,140	15,210	15,030	1.69%
Durables	7,380	7,330	7,360	7,330	7,140	-3.25%
Nondurables	7,400	7,560	7,780	7,890	7,890	6.62%
Transport. & Utilities	9,500	10,090	10,670	11,060	11,400	20.00%
Wholesale Trade	8,880	9,300	9,700	9,920	10,010	12.73%
Retail Trade	27,390	29,080	30,890	32,060	33,080	20.77%
F.I.R.E.	11,420	12,040	12,680	13,110	13,480	18.04%
Services	52,960	58,740	64,240	68,410	73,190	38.20%
Government	22,550	23,800	25,070	25,930	26,640	18.14%

Table 3-37

Summary of Future Projections for Employment Within the 13 Coastal Commuting Zones, 2000-2020

	2000	2005	2010	2015	2020	Change to 2020
Federal Civilian	1,760	1,760	1,770	1,780	1,740	-1.14%
Military	920	910	920	920	910	-1.09%
State and Local	19,880	21,130	22,380	23,240	23,990	20.67%

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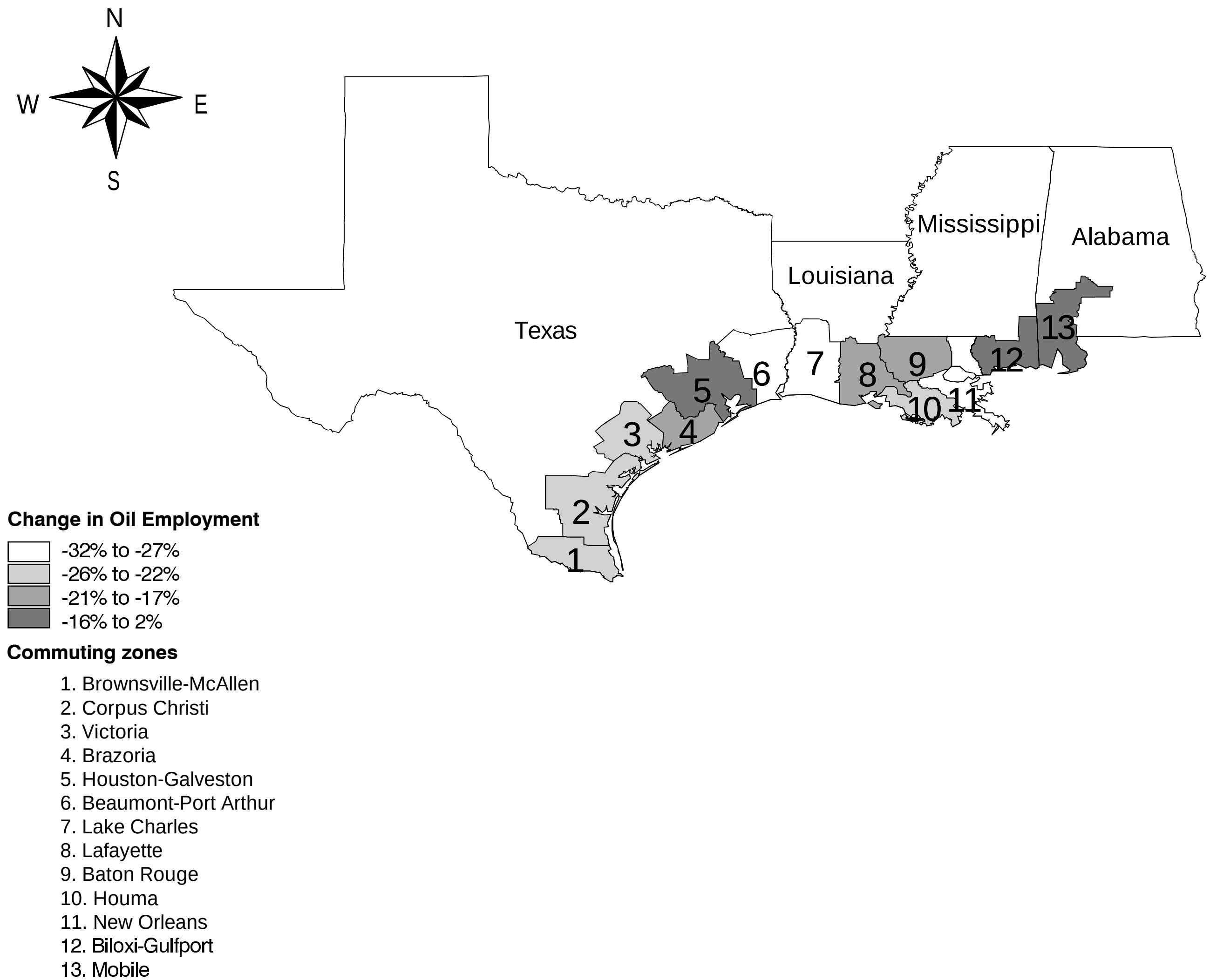

Figure 3-36 EMPLOYMENT RATES FOR THE OIL AND GAS INDUSTRY, 2000-2020

is highly correlated to rising world oil prices and increasing levels of domestic offshore (i.e., both OCS and state waters) activity. Such increases in population have prompted a corresponding need for improved infrastructure, housing, and public services. Between 1960 and 1980, the oil and gas industry realized a period of overall growth and expansion. Concurrently, double and triple digit percentage increases were realized in coastal Louisiana for expenditures associated with health care facilities and hospitals (404 percent), police protection (267 percent), public welfare (200 percent), fire protection (186 percent), education (184 percent), housing (86 percent), and highways (84 percent), as noted by USDOI, MMS (1997b).

Downturns in worldwide oil prices in the mid-1980s adversely affected domestic oil and gas activities, particularly in the central and western Gulf. This reduction in offshore production subsequently affected infrastructure-based expenditures and employment levels within coastal parishes and counties, with further strains placed on public services. While these trends were most evident in coastal Louisiana, coastal Texas was also affected but to a lesser extent due to that state's economic diversity (USDOI, MMS, 1997b).

Texas, Louisiana, and Mississippi all have approved coastal zone management (CZM) programs, the latter of which consider state, regional, and local land use plans. Planning efforts across the Gulf Coast, within the region of interest to this analysis, are variable at the state and local level. While state planning efforts have been hampered due to budgetary constraints, local efforts reflect varying degrees of participation. However, in spite of funding fluctuations or the level of local participation, all land use plans must be considered in a state's CZM program. Further, all offshore activities must receive concurrence with the appropriate CZM program prior to MMS approval (USDOI, MMS, 1997b).

3.3.2.4 Sociocultural Issues and Environmental Justice

The coastal zone of the northern GOM is not a homogeneous unit in terms of its physical, cultural, or economic characteristics (USDOI, MMS, 1997b). Community size is extremely variable, ranging from rural to heavily urbanized. Various researchers have characterized oil and gas boom and bust cycles and documented associated increases in social complexity (e.g., England and Albrecht, 1984; Gramling and Brabant, 1986). Nevertheless, the oil and gas industry has played a major role in the lives of Gulf Coast residents for several generations. Prior examinations of the impacts of OCS oil and gas activities on coastal counties and parishes suggest that most communities exhibit socioeconomic characteristics which are closely associated with (and affected by) the oil and gas industry, with notable exceptions (McKenzie *et al.*, 1993).

Executive Order 12898, issued in February 1994, states that any Federal action which requires analysis pursuant to NEPA must consider the impact of the proposed action on environmental justice issues. The implicit design of the executive order is to ensure that minority and/or low income communities are not subject, in a disproportionate fashion, to environmental and socioeconomic degradation. Of particular concern is the question of equity in the environmental and health conditions of impoverished communities. The impetus behind issuance of the executive order lies with previous onshore development (e.g., siting of oil and gas facilities proximal to low income and/or minority communities or neighborhoods) and the impacts such facilities have on the local population. While it is recognized that no new onshore facilities are projected in association with FPSO operations, environmental justice concerns will be considered in the impact analysis. Socioeconomic profiles of the 13 LMAs or commuting zones have been detailed previously (e.g., see tables 3-18 through 3-30).

3.3.3 Recreational Resources and Beach Use

The coastal zone of Texas, Louisiana, and Mississippi is considered a major U.S. recreational region. Prominent recreational resources within this area include coastal beaches, barrier islands, estuaries, bays and sounds, river deltas, and tidal marshes, as well as nearshore and offshore marine waters. The morphological and biological characteristics of these coastal features have been detailed previously in Section 3.2.1, and the biological and ecological importance of other offshore environments has been detailed in Sections 3.2.2 through 3.2.50

Coastal recreational resources have been categorized into publicly owned recreation areas (e.g., national seashores, parks, beaches, wildlife lands) and designated preservation areas (e.g., historic and natural sites, landmarks, wilderness areas, wildlife sanctuaries, scenic rivers). In addition, there are private and commercial recreational facilities along the Gulf Coast, including resorts, marinas, amusement parks, and ornamental gardens (USDOI, MMS, 1997b). Coastal recreational resources for the central and western Gulf are summarized in table 3-38. Such natural and man-made resources offer coastal visitors and residents exceptionally diverse opportunities for beach and waterways use.

Beaches are a major resource that attracts tourists and residents to the Gulf Coast for a variety of activities (e.g., fishing, beachcombing, camping, picnicking, bird watching, etc.). Beach use is a major economic component of many of the Gulf’s coastal communities, especially during the peak use seasons (spring and summer). According to USDOI, MMS (1997b), recreational resources, activities, and expenditures are not uniformly distributed along the Gulf but are focused where public beaches are close to major urban centers. Beach activities and the aesthetic value of the shoreline are important economic factors in the coastal zone. Tourism in the Gulf’s coastal zone, including Texas, Louisiana, Mississippi, Alabama, and Florida, has been estimated at $20 billion per year (USEPA, 1991, as cited in USDOI, MMS, 1997b). The scenic and aesthetic value of Gulf Coast beaches plays an important role in attracting both residents and tourists to the coastal zone.

One of the major recreational activities occurring on the OCS is offshore marine recreational fishing and diving. A substantial recreational fishery, including scuba diving, is directly associated with oil and gas production platforms and stems from the fact that platforms beneficially function as high-profile, artificial reefs that attract fishes. Witzig (1986) indicates that a majority of the offshore recreational fishing in the Central GOM Planning Area is directly associated with oil and gas structures. At least 46 different fish species are caught by recreational anglers fishing near oil and gas platforms in the central GOM (Stanley and Wilson, 1990). Interest remains high throughout the GOM region to acquire, relocate, and retain selected oil and gas structures in the marine environment to be used as dedicated artificial reefs to enhance marine fisheries when the structures are no longer useful for oil and gas production (Reggio, 1989). Other prominent natural features (e.g., Flower Garden Banks) also serve as primary diving destinations for sport divers.

Table 3-38

Summary of Major Recreational Areas in the Coastal Zones of Texas, Louisiana, and Mississippi (Adapted from: Minerals Management Service, 1986, 1997b)

Resource	County or Parish	Description/Comments
Texas:		
Mar Beach	Cameron County	Beach area
Brazos Island SRA	Cameron	State Recreation Area
Queen Isabella SFP	Cameron	State Fishing Pier
Port Isabella Lighthouse SHS	Cameron	State Historical Site
Laguna Atascosa NWR	Cameron	National Wildlife Refuge
Arroyo Colorado SRA	Willacy	State Recreation Area
Padre Island NS	Willacy/Kenedy/Kleberg	National Seashore, extends appr. 80 mi along the TX coast; visitation appr. 900,000/yr
Malaquite Beach	Kleberg	Beach area
Mustang Island SP	Nueces	State Park
Holiday Beach	Nueces	Beach area
Copano Bay Causeway SFP	Aransas	State Fishing Pier
Goose Island SRA	Aransas	State Recreation Area
Aransas NWR	Aransas/Refugio	National Wildlife Refuge
Matagorda Island WMA	Calhoun	Wildlife Management Area
Matagorda Island SP	Calhoun	State Park
Guadalupe Delta WMA	Calhoun	Wildlife Management Area
Swann Point FAA	Calhoun	Fishermen Access Area
Port Lavaca Causeway SFP	Calhoun	State Fishing Pier
Big Boggy NWR	Matagorda	National Wildlife Refuge
San Bernard NWR	Brazoria/Matagorda	National Wildlife Refuge
Bryan Beach SRA	Brazoria	State Recreation Area
Peach Point WMA	Brazoria	Wildlife Management Area
Brazoria NWR	Brazoria	National Wildlife Refuge
Brazoria County SP	Brazoria	State Park
Galveston Island SP	Galveston	State Park
Crystal Beach	Galveston	Beach area
Moody NWR	Chambers	National Wildlife Refuge
Anahuau NWR	Chambers	National Wildlife Refuge
McFaddin Marsh NWR	Jefferson	National Wildlife Refuge
Sea Rim SP	Jefferson	State Park
J.D. Murphree WMA	Jefferson	Wildlife Management Area
Texas Point NWR	Jefferson	National Wildlife Refuge
Sabine Pass Battleground	Jefferson	Historic site
Louisiana:		
Sabine NWR	Cameron Parish	National Wildlife Refuge
Pevisto Beach	Cameron	Beach area
Holly Beach	Cameron	Beach area
Little Cheniere SP	Cameron	State Park
Lacassine NWR	Cameron	National Wildlife Refuge
Lacassine WA	Cameron	Wilderness area
Rockefeller Refuge	Cameron/Vermilion	Wildlife refuge
Cheniere au-Tigre SP	Vermilion	State Park
La State Wildlife Refuge	Vermilion	Wildlife refuge
Palmeto Island SP	Vermilion	State Park
Marsh Island Wildlife Refuge	Iberia	Wildlife refuge
Shell Keys NWR	Iberia	National Wildlife Refuge
Cypremort Beach SP	St. Mary	State Park

Table 3-38

Summary of Major Recreational Areas in the Coastal Zones of Texas, Louisiana, and Mississippi
(Adapted from: Minerals Management Service, 1986, 1997b)

Resource	County or Parish	Description/Comments
Attakapas WMA	St. Mary	Wildlife Management Area
Atchafalaya Bay WMA	St. Mary/Terrebonne	Wildlife Management Area
Point au Chien WMA	Terrebonne/Lafourche	Wildlife Management Area
Wisner WMA	Lafourche	Wildlife Management Area
Fourchon Beach	Lafourche	Beach area
Salvadore WMA	St. Charles	Wildlife Management Area
Bayou Signette SP	Jefferson	State Park
Grand Isle	Jefferson	
Joyce WMA	Tangipahoa	Wildlife Management Area
Manchac WMA	St. John the Baptist	Wildlife Management Area
Fairview Riverside SP	St. Tammany	State Park
Fountainbleau SP	St. Tammany	State Park
St. Tammany Refuge	St. Tammany	Wildlife refuge
Pearl River WMA	St. Tammany	Wildlife Management Area
Fort Pike SCA	Orleans	State Conservation Area
Fort Macomb SCA	Orleans	State Conservation Area
Jean Lafitte NHP	St. Bernard/Orleans/Jefferson	National Historic Park
St. Bernard SP	St. Bernard	State Park
Breton NWR and WA	St. Bernard	National Wildlife Refuge and Wilderness Area
Bohemia WMA	Plaquemines	Wildlife Management Area
Delta NWR	Plaquemines	National Wildlife Refuge
Pass a Loutre WMA	Plaquemines	Wildlife Management Area
Mississippi:		
Buccaneer SP	Hancock County	State Park
Gulf Marine SP	Harrison	State Park
Gulf Islands NS and WA	Harrison/Jackson	National Seashore and Wilderness Area; appr. 1.3 visitors/year (1995 figures)
Davis Bayou Gulf Islands NS	Jackson	National Seashore
Mississippi Sandhill Cranes NWR	Jackson	National Wildlife Refuge
Shepard SP	Jackson	State Park

The primary source for marine recreational fisheries information in U.S. waters is the NMFS Marine Recreational Fisheries Statistics Survey (MRFSS). This survey combines random telephone interviews with on-site intercept surveys of anglers to estimate recreational catch and effort for inland, state, and Federal waters. In the Gulf of Mexico, surveys are conducted in western Florida, Alabama, Mississippi, and Louisiana. Texas conducts its own surveys; these data are not currently available. MRFSS data for 1998 cited below were obtained from NMFS via their online database access (www.noaa.nmfs,gov). Other recreational fishing information is available in Continental Shelf Associates, Inc. (1997) and USDOI, MMS (1999).

An estimated four million fishers from Florida, Alabama, Mississippi, and Louisiana engaged in some form of recreational fishing during 1998. These anglers fished from shore, piers, jetties, private/rental boats, party boats, and charter boats. Recreational fishing takes place from inland waters to the open Gulf, with most effort concentrated in coastal and inshore waters.

Of the four states, western Florida had the highest number of anglers and saltwater fishing trips in 1998 (i.e., >12 million trips involving approximately 3 million anglers). Following Florida (in descending order of number of trips) are Louisiana, Alabama, and Mississippi. (i.e., approximately 500,000 to 3 million trips). The mode of fishing that was most common in all Gulf states was private/rental boats comprising over 50 percent of the effort in each state. This was followed closely by fishing from shore and distantly by fishing from charter/party vessels. Party boats operate mostly from ports in Florida and Alabama, whereas charter boats found in all coastal states (USDOI, MMS, 1999).

In 1998, the percentage of effort expended in inland, state, and Federal waters varied by state. Mississippi and Louisiana most trips were made in inland waters as opposed to state and Federal waters. In Florida and Alabama the percentage of trips made in state waters was much higher than the other two states. Fishing in state and offshore shelf waters often occurs around artificial structures, and off Alabama, Mississippi, Louisiana, and Texas these structures are oil and gas platforms (Stanley and Wilson, 1990; Continental Shelf Associates, Inc., 1997; USDOI, MMS, 1999).

The top species commonly caught by recreational fishers in the Gulf coast states include seatrout (spotted, sand), snapper (gray, red), drum (red, black), white grunt, Spanish mackerel, gag, Crevalle jack, and southern flounder. Spotted seatrout, an inshore species, was the most common fish caught by recreational anglers in the Gulf of Mexico during 1998; estimated catch of this species for 1998 was over 20 million fish. The target species varied among states, with Florida being somewhat different than the other three states. This difference is reflected in the prevalence of hard bottom species such as gray snapper, white grunt, and gag in the Florida catches. Recreational fishers in the other three states caught soft bottom species such as red drum and sand seatrout, per NMFS MRFSS survey data. In offshore oceanic waters of the Gulf of Mexico, commonly sought species include yellowfin tuna, sailfish, blue marlin, dolphin, wahoo, and sharks (Continental Shelf Associates, Inc., 1997). Catch and effort for these epipelagic fishes is much less than for the inshore and shelf species (Continental Shelf Associates, Inc., 1997).

3.3.4 Cultural Resources

Prehistoric Resources

At the end of the Pleistocene epoch, approximately 12,000 years ago, much of Earth's water was locked up in continental glaciers, and sea levels at that time were approximately 60 m (33 fathoms; 197 ft) below present levels. The onset of the Holocene, defined as global amelioration of the climate, resulted in melting of the glaciers, release of glacial meltwaters, eustatic sea rise, and global marine transgressions. Between 12,000 and 4,000 years before present, large coastal areas, which in theory could have contained prehistoric sites, were inundated. This study, however, is only concerned with water depths greater than 200 m (656 ft). Such deep sections of the OCS had never constituted sub-areal landforms during the Pleistocene-Holocene and could not contain prehistoric sites. Conversely, currently unknown prehistoric remains may be extant in depths less than 60 m (197 ft) and along the modern shorelines.

Historical Resources

An MMS-funded study (Grierson *et al.*, 1989) has determined that there are more than 4,000 historical shipwrecks in the northern GOM. The positions of the historically known shipwrecks are identified on maps with varying degrees of accuracy, and few of them have actually been located on the sea bottom. Statistical analysis demonstrated that most of the shipwrecks are likely to be located in relatively shallow water in two types of environment: sea bottoms within 1 km (6.2 mi) of the shoreline, and sea bottoms in proximity to ports, barrier islands, and other locations of frequent ship loss.

However, high-probability search polygons center on the locations of a number of historically known shipwrecks at depth exceeding 200 m (656 ft), in the Mississippi Canyon, Atwater Valley, Lund, and East Breaks Area (table 3-39).

More than 100 ships were attacked by German U-boats in the Gulf during World War II. Approximately 33 merchant vessels were sunk by U-boats between 1942 and 1943 in the northern GOM on the OCS. Six of these ships are believed to be located at depths greater than 200 m (656 ft) in the Lund and Mississippi Canyon lease areas (table 3-40). In addition, the German submarine U-166 was probably sunk in 1942 in the Mississippi Canyon. These vessels are associated with important events in American history and are potentially eligible for listing in the National Register of Historic Places.

Some of the vessels that have been identified through remote sensing stand high above the sea floor, and contain within their hulls thousands of barrels of petroleum products. As such, they constitute a substantial hazard if the hulls are ruptured by oil and gas-related activities.

3.3.5 Other Uses

Deepwater portions of the central and western GOM are utilized by several other interests, including commercial shipping and the military. The magnitude of offshore oil and gas activities (e.g., tankering of crude oil, oil and gas supply, and support vessel operations) and

Table 3-39

Nineteenth- and Early Twentieth-Century Shipwrecks in Deepwater Blocks
(modified from Garrison *et al.*, 1989)

Ship Name*	Date of Wreck	Lease Area and Blocks Included in Search Polygon
Northern Eagle	1908	East Breaks 154, 155, 156, 198, 199, 200, 242, 243, 244
Carrie Strong	1916	Lund 730, 731, 732, 774, 775, 776, 818, 819, 820
W. H. Marston	1927	Lund 299, 300, 301, 343, 344, 345, 387, 388, 389
Western Empire	1875	Mississippi Canyon 287, 288, 289, 331, 332, 333, 375, 376, 377
Nokomis	1905	Mississippi Canyon 963, 964, 965, 1007, 1008, 1009 Atwater Valley 39, 40, 41

Source: MMS Deepwater EA (MMS, 2000b).

Table 3-40

World War II Shipwrecks Sunk in Over 200 Meters (656 Feet) of Water

Vessel Name	Date Sunk	Tonnage	Cargo	Lease Area
Gulfoil	5/16/42	5,188	54,000 bbl diesel oil	Mississippi Canyon
Gulfpenn	5/13/42	8,862	104,181 bbl fuel oil	Mississippi Canyon
Robert E. Lee	7/30/42	5,184	47 tons general, 268 passengers	Mississippi Canyon
Alcoa Puritan	5/06/42	6,759	9,700 tons bauxite	Mississippi Canyon
Carrabulle	5/26/42	5,030	42,307 bbl liquid asphalt	Lund
Amapala	5/15/42	--	Fruit	Lund

Source: MMS Deepwater EA (MMS, 2000b).

shipping operations through Gulf ports has led to the establishment of a series of safety fairways, or vessel traffic separation schemes, and anchorages to provide unobstructed approaches for vessels using U.S. ports (USDOI, MMS, 1990b, [Visual No. 2]). Shipping safety fairways, generally located inshore of the deepwater region considered in this analysis, are lanes or corridors in which no fixed structure, whether temporary or permanent, is permitted. Fairway anchorages are areas contiguous to and associated with a fairway in which fixed structures may be permitted within certain spacing limitations (33 CFR 166). All offshore structures, including any proposed FPSOs, must be adequately marked and lighted. After a structure is in place, it often becomes a landmark and an aid to navigation for vessels that regularly operate in the area (USDOI, MMS, 1990a).

Military operations may be conducted within nearshore or offshore waters throughout the GOM, staged either from onshore facilities (e.g., from an air station or air base) or as part of offshore fleet operations (e.g., routine fleet activities, special or joint maneuvers). U.S. Navy assets that might be operational on a transitory basis within the project area include surface vessels, submarines, and aircraft, typically operating between a shore base and offshore waters. The U.S. Coast Guard conducts routine activities and search-and-rescue operations using both surface vessels and aircraft. Similarly, the U.S. Air Force may conduct aerial operations over the deepwater region of the Gulf.

4. ENVIRONMENTAL CONSEQUENCES, CUMULATIVE EFFECTS, AND MITIGATION

4.1 Impact-Producing Factors

The following text describes three major phases of the proposed action, including installation, routine operations (for an FPSO and attendant shuttle tanker), and decommissioning. A thorough identification of impact-producing factors provides the basis for determining potential impacts on individual resources, the latter of which are detailed in Section 4.3.

4.1.1 Installation

The base-case scenario, as described earlier, consists of a large, newbuilt vessel moored in approximately 1,524 m (5,000 ft) of water by nine chain/wire lines terminated at the seafloor by drag anchors. The FPSO itself is connected to three nearby subsea well manifold clusters by insulated steel flowline risers and multifunctional control umbilicals. The FPSO is also connected to a steel line riser for export of gas. This section will describe the activities and equipment required for installation of a base-case scenario FPSO and will summarize the potential impact-producing factors.

Several separate but interrelated steps will be realized with the installation of an FPSO, including:

- Construction and Precommissioning
- Anchoring
- Manifold Installation
- Flowline and Gas Export Line Installation
- Umbilical Installation
- FPSO Tow and Hookup
- Riser and Gas Export Line Hookup
- Logistical Support

Each of these steps will be described in the following sections, followed by a summary of projected impact-producing factors associated with these installation activities.

4.1.1.1 Construction and Precommissioning

The double-hulled FPSO vessel can be constructed at a Gulf coast shipyard, but it might also be constructed at a yard along the U.S. east coast or overseas. Installation and precommissioning (i.e., testing equipment at as close to operating conditions as possible) of oil and gas processing facilities and utilities equipment aboard the FPSO may be performed at the hull construction site or at some other site. Since the base-case FPSO does not have propulsion equipment, the commissioned hull will be towed to the installation site. It is assumed in this analysis that precommissioning will occur along the Gulf coast, so the duration of the tow to the installation site will only be two or three days.

Installation Activities Overview

There are several separate activities at the field installation site which must be completed before the FPSO is mobilized. These relate to both drilling and hookup of the subsea wells and to the preparation of the FPSO mooring spread and include:

- Drilling of nine subsea wells
- Setting three subsea manifolds
- Laying subsea flowlines, umbilicals, and jumpers
- Laying gas export line
- Setting nine drag anchors and chain/wire lines

Following completion of these activities, the FPSO hull will be towed to the site and connected to the mooring spread. Several additional activities remain to be completed before startup, including:

- Installation of flowline risers
- Installation of umbilical risers
- Installation of riser for the gas export line
- Proofloading moorings
- Subsea well completions

The spatial relationships between system components and construction equipment selection will influence the timing and sequence of these activities. The geometry represented in figures 4-1 and 4-2 will be used for discussing installation and abandonment activities for this base-case evaluation. The FPSO is centered at least 3,658 m (12,000 ft) from the nearest subsea well cluster and each well cluster is separated by about the same distance.

It is assumed in this analysis that all well drilling and completion activities will be performed by a mobile offshore drilling unit (MODU) moored on location by eight to twelve drag anchors. It is possible that a dynamically positioned drillship may be employed in place of a MODU, however, for the purpose of this analysis a MODU is assumed. It is also assumed that the MODU will install wellheads and flowline/umbilical jumpers upon completion of each well. The geometry is such that one anchor setting will be sufficient for drilling all three wells for each of three manifold center locations and another setup for completion and hookup of each three well group. Since the drilling, completion, and hookup of subsea wells are not unique to an FPSO installation, they will not be considered further.

In several instances, there are at least two alternative approaches feasible for installation of other components of the FPSO system – use of a designated vessel for all installation tasks, or use of multiple or specialized vessels to complete installation. Use of a specific construction vessel for installation of several components would present some advantages, but would require that activities, which might be performed in parallel, be done in sequence. Vessel availability, cost, and a number of other considerations will also influence the final selection of construction equipment. The following combinations are believed to be representative for the base-case scenario:

- FPSO transportation - tow vessels (three to five vessels)
- Mooring anchors and lines - anchor handling vessels (one or two vessels)
- Flowlines and gas export line – dynamically positioned pipelaying vessel
- Umbilicals – dynamically positioned cable/umbilical vessel
- Installation of manifolds, hookup FPSO, installation of risers and hookup gas export line – dynamically positioned construction vessel

Most activities that are carried out below the water surface will rely on electrically powered remotely operated vehicles (ROVs) to provide visual perspective and to perform certain limited work functions.

A representative schedule of activities is illustrated in figure 4-3. Details of actual FPSO installation schedules will vary, especially when the same construction equipment is selected for different activities (which may be shown here as overlapping in time), but the potential impact-producing effects will likely by very similar. Overall, installation activities at the offshore site will likely extend over a period of three months or more and drilling and completion activities will extend over two or three years.

4.1.1.2 Anchoring

The anchors and lower chain and wire segments of the nine mooring lines will be preinstalled at the site. This work can be performed by either a pair of large anchor handling vessels (AHVs), taking approximately four weeks, or by a dynamically positioned construction vessel, taking about half the time. The scenario described here assumes two AHVs, each more than 61 m (200 ft) in length and having 15,000 to 20,000 horsepower.

Prior to the beginning of installation work at the site, a long baseline acoustic-positioning array will be established on the seafloor. This array provides accurate navigational control for positioning objects on the seafloor and is used for both drilling and construction activities. Each of the three anchor clusters will be positioned 2,438 to >3,048 m (8,000 to >10,000 ft) from the final FPSO location using the positioning array. The positioning array may, in fact, be made up of several smaller arrays; one with four or five transponders at each major worksite, including three anchor clusters, three subsea well/manifold clusters, etc. Each battery-powered transponder is mounted on a small support frame that sits on the seafloor and can be remotely released for recovery. The small support frames are left on the seafloor, but they affect only a few square feet of ocean bottom and do not penetrate significantly below the sediment surface. The transponders send and receive low-level acoustic signals.

Each of the preinstalled mooring segments will consist of a fabricated steel drag anchor (weighing several hundred thousand pounds), approximately 305 m (1,000 ft) of 13.7-cm (five-in) chain, a length of spiral wire strand (approximately 14 cm [five in] in diameter), and a temporary support buoy. The two AHVs would position themselves over each anchor location; one lowering the anchor while the other pays out the attached chain, wire, and buoy. Each anchor will be partially set by one or both AHVs pulling towards the eventual FPSO location. Proofloading of the anchors will be completed as part of the process of hooking up the FPSO on location. Final setting of each anchor is expected to disturb a volume of sediment approximately 3 to 6 m (10 to 20 ft) wide, as much as 61 m (200 ft) long and to a depth of 15 to 30 m (50 to 100 ft), depending on the strength of the seafloor sediments. The chain and wire segment of each

02:001000_MM01_00_03_90-B0266
Fig4-1.CDR-7/15/00-GRA

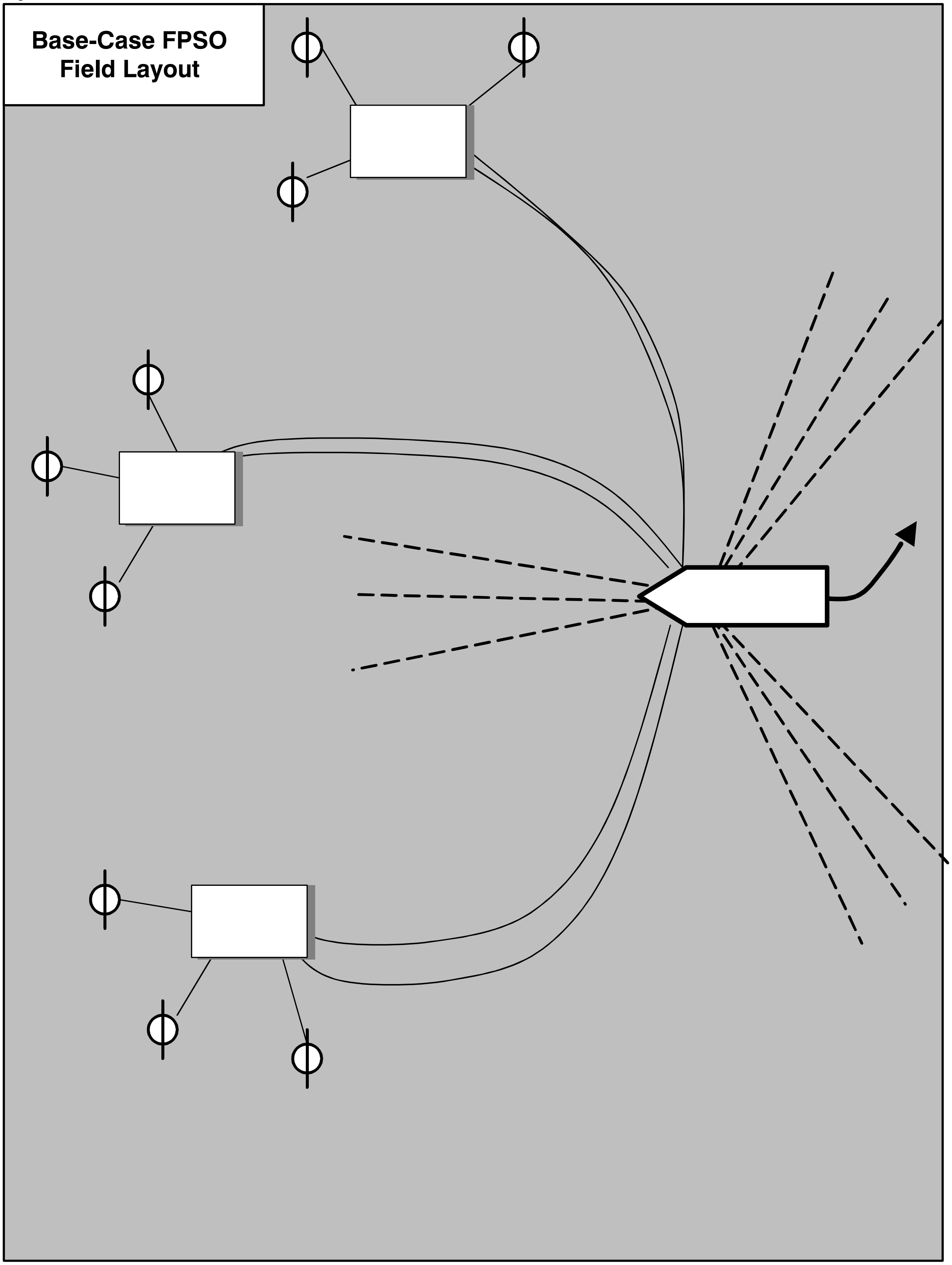

Figure 4-1. General layout of FPSO components.

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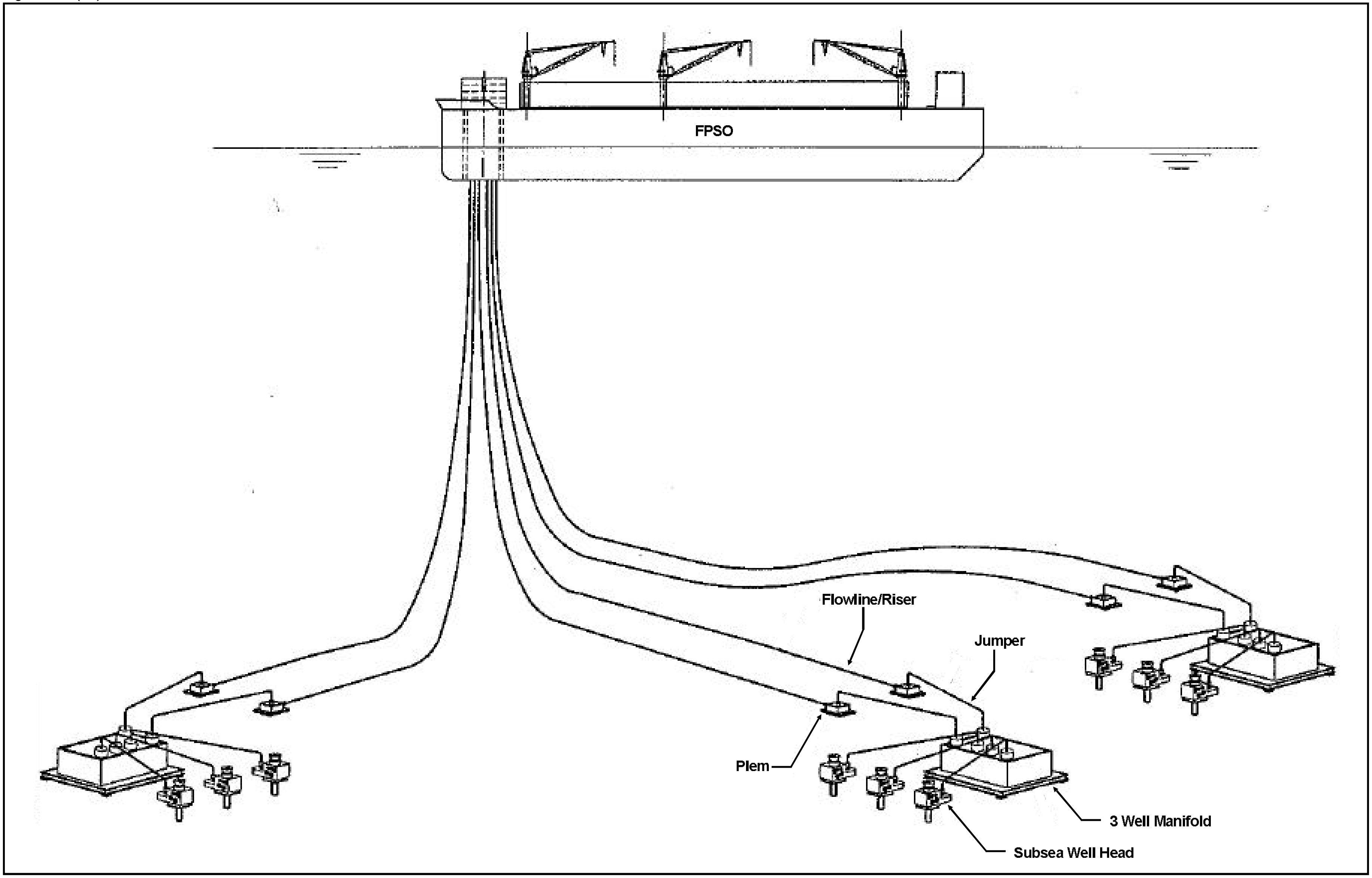
Fig4-2.CDR(P1)-7/15/00-GRA



Source: Aker Maritime 2000.

Figure 4-2 SCHEMATIC OF BASE-CASE SUBSEA SYSTEM

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Fig4-3.cdr-7/25/00-GRA

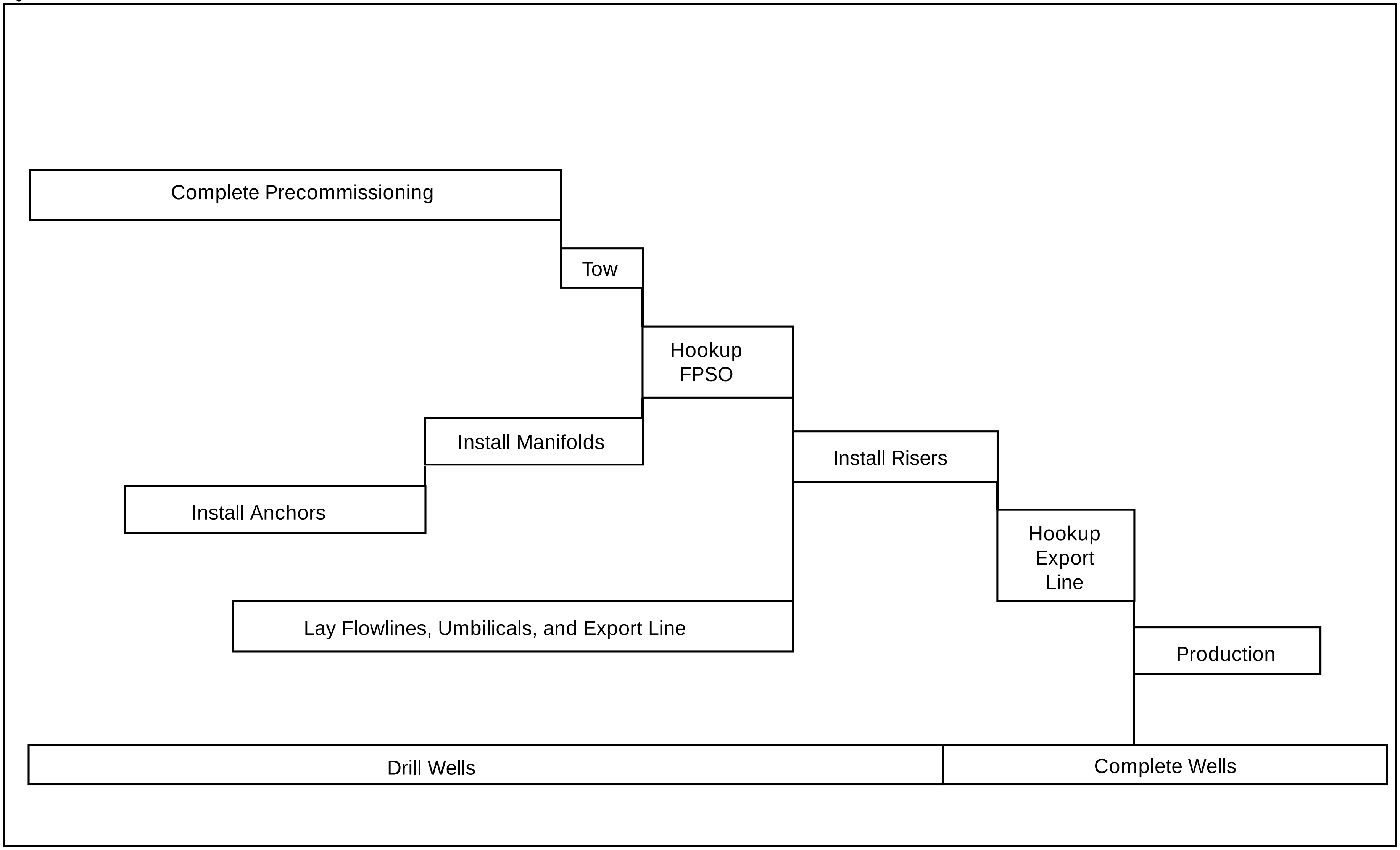

Figure 4-3 PROBABLE SEQUENCE OF FPSO INSTALLATION ACTIVITIES.

mooring line is expected to disturb a narrow zone of sediments from the anchor toward the center of the array for a distance of 305 to 610 m (1,000 to 2,000 ft), essentially laying on the seafloor intermittently over most of this distance. At completion of the preinstallation, a buoy will support each segment. The buoy may be fabricated steel or syntactic foam, but will be lighted and designed to minimize damage to either the buoy or a vessel in the event of a collision during the brief period leading up to FPSO hookup.

Installation of each preinstalled mooring segment will take approximately a day. Since the components are very large, it is assumed that the AHVs will make two round trips to the shorebase for resupply. Of the estimated 28-day duration of this activity, the AHVs will spend approximately half of this time working in the vicinity of the FPSO site and half in transit or at the shorebase.

4.1.1.3 Manifold Installation

Each of the three subsea manifolds will be installed on the seafloor at a location approximately 3,658 m (12,000 ft) or more radial distance from the FPSO location. Three subsea wells will have surface locations within a short distance (perhaps 30 m [100 ft] or so) from each manifold. In this base-case scenario, the manifolds will be installed on the seafloor by a dynamically positioned construction vessel, but an anchor handling vessel outfitted with an A-frame or a mobile drilling rig could also complete installation of small- to moderate-sized manifolds. If manifold installation is the first onsite activity for the construction vessel, the manifolds might be transported offshore as deck cargo. Otherwise, the manifolds would be transported on a cargo barge with an attendant tug, as is assumed in this analysis. Manifold configurations will vary widely, but might be expected to be a fabricated steel framework with integral piping, valving, and controls with dimensions of 6 to 9 m (20 to 30 ft) square by 9 m (20 ft) or more in height and weighing 1,814 or 2,722 kg (20 or 30 tons).

It is presumed that the manifolds will have short steel extensions below the seafloor, which will penetrate the sediments and provide horizontal resistance to movement, and mats along the seafloor surface to support the weight of the manifold and provide for leveling. Installation will be a matter of attaching lifting slings, lifting the manifold from the deck of the cargo barge and lowering it to set on the seafloor, using the acoustic positioning system to control location and orientation. Once on the seafloor, each manifold will disturb the surface sediments over an area roughly coincident with its plan dimensions (i.e., 37 to 56 m^2 [400 to 600 ft^2]). The seafloor extensions will penetrate 10 feet or so below the seafloor at each 'corner', depending on the strength of the sediments.

4.1.1.4 Flowline and Gas Export Line Installation

Production will flow from each subsea well, through a jumper, to a nearby manifold, thence through jumpers to flowline end modules (FEMs), which terminate in two 25-cm (10-in) steel flowlines. From the FEMs, the flowlines (i.e., one pair for each manifold) run along the seafloor and are connected individually to steel (lazy wave) production risers, which are suspended from the FPSO turret, passing through riser guide tubes within the turret cylinder, and connected at the riser termination deck on the turret.

Installation of the flowlines will be performed by a dynamically positioned lay vessel and will likely begin by lowering the FEM, with the flowline connected, setting the FEM on the seafloor within 15 to 30 m (50 to 100 ft) of the subsea manifold and laying in the direction of the FPSO location. The end of the flowline will be terminated, lowered, and temporarily abandoned on the seafloor in the vicinity of the planned location of the lower end of the production riser, which will be connected to the flowline and installed after the FPSO is moored in place. The lay vessel will likely be resupplied (with pipe, material, fuel, etc.) either by supply vessel or cargo barges towed by tugs. Disturbance of seafloor sediments by both FEMs and flowlines will be limited to narrow areal corridors and shallow sediment depths.

The gas export line in this base-case scenario is assumed to run from a FEM at the bottom end of the export riser from the FPSO a distance of up to 322 km (200 mi) to an undetermined shore crossing. The potential for an existing platform at some intermediate location would provide an opportunity to terminate shallow and deepwater portions of the line or connection into an existing pipeline, as well as providing an opportunity to boost pressure in the line. Using this latter scenario (i.e., tie in to an existing platform, or connection to an existing pipeline), the shallow water portion of the line will be installed by a conventional moored pipelaying barge. A dynamically positioned lay vessel will install the deepwater portion of the line. This sort of split in installation equipment will likely be employed even if there is not an intermediate platform. In either scenario, it is assumed that the shallow portion will be laid first, with the end of the line terminated and laid down somewhere along the route between the 152- and 305-m (500- and 1,000-ft) water depth contours. The dynamically positioned lay vessel will pick up the line and lay away in the direction of the FPSO site, terminating the line by lowering a FEM to the seafloor at the intended bottom termination of the gas export line riser. The lay vessels will likely be resupplied either by supply vessel or cargo barges towed by tugs. Shallow water portions of the gas export line will be buried, as required by regulation, and may involve sandbagged crossings of other existing pipelines along the route. As in the case of the subsea flowlines, disturbance of sediments by the deepwater portion of the gas export line will be limited to narrow areal corridors and shallow depths. The route will be selected to avoid sensitive features and problematic seafloor topography.

4.1.1.5 Umbilical Installation

Installation of the control umbilicals, one to each subsea manifold, will proceed in a manner similar to installation of flowlines and may be performed by a special dynamically positioned cable/umbilical vessel or by the same lay vessel which installs flowlines. Installation will likely begin by lowering a termination sled, analogous to a FEM for flowlines, with the umbilical connected, setting the termination sled on the seafloor within 15 to 30 m (50 to 100 ft) of the subsea manifold and laying in the direction of the FPSO location. If timing is such that the FPSO is in place at the start of umbilical installation, the preferred approach could proceed by laying the umbilical in one piece, installing buoyancy to achieve the desired lazy wave riser configuration and passing the end termination directly to the FPSO, where it is lowered underwater and brought up through guide tubes in the turret, terminating on the turret deck. If this is not possible, the umbilical will be terminated in another sled and lowered to the seafloor, to be connected later to a riser termination sled by jumpers. As in the case of the subsea flowlines and the gas export line, disturbance of seafloor sediments by the deepwater portion of the control umbilicals and termination sleds will be limited to narrow areal corridors and shallow depths.

4.1.1.6 FPSO Tow and Hookup

Since the FPSO is not self propelled, it will be towed from the precommissioning site to the installation site by three to five tugs. Assuming a Gulf of Mexico precommissioning site, the tow will last one or two days. Hookup of the FPSO to the mooring spread will be performed by a dynamically positioned construction vessel. The vessel will pickup the upper end of one of the preinstalled mooring segments, remove the buoy, connect another segment of wire, and move toward the FPSO, while also paying out wire. During this operation, the FPSO will be held on location by tugs. The construction vessel will pass the end termination of the mooring segment directly to the FPSO, where it is lowered underwater and brought up through fairleads, or guide tubes, in the turret, terminating on the turret deck. The construction vessel then proceeds to repeat the process with another segment of the mooring spread. Once enough segments are hooked up to keep the FPSO on station, the attending tugs can depart. Once all segments are hooked up, the FPSO can fully set and proofload each anchor by pulling with several opposing lines. This work can proceed while the construction vessel begins the riser and gas export line hookup process.

4.1.1.7 Riser and Gas Export Line Hookup

Installation of three umbilical risers, six production risers, and the gas export riser are required to complete the FPSO installation. This work can proceed in the order that is most convenient. All risers will be suspended underneath the turret of the FPSO in a lazy wave configuration, passing up through guide tubes within the turret cylinder, and connecting at the riser termination deck on the turret.

The previously terminated end of the 30-cm (12-in) gas export line, which was temporarily abandoned on the seafloor at the completion of its installation, will be relocated and raised to the surface by the construction vessel. The bottom end of the riser will be welded or connected to the terminus of the gas export line. The vessel will move toward the FPSO, paying out riser and attaching buoyancy elements to provide the lazy wave configuration, and will pass the top termination of the riser to the FPSO, where it will be lowered underwater and brought up through a guide tube in the turret, pulled in and terminated on the turret deck. Installation of production flowline risers will likely proceed in a similar manner. If the umbilicals are not connected to the FPSO in one piece during their installation, as described above, it is likely that the bottom ends of the umbilical risers will terminate in a sled. In this instance, umbilical riser installation will proceed similar to flowline installation. Final connection between each umbilical and its riser sled is made by jumpers. Jumper installation is accomplished by first positioning the construction vessel above the two termination sleds and accurately measuring the distance between connection points using the acoustic positioning array. Each jumper is then cut to fit on the deck of the construction vessel, then lowered and stabbed to make the needed connections.

4.1.1.8 Logistical Support

Actual logistical support for the FPSO installation will vary widely in detail, depending on the equipment, procedures, and sequencing of field operations. For example, material storage capacities for alternate equipment capable of installing the flowlines and gas export line, and therefore the resupply requirements, are considerably different. For this base-case, the following equipment spreads, timing, and durations offshore are thought to be conservative:

- Two round trip helicopter flights (i.e., nine-person capacity from shorebase to site) per week for a ten-week period, starting with flowline and gas export line installation and ending with gas export line hookup (i.e., six flight hours, including refueling)
- One round trip crew boat per week for the same period (one day per roundtrip)
- One cargo barge and attendant 1,200 HP tug on site for the same period
- One cargo barge and attendant 1,200 HP tug in transit between the FPSO site and the shorebase once per week for the same period, with an estimated transit time of 24-hours each way

4.1.1.9 Nature and Scope of Potential Impact-Producing Factors by Resource Being Affected

Neither the nature of the procedures nor the equipment involved in FPSO installation is expected to be unique and, with the exception of the FPSO itself, the components of the base-case FPSO system are expected to be similar to components of other deepwater development system alternatives. An overview of the potential impact-producing factors and resources impacted during FPSO installation is given in table 4-1.

Air Quality

All activities and sources listed involve internal combustion engines to power propulsion and/or work functions and therefore may impact air quality. Engine emissions of concern (as noted previously in Section 3.1.3) represent several criteria pollutants, as established by the EPA. Criteria pollutants include carbon monoxide (CO), ozone, lead, nitrogen oxides (NO_x), particulate matter (greater than 10 mm or PM_{10}), and sulfur dioxide (SO_2). Emission limits of these criteria pollutants (e.g., 1-, 3-, 8-, and/or 24-hour standards; annual standards) are intended to protect human health and the environment. An estimate of emissions during installation activities is contained in table 4-2 in terms of total fuel burned (generally #2 diesel) per day for each week of installation activities. Estimates are given for each major piece of equipment for the duration of installation.

Water Quality

There are two potential sources of impact on ambient water quality: disturbance of seafloor sediments in connection with construction activities and discharges from vessels participating in installation. Setting anchors, setting manifolds, installing flowlines, umbilicals, gas export line, and risers are expected to cause local disturbance of the seafloor, which will cause sediments to become suspended in the near-bottom water column. This alteration of water quality is expected to be localized and temporary, ceasing when individual installation activities (e.g., setting of anchors, manifolds, installation of flowlines, etc.) are complete.

Installation activities do not involve discharges into the water, other than the normal release of those associated with accommodation for workers on board each vessel. Discharges from vessels includes domestic wastes (e.g., sanitary wastes and gray water),and bilge water, and

Table 4-1

Impact Producing Factors Versus Resources Potentially
Affected by FPSO Installation

Factors	Air Quality	Water Quality	Bottom Sediments, Topography	Benthic Communities	Marine Mammals	Sea Turtles	Coastal and Marine Birds	Fishing and Fisheries	Coastal Habitats	Archeological Resources	Socioeconomic Resources
Install Anchors	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	-
FPSO Tow and Hookup	✔	✔	-	-	✔	✔	✔	✔	✔	-	-
Flowline, Umbilical, and Gas Export Line Laying	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	-
Install Risers	✔	✔	-	-	✔	✔	✔	✔	-	-	-
Hookup Gas Export Line	✔	✔	-	-	✔	✔	✔	✔	-	-	-

Table 4-2

Air Emission Levels During FPSO Installation (total priority pollutants in tons/week)

Sources	Location	Week of Installation									
Vessels:		1	2	3	4	5	6	7	8	9	10
Anchor Handling (2)	FPSO Site	19	19	19	19	-	-	-	-	-	-
	Transit	16	16	16	16	-	-	-	-	-	-
Construction (1)	FPSO Site	-	-	-	-	20	28	28	28	28	24
	Transit	-	-	-	-	8	-	-	-	-	8
Gas Export Line/Flowline (1)	FPSO Site	20	28	28	-	-	-	-	-	-	-
	Transit	8	-	-	28	28	28	28	-	-	-
Umbilical (1)	FPSO Site	-	-	-	25	-	-	-	-	-	-
	Transit	-	-	5	-	5	-	-	-	-	-
Tow (5)	FPSO Site	-	-	-	-	-	-	27	-	-	-
	Transit	-	-	-	-	-	21	-	-	-	-
Logistical (2)	FPSO Site	4	4	4	4	4	4	4	4	4	4
	Transit	3	3	3	3	3	3	3	3	3	3
Aircraft:											
Helicopter	Transit	1	1	1	1	1	1	1	1	1	1
Totals	FPSO Site	43	51	51	48	24	32	59	32	32	28
	Transit	30	20	25	48	45	53	32	4	4	12

Notes: Emission levels assume limited deepwater anchoring capability and the use of dynamically positioned vessels, where appropriate. Emission levels can be expected to decrease significantly (from those noted above) in the shallower portions of the study area where anchoring or mooring is possible. Two anchor handling vessels are required, each rated at 16,000 HP (w/ winches and thrusters); est. fuel consumption: 5,000 to 6,000 gal/day; duty cycle: 70 to 80 percent. One construction vessel (barge) rated at ~20,000 HP is required; est. fuel consumption: 9,000 gal/day; duty cycle: 40 to 50 percent. One pipelaying vessel (barge; for gas export line and/or flowline) rated at ~20,000 HP is required; est. fuel consumption: 9,000 gal/day; duty cycle: 40 to 50 percent. One umbilical vessel rated at 16,000 HP is required; est. fuel consumption: 6,000 to 8,000 gal/day; duty cycle: 70 to 80 percent. Five tow vessels are required, with two @ 7,000 HP, two @ 5,600 HP, and one @ 4,200 HP; est. fuel consumption: 2,400 gal/day (average); duty cycle: 70 to 80 percent. One tug and one crewboat (i.e., logistical) are required; est. fuel consumption: 1,200 to 2,800 gal/day, respectively; duty cycle: 70 to 80 percent and 70 to 90 percent, respectively. (Source: D. Calkins, Manager of Engineering and Projects, J. Ray McDermott, Mentor Subsea, August/September, 1999, personal communication). Helicopter support assumes one Sikorsky S-76 Class transport in use 8 hrs/day, 7 days/week. Pollutant speciation for PM, SO_2, NO_x, CO, and VOCs is 2, 27, 56, 13, and 2 percent, respectively.

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food scraps. The nature of these discharges will conform to regulatory requirements appropriate to each vessel. A listing of vessel type, the range of expected manning levels, and the expected duration of involvement at the site or in transit are estimated in table 4-3.

Seafloor Sediments, Topography, Benthic Communities, and Archeological Resources

Setting anchors, setting manifolds, and installing flowlines, umbilicals, gas export line and risers are expected to cause local disturbance of the seafloor sediments. All but anchor setting are expected to have impact limited to relatively shallow penetrations; between a few inches and a few feet of the seafloor, depending in part on sediment strengths. The areal extent of these disturbances is described in the activity descriptions in earlier sections. Installation of gas export line segments in shallow water (generally less than 61-m [200-ft] water depths) will involve burial of the line and may involve sandbagged crossings of other lines. Final setting and proofloading (i.e., testing of anchor components under load) of the preinstalled anchors may result in disturbance of seafloor sediments to a depth which may exceed 30 m (100 ft) in soft sediments.

In most cases, the disturbance occurs only during the construction period. Exceptions include the manifolds, FEMs, and termination sleds, each of which will permanently cover an area equal to their footprint, and the touchdown zones of risers and mooring lines, in which occasional storms cause sections to temporarily lift off the seafloor, to return again during the ensuing period of calm. Installation of the FPSO and its components is not expected to result in any significant change in bottom topography.

Current pipeline routing practices would avoid any identified archeological resources. Other aspects of FPSO installation are not expected to impact sites of archeological significance.

Marine Mammals, Sea Turtles, Birds, Fisheries, and Coastal Habitats

Noise and other disturbance associated with vessels and construction equipment employed during installation may disturb animal resources, but no physical contact is anticipated and all but the disturbance associated with FPSO and shuttle tanker operations will be temporary. Other than temporary disturbance of occasional passage of vessels in transit, installation activities are not expected to have any effect on coastal habitats.

Socioeconomic Issues

The potential socioeconomic effects of FPSO installation activities pertain primarily to: 1) where fabrication of FPSO-related vessels and associated processing equipment may be expected to occur; and 2) where support operations may be expected. Of most interest are any increases in the local labor force prompted by FPSO installation operations (e.g., demands for a specialized labor force) and the fiscal effects of such operations on the local economy.

4.1.2 Routine Operations

FPSO operations can be separated into several distinct steps, each of which includes identifiable characteristics and activities that may involve potential impact-producing factors.

Table 4-3

Manning levels and duration of installation activities.

			Duration of Involvement (Total Vessel-Days)									
Vessel	Manning Level	Primary Location	1	2	3	4	5	6	7	8	9	10
Anchor Handling (2)	15 - 20	Installation Site	7	7	7	7	-	-	-	-	-	-
		Transit to/from shorebase	7	7	7	7	-	-	-	-	-	-
Construction Vessel	100 – 125	Installation Site	-	-	-	-	5	7	7	7	7	5
		Transit to/from shorebase	-	-	-	-	2	-	-	-	-	2
Pipelay Vessel	100 – 125	Installation Site	5	7	7	-	-	-	-	-	-	-
		Transit to/from shorebase	2	-	-	7	7	7	7	-	-	-
Umbilical Vessel	30 – 50	Installation Site	-	-	-	7	-	-	-	-	-	-
		Transit to/from shorebase	-	-	1	-	1	-	-	-	-	-
Tow Vessels (5)	5 – 10	Installation Site	-	-	-	-	-	-	25	-	-	-
		Transit to/from shorebase	-	-	-	-	-	10	-	-	-	-
Tugs and Crewboats	3 - 10	Installation Site	7	7	7	7	7	7	7	7	7	7
		Transit to/from shorebase	3	3	3	3	3	3	3	3	3	3

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The primary activities that will take place on the FPSO include monitoring and operating the subsea wells, receiving and processing gas and fluids from the wells, temporary storage of oil, compression and export of gas, processing and discharge of produced water, and offloading of oil to a shuttle tanker. In connection with these operations, the FPSO will provide accommodation for up to 70 personnel and will receive supplies and send solid waste to shore for disposal. Wastes (e.g., produced water, domestic and sanitary waste, miscellaneous discharges; see Section 4.1.2.5) will be processed onboard the FPSO and discharged overboard in compliance with applicable NPDES permits or Coast Guard regulations. Details of the FPSO system, its components, and operating parameters are described in Section 1.3.2. Impacts of routine operations are detailed in Section 4.3, while potential effects associated with accidents and oil spill cleanup operations are described in Section 4.4.

Several different aspects of routine operations have been evaluated in this section, including:

- Production Processing and Maintenance
- Power Generation, Pumps, and Compression
- Well Control and Maintenance
- Gas Compression and Export
- Produced Water, Domestic and Sanitary Waste, Miscellaneous Discharges, and Solid Waste
- Logistical Support
- Storage Operations
- Offloading and Shuttle Tanker Operations
- Underwater Obstructions

Each of these aspects of routine operations will be described in the following sections, followed by a summary of projected impact-producing factors.

4.1.2.1 Production Processing and Maintenance

At peak design production levels, the base-case scenario FPSO will receive 150,000 barrels per day (BPD) of oil and 200 million standard cubic feet of gas per day (MMCFD) from its nine producing wells. The system will also be capable of handling a maximum of 70,000 barrels of produced water per day. Production will flow through the swivel and into a process train with three-stage separation. Each processing stage separates oil, gas, and water at successively lower pressures. The oil may pass through temporary separation tankage before being delivered to onboard storage tanks in the hull of the FPSO. Gas will be further processed to reduce its moisture content before being recompressed to sales pressure and shipped through the gas export line. All the other liquids extracted from the production flow (e.g., water, natural gas liquids, completion and workover fluids, chemicals injected for flow assurance) will be processed to remove and separate hydrocarbons, sediments, and other waste products; limited recovery of chemicals or workover fluids will also occur (e.g., glycol). Hydrocarbon liquids will be returned to the production stream. Produced water will be cleaned before being discharged overboard, in compliance with NPDES requirements. All production related waste products which do not meet NPDES discharge requirements will be sent to shore for proper disposal; all non-production-related discharges will be disposed of according to applicable permits. Any gases that separate from the liquid stream will be recombined with the production gas stream and exported. Diversion of any of the gas production stream to the flare system will only occur in the event of equipment failure or the need to relieve system pressure.

All maintenance operations will be performed under strict procedures which are designed to minimize chance spills and releases, as well as ensuring the safety of the system and personnel. In nearly all respects, routine production and maintenance operations on the FPSO will be the same as those on comparable processing facilities of other deepwater development systems. In addition, FPSOs will have unique inspection requirements, such as in-service hull inspections; mooring line and riser inspections; in-tank inspections (confined-space entry); turret and swivel inspections; etc. The two aspects of the FPSO operations which differ from many other development systems are 1) the existence of a large volume temporary oil storage on board, and 2) offloading and transport of production crude oil via shuttle tanker on a frequent and routine basis.

A notable feature of FPSOs is the existence of a solid vessel deck and the contained turret moon pool, with accompanying drains and pumps. This containment system ensures that few, if any, hydrocarbon, water, or chemical spills between the production risers and the export/offloading lines will ever reach the sea surface or water column.

4.1.2.2 Power Generation, Pumps, and Compression

The base case FPSO will utilize gas from the field production to fuel turbines which, in turn, will drive pumps, export gas compressors, and electric power generators. Diesel engines will also burn diesel fuel which has been transported to the FPSO. During startup, prior to attaining suitable gas production levels, other fuels (e.g., diesel) may be employed as needed. Similarly, during production, other non-natural gas fuels may be used as a replacement or supplement to natural gas. FPSO fuel sources are similar to other deepwater development technologies (e.g., TLPs, SPARs) and other offshore production systems. Details of reservoir performance can vary widely, but the period of peak production may last three to five years. Assuming new production is brought to the FPSO, operating levels may average half the peak level for the remainder of the field life. In addition, a small amount of diesel will be burned to drive fuel transfer pumps and other uses.

4.1.2.3 Well Control and Maintenance

Monitoring and control of subsea wells will be performed from the FPSO, except when control is turned over to a MODU during workovers and recompletion activities. Continuous FPSO activities involving the subsea wells may include injection of paraffin inhibitors and/or hydrate suppression chemicals. These chemicals are pumped through the umbilical to the manifold and are injected into the production stream at or near the wellhead. These chemicals either become incorporated into the production stream or are recovered on the FPSO, where they are either processed for reuse or shipped to shore for regeneration.

The characteristics of reservoir production streams vary widely, but paraffin, formation sediments, and other substances will in time become deposited in the flowlines. The base-case system has been designed with dual flowlines in order to facilitate “pigging.” Periodically, a pig will be pumped from the FPSO and routed through the flowline loop to clean out these deposits. The material which is removed from the flowlines will be processed on board in order to separate the various components. Hydrocarbons will be incorporated into the production stream, water will be cleaned up and discharged, and other materials will be shipped back to shore for disposal.

Drilling and downhole workover operations that may be required after installation will be performed by a floating drilling rig. The rig will be moored or dynamically positioned over the subsea "trees," as is typical of other subsea development schemes, and, other than initiating shut-in and restart of the wells, will not involve any activities on the FPSO itself.

Workover and maintenance operations on subsea wells may infrequently result in accidental release of one or more chemicals from manifolds or subsea tree connections. The following paragraphs outline the prevalent chemicals used during production operations that may be accidentally released from manifolds or subsea tree connections, including workover and maintenance activities. Chemical inhibitors will be injected continuously in order to prevent the formation of hydrates, corrosion, wax/paraffin, scale, emulsions, asphaltenes, and microorganisms. The following is a description of these subsea production problems and the recommended and expected prevention treatments.

Hydraulic Control Fluids

Hydraulic control fluids are water-based fluids specifically formulated for use in subsea production control systems. Their low viscosity promotes optimum system response. Additives provide protection against wear, corrosion, and microbiological degradation. The optimum fluid is one having a pour point for the worst ambient conditions to be encountered, while still having the lowest possible viscosity. Hydraulic control fluids normally operate within a closed system, and typically are not released into either the production stream or the environment.

Corrosion Inhibitors

Corrosion is the deterioration of a metal substance as a result of reacting with its environment. Corrosion can be controlled through the use of corrosion resistant alloys, metal coatings, or by chemical inhibition.

Corrosion inhibitors may be used on a continuous basis or selectively (e.g., during pigging operations) to establish and maintain an inhibiting film. Typical treatment dosages range between 5 and 100 parts per million (ppm). Corrosion inhibitors may be added to diesel or clean hydrocarbon condensate, either by continuous injection or in batch treatment applications (Maloney, 2000, personal communication). Such inhibitors remain in the production stream and are not recovered. Corrosion inhibitors normally operate within a closed system and typically are not released into the environment.

Wax/Paraffin Inhibitors

Waxes are high molecular weight paraffin components which are soluble in the liquid phases of black oils and condensates. Waxes present in crude oil are in the form of nonoxidized alkanes. The physical characteristics (e.g., viscosity or melting point) of these alkanes (C_nH_{2n+2}) are largely determined by the length of the alkane constituents present. As the production flow conditions change (predominately through thermal gradients), wax particles can start to precipitate out of solution, where they can interact to form a matrix that can entrap liquid, and gel the production fluid. Control of waxes/paraffins can be approached mechanically through cleaning pigs or through injection of paraffin control chemicals. The recommended wax/paraffin inhibitor treatment will lower the pour point and prevent paraffin deposits from forming downhole and in the flowlines.

Wax/paraffin inhibitors are typically used on a continuous basis or on an as-needed basis to prevent paraffin deposition downhole or in production equipment. Treatment dosages are determined based on the characteristics of the crude oil being produced. Wax/paraffin inhibitors are normally added via a chemical proportioning pump (Maloney, 2000). Such inhibitors remain in the production stream (i.e., are not recovered).

Hydrate Inhibitors

Hydrates are solid crystalline structures that form when smaller, light hydrocarbon molecules contact water molecules at elevated pressures and reduced temperatures. Hydrates can be controlled by methanol injection treatments at the tree and downhole. The methanol treatments are based upon water and total fluid production and increase as the water production and percent watercut increases.

In lieu of methanol, hydrates can be controlled through chemical injection of mono-ethylene glycol (MEG) at the production tree or downhole. The recommended glycol treatments are based upon total fluid production. MEG can be recovered for reuse by employing a glycol recovery unit at the platform or within the offshore processing system. A glycol recovery unit may recover up to 90 percent of the glycol. Unrecovered glycol remains in the production stream.

Scale Inhibitors

Scale is the deposition of the dissolved content in a produced fluid, as a result of evaporation, variation of pH levels, or changes in pressure, temperature, or flow conditions. Scale deposition can aid in the formation of hydrates or waxes because of the localized increased roughness on the deposition surface. Scale is commonly controlled through chemical injection of scale inhibitors. The recommended water-soluble inhibitor is formulated to prevent scale deposits such as calcium carbonate, calcium sulfate, and barium sulfate. A small concentration of chemical prevents scale deposition by holding a much larger quantity of multivalent cations in solution. The inhibitor is a highly effective anionic compound, slightly acidic, phosphonate scale inhibitor that is compatible with non-ionic, anionic, and some cationic formulations. Because it can precipitate insoluble complexes with high molecular weight cationic materials, compatibility tests should be conducted at usage concentrations prior to use.

Scale inhibitors are typically used on a continuous basis to prevent scale deposition downhole or in production equipment. Treatment dosages, which are based on the characteristics of the crude oil and the type of scale being produced, typically range from 5 to 15 ppm. Scale inhibitors are normally added neat down the tubing/casing annulus, with an overflush from the production bleeder required to carry the inhibitor down the wellbore (Maloney, 2000). Such inhibitors remain in the production stream (i.e., are not recovered).

Demulsifiers and Defoamers

Water is produced along with most crude oil and a stable emulsion is often formed with oil as the continuous phase. Breaking this emulsion normally requires neutralizing or destroying the natural emulsifying agent, allowing water droplets to coalesce (unite) into larger drops. Eventually the water settles by gravitational force; the term for this separation is demulsification. Demulsification can be accomplished by mechanical or chemical means or by a combination of these treatments. Demulsifiers are designed to favorably alter the forces that maintain stable water-in-oil emulsions; demulsifiers are typically comprised of complex resin adducts, sulfonates, esters, ethers, and complex organic polymers. The proper chemical required to resolve a specific emulsion must be determined by experimentation, commonly called bottle testing. The recommended demulsifier will rapidly separate the oil-water phases.

Demulsifiers are typically used on a continuous or intermittent basis to demulsify crude oil in a production stream. A one-gallon dosage of demulsifier (with dosage determined based on the characteristics of the production system being used and crude oil characteristics) typically treats from 50 to 2,500 bbl of crude oil. Lower demulsifier levels are typical of continuous treatment systems, while higher levels are routine for batch treatment. Demulsifiers are normally injected by a chemical proportioning pump into the crude oil stream(Maloney, 2000). Demulsifiers remain in the production stream (i.e., are not recovered), to be removed during processing.

Defoamers, or antifoam products, are used to provide foam control in the production stream. Defoamers are high molecular weight, surface-acting agents. They are typically used on a continuous basis, normally through use of a chemical proportioning pump. Typical dosages for defoamers in a continuous injection system are in the 10 ppm range, however, initial “charging” of the production system should occur at a 50 ppm dosage level (Maloney, 2000). Defoamers remain in the production stream (i.e., are not recovered).

Asphaltene Dispersants

Asphaltenes are heavy hydrocarbon molecules that occur naturally in crude oils. They precipitate out of the produced oil due to a change in pressure, temperature, or composition. These compounds may vary in chemical makeup from one crude composition to the next and are commonly associated with the formation of emulsions. Asphaltenes can be controlled mechanically through pigging or through chemical injection of asphaltene dispersants (also termed inhibitors). A typical liquid dispersant consists of a polymer in a hydrocarbon solvent. Asphaltene dispersants may contain organic solvents and may not be compatible with natural or man-made organic materials.

Asphaltene dispersants are typically used on a continuous basis to prevent buildup in flowlines and to prevent asphaltene pad formation in production equipment; they may also act to protect producing formations from damage due to asphaltene plugging. Treatment dosages, determined based on the characteristics of the crude oil, the type of system being used, and application method, typically range from 20 to 500 ppm. Applications entail injection of dispersants down the wellbore (Maloney, 2000). Such dispersants remain in the production stream (i.e., are not recovered).

Biocides

Biocides are used for microorganism control in oilfield water systems. Biocides can be water soluble, non-ionic, and non-surface acting chemicals.

Biocides are typically used on a continuous or intermittent basis to control growth of microorganisms. Initial treatment dosages typically range from 20 to 100 ppm, depending upon the severity of the problem. Subsequent dosages are identical, however treatment duration ranges from three to eight hours, one to seven times per week. Biocides are normally injected neat by a chemical proportioning pump where they remain in the production stream (Maloney, 2000).

Projected Volumes of Production and Maintenance Chemicals

Table 4-4 identifies the projected volumes of production and maintenance chemicals to be used at peak production under the base-case scenario. Separate and total daily estimated volumes for production of 200-mmcfsd of gas and 150,000-bbl of crude oil are noted. The fate of individual chemicals (e.g., closed system, production stream) is also identified.

4.1.2.4 Gas Compression and Export

The primary method of separating gas from the incoming production stream is by dropping pressure in stages. At the final stage, the gas pressure may be at only a few hundred pounds per square inch. Compressors are required to boost the gas back to pressure levels that are sufficient to put gas into the export line. The 2,500 psig max pressure at the inlet to the gas export line is estimated to require 12,500 HP of compression, although actual horsepower requirements will be dependant upon the location of the FPSO and its distance to shore or an existing gas pipeline network. The base-case design assumes turbine-driven compressors fueled by gas from the production stream.

4.1.2.5 Produced Water, Domestic and Sanitary Waste, Miscellaneous Discharges, and Solid Waste

The amounts of water produced from deepwater reservoirs can vary widely, but the base-case design assumes a maximum rate of 70,000 barrels per day. It is likely that initial water production will be quite small, increasing over the time to a maximum near the end of the field life.

Other wastes generated during production operations include domestic and sanitary waste, deck drainage, miscellaneous discharges, and solid waste (trash, garbage), as detailed below. A summary of expected volumes of solid and liquid wastes from production operations is provided in table 4-5.

Sanitary waste, or black water, is composed of human body wastes from toilets and urinals. Domestic waste, or gray water, originates from showers, sinks, laundries, and galleys, as well as from safety shower and eye-wash stations. All sanitary wastes will to be processed through an on-site waste treatment plant before being discharged overboard. Domestic wastes will be discharged directly to the ocean in accordance with the USEPA NPDES discharge permit or Coast Guard regulations.

Table 4-4

Estimated Type and Volume of Chemicals Used for Well Control and Maintenance and Flow Assurance

Base Case Scenario		Volume (gal/day)		
Chemical	Fate	Gas Producing Wells (200mmcfsd)	Oil Producing Wells (150 kbpd)	Total
Hydraulic Control Fluids	Closed system	23.0	71.9	94.9
Corrosion Inhibitors	Prod stream	94.6	133.9	228.4
Wax/Paraffin Inhibitors	Prod stream	NA	1575.0	1,575.0
Hydrate Inhibitor	Prod stream	21,216.0	34,650.0	55,866.0
Scale Inhibitors	Prod stream	NA	3.9	3.9
Emulsifiers	Prod stream	NA	252.0	252.0
Demulsifiers	Prod stream	NA	0.8	0.8
Defoamers	Prod stream	NA	126.0	126.0
Asphaltene Dispersants	Prod stream	NA	1,260.0	1,260.0
Biocides	Prod stream	NA	1.6	1.6

Notes: Estimated types and volumes of chemicals are for maximum daily production levels from nine wells under the Base Case (i.e., total gas production of 200 mmcfsd; total oil production of 150,000 barrels per day).

Hydraulic control fluids are maintained in a closed system. Chemicals used for flow assurance or to maintain the well typically enter the production stream (prod stream) and are removed during onshore processing and refining.

While methanol is the prevalent hydrate inhibitor currently being used on the Gulf of Mexico OCS, MEG (glycol) may also be employed. While methanol is not recovered, glycol can be recycled from the production stream aboard the FPSO, often at or near 90 percent recovery. Recovery of glycol, should it be used, is preferred given concerns over cost and space limitations.

Table 4-5

Solid and Liquid Wastes Estimated for FPSO Operations, Exclusive of Produced Water

Type of Waste	Agency Responsible for Applicable Discharge Regulations[a]	Treatment	Disposal Method	Disposal Frequency	Generation Rate[b]
Domestic Waste (Gray Water)	USCG	None necessary	Discharge to ocean	Continuously	3,300 gal/day
Sanitary Wastes	USCG	Waste treatment (biodegraded, chlorinated)	Discharge to ocean	Daily	2,200 gal/day
Deck Drainage and Washdown Water	MMS	Solids removal, oil-water separation	Discharge to ocean	Daily	50-200 bbl/day
Fire Control System Water	USCG	None necessary	Discharge to ocean	Variable, as needed	210 gal/day
Miscellaneous Discharges[c]	USGC and MMS	None necessary	Discharge to ocean	Variable, as needed	Variable
Ballast Water	USCG	None necessary	Discharge to ocean	Variable, as needed	Variable[e]
Trash	USCG	None necessary	Onshore disposal[d]	Twice weekly	150 lb/day
Biodegradable Food Waste	USCG	Ground to <25 mm diameter	Discharge to ocean	Daily	30 lb/day
Support Vessel Discharges	USCG	Variable	Discharge to ocean	Only while on-site	Appr. 100 gal/day

Footnotes:

[a] - as of December 2000, the MMS and USCG continue to discuss regulatory authority for future FPSO operational discharges. For the purpose of this analysis, it is expected that MMS will oversee discharge permit requirements (under an existing or future NPDES permit issued by the USEPA) for any drilling- or production-related wastes. USCG is expected to oversee discharges for non-drilling or non-production wastes.

[b] - assumes an average of 0.110 m^3/day and 0.075 m^3/day (30 and 20 gal/day) per person, respectively, for domestic and sanitary wastes; assumes deck drainage and washdown water average production ranging from 50 to 200 bbl/day, although production rates will vary during the life of the field, rates adapted from MMS (1999), USEPA (1993) and Continental Shelf Associates, Inc. (1988, 1995);

[c] - includes all other point source discharges (exclusive of produced water, ballast water, drilling fluids, deck drainage, well treatment and workover fluids, and sanitary and domestic wastes), including minor amounts of desalinization unit discharge, diatomaceous earth filter media, blowout preventer fluid, uncontaminated bilge water, boiler blowdown, source water and sand, excess cement slurry, and uncontaminated freshwater;

[d] - onshore disposal requires waste containerization, offloading (FPSO to support vessel), transport to shore, and appropriate disposal; and

[e] - ballast water will be onloaded and subsequently discharged from the ballast tanks of the FPSO to maintain proper vessel draft and hydrodynamic characteristics. The ballast water discharge cycle will be dependant upon daily oil production (i.e., ballast water will be released in approximately equal volumes as oil is stored). The frequency of oil offloading will determine the timing of ballast water loading (i.e., ballast water will be onloaded as oil is offloaded to the shuttle tanker); given an FPSO storage capacity of 500,000 bbls (21,000,000 gal) of oil, similar volumes of untreated seawater will be released as oil is produced and stored aboard the FPSO. With an oil offloading frequency of three days, it is projected that similar volumes of ballast water will be discharged on a nearly continuous basis over each three-day period.

Deck drainage includes all effluents resulting from rain, deck washings, tank cleaning operations, and runoff from curbs, gutters, and drains, including drip pans in work areas. Deck drainage will be processed on site (e.g., through hydrocyclones) to remove oil and discharged. Removed oil will be recycled through the production stream, while recovered vapors will be injected into the gas stream. There will be no discharge of free oil in processed deck drainage discharges which would cause a film, sheen, or discoloration of the surface of the water, or a sludge or emulsion to be deposited beneath the surface of the water.

Depending upon the nature of the production reservoir, sand may also be present in the production stream. Sludge is also generated as a by-product of crude oil/natural gas processing. During cleaning of processing equipment, sand and sludge is removed, containerized, and shipped to shore for proper disposal.

The term "miscellaneous discharges" is defined by the U.S. Environmental Protection Agency (USEPA, 1999) to include point source discharges such as blowout preventer fluid, desalinization unit discharge, diatomaceous earth filter media, uncontaminated ballast water, uncontaminated bilge water, uncontaminated freshwater, uncontaminated seawater, boiler blowdown, source water and sand, and excess cement slurry. It is envisioned that the term “uncontaminated seawater” would also include cargo tank washwater that has been treated (e.g., by hydrocyclone or gravity separation) to comply with NPDES permit or Coast Guard requirements. USEPA (1999) also defines separately a series of miscellaneous discharges of seawater and freshwater which have been chemically treated, including fire control and utility lift pump water, pressure test water, ballast water, “once through” non-contact cooling water, and desalinization unit discharges. Uncontaminated ballast water will be discharged in large volumes on a routine basis to maintain proper draft during production and offloading. Small volume discharges from remaining sources are expected to occur during the course of FPSO production operations. All discharges from the FPSO will be regulated by either the USEPA NPDES permit or under Coast Guard regulations, as appropriate..

A variety of solid waste materials made of glass, metal, paper, plastic, and wood are generated during production operations. Much of this is associated with galley and food service operations and with operational supplies such as shipping pallets, containers, and protective coverings. No trash or debris will intentionally be disposed of into the marine environment. All solid waste (exclusive of garbage [food scraps and waste] will be collected and shipped to shore for processing and disposal. Comminuted food waste (i.e., <25 mm [1 in] diameter) will be discharged on site.

In all cases, the discharge of produced water and other production-related wastes will conform to NPDES permit limitations. Discharges from the FPSO and associated vessels that are not production related (e.g., domestic and sanitary waste, miscellaneous discharges, and food waste) are expected to conform to limitations to be established by Coast Guard (e.g., under applicable MARPOL limitations).

4.1.2.6 Logistical Support

Helicopters carrying personnel and boats carrying supplies are expected to visit the FPSO site continuously during the entire field life. Two or three flights per week will be required for crew change for most of this time. Occasionally, additional flights will be required to transport temporary personnel. One supply boat trip per week to the FPSO is also expected, carrying food, chemicals, supplies, and fuel. Containerized wastes (e.g., solid waste and trash; sludge) and unused chemicals will be loaded aboard the supply boat and transported to shore. In summary, FPSO operations are expected to require the following logistical support:

- Two or three round trip helicopter flights on a routine basis (i.e., nine-person capacity from shorebase to site) per week for the production life of the field (i.e., six flight hours, including refueling), with additional flights, as needed
- One round trip supply vessel per week for the same period (one day per round trip)

4.1.2.7 Storage Operations

The storage of produced oil within the FPSO, coupled with the shuttling of oil to shore, are unique characteristics of FPSO operations. Potential impact-producing factors are associated primarily with safety issues (e.g., potential for explosion; the need for vapor controls; conduct of routine inspection and maintenance) and the potential for accidents. Current regulations determine the nature of appropriate safety precautions. MMS and Coast Guard will review and approve inspection and maintenance schedules and the vapor recovery system to be employed during production operations, storage aboard the FPSO, and offloading. Safety precautions, inspection and maintenance activities, and the vapor recovery system do not represent unique impact-producing factors (when compared to comparable deepwater development options). The potential for accidental oil release is discussed in Section 4.4.1.

4.1.2.8 FPSO Offloading and Shuttle Tanker Operations

Offloading operations will involve the arrival, positioning, and hook-up of a shuttle tanker to the FPSO. Offloading configurations can vary depending upon the FPSO stationkeeping method, environmental conditions, and other design factors, including tandem, side-by-side, and buoy-based arrangements. For the purpose of this analysis, the tandem offloading configuration is the most likely method. As outlined previously in Section 1.4.2.6:

- The FPSO and shuttle tanker oriented in a tandem configuration would be capable of offloading 50,000 barrels per hour (BPH)
- Offloading frequency would range from one to 10 days, with a frequency of once every three days during peak production

Under the Base Case, tandem offloading would occur under maximum wave height limitations of 3.5 m (11.5 ft) for hook up/connection and 4.5 m (14.8 ft) for disconnect. These wave height limitations, currently being used in North Sea FPSO operations, are established in the absence of service vessel hook up support. Hook up is accomplished by the use of a retractable hose and a messenger line. Under this approach, a messenger line is fired from the FPSO to the shuttle tanker via compressed air. The hawser and hose(s) are then pulled over to the shuttle tanker and connected. Should a service vessel be used for hook up and disconnect, a 3 m (10 ft) wave height limitation would be in effect. Neither approach alters the results of the risk assessment (i.e., the selection of either method does not affect accident frequencies), as detailed in Section 4.4.1. Based on a review of FPSO-related accident records, there have been service vessel collisions with shuttle tankers during hook up operations, but no spill incidents as a result (J. Spires, DNV, 2000, personal communication).

Cargo oil would be offloaded to the shuttle tanker using the FPSO's main cargo pumps, with oil being routed through a deck line to a stern offloading station, and then through a floating hose to the midship loading manifold of the tanker. Safety features, such as marine break-away offloading hoses and emergency shut-off valves, will be incorporated in order to minimize the potential for, and size of, an oil spill. In addition, weather and sea state limitations will be established to further ensure that hook-up and disconnect operations will not lead to accidental oil release. A vapor recovery system between the FPSO and shuttle tanker would be employed to minimize release of fugitive emissions from cargo tanks during offloading operations.

The required number of shuttle tanker trips to port in a given year is primarily a function of the FPSO production rate and the capacity of supporting shuttle tankers. The base-case scenario considers an FPSO operating at a peak production rate of 150,000 bbl/day, supported by shuttle tankers of 500,000 bbl capacity (table 4-6). When the FPSO is operating at or near peak production rate, offloading events would occur at a rate of one every 3.3 days. Assuming the FPSO can maintain the production rate for a period of one year, this would equate to 54.75 million bbl annual production and 110 offloading events and shuttle tanker transits to port. The proposed action includes the potential for up to five FPSOs to be operating on the GOM OCS by the year 2010. When considering the cumulative scenario for five concurrent base-case scenario FPSO operations operating at peak capacity on an annual basis, the combined 273.75 million bbl produced would require 548 offloading events and shuttle tanker transits to port. However, there are certain variables with respect to production rates and shuttle tanker capacities that could result in either more or fewer shuttle tanker transits. For example, as a group, the five FPSOs might average less than a 150,000 bbl/day production rate over the course of a year, or shuttle tanker capacity might average less than 500,000 bbl. If the five FPSOs average, as a group, 100,000 bbl/day production and are served by 500,000 bbl capacity shuttle tankers, the result would be 365 offloading events and shuttle tanker transits to port. On the other hand, if the five FPSOs average, as a group, 150,000 bbl/day production, but shuttle tanker capacity averages only 400,000 bbl, the result would be 684 offloading events and transits to port.

4.1.2.9 Underwater Obstructions

FPSO surface location will represent an obstruction to other surface activities, such as fishing. Underwater obstruction from the array of nine mooring lines will range from 30 to 60 m (100 to 200 ft) below the water surface in the vicinity of the FPSO to the seafloor at a radial distance of 3,048 m (10,000 ft) or more. Production risers, umbilicals, and the export gas line hang almost vertically under the FPSO to a depth of 300 m (1,000 ft) or more, flaring horizontally into a lazy wave and intercepting the seafloor several thousand feet from the FPSO location. The gas export line, flowlines, and umbilicals will be at or below the seafloor for most of their length. Jumpers to the manifolds may extend as much as 3 m (10 ft) above the seafloor. The three subsea manifolds and nine subsea wellheads may extend 6 to 9 m (20 to 30 ft) above the seafloor. An approximate layout is pictured in figures 4-1 and 4-2. The three module/subsea well clusters are 3,658 m (12,000 ft) or more from both the FPSO location and from each other.

Table 4-6

Estimated Offloading Events and Shuttle Tanker Transits to Port
for the Base-Case Scenario FPSO
(and other production rate/shuttle tanker capacity scenarios)

Number of FPSOs	FPSO Average Daily Production Rate (million bbl/day)	Cumulative Annual Production (million bbl/year)	Shuttle Tanker Size (bbl)	Offloading events and transits to port/year	Offloading Frequency (per each FPSO)
1[a]	0.15	54.75	500,000	110	3.3 days
5 [b]	0.15	273.75	500,000	550	3.3 days
5	0.15	273.75	400,000	685	2.7 days
5	0.10	182.50	500,000	365	5 days
5	0.10	182.50	400,000	456	4 days

[a] Base-case scenario FPSO operating at peak crude production.
[b] Five base-case FPSOs operating at peak crude production.

4.1.2.10 Nature and Scope of Potential Impact-Producing Factors by Resource Being Affected

Air Quality

It has been assumed that generators, pumps, and compressors will operate at or near peak levels for a period of three to five years, then average half that level for the remainder of the field life. Emissions of concern (i.e., criteria pollutants) associated with FPSO and shuttle tanker operations include NO_x, SO_2, suspended particulates, and CO. Table 4-7 itemizes the various pieces of equipment expected to be used during routine FPSO operations, the duty cycle projected for each, and the projected emissions by pollutant. For analytical purposes, the air quality analysis assumes that gas flaring might be allowed to occur for a period of up to a year if production does not yet support the gas export line. After that period, only emergency flaring will be allowed. Such emissions have the potential to create a human health hazard and/or to adversely affect the environment, particularly in nonattainment areas (e.g., Class I areas).

Shuttle tankers would offload crude oil in GOM ports and terminals. This section provides a profile of estimated emissions from a base case scenario shuttle tanker unloading 500,000 bbls of crude oil while the tanker is docked in port. To develop this emissions profile, EPA's AP-42 (Fifth Edition, Volume I: Stationary Point and Area Sources, Section 3.4-1, October 1996) was used to quantify emissions from the diesel engines. Table 2.4 from EPA-453/R-95-017 (Oil and Gas Operations Average Emission Factors) was also used to determine fugitive emissions from deck fittings. An estimate of the emissions that would be expected for a base case scenario shuttle tanker is summarized in Table 4-8.

The emissions profile is intended to be representative of a base case scenario shuttle tanker, however the specifications for oil tankers would likely vary somewhat in terms of type of main propulsion system, pumping systems, and inerting systems, all of which contribute to the emissions of pollutants from the vessel. Therefore, the following assumptions were applied regarding the shuttle tanker addressed in this analysis:

- Large diesels have replaced steam turbines as the engine of choice for ocean going tankers. Unlike steam boilers, these diesel engines can be started on short notice (as long as the lubrication systems and block heaters are functioning). For this profile, emissions were assumed for two hours of operations at idle, with the engine not operating during the remainder of the time in port.
- For tankers powered by diesel main engines, tank pumping systems are normally driven by separate diesel engines or electric motors. In this case, it has been assumed that the tanker would have electric-driven pumps used to transfer crude between different storage compartments aboard the vessel, and to transfer crude oil from the vessel to the receiving terminal. An unloading rate of 20,000 barrels per hour is assumed, which is typical for petroleum refining receiving operations. Other facilities, such as the Louisiana Offshore Oil Port (LOOP) can offload tankers at rates up to 50,000 barrels per hour. It is also assumed that power for the electric pumps would be provided by diesel-driven auxiliary power generators located aboard the ship. It is estimated that 1,360 kilowatts (kW) of generating power would be required during offloading operations. The calculated emissions from the generators are

Table 4-7

Summary of Projected Air Emissions for Routine FPSO Operations by Equipment and Duty Cycle

Operations	Equipment		Maximum Fuel	Actual Fuel	Run Time		Pounds per Hour (Tons per Year)				
	Diesel Engines	HP	Gal/hr	Gal/day							
	Nat. Gas Engines	HP	SCF/hr	SCF/day							
	Burners	MMBTU/ hr	SCF/hr	SCF/day	Hr/day	Days	TSP	SOx	NOx	VOC	CO
Production@	Turbine Driven Generator	5,500	52,382.0	1,257,168	24	365			15.79	0.12	10.62
									(69.16)	(0.53)	(46.52)
150,000	Turbine Driven Generator	5,500	52,382.0	1,257,168	24	365			15.79	0.12	10.62
Bbl/Day									(69.16)	(0.53)	(46.52)
200	Turbine Driven Generator	5,500	52,382.0	1,257,168	24	365			15.79	0.12	10.62
MMCF/Day									(69.16)	(0.53)	(46.52)
	Turbine Driven Generator	5,500	52,382.0	1,257,168	12	365			15.79	0.12	10.62
									(34.58)	(0.26)	(23.26)
	Turbine Driven Compressor	14,500	138,098.0	3,314,352	24	365			41.62	0.32	27.99
									(182.30)	(1.40)	(122.60)
	Emergency Generator	670	32.4	777	1	52	0.47	8.04	16.08	0.47	3.69
	(>600 hp diesel)						(0.01)	(0.21)	(0.42)	(0.01)	(0.10)
	Emergency Generator	670	32.4	777	1	52	0.47	8.04	16.08	0.47	3.69
	(>600 hp diesel)						(0.01)	(0.21)	(0.42)	(0.01)	(0.10)
	Fire Pump	572	27.6	663	1	52	1.26	1.17	17.73	1.41	3.82
	(<600 hp diesel)						(0.03)	(0.03)	(0.46)	(0.04)	(0.10)
	Fire Pump	572	27.6	663	1	52	1.26	1.17	17.73	1.41	3.82
	(<600 hp diesel)						(0.03)	(0.03)	(0.46)	(0.04)	(0.10)
	Deck Crane	572	27.6	663	5	365	1.26	1.17	17.73	1.41	3.82
	(<600 hp diesel)						(1.15)	(1.07)	(16.18)	(1.29)	(3.49)
	Deck Crane	572	27.6	663	5	365	1.26	1.17	17.73	1.41	3.82
	(<600 hp diesel)						(1.15)	(1.07)	(16.18)	(1.29)	(3.49)
	Deck Crane	572	27.6	663	5	365	1.26	1.17	17.73	1.41	3.82
	(<600 hp diesel)						(1.15)	(1.07)	(16.18)	(1.29)	(3.49)
	Air Compressor	110	5.3	128	1	365	0.24	0.23	3.41	0.27	0.73
	(<600 hp diesel)						(0.04)	(0.04)	(0.62)	(0.05)	(0.13)
	Support Vessel,	1,040	50.2	1,206	18	365	0.73	12.48	24.96	0.73	5.72
	idle diesel						(2.40)	(41.00)	(81.99)	(2.40)	(18.79)
	Lightering Tanker,	7,425	358.6	8,607	12	110	5.20	89.10	178.20	5.23	40.84
	idle diesel						(3.43)	(58.81)	(117.61)	(3.45)	(26.95)
	Chem-electric heater treater	26	24,761.9	594,286	24	365	0.19	0.01	2.48	0.14	2.08
							(0.83)	(0.04)	(10.86)	(0.61)	(9.11)
	Miscellaneous	BPD	SCF/hr	Count							
	Wet Oil Tank (controlled by	10,500			24	365				0.26	
	VRU)									(1.14)	

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Table 4-7

Summary of Projected Air Emissions for Routine FPSO Operations by Equipment and Duty Cycle

Operations	Equipment		Maximum Fuel	Actual Fuel	Run Time				Pounds per Hour (Tons per Year)		
	Dry Oil Storage (controlled by inert gas blanket)	150,000			24	365				3.75 (16.42)	
	Flare (during startup ops)		4,166,667		24	120		2.375 (3.42)	297.50 (428.40)	251.25 (361.80)	1,618.75 (2,331.0)
	Process Vent		100		24	365				0.34 (1.49)	
	Fugitives			6,000.0		365				0.15 (0.66)	
	Glycol Still Vent (controlled)		8,333,333		24	358				1.10 (4.73)	
	TOTALS	**Fuel Use:**	**8,308,725.71**	**SCF/DAY**			**13.59 (10.23)**	**126.14 (107.00)**	**732.12 (1,097.96)**	**272.04 (399.97)**	**1,765.04 (2,682.27)**

Notes: Annual emission estimates (tons per year) based on duty cycle of individual equipment (i.e., hours/day, days/year) and estimates of hourly emissions (i.e., pounds per hour), rounded to the nearest hundredth of a ton; annual totals by pollutant based on the sum of each piece of equipment.

The USEPA's AP-42 guidance document used in this analysis (USEPA, 1998) assumes that all sulfur in diesel fuel is converted to SO_2. The sulfur content of the diesel fuel evaluated in this air quality analysis was assumed to be 1.5 percent (off road diesel), consistent with current MMS guidelines. Crude-oil transfer pumps were assumed to be driven by electric motors drawing power from one (or more) of the four 5,500-hp turbine-driven electrical generators aboard the FPSO. Power requirements for the transfer pumps were not considered in calculating emissions because emissions from the turbine-driven generators were calculated at full load and 8,760 hours per year operation. The shuttle tanker was assumed to produce 22,275 hp at maximum load, while idle horsepower was assumed to be one-third of the maximum horsepower, or 7,425 hp. While this assumption may be deemed conservative, both fuel consumption and emissions increase significantly when engine are operated at less than 70 percent load.

Table 4-8

Estimated Emissions for Base Case Scenario Shuttle Tanker While Offloading In Port

Source	Pollutants (pounds per hour)				
	Particulates	Sulfur Dioxide	Oxides of Nitrogen	Carbon Monoxide	VOCs
Power Plant	5.2	89.1	178.2	40.8	5.23
Auxiliary Generator	1.3	21.7	43.4	10.0	1.28
Fugitive Sources	-	-	-	-	0.83
Total (lbs/Port)*	46.0	786.4	1573.0	360.0	69.54

* Assumes 28 hours in port, with main engines operating for a period of two hours.

assumed to occur during 28 hours of operation, which includes three hours of demurrage while in port.

- It is assumed that a tank inerting system would be operational, using the exhaust gas from the auxiliary generator with no additional emissions.
- Emissions of VOCs during unloading operations would be limited to fugitive emissions from deck fittings and pumps, as the storage tank vapor displacement would occur at the terminal rather than in the shuttle tanker.

Based on the assumptions outlined above, the total emissions pollutants for the offloading shuttle tanker would be approximately 1.4 tons per port call.

Water Quality

Continuous, daily, or periodic discharges expected to occur on site were detailed in table 4-5. Discharges can be grouped by the following categories: produced water, domestic and sanitary wastes, and miscellaneous wastes. The nature of these discharges is consistent with other platform-based production operations; the maximum output of produced water (i.e., to be realized towards the end of the life of a producing field) is at the higher end of the spectrum for platform-based production. However, the periodic, high-volume releases of uncontaminated ballast water are unique to FPSO systems. For all discharges associated with FPSO production, there is limited potential for adverse effects to ambient water quality.

Seafloor Sediments, Topography, Benthic Communities, and Archeological Resources

Seafloor sediments, benthic communities, and archeological resources in water depths of 200 m (656 ft) and greater are removed (by water depth) from surface production and tankering operations. Infrequent gear or equipment loss from the FPSO, shuttle tanker, or support vessels may occur during loading or offloading operations. Minor leakage of hydraulic control fluids or well maintenance chemicals may occur from bottom-founded structures, both of which have the potential for impact to benthic resources. No other impact-producing factors from routine operations are evident.

Marine Mammals, Sea Turtles, Birds, Fisheries, and Coastal Habitats

Routine operations will result in several potential impact-producing effects. Helicopters and supply boats will transit between shorebase and FPSO site weekly. Supply boats will maintain station at the site for several hours each trip to onload/offload supplies. Shuttle tankers will transit between port and the FPSO site every few days and will remain on station approximately twelve hours each trip. Helicopters and supply vessels produce noise which may affect marine mammals, turtles, and birds. The amplitude, frequency, and duration of noise transmitted into the air and into the water column is not well understood, but levels should be comparable to that of other deepwater development systems of comparable size. Supply vessels on site discharge treated sanitary wastes and bilge water, both of which may produce impacts to marine mammals, turtles, birds, and fish; however, the amount discharged should be comparable to that of supply vessels visiting other deepwater development systems of comparable size.

Vessels in transit and close to shore may also affect coastal habitats through routine discharges and vessel wake (i.e., potentially affecting erosion, sedimentation, and turbidity).

The FPSO system will present a surface obstruction to fishing and other activities over a relatively localized area. Underwater obstructions will extend over an area of several square miles, but are generally concentrated in multiple clusters near the seafloor.

Socioeconomic Issues

The potential socioeconomic demands of FPSO operations, including shore-based support activities, pertain primarily to the need for a local, specialized labor force (i.e., direct employment). Marine crew (for both FPSO and shuttle tankers) and FPSO production personnel would be required. Onshore locations (where FPSO support operations may be expected to occur) could be expected to realize the greatest impact, particularly if non-local, specialized personnel necessary for FPSO operations are relocated . Indirect and induced employment and associated fiscal impacts may also be realized in areas supporting FPSO operations. As was noted for installation activities, of most interest are any increases in the local labor force prompted by FPSO operations (e.g., demands for a specialized labor force) and the fiscal effects of such operations on the local economy.

4.1.3 Decommissioning

Typically, an operator proposes a decommissioning strategy as part of its DWOP submittal, the latter of which is subject to approval by MMS. Current decommissioning requirements do not vary with water depth. Lessees are required to remove all structures and related underwater obstructions within one year after termination of their lease. Complete removal of system components on and below the surface of the seafloor will become increasingly difficult as water depth increases; such removal may require the use of explosives and may even challenge physical limits of (de)construction capabilities. Further, and perhaps more importantly, activities associated with complete removal of manifolds, anchors, flowlines, and umbilicals would likely increase the risk of human injury and may even produce greater disturbance to the environment than would abandonment in place. The following strategy is believed to be representative of what will be proposed for FPSO systems:

System Component	Strategy
FPSO Hull	• Removed from field for salvage or reuse
Mooring Lines	• Removal
Anchors	• Removal
Subsea Wells	• Plug in accordance with 30 CFR 250, Subpart G
Subsea Production Trees	• Retrieve
Production, Umbilical and Export Risers	• Remove for salvage
Gas export line	• Decommission (cleaned and capped), abandon on the seafloor

System Component	Strategy
Flowlines and Umbilicals	• Decommission (cleaned and capped), abandon on the seafloor
Well and Umbilical Jumpers	• Retrieve
Seafloor Structures (manifold, transponder supports)	• Removal

The following text will describe the activities and equipment required for decommissioning of a base-case scenario FPSO and will summarize their potential impact-producing factors. The implications of complete removal will be cited where abandonment in place is proposed.

Decommissioning Activities Overview

Risers, flowlines, gas export lines, umbilicals, manifolds and jumpers will be flushed as required by regulation prior to the start of any removal operations. Subsea wells will be plugged and abandoned in accordance with 30 CFR 250, Subpart G and wellheads and manifold jumpers will be removed by a mobile drilling rig, which will anchor temporarily over each well cluster.

Selection of equipment and procedures to be employed in other decommissioning activities will depend on many of the same factors which influence selections for installation, including availability and cost of equipment and sequence of operations. It has been assumed in this analysis that a dynamically positioned construction vessel will undertake all removal activities, but flowlines and umbilicals might be abandoned using a dynamically positioned pipelaying vessel. It is believed that the potential impact-producing effects will be essentially the same.

The sequence of decommissioning, abandonment, and/or removal operations will proceed essentially in reverse of the installation sequence, but the overall duration of work will be shorter – perhaps only three or four weeks total. As in the case of installation, certain decommissioning activities can be carried out simultaneously. Figure 4-4 shows a representative decommissioning sequence.

4.1.3.1 Riser Removal

Decommissioning of the three umbilical risers, six production risers, and the gas export riser can proceed in the order that is most convenient. The top termination for each riser will be released from its turret support, suspended under the FPSO, and passed to the construction vessel. The construction vessel will then move toward a location over the bottom connection of the riser, taking in and laying down riser and buoyancy elements on the deck of the vessel or directly onto a cargo barge. When the connection between the riser and the flowline, umbilical, or gas export line reaches the surface, the construction vessel will disconnect the riser, place a closure on the end of the flowline, umbilical, or line, and lower it to the seafloor. This work may require only a week, or may extend to two weeks should removal operations be more complex.

For the purpose of this analysis, riser removal is projected to take a week and a half. It is assumed that one cargo barge and an attending tug will be on location throughout this work and will transport the removed components to a shorebase for salvage or storage.

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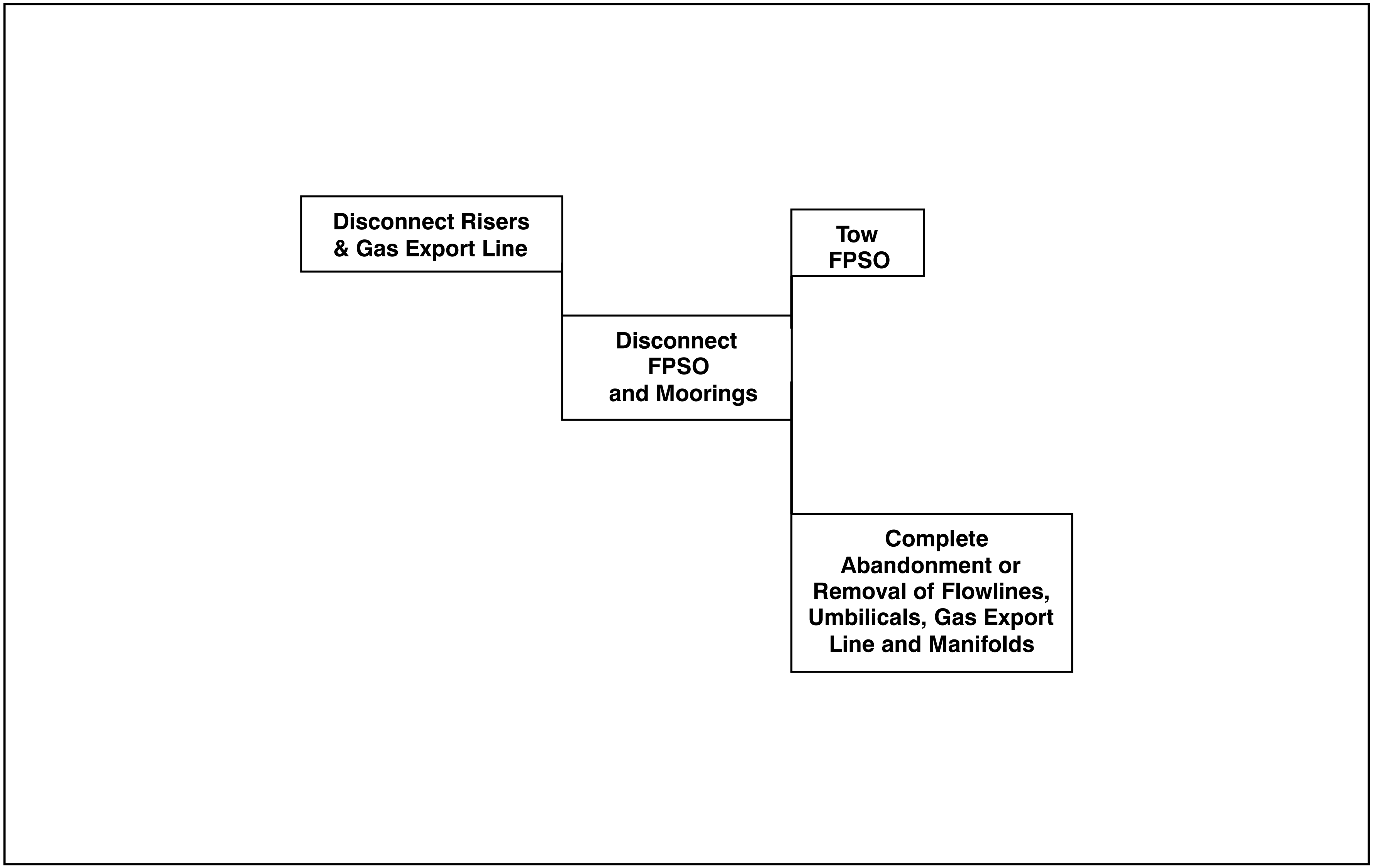

Fig. 4-4. Probable sequence of FPSO decommissioning.

4.1.3.2 Mooring Spread Removal

Decommissioning of the mooring spread will proceed as the reverse of the installation procedure. Maintaining some degree of symmetry with respect to the remaining lines, each line will be slacked and released from its support/jacking system on the FPSO and passed to the construction vessel. The construction vessel will then move in the direction of the respective anchor location, taking in and laying down the mooring wire as it proceeds. Upon reaching the connection point between the top and lower lengths of the line, it will disconnect the FPSO end of the line and remove it. It is assumed that this work will take a week and a half and that one cargo barge and an attending tug will be on location throughout this work and will transport the removed components to a shorebase for salvage or storage.

4.1.3.3 FPSO Removal

It is assumed that three to five tugs will be in attendance during the latter stages of the process of releasing the moorings and that they will then tow the FPSO to a shorebase for further decommissioning, refurbishment, or salvage. It is assumed here that the tow tugs will be at the offshore location for a week and on route to the shorebase for two days.

4.1.3.4 Flowline, Umbilical, Gas Export Line, and Manifold Abandonment

Decommissioning of the gas export line is complete when the line is capped and lowered to the seafloor at the completion of riser removal. Decommissioning of the flowlines and umbilicals is completed by removing the jumpers between each of the three manifolds and the other end of each flowline/umbilical and the placement of any necessary sealing plugs. It may also be necessary to place plugs in some manifold connections, but this work will likely be shared with the floating drilling rig which abandons the subsea wells and removes the wellheads and jumpers. This work should take no longer than a week and will not require a cargo barge.

4.1.3.5 Logistical Support

Logistical support for the FPSO decommissioning will vary widely in detail, depending on the equipment, procedures, and sequencing of field operations. For this base case, the following equipment spreads, timing, and duration offshore are thought to be conservative:

- Two round trip helicopter flights (i.e., nine-person capacity from shorebase to site) per week for a four-week period, beginning with riser removal and ending with completion of flowline/umbilical/manifold abandonment and removal (i.e., six flight hours, including refueling)
- One round trip crew boat per week for the same period (one day per round trip)
- One cargo barge and attendant 1,200 HP tug on site for the first three weeks
- One cargo barge and attendant 1,200 HP tug in transit between site and shorebase twice during the same three week period (24-hour tow each way)

4.1.3.6 Nature and Scope of Potential Impact-Producing Factors by Resource Being Affected

Neither the nature of the procedures nor the equipment involved in FPSO decommissioning is expected to be unique, and are similar to comparable activities for other deepwater development system alternatives. An overview of potential impact-producing factors and resources impacted during FPSO decommissioning is provided in table 4-9.

Air Quality

As in the case of installation, all activities and sources involved in decommissioning involve internal combustion engines to power propulsion and/or work functions and therefore will impact air quality. NO_x, SO_2, CO, and PM_{10} are the primary emissions of concern. An estimate of emissions during decommissioning activities is contained in table 4-10 in terms of total fuel burned (generally #2 diesel) per week. Estimates are given for each major piece of equipment for the duration of decommissioning.

Water Quality

As with installation, there are two potential sources of impact on water quality: disturbance of seafloor sediments in connection with decommissioning activities and discharges from vessels participating in decommissioning activities. Removal of production risers, umbilical risers, gas export line riser, and mooring lines and abandonment flowlines are expected to cause temporary, localized disturbances on the seafloor, causing resuspension of sediments in the near-bottom water column.

Decommissioning activities do not involve discharges into the water, other than the normal release of processed water associated with operation of the accommodation for workers on board each vessel. Vessel discharges include treated sanitary wastes and bilge water, both of which have the potential for impact to ambient water quality. The nature of the discharge will conform to regulatory requirements appropriate to each vessel. Table 4-3 provides estimates of expected manning level requirements.

Seafloor Sediments, Topography, Benthic Communities, and Archeological Resources

Operations associated with removing production, umbilical, and gas export line risers would involve temporarily lifting a length of several thousand feet (perhaps one to one and a half times the water depth) of the associated line off the seafloor to enable disconnecting the riser and plugging the line. The line would then be lowered back to the seafloor and may or may not lay along the line of bottom contact. Similarly, removal of the upper length of mooring lines may temporarily lift part of the lower end of the line off the seafloor during the removal process. All these operations are expected to have impact limited to relatively shallow penetrations, between a few inches and a few feet of the seafloor, depending in part on sediment strength.

Table 4-9

Impact Producing Factors Versus Resources Potentially Affected by FPSO Decommissioning

Factors	Air Quality	Water Quality	Bottom Sediments, Topography	Benthic Communities	Marine Mammals	Sea Turtles	Coastal and Marine Birds	Fishing and Fisheries	Coastal Habitats	Archeological Resources	Socioeconomic Resources
Decommission Wells and Manifolds	✔	✔	-	-	✔	✔	✔	✔	-	-	-
Riser Removal	✔	✔	✔	✔	✔	✔	✔	✔	-	-	-
Mooring Spread Abandonment	✔	✔	✔	✔	✔	✔	✔	✔	-	-	-
FPSO Removal	✔	✔	-	-	✔	✔	✔	✔	-	-	-
Flowline, Umbilical and Gas Export Line Abandonment	✔	✔	✔	✔	✔	✔	✔	✔	-	-	-

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Table 4-10

Air Emission Levels During FPSO Decommissioning (total priority pollutants in tons/week)

Sources	Location	Week of Decommissioning					
Vessels:		1	2	3	4	5	6
Construction (1)	FPSO Site	-	28	28	28	28	-
	Transit	8	-	-	-	-	8
Tow (5)	FPSO Site	-	-	32	43	-	-
	Transit	-	-	11	21	-	-
Logistical	FPSO Site	-	4	4	4	-	-
	Transit	0.4	1	2	1	0.4	-
Aircraft:							
Helicopter	Transit	1	1	1	1	1	1
Totals	FPSO Site	-	32	64	75	28	-
	Transit	9.4	2	14	23	1.4	9

Notes: Emission levels assume limited deepwater anchoring capability and the use of dynamically positioned vessels, where appropriate. Emission levels can be expected to decrease significantly (from those noted above) in the shallower portions of the study area where anchoring or mooring is possible. One construction vessel (barge) rated at ~20,000 hp is required; estimated fuel consumption: 9,000 gal/day; duty cycle: 40 to 50 percent. Five tow vessels are required, with two at 7,000 hp, two at 5,600 hp, and one at 4,200 hp; estimated fuel consumption: 2,400 gal/day (average); duty cycle: 70 to 80 percent. One tug and one crewboat (i.e., logistical) are required; estimated fuel consumption: 1,200 to 2,800 gal/day, respectively; duty cycle: 70 to 80 percent and 70 to 90 percent, respectively. (Source: D. Calkins, Manager of Engineering and Projects, J. Ray McDermott, Mentor Subsea, personal communication, August/September, 1999). Helicopter support assumes one Sikorsky S-76 Class transport in use 8 hrs/day, 7 days/week. Pollutant speciation for PM, SO_2, NO_x, CO, and VOCs is 2, 27, 56, 13, and 2 percent, respectively.

Marine Mammals, Sea Turtles, Birds, Fisheries, and Coastal Habitats

As in the case of installation, noise and other disturbance associated with vessels and construction equipment employed during decommissioning and removal may disturb animal resources, but no physical contact is anticipated and all operations will be temporary. Other than temporary disturbance of occasional passage of vessels in transit, decommissioning activities are not expected to have impact-producing effects on coastal habitats.

Socioeconomic Issues

The potential socioeconomic effects of FPSO decommissioning operations, including shore-based support activities, pertain primarily to where such decommissioning support operations may be expected to occur. As was noted for installation activities, of most interest are any increases in the local labor force prompted by FPSO decommissioning operations (e.g., demands for a specialized labor force) and the fiscal effects of such operations on the local economy.

4.2 Cumulative Impact-Producing Factors

Cumulative impacts are the combined and/or incremental effects upon the environment (marine, coastal, terrestrial, and air resources and socioeconomic systems) that potentially could occur as a result of past, present, and reasonably foreseeable future actions, including the proposed action. The purpose of addressing cumulative impacts in the context of this EIS is to assess the incremental contribution of the proposed action toward the effects of a broader range of impacting factors that combined may potentially impact resources. The proposed use of FPSOs on the OCS in the Western and Central Planning Areas is projected to include the potential installation, startup, and operation of as many as five FPSOs during the ten-year period of 2001 through 2010. The first FPSO would be installed as early as 2001, and the remaining of the four FPSOs would be installed as late as 2010.

MMS has identified cumulative impact-producing activities, and addressed the cumulative impacts, for planned and projected GOM OCS oil and gas development activities in two recent lease sale NEPA documentation efforts. These are the published Final EIS documents for *Gulf of Mexico OCS Oil and Gas Lease Sales 171, 174, 177, and 180, Western Planning Area, OCS EIS/EA MMS 98-0008, May, 1998,* and *Gulf of Mexico OCS Lease Sales 169, 172, 175, 178 and 182, Central Planning Area, OCS EIS/EA MMS 97-0033, November 1997."* These two multi-sale FEISs provide a comprehensive assessment of the types and scales of activities that would represent the cumulative scenario for 1996 through 2036, encompassing the ten-year period of proposed use of FPSOs addressed in this EIS. Cumulative factors addressed in these lease sale FEISs for the Western and Central Planning Areas that are relevant to the cumulative scenario for the proposed use of FPSOs include:

- Future offshore OCS operations (i.e., development timetables and activities),
- Future coastal activities related to OCS operations (i.e., infrastructure and activities); and,

- Other major offshore, coastal, and onshore activities (e.g., dredge spoil disposal, tanker and barge activity, military activities, artificial reef programs, etc.).

For this EIS addressing the proposed use of FPSOs on the GOM OCS, a ten-year time frame (2001 through 2010) was chosen for the analysis because there are a number of factors that make projections beyond this time frame very uncertain. The pace of economic growth, fluctuations in oil and gas prices, demand for hydrocarbon-derived products, success of other deepwater projects and evolving technologies in offshore oil and gas development methods greatly affect the pace and intensity of development activity. Industry plans for development in the next five years are fairly well known. Projections for the five years beyond that are based on extrapolations of known activity levels and expected availability of the required additional support infrastructure. Activity levels and technological advancements beyond the next 10 years, especially for newly emerging development methods in the GOM (e.g., the proposed use of FPSOs) are not reasonably foreseeable and were not projected for this scenario.

4.2.1 OCS and Other Offshore Oil and Gas Development Activities

U.S. Department of Energy (1999) projections indicate an increase in the domestic demand for petroleum products to continue through at least the next two decades. Average annual growth rates for petroleum consumption in the U.S. for the years 1998 through 2020 are projected to be between 1.1 and 1.4 percent. Imports of oil and petroleum products are expected to increase from 51 percent of domestic petroleum consumption (in 1999) to over 62 percent in 2010.

During the period of 1997 through 2010, domestic production of crude oil is projected to decrease 20.7 percent, from 6.45 million bbl/day to 5.18 million bbl/day. The projected annual decrease in domestic production of crude oil is attributed to declining production in Alaskan fields and conventional onshore and near-shore fields in the lower 48 states. The decrease in domestic production is somewhat tempered in the DOE projections in that advances in enabling technologies are expected to facilitate enhanced oil recovery (EOR) production in conventional fields, as well as development of deepwater fields on the OCS. The degree to which the enabling technologies in these areas will contribute toward stemming the decline in domestic production is largely dependent on economic feasibility, which in turn is heavily tied to oil prices (U.S. Department of Energy, 1999).

Technological advances have allowed exploration in the GOM to move gradually from the near-shore, shallow-water areas off Louisiana to leases in water depths exceeding 2,300 m (7,700 ft). To date, most producing deepwater wells are located on the continental slope in water depths ranging from 200 to 400 m (656 to 1,312 ft). It is common for the leasing activity on the continental slope (i.e., waters >200 m [656 ft]) to precede by several years the lessees' ability to drill and develop. Often bids in frontier areas (on unproven "wildcat" objectives) are based on industry's anticipation that technology will be available in the near future to more clearly define and develop potential prospects. Advances in seismic data acquisition, processing, and interpretation have reduced the risks inherent in the exploration of frontier areas. Enhancements in development and production techniques (e.g., spar, TLP, and subsea completions) for deepwater fields, coupled with the large volume of hydrocarbons and extremely favorable production rates, determine the long-term viability of the deepwater OCS (USDOI, MMS, 2000b).

4.2.1.1 Drilling Activities

At present, 250 to 350 exploration and delineation wells are drilled annually in the GOM. By far, the majority of these are in the Central Planning Area. Exploratory well drilling is expected to be at its peak in the Western and Central Planning Areas during the next 10 years. In addition, between 285 and 575 development wells are presently being drilled annually in the Western and Central Planning Areas. Of these, 60 to 100 development wells are drilled annually in the Western Planning Area, and 225 to 475 wells are drilled in the Central Planning Area. There is currently no development well drilling activity in the Eastern Planning Area of the GOM. Based on industry projections and anticipated new development starts that are currently in the planning stages, it is expected that up to 50 percent of the wells in water depths greater than 305 m (1,000 ft) will be completed as subsea development wells. The overall annual rate is expected to decline over time as more areas reach peak development. Development drilling is expected to be at its peak in the Western and Central Planning Areas during the ten-year time frame of the proposed action. Beyond this time frame, MMS expects that the impetus for exploration, delineation, and development well drilling activities will have matured and there will then be a steady downward trend in the annual number of completions (USDOI, MMS 1997, 1998a).

The first well drilled in the deeper waters of the continental slope was spudded by Atlantic Richfield in November 1974 on Mississippi Canyon Block 148 in a water depth of 212 m (696 ft). More than 2,100 wells have been spudded in water depths greater than 200 m since the drilling of that first well more than 25 years ago; more than half of these wells were drilled in the last ten years.

Exploration drilling in the GOM continues to move into deeper waters. The deepest proposed well as of January 2000 is in 9,838 feet of water in the Alaminos Canyon area. Shell's Baha well, also in the Alaminos Canyon area, was completed in 7,896 feet of water. Another well in the Walker Ridge Area is planned in 8,902 feet of water.

4.2.1.2 Production Facilities

At present, 90 to 150 platforms are installed annually in the GOM. More than 80 percent of these are conventional fixed platforms in water depths less than 60 m (197 ft). Although the rate of platform installation in deeper water areas (greater than 200 m [656 ft]) is expected to increase over the next decade, the overall platform installation rate is expected to decrease. The rate of platform installation is expected to be greater than the number of platforms removed annually. This is because new geophysical techniques are being used to better identify productive hydrocarbon bearing zones that were not previously targeted in developed areas. For this reason, many platforms that would otherwise have been removed are being left in place to develop these new targets. (USDOI, MMS 1997b, 1998a)

As of January 2000, there were 106 discoveries with 42 fields producing in water depths greater than 305 m (1,000 ft). Production facilities installed on the deepwater OCS include 10 fixed facilities (three compliant towers and seven fixed platforms), 11 floating facilities (including eight TLPs and three spars) and 23 subsea developments tied back to host facilities. Thirty-eight of these fields are concentrated around the Mississippi River delta and are located in the Green Canyon, Ewing Bank, Mississippi Canyon, and Viosca Knoll lease areas in the Central Planning Area. Six of the deepwater production facilities are operating in the Garden Banks lease area of the Western Planning Area. During the year 2000, approximately 13 deepwater production startups could commence. The Mississippi Canyon and Green Canyon lease areas will continue to be the focus for most of this new production activity, with deepwater production startups occurring for the first time in the East Breaks and Alaminos Canyon lease areas in the Western Central Planning Area. Based on discoveries made in recent years, Mississippi Canyon, Green Canyon, and Garden Banks will be the emphasis for new production startups during the next 10 years (2001 through 2010). These three lease areas combined represent 75 percent of the projected new production startups in the deepwater areas during this period. (Regg 2000b)

Table 4-11 shows the projected number of deepwater production startups that are estimated to occur in the Western and Central Planning Areas during the period of 2001 through 2010. The projection reflects the trend toward floating versus fixed systems as development activity moves into the deeper waters of the OCS, and the continued use of subsea systems (tied back to host facilities). Based on industry projections and anticipated new development starts that are currently in the planning stages, it is expected that up to 50 percent of the wells in water depths greater than 1,000 feet will be completed as subsea production wells. Of the 88 projected startups during the ten-year period, it is estimated that five of these will occur as FPSO developments (Regg 2000a). Given that approximately 55 deepwater production startups will have commenced on the OCS by the end of 2000, and that an additional 88 startups are projected for the ten-year period of 2001 through 2010, the projected five FPSO systems represent a small fraction of the overall development in the deepwater GOM. This is likely an indicator of the focused use of FPSO-based development technologies as activities continue to progress into the more remote areas (i.e., remote from infrastructure) of the GOM OCS.

4.2.1.3 Pipelines

Presently, the transport method for delivering produced oil and gas from offshore to onshore refining and processing facilities is through pipelines. As of April 1998, there were approximately 42,799 km (26,600 mi) of pipeline on the GOM’s seafloor. Most of these pipelines support shelf and near-shelf facilities; a small percentage supports deepwater operations. Between 1990 and 1997, 14,547 km (9,041 mi) of additional pipeline were installed in the GOM, including 2,528 km (1,571 mi) of new pipeline in the deepwater OCS. During the period 1990-1995, the growth in deepwater pipeline activities fluctuated through a range of 2 to 19 percent of all pipelines installed in the GOM. A dramatic increase occurred in the years 1996 and 1997, with deepwater pipeline installations being 34 and 46 percent, respectively, of all pipelines installed in these years. Approximately 58 percent of all existing deepwater pipeline miles installed from 1990 to 1997 were installed during the two-year period of 1996-1997 (USDOI, MMS, 2000b).

Product stream quality, available pipeline capacity, and existing infrastructure are issues affecting an expected increase of pipelines and shore approaches resulting from deepwater development activities through 2010. Factors such as the aging condition of existing pipeline systems and existing systems operating at or near capacity in the GOM, combined with the projected production from new developments, require consideration for enhancement and expansion of the existing pipeline system. MMS projects that between 483 and 805 km (300 and 500 mi) of pipeline will be installed in the deepwater areas annually during the period of 2001 through 2010. This projection does not include the installation of replacement pipelines on the shelf to support deepwater operations (USDOI, MMS, 2000b).

Table 4-11

Projected (Estimated) Number of Deepwater Developments (“ Start-ups”) by Year

Year	Type of Development						
	Subsea	TLP	Spar	Fixed	FPS	FPSO	Total
2001	6	2	2		1		11
2002	6	1	1	1	1	1	11
2003	6	1	1			1	9
2004	6	1		1	1		9
2005	6		1			1	8
2006	6		1	1			8
2007	6	1				1	8
2008	6	1	1				8
2009	6				1		8
2010	6	1				1	8

Key:

FPS = Floating Production System.
FPSO = Floating Production, Storage, and Offloading System.
TLP = Tension leg platform.

Source: MMS, March 2000.

Operators that develop deepwater prospects must evaluate all transportation options prior to making decisions on whether to install new pipelines. Installing a pipeline "to shore" from a deepwater field would be justified only for a major discovery. An alternative to installing new pipelines is to increase the carrying capacity of the existing pipeline system to accommodate new production from deepwater areas. One method for achieving additional carrying capacity for existing pipelines is increasing the maximum allowable operating pressure (MAOP) within a pipeline.

Pipeline installation methods for deepwater pipelines may be different from methods used on the shelf. The "J" lay and "bottom tow" installation methods (anchored systems) would be unique to deep water. Deepwater pipelines may be installed using dynamically positioned lay barges rather than the traditional anchored systems. While dynamic positioning eliminates the environmental effects of anchoring, air emissions may increase due to combustion of fuel to power positional thrusters.

Pipeline installation activities in deepwater areas can be difficult both in terms of route selection and construction. Depending on the location, the sea bottom surface can be extremely irregular and present engineering challenges (e.g., high hydrostatic pressure, cold temperatures, and darkness in the deeper waters, as well as varying surface and subsurface current velocities and directions). In addition to the emissions generated by work vessels, installation activities cause bottom disturbance that results in turbidity and water quality impacts, and impacts to ocean-bottom communities, although these effects are typically localized and of short duration. In the shallower waters of the shelf (i.e., less than 200 m [656 ft]), pipelines may present an obstruction to commercial fishing where bottom trawling nets are used; however, pipelines must be buried in waters less than 61 m (200 ft) deep. Though the locations of pipelines are made available to the public, the potential for pipelines being damaged by large anchors exists. Coastal approaches and landfalls for pipelines can potentially result in shoreline disturbance and loss of wetlands.

Once installed and operational, there is the potential that subsea spills may occur from deepwater pipelines as a result of leaking or damage. There are many technical and environmental questions related to detection of deepwater pipeline leaks, hydrocarbon movement in the water column, formation of hydrates at the leak site, and spill treatment and/or cleanup. Research is ongoing to enhance the ability to detect a seafloor pipeline leak in deep water, to stop the spill source once it is detected, and to ensure pipeline integrity in the long term.

4.2.1.4 Ports and Service Bases

Service bases are shore facilities and associated businesses that load, store, and supply equipment and supplies needed at offshore work sites. They may also serve as transportation bases for offshore workers.

Ninety percent of the current deepwater activity is occurring along the continental slope in the Central Planning Area and the eastern extent of the Western Planning Area, offshore of Louisiana (Viosca Knoll to Garden Banks). Port Fourchon is located on the Louisiana coast, where it is geographically central for this activity. Port Fourchon is one of the few Gulf ports that can accommodate the draft of fully laden deepwater service vessels, and its location will be advantageous to operators for the next 10 to 25 years. Venice, Port Fourchon, and Morgan City currently service most of the deepwater activity. Galveston is expected to be the primary port supporting deepwater activity in the Western Planning Area. The projected development of deepwater lease blocks east of Viosca Knoll could lead to the development of yet another deepwater service base located in the eastern GOM (USDOI, MMS, 2000b).

As OCS operations move into deeper waters, larger vessels with deeper drafts have been phased into service. Typically, these deeper-draft vessels will not need channels with depths greater than 6 to 7 m (20 to 23 ft). Deepwater operations have increased activity levels at deepwater service bases, most of which have access channels deeper than about 5 m (16 ft). Not all deepwater service bases have access channels that are deeper than 5 m (16 ft). Shallow-water service bases will continue to play a role in deepwater support. Other service bases that can accommodate deepwater vessels include Port Isabel, Corpus Christi, Pelican Island, and Port Arthur, Texas; Lake Charles, Louisiana; and Theodore and Mobile, Alabama. Pensacola, Panama City, and Tampa, Florida, are not currently used to support OCS activities.

Service bases that are currently centers of deepwater activity are expected to continue as important centers. Some ports are expected to expand to attract and capture additional deepwater business. Expansion may involve deepening access channels, upgrading infrastructure, or adding attributes important for attracting deepwater and other offshore petroleum activities.

As deepwater activities increase off southern Texas, service bases in that area are projected to expand their support of those activities. Existing development patterns indicate that Port Aransas, Port O'Connor, and Galveston are the most likely service bases to capture this business. To support developing deepwater activities east of the Mississippi River, up to two additional deepwater-related service bases may be developed in the vicinity of Alabama and the Florida Panhandle (USDOI, MMS, 2000b).

Port administrations are expected to promote, capture, and accommodate business generated by increased deepwater activities, as well as continuing support of offshore oil and gas activities in general, commercial and recreational fishing, and other shipping activities. In addition to the economic benefits afforded local port communities, port expansions often generate conflicts with other coastal resource users located in the port and its vicinity.

4.2.2 Other Major Activities

Other major activities that have taken place, and will continue to occur in the northwestern GOM, each contribute to the cumulative effect of a broad range of human activities in this region. These activities include marine transportation systems (including ports and non-OCS-related tanker and barge activities; dredging and dredge material disposal; the Louisiana Offshore Oil Port [LOOP]); military activities; and artificial reef and "rigs-to-reefs" developments.

4.2.2.1 Marine Transportation Systems

The northern GOM is an active maritime province, comprised of both international and domestic waterborne commerce. Maritime transport of cargo occurs between GOM ports and with foreign and domestic ports outside of the region. In addition to coastwise transport between ports, much of the domestic traffic between ports is via the Gulf Intracoastal Waterway (GIWW).

There are 15 Gulf Coast ports that handle between 10 million and 275 million tons of cargo annually. Eight of these ports—Corpus Christi, Houston, Texas City, Beaumont, Lake Charles, New Orleans, Mobile, and Tampa—are among the top 25 ports in the U.S., in terms of cargo tonnage. With the exceptions of Mobile and Tampa, all of these large ports are within the region where the proposed FPSO shuttle tankers would operate and/or berth for offloading crude oil cargo. The above-mentioned Texas and Louisiana ports received a combined total of over 18,200 vessel calls in 1997, of which 12,600 were tankers (excluding non-self-propelled vessels under 1,000 gross tons) (USDOT 1999). At the present time, the total vessel traffic in the GOM includes an estimated 15,220 foreign and 1,114 domestic tanker vessel transits into ports per year (Mire, 1999, personal communication). These figures demonstrate the degree to which petroleum import activities dominate the Gulf coast marine transportation system.

As of October 1998, there were 112 privately owned ocean-going tankers in the U.S.-flag (Jones Act) fleet. The vessels are operated by vessel-operating subsidiaries of major oil or other companies. These tankers are specifically designed for and used to transport oil, petroleum products, liquid natural gas, and liquid petroleum gas. As of April 1999, the Jones Act tanker fleet was reported to have a cargo capacity of 7.67 million dead weight tons, or 56 million bbl. The skilled labor force associated with these vessels was 3,000 licensed and unlicensed employees (Transportation Institute 2000).

During the period of 1999 through 2010, imports of crude oil are projected to increase 33 percent, from 8.6 million bbl/day to 11.45 million bbl/day. This projected steep increase in imports is a function of steadily increasing demand for petroleum products in the U.S. and an expected decline in domestic production levels during this period. The additional imports are expected to cause a steady increase in tanker transits in the GOM during the ten-year period.

Given that refining capacity in the U.S. is projected to expand by only eight percent during this period, additional imports of intermediate and refined products are expected in addition to the required crude oil imports. It is projected that import of these products will increase from 2.0 million bbls/day in 1999 to 3.3 million bbl/day by 2010, an increase of about 62 percent (U.S. Department of Energy 1999). Consequently, it is expected that tanker vessel transits for transporting petroleum products through GOM waters will increase during the ten-year period; however much of the increase in imported products may be realized directly at U.S. East Coast and West Coast ports that are nearer to large metropolitan markets.

The greatest environmental concern with respect to marine transportation in the GOM is the potential for an accident involving a large-volume oil spill. Ocean-going vessels could occasionally be subject to operational errors, which could in turn result in oil spills, groundings, or collisions involving other vessels, floating systems, or fixed structures such as platforms and rigs. The frequency of vessel transits in the GOM, and in Gulf ports, would also have bearing on the degree to which marine and coastal resources and the socioeconomic systems of coastal communities are vulnerable to the cumulative impacts of associated day-to-day operations. An increase in tanker vessel activity will also place additional demands on port infrastructure and on the required services.

4.2.2.2 Dredging and Dredged Material Disposal

Dredging operations considered here include new channelization, maintenance, and modification of existing channels; dam construction; sediment harvesting; and stream bank or shoreline changes. During the ten-year period of 2001 through 2010, dredging activities to deepen and/or maintain channels and port control depths are expected to occur at numerous locations along the Gulf coast. Serving the needs of coastal shipping, maintenance dredging activities would also occur for locations along the GIWW. The GIWW follows the coast inland and through bays and estuaries, and in some cases offshore. It extends along the Gulf coast from Brownsville, Texas, to Fort Myers, Florida.

Dredging activities in the U.S. declined somewhat in the 1990s but are expected to increase during the ten-year period. This expected increase is attributed to the increasing vessel traffic in channels and ports, increased demand for channel reliability, and the continued trend toward larger vessels and the deeper drafts required (e.g., the Houston-Galveston ship channel is being deepened to 13.7 m [45 feet]) (USDOT 1999).

Dredged materials are dispersed into coastal waters by the dredging activity; dumping dredged materials into water bodies; and dumping dredged materials onto spoil banks or into spoil containment areas where they may overflow and subsequently erode. Sediment discharges from dredging operations can be a major source of pollution in coastal waters in and around the GOM. In addition, inland and shallow offshore disposal can change the natural flow and circulation of water bodies and the navigability of water bodies. Most of the dredge spoil material that is dumped into ocean waters around the U.S. consists of sediments dredged from U.S. harbors and channels (USDOI, MMS 1997b, 1998a).

4.2.2.3 Louisiana Offshore Oil Port

The Louisiana Offshore Oil Port (LOOP), a corporation owned by five oil companies, provides offshore terminal facilities for offloading and storage of crude oil for tankers that are too large for conventional ports. LOOP is located in 35 m (115 ft) of water in Grand Isle Block 59, approximately 30 km (19.6 mi) from the Louisiana coastline. In 1996, LOOP offloaded 823,000 bbl/day of foreign crude oil from tankers (13 percent of the nation’s crude oil imports), and 60,000 bbl/day of domestic crude oil while spilling less than 7 gallons in eight incidents. Oil is moved from LOOP to refineries through a system of outgoing pipelines.

4.2.2.4 Military Activities

The air space and waterways of the eastern GOM are used extensively by the Department of Defense (DOD) for conducting various air-to-air, air-to-surface, surface-to-surface, and fleet training mission operations. DOD has designated essentially the entire Eastern Planning Area and portions of the Western and Central Planning Areas into operating areas of various types. Nine military warning areas (MWAs) and five water test areas are located within the GOM (figure 4-5). These warning and water test areas are multiple-use areas where military operations and oil and gas development have coexisted without conflict for many years.

MWA’s are areas of airspace designated by the Air Force in which military aircraft conduct various training missions. During training periods, the Federal Aviation Administration (FAA), the controlling agency, will route civilian aircraft so as to avoid the military operations. Occasionally, these operations include activities that result in debris that may burn up in the atmosphere or fall to the Gulf surface. When this occurs, the area is cleared of all shipping prior to the operations.

The Navy uses the GOM for shakedown cruises for newly built ships, for ships completing overhaul or extensive repair work in GOM shipyards such as Pascagoula, Mississippi, and for various types of training operations. While no aircraft carriers are currently home-ported in the GOM, carriers may occasionally conduct flight operations in the GOM. No areas in the GOM have been designated as Naval operating areas requiring restrictions on the navigation of other vessels.

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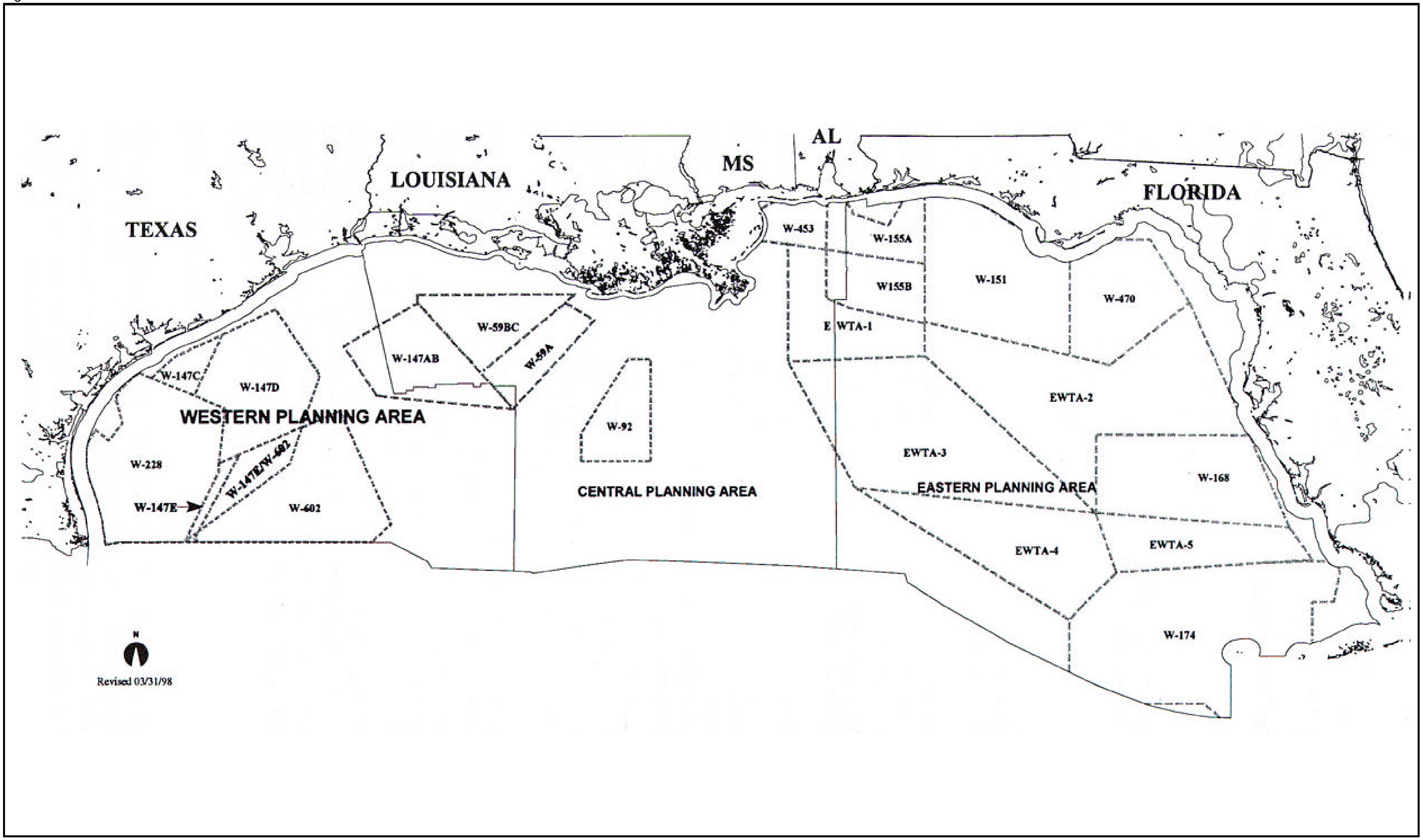

Source: MMS, 1998.

Figure 4-5 MILITARY WARNING AREAS IN THE GULF OF MEXICO

4.2.2.5 Artificial Reefs and Rigs-to-Reefs Development

The National Artificial Reef Plan (NARP) was developed by NMFS in 1985 in response to the National Fisheries Enhancement Act of 1984. The NARP recommended state-specific artificial reef plans, and most Gulf Coast and Atlantic states have done so. Artificial Reef Working Committees comprised of both state-level program specialists and federal agency representatives have worked toward developing artificial reef policies. The use of obsolete oil and gas platforms for artificial reefs has proved to be highly successful. The states of Texas and Louisiana have established Rigs-to-Reef (RTR) programs. Rather than dismantling an obsolete platform for onshore disposal, an oil and gas company may donate the structure, and transfer ownership and liability, to the state. A portion of the disposal cost savings by the oil and gas company is donated to the state to support the artificial reef program. More than 100 retired platforms have been donated by industry and used for artificial reefs in offshore Louisiana and Texas. Mississippi and Alabama are currently developing RTR programs.

4.3 Environmental Impacts of the Proposed Action – Routine Operations

4.3.1 Introduction

The following discussion of environmental impacts associated with routine FPSO operations considers six separate alternatives organized within three major alternative groups, as outlined previously in Section 2.2. Alternatives considered in this analysis include:

- **Alternative A – Conceptual Approval of FPSOs (The Proposed Action)**: Implementation of a policy approving the concept of using FPSOs in the deepwater areas of the Western and Central Planning Areas of the GOM. Under this alternative, FPSOs within the range of options defined for the base-case scenario would be considered as acceptable deepwater development technology. Operators would still be required to submit Deepwater Operations Plans (DWOPs; NTL-98-8N) for technical review of the concept and subsequent project-specific development plans (Development Operations Coordination Documents; DOCDs) for site-specific technical, safety, and environmental review.
- **Alternative B – Conditional Approval of FPSOs (The Proposed Action with General Restrictions or Conditions)**: Implementation of a policy accepting the conceptual use of FPSOs in the deepwater areas of the Western and Central Planning Areas of the GOM with certain restrictions on the operation or geographic location as conditions of approval.

  Geographic Exclusion Areas

  - **Alternative B-1 – Exclusion of FPSOs from Designated Lightering Prohibited Areas**: FPSOs would be prohibited in lightering-prohibited areas that have been established by Coast Guard and are located within the project area.

- **Alternative B-2 – Exclusion of FPSOs from Lease Areas Nearest South Texas**: FPSOs would not be permitted within the Corpus Christi and Port Isabel map protraction areas, which are the lease areas located nearest to shore.
- **Alternative B-3 – Exclusion of FPSOs from Lease Areas Nearest Mississippi Delta**: FPSOs would be excluded from lease areas near the Mississippi Delta, specifically the Viosca Knoll and Mississippi Canyon map protraction areas.

Stipulations on FPSO Operations

- **Alternative B-4 – Requirement for Attendant Vessel During Offloading Operations**: MMS would require that an attendant vessel be present during offloading operations.

- **Alternative C – No Action**: The general concept of using FPSOs in the GOM OCS would not be accepted, based on the findings contained within this EIS. However, this alternative would not necessarily prohibit the use of an FPSO in the GOM.

Impact text has been organized to reflect consideration of these six alternatives. Alternative A, the Proposed Action, has been evaluated initially. Alternative A considers the base case and the range of options feasible under the base-case scenario. This alternative encompasses three phases, including installation, routine operations, and decommissioning. The range of options is evaluated under routine operations relative to the base case. Discussion of Alternative A is followed by consideration of the four Alternative B options and Alternative C.

The impact discussion addressing routine FPSO operations focuses on the potential impacts of the alternatives on various environmental and socioeconomic components of the environment, and identifies feasible measures (i.e., mitigation) to reduce or eliminate those impacts. Impacts may be classified into one of three impact levels (i.e., degree of impact), including:

- Significant impact
- Adverse (but not significant) impact
- No (or negligible) impact

The three impact levels cited above categorize the negative effects on a resource and reflect the range of negative (or neutral) impacts. Beneficial impacts may also be realized; however, such impacts are not considered in a determination of significance. Of most intense interest are the negative impacts that are potentially significant. The threshold for determining a significance impact, termed ***significance criteria***, varies depending upon several factors, including: a) the resource affected; and b) the spatial and temporal attributes (or scope) of each impact-producing factor (i.e., local vs. regional; short- vs. long-term). Within a NEPA framework, such attributes correspond to “context” (i.e., extent, duration) and “intensity” (i.e., magnitude, severity). Therefore, significance criteria are resource-specific. Impacts from a proposed action or alternative(s) may also be direct or indirect. As a consequence, direct impacts evaluated in the following sections are classified based on level or degree of impact and the spatial and temporal attributes. Indirect impacts are similarly classified, as appropriate. Each resource discussion is preceded by a statement of applicable significance criteria. Appropriate definitions of spatial and temporal attributes for resource-specific impacts are also defined, where applicable.

4.3.2 Air Quality

> ***Significance Criteria:*** *Any exceedance of onshore ambient air quality standards is considered to be a* ***significant*** *impact. Specifically, this would include non-compliance with state and National Ambient Air Quality Standards (NAAQS) for any of six criteria pollutants, including sulfur dioxide (SO_2), nitrogen dioxide (NO_2), respirable particulates (PM_{10} , particulates <10 microns in diameter), carbon monoxide (CO), zone (O_3), and lead (Pb). Significance levels established by the MMS and the U.S. Fish and Wildlife Service (USFWS) are detailed in table 4-12. Exceedance of the MMS standard would be considered significant under NAAQS and PSD regulations. An exceedance of the USFWS impact levels at a receptor located in a Class I area would be considered significant.*
>
> ***Terminology and Resource-Specific Definitions:*** *As they apply to air quality impact assessment, the terms "short term" and "long term" refer to pollutant concentration averaging periods for the NAAQS as codified in 40 CFR Part 50. "Short term" averaging periods are 24 hours or less. "Long term" refers to annual averaging periods. When short term standards are most restrictive, the NAAQS sometimes considers a broader range of concentrations than the highest modeled value. For the purposes of air quality modeling and the interpretation of modeling results, the terms "local" (or "localized") and "regional" refer to the spatial area of impact. An impact to air quality is typically considered "local" if the impact area has a diameter of less than 10 km (6 mi). Regional impacts refer to air quality degradation in an area with a diameter between 10 and 200 km (6 to 124 mi), with 200 km (124 mi) being the largest impact area safely estimated with the Offshore and Coastal Dispersion (OCD) model (Version 5.0). While other air quality models have the ability to measure air quality impacts with a diameter greater than 200 km (124 mi), these impacts would still be considered regional.*

The OCD model (Version 5.0) was used in this analysis to simulate the effects of emissions from production phases of the proposed action only. Installation and decommissioning activities were not modeled, in part due to the fact that they are expected to be short-term and transitory in nature. Shuttle tanker offloading activities at GOM ports and terminals were not modeled. A profile of estimated emissions for a base case scenario shuttle tanker was provided in Section 4.1.2.10. The emissions associated with offloading of crude in port, or at an offshore terminal such as LOOP, is expected to be essentially the same as the emissions that presently occur for offloading tankers and permitted facilities in GOM refinery ports and terminals. MMS expects that the general conformity rule at 40 CFR Part 93, Subpart B would be applicable for approval of site specific development proposals involving shuttle tanker offloading of crude oil in GOM refinery ports and terminals. The rule requires that responsible agencies (Federal agencies conducting or permitting an action) must ensure that proposed activities do not interfere with state(s) implementation plan(s) (SIP[s]) for air quality attainment. As this EIS is a programmatic document addressing a generic FPSO system, the MMS believes that a conformity

Table 4-12

Significant Impact Levels for Air Emissions

Pollutant	Averaging Period	MMS Significant Impact Levels[a] ($\mu g/m^3$)	USFWS Significant Impact Levels[b] ($\mu g/m^3$)
Nitrogen Dioxide (NO_2)	Annual	1.0	0.1
Sulfur Dioxide (SO_2)	Annual	1.0	0.1
	24-Hour	5.0	0.2
	3-Hour	25	1.0
Particulates (PM_{10} or TSP)	Annual	1.0	0.16
	24-Hour	5.0	0.32
Carbon Monoxide (CO)	8-Hour	500	N/A
	1-Hour	2,000	N/A

[a] 30 CFR Chapter II, Minerals Management Service, U.S. Department of the Interior, Section 250.303(e); 30 CFR Chapter II, Minerals Management Service, U.S. Department of the Interior, Section 250.45(e).

[b] Update and clarification of Guidance Document for the Review of Offshore Air Pollutant Emissions Sources, USFWS, September 1997.

analysis is not appropriate at this programmatic stage. If an OCS Plan for an FPSO with tankering of OCS-produced oil to a port or ports affected by a SIP is submitted to the MMS, a conformity analysis will be required in support of the MMS review and decision process. Consultation and coordination with the affected state(s) would occur in conjunction with the conformity analysis. The MMS believes that it is appropriate to address general conformity during the site/project-specific review because detailed information on the proposed frequency of offloading, shuttle tanker equipment, offloading procedures, and destination ports is necessary to complete the conformity analysis.

FPSO routine operations (including offloading to shuttle tankers) are addressed in this section. Emissions evaluated included carbon monoxide (CO), nitrogen oxides (NO_X), particulate matter with an aerodynamic diameter less than ten microns (PM_{10}), and sulfur dioxide (SO_2). Exploration activities were not modeled. Impacts at 24 discrete land-based receptor locations (figure 4-6) were investigated. Selection of these locations was based on their proximity to the modeled FPSO location. Receptors were spaced along the coastline at 40-km (25-mi) intervals. Additional receptors were placed in environmentally sensitive areas (e.g., Delta National Wildlife Refuge, Bohemia Wildlife Management Area [WMA], Biloxi WMA, etc.) and Class I areas. Four of these receptors were located in the Breton Sound National Wilderness Area (NWA), which is the nearest Class I area.

Historically, the OCD model was developed to determine the effects of offshore emission sources on the onshore air quality of coastal regions. While similar in many aspects to models employed to determine source impacts in land-only environments, OCD includes special algorithms that account for overwater plume transport and dispersion, as well as changes that take place as the plume crosses the shoreline. Furthermore, the OCD model includes treatments of plume dispersion over complex terrain and a routine to calculate downwash effects from platform structures.

Results of the modeling analysis for CO, NO_X, PM_{10}, and SO_2 associated with the proposed action are presented in table 4-13. The proposed action was modeled at a single location offshore of the Breton Sound NWA. This site was selected for modeling because 1) Breton Sound represents the most environmentally sensitive area in the region (i.e., most conservative approach); and 2) this location represents the nearest point to shore employed in the oil spill analysis (Section 4.4.2). The location of the FPSO for the air quality modeling scenario is within the Mississippi Canyon lease area, coincident with OSRA spill launch point MC1; the coordinates for this location are lat. 28°37’38” N and long. 88°21’27” W, as denoted in figure 4-6. It should be recognized that only a single location was modeled. Modeling for another location would be expected to give different results. Some results would yield greater impact, and other results would yield less.

The objective of this analysis was to determine the impact of the proposed action in comparison with the modeling significance levels noted previously. Both MMS and USFWS significance criteria were used as a basis for determining whether air emissions were projected to produce a significant impact. Because threshold levels were different between the two sets of criteria, the more conservative (i.e., lowest) USFWS thresholds were used. As discussed, new facilities are required to model impacts using an approved model to determine whether the projected emissions of those air pollutants from the facility result in an onshore ambient air concentration above the modeling significance levels.

Table 4-13

Summary of OCD Modeling Results

		NOx		SO_2				PM-10			CO		
Year	Mixing Height	Annual	Receptor Location	3-hour	24-hour	Annual	Receptor Locations	24-hour	Annual	Receptor Locations	1-hour	8-hour	Receptor Locations
96	100	0.04	5	1.79	0.60	0.04	9[a], 11[a], 5	0.06	0.00	11[a]	2.14	1.06	11[a], 5
96	300	0.03	5	0.88	0.21	0.02	8, 8, 5	0.02	0.00	9[a]	2.41	0.86	5,8
96	500	0.02	5	0.70	0.17	0.01	12[a], 5, 5	0.02	0.00	9[a]	2.41	0.52	5,8
96	700	0.02	5	0.70	0.16	0.01	12[a], 5, 5	0.01	0.00	5	2.41	0.44	5,5
96	900	0.02	5	0.70	0.16	0.01	10[a], 9[a], 5	0.02	0.00	5	2.41	0.44	5,5
96	1,100	0.02	5	0.70	0.16	0.01	10[a], 9[a], 5	0.02	0.00	5	2.56	0.45	11[a], 5
97	100	0.03	5	2.01	0.54	0.03	11[a], 9[a], 5	0.02	0.00	5	2.19	1.21	9[a], 10[a]
97	300	0.02	5	0.99	0.23	0.01	11[a], 9[a], 5	0.02	0.00	9[a]	2.43	0.62	9[a], 11[a]
97	500	0.01	5	0.72	0.16	0.01	11[a], 9[a], 5	0.02	0.00	9[a]	2.43	0.41	9[a], 11[a]
97	700	0.01	5	0.72	0.16	0.01	11[a], 9[a], 5	0.02	0.00	9[a]	2.43	0.40	9[a], 11[a]
97	900	0.01	5	0.72	0.16	0.01	11[a], 9[a], 5	0.02	0.00	9[a]	2.43	0.40	9[a], 11[a]
97	1,100	0.01	5	0.72	0.16	0.01	11[a], 9[a], 5	0.02	0.00	9[a]	2.43	0.40	9[a], 11[a]
Highest Modeled Impact		0.04	5	2.01	0.60	0.05	-	0.07	0.01	-	2.56	1.28	-
FWS Class I Significance Level		0.1	-	1	0.2	0.1	-	0.32	0.16	-	2,000	500	EPA Standard

[a] - Receptors in the Breton Sound NWA are Numbers 9 through 12.

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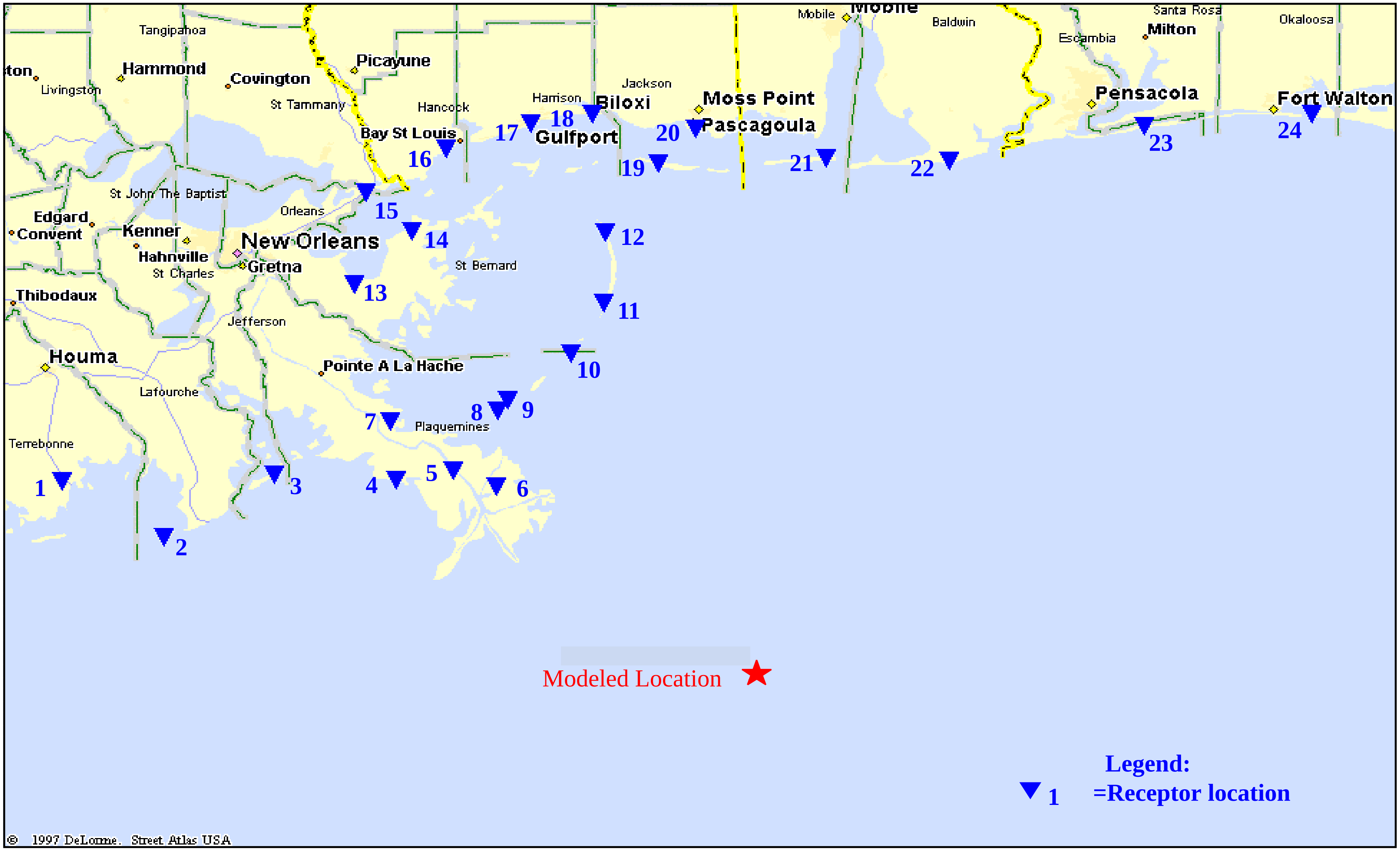

Figure 4-6 LOCATION OF ONSHORE RECEPTORS AND THE HYPOTHETICAL FPSO AS EVALUATED BY THE OCD MODEL

4.3.2.1 Meteorological Data

The OCD model requires both over-land and over-water meteorological data. Meteorological data for this analysis were provided from the following sources, as detailed in Section 3.1.2 and figure 3-5: 1) water and air temperatures from offshore Data Buoy 42040; 2) wind speed and directions from the BURL1 coastal station; and 3) upper atmospheric conditions from Slidell (Louisiana) for the years 1996-1997. These data, derived from a meteorological set which was previously approved by the MMS, was used in this analysis because:

- Data Buoy 42040 is the closest to the Mississippi Canyon launch point in both position and water depth. Because water temperature has an effect on offshore atmospheric stability, Data Buoy 42040 (at 240 m [787 ft] water depth) was believed to most closely match the average over-water sea conditions at the location of the proposed action.
- The BURL1 coastal station is the closest surface station to the Mississippi Canyon launch point, located north and west of the proposed action. The wind direction and wind speed at this location should most closely match the conditions at the site and in between where most of the dispersion is occurring.
- The Slidell station is the closest upper air station.

Missing data were automatically interpolated where single data points were missing. Where groups of data points were missing, the gaps were reviewed and modified by hand adjustments, per EPA recommendations. In virtually all cases, the missing data and general trends were best represented by linear interpolation between known points of data.

Based on data supplied by the National Data Buoy Office, an anemometer and temperature height of 10 m (33 ft) was used. Per MMS recommendations, modeling runs were performed using over-water mixing heights of 100, 300, 500, 700, 900 and 1,100 m (328, 984, 1,640, 2,297, 2,953, and 3,609 ft) for each of the years evaluated.

4.3.2.2 Land Mass Configuration and Receptors

The OCD model requires the specification of the shoreline geometry to determine the plume characteristics at the land-sea interface. This requirement allows the model to simulate the differences between over-land and over-water pollutant transport and dispersion. The traditional approach to preparing the shoreline data was to overlay a grid on the area of interest and digitize the areas of land. The shoreline for this modeling exercise was developed using the OCD Version 5 MAKEGEO processor because it is less prone to errors and less time consuming than the traditional method.

To determine the impact on the shoreline areas, receptors were placed from Cocodrie, Louisiana to Destin, Florida. Twenty-four receptors were used in this modeling analysis. Four of these receptors were placed in the lower Mississippi River Delta because it is the closest landmass to the proposed action area. Four additional receptors were placed throughout the Breton Sound NWA, which is the closest Class I area. The remaining receptors were located at various coastal and inland locations within a 250-km (155-mi) radius from the modeled location.

4.3.2.3 Source Parameters and Emission Rates

Emission sources associated with the proposed action consist of natural gas-fired turbine generators and compressors, diesel-fired deck cranes, oil treating equipment, a support vessel, and the lightering tanker, as detailed previously in table 4-7 (Section 4.1). The impact for SO_2 involves both short-term (i.e., three hour and 24-hour) and long-term (i.e., annual) standards. A tanker was modeled at idle 24 hours per day because loading the tanker is estimated to take 24 hours to complete and two or three tankers per week are expected at peak FPSO production.

Source parameters for the sources used in the model are represented in table 4-14. Most emissions sources from the FPSO were assumed to be mounted on the deck at an elevation of 20 m (66 ft) above sea level. Sources with similar discharge characteristics (e.g., stack orientation, exit velocity, exit temperature) were combined into a single source by summing their emissions. There is assumed to be one downwash structure – the crew quarters located at the stern of the FPSO, a rectangular structure measuring 10.67 m (35 ft) high and 40 m (131 ft) wide.

Emissions were calculated using the USEPA's *Compilation of Air Pollutant Emission Factors AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources* (USEPA, 1998) and factors provided by the MMS. These factors were used in combination with the heat input (or power rating) and operating hours of each piece of equipment to calculate emissions. Emission rates were noted previously in table 4-7. A worst-case NO_2 emission rate was evaluated in the model by conservatively assuming complete conversion of NO_x to NO_2.

4.3.2.4 Model Options

The OCD model options are listed in table 4-15. The sources modeled in this analysis were considered to be point sources. Since the Mississippi River delta and the Gulf coast are near sea level and relatively flat, no terrain features were considered in this modeling analysis (i.e., OCD runs considered simple terrain only).

4.3.2.5 Model Results and Impacts

Alternative A - Installation

No modeling was conducted to evaluate installation activities. However, based on the fuel consumption rates and duty cycles for the required vessels identified in Section 4.1, air quality impacts from installation activities are expected to be localized and temporary, effectively eliminated once installation and commissioning is complete and all equipment is moved off site. Based on the maximum on site fuel use detailed in Section 4.1, maximum on-site horsepower was calculated at 98,343, as compared to 66,000 for the FPSO (including all sources). Given that many of the FPSO sources are natural gas-fired (with little emissions of SO_2) and installation sources are diesel fired (with higher SO_2 emissions), the possibility exists that localized, short-term exceedances of the SO_2 standard could be realized during installation activities.

Table 4-14

Summary of FPSO Emissions-Producing Equipment and Corresponding Stack Parameters

Equipment Type	Stack Parameters Height (m)	Temperature (^{O}C)	Velocity (m/s)	Orientation	Diameter (m)
Turbine Generators	22.8	509	64.4	Horizontal	0.91
Turbine Compressor	23.8	486	80.0	Horizontal	1.21
Deck Cranes	24.0	374	11.55	Vertical	0.19
Air Compressor	24.0	374	33.8	Vertical	0.10
Lightering Tanker (idle)	29.6	374	35.85	Vertical	1.00
Chem-Electric Heater	25.6	440	9.07	Vertical	0.36

Table 4-15

Summary of OCD Modeling Options

Offshore and Coastal Dispersion (OCD) Model, Version 5.0

MMS FPSO Gulf of Mexico EIS
Launch Point MC1 (Mississippi Canyon lease area; OSRA Launch Point MC1)
NOx Significance - 100 m Mixing

General Input Information
This run of the OCD model is for the pollutant NO_x for 8784 1-hour periods. Concentration estimates begin on hour- 1, julian day- 1, year-1996.
1.0 user length unit in the horizontal = 1.0000000 kilometers. 0 significant sources are to be considered.
This run will not consider any pollutant loss.
High-five summary concentration tables will be output for 4 averaging periods. Avg times of 1, 3, 8, and 24 hours are automatically displayed.

Option List Option Specification: 0 = Ignore Option 1 = Use Option
--Technical Options--

Option Number	OPTION	SETTING
1	Consider terrain adjustments	0
2	Do not include stack downwash calculations	0
3	Do not include gradual plume rise calculations	0
4	Calculate initial plume size due to buoyancy	1
--Input Options--		
5	Source of met data	2
	= 0, Met data from separate binary pcrammet file	
	= 1, ASCII met data included in control file	
	= 2, Met data from separate ascii pcrammet file	
6	6 Read hourly emissions	0
7	7 Specify significant sources	0
8	8 Receptor types	0
	= 0, Discrete receptors only	
	= 1, Discrete and polar receptors	
	= 2, Discrete and cartesian receptors	
	= 3, Discrete, polar and cartesian receptors	
	= 4, Polar receptors	
	= 5, Cartesian receptors	
	= 6, Polar and cartesian receptors	
--Printed Output Options--		
9	Delete emissions with height table	1
10	Delete met data summary for avg period	1
11	Delete hourly contributions	1
12	Delete met data on hourly contributions	
13	Delete plume rise/transport on hrly contributions	1
14	Delete hourly summary	1
15	Delete met data on hrly summary	1
16	Delete plume rise/transport on hrly summary	1
17	Delete avg-period contributions	1
18	Delete averaging period summary	1
19	Delete avg concentrations and hi-5 tables	0
--Other Control And Output Options--		
20	Source type (0=point; 1=area; 2=line)	0
21	Create summary output file called extra.out	0
22	Write hourly conc to disk	1
23	Calculate annual impact from non-permanent activities	0
24	Land source (do not modify wind speed)	0
25	Specify pollutant chemical transformation rate	0
--	Perform normal run (=1) or test run (=0)	1

Land anemometer height (meters) = 10.01
Land surface roughness length (meters) = 0.10000

A single gas export line will be required under the FPSO's base-case scenario. With any other form of deepwater development, two or more pipelines may be required, depending upon the operating parameters of each pipeline and the production operation. There are inherent risks associated with pipeline installation and operation, as well as air emissions associated with installation activities. It is noteworthy that the extent of pipelaying activities will be less with an FPSO than other forms of deepwater development, given that the FPSO will support tanker transport of oil instead of a pipeline. The emissions associated with an FPSO pipeline will be discussed in greater detail within Major Cumulative Actions (Section 4.5).

Alternative A - Routine Operations

Table 4-13 summarizes the maximum modeled concentrations for both years of meteorological data and at each mixing height. The nearest Class I receptors (Receptor Numbers 9 through 12) are footnoted accordingly in the table and are indicated on figure 4-6. The table indicates no modeled concentrations greater than the NO_x significance level. The SO_2 three-hour modeled impact is greater than or equal to the USFWS Class I significance level of 1 $\mu g/m^3$ two times in the two-year period. The modeled concentrations of SO_2 compared with the 24-hour significance level indicate four exceedances in the two-year period. The model did not indicate concentrations of PM_{10} or CO greater than the Class I significance levels.

Section 4.1.2.10 summarized the various emission sources aboard the FPSO and shuttle tanker, including generation rates for criteria pollutants (i.e., NO_x, SO_2, PM_{10}, CO). Aside from pumps used to transfer oil from the FPSO to a shuttle tanker, equipment aboard the FPSO is similar to that found in other deepwater technologies. Additional emissions unique to FPSO operations include those from a shuttle tanker and possible fugitive emissions. Modeling was conducted utilizing a conservative approach through the selection of a site close to shore; the majority of the remaining portion of the deepwater study area lies further offshore (i.e., emissions subject to further dispersion). For that portion of the deepwater study area lying as close to shore as the Mississippi Canyon location, the absence of sensitive onshore receptors precludes significant impact.

For the Mississippi Canyon site, model results from the proposed action demonstrate that emissions of SO_2 may result in concentrations of SO_2 greater than the long-term and short-term significance levels at onshore receptors at Breton Sound NWA. Emissions of other criteria pollutants were not shown to produce a significant impact. Overall, while FPSO-related emissions are generally comparable to those from other deepwater development systems, FPSO operations produce additional emissions (i.e., emissions above and beyond those from other deepwater development systems) associated with 1) shuttle tanker idling, and 2) offloading of crude oil from the FPSO to the shuttle tanker. It is also noteworthy that other deepwater operations have also had SO_2 impact issues with the Breton Sound NWA.

For proposed operations outside of the modeled location in Mississippi Canyon, emissions are not expected to produce significant impacts on ambient air quality for any of the criteria pollutants. This is attributed to increased distance of FPSOs from shore (i.e., increasing dispersion) and the absence of sensitive onshore receptors (i.e., Class I or nonattainment areas).

Alternative A - Range of Options

There are several options to the base-case scenario that have the potential to adversely affect onshore air quality. While the base-case scenario studies one FPSO location, there is an option for up to five geographically dispersed FPSOs. The extent that this option would impact air quality depends on the definition of "geographically dispersed". For example, if the five FPSO were dispersed throughout the FPSO study area (i.e., separated by approximately 320 km [199 mi]), it is not likely that five FPSOs would have significantly more impact on any receptor than one FPSO because the emissions from each FPSO would disperse into a substantial volume of the atmosphere. However, in the unlikely event the five FPSOs were placed near sensitive receptors (e.g., Mississippi Canyon) in an area with a 50-km (31-mi) radius, the FPSOs may be considered "geographically dispersed" yet their emissions have a potential cumulative impact on sensitive receptors. While the extent of this potential impact cannot be precisely determined without further modeling, it can be stated that significant impacts would be expected (i.e., a higher number of exceedances of the SO_2 threshold would be expected).

Options for increased storage capacity (e.g., 2,300,000 barrels vs. 1,000,000 barrels) and increased production rates (300,000 BPD vs. 100,000 BPD) are expected to produce a slightly greater impact on air quality because VOC emissions from storage, offloading, and fugitives (from larger and/or higher numbers of processing equipment) would be more than the base-case scenario. The extent of this impact cannot be precisely determined in the absence of additional modeling (i.e., emissions from a larger vessel; emissions associated with a higher level of production).

The flaring/venting options for gas disposal could have significant impacts on air quality. The impact from flaring has been calculated in table 4-7 (as flaring for emergency only) and indicates emissions of 595 lb/hr of NO_x, 503 lb/hr of VOC and 3,238 lb/hr of CO. Venting the gas without flaring could emit up to 26,000 lb/hr of VOCs based on a typical GOM gas operation.

The addition of thrusters to the FPSO vessel will adversely impact air quality if additional horsepower is required aboard the vessel to operate the thrusters. Additionally, the use of a tug in offloading operations would have either positive or negative impacts on air quality, depending on the method of operation. For example, if tug and shuttle tanker engines are both operating during offloading operations, then tug operation would have a negative impact because more pollutants are being emitted than if the shuttle were operating alone. If however, the shuttle tanker engine could be shut down while the tug holds the tanker in place, the impact on air quality would be less because the tug would have relatively fewer total emissions than the shuttle tanker.

Alternative A - Decommissioning

No modeling was conducted to evaluate decommissioning activities. However, based on the fuel consumption rates and duty cycles for the required vessels identified in Section 4.1, air quality impacts from these activities are expected to be localized and temporary, effectively eliminated once decommissioning equipment is moved off site.

Alternative B (B1 through B4)

Alternative B-1, exclusion of FPSOs from designated lightering prohibited areas, will have negligible impact on ambient air quality relative to those impacts already noted for Alternative A. It is unknown whether commercial reserves lie beneath or in close proximity to the lightering prohibited areas; thus, it cannot be determined if such a prohibition would affect access to such reserves, whether access might be gained from operations outside of the lightering areas, or whether such reserves might be inaccessible under the exclusion. In general, FPSO operations excluded from lightering prohibited areas could be expected to move to other deepwater prospects. Operations located further offshore are less likely to create significant air quality impacts, primarily due to increased dispersion.

Alternative B-2, exclusion of FPSOs from lease areas nearest south Texas (Corpus Christi and Port Isabel lease blocks located nearest to shore), will have negligible impact on ambient onshore air quality. No Class I areas are found inshore of the Corpus Christi and Port Isabel lease areas. In addition, these lease areas lie further offshore than the Mississippi Canyon site modeled in this analysis. An absence of sensitive onshore receptors in the Texas coastal zone, coupled with increased dispersion of emissions, suggests that exclusion of nearshore lease blocks off the Texas coast will have a negligible impact on air quality.

Alternative B-3, exclusion of FPSOs from lease areas nearest the Mississippi Delta, would effectively mitigate the significant impact of FPSO emissions in the northeastern potion of the Mississippi Canyon lease area identified under Alternative A. Such an exclusion would have no effect on proposed operations elsewhere in the deepwater area.

Alternative B-4, requirement for an attendant vessel to be present during offloading operations, will have an incremental impact on air quality above what is projected for the proposed action (Alternative A). Assumptions regarding fuel usage for attendant vessels were detailed in Section 4.1. The addition of an attendant vessel during offloading (i.e., every third day for 24 hours) could be expected to add 0.6 tons/year of total suspended particulates, 3.7 tons/year of SO_x, 27.6 tons/year of NO_x, 0.8 tons/year of VOC, and 6 tons/year of CO; these estimates are based on one-third of the annual utility vessel emissions (table 4-7). If the proposed action occurs in any of the deepwater region exclusive of the northeastern corner of Mississippi Canyon lease area, this incremental impact is not expected to be significant. For operations within the northeastern portion of Mississippi Canyon, however, any significant impact will be further exacerbated.

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: Air quality impacts from installation activities are expected to be localized and temporary; however, the possibility exists that localized, short-term exceedances of the SO_2 standard could be realized, a significant impact. For routine operations, air quality modeling results for the Mississippi Canyon site demonstrated that emissions may result in concentrations of SO_2 greater than the long-term and short-term significance levels at onshore receptors at Breton Sound NWA, a significant impact using USFWS thresholds. Modeled emissions of other criteria pollutants (i.e., NO_x, PM_{10}, and CO) were below threshold levels, as were SO_2 emissions using MMS thresholds, an adverse but not significant impact. For the range of options under Alternative A, the installation of up to five geographically dispersed FPSOs may adversely affect air quality, depending upon location and proximity to shore and one another. Broadly distributed FPSOs outside of the Mississippi Canyon lease area are expected to produce adverse but not significant impacts to air quality. If the five FPSOs were placed near sensitive receptors (e.g., Mississippi Canyon) in an area with a 50-km (31-mi) radius, significant air quality impacts are expected from SO_2 emissions. Options for increased storage capacity and increased production rates are expected to produce a slightly greater impact on air quality, although the extent of this impact cannot be precisely determined in the absence of additional modeling. The flaring/venting options for gas disposal could have significant impacts on air quality. The addition of thrusters to the FPSO vessel will adversely impact air quality if additional horsepower is required. The use of a tug in offloading operations would have either positive or negative impacts on air quality, depending on the method of operation. Decommissioning operations are predicted to produce localized and short term adverse impacts to air quality. As with installation operations, localized, short-term exceedances of the SO_2 standard could be realized, a significant impact.

Alternative B: Alternatives B-1 and B-2 will have negligible impact on ambient air quality beyond those already noted for Alternative A. Alternative B-3 would effectively mitigate the significant impact of FPSO emissions in the northeastern potion of the Mississippi Canyon lease area; such an exclusion would have no effect on proposed operations elsewhere in the deepwater area. Alternative B-4 will have an incremental increase in impact above what is projected for Alternative A (i.e., significant impacts from SO_2 emissions in the Mississippi Canyon lease area). If the proposed action occurs in any of the deepwater region exclusive of the northeastern corner of Mississippi Canyon lease area, this incremental impact is not expected to produce significant air quality impacts. For operations within the northeastern portion of Mississippi Canyon, however, any significant impact will be further exacerbated.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.3 Water and Sediment Quality

> ***Significance Criteria:*** *Any exceedance of current effluent or discharge limitations established under existing regulatory discharge limitations (e.g., by the National Pollutant Discharge Elimination System general permit for new and existing sources in offshore waters of the Gulf of Mexico, or anticipated limits to be established by Coast Guard for non-production-related discharges) would be considered a* ***significant*** *impact.*
> ***Terminology and Resource-Specific Definitions:*** *For water and sediment quality impact assessment, "local" (or "localized") impacts can be broadly defined as those that occur within 10 km (6 mi) of the source, whereas "regional" impacts occur on the order of 100 km (62 mi) or more from the source. Temporal attributes are not easily quantified and are more problematic. In general, for water quality impacts, the terms "long term" and "short term" correspond to the duration of a discharge. For sediment quality impacts, temporal attributes are a function of the longevity of the chemical species of concern.*

The USEPA, Region 6 released its Final NPDES permit (GMG290000) for new and existing sources in offshore waters of the western portion of the GOM in January and November 1998 (63 FR 2238; 63 FR 58722) and a subsequent modification on April 19, 1999 (64 FR 19156). Under this permit, new sources (in the offshore subcategory of the oil and gas extraction point source category) are allowed to discharge produced water, domestic and sanitary wastes, and minor wastes (e.g., treatment chemicals, biocides, ballast water) under established limitations, some of which include periodic effluent testing, acute or chronic toxicity testing, and monitoring. Limits based on ocean discharge criteria are included in the permit to ensure compliance with Section 403(c) of the Clean Water Act. At this time, it is expected that production-related discharges (e.g., produced water) will conform to NPDES permit limitations, as established by USEPA. Non-production-related discharges (e.g., domestic and sanitary wastes) are expected to be regulated by Coast Guard (e.g., under applicable MARPOL limitations).

A base case and range of options for the working scenario have been described for FPSO operations in Section 1.3. The base-case scenario consists of three separate phases, as detailed in Section 4.1, including: installation, routine production operations, and decommissioning. There are aspects of each of the phases that have the potential to affect offshore marine and coastal water and sediment quality.

4.3.3.1 Offshore

Alternative A - Installation

During the commissioning or installation phase of FPSO operations, wastewater discharges from the supporting vessels are the potential contributor to degradation of offshore water quality. According to the base-case scenario, there will be a number of support vessels involved in the installation phase. Discharges from these vessels will include treated sanitary waste (i.e., human body waste), domestic wastes, and bilge water. Estimated quantities of these discharges at the FPSO site and during transits to and from the shorebase are presented in tables 4-16 and 4-17. Total estimated quantities are as follows:

Sanitary waste	1,075,875 L (284,286 gal),
Domestic wastes	1,577,950 L (416,894 gal), and
Bilge water	957,776 L (253,044 gal).

Sanitary wastes will introduce additional nutrients into the water column. Discharges of sanitary wastes and domestic wastes will be rapidly diluted and dispersed (i.e., to ambient levels within several thousand meters of the discharge). Therefore, they are not expected to have any significant impact on water quality in the offshore GOM. There will be some oil associated with bilge water discharges. Because of the water depth at the site of the FPSO, discharges from support vessels are not expected to affect the seafloor in the offshore GOM.

During the installation phase of FPSO operations, three anchor clusters and associated mooring lines will be installed. Anchor clusters will be located approximately 3,000 m (10,000 ft) from the final location of the FPSO. Three subsea manifolds also will be installed approximately 3,700 m (12,000 ft) from the FPSO. A reasonable estimate of the area of seafloor that potentially could be disturbed by these installation/emplacement activities is 43 km^2 (17 mi^2) which compared to the area of the GOM is insignificant (i.e., the total area of the Central and Western Gulf of Mexico Planning Areas is approximately 425,413 km^2 [164,252 mi^2]. In addition, a gas export line will be laid over a 322-km (200-mile) route to a shore crossing, or tied into an existing gas pipeline in shallower water. Deepwater portions of this export line will be limited to narrow corridors; the route will be selected to avoid sensitive habitats; and a dynamically positioned laying vessel will be used. As a result, bottom disturbance in the offshore GOM from the gas export line emplacement will be minimal.

Alternative A - Routine Operations

During routine production operations at the FPSO, there will be produced water discharges and wastewater discharges from the FPSO and support vessel. Supplies or equipment may also be accidentally lost overboard during supply transfer or during regular operations. The most significant source of potential impact to water and sediment quality rests with produced water discharges.

Table 4-16

Estimated Quantities of Treated Sanitary Wastes and Domestic Wastes that will be Discharged from Support Vessels During the Commissioning Phase at the FPSO Site and in Transit Between the FPSO Site and the Shorebase

		On Site			In Transit to/from Shorebase		
Vessel Type/Task	Manning Level	Total Man Days	Estimated Treated Sanitary Wastes[a] (L)	Estimated Domestic Wastes[b] (L)	Total Man Days	Estimated Treated Sanitary Wastes[a] (L)	Estimated Domestic Wastes[b] (L)
Anchor Handling Vessel	20	560	42,000	61,600	560	42,000	61,600
Construction Vessel	125	4,750	356,250	522,500	500	37,500	55,000
Pipelaying Vessel	125	2,375	178,125	261,250	3,750	281,250	412,500
Umbilical Vessel	50	350	26,250	38,500	100	7,500	11,000
Tow Vessels	10	250	18,750	27,500	150	11,250	16,500
Tug	10	700	52,500	77,000	200	15,000	22,000
Crew boats	10	--	--	--	100	7,500	11,000

[a] Treated sanitary waste discharge estimates based on 75 L/man/day (Minerals Management Service, 1999a);
[b] Domestic waste discharge estimates based on 110 L/man/day (Minerals Management Service, 1999a)

Table 4-17

Estimated Quantities of Bilge Water that will be Discharged from Support Vessels During the Commissioning Phase at the FPSO Site and in Transit Between the FPSO Site and the Shorebase

			On Site		In Transit to/from Shorebase	
Vessel Type/Task	Manning Level	DWT[a]	Vessel Days	Estimated Bilge Water Discharge[b] (L)	Vessel Days	Estimated Bilge Water Discharge[b] (L)
Anchor Handling Vessel	20	200	28	122,035	28	122,035
Construction Vessel	125	200	38	165,619	4	6,720
Pipelaying Vessel	125	200	19	82,810	30	130,752
Umbilical Vessel	50	200	7	30,509	2	8,717
Tow Vessels	10	200	25	108,960	15	65,376
Tug	10	170	70	91,392	20	3,088
Crew boats	10	95	--	--	10	19,753

[a] DWT = dead weight tonnage; based on data provided by MMS (G. Rainey, MMS, Gulf of Mexico OCS Region, New Orleans, LA, 2000, personal communication,); DWT for anchor handling, construction, pipelaying, umbilical, and tow vessels estimated at 200 DWT;
[b] Bilge water discharge estimates based on the following formula: Q (quantity in L/hr) = 0.908T (dead weight tonnage) (New England River Basins Commission [NERBC], 1976). Total discharges assume continuous vessel operations (i.e., 24 hrs/days).

Produced Water Discharges

Based on the experience of typical oil and gas operations in the GOM, produced water is the largest individual source of discharges. Generally, discharges are lowest at the beginning of production and gradually increase as the production continues over time. In nearly depleted fields, for example, production may be as high as 95 percent water and 5 percent fossil fuels (Read, 1978). Over the life of a producing field, the volume of produced water may be ten times greater than the volume of produced fossil fuel (Stephenson, 1991).

Produced water contains a variety of chemicals that have been dissolved from the geologic formations in which the produced water resided for millions of years, including inorganic salts from the relic seawater in the formation, metals, organic compounds, and radionuclides. Although the salt concentration (salinity) of produced water can be only a few parts per thousand, most produced waters from offshore sources have salinities greater than that of sea water (≈ 35 g/L). Continental Shelf Associates, Inc. (1997b) reported total dissolved solid concentrations (salinities) between 90 and 176 g/L for produced water samples collected at four platforms in the GOM. In addition, a number of specialty chemicals may be added to produced water during the treatment process. Neff (1997) reviewed published data for the metals and organic chemicals associated with produced water discharges (table 4-18).

Total Organic Carbon Neff (1997) reported that the concentration of total organic carbon (TOC) in produced water can vary from less than 0.1 to as high as 2,100 mg/L and is highly variable from one location to another. Produced water from production wells in the GOM commonly contain 68 to 540 mg/L TOC, and most of this organic matter is in solution or colloidal suspension in the produced water (Means *et al.*, 1989).

Petroleum Hydrocarbons Petroleum hydrocarbons in produced water discharges are a major environmental concern. Petroleum hydrocarbons (measured as oil and grease by infrared spectrometry) accounted for 8.5 to 16 percent of the TOC in produced water samples from the GOM analyzed by Neff *et al.* (1989).

The most abundant hydrocarbons in produced water are the one-ring aromatic hydrocarbons, benzene, toluene, ethylbenzene, and xylenes (the BTEX compounds) and low molecular weight saturated hydrocarbons. Produced waters from wells in the northwestern GOM contain 68 to 38,000 μg/L total BTEX (table 4-18). Toluene often is the most abundant BTEX compound in Gulf coast produced water, followed by benzene. Ethylbenzene and the three xylene isomers usually are present at only a small fraction of the concentrations of benzene and toluene. Continental Shelf Associates, Inc. (1997b) reported BTEX concentrations in produced water samples collected at four platforms in the GOM and in ambient water samples collected at least 2,000 m (1,234 ft) from the four platforms (table 4-19). Clearly, concentrations of these compounds are orders of magnitude greater in produced water than in ambient GOM marine waters.

Saturated (aliphatic) hydrocarbons or alkanes with molecular weights in the range of those of BTEX usually are present at much lower concentrations than the monoaromatic hydrocarbons in produced waters (Middleditch, 1981; Sauer, 1981; Neff *et al.*, 1989). For example, two samples of produced water from coastal Louisiana analyzed by Neff *et al.* (1989) contained 1,090 to 2,140 μg/L C_1 through C_8 alkanes and 2,430 to 9,510 μg/L BTEX. This is due in large part to the much greater aqueous solubility of BTEX than of saturated hydrocarbons of similar molecular weight (McAuliffe, 1966).

Table 4-18

Published Concentration Ranges of Several Classes of Naturally-occurring Organic Compounds in Produced Water from the U.S. Gulf of Mexico (From: Neff, 1997)

Compound Class	Concentration Range	References[a]
Total organic carbon (µg/L)	68,000 - 540,000	1,2,3
Total BTEX (µg/L)	68 – 38,000	1,2,3,4,5,6,7,8,9,10,11,12
Benzene (µg/L)	2.0 – 17,700	See Total BTEX
Toluene (µg/L)	60 – 19,800	See Total BTEX
Ethylbenzene (µg/L)	6.0 - 6,000	See Total BTEX
Xylenes (µg/L)	15 - 5,800	See Total BTEX
Total PAHs (µg/L)	80 - 1,860	1,2,5,6,7
Arsenic (µg/L)	<0.11 - 320	2,4,6,12
Barium (µg/L)	1.0 - 650,000	1,2,4,6,7,12,18,19,20
Cadmium (µg/L)	0.06 - 98	1,2,3,4,6,7,8,12
Chromium (µg/L)	<0.01 - 390	1,2,3,4,6,7,12,18
Copper (µg/L)	<0.05 - 210	1,4,6,7,12
Lead (µg/L)	<0.08 - 5,700	1,2,3,4,6,7,8,12,18
Mercury (µg/L)	0.06 - 0.19	1,3,4,6,7,12
Nickel (µg/L)	0.1 - 1,674	1,2,3,4,6,7,8,12,18
Zinc (µg/L)	7.3 - 10,200	1,2,3,4,6,7,12,18
Total Radium (pCi/L)	0 - 2,802	21,22,23,24
^{226}Radium (pCi/L)	0 - 1,565	See Total Radium
^{228}Radium (pCi/L)	0 - 1,509	See Total Radium

[a] Key to references: 1) Neff *et al.*, 1989; 2) Means *et al.*, 1989; 3) Lysyj, 1982; 4) Means *et al.*, 1990; 5) Armstrong *et al*., 1979; 6) Boesch *et al.*, 1989; 7) Rabalais *et al*., 1991; 8) Burns and Roe Industrial Services Corporation, 1983; 9) Brooks *et al.*, 1980; 10) Middleditch, 1981; 11) Sauer, 1981; 12) Middleditch, 1984; 13) Brown *et al.*, 1990; 14) Hanor *et al*., 1986; 15) Hanor and Workman, 1986; 16) McGowan and Surdam, 1988; 17) Fisher, 1987; 18) O'Day and Tomson, 1987; 19) Macpherson, 1989; 20) Kharaka *et al.*, 1978; 21) Louisiana Dept. of Environmental Quality, 1990; 22) Hamilton *et al*., 1992; 23) Kraemer and Reid, 1984; 24) Stephenson and Supernaw, 1990.

Table 4-19

Concentrations of Benzenes, Toluenes, Ethylbenzene, and Xylenes in Produced Water Samples Collected at Four Platforms in the Gulf of Mexico and in Ambient Water Samples Collected at Least 2,000 m from the Four Platforms (From: Continental Shelf Associates, Inc., 1997b)

	Concentration (μg/L)	
Compound	Produced Water	Ambient Water
Benzene	820 - 2,500	ND - 1.50
Toluene	490 - 1,500	ND - 1.00
Ethylbenzene	52 - 110	ND - 0.20
m-,p-Xylenes	180 - 460	ND - 0.83
o-Xylene	110 - 230	ND - 1.50
C3-Benzenes	100 - 290	ND - 0.96
C4-Benzenes	ND - 110	ND
Total Target Benzenes	1,800 - 5,200	NDC

Key:

ND = not detectable.
NDC = no data collected.

Polycyclic aromatic hydrocarbons (PAHs) are hydrocarbons that contain two or more fused aromatic rings and are the petroleum hydrocarbons of greatest environmental concern in produced water due to the toxicity of some PAHs and their persistence in the marine environment (Neff, 1987). Naphthalene, phenanthrene, and their alkyl homologues are the only PAHs that are occasionally present at higher than trace concentrations. These lower molecular weight PAHs often are present at higher concentrations in produced water from gas wells than in produced water from oil wells (Stephenson *et al.*, 1994). Individual higher molecular weight PAHs (e.g., benzo(a)pyrene) are rarely present in produced water at quantifiable concentrations (greater than about 0.1 μg/L).

Measured concentrations of total PAHs in the GOM produced water are in the range of 80 to 1,860 μg/L (table 4-18). Concentrations of individual PAH from naphthalene to chrysene nearly always are in the range of a few tenths to about 100 ppb (tables 4-20 and 4-21) (Boesch *et al.*, 1989; Means *et al.*, 1989, 1990; Neff *et al.*, 1989; Rabalais *et al.*, 1991; Continental Shelf Associates, Inc., 1997a,b). Concentrations tend to decrease as molecular weight increases. The most abundant PAHs in produced water are the low molecular weight two- and three-ring compounds and their alkyl homologs. These low molecular weight PAHs usually represent more than 95 percent of the total PAHs in produced water.

Metals Because it is often remnant seawater, metals are commonly present in produced water. The concentrations of metals in produced water depend on the age and geology of the formation from which oil and gas, and commensurately produced water, are produced (Collins, 1975). Some metals can be present in produced waters at concentrations substantially higher than their respective concentrations in clean natural seawater. The metals most frequently present in produced water at elevated concentrations include barium, cadmium, chromium, copper, iron, lead, nickel, and zinc (Neff *et al.*, 1987) (table 4-18). Neff *et al.* (1989, 1992) reported that only barium, lead, and zinc are present at elevated concentrations in produced water from two Louisiana platforms.

Continental Shelf Associates, Inc. (1997a,b) reported metal concentrations for produced water and ambient water samples collected in the GOM (tables 4-22 and 4-23). Concentrations of arsenic, barium, cadmium, chromium, iron, and lead were notably greater in some produced water samples compared to concentrations in ambient water.

Radioisotopes ^{226}Ra and ^{228}Ra may occur at trace concentrations in produced water, and the concentrations of radium isotopes in produced water may tend to increase as the salinity of the produced water increases. However, the correlation between the salinity and concentrations of ^{226}Ra, ^{228}Ra, and total radium in produced water is not strong because many produced waters of all salinities contain little or no radium and some low-salinity produced waters contain significant amounts of radium.

^{226}Ra plus ^{228}Ra levels in produced water from oil, gas, and geothermal wells along the Gulf of Mexico coast range from less than 0.2 picocuries/liter (pCi/L) to 13,808 pCi/L (Kraemer and Reid, 1984; Neff *et al.*, 1989). Radium concentrations often are much higher in coastal and estuarine waters; a typical background concentration of total radium isotopes in nearshore Gulf of Mexico seawater is 1.0 pCi/L (Reid, 1983). Continental Shelf Associates, Inc. (1997b) reported levels of ^{226}Ra and ^{228}Ra in produced water samples of 56 to 1,494 and 69 to 600 pCi/L, respectively; by comparison, ^{226}Ra and ^{228}Ra levels of 0.07 to 0.30 and <0.30 to 0.93 pCi/L, respectively, were recorded for ambient water samples collected at reference sites during the same study. In a separate study, Continental Shelf Associates, Inc (1997a) reported levels of ^{226}Ra and ^{228}Ra in produced water samples of 230 to 380 and 460 to 960 pCi/L, respectively; by

Table 4-20

Concentrations of Polycyclic Aromatic Hydrocarbons in Produced Water Samples Collected at Four Platforms in the Gulf of Mexico and in Ambient Water Samples Collected at Least 2,000 m from the Four Platforms (From: Continental Shelf Associates, Inc.,1997b)

	Concentration (µg/L)	
Compound	Produced Water	Ambient Water
Naphthalene	19.6 - 90.2	ND - 0.038
C1-Naphthalene	14.0 - 73.2	ND - 0.019
C2-Naphthalene	8.00 - 88.2	0.004 - 0.023
C3-Naphthalene	5.24 - 82.6	ND - 0.004
C4-Naphthalene	2.55 - 52.4	ND
Acenaphthylene	ND	ND
Acenaphthene	ND - 0.059	ND
Biphenyl	0.784 - 10.6	0.002 - 0.008
Fluorene	0.159 - 2.79	ND - 0.011
C1-Fluorenes	0.315 - 8.70	ND
C2-Fluorenes	0.555 - 15.5	ND
C3-Fluorenes	0.601 - 17.6	ND
Anthracene	0.014 - 0.446	ND - 0.012
Phenanthrene	0.258 - 8.84	ND - 0.004
C1-Phenanthrenes	0.372 - 25.1	ND - 0.006
C2-Phenanthrenes	0.524 - 31.2	ND - 0.004
C3-Phenanthrenes	0.404 - 22.5	ND
C4-Phenanthrenes	0.388 - 11.3	ND
Dibenzothiophene	0.098 - 4.60	ND - 0.001
C1-Dibenzothiophenes	0.252 - 13.3	ND - 0.004
C2-Dibenzothiophenes	0.266 - 24.8	ND - 0.011
C3Dibenzothiophenes	0.290 - 25.1	ND - 0.022
Fluoranthene	0.007 - 0.115	0.001 - 0.011
Pyrene	0.010 - 0.292	ND - 0.008
C1-Fluoranthenes/Pyrenes	0.060 - 2.41	ND
C2-Fluoranthenes/Pyrenes	0.048 - 4.36	ND
C3-Fluoranthenes/Pyrenes	0.062 - 5.30	ND
Benz(a)anthracene	ND - 0.197	ND
Chrysene	0.003 - 0.849	ND - 0.004
C1-Chrysenes	0.014 - 2.39	ND
C2-Chrysenes	0.030 - 3.51	ND
C3-Chrysenes	0.050 - 3.31	ND
C4-Chrysenes	0.045 - 2.55	ND
Benzo(b)fluoranthene	ND - 0.031	ND - 0.006
Benzo(k)fluoranthene	ND - 0.072	ND - 0.003
Benzo(e)pyrene	ND - 0.101	ND - 0.004
Benzo(a)pyrene	0.007 - 0.087	0.006 - 0.013
Perylene	0.085 - 1.95	ND - 0.004
Indeno(1,2,3-cd)pyrene	ND - 0.006	ND - 0.002
Dibenz(a,h)anthracene	ND - 0.024	ND
Benzo(ghi)perylene	ND - 0.029	ND - 0.014
Total PAHs	58.2 - 596	0.058 - 0.170
Total Low MW PAHs	57.6 - 569	0.042 - 0.100

Key:

ND = not detectable.

Table 4-21

Ranges of Polycyclic Aromatic Hydrocarbon Concentrations in Produced Water Samples Collected at Two Discharging Platforms in the Gulf of Mexico During Two Separate Surveys in Spring and Fall 1995 (From: Continental Shelf Associates, Inc., 1997a)

Compound	Concentration (ng/L)
Naphthalene	5,500 - 15,000
2-Methylnaphthalene	3,800 - 11,000
1-Methylnaphthalene	3,500 - 9,400
2,6-dimethylnaphthalene	600 - 1,700
2,3,5-trimethylnaphthalene	270 - 2,000
C1-Naphthalenes	4,400 - 12,000
C2-Naphthalenes	5,000 - 13,000
C3-Naphthalenes	2,700 - 15,000
C4-Naphthalenes	1,100 - 7,500
Acenaphthylene	ND - 370
Acenaphthene	ND - 87
Biphenyl	370 - 1,000
Fluorenea	110 - 260
C1-Fluorenes	100 - 900
C2-Fluorenes	220 - 1,800
C3-Fluorenes	330 - 2,900
Anthracene	ND - 48
Phenanthrene	120 - 1,100
1-Methylphenanthrene	73 - 1,500
C1-Phenanthrenes/anthracenes	250 - 5,400
C2-Phenanthrenes/anthracenes	270 - 9,000
C3-Phenanthrenes/anthracenes	130 - 8,000
C4-Phenanthrenes/anthracenes	210 - 6,600
Dibenzothiophene	72 - 1,300
C1-Dibenzothiophenes	180 - 4,900
C2-Dibenzothiophenes	280 - 13,000
C3-Dibenzothiophenes	350 - 15,000
Fluoranthene	ND - 10
Pyrene	10 - 220
C1-Fluoranthenes/pyrenes	ND - 750
C2-Fluoranthenes/pyrenes	ND - 1,400
Benzo[a]anthracene	ND
Chrysene	ND - 170
C1-Chrysenes	ND - 640
C2-Chrysenes	ND - 1,300
C3-Chrysenes	ND - 990
C4-Chrysenes	ND - 1,000
Benzo[b]fluoranthene	ND
Benzo[k]fluoranthene	ND
Benzo[e]pyrene	ND - 30
Benzo[a]pyrenea	ND - 27
Perylene	36 - 310
Indeno[1,2,3,-c,d]pyrene	ND
Dibenzo[a,h]anthracene	ND
Benzo[g,h,i]perylene	ND – 6

Key:

ND = not detectable.

Table 4-22

Concentrations of Metals in Produced Water Samples Collected at Four Platforms in the Gulf of Mexico and in Ambient Water Samples Collected at Least 2,000 m from the Four Platforms and at Four Reference Sites (From: Continental Shelf Associates, Inc., 1997b)

Metal	Produced Water	Ambient Water
As (μg/L)	0.5-31	1-2
Ba (mg/L)	81-342	0.01-0.09
Cd (μg/L)	<0.05-1.0	0.020
Cr (μg/L)	<0.1-0.8	ND
Cu (μg/L)	<0.2	0.2-1.7
Fe (mg/L)	10-37	<0.001
Hg (μg/L)	<0.01-0.2	<0.01
Mn (mg/L)	1-7	NDC
Mo (μg/L)	0.3-2.2	3-10
Ni (μg/L)	<1-7	0.25-1.6
Pb (μg/L)	<0.1-28	0.02-0.05
V (μg/L)	<1.2	1.1-1.7
Zn (mg/L)	0.01-3.6	NDC

Key:

ND = not detectable.
NDC = no data collected.

Table 4-23

Ranges of Mean Concentrations of Arsenic, Barium, Cadmium, and Mercury in Produced Water Samples Collected at Two Discharging Platforms in the Gulf of Mexico and in Ambient Water Samples Collected at Least 2,000 m from Two Discharging and Two Non-discharging (i.e., Reference) Platforms in the Gulf of Mexico. Samples were Collected During Two Separate Surveys in Spring and Fall 1995 (From: Continental Shelf Associates, Inc., 1997a)

	Concentration (μg/L)	
Metal	Produced Water	Ambient Water
Arsenic	4.6 – 27	0.89 - 1.6
Barium	89,000 - 250,000	6.7 - 15
Cadmium	<0.3 - 14	<0.005
Mercury	<0.01	<0.01

comparison, ^{226}Ra and ^{228}Ra levels in ambient water samples ranged from non-detectable to 0.29 and non-detectable to 0.58 pCi/L, respectively.

The results of ecological and human health risk assessments presented in Continental Shelf Associates, Inc. (1997a,b) indicated that radium in produced water discharges at offshore platforms present very little, if any, toxicological risk to the biota or to humans eating biota collected at the platforms. Discharged produced water plumes are rapidly mixed with receiving ambient water at offshore discharge sites. This rapid dilution is supported by reduction in ^{226}Ra by a factor of as high as 1,668 at a distance of 5 m (16 ft) from the produced water discharge point observed at an offshore platform (Continental Shelf Associates, Inc., 1997b). This dilution is very important to the low toxicological risks from produced water discharges. Modeling by the U.S. EPA, in conjunction with laboratory tests, has indicated that produced water discharges will reach non-toxic levels within 100 m of the discharge point, assuming discharge rates up to 25,000 barrels per day (USDOI, MMS, 1998a). Because the maximum potential discharge rate that are projected to occur at an FPSO is 70,000 barrels per day, the distance projected by a similar modeling effort may be somewhat greater.

Produced Water Impacts Under the base-case scenario, maximum produced water discharges from the FPSO could be as high as 70,000 barrels per day. MMS (1995a) estimated that approximately 660 million barrels per year, or about 1.8 million barrels per day of produced water was discharged to the OCS of the GOM for the period from 1987 through 1991. Based on these statistics, an FPSO discharging at the maximum rate could be responsible for approximately 4 percent of the produced water discharged into the GOM. Produced water discharges from the FPSO will produce localized impacts to offshore water quality, an adverse but not significant impact.

An FPSO will be anchored in water depths exceeding 300 m (984 ft). Because produced water plumes do not penetrate deep into the water column (USDOI, MMS, 1998a) and the discharge plume is rapidly diluted, the possibility of sediment contamination is remote. Produced water can contain high concentrations of iron in a reduced state. When discharged into receiving marine water, which is an oxidizing environment, a solid phase occurs that is probably composed of a number of iron-containing compounds (e.g., $Fe(OH)_3$, FeO, $FeSO_4$). This solid phase is stable and an efficient scavenger of metals from produced water, and the scavenged metals are less biologically available. The eventual fate of this solid phase is probably the sediments, but because an FPSO will be moored in deepwater, particles of this solid phase will reach the seafloor at great distances from the FPSO site (John Trefry, Professor, Florida Institute of Technology, 1999, personal commun.). Therefore, surface discharges will have negligible impact on offshore sediment quality.

Vessel-Related Discharges

During routine FPSO operations, wastewater and operational discharges from the FPSO, shuttle tankers, and supply boats will occur and are potential contributors to degradation of offshore water quality. Discharges from all of these vessels will include sanitary waste, domestic wastes, and bilge water. In addition, high volumes of ballast water will also be used to maintain stability aboard the FPSO during production and offloading operations. Ballast water will be onloaded and subsequently discharged from the segregated ballast tanks of the FPSO to maintain proper vessel draft and hydrodynamic characteristics. With segregated ballast tanks, there will be no mixing of stored oil and ballast water. Permit stipulations require periodic monitoring of ballast water to ensure that free oil is not being discharged into the marine environment. The ballast water discharge cycle will be dependant upon daily oil production (i.e., ballast water will be released in approximately equal volumes as oil is stored). The frequency of oil offloading will determine the timing of ballast water loading (i.e., ballast water will be onloaded as oil is offloaded to the shuttle tanker); given a FPSO storage capacity of 500,000 bbls (21,000,000 gal) of oil, similar volumes of untreated seawater will be released as oil is produced and stored aboard the FPSO. With an oil offloading frequency of three days, it is projected that similar volumes of ballast water will be discharged on a nearly continuous basis over each three-day period. Estimated daily discharge quantities of domestic and sanitary wastes and bilge water at the FPSO site and during transits to and from the shorebase are presented in table 4-24. Although nutrients will be introduced into the water column as a result of sanitary and domestic wastewater discharges, these discharges will be rapidly diluted and dispersed (i.e., to ambient levels within several thousand meters of the discharge), and they are therefore not expected to have any significant impact on water quality in the offshore GOM. Untreated ballast water will be discharged onsite, with no impact expected. Some oil will be associated with bilge water discharges; however, any such discharge will need to be treated to meet either Coast Guard/MARPOL discharge criteria (i.e., 15 ppm maximum oil content) or the USEPA NPDES permit limits (i.e., no sheen). Discharges from supply boats and shuttle tankers vessels are not expected to affect the seafloor in the offshore GOM because of the water depths.

Lost Equipment

During routine operations, it is likely that equipment or supplies might be accidentally lost overboard during transport, transfer, or daily operations. Under current MMS regulations, operators are required to make every possible attempt to recover any equipment lost overboard. Impacts to offshore water and sediment quality would be negligible and very localized.

Alternative A - Range of Options

Under the base-case scenario, one FPSO will be deployed. One option is the deployment of up to five geographically dispersed FPSOs. Because these vessels will be deployed in deep water and most likely far from each other, the impacts to water quality and sediment quality resulting from the commissioning and decommissioning phases will be localized and, from the perspective of the entire GOM, additive (i.e., cumulative). Similarly, effects on water quality from routine operations at the FPSO sites will be localized and should not have a regional effect on water quality in the GOM. Shuttle tanker traffic would increase to service multiple FPSO sites. Impacts from this increase should not measurably degrade water quality beyond what occurs at the present normal levels of vessel traffic in the GOM.

The base-case scenario indicates that the offloading frequency from the FPSO to a shuttle tanker will be once every three days during peak production periods. As an option, this frequency could increase to once per day. This increase would triple the number of tanker trips to the FPSO. This would affect the quantities of sanitary and domestic waste discharges and the quantities of bilge water discharges. Because these discharges are rapidly diluted and dispersed, there would be no significant effect on water quality anticipated.

Table 4-24

Estimated Daily Discharges of Sanitary, Domestic, and Bilge Water Wastes from an FPSO, Shuttle Tanker, and Supply Boats During Routine Operations

Vessel	Manning Level	Estimated Daily Treated Sanitary Wastes[a] (L)	Estimated Daily Domestic Wastes[b] (L)	Estimated Daily Bilge Water Discharges[c] (L)
FPSO	110	8,250	12,100	286
Shuttle Tanker	25	1,875	2,750	200 – 500
Supply boats	10	750	1,100	4,358

Footnotes:

[a] Treated sanitary waste discharge estimates based on 75 L/man/day, or approximately 20 gal/man/day; data from Minerals Management Service (1998a);

[b] Domestic waste discharge estimates based on 110 L/man/day, or approximately 30 gal/man/day; data from Minerals Management Service (1998a);

[c] FPSO discharge estimates based on bilge water produced from the machinery spaces. Typically, this water is collected and piped to a bilge water storage tank, then periodically pumped to a dedicated tote tank on deck for transportation ashore. However, there is also the facility to discharge this water via an oil/water separator as per MARPOL Annex 1, Regulation 21; the FPSO bilge water discharge estimate above reflects on-site discharge. Shuttle tanker bilge water is also produced from the machinery spaces. Bilge water production range depends on the age and condition of the equipment. Shuttle tankers are obliged to comply with the MARPOL requirements, Regulation 9 (b)(ii), which states that discharge of bilge water is allowed only when the vessel is en route (i.e., while at an FPSO, a shuttle tanker will not discharge bilge water). Shuttle tankers will be fitted with a bilge water storage tank for use while the shuttle tanker is moored at the FPSO, or while the shuttle tanker is en route to port. Tankers may also discharge bilge water while in transit; the shuttle tanker bilge water discharge estimate above reflects in-transit discharge (R. Gilbert, Offshore Installation Manager, Bluewater, The Netherlands, July 2000, personal communication). Bilge water discharges from supply boats based on the formula: Q = 0.908T (dead weight tonnage), as cited in Minerals Management Service (1998a), as derived originally from New England River Basins Commission (1976); supply boats estimated at 200 DWT (dead weight tons).

Alternative A - Decommissioning

During the decommissioning phase, wastewater discharges from the supporting vessels are the potential contributor to degradation of offshore water quality. In the base-case scenario, there will be a number of support vessels involved in the decommissioning phase, and discharges from these vessels will include sanitary waste, domestic wastes, and bilge water. Estimated quantities of these discharges at the FPSO site and during transits to and from the shorebase are presented in tables 4-25 and 4-26. Total estimated quantities are as follows:

Sanitary waste	59,250 L (15,654 gal),
Domestic wastes	86,900 L (22,959 gal), and
Bilge water	318,461 L (84,137 gal).

Sanitary and domestic waste water discharges will add nutrients to the water column, but these discharges will be rapidly diluted and dispersed, and they will probably not have any significant impact on water quality in the offshore GOM. There will be some oil associated with bilge water discharges. Because of the water depth at the site of the FPSO, discharges from support vessels are not expected to affect the seafloor in the offshore GOM.

Decommissioning of the FPSO is not expected to have any significant effect on the seafloor.

Alternative B (B1 through B4)

Alternative B-1, exclusion of FPSOs from designated lightering prohibited areas, will have negligible impact on ambient offshore water and sediment quality. In general, FPSO operations excluded from lightering prohibited areas could be expected to move to other deepwater prospects. Operations located further offshore, in deeper water, are less likely to create significant water quality impacts.

Alternative B-2, exclusion of FPSOs from the Corpus Christi and Port Isabel lease blocks located nearest to shore, will have a negligible impact on ambient water and sediment quality. Similarly, Alternative B-3, exclusion of FPSOs from lease areas nearest the Mississippi Delta, would also have a negligible effect on water and sediment quality.

Alternative B-4, requirement for an attendant vessel to be present during offloading operations, will have an incremental impact on offshore water quality. No impacts to offshore sediment quality are expected under Alternative B-4. In the absence of specific details regarding the size of a candidate attendant vessel, it is assumed that the characteristics of support or supply vessel discharges are applicable (e.g., see Section 4.1 and table 4-24). The addition of an attendant vessel during offloading (i.e., every third day for 24 hours) could be expected to add quantities or sanitary waste, domestic wastes, and bilge water on site every third day. Estimated quantities for a day on site are as follows, assuming a manning level for the attendant vessel of 10 crew members:

Sanitary waste	750 L (185 gal),
Domestic wastes	1,100 L (291 gal), and
Bilge water	1,680 L (444 gal).

Such volumes are expected to produce only negligible impact to ambient water quality.

Table 4-25

Estimated Quantities of Treated Sanitary Wastes and Domestic Wastes that will be Discharged from Support Vessels During the Decommissioning Phase at the FPSO Site and in Transit Between the FPSO Site and the Shorebase

		On Site			In Transit to/from Shorebase		
Vessel Type/Task	Manning Level	Total Man Days	Estimated Treated Sanitary Wastes[a] (L)	Estimated Domestic Wastes[b] (L)	Total Man Days	Estimated Treated Sanitary Wastes[a] (L)	Estimated Domestic Wastes[b] (L)
Tow Vessels	10	350	26,250	38,500	150	11,250	16,500
Tug	10	210	15,750	23,100	40	3,000	4,400
Crew boats	10	0	0	0	40	3,000	4,400

Key:

[a] Treated sanitary waste discharge estimates based on 75 L/man/day (Minerals Management Service, 1999a);
[b] Domestic waste discharge estimates based on 110 L/man/day (Minerals Management Service, 1999a).

Table 4-26

Estimated Quantities of Bilge Water That Will be Discharged From Support Vessels During the Decommissioning Phase at the FPSO Site and in Transit Between the FPSO Site and the Shorebase

			On Site		In Transit to/from Shorebase	
Vessel Type/Task	Manning Level	DWT[a]	Vessel Days	Estimated Bilge Water Discharge [a] (L)	Vessel Days	Estimated Bilge Water Discharge [a] (L)
Tow Vessels	10	200	35	152,544	15	65,376
Tug	10	170	21	77,818	4	14,822
Crew boats	10	95	--	--	4	7,901

Footnotes:

[a] DWT = dead weight tonnage; based on data provided by MMS (G. Rainey, MMS, Gulf of Mexico OCS Region, New Orleans, LA, 2000, personal communication,); DWT for tow Vessel estimated at 200 DWT;

[b] Bilge water discharge estimates based on the following formula: Q (quantity in L/hr) = 0.908T (dead weight tonnage) (as cited in Minerals Management Service, 1998a, as derived originally from New England River Basins Commission, 1976). Total discharges assume continuous vessel operations (i.e., 24 hrs/day).

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: During installation, there will no exceedances of water quality criteria. Wastewater discharges from support vessels will be rapidly diluted and dispersed (i.e., to ambient levels within several thousand meters of the discharge) – an adverse but not significant impact to offshore water quality. No impacts to offshore sediment quality are expected from surface discharges released during installation. Anchoring installation/emplacement activities will produce localized, short term impacts to sediment quality, an adverse but not significant impact. During routine production operations at the FPSO, there will be no exceedances of water quality criteria. Produced water discharges and wastewater discharges from the FPSO and support vessels will produce localized impacts to offshore water quality, an adverse but not significant impact. Surface discharges of produced water will not reach the seafloor, however, iron precipitates may be deposited far from the FPSO, a negligible impact on offshore sediment quality. Supplies or equipment may also be accidentally lost overboard during supply transfer or during regular operations, a localized, negligible impact to offshore sediment quality. For the range of options, the deployment of up to five geographically dispersed FPSOs will produce localized, additive impacts to water quality, an adverse but not significant impact. Negligible impacts to sediment quality may also be realized from supplies or equipment lost overboard. Increases in offloading frequency will increase quantities of sanitary and domestic waste discharges and the quantities of bilge water discharges; however, impacts to offshore water quality will remain adverse but not significant. During decommissioning, there will be no exceedances of water quality criteria. Discharges from support vessels will produce localized, temporary degradation to offshore water quality, an adverse but not significant impact. Decommissioning of the FPSO is expected to produce localized, negligible impacts to sediment quality.

Alternative B: Alternatives B-1 through B-3 will have negligible impact on ambient offshore water and sediment quality, relative to Alternative A. Alternative B-4 will have an incremental impact on offshore water quality above those already noted for Alternative A, however, impacts are expected to remain adverse but not significant. No impacts to offshore sediment quality are expected under Alternative B-4.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.3.2 Coastal

Alternative A - Installation

During the commissioning phase, there will be a slight increase in support vessel traffic from the shorebase(s) to the FPSO site. This increase could result in increased turbidity in channels from support vessel passage. If dredging of channels is necessary to provide for the increased traffic, water quality will be affected and sediments in and around the channel will be disturbed. Turbidity levels could be temporarily increased as a result of dredging operations. Mixing of anaerobic sediments into the water column could affect oxygen levels and metal concentrations.

Alternative A - Routine Operations

Shuttle tankers traversing between the FPSO and port, as well as supply boats moving from the shorebase(s) to the FPSO site, could affect coastal water quality as a result of operational discharges. Discharges would include sanitary wastes, domestic wastes, and bilge water. The quantity of these discharges would not be sufficient to significantly degrade water quality beyond that occurring from normal vessel traffic. Turbidity levels could increase in shallow water as a result of vessels stirring up sediments. If dredging channels is necessary to support increased vessel traffic at the shorebase, water quality and sediment quality could be affected as discussed previously.

Alternative A - Range of Options

Additional FPSOs and associated increases in shuttle tanker traffic would increase vessel traffic in coastal areas. Turbidity in channels may increase from additional shuttle tanker and supply boat traffic. Vessel-associated discharges would also increase. If this vessel traffic is concentrated in one or a few ports, then water quality and sediment quality could be significantly affected in the localized area (i.e., from increases in erosion and turbidity).

Alternative A - Decommissioning

There will be additional support vessel traffic to and from the shorebase to the FPSO site during decommissioning. This increase could result in increased turbidity in channels from support vessel passage. There would be additional discharges, which would include sanitary wastes, domestic wastes, and bilge water. The quantity of these discharges would not be sufficient to significantly degrade water quality beyond that occurring from normal vessel traffic. Turbidity levels could increase in shallow water as a result of vessels stirring up sediments.

Alternative B (B1 through B4)

Alternative B-1, exclusion of FPSOs from designated lightering prohibited areas, will have negligible impact on ambient coastal water and sediment quality. Operations located further offshore, in deeper water, are less likely to create significant water quality impacts.

Alternative B-2, exclusion of FPSOs from the Corpus Christi and Port Isabel lease blocks located nearest to shore, will have a negligible impact on ambient water and sediment quality in coastal waters. Similarly, Alternative B-3, exclusion of FPSOs from lease areas nearest the Mississippi Delta, would also have a negligible effect on coastal water and sediment quality.

Alternative B-4, requirement for an attendant vessel to be present during offloading operations, will have a negligible effect on coastal water and sediment quality. The attendant vessel would create additional discharges while in transit, as well as on site (see Offshore Water Quality, Alternative B-4). In the absence of details regarding a candidate attendant vessel, corresponding manning levels, and transit time from port to the FPSO site, it has been assumed that such a vessel would: 1) be similar to a supply boat; 2) be manned by 10 crew members; and 3) be in transit approximately 24 hours. Under these assumptions, and applying the discharge rates noted in table 4-24, it is expected that in-transit discharges (i.e., discharges into coastal and offshore waters while in transit) would be:

Sanitary waste	750 L (198 gal),
Domestic wastes	1,100 L (291 gal), and
Bilge water	1,680 L (444 gal).

Of these estimated volumes, it is projected that only 20 to 25 percent, maximum, would be discharged into coastal waters from the attendant vessel; the remainder would be discharged to offshore waters while in transit to and from the FPSO and while on site. Such limited volumes will have a negligible impact on coastal water quality.

Transit into and out of port by an attendant vessel also has the potential to affect sediment quality. In coastal waters, the potential for additional turbulence would be increased as a result of the additional vessel traffic.

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: During installation, increases in support vessel traffic from the shorebase(s) to the FPSO site and associated increases in turbidity within transit channels will produce adverse but not significant impacts on coastal water and sediment quality. If dredging of channels is necessary to provide for the increased traffic, water quality will be affected and sediments in and around the channel will be disturbed, an adverse but not significant impact. During routine operations, shuttle tankers traversing coastal waters will produce localized degradation of water quality, an adverse but not significant impact. Under the range of options, additional FPSOs and/or additional shuttle tanker traffic would increase vessel traffic in coastal areas, increasing turbidity within transit channels, an adverse but not significant impact. If vessel traffic is concentrated in one or a few ports, then significant, localized impacts to water quality and sediment quality could be realized. During decommissioning. additional support vessel traffic will produce adverse but not significant impacts on coastal water and sediment quality.

Alternative B: Alternatives B-1 through B-3 will produce negligible impacts to ambient coastal water and sediment quality above those already noted for Alternative A. Alternative B-4 will produce incremental increases in impacts above those noted for Alternative A; impacts are expected to remain adverse but not significant.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.4 Coastal Environments

Significance Criteria: *Impacts on coastal environments are considered locally* ***significant*** *if they are likely, either directly or indirectly, to cause measurable change in: 1) species composition or abundance beyond that of normal variability, or 2) change the ecological function of the habitat in a localized area for five years or longer (i.e., cause long-term change).*

Terminology and Resource-Specific Definitions: *For coastal environments impact assessment, a "short term" impact would include any impact to coastal landforms or communities that is not observable one year (i.e., one annual cycle) after the event. "Long term" would include any impact to coastal landforms or biotic communities that is permanent (based on human time frames), persists for an indefinite period of years, or remains observable more than 10 years after the event. A "local" impact is one that is confined to a well-defined and specific geographic area along a coastline. A "regional" impact is one that affects coastal landforms or biotic communities over a large geographic area, or specific types of landforms or biotic communities over widely separated geographic areas.*

In this case, the threshold or risk for significant environmental impact must be estimated based on scientific judgement and taking into consideration the relative condition and abundance of specific marine resources in the vicinity of proposed shuttle tanker destination ports.

4.3.4.1 Coastal Barrier Beaches and Associated Dunes

Alternative A - Installation

Installation activities associated with FPSO commissioning will not affect coastal barrier beaches and dunes. There are expected to be slight increases in the number of vessel transits to and from support bases and fabrication yards, resulting in minor incremental impacts to channels and coastal erosion rates. Given the limited number of vessels required and the relatively short timeframe for each phase of installation activity, such impacts are short term and extremely localized.

Alternative A - Routine Operations

During routine operations, the only impacts FPSOs will produce on sensitive coastal environments will be those associated with the incremental increase in vessel traffic due to the shuttle tankers. The significance of these incremental increases in impacts varies depending upon the location of the shuttle tanker destinations. Proposed shuttle tanker destinations, or destination port areas, are as follows:

- Mississippi River Ports
- LOOP
- Lake Charles-Cameron
- Port Arthur-Beaumont
- Houston-Galveston

- Freeport
- Corpus Christi

The base-case scenario calls for one FPSO to be stationed at an unspecified location in the Western and Central planning areas of the Gulf of Mexico, with an offloading frequency of once every three days. This implies approximately 110 offloading events and shuttle tanker transits to port per year under maximum production of a single FPSO. Therefore, the total number of shuttle tanker vessel movements per year is approximately 220 (i.e., one exit, one entrance), assuming maximum production levels and a 500,000 barrel storage capacity. Vessel traffic through channels and in close proximity to barrier islands has been shown to move considerably more bottom sediment than tidal currents, thus increasing coastal and barrier island erosion rates. The magnitude of these erosion effects is dependent primarily upon ship speed and channel cross section (Renger and Bednarczyk, 1986; Kwik, 1992).

Table 4-27 shows the type and status of the coastal landforms where the proposed shuttle tanker destination ports are located. The incremental increases in channel and coastal erosion associated with increased vessel traffic can be expected to be more significant in those areas currently undergoing transgression. However, given the level of other tanker and vessel traffic using Gulf ports, impacts on coastal environments from FPSO-related tankering operations is considered to range from negligible to adverse but not significant, depending upon the nature of adjacent coastal environments.

Alternative A - Range of Options

Optional scenarios call for as many as five FPSOs to be operating at geographically dispersed areas throughout the Western or Central planning areas of the Gulf of Mexico. The rate of offloading for these facilities would range from once every ten days up to once per day based on the peak production rate and shuttle tanker size. No additional alternative destination ports are available, so it is assumed that all shuttle tanker traffic would be handled by some combination of the port areas listed above. Based on the assumptions outlined in Sections 4.2 and 4.5, production offloading estimates from five FPSOs on the OCS would be expected to generate between 365 and 685 shuttle tanker transits to GOM ports. Potential distribution of this increased shuttle tanker workload is outlined in table 4-28. At the present time, the tanker traffic in the Gulf of Mexico consists of an estimated 15,220 foreign and 1,114 domestic vessels per year (T. G. Mire, Chief, Quality Control, Products and Services, Waterborne Commerce Statistics Center, U. S. Army Corps of Engineers, 1999, personal communication). These may be different vessels or the same vessel making several trips through the Gulf. Each tanker makes one harbor entrance and one harbor exit per trip, yielding a current level of 32,668 tanker harbor and channel transits per year. Given the projected increases of imported crude oil and products (exclusive of FPSO production) that will pass through Gulf ports (Section 4.2), foreign and domestic tanker transits at these ports may proportionately increase from the current 16,334 transits to between 20,400 and 22,000 transits annually. At a projected level of 20,400 non-FPSO based one-way transits per year, the FPSO development scenarios represent an increase of between 1.8 and 3.4 percent in the number of tanker harbor and channel transits per year. At a projected level of 22,000 non-FPSO based one-way transits per year, FPSO development scenarios represent an increase in tanker traffic of 1.5 to 3.1 percent. Depending upon the nature

Table 4-27

Type and Status of Coastal Landforms Present Near Proposed Shuttle Tanker Ports

Proposed Shuttle Tanker Port	Landform Complex	Geologic Condition
Mississippi River Ports	The Mississippi River “Bird’s Foot” Delta	Current delta of the Mississippi River; regressive deposits laid down in the very resent past; experts agree that this delta has reached its maximum expansion and would already have begun to erode away if the Mississippi’s course had not been stabilized
LOOP	Not applicable given that LOOP is offshore; the closest landform is the Mississippi Deltaic Complex	The Mississippi Deltaic Complex is a transgresive deposit from an old Mississippi River Delta currently undergoing erosion and subsidence
Lake Charles/Cameron	Chenier Plain Landform Complex	Regressive mud and sand deposits from the Mississippi and Atchafalaya Rivers; there are areas along this coastline undergoing erosion but overall these deposits are regressive and relatively stable
Port Arthur/Beaumont	Chenier Plain Landform Complex	While this area is a physiographic continuation of the Chenier Plain, the sediments are transgressive, migrating landward over tidal marshes
Houston/Galveston	Texas Barrier Island Landform Complex	Transgressive sediment deposits that are experiencing net erosion at this time
Freeport	Texas Barrier Island Landform Complex	Transgressive sediment deposits that are experiencing net erosion at this time
Corpus Christi	Texas Barrier Island Landform Complex	Transgressional barrier island

Table 4-28

Minimum and Maximum Number of New Harbor Transits Per Year Considering the Range of FPSO Operations[a]

Options	Minimum Number of New Harbor Transits Per Year	Maximum Number of New Harbor Transits Per Year
Option 1 - One port assumes all shuttle tanker traffic	365	685
Option 2 – Two ports split the shuttle tanker traffic evenly	183	343
Option 3 – Three ports divide the shuttle tanker traffic evenly	122	228
Option 4 – Four ports share shuttle tanker traffic evenly	91	171
Option 5 – Five ports share the shuttle tanker traffic evenly	73	137
Option 6 – Six ports share the shuttle tanker traffic evenly	61	114
Option 7 – All seven potential port areas share the shuttle tanker traffic evenly	52	98

Footnote:

[a] The rate of offloading is expected to range from once every ten days up to once per day based on the peak production rate, on site storage capacity, and shuttle tanker size. See Sections 4.2 and 4.5 for the assumptions upon which the range of 365 to 685 shuttle trips into port are based.

of adjacent coastal environments, impacts are expected to range from negligible to adverse but not significant as a result of this incremental increase in FPSO-related tanker traffic.

Alternative A - Decommissioning

Decommissioning activities associated with FPSO removal will not affect coastal barrier beaches and dunes. As with installation activities, there are expected to be slight increases in the number of vessel transits to and from support bases and onshore yards (e.g., recycling, reconditioning), resulting in minor incremental impacts to channels and coastal erosion rates. Given the limited number of vessels required and the relatively short timeframe for each phase of decommissioning, such impacts are short term and extremely localized.

Alternative B (B1 through B4)

Alternative B-1, exclusion of FPSOs from designated lightering prohibited areas will probably have negligible impacts on coastal barrier beaches and associated dunes. Exclusion from these areas will not, in and of itself, reduce or eliminate shuttle tanker traffic to any specific port. In general, FPSO operations excluded from lightering prohibited areas could be expected to move to other deepwater prospects.

Alternative B-2, exclusion of FPSOs from lease areas nearest south Texas (Corpus Christi and Port Isabel lease blocks located nearest to shore), will have negligible impact on coastal barrier beaches and associated dunes. Exclusion from these areas will not in and of itself reduce of eliminate shuttle tanker traffic to any specific port.

Alternative B-3, exclusion of FPSOs from lease areas nearest the Mississippi Delta, would have no effect on proposed operations elsewhere in the deepwater area and thus no effects on the impacts associated with shuttle tanker traffic discussed under Alternative A.

Alternative B-4, requiring that an attendant vessel to be present during offloading operations, has the potential to produce minor incremental increases in impacts on coastal barrier beaches and associated dunes above those projected for the proposed action (Alternative A), given that the attendant vessel will have to visit port periodically. The attendant vessel will remain on station during offloading, will not accompany the shuttle tanker to port, but will remain on station to assist in the next offloading. The extent of impacts caused by a few additional harbor transits would depend upon harbor characteristics, vessel hull design, transit speed, and the other factors discussed under Alternative A. Considering that an attendant vessel will make a limited number of port visits under Alternative B-4, no significant impacts are expected.

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: Installation activities associated with FPSO commissioning will not affect coastal barrier beaches and dunes, although minor incremental impacts to channels and coastal erosion rates may be realized (i.e., negligible impact). During routine FPSO operations, incremental increases in vessel traffic will produce negligible to adverse but not significant impacts to sensitive coastal environments, depending upon the location of operations and nature of adjacent beaches. Under the range of options, incremental increases in the numbers of shuttle tanker trips will have negligible to adverse but not significant impacts to adjacent barrier beaches and dunes. Decommissioning activities associated with FPSO removal will not affect coastal barrier beaches and dunes. Slight increases in the number of vessel transits to and from support bases and onshore yards will result in minor, incremental impacts to channels and coastal erosion rates, a negligible impact.

Alternative B: Alternative B-1 is expected to produce negligible impacts on coastal barrier beaches and associated dunes, relative to Alternative A, given that exclusions from specific lightering areas are not expected to concentrate shuttle tanker traffic in specific ports. Alternative B-2 will have negligible impact on coastal barrier beaches and associated dunes above those noted for Alternative A. Alternative B-3 would have no effect on proposed operations elsewhere in the deepwater area and thus no effects on the impacts associated with shuttle tanker traffic discussed under Alternative A. Alternative B-4 has the potential to produce an incremental increase in impacts on coastal barrier beaches and associated dunes above those projected for Alternative A; the extent and significance of impacts caused by these additional harbor transits will depend upon harbor characteristics, vessel hull design, transit speed, and the other factors. Considering the number of additional vessels possible under Alternative B-4, impacts are not expected to be significant.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.4.2 Wetlands

Alternative A - Installation

Installation activities associated with FPSO commissioning will not affect coastal wetlands significantly. There are expected to be slight increases in the number of vessel transits to and from support bases and fabrication yards, resulting in minor incremental impacts to channels and coastal erosion rates. There is the potential for these channel or coastline losses to exacerbate wetland losses, but this potential is considered minimal. Given the limited number of vessels required and the relatively short timeframe for each phase of installation activity, such impacts are short term and extremely localized.

Alternative A - Routine Operations

At this time, it is not known whether any new processing or handling facilities will need to be constructed at any specific port to handle the petroleum products brought to shore by the FPSO shuttle tankers. If new construction were required these construction efforts could potentially increase the cumulative impacts of port activities in the coastal wetlands seen at and near these sites.

Ship traffic within harbors, bays, sounds, and lagoons produces incremental increases in erosion rates, sediment re-suspension, and turbidity (Irvine *et al.*, 1997), all of which produce adverse environmental effects in coastal wetland and submerged aquatic vegetation (seagrass) habitats. Any maintenance dredging operations required to accommodate FPSO-related shuttle tankering in the seven proposed ports may exacerbate adjacent wetland loss. Incremental wetland loss for any reason is a major concern in the Mississippi deltaic complex of Louisiana, which has the highest rate of coastal wetland loss in the nation (U. S. Geological Survey, 1988).

Table 4-29 shows the type of embayment (harbor, estuary, lagoon, or sound) associated with (or in proximity to) each of the proposed shuttle tanker ports and list the type of wetland resources seen in those areas.

Under the base-case scenario an increase of 110 one-way harbor transits per year can be expected at one or a combination of the seven possible shuttle tanker destination ports listed above. This number of new ship transits will undoubtedly produce impacts within the coastal environment. The significance of these impacts will depend upon a number of variables associated with both shuttle tanker design and local conditions at each potential destination port.

Alternative A - Range of Options

Optional scenarios call for as many as five FPSOs to be operating at geographically dispersed areas throughout the northwestern Gulf of Mexico. The rate of offloading for these facilities would be variable (i.e., from once every 10 days up to once per day), based on peak production rate and shuttle tanker size. Assuming that all shuttle tankers will be handled by a combination of the ports noted previously, offloading estimates yield a range of 365 to 685 shuttle tanker harbor transits per year (Section 4.2 and table 4-28). Harbor and channel transits are projected to increase between 1.5 and 3.5 percent above projected non-FPSO tanker activity levels, depending upon production levels, numbers of FPSOs in production, etc. Given these

Table 4-29

Types of Bays, Estuaries, Lagoons, Sounds, and Coastal Wetlands Resources Seen in Proposed Destination Ports for FPSO Shuttle Tankers

Proposed Homeport Area	Type Embayment of Harbor	Wetland Resources
Mississippi River Ports	Extended River Channel	Coastal Wetlands and Marshes
LOOP	Sound	Coastal Wetlands
Lake Charles/Cameron	Estuary With Entrance Channel	Coastal Wetlands and Marshes
Port Arthur/Beaumont	Estuary With Entrance Channel	Coastal Wetlands and Marshes
Houston/Galveston	Bay With Entrance Pass, Barrier Islands, and Extended Canal	Marshes and Seagrass Beds
Freeport	Harbor	Coastal Beaches
Corpus Christi	Bay With Entrance Pass and Barrier Islands	Marshes and Seagrass Beds

projected increases in tankering activity, only minor incremental impacts to channels and coastal erosion are expected. Such impacts are projected to be negligible.

Alternative A - Decommissioning

Decommissioning activities associated with FPSO removal will not affect coastal wetlands. As with installation activities, there are expected to be slight increases in the number of vessel transits to and from support bases and onshore yards (e.g., recycling, reconditioning), resulting in minor incremental impacts to channels and coastal erosion rates. Given the limited number of vessels required and the relatively short timeframe for each phase of decommissioning, such impacts are short term and extremely localized.

Alternative B (B1 through B4)

Alternative B-1, exclusion of FPSOs from designated lightering prohibited areas will have no impacts on coastal wetlands.

Alternative B-2, exclusion of FPSOs from lease areas nearest south Texas (Corpus Christi and Port Isabel lease blocks located nearest to shore), will have no impacts on coastal wetlands. Exclusion from these areas will not in and of itself reduce of eliminate shuttle tanker traffic to any specific port.

Alternative B-3, exclusion of FPSOs from lease areas nearest the Mississippi Delta, will have no effect on proposed operations elsewhere in the Gulf and thus no effects on the impacts associated with shuttle tanker traffic discussed under Alternative A.

Alternative B-4, requiring that an attendant vessel to be present during offloading operations, will have a minor incremental impact on ship traffic through harbor areas above what is projected for the proposed action (Alternative A). The addition of an attendant vessel during offloading will increase slightly the ship traffic entering Gulf ports. Because the attendant vessel will remain on site at the FPSO and will not accompany the shuttle tanker to port, the number of additional vessel trips attributed to the attendant vessel will be determined by how long such a vessel can remain at the FPSO. The exact impacts of these additional vessels on coastal erosion rates and accompanying wetlands loss would depend upon their hull design, speed, and the other factors discussed under Alternative A.

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: Installation activities associated with FPSO commissioning will produce slight increases in the number of vessel transits, resulting in minor incremental impacts to channels and coastal erosion rates, a negligible impact. During routine operations, ship traffic will produce an incremental increase in erosion rates, sediment re-suspension, and turbidity, an adverse but not significant impact to coastal wetland and seagrass habitats. Any new channeling through coastal wetlands would destroy wetlands, and ship traffic within dredged channels would exacerbate adjacent wetlands loss, a potentially significant impact. Under the range of options, increases in shuttle tanker trips into Gulf ports will produce a negligible impact to coastal wetlands. During decommissioning, slight increases in the number of vessel transits will result in minor incremental impacts to channels and coastal erosion rates, a negligible impact.

Alternative B: Alternatives B-1, B-2, and B-3 will have no impact on coastal wetlands above those noted for Alternative A. Alternative B-4 will have a minor incremental impact on ship traffic through harbor areas above what is projected for Alternative A; while the exact nature of such impacts on coastal erosion rates and accompanying wetlands loss are variable (i.e., depending on hull design, speed, and the other factors), impacts are projected to be adverse but not significant.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.5 Offshore Environments

Offshore environments encompass the water column (i.e., phytoplankton, zooplankton, ichthyoplankton) and deep benthic environments, the latter of which is comprised of chemosynthetic communities, soft bottom benthos, and topographic features. Topographic features are located well inshore of the deepwater area of interest, and therefore will not be affected directly by FPSO onsite operations. It is assumed, for the purpose of this analysis, that no topographic features found in deepwater will be within a 1-km (0.6-mi) radius of any FPSO component. Any features deemed significant by the MMS during lease-specific reviews will be avoided; MMS (2000b) discusses several potential mitigation measures relevant to topographic or sensitive hard bottom features (Section 4.1.15).

***Significance Criteria**: An impact on offshore environments (including water column and deep benthic environments [chemosynthetic communities, soft bottom benthos, topographic features]) is considered to be locally **significant** if it is likely to directly or indirectly cause measurable change in 1) species composition or abundance beyond that of normal variability, or 2) ecological function within a species range for 5 years or longer (i.e., long-term). Measurable changes occurring for less than 5 years would be considered short-term, locally significant impacts. For an impact to be locally significant, the extent of the impact would be relatively small compared to total population or community size in the immediate region. The threshold for significance is determined by scientific judgement, and takes into consideration the relative importance of the habitat and/or species affected.*

Impacts of regional significance are judged by the same criteria as those for local significance, except that the impacts cause a change in the ecological function within the population or community. The expected extent of the impact (e.g., total numbers affected), relative to those present in the region, is determined in the same way as that for locally significant impacts. This determination takes into consideration the importance of the species and/or habitat affected and its relative sensitivity to environmental perturbations.

***Terminology and Resource-Specific Definitions:** For offshore environments impact assessment, the term "short term" can be broadly defined as a time period of five years or less, whereas "long term" would include time periods greater than five years. Spatial attributes are not as easily quantified. "Local" (or "localized") impacts can be broadly defined as those that occur in a relatively small area, compared to the broad or limited extent of the community or population of concern. "Regional" impacts would encompass broader areal extent, yet would also consider the extent of the community or population.*

Alternative A - Installation

Installation operations will have minimal impact on the water column environment. Surface discharges of sanitary and domestic waste and bilge water will be rapidly diluted in receiving waters. In very close proximity to the discharge, minor and localized impacts to planktonic communities could be expected.

Soft bottom benthic and chemosynthetic communities could be impacted by installation activities that occur on the seafloor, including those associated with anchoring, structure emplacement, and pipelaying. Anchors from support vessels and pipelaying vessels, as well as the mooring anchors themselves, may cause severe disturbance to small areas of the seafloor, depending upon the dimensions of the anchors being used and the amount (length) of anchor chain resting on the seafloor. Section 4.1 noted that anchor emplacement will produce a corridor measuring 3 to 6 m (10 to 20 ft) wide, up to 61 m (200 ft) long, and 15 to 30 m (50 to 100 ft) into the substrate. Further, anchor chain will be laid on the seafloor for 305 to 710 m (1,000 to 2,000 ft) (toward the FSPO location), to remain in place until proofloading and hookup. With drag anchors, a corridor of disturbance is expected (e.g., 185 to 372 m^2 [2,000 to 4,000 ft^2], per anchor), as the anchors are dragged along the seafloor until sufficiently anchored. Any extra scope (length) of anchor chain will potentially disturb a larger seafloor area than either an anchor alone or an anchor chain with limited scope. For example, MMS (2000b) has estimated that a

50-m (165-ft) radius of chain movement on the bottom around a mooring anchor could destroy communities in an area of nearly 8,000 m^2 (86,800 ft^2) Pipelaying activities in deepwater areas could also adversely affect the benthos; MMS (2000b) has assumed that 0.32 ha of bottom is disturbed per kilometer of pipeline installed. Overall, the total area affected by anchoring operations will depend on water depth, length of chain, size and type of anchor, and ambient current conditions. Disturbance of the seafloor from anchor emplacement and anchor chain movement is attributed to crushing (by the anchor itself) or scraping and scouring (by both the anchor and anchor chains).

Such bottom disturbance is expected to alter the seafloor environment and eliminate or reduce soft bottom infaunal or epifaunal communities in several localized areas. Given the widespread nature of soft bottom communities in the deepwater portions of the Gulf of Mexico, such impacts are considered to be adverse but not significant. The duration of such impact (i.e., alteration of soft bottom benthic communities) will occur throughout installation, continuing through routine production operations and into decommissioning; as a result, they are considered to be long term in nature.

Chemosynthetic communities, in contrast, are not widespread, yet represent unique assemblages. MacDonald *et al.* (1990b) has described four general community types, including communities dominated by: 1) vestimentiferan tube worms (*Lamellibrachia c.f. barhami* and *Escarpia* n.sp.), 2) mytilid mussels, 3) vesicomyid clams (*Vesicomya cordata* and *Calyptogena ponderosa*), and 4) infaunal lucinid or thyasirid clams (*Lucinoma* sp. or *Thyasira* sp.). Damage to or elimination of chemosynthetic communities would be a significant, long-term impact. While the MMS (2000b) has estimated that the impacts to chemosynthetic communities from bottom-disturbing activities are expected to be relatively rare, should they occur, impacts would be quite severe to the immediate area affected. Recovery times could be as long as 200 years for mature tube worm communities. The possibility exists that affected chemosynthetic communities may never recover from such impact. Identification and avoidance of chemosynthetic communities is required under current MMS requirements (i.e., Notice to Lessees [NTL] 98-11). Current practice is to use geophysical survey information to identify potential chemosynthetic habitats. These areas are avoided without verifying the actual presence or absences of a chemosynthetic community. However, hydrocarbon seeps that allow chemosynthetic communities to exist are known to modify the geological characteristics of the seafloor, thereby allowing for remote detection (e.g., precipitation of authigenic carbonate in the form of micronodules, nodules, or rock masses; formation of gas hydrates; modification of sediment composition through concentration of hard chemosynthetic organism remains, such as shell fragments and layers; formation of interstitial gas bubbles or hydrocarbons; formation of depressions or pockmarks by gas expulsion). Potential locations for most types of chemosynthetic communities can be determined by careful interpretation of these various geophysical modifications, but to date, this process remains imperfect. Recent MMS-funded efforts have been directed at improving geophysical interpretation. For example, Sager (1997) has characterized the geophysical responses of seep areas that support chemosynthetic communities in an attempt to refine the protocols associated with geophysical remote-sensing techniques. The purpose of this effort is to locate chemosynthetic communities more reliably.

Benthic communities in close proximity to component emplacement (e.g., anchors, turret, manifolds) will realize some degree of sedimentation from installation activities, as disturbance of the seafloor will temporarily suspend sediments, locally increasing turbidity. Soft bottom communities will only realize negligible impacts from minor increases in sedimentation and turbidity.

In summary, installation operations on the seafloor will result in negligible impacts to soft bottom benthos. Soft bottom benthic communities beneath anchors, turret, and manifolds will be crushed during emplacement, and an area around each anchor will continue to be affected via anchor dragging, depending upon water depth and the amount of anchor chain scope allowed. Anchor chains temporarily laid on the seafloor will also disturb the benthos along each corridor from the anchors toward the FPSO or turret location. Areas disturbed by temporary anchoring or equipment deployment will recolonize following temporary anchor or equipment removal, typically within days to several years (depending upon the species). Where areas of the seafloor are buried (from furrows or suspended sediments), recolonization of the benthos will occur from neighboring substrate. In contrast, chemosynthetic communities could potentially realize significant impacts from anchor, turret, and manifold emplacement. Identification and avoidance of such communities, per NTL 98-11, should eliminate or significantly reduce the potential for such impact.

Discharges from various installation vessels (e.g., sanitary and domestic wastes, bilge water) will be rapidly diluted in surface and near surface waters (i.e., to ambient levels within several thousand meters of the discharge), and will not reach the benthos. During installation, the possibility exists that equipment or supplies might be lost overboard. Impacts to the benthos from lost equipment would be negligible and very localized.

Alternative A - Routine Operations

Routine operations will have minimal impact on the water column environment. Continuous or frequent intermittent discharges of produced water, sanitary and domestic waste, and minor discharges will occur during the life of the field, with effluent limits established under an NPDES permit or Coast Guard regulations. Such discharges become rapidly diluted in the water column, mixing with ambient water through current action and natural dispersion. Instantaneous or extremely short-term exposure to such discharges in the very near field can be expected to cause limited mortality to a small percentage of the planktonic community, a negligible impact.

Once installation of bottom-founded structures is completed, seafloor impacts will have already occurred. Anchor scraping and scouring of the seafloor will continue throughout routine operations, for as long as anchor chains touch the seafloor. The presence of structures on the seafloor during routine operations will have negligible impacts to soft bottom benthos; epifauna and infauna immediately beneath such structures will be crushed. Bottom-founded structures may provide hard substrate for epifaunal attachment, possibly a beneficial impact, although colonization rates in the deep sea are considerably slower than those evident in shallow, shelf environments. During routine operations, periodic inspection of FPSO components on the seafloor is expected (via ROV) which may cause limited, localized bottom disturbance, a negligible impact. Benthic communities beneath anchors, turret, and manifolds will have already been crushed; recolonization of disturbed areas is expected during the first several years following FPSO installation and operation.

Discharges from the FPSO and associated vessels will be rapidly diluted, with minimal impact on the water column and benthic environments. In very close proximity to the discharge, minor and localized impacts to planktonic communities could be expected; this will be a negligible impact.

During routine operations, it is quite likely that equipment or supplies might be lost overboard during transport, transfer, or daily operations. With such loss, impact to the benthos would be negligible and very localized.

Alternative A - Range of Options

The vast majority of the options identified will have no effect on either impact-producing factors or subsequent impacts to resources of the offshore environment. For example, subsea systems and riser options do not directly or indirectly affect the benthos beyond those impacts associated with the base-case scenario. Changes in production rates or turret and fluid transfer systems will not alter identified impacts, beyond those associated with increased or decreased risk of accidental releases.

Only one of the options has the potential to affect the benthic environment. Alteration of vessel mooring characteristics may reduce impacts to the benthos. The selection of drag anchors under the base-case scenario produces the greatest impacts to the seafloor and associated infaunal and epifaunal communities, as a larger area of soft bottom is affected during anchor dragging and final emplacement. Use of either suction pile or driven pile anchoring techniques may slightly reduce impacts by reducing the total amount of seafloor area affected.

With the exception of increased daily production, none of the available options will either increase or decrease the projected volumes of water-borne discharges, leaving impacts to the water column environment unchanged from the base-case scenario. With increased daily production levels, total amounts of produced water and other production-based discharges will increase. Such increases will produce only negligible impacts to water column resources and are not expected to affect the benthos. Increases in production are not expected to prompt increased manning levels, thus domestic discharges and their associated impacts are not expected to increase above the base-case scenario.

Alternative A - Decommissioning

In similar fashion to installation, decommissioning operations will have minimal impact on the water column environment. Surface discharges of sanitary and domestic waste and bilge water from decommissioning vessels will be rapidly diluted in receiving waters. In very close proximity to these discharges, minor and localized impacts to planktonic communities could be expected, a negligible impact.

It is unlikely that soft bottom benthic and chemosynthetic communities will be adversely affected, beyond localized areas where temporary anchoring activities may occur. Any anchoring will result in small, locally severe disturbance to the seafloor, depending upon the dimensions of the anchors being used and the amount (length) of anchor chain resting on the seafloor. Structure removal will produce increases in turbidity through resuspension of benthic sediments. Benthic communities in close proximity will realize some degree of sedimentation from removal operations; such bottom disturbance has a very limited potential to significantly alter the seafloor environment. Such impacts are considered to be negligible. The duration of such impact will extend throughout decommissioning.

It is expected that chemosynthetic communities in the vicinity of FPSO operations will be properly identified and described, and that appropriate avoidance measures will be implemented per NTL 98-11. Any damage to or elimination of chemosynthetic communities would be considered a significant, long-term impact.

In summary, decommissioning operations on the seafloor will result in negligible impacts to soft bottom benthos. Soft bottom benthic communities previously located beneath anchors, turret, and manifolds will recolonize the area once each structure is removed. In contrast, chemosynthetic communities could potentially realize significant impacts from any anchoring activity if not properly located and characterized. Identification and avoidance of such communities, per NTL 98-11, should eliminate or reduce the potential for such impact.

Discharges from various decommissioning vessels (e.g., sanitary and domestic wastes, bilge water) will be rapidly diluted in surface and near surface waters, and will not reach the benthos. During decommissioning, the possibility exists that equipment or supplies might be lost overboard. Impact to the benthos from lost equipment would be negligible and very localized. Structures which are abandoned in place will not result in significant impacts to the benthos.

Alternative B (B1 through B4)

Alternative B-1, exclusion of FPSOs from designated lightering prohibited areas, will have no impact on offshore environments. Operations located further offshore will not adversely affect offshore environments.

Alternative B-2, exclusion of FPSOs from lease areas nearest south Texas (Corpus Christi and Port Isabel lease blocks located nearest to shore), will have no impact on offshore environments. Alternative B-3, exclusion of FPSOs from lease areas nearest the Mississippi Delta, similarly, would have no impact on offshore resources.

Alternative B-4, requirement for an attendant vessel to be present during offloading operations, may produce a slight increase in impact to both water column and deep benthic environments. These would be incremental impacts above what is projected for the proposed action (Alternative A). An attendant vessel is expected to discharge wastes, with daily volumes expected to be similar to a supply vessel. This incremental increase in discharges is minor, and impacts to plankton will remain negligible. Impacts of an attendant vessel on the benthos center on the need for additional anchoring capability at the FPSO site. If a dedicated anchor is required, additional, minor anchor impacts are predicted. Impacts to benthic communities would remain adverse but not significant.

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives

B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: During installation, surface discharges will produce negligible impacts to planktonic communities. Anchoring, subsea equipment emplacement, FPSO emplacement, and pipelaying will produce adverse but not significant impacts to soft bottom benthic communities. Because of their unique nature, chemosynthetic communities must be properly identified and avoided. With proper avoidance, impacts to chemosynthetic communities from installation activities will be negligible. However, if chemosynthetic communities remain undetected, or if they are detected but are damaged during installation, such damage to (or elimination of) chemosynthetic communities would represent a significant, long-term impact. Discharges from installation operations will be rapidly diluted and will not reach the benthos (i.e., no impact). During installation, the loss of equipment or supplies overboard will result in a negligible impact to the benthos. During routine operations, discharges can be expected to cause limited mortality to the planktonic community, a negligible impact. Anchor scraping and scouring of the seafloor will continue throughout routine operations, a negligible impact. The presence of structures on the seafloor during routine operations will have negligible impacts to soft bottom benthos. Bottom-founded structures may provide hard substrate for epifaunal attachment, possibly a beneficial impact. During routine operations, periodic inspection via ROV will cause limited, localized bottom disturbance, a negligible impact. Benthic communities beneath anchors, turret, and manifolds will have already been crushed; recolonization of disturbed areas is expected during the first several years following FPSO installation and operation. Loss of equipment or supplies overboard will result in a negligible and very localized impact to the benthos. Most of the optional scenarios considered under the range of options will have no effect on benthic resources beyond those associated with the base-case scenario. Only one of the options has the potential to affect the benthic environment – alteration of vessel mooring characteristics. Use of either suction pile or driven pile anchoring techniques may slightly reduce impacts to the benthos by reducing the total amount of seafloor area affected. Increases in daily production will prompt incremental increases in the total amount of produced water and other production-based discharges, resulting in negligible impacts to water column resources. During decommissioning, surface discharges will have a negligible impact on the water column environment. Soft bottom benthic and chemosynthetic communities will not be adversely affected, beyond localized areas where temporary anchoring activities may occur, a negligible impact. As with installation, any damage to or elimination of chemosynthetic communities from decommissioning operations would be considered a significant, long-term impact. Discharges from various decommissioning vessels will not reach the benthos (i.e., no impact). Equipment or supplies lost overboard will result in a negligible and very localized impact on the benthos. Subsea equipment abandoned in place will result in negligible impacts on the benthos.

Alternative B: Alternatives B-1, B-2, and B-3 will have no impact on offshore resources above those noted for Alternative A. Alternative B-4 may produce a slight increase in impact to both water column and deep benthic environments above those noted for Alternative A. This incremental increase in discharges is minor, and impacts to plankton will remain negligible. If a dedicated anchor is required, additional, minor anchor impacts are predicted. Impacts to benthic communities would remain adverse but not significant.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.6 Marine Mammals

Significance Criteria: *Any impact is* ***significant*** *if: a) the potential biological removal (PBR) level is exceeded for any marine mammal stock (i.e., any mortality or serious injury would be considered an exceedance of the PBR level for any strategic stock or listed species); or b) any listed species or strategic stock is displaced from critical habitat (or key habitat if critical habitat is not formally designated) for any length of time; or c) there is long-term or permanent displacement of any species from preferred feeding, breeding, or nursery habitats (other than critical habitat); or d) there is a substantial (or chronic) disruption of behavioral patterns to an extent that may adversely affect a species or stock through effects on annual rates of recruitment or survival. Any impact is* ***adverse but not significant*** *if; a) mortality or serious injury occurs to marine mammals, but not in excess of the PBR (i.e., no deaths or serious injuries of strategic stocks or listed species); or b) there is a short-term displacement of marine mammals from preferred feeding, breeding, or nursery grounds (but not critical habitat); or c) there is some disruption of behavioral patterns, but to an extent that is unlikely to adversely affect a species or stock through effects on annual rates of recruitment or survival. Any is* ***negligible*** *if there is: a) no mortality or serious injury to any marine mammal; or b) no displacement of listed species or strategic stocks from critical habitat; or c) no displacement of any species from preferred feeding, breeding, or nursery grounds; or d) little or no disruption of behavioral patterns or other sublethal effects.*

Terminology and Resource-Specific Definitions: *For marine mammal impact assessment, a "short term" impact can be defined as infrequent and temporary, one which is characterized by sudden onset and short duration. Short-term impacts may occur within fixed and varied geographic locations. Considering the average life spans of marine mammals, the duration of a short-term impact would be one which may last seconds, hours, or perhaps even up to several days. A "long term" impact is an impact or series of impacts which is characterized by long duration or frequent reoccurrence, typically within a specific geographic location. Considering the average life spans of* *marine mammals, the duration of a long-term impact would be one which may last an appreciable fraction of an individual animal's lifetime (i.e., perhaps months to years). A "local" (or "localized") impact is one which occurs within a defined location, is not widespread or general in extent, and affects only restricted numbers of individuals of one or more species but is unlikely to affect the population status of the impacted species or stock of a species. A "regional" impact is one which may affect the status of a species or local stock of a species. The areal extent of a regional impact may vary greatly, ranging from a broad geographic area (one which encompasses one or more ecological habitats or systems) to a much smaller area, as in the case where a species, stock, or a life stage of a species is concentrated into a relatively small area (e.g., sperm whales off the Mississippi River Delta). A "strategic stock" includes those stocks that are not listed under the Endangered Species Act but that have estimated human-caused mortality greater than PBR. The term "population stock" or "stock" means a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature. The term "PBR" refers the total number of individuals of a particular species (or stock) that may be removed without seriously and irreversibly affecting that species' ability to maintain itself.*

Alternative A - Installation

Impact-producing factors that may affect marine mammals as a result of the installation of an FPSO system in the Central and Western Planning Areas of the Gulf of Mexico include: degradation of water quality resulting from discharges from OCS service and construction vessels; noise from helicopter and OCS support vessels; collisions with OCS vessel traffic; and ingestion of, or entanglement in, debris accidentally lost overboard.

The major operational discharges generated during installation of offshore FPSO systems include sanitary and domestic wastes and limited operational wastes (e.g., bilge water). All operational wastes will be treated or monitored for relative levels of contaminants prior to discharge, and plumes of released wastes mix rapidly with ambient seawater and are thus diluted. The bilge water within these vessels may contain some quantity of machinery waste oil. The type and quantity of fluid waste discharge permitted from vessels offshore is a function of the distance of the vessel from shore, according to international protocols provided by MARPOL 73/78 (33 CFR 157). It is anticipated that the FPSO system will be installed at a distance from shore which would permit the discharge of waste fluids from these vessels. The proposed action predicts that installation activities will require ten weeks to complete. There will be one service vessel visit to the site per week, one cargo barge and attendant tug on site, and one cargo barge and attendant tug visit per week during this period. Fluid wastes from these vessels, when permitted, will be released into the open ocean where it is expected they will be diluted and dispersed rapidly (i.e., to ambient levels within several thousand meters of the discharge). With this anticipated level of vessel traffic and discharge, it is expected that the impacts of fluid waste discharges from OCS service and construction vessels to marine mammals will be negligible.

All sanitary and domestic wastes will either be treated or monitored for relative levels of contaminants prior to discharge. Plumes of released wastes mix rapidly with ambient seawater and are thus diluted. Discharges will be released within oceanic waters of the Gulf and are therefore not expected to impact marine mammals.

OCS logistic support helicopters and service and construction vessels can affect marine mammals from machinery noise and/or visual disturbances (Richardson *et al.*, 1995). Noise from vessels and helicopters is typically in the lower frequency ranges (e.g., 10 to 200 Hz for vessels). Potential responses of marine mammals to noise have been defined by Richardson *et al.* (1995). The four zones of potential noise effects on marine mammals (in order of decreasing severity) include:

- Hearing loss, discomfort, and injury (physical effects);
- Auditory masking;
- Responsiveness (behavioral effects); and
- Audibility.

These categories provide a useful framework for discussing impacts of noise on GOM marine mammals. Audibility *per se* is not an impact and will not be discussed. At the other end of the "effects spectrum," physical impacts of noise may range from temporary hearing impairment to gross physical injury. Given the sound intensity levels characteristic of these noise sources, and considering the continuous and transient nature of the sound, vessels and helicopters will not produce gross physical damage in marine mammals; further, these sources will not produce discomfort or injury. Auditory masking occurs when a sound signal that is of importance to a marine mammal (e.g., communication calls, echolocation, environmental sound cues) is rendered undetectable due to the high noise-to-signal ratio in a relevant frequency band. In the case of vessel or helicopter noise, masking may occur for brief periods (e.g., during passage of the vessel or helicopter; tens of seconds to several minutes) within proximity to the sound source (i.e., within 100 m [328 ft] or less). Under such circumstances, the effect of masking is likely to be extremely low and restricted to those groups with low-frequency hearing capabilities (i.e., mysticetes). Available data on behavioral effects from various noise sources (e.g., continuous platform noise, intermittent seismic noise, etc.) has been compiled by Richardson *et al.* (1995). In most cases, the biological importance of such responses (e.g., effects on energetics, survival, reproduction, population status) are not known.

The degree of impacts associated with aircraft and vessel traffic appear to be highly variable, though transient, and may cause short-term behavioral changes such as disruption of activities or departure from the area of disturbance (Davis and Fargion, 1996). Although areas with heavy vessel traffic may not be avoided by marine mammals, generally most species exhibit considerable tolerance to ship and aircraft noise. Helicopters and vessels associated with installation of an FPSO system will originate from coastal ports and travel across the continental shelf to the project area, located within oceanic waters. In addition, activities involving the laying of a gas export line will involve operations across the continental shelf and into coastal waters. Therefore, the effects of sound generated from these activities by helicopters and vessels may impact any marine mammal species which is known to occur within the Central and Western Gulf of Mexico. However, activities associated with the installation phase of FPSO components are relatively short-term in duration. Therefore, impacts to oceanic cetaceans resulting from sounds produced by OCS helicopter and vessel traffic are expected to be adverse but not be significant.

The expected increase in OCS service vessel and construction vessel traffic associated with the installation of the FPSO system may also increase the likelihood of collisions between these vessels and marine mammals. The risk of collisions may vary, depending upon the species of marine mammal, behavioral attributes, location, and during vessel operations conducted at night and during other periods of reduced visibility. Certain marine mammals, such as deep diving cetacean species which spend extended periods of time at the surface prior to or following their dives (such as sperm whales), may be particularly vulnerable to collisions with offshore vessels in oceanic waters. Within inshore waterways and coastal waters, the manatee (when present), may also be particularly vulnerable. Operations within certain OCS areas may also pose greater risk for collision with the aforementioned groups. For example, the continental slope and submarine canyon areas south of the Mississippi River delta may support a resident population of sperm whales. Collisions with a single marine mammal which is currently listed as an endangered species, such as the sperm whale, would constitute a significant impact. A collision with a nonlisted species would be considered adverse, but not locally or regionally significant, if the take does not exceed current PBR levels.

Ingestion of, or entanglement with, accidentally lost solid debris associated with the installment phase of a FPSO system can adversely impact marine mammals. Ingestion of plastic debris can impact the alimentary canal or remain within the stomach. Entanglement in plastic debris can result in reduced mobility, drowning, and constriction of and subsequent damage to limbs (MMC, 1998). Currently, the discharge or disposal of solid debris from both OCS structures and vessels is prohibited by the MMS to lessees (30 CFR 250.40) and Coast Guard (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Therefore, accidental loss of debris from FPSO installations is not expected to adversely affect marine mammals in the Gulf of Mexico.

Alternative A - Routine Operations

Major impact-producing factors affecting marine mammals as a result of routine operations of FPSO systems in deepwater environments of the Central and Western Planning Areas of the Gulf of Mexico include: degradation of water quality resulting from operational discharges, including possible discharges from additional drilling and downhole workover operations subsequent to installation; noise from OCS support helicopters, service vessels, and shuttle tankers; collisions with OCS service vessels and shuttle tankers; and ingestion of, or entanglement in, debris that has been accidentally lost overboard.

Major operational wastes generated during offshore oil and gas development include produced waters. Other wastes include: produced sand; workover fluids; deck drainage; miscellaneous well fluids (e.g., cement); sanitary and domestic wastes; gas and oil processing wastes; ballast water; and storage displacement water. Many of these operational discharges include components or compounds which may be injurious to marine mammals. However, most operational waste fluids are treated and/or monitored for relative levels of oil and grease, and priority contaminants prior to discharge. In addition, resultant plumes of released wastes mix rapidly with ambient seawater and are thus diluted. Produced solids are not discharged. Discharged fluids may, however, have sublethal effects on oceanic cetaceans under certain circumstances. These effects may be indirect, as a result of the impacts of the discharges on prey species (reduction in prey), or possibly direct, through prolonged exposure to the discharge or through the ingestion of affected prey species. However, based on the low concentrations of contaminants discharged, the rapid dilution of discharged fluid plumes in offshore waters, and the short-term duration of possible drilling operations, impacts to marine mammals associated with the release of operational discharges are expected to be negligible.

Operational discharges from OCS service vessels and shuttle tankers include bilge and ballast waters, and sanitary and domestic wastes. The bilge and ballast waters within these vessels may contain some quantity of machinery waste oil or residual storage tank oil, respectively. The type and quantity of fluid waste discharge from vessels offshore is a function of the distance of the vessel from shore, according to international protocols provided by MARPOL 73/78 (33 CFR 157). Furthermore, there are limitations to discharges of bilge and ballast waters from oil tankers, with requirements in place for terminal areas to maintain onshore receptacles to receive these wastes. It is anticipated that the FPSO system will operate at a distance from shore where it is permitted to discharge fluid wastes under effluent limitations established by Coast Guard. These wastes will be released into the open ocean where it is expected they will dilute and be dispersed rapidly. The proposed action predicts approximately one supply boat trip per week. The expected range of operations for shuttle tanker trips is once a day to once every 10 days during the entire field life, with the base-case scenario establishing one shuttle tanker visit every third day. Assuming this level of vessel traffic, it is not expected that fluid waste discharges from these sources will adversely or significantly impact marine mammals (i.e., impact is negligible).

OCS helicopters, service vessels, and shuttle tankers can affect marine mammals from machinery noise and/or visual disturbances (Richardson *et al.*, 1995). The degree of impacts associated with helicopter and vessel traffic appear to be highly variable, though transient, and may cause short-term behavioral changes such as disruption of activities or departure from the area of disturbance (Richardson *et al.*, 1995). Although areas with heavy vessel traffic may not be avoided by marine mammals, generally most species exhibit considerable tolerance to ship and aircraft noise. It is possible that marine mammals may move toward a noise source that may adversely affect their hearing abilities; however, the transitory nature of the noise sources associated with the proposed operations reduces the potential for serious hearing effects.

Helicopters and vessels associated with routine operations of a FPSO system will originate from coastal ports and travel across the continental shelf to the project area, located within oceanic waters. Therefore, the effects of sound generated from these activities by OCS helicopter and vessel traffic may impact any marine mammal species which is known to occur within the Central and Western Gulf of Mexico. The proposed action predicts approximately two to three helicopter flights per week, one supply boat trip per week, and two to three shuttle tanker trips per week during the entire field life. Such sources produce sound of a continuous, but transitory, nature in the low frequency range. Assuming this level of helicopter and vessel traffic, it is expected that impacts on marine mammals resulting from sounds produced from these sources may, under some circumstances, result in the temporary displacement of certain individuals or groups. Therefore, impacts from OCS helicopter and vessel traffic are considered adverse but not significant.

The expected increase in OCS service vessel and shuttle tanker traffic associated with normal operations of the FPSO system may increase the likelihood of collisions between these vessels and marine mammals. The risk of collisions may vary, depending upon the species of marine mammal, behavioral attributes, location, and during vessel operations conducted at night and during other periods of reduced visibility. It is also possible that species that normally inhabit deeper water may move into shallower water. Certain marine mammals, such as deep diving cetacean species which spend extended periods of time at the surface (such as sperm whales), may be particularly vulnerable to collisions with offshore vessels in oceanic waters. Within inshore waterways and coastal waters, the manatee (when present), may also be particularly vulnerable. Operations within certain OCS areas may also pose greater risk for collision with the aforementioned groups. For example, the continental slope and submarine canyon areas south of the Mississippi River delta may support a resident population of sperm whales. Collisions with a single marine mammal which is currently listed as endangered species, such as the sperm whale, would constitute a significant impact. A collision with a nonlisted species would be considered adverse, but not locally or regionally significant.

Ingestion of, or entanglement with, solid debris (accidentally lost overboard) associated with normal operations of the FPSO system can adversely impact marine mammals. Ingestion of plastic debris can impact the alimentary canal or remain within the stomach. Entanglement in plastic debris can result in reduced mobility, drowning, and constriction of and subsequent damage to limbs (MMC, 1998). Currently, the discharge or disposal of solid debris from both OCS structures and vessels is prohibited by the MMS to lessees (30 CFR 250.40) and Coast Guard (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Therefore, debris that has been accidentally lost overboard during the operations phase of the FPSO is not expected to adversely affect marine mammals in the Gulf of Mexico (i.e., impacts are negligible).

Alternative A - Range of Options

Two variables considered in the range of options may affect marine mammals in the Gulf of Mexico. These include varied water depth and active or assisted weathervaning methods.

Survey data suggest that marine mammals which are known to occur within the Gulf of Mexico show marked depth preferences in their distributions. Continental shelf waters are inhabited almost exclusively by only two species: Atlantic spotted dolphins and bottlenose dolphins. The manatee is normally limited to nearshore waters and inshore waterways and embayments. The majority of other marine mammal species which occur within the Gulf are typically sighted within waters near the offshore boundary of the continental shelf (i.e., near the shelf edge) and over the continental slope. FPSO activities which may be established within the shallowest depths indicated in the range of operations (i.e., ~183 m [600 ft]) will be located on the outer continental shelf edge. Therefore, operations in these areas may be slightly shallower than the preferred depth range of many of the marine mammal species which occur in the Gulf.

Active, or assisted FPSO vessel weathervaning will involve the use of thrusters onboard the FPSO storage vessel or support vessel propulsion, respectively. These activities will generate additional subsea mechanical noise during their intermittent or occasional operation, which may occur at random times. This potential additional source of subsea noise may impact marine mammals in the immediate vicinity of the FPSO. Given their ability to move away from noise sources, marine mammal exposure to sources of additional noise is considered to be a negligible impact. While it is possible that marine mammals may move toward a noise source that may adversely affect their hearing abilities, the transitory nature of the noise sources is expected to result in negligible impact.

Alternative A - Decommissioning

Major impact-producing factors affecting marine mammals as a result of the decommissioning and removal of FPSO systems in the Central and Western Planning Areas of the Gulf of Mexico include: discharges from service and construction vessels associated with decommissioning activities; noise generated from OCS helicopters, service and construction vessels, and mobile offshore drilling units (MODUs) used to remove wellheads and manifold jumpers; collisions with OCS vessel traffic; and ingestion of, or entanglement in, debris that has been accidentally lost overboard.

Operational discharges from OCS service and construction vessels include bilge and ballast waters, and sanitary and domestic wastes. The bilge water within these vessels may contain some quantity of machinery waste oil. The type and quantity of fluid waste discharged from vessels offshore is a function of the distance of the vessel from shore, according to international protocols provided by MARPOL 73/78 (33 CFR 157). It is anticipated that the FPSO system will be located at a distance from shore where it is permitted to discharge fluid wastes from vessels. However, these wastes will be released into the open ocean where it is expected they will be diluted and dispersed rapidly. The proposed action predicts approximately one supply boat trip per week, one cargo barge and attendant tug on site for three weeks, and two cargo barge and attendant tug trips during the three-week decommissioning and removal period. Assuming this level of vessel traffic, it is not expected that fluid waste discharges from these sources will adversely or significantly impact marine mammals during the FPSO decommission and removal phase (i.e., impacts are negligible).

During the decommissioning phase, a MODU will be used to plug subsea wells and remove wellheads and manifold jumpers. During these operations, it is expected that the drilling facility will produce a broad array of sounds at frequencies and intensities which may be detected by oceanic cetaceans within the project area (Geraci and St. Aubin, 1987). These sounds could directly and adversely affect cetaceans by: physically injuring their hearing; producing behavioral or physiological disturbances which may disrupt normal activities or lead to short- or long-term displacement from areas which may be important for feeding or reproduction; or masking their ability to utilize (i.e., receive) sounds produced for echolocation or communication (Richardson *et al.*, 1995). Sound may also disperse potential cetacean prey species (NRC, 1994). The response threshold of oceanic cetaceans in open ocean conditions to sounds typical of offshore drilling operations is poorly known for most species. Data suggest that subsequent to an initial behavioral response to a sound source, the response of cetaceans may vary depending upon whether they become habituated or sensitized to the source (Richardson *et al.*, 1995). Subsea activities associated with the decommissioning and removal phase of an FPSO system are expected to take approximately three weeks. Therefore, impacts to oceanic cetaceans resulting from sounds produced during subsea decommission and removal operations are expected to be locally adverse but not significant.

OCS helicopters, and service and construction vessels can affect marine mammals from machinery noise and/or visual disturbances (Richardson *et al.*, 1995). The degrees of impact associated with helicopter and vessel traffic appear to be highly variable, though transient, and may cause short-term behavioral changes such as disruption of activities or departure from the area of disturbance (Davis and Fargion, 1996). Although areas with heavy vessel traffic may not be avoided by marine mammals, generally most species exhibit considerable tolerance to ship and aircraft noise. Helicopters and vessels associated with the decommissioning and removal of an FPSO and its components will originate from coastal ports and travel across the continental shelf to the project area, located within oceanic waters. Therefore, the effects of sound generated from these activities by helicopters and vessels may impact any marine mammal species which is known to occur within the Central and Western Gulf of Mexico. The proposed action predicts approximately two helicopter trips per week, one supply boat trip per week, one cargo barge and attendant tug on site for three weeks, and two cargo barge and attendant tug trips during the three-week decommissioning and removal period. Therefore, assuming this level of helicopter and vessel traffic, impacts to marine mammals resulting from sounds produced by these sources during the decommissioning and removal phase are expected to be adverse but not significant.

The expected increase in OCS service vessel and construction vessel traffic associated with the decommissioning and removal of the FPSO system may increase the likelihood of collisions between these vessels and marine mammals. The risk of collisions may vary, depending upon the species of marine mammal, behavioral attributes, location, and vessel operation limitations (e.g., vessel operations at night and during other periods of reduced visibility). Certain marine mammals, such as deep diving cetacean species which spend extended periods of time at the surface (such as sperm whales), may be particularly vulnerable to collisions with offshore vessels in oceanic waters. Within inshore waterways and coastal waters, the manatee (when present), may also be particularly vulnerable. Operations within certain OCS areas may also pose greater risk for collision with the aforementioned groups. For example, the continental slope and submarine canyon areas south of the Mississippi River delta may support a resident population of sperm whales. Collisions with a single marine mammal which is currently listed as an endangered species, such as the sperm whale, would constitute a significant impact. A collision with a nonlisted species would be considered adverse, but not locally or regionally significant.

Ingestion of, or entanglement with, solid debris (accidentally lost overboard) associated with the decommissioning and removal phase of a FPSO system can adversely impact marine mammals. Ingestion of plastic debris can impact the alimentary canal or remain within the stomach. Entanglement in plastic debris can result in reduced mobility, drowning, and constriction of and subsequent damage to limbs (MMC, 1998). Currently, the discharge or disposal of solid debris from both OCS structures and vessels is prohibited by the MMS to lessees (30 CFR 250.40) and Coast Guard (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Therefore, debris that has been accidentally lost overboard from FPSO decommissioning and removal are not expected to adversely affect marine mammals in the Gulf of Mexico (i.e., impacts are negligible).

Alternative B (B1 through B4)

Alternative B-1, the exclusion of the FPSO system and operations from designated lightering prohibited areas, will not alter impacts to marine mammals in the Gulf of Mexico as described in Alternative A. There is no evidence that these lightering prohibited areas either exclude or attract marine mammals (and, thus, may be considered preferred or critical habitats) when compared to surrounding waters.

Alternative B-2, the exclusion of the FPSO system from lease areas nearest south Texas (Corpus Christi and Port Isabel lease blocks located nearest to shore), will not produce additional impacts to marine mammals in the Gulf of Mexico. As mentioned above, there is no evidence that these specific lease blocks are considered preferred or critical habitats to marine mammals.

Alternative B-3, exclusion of the FPSO system from lease areas near the Mississippi Delta, may effectively mitigate potential impacts of FPSO activities on local deepwater marine mammal species, especially the endangered sperm whale. These waters are considered to support a resident population of sperm whales.

Alternative B-4, the requirement for an attendant vessel to be present during offloading operations, has the potential for minor impacts to marine mammals. The attendant vessel will generate additional subsea mechanical noise during its operation, along with additional overboard discharge of waste fluids and bilge water. This potential additional source of subsea noise and discharged contaminants may sublethally impact marine mammals in the immediate vicinity of the FPSO system. However, the impacts to marine mammals resulting from these sources of additional noise or discharges are not considered to be significant.

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: During installation, operational discharges will produce negligible impacts to marine mammals. Noise and/or visual disturbance to marine mammals from support helicopters and service and construction vessels can be highly variable, is normally transient, and may cause short-term behavioral changes. Such impacts are considered to be adverse but not be significant. Impacts to marine mammals from the ingestion of, or entanglement with, solid debris (accidentally lost overboard) associated with the installation will be negligible. During routine operations, operational discharges are expected to produce negligible impacts on marine mammals. Noise and/or visual disturbances from helicopters, service vessels, and shuttle tankers are expected to produce adverse but not significant impacts to marine mammals. Expected increases in service vessel and shuttle tanker traffic associated with normal operations may increase the likelihood of collisions between these vessels and marine mammals. The risk of collisions may vary, depending upon the species of marine mammal, behavioral attributes, location, and characteristics of vessel operations. Collisions with a single marine mammal which is currently listed as endangered species, such as the sperm whale, would constitute a significant impact. A collision with a nonlisted species would be considered adverse, but not locally or regionally significant. Ingestion of, or entanglement with, solid debris (accidentally lost overboard) associated with normal operations will produce a negligible impact to marine mammals. Under the range of options, two variables may affect marine mammals in the Gulf of

Mexico – water depth and active or assisted weathervaning methods. FPSO activities which may be established within the shallowest depths (i.e., 183 m [~600 ft]) will be located on the deeper portions of the outer continental shelf. Therefore, operations in these areas may be slightly shallower than the preferred depth range of many of the marine mammal species which occur in the Gulf; as a result, the potential for impact (e.g., collision) increases slightly. Active, or assisted FPSO vessel weathervaning and the associated use of thrusters will generate additional subsea mechanical noise during normal operations. Given their ability to move away from noise sources, marine mammal exposure to sources of additional noise is considered to be a negligible impact. While it is possible that marine mammals may move toward a noise source that may adversely affect their hearing abilities, the transitory nature of the noise sources associated with decommissioning is expected to result in negligible impact. During decommissioning, discharges from service and construction vessels will produce negligible impacts to marine mammals. Noise from helicopters, service and construction vessels, and drilling units will produce locally adverse but not significant impacts to oceanic cetaceans. Expected increases in service vessel and construction vessel traffic may increase the likelihood of collisions between these vessels and marine mammals. Collisions with a single marine mammal which is currently listed as an endangered species would constitute a significant impact. Collision with a nonlisted species would be considered adverse, but not locally or regionally significant. Ingestion of, or entanglement with, solid debris (accidentally lost overboard) is expected to produce only negligible impacts on marine mammals.

Alternative B: Alternatives B-1 and B-2 will not alter impacts on marine mammals, as defined under Alternative A. Alternative B-3 may effectively mitigate potential impacts of FPSO activities on local deepwater marine mammal species, especially the endangered sperm whale. Alternative B-4 has the potential for minor impacts on marine mammals; however, the impacts from additional noise or discharges are considered to range from negligible to adverse but not significant.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.7 Sea Turtles

Significance Criteria: *Any impact is* ***significant*** *if: a) the species-specific jeopardy threshold level is exceeded for any sea turtle; or b) there is any displacement of sea turtle species from critical habitat (or key habitat, in the absence of a formally designated critical habitat); or c) there is a long-term or permanent displacement of any sea turtle species from preferred feeding, breeding, or nursery habitats (other than critical habitat); or d) there is a substantial (or chronic) disruption of behavioral patterns to an extent that may adversely affect a species or stock through effects on annual rates of recruitment or survival. Any impact is* ***adverse but not significant*** *if there is: a) mortality or serious injury to sea turtles, but not exceeding jeopardy threshold standards; or b)* *short-term displacement of sea turtles from preferred feeding, breeding, or nursery grounds (but not critical habitat); or c) some disruption of behavioral patterns, but to an extent that is unlikely to adversely affect a species or stock through effects on annual rates of recruitment or survival. Any impact is **negligible** if there is: a) no mortality or serious injury to any sea turtle; or b) no displacement of any species from critical habitat; or c) no displacement of any species from preferred feeding, breeding, or nursery grounds; or d) little or no disruption of behavioral patterns or other sublethal effects.*

Terminology and Resource-Specific Definitions: *For sea turtle impact assessment, the spatial and temporal definitions are similar to those noted for marine mammals. A "short-term" impact is one that is infrequent and temporary, characterized by sudden onset and short duration, and occurring within either fixed or varied geographic locations; the duration of a short-term impact ranges from seconds to several days. A "long-term" impact is one or a series of impacts characterized by long duration or frequent reoccurrence, typically within a specific geographic location; the duration of a long-term impact may represent an appreciable fraction of an individual animal's lifetime (i.e., perhaps months to years). A "local" (or "localized") impact is one that occurs within a defined location, is not widespread or general in extent, and affects only restricted numbers of individuals of one or more species but is unlikely to affect the population status of the impacted species or stock of a species. A "regional" impact is one that may affect the status of a species or local stock of a species. The areal extent of a regional impact may vary greatly, ranging from a broad geographic area (one that encompasses one or more ecological habitats or systems) to a much smaller area, as in the case where a species, stock, or a life stage of a species is concentrated into a relatively small area.*

Alternative A - Installation

Impact-producing factors that may affect sea turtles as a result of installation of an FPSO system in the Central and Western Planning Areas of the Gulf of Mexico include: degradation of water quality resulting from discharges from drilling operations and OCS service and construction vessel discharges; noise from helicopters and OCS vessels; collisions with OCS vessel traffic; destruction of nearshore and coastal habitat from the installation of a new OCS pipeline landfall; and ingestion of, or entanglement in, debris that may accidentally be lost overboard.

The major operational discharges generated during installation of offshore FPSO systems include sanitary and domestic wastes and limited operational wastes (e.g., bilge water). All operational wastes will be treated or monitored for relative levels of contaminants prior to discharge, and plumes of released wastes mix rapidly with ambient seawater and are thus diluted. The bilge water within these vessels may contain some quantity of machinery waste oil. The type and quantity of fluid waste discharge permitted from vessels offshore is a function of the distance of the vessel from shore, according to international protocols provided by MARPOL 73/78 (33 CFR 157). It is anticipated that the FPSO system will be installed at a distance from shore which would permit the discharge of waste fluids from these vessels. The proposed action predicts that installation activities will require ten weeks to complete. There will be one service vessel visit to the site per week, one cargo barge and attendant tug on site, and one cargo barge and attendant tug visit per week during this period. Fluid wastes from these vessels, when permitted, will be released into the open ocean where it is expected they will be diluted and dispersed rapidly. With this anticipated level of vessel traffic and discharge, it is expected that the impacts of fluid waste discharges from OCS service and construction vessels to sea turtles will be negligible.

All sanitary and domestic wastes will either be treated or monitored for relative levels of contaminants prior to discharge. Plumes of released wastes mix rapidly with ambient seawater and are thus diluted. Historical survey data indicate that the majority of sea turtles in the Gulf of Mexico, both in terms of numbers of species and overall densities, are distributed within coastal waters and waters of the continental shelf (Davis *et al.*, 2000; Davis and Fargion, 1996). Discharges will be released within oceanic waters of the Gulf and are therefore not expected to contact and subsequently impact most Gulf sea turtles. For those turtles that may swim close to the discharge, rapid dilution is expected to result in only negligible impacts to turtles.

OCS logistic support helicopters, and service and construction vessels can affect sea turtles from machinery noise and/or visual disturbances (NRC, 1990). The degree of impacts associated with helicopter and vessel traffic appear to be highly variable, though transient, and may cause short-term behavioral changes such as disruption of activities or departure from the area of disturbance. Although areas with heavy vessel traffic may not be avoided by sea turtles, generally most species appear to exhibit considerable tolerance to ship and aircraft noise. Helicopters and vessels associated with installation of an FPSO system will originate from coastal ports and travel across the continental shelf to the project area, located within oceanic waters. In addition, activities involving the installation (laying) of an export gas line will involve operations across the continental shelf and into coastal waters. Therefore, the effects of sound generated from these activities by helicopters and vessels may impact any sea turtle species which is known to occur within the Central and Western Gulf of Mexico. However, activities associated with the installation phase of the FPSO system are relatively short-term in duration. Therefore, impacts to sea turtles resulting from sounds produced by OCS helicopter and vessel traffic are expected to be negligible.

The expected increase in OCS service vessel and construction vessel traffic associated with the installation of the FPSO system may also increase the likelihood of collisions between these vessels and sea turtles. The risk of collisions may vary, depending upon the location and during vessel operations conducted at night and during other periods of reduced visibility. Data indicate that most turtle sightings occur within coastal waters and waters of the continental shelf. Collisions with a single sea turtle resulting in mortality, as all species are currently listed as endangered or threatened species, would constitute a significant impact.

There is the possibility that the gas export line will come ashore at some undetermined location along the Gulf coast. The destruction of shallow water habitats and beaches as a result of the installation of OCS pipelines can adversely affect sea turtles. Shallow water habitats such as seagrass beds and live bottom communities are commonly utilized by turtles for feeding or resting. Certain beaches may also be utilized as nesting grounds by sea turtles, although data suggest that the Central and Western Gulf Planning Areas are not used extensively for this purpose. Pipeline landfalls associated with the proposed FPSO installation are anticipated to impact a relatively small swath of nearshore and coastal habitat, and natural restoration of nearshore biological communities destroyed or altered by this action is expected to occur relatively quickly. Therefore, impacts to sea turtles resulting from the installation of an OCS gas export line are expected to be locally adverse over a short time period but not significant.

Ingestion of, or entanglement with, solid debris (accidentally lost overboard) associated with the installment phase of a FPSO system can adversely impact sea turtles. Reports of the ingestion of plastic and other nonbiodegradable debris exist for almost all sea turtle species and life stages. Ingestion of plastic debris can impact the alimentary canal or remain within the stomach. Sublethal quantities of ingested plastic debris can result in effects including positive buoyancy in certain turtles, making them more susceptible to collisions with vessels or at increased risk from predation (Lutcavage *et al.*, 1996). Certain species of adult sea turtles, such as loggerheads and leatherbacks, appear to readily ingest certain plastic debris. In oceanic waters, floating or subsurface translucent plastic material and sheeting may be mistaken for gelatinous prey items such as jellyfish and siphonophores. Entanglement in plastic debris can result in reduced mobility, drowning, and constriction of and subsequent damage to limbs (Lutcavage *et al.*, 1996). Currently, the discharge or disposal of solid debris from both OCS structures and vessels is prohibited by the MMS to lessees (30 CFR 250.40) and Coast Guard (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Therefore, debris accidentally lost from FPSO installations is expected to produce only negligible impacts on sea turtles in the Gulf of Mexico.

Alternative A - Routine Operations

Major impact-producing factors affecting sea turtles as a result of routine operations of FPSO systems in deepwater environments of the Central and Western Planning Areas of the Gulf of Mexico include: degradation of water quality resulting from operational discharges, including possible discharges from additional drilling and downhole workover operations subsequent to installation; noise from OCS support helicopters, service vessels, and shuttle tankers; collisions with service vessels and shuttle tankers; and ingestion of, or entanglement in, debris that has been accidentally lost overboard.

The major operational waste generated during offshore oil and gas development consists of produced water. Other wastes include produced sand, workover fluids, deck drainage, miscellaneous well fluids (e.g., cement), sanitary and domestic wastes, gas and oil processing wastes, ballast water, and storage displacement water. Many of these operational discharges include components or compounds which may be injurious to sea turtles. However, most operational waste fluids are treated and/or monitored for relative levels of oil and grease, and priority contaminants prior to discharge. In addition, resultant plumes of released wastes mix rapidly with ambient seawater and are thus diluted. Produced solids are not discharged. Discharged fluids may, however, have sublethal effects on oceanic sea turtles under certain circumstances. These effects may be indirect, as a result of the impacts of the discharges on prey species (reduction in prey), or possibly direct, through prolonged exposure to the discharge or through the ingestion of affected prey species (Kennicut, 1995; API, 1989; NRC, 1983). However, based on the low concentrations of contaminants discharged, the rapid dilution of discharged fluid plumes in offshore waters, and the short-term duration of drilling operations, impacts to oceanic sea turtles associated with the release of operational discharges are not expected to be significant (i.e., impacts are negligible).

Operational discharges from OCS service and construction vessels include bilge and ballast waters, and sanitary and domestic wastes. The bilge and ballast waters within these vessels may contain some quantity of machinery waste oil or storage tank oil, respectively. The type and quantity of fluid waste discharge from vessels offshore is a function of the distance of the vessel from shore, according to international protocols provided by MARPOL 73/78 (33 CFR 157). Furthermore, there are limitations to discharges of bilge and ballast waters from oil tankers, with requirements in place for terminal areas to maintain onshore receptacles to receive these wastes. It is anticipated that the FPSO system will operate at a distance from shore where it is permitted to discharge fluid wastes in compliance with Coast Guard regulations. These wastes will be released into the open ocean where it is expected they will be diluted and dispersed rapidly. The proposed action predicts approximately one supply boat trip per week. The expected range of operations for shuttle tanker trips is once a day to once every 10 days during the entire field life, with shuttle tanker visitation every third day under the base-case scenario. Each shuttle tanker may also require a tug to assist in mooring. Assuming this level of vessel traffic, it is not expected that fluid waste discharges from these sources will adversely or significantly impact sea turtles (i.e., impacts are negligible).

OCS helicopters, service vessels, and shuttle tankers can affect sea turtles from machinery noise and/or visual disturbances (NRC, 1990). The degree of impacts associated with helicopter and vessel traffic appear to be highly variable, though transient, and may cause short-term behavioral changes such as disruption of activities or departure from the area of disturbance. Helicopters and vessels associated with routine operations of a FPSO system will originate from coastal ports and travel across the continental shelf to the project area, located within oceanic waters. Therefore, the effects of sound generated from these activities by OCS helicopter and vessel traffic may impact any sea turtle species which is known to occur within the Central and Western Gulf of Mexico. The proposed action predicts approximately two to three helicopter flights per week, one supply boat trip per week, and two to three shuttle tanker trips per week during the entire field life. Assuming this level of helicopter and vessel traffic, it is expected that impacts to sea turtles resulting from sounds produced from these sources may, under some circumstances, result in the temporary displacement of certain individuals until those individuals become acclimated. Therefore, impacts from OCS helicopter and vessel traffic are considered to be adverse but not significant.

The expected increase in OCS service vessel and shuttle tanker traffic associated with normal operations of the FPSO system may increase the likelihood of collisions between these vessels and sea turtles. The risk of collisions may vary, depending upon the location and during vessel operations conducted at night and during other periods of reduced visibility. Survey data indicate that the majority of sea turtles are not distributed within oceanic waters but rather nearshore waters and waters of the continental shelf. However, as all sea turtle species are currently listed as endangered or threatened species, any collision resulting in mortality would constitute a significant impact.

Ingestion of, or entanglement with, solid debris (accidentally lost overboard) associated with normal operations of a FPSO system can adversely impact sea turtles. Reports of the ingestion of plastic and other nonbiodegradable debris exist for almost all sea turtle species and life stages. Ingestion of plastic debris can impact the alimentary canal or remain within the stomach. Sublethal quantities of ingested plastic debris can result in effects including positive buoyancy in certain turtles, making them more susceptible to collisions with vessels or at increased risk of predation (Lutcavage *et al.*, 1996). Certain species of adult sea turtles, such as loggerheads and leatherbacks, appear to readily ingest certain plastic debris. In oceanic waters, floating or subsurface translucent plastic material and sheeting may be mistaken for gelatinous prey items such as jellyfish and siphonophores. Entanglement in plastic debris can result in reduced mobility, drowning, and constriction of and subsequent damage to limbs (Lutcavage *et* *al.*, 1996). Currently, the discharge or disposal of solid debris from both OCS structures and vessels is prohibited by the MMS to lessees (30 CFR 250.40) and Coast Guard (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Therefore, debris (accidentally lost overboard) from FPSO installations is expected to produce only negligible impacts on sea turtles in the Gulf of Mexico.

Alternative A - Range of Options

Two variables listed in the range of options may affect sea turtles in the Gulf of Mexico. These include varied water depth and active or assisted weathervaning methods.

Survey data suggest that the majority of sea turtle species which are known to occur within the Gulf of Mexico show marked depth preferences in their distributions. With the possible exception of the leatherback turtle, most species are predominantly distributed within waters of the continental shelf. FPSO activities which may be established within the shallowest depths indicated in the range of operations (i.e., ~183 m [600 ft]) will be located on the outer continental shelf. Therefore, operations in these areas may be within the preferred depth range of most of the sea turtle species which occur in the Gulf, effectively increasing the potential for impact. Of particular concern are the potentially significant impacts associated with vessel collision with a listed species.

Active, or assisted FPSO vessel weathervaning will involve the use of thrusters onboard the FPSO storage vessel or support vessel propulsion, respectively. These activities will generate additional subsea mechanical noise during their operation, which may occur at random times. This potential additional source of subsea noise may impact sea turtles in the immediate vicinity of the FPSO system. However, impacts to sea turtles resulting from these sources of additional noise are not considered to be significant (i.e., impacts are negligible).

Alternative A - Decommissioning

Major impact-producing factors affecting sea turtles as a result of the decommissioning and removal of FPSO systems in the Central and Western Planning Areas of the Gulf of Mexico include: discharges from vessels associated with decommissioning activities; noise generated from OCS helicopters, service and construction vessels, and drilling units (MODU's) used to remove wellheads and manifold jumpers; collisions with OCS vessel traffic; and ingestion of, or entanglement in, debris that has been accidentally lost overboard.

Operational discharges from OCS service and construction vessels include bilge and ballast waters, and sanitary and domestic wastes. The bilge water within these vessels may contain some quantity of machinery waste oil. The type and quantity of fluid waste discharge from vessels offshore is a function of the distance of the vessel from shore, according to international protocols provided by MARPOL 73/78 (33 CFR 157). It is anticipated that the FPSO system will be located at a distance from shore where it is permitted to discharge fluid wastes from vessels. However, these wastes will be released into the open ocean where it is expected they will be diluted and dispersed rapidly. The proposed action predicts approximately one supply boat trip per week, one cargo barge and attendant tug on site for three weeks, and two cargo barge and attendant tug trips during the three-week decommissioning and removal period. Assuming this level of vessel traffic, it is not expected that fluid waste discharges from these sources will adversely or significantly impact sea turtles during the FPSO decommissioning and removal phase (i.e., impacts are negligible).

During the decommissioning phase, a MODU will be used to plug subsea wells and remove wellheads and manifold jumpers. During these operations, it is expected that the drilling facility will produce a broad array of sounds at frequencies and intensities which may be detected by sea turtles within the project area (Geraci and St. Aubin, 1987). These sounds could directly and adversely affect sea turtles by: physically injuring their hearing; or producing behavioral or physiological disturbances which may disrupt normal activities or lead to short- or long-term displacement from areas which may be important for feeding or reproduction. Subsea activities associated with the decommissioning and removal phase of an FPSO system are expected to take approximately three weeks. Therefore, impacts to sea turtles resulting from sounds produced during subsea decommission and removal operations are expected to be locally adverse but not significant.

OCS service helicopters and surface vessels can affect sea turtles from machinery noise and/or visual disturbances (NRC, 1990). The degree of impacts associated with helicopter and service vessel traffic appear to be highly variable, though transient, and may cause short-term behavioral changes such as disruption of activities or departure from the area of disturbance. Helicopters and vessels associated with the decommissioning and removal of an FPSO system will originate from coastal ports and travel across the continental shelf to the project area, located within oceanic waters. Therefore, the effects of sound generated from these activities by helicopters and vessels may impact any sea turtle species which is known to occur within the Central and Western Gulf of Mexico. The proposed action predicts approximately two helicopter trips per week, one supply boat trip per week, one cargo barge and attendant tug on site for three weeks, and two cargo barge and attendant tug trips during the three week decommissioning and removal period. Therefore, assuming this level of helicopter and vessel traffic, impacts to sea turtles resulting from sounds produced by these sources during the decommissioning and removal phase are expected to negligible.

The expected increase in OCS service vessel and shuttle tanker traffic associated with the decommissioning and removal of the FPSO system may increase the likelihood of collisions between these vessels and sea turtles. The risk of collisions may vary, depending upon the location and during vessel operations conducted at night and during other periods of reduced visibility. Survey data indicate that the majority of sea turtles are not distributed within oceanic waters but rather nearshore waters and waters of the continental shelf. However, as all sea turtle species are currently listed as endangered or threatened species, any collision resulting in sea turtle mortality would constitute a significant impact.

Ingestion of, or entanglement with, solid debris (accidentally lost overboard) associated with the decommissioning and removal of a FPSO system can adversely impact sea turtles. Reports of the ingestion of plastic and other nonbiodegradable debris exist for almost all sea turtle species and life stages. Ingestion of plastic debris can impact the alimentary canal or remain within the stomach. Sublethal quantities of ingested plastic debris can result in effects, including positive buoyancy in certain turtles, making them more susceptible to collisions with vessels or at increased risk of predation (Lutcavage *et al.*, 1996). Certain species of adult sea turtles, such as loggerheads and leatherbacks, appear to readily ingest certain plastic debris. In oceanic waters, floating or subsurface translucent plastic material and sheeting may be mistaken for gelatinous prey items (e.g., jellyfish, siphonophores). Entanglement in plastic debris can result in reduced mobility, drowning, and constriction of and subsequent damage to limbs

(Lutcavage *et al.*, 1996). Currently, the discharge or disposal of solid debris from both OCS structures and vessels is prohibited by the MMS to lessees (30 CFR 250.40) and Coast Guard (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Therefore, debris (accidentally lost overboard) from FPSO decommissioning is expected to produce only negligible impacts on sea turtles in the Gulf of Mexico.

Alternative B (B1 through B4)

Alternative B-1, the exclusion of the FPSO system and operations from designated lightering prohibited areas, will not alter impacts to sea turtles in the Gulf of Mexico as described in Alternative A. There is no evidence that these lightering prohibited areas either exclude or attract sea turtles (and, thus, may be considered preferred or critical habitats) when compared to surrounding waters.

Alternative B-2, the exclusion of the FPSO system from lease areas nearest south Texas (Corpus Christi and Port Isabel lease blocks located nearest to shore), will not reduce or increase impacts to sea turtles in the Gulf of Mexico. Current survey data suggest that Kemp's ridley turtles may be found in greater concentrations in south Texas and Louisiana coastal and near coastal waters. However, the lease blocks in consideration under Alternative B-2 lie outside of these near coastal waters which, in some areas, appear to be preferred habitat and a common transitory pathway for this endangered species.

Alternative B-3, exclusion of the FPSO system from lease areas near the Mississippi Delta, will not alter impacts of FPSO activities on sea turtles in the Gulf of Mexico. The relative high productivity of these waters may periodically attract those species which are commonly sighted within deep water areas, such as loggerhead and leatherback turtles. This area is not, however, considered to be critical or preferred habitat for these species.

Alternative B-4, requirement for attendant vessel during offloading operations, has the potential for impact to sea turtles. The attendant vessel will generate additional subsea mechanical noise during its operation, along with additional overboard discharge of waste fluids and bilge water. This potential additional source of subsea noise and discharged contaminants may sublethally impact sea turtles in the immediate vicinity of the FPSO system. However, the impacts to sea turtles resulting from these sources of additional noise or discharges are considered to be adverse but not significant.

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: During installation, operational discharges from service and construction vessels will result in negligible impacts to sea turtles. Similarly, noise and/or visual disturbance associated with helicopters and vessels will produce negligible impacts to sea turtles. Expected increases in vessel traffic associated with installation may also increase the likelihood of collisions between these vessels and sea turtles. While the risk of collisions may vary, any collision with a single sea turtle which results in mortality would constitute a significant impact, as all species are currently listed as endangered or threatened species. Destruction of shallow water habitats and beaches as a result of the installation of an OCS gas export line may produce adverse but not significant impacts to sea turtle shallow water habitat. Ingestion of, or entanglement with, solid debris (accidentally lost overboard) associated with the installation will result in negligible impacts. For routine operations, operational wastes are expected to result in negligible impacts on sea turtles. Noise and/or visual disturbance from helicopters, service vessels, and shuttle tankers will produce adverse but not significant impacts. Increases in service vessel and shuttle tanker traffic associated with normal operations may increase the likelihood of collisions between these vessels and sea turtles. While the risk of collisions may vary, should a collision occur resulting in the loss of a sea turtle, a significant impact would result, as all sea turtle species are currently listed as endangered or threatened species. Ingestion of, or entanglement with, solid debris (accidentally lost overboard) associated with normal operations is expected to produce only negligible impacts to sea turtles in the Gulf of Mexico. Under the range of options, two variables may affect sea turtles – water depth and active or assisted weathervaning methods. If FPSO operations are established in the shallower portions of the deepwater area (i.e., within the preferred depth range of most of the sea turtle species which occur in the Gulf), there will be an increase in the potential for vessel collision with a listed species. Active, or assisted FPSO vessel weathervaning and the associated use of thrusters will generate additional subsea mechanical noise; noise impacts are considered negligible. During decommissioning, operational discharges will result in negligible impacts to sea turtles. Use of a MODU will produce a broad array of sounds, a locally adverse but not significant impact. Noise and/or visual disturbances from vessels will produce negligible impacts to sea turtles. Expected vessel traffic associated with decommissioning may increase the likelihood of collisions. Any collision resulting in sea turtle mortality would constitute a significant impact. Ingestion of, or entanglement with, solid debris (accidentally lost overboard) is expected to produce only negligible impacts on sea turtles in the Gulf of Mexico.

Alternative B: Alternatives B-1 and B-3 will not alter impacts to sea turtles in the Gulf of Mexico as described in Alternative A. In general, Alternative B-2 will not reduce or increase impacts to sea turtles in the Gulf of Mexico above those noted for Alternative A. However, the lease blocks in consideration under Alternative B-2 lie outside of these near coastal waters which, in some areas, appear to be preferred habitat and a common transitory pathway for this endangered species. Alternative B-4 has the potential for increased impact to sea turtles from additional subsea mechanical noise and additional discharges above those noted for Alternative A. Impacts on sea turtles resulting from these sources are considered to be adverse but not significant.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.8 Coastal and Marine Birds

Significance Criteria: *Any impact is* ***significant*** *if there is: a) exceedance of the species-specific jeopardy standard threshold for any coastal or marine bird; or b) any displacement of coastal or marine bird species from critical habitat (or key habitat, if a formal critical habitat has not been designated) for any length of time; or c) long-term or permanent displacement of any coastal or marine bird species from preferred feeding, breeding, or nursery habitats (other than critical habitat); or d) substantial (or chronic) disruption of behavioral patterns to an extent that may adversely affect a species or stock through effects on annual rates of recruitment or survival. Any impact is* ***adverse but not significant*** *if there is: a) mortality or serious injury to coastal or marine birds, but not exceeding jeopardy threshold standards; or b) short-term displacement of coastal or marine birds from preferred feeding, breeding, or nursery grounds (but not critical habitat); or c) some disruption of behavioral patterns, but to an extent that is unlikely to adversely affect a species or stock through effects on annual rates of recruitment or survival. Any impact is* ***negligible*** *if there is: a) no mortality or serious injury to any coastal or marine bird; or b) no displacement any coastal or marine bird species from critical habitat; or c) no displacement of any species from preferred feeding, breeding, or nursery grounds; or d) little or no disruption of behavioral patterns or other sublethal effects.*

Terminology and Resource-Specific Definitions: *For coastal and marine bird impact assessment, the spatial and temporal definitions are similar to those noted for marine mammals and sea turtles. A "short-term" impact is one that is infrequent and temporary, characterized by sudden onset and short duration, and occurring within either fixed or varied geographic locations; the duration of a short-term impact ranges from seconds to several days. A "long-term" impact is one or a series of impacts characterized by long duration or frequent reoccurrence, typically within a specific geographic location; the duration of a long-term impact may represent an appreciable fraction of an individual animal's lifetime (i.e., perhaps months to years). A "local" (or "localized") impact is one that occurs within a defined location, is not widespread or general in extent, and affects only restricted numbers of individuals of one or more species but is unlikely to affect the population status of the impacted species or stock of a species. A "regional"* *impact is one that may affect the status of a species or local stock of a species. The areal extent of a regional impact may vary greatly, ranging from a broad geographic area (one that encompasses one or more ecological habitats or systems) to a much smaller area, as in the case where a species, stock, or a life stage of a species is concentrated into a relatively small area.*

Alternative A - Installation

Impact-producing factors that may affect coastal and marine birds as a result of the installation of an FPSO system in the Central and Western Planning Areas of the Gulf of Mexico include: degradation of water quality resulting from discharges from OCS service and construction vessels; disturbance from helicopter and OCS vessel traffic across or within coastal and nearshore habitats; ingestion of, or entanglement in, debris that has been accidentally lost overboard; and destruction or alteration of coastal habitat and related disturbance from a new OCS gas export line landfall.

The major operational discharges generated during installation of offshore FPSO systems include sanitary and domestic wastes and limited operational wastes (e.g., bilge water). All operational wastes will be treated or monitored for relative levels of contaminants prior to discharge, and plumes of released wastes mix rapidly with ambient seawater and are thus diluted. The bilge water within these vessels may contain some quantity of machinery waste oil. The type and quantity of fluid waste discharge permitted from vessels offshore is a function of the distance of the vessel from shore, according to international protocols provided by MARPOL 73/78 (33 CFR 157). It is anticipated that the FPSO system will be installed at a distance from shore which would permit the discharge of waste fluids from these vessels. The proposed action predicts that installation activities will require ten weeks to complete. There will be one service vessel visit to the site per week, one cargo barge and attendant tug on site, and one cargo barge and attendant tug visit per week during this period. Fluid wastes from these vessels, when permitted, will be released into the open ocean where it is expected they will be diluted and dispersed rapidly. With this anticipated level of vessel traffic and discharge, it is expected that the impacts of fluid waste discharges from OCS service and construction vessels to coastal and marine birds will be negligible.

All sanitary and domestic wastes will either be treated or monitored for relative levels of contaminants prior to discharge. Plumes of released wastes mix rapidly with ambient seawater and are thus diluted. Discharges will be released within oceanic waters of the Gulf and are therefore not expected to contact and possibly impact coastal or continental shelf bird species. Based on the low concentrations of discharged contaminants, and the short-term duration of installation-associated construction activities, impacts on seabirds associated with the release of operational discharges are expected to be negligible.

Helicopter and service vessel traffic related to the installment of a FPSO system could, on occasion, disturb individual or groups of coastal or marine birds. These disturbances would pertain to helicopter or service vessel travel within or across sensitive coastal habitats such as wetlands which may support feeding, resting, or breeding birds. The effects of disturbance from FPSO installation helicopter and vessel traffic is highly variable, based on the bird species, type of vehicle (e.g., helicopter, vessel, and type, relative noise level, and speed of vessel), altitude and distance of the vehicle, frequency of occurrence of the disturbance, and season. Federal Aviation Administration guidelines and corporate helicopter operatives request that pilots maintain a minimum altitude of 213 m (700 ft) while in transit offshore, 305 m (1,000 ft) altitude over unpopulated areas or across coastlines, and 610 m (2,000 ft) altitude over populated areas and sensitive habitats such as wildlife refuges and park properties. Vessel operators are required to maintain slow, wake-free speeds while transiting across most sensitive inland waterways. Therefore, with these guidelines in effect, it is assumed that helicopter traffic or vessel traffic associated with the installation of a FPSO system will produce only negligible impacts on coastal and marine birds in the Central and Western Gulf of Mexico.

Coastal and marine birds are susceptible to entanglement with debris that has been accidentally lost overboard. In addition, many species ingest particles of debris. Entanglement with debris can lead to damaged or loss of limbs, entrapment, or the prevention or hindrance of their ability to fly or swim. Ingested debris may irritate or block the digestive tract, impair digestion of food in the digestive tract, or release toxic chemicals. Currently, the discharge or disposal of solid debris from both OCS structures and vessels is prohibited by the MMS to lessees (30 CFR 250.40) and Coast Guard (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Therefore, debris that has been accidentally lost overboard from FPSO installation activities is expected to produce only negligible impacts on coastal and marine birds in the Central and Western Gulf of Mexico.

The greatest potential impact to coastal and marine birds resulting from the installation of the FPSO system is the extent of coastal habitat loss or alteration from a new OCS gas export line landfall. The effects from this landfall are highly variable, based on the specific location of the landfall (e.g., whether the proposed landfall may be classified as critical or preferred habitat for activities such as nesting or feeding, and the extent and duration of damage to sensitive inshore habitats) and which species are potentially impacted. Certain listed species of coastal birds utilize shoreline habitats of the Gulf of Mexico during certain seasons of the year. Examples of these species which occur along the shorelines of the Central and Western Gulf and are currently listed as endangered species include: whooping crane (*Grus americana*) , bald eagle (*Haliaeetus leucocephalus*), brown pelican (*Pelicanus occidentalis*), and piping plover (*Charadrius melodus*).

Alternative A - Routine Operations

Major impact-producing factors affecting coastal and marine birds as a result of routine operations of FPSO systems in deepwater environments of the Central and Western Planning Areas of the Gulf of Mexico include: degradation of water quality resulting from operational discharges, including possible discharges from additional drilling and downhole workover operations subsequent to installation; disturbance from OCS support helicopters, service vessels, and shuttle tankers within coastal habitats; and ingestion of, or entanglement in, debris that has been accidentally lost overboard.

Major operational wastes generated during offshore oil and gas development include produced waters. Other wastes include: produced sand; workover fluids; deck drainage; miscellaneous well fluids (e.g., cement); sanitary and domestic wastes; gas and oil processing wastes; ballast water; and storage displacement water. Many of these operational discharges include components or compounds which may be injurious to seabirds in the vicinity of the FPSO structure. However, most operational waste fluids are treated and/or monitored for relative levels of oil and grease, and priority contaminants prior to discharge. In addition, resultant plumes of released wastes mix rapidly with ambient seawater and are thus diluted.

Produced solids are not discharged. Discharged fluids may, however, have sublethal effects on seabirds under certain circumstances. These effects may be indirect, as a result of the impacts of the discharges on prey species (reduction in prey), or possibly direct, through prolonged exposure to the discharge or through the ingestion of affected prey species (Kennicut, 1995; API, 1989; NRC, 1983). However, based on the low concentrations of contaminants discharged, the rapid dilution of discharged fluid plumes in offshore waters, and the short-term duration of drilling operations, impacts on seabirds associated with the release of operational discharges are expected to be adverse but not significant.

Operational discharges from OCS service and construction vessels include bilge and ballast waters, and sanitary and domestic wastes. The bilge water within these vessels may contain some quantity of machinery waste oil. The type and quantity of fluid waste discharge from vessels offshore is a function of the distance of the vessel from shore, according to international protocols provided by MARPOL 73/78 (33 CFR 157). Furthermore, there are significant limitations to discharges of bilge and ballast waters from oil tankers, with requirements in place for terminal areas to maintain onshore receptacles to receive these wastes. It is anticipated that the FPSO system will operate at a distance from shore where it is permitted to discharge fluid wastes. However, these wastes will be released into the open ocean where it is expected they will be diluted and dispersed rapidly. The proposed action predicts approximately one supply boat trip per week. The expected range of operations for shuttle tanker trips is once a day to once every 10 days during the entire field life, with a shuttle tanker expected every third day under the base-case scenario. Assuming this level of vessel traffic, it is not expected that fluid waste discharges from these sources will significantly impact seabirds (i.e., impacts are negligible).

Helicopter and service vessel traffic related to normal operations of a FPSO system could on occasion disturb individual or groups of coastal or marine birds. These disturbances would pertain to helicopter or service vessel travel within or across sensitive coastal habitats such as wetlands which may support feeding, resting, or breeding birds. The effects of disturbance from FPSO installation helicopter and vessel traffic is highly variable, based on the bird species, type of vehicle (helicopter, vessel, and type, relative noise level, and speed of vessel), altitude and distance of the vehicle, frequency of occurrence of the disturbance, and season. Federal Aviation Administration guidelines and corporate helicopter operatives request that pilots maintain a minimum altitude of 213 m (700 ft) while in transit offshore, 305 m (1,000 ft) altitude over unpopulated areas or across coastlines, and 610 m (2,000 ft) altitude over populated areas and sensitive habitats such as wildlife refuges and park properties. Vessel operators are required to maintain slow, wake-free speeds while transiting across most sensitive inland waterways. Therefore, with these guidelines in effect it is assumed that helicopter traffic or vessel traffic associated with the installation of a FPSO system will produce only negligible impacts on coastal and marine birds in the Central and Western Gulf.

Coastal and marine birds are susceptible to entanglement with debris that has been accidentally lost overboard. In addition, many species ingest particles of debris. Entanglement with debris can lead to damaged or loss of limbs, entrapment, or the prevention or hindrance of their ability to fly or swim. Ingested debris may irritate or block the digestive tract, impair digestion of food in the digestive tract, or release toxic chemicals. Currently, the discharge or disposal of solid debris from both OCS structures and vessels is prohibited by the MMS to lessees (30 CFR 250.40) and Coast Guard (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Therefore, debris that has been accidentally lost overboard from FPSO operations is expected to produce only negligible impacts on coastal and marine birds in the Central and Western Gulf of Mexico.

Alternative A - Range of Options

Variables that are listed in the range of options are not expected to affect coastal and marine birds in the Gulf of Mexico. Neither adverse nor beneficial impacts, above those already noted for the proposed action, will be realized under any of the options.

Alternative A - Decommissioning

Major impact-producing factors affecting coastal and marine birds as a result of the decommissioning and removal of FPSO systems in the Central and Western Planning Areas of the Gulf of Mexico include: discharges from vessels associated with decommissioning activities; disturbance from OCS helicopters, and service and construction vessels within coastal habitats; and ingestion of, or entanglement in, debris that has been accidentally lost overboard.

Operational discharges from OCS service and construction vessels include bilge and ballast waters, and sanitary and domestic wastes. The bilge water within these vessels may contain some quantity of waste oil. The type and quantity of fluid waste discharge from vessels offshore is a function of the distance of the vessel from shore, according to international protocols provided by MARPOL 73/78 (33 CFR 157). It is anticipated that the FPSO system will be located at a distance from shore where it is permitted to discharge fluid wastes from vessels. These wastes will be released into the open ocean where they will be diluted and dispersed rapidly. The proposed action predicts approximately one supply boat trip per week, one cargo barge and attendant tug on site for three weeks, and two cargo barge and attendant tug trips during the three-week decommission and removal period. Assuming this level of vessel traffic, it is not expected that fluid waste discharges from these sources will adversely or significantly impact coastal and marine birds during the FPSO decommissioning and removal phase (i.e., impacts are negligible).

Helicopter and service vessel traffic related to the decommissioning and removal phase of a FPSO system could, on occasion, disturb individual or groups of coastal or marine birds. These disturbances would pertain to helicopter or service vessel travel within or across sensitive coastal habitats such as wetlands which may support feeding, resting, or breeding birds. The effects of disturbance from FPSO installation helicopter and vessel traffic is highly variable, based on the bird species, type of vehicle (i.e., helicopter, vessel, and type, relative noise level, and speed of vessel), altitude and distance of the vehicle, frequency of occurrence of the disturbance, and season. Federal Aviation Administration guidelines and corporate helicopter operatives request that pilots maintain a minimum altitude of 213 m (700 ft) while in transit offshore, 305 m (1,000 ft) altitude over unpopulated areas or across coastlines, and 610 m (2,000 ft) altitude over populated areas and sensitive habitats such as wildlife refuges and park properties. Vessel operators are required to maintain slow, wake-free speeds while transiting across most sensitive inland waterways. Therefore, with these guidelines in effect, it is assumed that helicopter traffic or vessel traffic associated with the decommissioning and removal of a FPSO system will produce only negligible impacts on coastal and marine birds in the Central and Western Gulf.

Coastal and marine birds are susceptible to entanglement with debris that has been accidentally lost overboard. In addition, many species ingest particles of debris. Entanglement with debris can lead to damaged or loss of limbs, entrapment, or the prevention or hindrance of their ability to fly or swim. Ingested debris may irritate or block the digestive tract, impair digestion of food in the digestive tract, or release toxic chemicals. Currently, the discharge or disposal of solid debris from both OCS structures and vessels is prohibited by the MMS to lessees (30 CFR 250.40) and Coast Guard (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Therefore, debris that has been accidentally lost overboard from FPSO decommissioning and removal operations is expected to produce only negligible impacts on coastal and marine birds in the Central and Western Gulf of Mexico.

Alternative B (B1 through B4)

Alternative B-1, the exclusion of the FPSO system and operations from designated lightering prohibited areas, will not alter impacts on coastal and marine birds in the Gulf of Mexico as described in Alternative A. There is no evidence that these lightering prohibited areas either exclude or attract these birds when compared to surrounding waters.

Alternative B-2, the exclusion of the FPSO system from lease areas nearest south Texas (Corpus Christi and Port Isabel lease blocks located nearest to shore), will not reduce or increase impacts on coastal and marine birds in the Gulf of Mexico as described in Alternative A.

Alternative B-3, exclusion of the FPSO system from lease areas near the Mississippi Delta, will produce only negligible impacts from FPSO activities on coastal and marine birds in the Gulf of Mexico. The relative high productivity of these waters may periodically attract seabird species which are commonly sighted within deepwater areas. This area is not, however, considered to be critical or preferred habitat for these species.

Alternative B-4, requirement for attendant vessel during offloading operations, will not appreciably increase impacts on coastal and marine birds in the Gulf of Mexico as described in Alternative A. The attendant vessel will generate additional overboard discharge of waste fluids and bilge water. This potential additional source of discharged contaminants may sublethally impact offshore seabirds in the immediate vicinity of the FPSO system. However, the impacts on these birds resulting from this source of additional discharge are considered negligible.

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: During installation, the degradation of water quality resulting from discharges from OCS service and construction vessels will produce only negligible impacts on coastal and marine birds. Disturbance from helicopter and OCS vessel traffic moving across or within coastal and nearshore habitats is highly variable, based on the bird species, type of vehicle (e.g., helicopter, vessel, and type, relative noise level, and speed of vessel), altitude and distance of the vehicle, frequency of occurrence of the disturbance, and season. With adherence to FAA and no-wake guidelines, helicopter traffic or vessel traffic associated with the installation of a FPSO system will produce negligible impacts on coastal and marine birds in the Central and Western Gulf. Ingestion of, or entanglement in, debris that has been accidentally lost overboard will produce negligible effects on coastal and marine birds. In the event a new OCS gas export line landfall is required, the associated destruction or alteration of coastal habitat and related disturbance from installation operations will be variable, based on the specific location of the landfall. With appropriate placement (and avoidance of sensitive avian habitat), impacts are expected to be adverse but not significant. During routine operations, discharges will mix rapidly with ambient seawater and be diluted, producing either negligible or adverse but not significant impacts to seabirds present, depending upon the discharge. Helicopter and service vessel traffic related to normal operations could occasionally disturb individual or groups of coastal or marine birds. Proper adherence to existing altitude restrictions and no-wake limitations will produce only a negligible impact to coastal and marine birds. Debris accidentally lost overboard from FPSO operations is expected to produce only negligible impacts on coastal and marine birds. Variables that are listed in the range of options are not expected to affect coastal and marine birds in the Gulf of Mexico. Neither adverse nor beneficial impacts, above those already noted for the proposed action, will be realized under any of the options. During decommissioning, operational discharges will not adversely or significantly impact coastal and marine birds (i.e., impacts are negligible). Helicopter and service vessel traffic has the potential for disruption to individual or groups of coastal or marine birds. Adherence to existing altitude and no-wake restrictions will produce only negligible impacts on coastal and marine birds. Debris that has been accidentally lost overboard from FPSO decommissioning activities will produce negligible impacts on coastal and marine birds.

Alternative B: Alternatives B-1 through B-4 will not reduce or increase impacts on coastal and marine birds in the Gulf of Mexico beyond those already described under Alternative A.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action

(Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.9 Fish Resources

Significance Criteria: *An impact on resources is considered to be locally* ***significant*** *if it is likely to directly or indirectly cause measurable change in 1) species composition or abundance beyond that of normal variability, or 2) ecological function within a species range for 5 years or longer (i.e., long term). Measurable changes occurring for less than 5 years would be considered short-term, locally significant impacts. For an impact to be locally significant, the extent of the impact (e.g., individual species, total number of fish affected) would be relatively small compared to total population or community size in the immediate region. The threshold for significance is determined by scientific judgement, and takes into consideration the relative importance of the habitat and/or species affected. Impacts of regional significance are judged by the same criteria as those for local significance, except that the impacts cause a change in the ecological function within the population or community. The number of fish affected, relative to those present in the region, is determined in the same way as that for locally significant impacts. This determination takes into consideration the importance of the species and/or habitat affected and its relative sensitivity to environmental perturbations. Consideration of Essential Fish Habitat (EFH) is an important and necessary component of any impact assessment.*

Terminology and Resource-Specific Definitions: *In fish resources impact assessment, "short term" refers to periods of a year or less, whereas "long term" encompasses a time period of more than a year, up to one or more decades. "Local" (or "localized") impacts extend from meters up to one km (0.6 mi), whereas "regional" ranges from one km (0.6 mi) to hundreds of kilometers (0.6 to 62+ mi).*

Fishes are broadly classified as pelagic or benthic. Within the pelagic group, three depth related subdivisions exist, including epipelagic, mesopelagic, and bathypelagic, as detailed in Section 3.2.6. These same broad classes are used in this analysis to summarize potential impacts of the FPSO base-case scenario and the range of options, as well as alternatives.

Potential impacts to deepwater fishes by deepwater oil and gas activities were listed during a workshop convened by MMS to raise issues surrounding deepwater oil and gas development (Carney, 1997). Primary concerns with respect to fishes were as follows:

- interference with natural movement;
- interference with feeding and spawning;
- contamination (e.g., oil spills and produced water discharges);
- abandonment of seafloor structures; and
- possible effects to regional biodiversity.

Consideration of these concerns is evident in the assessment of impacts that follow.

Prior to 1998, no deepwater or slope areas of the OCS had been identified as EFH by the Gulf of Mexico Fishery Management Council (GOMFMC, 1998). More recently, however, EFH has been identified beyond the shelf edge for several Gulf fish species (see table 3-16). The MMS (2000b) notes that both the Management Council and the MMS suggest that deepwater areas of the Gulf of Mexico may be an important spawning area for many fishery resources, including species of recreational and/or commercial value. It remains unclear how important deepwater processes (e.g., currents) may be to larval and juvenile forms; however, MMS (2000b) notes that highly migratory species (e.g., tunas, swordfish) may be particularly susceptible to water column effects since they use this environment as a nursery ground.

Only limited data are currently available on the early life histories of both migratory species and other species found in deepwater areas, including information on fish larvae. In the vicinity of Viosca Knoll and DeSoto Canyon, ichthyoplankton surveys are available from only two seasons and two different locales (USDOI, MMS, 2000b). While total abundance of fish larvae in these deepwater areas is comparable to other areas of the Gulf, diversity is reduced compared to shallower waters (<100 m [328 ft]). Seasonal fluctuations in species diversity are also evident, with higher fall diversity estimates attributed to changes in current patterns. It is important to note that only about 10 percent of larvae collected in the Gulf can be identified to the species level, with more than 2,000 species of fishes documented in the Gulf of Mexico and adjacent waters (Lyczkowski-Shultz, 1999).

Alternative A - Installation

Impact-producing factors that may affect fishery resources as a result of FPSO installation activities in the Central and Western Planning Areas of the Gulf of Mexico include: discharges from OCS service and construction vessels; and physical emplacement of anchors and other bottom-founded structures.

Operational discharges from construction and service vessels include sanitary and domestic wastes, and bilge and ballast waters. Sanitary and domestic wastes will be treated before being discharged overboard and in compliance with Coast Guard regulations. Bilge water from surface vessels may contain some quantity of waste oil. The type and quantity of fluid waste discharge from vessels offshore is a function of the distance of the vessel from shore. It is anticipated that the FPSO system will be located at a distance from shore where it is permitted to discharge fluid wastes from vessels. These wastes will be released into the open ocean where they will be diluted and dispersed rapidly. Planktonic larval forms appear to be at greatest risk, while juveniles and adults passing through the discharge will not be adversely affected. Installation activities are projected to require ten weeks to complete. There will be one service vessel visit to the site per week, one cargo barge and attendant tug on site, and one cargo barge and attendant tug visit per week during this period. With this anticipated level of vessel traffic and discharge, it is expected that the impacts of fluid waste discharges from OCS service and construction vessels to fishery resources will be negligible.

The installation of bottom-founded structures may produce several localized impacts to fishery resources. Installation of seafloor anchors, turret, and manifolds will disturb the seafloor, as detailed in Section 4.3.5. Motile epipelagic and benthic fishes can be expected to move out of the area of installation activity while each phase is completed. Depending upon the amount of disturbance, displaced fish may or may not return. In either case, the impact to affected fishery resources is considered negligible. Once put in place, bottom-founded structures will serve as fish attraction devices (FADs). For those species preferring bottom relief (e.g., snappers, groupers), the presence of additional FADs is a beneficial impact. In contrast, the physical presence of FADs in deepwater may seriously impact conservation of highly migratory fish species by causing changes in feeding and spawning behavior (USDOI, MMS, 2000b); such impacts would be considered to be adverse but not significant, as detailed below.

Alternative A - Routine Operations

Impact-producing factors that may affect fishery resources as a result of routine FPSO operations in the Central and Western Planning Areas of the Gulf of Mexico include: the physical presence of the FPSO, anchors and anchor lines, risers, and bottom-founded structures; and degradation of water quality resulting from discharges from production operations and OCS service and supply vessels.

The physical presence of FPSO components may interfere with natural migratory routes, as the FPSO and attendant mooring lines will act as a fish attraction device (FAD). The FAD effect would be most pronounced for epipelagic fishes such as tunas, dolphin, billfishes, and jacks. These species are commonly attracted to fixed and drifting surface structures (e.g., Hunter and Mitchell, 1967; Gooding and Magnuson, 1967; Holland *et al.*, 1990; Kingford, 1992, 1993, 1995; Higashi, 1994; Relini *et al.* 1994). The concern is that these highly migratory species would be diverted from traditional migratory routes and, consequently, from traditional spawning or feeding areas. Because of the highly migratory nature of many epipelagic species, these effects could extend to the regional scale. However, information documenting the evolution of migratory routes is limited. Although little is known about their habits, vertically migrating mesopelagic fishes may also be attracted to or repelled by an FPSO structure. In addition, the forms may be affected by lights on the FPSO at night when migrations usually take place. Light intensity is thought to be an important mediator for vertically migrating lanternfishes (Nafpaktitis *et al.*, 1977). Any disruptions to vertically migrating mesopelagic fishes by alteration of light intensity would be restricted to the local scale. Benthic and bathypelagic fishes are not known to undergo extensive migrations and therefore should not be affected in this respect.

The disruption of migrations could result in short- or long-term effects on the feeding behavior in deepwater fishes. The FAD effect mentioned previously would possibly enhance feeding of epipelagic predators by attracting and concentrating smaller prey species. Vertical migrations undertaken by mesopelagic fishes usually are feeding episodes (e.g., Nafpaktitis *et al.*, 1977; Sutton and Hopkins, 1996), and certainly an FPSO could disrupt these migrations and have local-scale effects on mesopelagic food webs. Effects of an FPSO on food resources and feeding behavior would be prevalent in benthic species. Deepwater benthic-feeding fishes would be displaced from small areas by seafloor structures such as anchors, manifolds, and wellheads. Some minor loss of benthic (epifaunal and infaunal) food items would also occur. These effects would be adverse but not significant and would occur only on a local scale.

In addition to displacement of migratory species from spawning grounds by FAD effects, the spawning products (i.e., eggs and larvae) from epipelagic and mesopelagic fishes could be exposed to contaminants discharged from an FPSO. Eggs and larvae of these epi- and mesopelagic fishes are commonly found in the surface waters of the open Gulf (Richards *et al.*, 1989, 1993). Produced water and domestic discharges could be lethal to early life history stages occurring close to an FPSO. Higher impacts would be realized if eggs and larvae are unusually concentrated. However, population-level effects would not be likely given the total volumes expected and the ability of receiving waters to quickly and effectively disperse discharges (i.e., to ambient levels within several thousand meters of the discharge). Impacts associated with routine discharges are expected to be negligible.

Alternative A - Range of Options

While most of the FPSO location or vessel/system options will not appreciably increase or decrease impacts previously identified for the base-case scenario, the question of FPSO water depth is problematic. Given the limited data base available for deepwater fish species, particularly in regards to life history information, it is possible that slightly increased impacts might be realized from FPSO production-related discharges in deeper water. However, under a worst case scenario, such impacts would only increase from negligible to adverse but not significant.

With the exception of increased daily production (and water depth noted previously), none of the remaining options will either increase or decrease the projected volumes of water-borne discharges, leaving impacts to fishery resources unchanged from the base-case scenario. With increased daily production levels, total amounts of produced water and other production-based discharges will increase. Such increases will produce incremental increases to fishery resources above those noted for the base-case scenario. Increases in production are not expected to prompt increased manning levels, thus domestic discharges and their associated impacts are not expected to increase above the base-case scenario.

Alternative A - Decommissioning

Major impact-producing factors affecting fish resources as a result of FPSO decommissioning and removal include: discharges from vessels associated with decommissioning activities; and effects of either removal or abandonment of various components (e.g., anchors and other bottom-founded structures).

Operational discharges from decommissioning vessels include sanitary and domestic wastes, and bilge and ballast waters. Sanitary and domestic wastes will be treated before being discharged overboard, with effluent discharge limitations to be established according to Coast Guard regulations. Bilge water from surface vessels may contain some quantity of waste oil. The type and quantity of fluid waste discharge from vessels offshore is a function of the distance of the vessel from shore. It is anticipated that the FPSO system will be located at a distance from shore where it is permitted to discharge fluid wastes from vessels. These wastes will be released into the open ocean where they will be diluted and dispersed rapidly. Planktonic larval forms appear to be at greatest risk, while juveniles and adults passing through the discharge will not be adversely affected. The proposed action predicts approximately one supply boat trip per week, one cargo barge and attendant tug on site for three weeks, and two cargo barge and attendant tug trips during the three-week decommission and removal period. Assuming this level of vessel traffic, it is not expected that fluid waste discharges from these sources will adversely or significantly impact fish resources during the FPSO decommissioning and removal phase (i.e., impacts are negligible).

In situ abandonment of bottom-founded structures such as mooring wires, anchors, and wellheads would likely have an artificial reef or FAD effect for benthic fishes. The direct or indirect impacts of abandonment cannot be determined, given that there is extremely limited information concerning the attraction of deepwater benthic fishes to seafloor structures. By comparison, the removal of structures will eliminate any FAD impacts. Removal or abandonment operations are expected to be short term and localized, creating only minor impacts to fish resources.

Alternative B (B1 through B4)

Alternative B-1, exclusion of FPSOs from designated lightering prohibited areas, may have a positive impact on shallower water fish resources. In general, FPSO operations excluded from lightering prohibited areas could be expected to move to other deepwater prospects. Operations located further offshore simply shift impacts discussed above from shallow to deeper waters.

Alternative B-2, exclusion of FPSOs from lease areas nearest south Texas (Corpus Christi and Port Isabel lease blocks located nearest to shore), will have no appreciable change on fish resources impacts. Alternative B-3, exclusion of FPSOs from lease areas nearest the Mississippi Delta, may significantly alter impacts to fish resources, although a definitive determination of impact cannot be established. As noted by MMS (2000b), oil and gas operations currently being conducted in this portion of the Gulf (i.e., areas south and east of the Mississippi River Delta) have produced both positive and negative impacts. Positive (beneficial) impacts are associated with the presence of structures and corresponding enhanced fishing activity. Negative (negligible) impacts are related to increased conflicts with fishing interests (i.e., commercial and recreational) and oil and gas operations. Implementation of Alternative B-3 would eliminate the potential for additional conflict, but would also eliminate any potentially beneficial impacts of FPSO structure presence.

Alternative B-4, requirement for an attendant vessel to be present during offloading operations, will have an incremental impact on fish resources above what is projected for the proposed action (Alternative A). The presence of an attendant vessel every third day would increase the total amount of on-site discharges of domestic and sanitary wastes and bilge water. This incremental impact is not expected to be significant (i.e., impacts remain negligible).

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: During installation, discharges from service and construction vessels will produce negligible impacts to fishery resources. Physical emplacement of anchors and other bottom-founded structures will produce several localized impacts to fishery resources, a negligible impact. Once in place, bottom-founded structures will serve as FADs, a beneficial impact on species preferring bottom relief. Highly migratory fish species will be affected, an adverse but not significant impact. During routine operations, the physical presence of FPSO components may interfere with natural migratory routes, may cause diversion from traditional migratory routes and, consequently, from traditional spawning or feeding areas. Such disruptions in migration patterns could result in short- or long-term effects on the feeding behavior in deepwater fishes, an adverse but not significant impact. In addition to displacement of migratory species from spawning grounds by FAD effects, the spawning products (i.e., eggs and larvae) from epipelagic and mesopelagic fishes could be exposed to contaminants discharged from an FPSO, a negligible impact. Under the range of options, most of the FPSO location or vessel/system options will not appreciably increase or decrease impacts previously identified for the base-case scenario. However, the question of FPSO water depth is problematic; it is possible that slightly increased impacts might be realized from FPSO production-related discharges in deeper water. Under a worst case scenario, such impacts would increase from negligible to adverse but not significant. With the exception of increased daily production (and water depth noted previously), none of the remaining options will either increase or decrease the projected volumes of water-borne discharges, leaving impacts to fishery resources unchanged from the base-case scenario (i.e., negligible). During decommissioning, operational discharges from vessels will produce negligible impacts to fishery resources. In situ abandonment of bottom-founded structures will likely have an artificial reef or FAD effect for benthic fishes; the direct or indirect impacts of such abandonment cannot be determined, although impacts are expected to range from negligible to adverse but not significant.

Alternative B: Alternative B-1 may have a positive (beneficial) impact on shallower water fish resources. Alternative B-2 will have no appreciable change on fish resources impacts. Alternative B-3 may significantly alter impacts on fish resources, although a definitive determination of impact cannot be established. Positive (beneficial) impacts are associated with the presence of structures and corresponding enhanced fishing activity, while negative (negligible) impacts are related to increased conflicts with fishing interests (i.e., commercial and recreational) and oil and gas operations. Implementation of Alternative B-3 would eliminate the potential for additional conflict, but would also eliminate any potentially beneficial impacts of FPSO structure presence. Alternative B-4 will have an incremental impact on fish resources above what is projected for Alternative A (i.e., negligible impact).

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

EFH Assessment

Description of the Proposed Action

The proposed action, as detailed in Sections 1 and 2, encompasses the potential placement of one or more (up to five) FPSOs in the deepwater (i.e., >200 m [>656 ft]) areas of the Central and Western GOM. As noted previously, several alternatives have been considered in this analysis. Impact-producing factors outlined in Section 4.1 identified several factors that may affect EFH, including: physical disturbance and alteration of the seafloor, areal preclusion, and operational discharges. Potential impacts of oil spills on EFH are considered in Section 4.4.4.

Physical Disturbance Effects

Emplacement of bottom-founded structures may produce several localized impacts on EFH. Installation of anchors, turret, and manifolds will disturb the seafloor, as detailed in Section 4.3.5, creating localized and short-term impacts on the benthos and lower portions of the water column (i.e., turbidity increases, resuspension of sediments, increased sedimentation rates, creation of furrows, depressions, and/or drag marks). Because of their limited areal extent, EFH impacts resulting from such physical disturbance are considered to be negligible.

Once put in place, bottom-founded structures will serve as fish attraction devices (FADs). For those species preferring bottom relief (e.g., snappers, groupers), the presence of additional FADs is a beneficial impact on EFH. In contrast, the physical presence of FADs in deep water may seriously impact conservation of highly migratory fish species by causing changes in feeding and spawning behavior. However, while the presence of additional FADs may affect highly migratory species, the direct impacts on EFH are considered negligible.

Areal Preclusion Effects

The area initially precluded as a result of early phases of FPSO installation and commissioning (and subsequently during decommissioning and removal) will be considerably less than the total area precluded by an operational FPSO. During steps of installation and removal (with the exception of construction and precommissioning), surface and seafloor activities will effectively exclude small fishable areas around each installation and removal vessel. Similarly, flowline and gas export line installation and umbilical installation will create corridors extending from the future FPSO site to each manifold. While bottom and surface fishing activities would be precluded in and around each well manifold, as well as around the FPSO anchor system and turret, the impact of such preclusion on EFH could be considered beneficial.

Once installed, FPSO presence will effectively preclude a portion of the water column and seafloor. The total maximum area of water column and seafloor excluded by a single FPSO configuration (i.e., moorings, anchor spread, drag anchors, manifolds, and wellheads) is approximately 41 km^2 (16 mi^2, assuming a 1,115 m^2 [12,000 ft^2] radius, FPSO to wellheads). Under those circumstances where a maximum of five FPSOs are emplaced, the total areal exclusion would encompass 205 km^2 (80 mi^2). The impact of such preclusion on EFH could be considered beneficial.

Operational Discharges Effects

While the eggs and larvae of epipelagic and mesopelagic fishes could be locally exposed to contaminants discharged from an FPSO, operational discharges (e.g., produced water, sanitary and domestic wastes) are expected to produced localized degradation of water quality in near surface waters (including near surface waters of EFH). Concentrations of discharged pollutants will reach ambient levels within several thousand meters of the discharge. Such degradation will occur during the life of the FPSO operation; however, because of the localized nature of the water quality effects, impacts on EFH are considered negligible.

Under the Range of Options, additional FPSOs and associated increases in shuttle tanker traffic are expected to result in increased vessel traffic in coastal areas and associated increases in turbidity within transit channels. Vessel-associated discharges would also increase. If this vessel traffic is concentrated in one or a few ports, then water quality and sediment quality could be significantly affected in the localized area (i.e., from increases in erosion and turbidity) close to shore (i.e., close to vessel transit routes nearshore). Such nearshore impacts to water and sediment quality may prompt similar impacts on EFH for shallow-water species of concern.

Agency Review

As noted previously, it is expected that the proposed action will result in negligible impacts on EFH. The Regional NMFS EFH team has the opportunity to provide comment on this assessment as part of public and agency review of the DEIS.

Proposed Mitigation(s)

Given the determination of only negligible impacts on EFH from the proposed action, mitigation measures are not required.

4.3.10 Commercial Fisheries

Significance Criteria**:** *Impacts are considered* ***significant*** *if: a) Fishers are precluded from two percent or more of the fishing grounds during FPSO operation; b) two percent or more of the fishers are precluded from a fishing area for all or most of a fishing season; or c) economic losses due to a decrease in catchability of target species exceeds two percent of the annual value.*

Terminology and Resource-Specific Definitions: *In commercial fisheries impact assessment, spatial and temporal definitions are identical to those provided for fish resources. "Short term" refers to periods of a year or less, whereas "long term" encompasses a time period of more than a year, up to one or more decades. "Local" (or "localized") impacts extend from meters up to one km (0.6 mi), whereas "regional" ranges from one km (0.6 mi) to hundreds of kilometers (0.6 to 62+ mi).*

Important commercial fisheries occurring in water depths greater than 183 m (600 ft) in the Central and Western Planning Areas were identified (Section 3.3.1) as bottom trawling for royal red shrimp, trapping for golden crab, bottom longlining for grouper and tilefish, and surface longlining for yellowfin tuna, sharks, and swordfish. The golden crab fishery is extremely limited in the Gulf of Mexico, and the few vessels involved apparently restrict their activities to the eastern Gulf. Therefore, potential impacts on golden crab trapping by FPSOs will not be considered further.

The most important impact to deepwater fisheries from an FPSO and its attendant activities is space-use: the preclusion of fishers from viable fishing grounds over time. To evaluate the extent of expected space-use conflicts related to the FPSO base case and optional scenarios, several significance criteria were established.

Significance criteria are difficult to apply for generic base case and optional scenarios covered in this EIS because the precise locality of FPSO placement will usually determine whether the significance criteria are exceeded or not (i.e., if the FPSO is located within primary fishing grounds). Since no specific FPSO locations are evaluated in this analysis, impacts can only be approximated for bottom trawling and bottom longlining. The pelagic longline fishery, however, utilizes much of the open Gulf as its fishing grounds and estimates of space use can be projected for that area as a fishing ground. For bottom longlining and trawling, it is difficult to determine catch and effort for general areas of the open Gulf or how much revenue they can generate from a unit of ocean surface without knowing what area in particular will have an FPSO.

The approach taken in this analysis was to determine the amount of physical space at the seafloor and at the water surface that an FPSO installation and attendant activities will occupy, or effectively preclude. This estimated seafloor or water surface area was then used to estimate potential conflicts with fishers by calculating the amount of available area rendered unfishable during FPSO operation. This approach only addresses the first significance criterion given above; the two other criteria cannot be addressed in this analysis, and will have to be estimated on a case-by-case basis once an actual FPSO location is established. Areal preclusion was considered the same for the base-case scenario and alternatives. The most important variable separating the base-case scenario from the alternatives was water depth of FPSO installation.

Methods

For each fishery type considered (i.e., bottom trawling, bottom longlining, and surface longlining), the area precluded by an FPSO was estimated using various information. The total area of seafloor used by FPSO installation and operation depends upon water depth, anchor spread in moored systems, and placement of manifolds, wellheads and other seafloor structures relative to the FPSO. The maximum distance of a manifold from the FPSO is 3,658 m (12,000 ft) (Section 4.1); this value was used as the radius for calculating a circular area of seafloor that would be unavailable to bottom fishing with trawls or longlines.

To determine the area precluded to surface drifting longline by a single FPSO, the influence of the winds and surface currents as well as set and retrieval time for the gear must be considered. Centaur Associates, Inc (1981) proposed an approach which estimates a triangular area up-current from a surface structure that would be closed to fishing with surface-drifting gear. The apex of the triangle lies at the surface structure; the height of the triangle is estimated as average current velocity times the average duration of gear deployment (and retrieval); and the base of the triangle equals the expected uncertainty in drift orthogonal to the current direction (Centaur Associates, Inc., 1981).

The overall area available to fishers for each fishery was estimated using general Geographical Information System (GIS) maps that displayed bathymetry and planning area boundaries. For bottom longlining, the area available to fishers was estimated from published depth ranges of target species (Robins *et al.*, 1986; Hoese and Moore, 1998) for the Gulf of Mexico. Also, the area of the primary royal red shrimp grounds was estimated from maps prepared by NOAA (1985).

Alternative A - Installation

Under the base-case scenario, the total maximum area of seafloor excluded by the FPSO configuration (i.e., moorings, anchor spread, drag anchors, manifolds, and wellheads) is approximately 41 km^2 (16 mi^2, assuming a 1,115 m^2 [12,000 ft^2] radius, FPSO to wellheads). The area initially precluded as a result of early phases of installation and commissioning will be considerably less than that total area precluded by an operational FPSO. During these earlier steps of installation, with the exception of construction and precommissioning, surface and seafloor activities will effectively exclude small fishable areas around each installation vessel. For example, setting of the acoustic array during anchoring and manifold installation will preclude an area encompassing each work vessel plus a safety or buffer zone around each vessel, as well as the area of the array. Similarly, flowline and gas export line installation and umbilical installation will create corridors extending from the future FPSO site to each manifold. Bottom and surface fishing activities would be precluded in and around each well manifold, as well as around the FPSO anchor system and turret. Finally, installation of the FPSO will effectively preclude the maximum amount of area to be excluded around the FSPO (41 km^2 [16 mi^2]).

Installation activities will produce a negligible impact on commercial fisheries of this portion of the Gulf of Mexico. However, the short-term nature of the installation impacts leads to a longer-term impact (i.e., life of the production field) from routine operations.

Alternative A - Routine Operations

Bottom Trawling. Bottom trawling gear includes large trawl doors and a tickler chain that are in contact with the seafloor while the trawl is operating (Harrington *et al.*, 1988). These trawl components will easily foul or snag pipelines, anchors, manifolds, wellheads, and other debris protruding above the seafloor. In addition, because trawl doors will penetrate the substrate as deep as 10 to 12 inches, even partially buried objects may be snagged. Thus, total bottom area rendered untrawlable by the placement of the base-case scenario FPSO configuration would encompass moorings, anchor spread, drag anchors, manifolds, and wellheads. Assuming a 1,115 m^2 (12,000 ft^2) radius, this area is 41 km^2 (16 mi^2) around a single FPSO that is unavailable to bottom trawling for the duration of FPSO operations. A gas export line corridor and a vessel traffic lane is included within this areal estimate.

When area precluded is divided by the total available fishing area for the primary royal red shrimp grounds (i.e., the area bounded by long. 87 degrees W and 90 degrees W, and water depths between 91 and 549 m [300 and 1,800 ft]), the proportion of area excluded to fishable area is well below 10 percent. When five FPSOs are considered, the total area precluded relative to available depths it less than 3 percent. Because the base-case scenario assumes 1,524 m (5,000 ft) water depths, there would little, if any impact, to the royal red shrimp fishery which takes place in shallower depths. For optional scenarios that include FPSO placement in shallower waters (i.e., 183 m [600 ft]), the potential for space use conflicts would increase. However, even in the worst-case situation of five FPSOs within the primary fishing grounds, the area precluded would still be small and below the criteria for a significant impact. Only a few vessels engage in fishing for royal red shrimp, thus it would not take much to displace them. Once the area was abandoned, bottom-founded debris such as flowlines, anchors, mooring lines would present obstacles to trawling. Impacts associated with areal preclusion are considered to be adverse but not significant.

The most obvious measure available to reduce the potential conflicts with bottom trawling would be to ensure that FPSOs are not located in the primary royal red shrimp grounds in water depths of 183 to 549 m (600 to 1,800 ft). As mentioned previously, the base-case scenario already accomplishes this by virtue of the proposed 1,524 m (5,000 ft) operating water depths. Depending upon local bathymetry, a portion of the precluded area could extend into shrimping areas even if the FPSO itself is in deeper waters.

Bottom Longlining. Bottom longlines seldom exceed three to six km (two to four miles) long, but can be as long as 32 km (20 mi) in the Gulf of Mexico fishery. This gear is fished primarily in water depths less than 305 m (1,000 ft) for snappers, groupers, tilefishes, and sharks. Multiple hooks, monofilament mainline, surface buoys and weights composing a typical bottom longline could snag or tangle with bottom structures associated with the base-case scenario and optional FPSO operations. Space-use impacts to bottom longlines would be the same as those discussed above for bottom trawling. For the base-case scenario, gear use would be precluded from a 41 km^2 (16 mi^2) area which includes corridors for surface vessel traffic and the gas export line. The area precluded would be cumulative as more FPSOs are added up to five installations.

Bottom longlining is more widely distributed than bottom trawling in deepwater. The general area available to bottom longline fishers was estimated to include the area bounded by the eastern margin of the Central Planning Area and the western boundary of the Western Planning Area between the 91 and 549 m (300 and 1,800 ft) isobaths. This area encompasses 18,335 km^2 (5,338 nmi^2) for the Central Planning Area and 21,729 km^2 (6,326 nmi^2) for the Western Planning Area, or a total of 40,064 km^2 (11,664 nmi^2) for both planning areas combined. Therefore, the total area precluded by a moored FPSO would be much less than 10 percent of the total fishable area (i.e., 0.1 percent). The cumulative total of 207 km^2 (80 nmi^2) for five FPSOs would still represent much less than 10 percent of the available area (i.e., 0.5 percent).

Surface Longlining. Surface (pelagic) longlines used in the Gulf of Mexico yellowfin tuna fishery consist of mainline averaging 48 km (30 mi) but can exceed 97 km (60 mi) (NMFS, 1999b). Between 20 and 30 hooks (attached to short leaders) are attached per mile of mainline. Buoys with radar reflectors are placed regularly along the length of the passively drifting mainline. Thus, a longline deployed upstream of a fixed FPSO can snag surface and subsurface structures. In addition, the surface buoys can be run over by tankers and support vessels. Because this gear is passively drifting, space precluded by a surface object will include much more than the actual area of the surface vessel.

Surface currents in the Gulf of Mexico vary considerably and can range from 26 to 154 cm/sec (0.5 to 3 kn). Surface longlines are allowed to drift for four to five hours before a 10 to 12 hour retrieval period (Lopez *et al.*, 1979; Sakagawa *et al.*, 1987). Thus, for a 154 cm/sec (3 kn) current with a 17 hour set time and a 3.7 km (2.3 mi) uncertainty base, the triangular area upstream of the FPSO precluded to surface longlining would be 175 km^2 (51 nmi^2). Given a 26 cm/sec (0.5 kn) current with a 14 hour set time and 3.7 km (2.3 mi) uncertainty base, the triangular area precluded to longline fishing would be 24 km^2 (7 nmi^2).

Although these are large areas of preclusion, they are small relative to the entire fishing area utilized by surface longliners. Surface longlining occurs throughout the Central and Western Planning Areas, from seaward of the 183 m (600 ft) isobath to the edge of the Exclusive Economic Zone, an area estimated to encompass 243,185 km^2 (70,800 nmi^2). When the range of estimated areas to be precluded by FPSOs (i.e., 24 to 175 km^2 [7 to 51 nmi^2]) is considered relative to the area of the Central and Western Planning Areas, the total area precluded is very small, well below the 10 percent significance threshold (i.e., <0.08 percent).

A detailed analysis of potential conflicts between deepwater fishing and oil and gas operations has recently been contracted by MMS. This project will examine potential conflicts with all types of deepwater oil and gas operations and fishing practices. The results of the study will contribute more to the issues addressed in this section which focused only on generic placement of FPSOs.

Alternative A - Range of Options

As with royal red shrimping, placement of FPSOs in water depths of greater than 305 m (1,000 ft) would greatly lessen the chance for conflicts with bottom longlining. Because the base-case scenario is located at a 1,524 m (5,000 ft) depth, there should be no conflicts with bottom longlining as currently practiced in the Gulf. If optional scenarios involve shallower waters (e.g., along the 183 m [600 ft] isobath), then the potential for impact would increase, but only classify as significant if the FPSO was located on or near a known fishing area.

Remaining options available under Alternative A will have no effect on commercial fishing operations.

Alternative A - Decommissioning

The area precluded during decommissioning would be dependant upon several factors, including when each decommissioning step will be completed relative to the remaining steps. Decommissioning and removal of FPSO components is optimal from a commercial fishing perspective, however, on site abandonment of several components will ensure that several potential seafloor obstacles remain. Surface longlining will not be affected, while bottom trawlers will. Areas left untrawlable will represent only a fraction of the area excluded by FPSO operations. Decommissioning will result in negligible impacts to commercial fisheries. Following decommissioning, surface waters will no longer be precluded. Only limited seafloor will remain untrawlable.

Alternative B (B1 through B4)

Alternative B-1, exclusion of FPSOs from designated lightering prohibited areas, will have a positive impact on demersal fisheries (i.e., bottom longlining and trawling). This is particularly true for lightering prohibited areas located in water depths between 183 and 457 m (600 and 1,500 ft), where most deepwater demersal fisheries take place. Because FPSO operations excluded from lightering prohibited areas could be expected to move to other deepwater prospects, these operations are less likely to create space-use problems with demersal fisheries. This action will, however, incrementally increase space-use conflicts with the surface longline fishing.

Alternative B-2, exclusion of FPSOs from lease areas nearest south Texas (Corpus Christi and Port Isabel lease blocks located nearest to shore), will have limited impact on demersal fisheries for areas in the 183 and 457 m (600 to 1,500 ft) depth range. As stated previously, this will be beneficial to the demersal fisheries, but will potentially increase the space-use problems with the surface longline fisheries.

Alternative B-3, exclusion of FPSOs from lease areas nearest the Mississippi Delta, would effectively mitigate the adverse but not significant impact of FPSO space preclusion on the royal red shrimp fishery, which generally occurs in that area (i.e., within water depths of 183 and 457 m [600 to 1,500 ft]). This exclusion would slightly increase the space-use conflicts elsewhere in the deepwater areas where surface longlining occurs.

Alternative B-4, requirement for an attendant vessel to be present during offloading operations, will not impact commercial fisheries above what is projected for the proposed action (Alternative A).

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: During installation, with the exception of construction and precommissioning, surface and seafloor activities will effectively exclude small fishable areas around each installation vessel, a negligible impact. During routine operations, the total bottom area rendered untrawlable (i.e., area precluded) by the placement of the FPSO, gas export line corridor, and vessel traffic lane is small, an adverse but not significant impact. Space-use impacts to bottom longlines would be the same, adverse but not significant. Surface longlining impacts are also expected to be adverse but not significant. Under the range of options, the placement of FPSOs in water depths of greater than 305 m (1,000 ft) would greatly lessen the chance for conflicts with bottom longlining. If optional scenarios involve shallower waters (e.g., along the 183 m [600 ft] isobath), then the potential for impact would increase, but would only be significant if the FPSO was located on or near a known fishing area. Remaining options available under Alternative A will have no effect on commercial fishing operations. During decommissioning, surface longlining will not be affected (i.e., no impact). Areas left untrawlable (via abandonment on the seafloor) represent a negligible impact to commercial fisheries.

Alternative B: Alternative B-1 will have a positive (beneficial) impact on demersal fisheries (i.e., bottom longlining and trawling), particularly for lightering prohibited areas located in water depths between 183 and 457 m (600 and 1,500 ft). Alternative B-1 will, however, produce an incremental increase space-use conflicts with the surface longline fishing, an adverse but not significant impact. Alternative B-2 will have limited impact on demersal fisheries for areas in the 183 and 457 m (600 to 1,500 ft) depth range. As noted previously, this will be beneficial to the demersal fisheries, but will potentially increase the space-use problems with the surface longline fisheries, an adverse but not significant impact. Alternative B-3 would effectively mitigate the adverse but not significant impact of FPSO space preclusion to the royal red shrimp fishery which generally occurs in that area (i.e., within water depths of 183 and 457 m [600 to 1,500 ft]). This exclusion would slightly increase the space-use conflicts elsewhere in the deepwater areas where surface longlining occurs, an adverse but not significant impact. Alternative B-4 will not impact commercial fisheries above what is projected for the proposed action (Alternative A), an adverse but not significant impact.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.11 Social and Economic Environment

Significance Criteria: *There are yet to be established widely accepted conventions regarding significance criteria or standards for social and economic environmental outcomes. In some cases, socioeconomic and sociocultural information does not readily lend itself to quantification. Most analysts assess socioeconomic and sociocultural outcomes in qualitative terms, assessing the available evidence noting positive and negative consequences thereof. For the purposes of this analysis, a* ***significant*** *impact to social and economic resources would be realized if three to five percent of the labor force is affected, although this determination must be considered relative to the qualitative evidence available.*

Terminology and Resource-Specific Definitions: *For social and economic impact assessment, "short term" refers to an impact duration of five years or less, whereas "long term" is defined as any impact that exceeds five years. "Local" (or "localized") is defined as an impact that occurs within a specified labor market area, whereas* *"regional" encompasses those impacts that are manifest within a set of two or more labor market areas.*

No experimental modeling of social and economic environmental outcomes was conducted to assess the impact of routine FPSO operations on the Gulf coast communities of Texas, Louisiana, Mississippi, and Alabama. Such an effort would have required, among other things, derivation of economic multipliers from input/output modeling. An iterative exercise of this nature requires more precise site-specific information (e.g., FPSO location, location and manpower estimates for service and supply vendors involved in all phases of installation, operation, and decommissioning) that remains unavailable (i.e., beyond the scope of the present socioeconomic analysis). In lieu of a modeled analysis, the impact assessment has relied on a fundamental comparison of population and labor trends and projections for the Gulf region and select labor market areas, an evaluation of employment demands associated with FPSO development, and an assessment of the proportional contribution FPSO development may be expected to produce to the oil and gas-related labor market.

As noted by MMS (2000b), deepwater oil and gas development has far-reaching employment implications. For every million dollars invested in offshore projects, 20 jobs are created; for every 10 jobs created offshore, 37 jobs are created onshore. It has been estimated that full field deepwater drilling and development costs can exceed $1 billion, thereby creating over 20,000 new jobs for a single field (USDOI, MMS, 2000b).

An average deepwater project is estimated to require approximately 400 employees, the majority of which are expected to be drawn from the current labor force residing in the Gulf of Mexico coastal region. In addition, employment demands from outside of the Gulf of Mexico coastal area may also be realized, creating in migration of skilled labor.

As noted in Section 3.3.2, past historical trends and future projections in population, labor, and employment for the Gulf coast region of interest (i.e., Alabama, Louisiana, Mississippi, Texas) were completed as part of this analysis, with an emphasis on descriptions and socioeconomic profiles of the 13 coastal labor market areas (LMAs).

The Gulf coastal region realized a population increase between 1970 and 1980 of 27 percent, followed by a more modest increase of 10 percent between 1980 and 1990. Since the 1990 decennial census, the region's population had grown 13 percent as of 1998, yielding a total of more than 11 million persons. The LMAs reflect diverse patterns for the 1970 to 1998 period, with highest growth evident in Brownsville, Brazoria, and Houston-Galveston. Other labor market areas exhibit slower growth, with several showing population declines between 1980 and 1990, coincident with a major contraction in oil and gas industry activity along the Gulf coast

The civilian labor force in the region expanded substantially from 1970 to 1980 and more modestly from 1980 to 1990. The largest industry sectors in terms of employment included services and wholesale/retail trade. The most notable change in the occupation distribution has been the increased share for management and professional occupations. These overall trends vary substantially from one labor market area to another.

Population trends and projections for the four-state region (i.e., Alabama, Louisiana, Mississippi, and Texas) and for the 13 coastal commuting zones of interest were established for the period from 2000 to 2020, as detailed in Section 3.3.2. Both the Gulf coast area and the region as a whole are projected to realize increases in population, although this tapers off throughout the projection period. During this period, both the four-state region and Gulf coast are projected to experience a considerable shift in age structure, with three demographic factors at work (i.e., the influence of the Baby Boomers and the shift in population balance towards older groups over time; low fertility levels of the late 1960s and 1970s adding fewer people to the generation that followed the Boomers; slow population growth in the nation, in the South, and in the LMAs of interest).

Differences in age structure, as well as in net migration, among the coastal commuting zone areas could create variations in population growth. The highest population growth rates from 2000 to 2020 are projected to be in Brownsville and Beaumont-Port Arthur, followed by Brazoria and the Houston-Galveston area. All have rates above 27 percent for this time period. The lowest population growth rates (under 14 percent) are found in the coastal Louisiana commuting zones of Lake Charles, Lafayette, Houma, and New Orleans. Biloxi-Gulfport, Baton Rouge, Corpus Christi, Mobile, and Victoria are all expected to exhibit low to moderate population growth during this time period.

Although labor force changes and population changes are interrelated, trends can and do diverge when much of the change in population is found in the non-working ages. This is the case in both the four-state region and coastal commuting zones evaluated. Population changes are expected to generally remain constant while the five-year rates for labor force change decrease throughout the projection period. Once in double digits during the 1980 to 1985 period, labor force change is projected to drop to 2.45 percent for the region and 5.67 percent for the coastal areas by the 2015 to 2020 period.

The coastal Texas commuting zones of Brownsville and Beaumont-Port Arthur have the highest labor force growth rates, followed by Brazoria and the Houston-Galveston area. The coastal Louisiana commuting zones of Lake Charles, Lafayette, Houma, and New Orleans have the lowest growth rates. Moderate labor force growth is projected for Biloxi-Gulfport, Baton Rouge, Corpus Christi, Mobile, and Victoria.

Although the growth of the labor force is projected to slow considerably during the first two decades of the 21st century, these growth rates vary considerably by industry. For the coastal areas of the Central and Western Gulf, the overall change in labor force of 20 percent is primarily driven by retail and services growth. Total employment in oil and gas is projected to decrease from 132,209 to 106,108. This would constitute a loss of 19 percent for the coastal commuting zones, irrespective of any proposed FPSO activities.

The areas most effected by this loss in oil and gas employment are the Lake Charles and New Orleans commuting zones in Louisiana, and the Beaumont-Port Arthur area in Texas. However, with the exception of Biloxi-Gulfport, all areas are projected to lose employment in this industry. Projected declines in oil and gas employment are expected in all but one of the coastal commuting zones, with declines ranging from nearly 16 to more than 32 percent. The sole exception to this trend is evident for the Biloxi-Gulfport area; while employment projections in the oil and gas industry for this area are positive, these projections involve a very small number of jobs (i.e., 356 in 2000, increasing to 363 in 2020).

Alternative A - Installation

Assuming that the installation phase includes construction associated with vessel fabrication, this could be a source of positive social and economic impact on coastal communities. However, the scenarios that have been developed indicate that the vessel(s) might or might not be built in a Gulf port. If the vessels are constructed at a port along the Gulf of Mexico, that port could experience a beneficial, but relatively short-term increase in activity. Pike (1999) concludes that construction and outfitting of an FPSO and possible associated shuttle tankerage on the Gulf of Mexico will require expenditures of approximately 159 to 239 million dollars. These funds, in turn, generate economic benefits to the region of between 463 and 720 million dollars (with shuttle tanker construction) using an industry accepted multiplier of 2.0 to 2.5. These funds will be dispersed to the local economy through direct and ancillary employment; local, regional and Federal taxation; and increased demand for capital and consumer goods (Pike, 1999).

Pike (1999) estimates 469 full-time shipyard jobs over a two-year period. Thus, if the vessels are constructed at a port along the Gulf of Mexico, that port could experience a beneficial, but relatively short-term increase in activity. However, since the vessels could be floated in from virtually any construction site in the world, it is important to assess this potential beneficial impact of construction on local employment levels with this caveat in mind.

Alternative A - Routine Operations

One source of socioeconomic impact associated with FPSO operations is employment. The 13 LMAs that form the baseline for this analysis have an aggregate population of more than 11 million persons. It is highly unlikely that routine FPSO operations will significantly affect such a coastal labor force of this scope and complexity. The base-case scenario indicates that the FPSO vessel would have a standard staffing of 40 persons. While still others could be employed in shuttle transport, the sum total of employment (i.e., several hundred people) cannot approach a level that will significantly impact any particular labor market. As a consequence, impacts of FPSO operations on employment are considered to be negligible.

As noted in Section 4.3.4, current tanker traffic in the Gulf of Mexico consists of an estimated 15,220 foreign and 1,114 domestic vessels per year. These may be different vessels or the same vessel making several trips through the Gulf. Relative to existing tanker traffic, FPSO development may increase the number of tankers operating in the Gulf a few percent. Future projections suggest that FPSO-related tanker traffic will represent 1.5 to 3.1 percent of total tanker levels for Gulf ports. Given the level of current shuttle tanker operations, the incremental impact of these operations is modest, and subsequent impacts to the socioeconomic environment are considered negligible. In terms of safety concerns for offshore workers, there is no evidence to suggest that existing FPSO operations elsewhere have resulted in safety problems in excess of that which is routine for offshore work.

Alternative A - Range of Options

The are several options to the base-case FPSO that have the potential to adversely affect the socioeconomic environment. While the base-case scenario studies one FPSO location, there is an option for up to five geographically dispersed FPSOs. If the five FPSO were dispersed throughout the FPSO study area (i.e., separated by approximately 320 km [199 mi]), it is not likely that five FPSOs would have significantly more impact on socioeconomic resources than one FPSO because the labor and support demands from each FPSO would be distributed to ports and shorebase facilities closest to each FPSO. However, if the five FPSOs were placed in close proximity to one another, it is possible that one or two port facilities would realize the bulk of the socioeconomic impact. While the extent of this potential impact cannot be precisely determined without further project-specific details, only adverse but not significant impacts would be realized.

Options for increased storage capacity (e.g., 2,300,000 barrels vs. 1,000,000 barrels) and increased production rates (300,000 BPD vs. 100,000 BPD) are expected to produce a slightly greater impact on socioeconomic resources, given that labor requirements would be expected to increase above those noted for the base-case scenario. The extent of this impact cannot be precisely determined; however, it is suggested that such impacts would be negligible given the size of the current and projected labor force, coupled with the current assessment that base-case FPSO operations will only produce negligible impacts on the labor force.

The use of a tug in offloading operations would prompt a minor increase in labor force demands, a negligible impact.

Alternative A - Decommissioning

There is no basis in the literature for assessing the socioeconomic implications of FPSO decommissioning. Given the proposed level of support and the relatively short timeframe required for decommissioning operations, only negligible socioeconomic impacts are expected.

Alternative B (B1 through B4)

Alternative B-1, exclusion of FPSOs from designated lightering prohibited areas, will have negligible impact on social and economic outcomes beyond those already noted for Alternative A.

Alternatives B-2 and B-3, exclusion of FPSOs from lease areas nearest south Texas (Corpus Christi and Port Isabel lease blocks located nearest to shore) and exclusion of FPSOs from lease areas nearest the Mississippi Delta, will have negligible social and economic impact overall. Such an action might dampen any beneficial effects of FPSO-related offshore employment of workers residing along coastal areas adjacent to the exclusion zones. This is not likely to be a very substantial problem, however, as offshore employment tends to draw from a very wide geographic region. Presumably, such an exclusion would not preclude FPSO vessel or related tankerage construction in coastal ports near any excluded areas.

Alternative B-4, requirement for an attendant vessel to be present during offloading operations, will have a minor incremental impact on social and economic impacts above what is projected for the proposed action (Alternative A). It would be reasonable to expect slightly more employment associated with operation of attendant vessels. The overall employment levels for routine FPSO operations would appear to have a negligible impact on the Gulf coast economy.

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives

B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: If one or more FPSOs vessels are constructed at a port along the Gulf of Mexico, a beneficial, but relatively short-term impact would be realized as a consequence of that increase in activity. If one or more FPSOs are floated in from a construction site elsewhere (i.e., outside the Gulf region), no impact on local employment levels will be realized. For routine operations, impacts of FPSO operations on employment are considered to be negligible. Shuttle tankering operations will produce an incremental but negligible impact on the socioeconomic environment. Under the range of options, the installation of up to five geographically dispersed FPSOs are expected to produce negligible impacts to socioeconomic resources. In the event five FPSOs were placed in close proximity to one another, it is possible that one or two port facilities would realize the bulk of the socioeconomic impact – an adverse but not significant impact. Increased storage capacity and increased production rates are expected to produce a slightly greater impact on socioeconomic resources relative to the base case, a negligible impact. The use of a tug in offloading operations would prompt a minor increase in labor force demands, a negligible impact. For decommissioning, the level of support and the relatively short time frame required will produce only negligible socioeconomic impacts.

Alternative B: Alternative B-1 will have negligible impact on social and economic outcomes. Alternatives B-2 and B-3 will have negligible social and economic impact overall, however, the beneficial effects of FPSO-related offshore employment (of workers residing along coastal areas adjacent to the exclusion zones) may be dampened slightly. Alternative B-4 will have a minor incremental impact on social and economic impacts above what is projected for the proposed action (Alternative A), a negligible impact.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.12 Recreational Resources and Beach Use

Significance Criteria: *There are no established, quantitative criteria available for impacts to recreational resources and beach use. Qualitative criteria for recreational resources, including aesthetic or visual considerations, encompass the following:*

- *Recreational impacts are considered* ***significant*** *if they cause long-term interference with coastal access or recreational use, or long-term degradation of a significant recreational resource; and*
- *Visual and aesthetic impacts are considered* ***significant*** *if they affect a large viewing population, are relatively close to the affected viewing population, remain for a long period of time, or present a substantial degree of change inconsistent with the existing viewshed.*

Terminology and Resource-Specific Definitions: *For the impact assessment pertinent to recreational resources and beach use, spatial and temporal definitions are similar to those applied to social and economic resources. "Short term" refers to an impact duration of five years or less, whereas "long term" is defined as any impact which exceeds five years. "Local" (or "localized") is defined as an impact which occurs within a specified recreational area or beach, or within several recreational or beach areas within close proximity to one another (e.g., within 15 km [9 mi]). The definition for "regional" is problematic. However, in general, "regional" encompasses those impacts which are manifest within one or more recreational or beach areas, depending upon the extent of the individual recreational or beach area, or the proximity of several areas to one another (e.g., greater than 15 km [9 mi]).*

As summarized in Section 3.3.3, the coastal zone of Texas, Louisiana, and Mississippi is considered a major U.S. recreational region. Prominent recreational resources within this area include coastal beaches, barrier islands, estuaries, bays and sounds, river deltas, and tidal marshes, as well as nearshore and offshore marine waters.

Coastal recreational resources include recreation areas (e.g., national seashores, parks, beaches, wildlife lands) and designated preservation areas (e.g., historic and natural sites, landmarks, wilderness areas, wildlife sanctuaries, scenic rivers), as well as resorts, marinas, amusement parks, and ornamental gardens.

Beaches are a major resource that attracts tourists and residents, and serve as a major economic component for many of the Gulf's coastal communities, especially during the peak use seasons (i.e., spring, summer). According to the MMS (1997b), recreational resources, activities, and expenditures are not uniformly distributed along the Gulf, but are focused where public beaches are close to major urban centers, coincident with potential shorebase locations which will support FPSO operations.

Alternative A - Installation

Installation activities associated with FPSO commissioning will not directly affect recreational resources and beach use. There are expected to be slight increases in the number of supply and support vessel transits to and from support bases and fabrication yards, resulting in minor incremental impacts to the viewshed of beach and waterway users within sight of these facilities or the transit lanes that they will employ. Oil and gas support operations are a common and accepted component of the Gulf environment. Given the limited number of vessels required (above existing levels) and the relatively short timeframe for each phase of installation activity, such negligible impacts are short term and extremely localized.

The aesthetic aspects of beach and waterways use are based, in part, on the both perceived and measured water quality in coastal, nearshore waters. Based on the water quality impact assessment presented in Section 4.3.3, discharges from installation will not adversely affect either offshore or coastal water quality. As a result, because there is no predicted diminution in ambient water quality, impacts to recreational resources and beach use are not expected.

Alternative A - Routine Operations

During routine operations, the only impacts FPSOs will produce on recreational resources and beach use will be those associated with the incremental increase in vessel traffic due to supply boat support and shuttle tankers, as well as helicopters. The incremental increase in support vessel or helicopter traffic is negligible, given the current levels being experienced in the Gulf. The significance of incremental increases in shuttle tankering varies depending upon the location of the shuttle tanker destinations. Proposed shuttle tanker destinations include:

- Mississippi River Ports
- LOOP
- Lake Charles-Cameron
- Port Arthur-Beaumont
- Houston-Galveston
- Freeport
- Corpus Christi

The base-case scenario calls for one FPSO to be stationed at an unspecified location in the northwestern Gulf of Mexico, with an offloading frequency of once every three days. This suggests a shuttle tanker total of approximately 220 harbor transits per year at peak production. Relative to other commercial vessel traffic (i.e., 15,220 foreign and 1,114 domestic vessels per year), this incremental increase is minor. Individuals using recreational resources (e.g., beaches, waterways) in close proximity to ports being proposed for FPSO operations should not be significantly affected by this increase in shuttle tanker frequency; impacts to recreational resources and beach use are considered negligible.

Based on the water quality impact assessment presented in Section 4.3.3, discharges from routine operations will not adversely affect either offshore or coastal water quality. As a result, because there is no predicted diminution in ambient water quality in coastal, nearshore waters, impacts to recreational resources and beach use are not expected.

Alternative A - Range of Options

The are several options to the base-case FPSO that have the potential to further affect recreational resources and beach use, above those impact levels noted for the base-case scenario.

If the five FPSO were dispersed throughout the FPSO study area (i.e., separated by approximately 320 km [199 mi]), it is not likely that five FPSOs would have significantly more impact on recreational resource and beach use. However, if the five FPSOs were placed in close proximity to one another, it is possible that one or two port facilities would realize the bulk of the shuttle tanker and support vessel traffic. While the extent of this potential impact cannot be precisely determined without further project-specific details, it is projected that negligible impacts associated with the bases case would increase slightly to adverse but not significant.

Options for increased storage capacity (e.g., 2,300,000 barrels vs. 1,000,000 barrels) and increased production rates (300,000 BPD vs. 100,000 BPD) are expected to produce a higher level of shuttle tanker traffic, above those noted for the base-case scenario. The extent of this impact cannot be precisely determined, however, it is suggested that such impacts would be negligible given the amount of tankering activity currently being conducted at Gulf ports.

Alternative A – Decommissioning

Activities associated with FPSO decommissioning will not directly affect recreational resources and beach use. There are expected to be slight increases in the number of supply and support vessel transits to and from support bases, resulting in minor incremental impacts to the viewshed of beach and waterway users within sight of these facilities or the transit lanes that they will employ. Oil and gas support operations are a common and accepted component of the Gulf environment. Given the limited number of vessels required (above existing levels) and the relatively short timeframe for each phase of decommissioning, such negligible impacts are short term and extremely localized.

Based on the water quality impact assessment presented in Section 4.3.3, discharges from decommissioning activities will not adversely affect either offshore or coastal water quality. As a result, because there is no predicted diminution in ambient water quality, impacts to recreational resources and beach use are not expected.

Alternative B (B1 through B4)

Alternative B-1, exclusion of FPSOs from designated lightering prohibited areas, will have no impact on recreational resources and beach use.

Alternatives B-2 and B-3, exclusion of FPSOs from lease areas nearest south Texas (Corpus Christi and Port Isabel lease blocks located nearest to shore) and exclusion of FPSOs from lease areas nearest the Mississippi Delta, will have negligible impact on recreational resources and beach use. Given the distance these nearshore lease blocks are from shore, the viewshed of beach and waterways users will not be affected.

Alternative B-4, requirement for an attendant vessel to be present during offloading operations, will have no impact on recreational resources and beach use. The addition of one vessel every third day to existing vessel activity levels will be inconsequential.

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: Installation activities associated with FPSO commissioning will not directly affect recreational resources and beach use. Slight increases in the number of supply and support vessel transits will produce minor, incremental impacts to the viewshed, a negligible impact which will be short term and extremely localized. No impacts to recreational resources and beach use are expected in association with perceived water quality degradation. During routine operations, incremental increases in vessel traffic and helicopter operations will produce negligible impacts to recreational resources and beach use. Under the range of options, impacts to recreational resources and beach use are expected to be adverse but not significant. Options for increased storage capacity and increased production rates will result in negligible impacts given the amount of tankering activity currently being conducted at Gulf ports. Activities associated with FPSO decommissioning will not directly affect recreational resources and beach use. Slight increases in the vessel traffic will result in minor incremental impacts to the viewshed, a negligible impact. No impacts to recreational resources and beach use are expected from perceived alteration of ambient water quality.

Alternative B: Alternatives B-1 and B-4 will have no impact on recreational resources and beach use, while Alternatives B-2 and B-3 will produce negligible impact to these resources.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.13 Cultural Resources

In this EIS, impacts on cultural resources were considered but not analyzed in detail, given the fact that there are no unique FPSO-related activities (and associated impact-producing factors) that might adversely affect cultural resources.

Alternative A - Installation

Utilization of FPSOs for deepwater development will require the installation of subsea systems consisting of production wells, manifolds, and flowlines. Construction of these facilities will affect highly localized areas of the seafloor. Disturbance of the seafloor during installation of the FPSO will not differ materially from the bottom sediment disturbances that would take place during the installation of any other conventional subsea system. If historical shipwrecks exist at the location of any proposed FPSO subsea facilities, those facilities will be installed by the operator subsequent to the studies of the bottom conditions undertaken as the part of the DWOP. Shipwrecks can be identified by remote-sensing technologies (e.g., magnetometers, side-scan sonar) and avoided as the most effective mitigation measure.

Utilization of an FPSO will not involve installation of oil pipelines on the seafloor between the shore and the 200-m bathymetric contour. However, it is possible that a gas export line may be laid from the FPSO across the continental shelf to an undetermined shoreline landfall, in the event the FPSO gas export line cannot be tied into an existing gas pipeline network. Since the coastal areas and the nearshore bottom sediments can contain both historic shipwrecks and prehistoric sites, application of the FPSO development methods is likely to slightly increase the probability of adverse effects on significant cultural resources. This increase, however, is not as great as impacts associated with conventional methods of oil production and transport (i.e., laying of oil pipelines in shallow, nearshore waters).

Alternative A - Routine Operations

Routine operation of an FPSO will not affect cultural resources in the deepwater portions of the Central and Western Planning Areas. Prior to installation and operation, remote sensing surveys (i.e., magnetometer, side-scan sonar) will be conducted at the FPSO site. Should the survey results indicate the presence of cultural resources, the MMS will establish an appropriate buffer zone around the resource, effectively precluding FPSO operations from that area and eliminating the potential for impact. Therefore, no impacts to cultural resources from routine operations are expected.

Alternative A - Range of Options

Implementation of any of the range of options under Alternative A will not affect cultural resources in the deepwater portions of the Central and Western Planning Areas. No impacts are expected.

Alternative A – Decommissioning

Decommissioning operations will have no impact on cultural resources.

Alternative B (B1 through B4)

Alternatives B-1 through B-4 will have no impact on cultural resources.

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: Installation of the FPSO and associated subsea systems will have no impact on cultural resources, provided that remote sensing of the FPSO site is completed and possible resources are avoided. In the event a gas export line is installed between the FPSO and a shoreline landfall, there is a possibility that cultural resources in shallow water could be affected, an adverse but not significant impact. Operation and decommissioning of the FPSO will have no impact on cultural resources.

Alternative B: None of the alternatives will produce an impact to cultural resources.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.14 Other Uses

> ***Significance Criteria:*** *There are no established, quantitative criteria available for impacts to other uses. A qualitative criterion for a* **significant** *impact includes long-term interference with other uses of the Gulf by commercial and/or military interests.*
> ***Terminology and Resource-Specific Definitions:*** *For other uses impact assessment, the absence of quantitative significance criteria is problematic, however, similarities can be established between other uses and specific resource areas (i.e., recreational resources and beach use). In general, a "short term" impact refers to an impact duration of five years or less, whereas "long term" is defined as any impact which exceeds five years. "Local" (or "localized") is defined as an impact that occurs within 15 km (9 mi) of the impact source. In general, "regional" encompasses those impacts which are manifest within an area greater than 15 km (9 mi) from the source of the impact.*

Deepwater portions of the Central and Western Gulf of Mexico are utilized by several other interests, including commercial shipping and military use. The magnitude of both offshore oil and gas activities (e.g., tankering of crude oil, oil and gas supply and support vessel operations) and shipping operations through Gulf ports has led to the establishment of a series of safety fairways or vessel traffic separation schemes, and anchorages to provide unobstructed approach for vessels using U.S. ports. Shipping safety fairways, generally located inshore of the deepwater region considered in this analysis, are lanes or corridors in which no fixed structure, whether temporary or permanent, is permitted. Fairway anchorages are areas contiguous to and associated with a fairway, in which fixed structures may be permitted within certain spacing limitations. All offshore structures, including any proposed FPSOs, are required to be adequately marked and lighted. After a structure is in place, it often becomes a landmark and an aid to navigation for vessels that operate in the area on a regular basis.

Military operations may be conducted within nearshore or offshore waters throughout the Gulf of Mexico, staged either from onshore facilities (e.g., from an air station or air base) or as part of offshore fleet operations (e.g., routine fleet activities, special or joint maneuvers). U.S. Navy assets which might be operational on a transitory basis within the project area include surface vessels, submarines, and aircraft, typically between a shorebase and offshore waters. The Coast Guard conducts routine activities and search and rescue operations using both surface vessels and aircraft. Similarly, the U.S. Air Force may conduct aerial operations over the deepwater region of the Gulf.

Alternative A - Installation

Installation activities associated with FPSO commissioning will not directly affect other uses. There are expected to be slight increases in the number of supply and support vessel transits to and from support bases and fabrication yards as a result of installation. Given the limited number of vessels required (above existing levels) and the relatively short timeframe for each phase of installation activity, such negligible impacts are short term and extremely localized. Impacts to other uses from FPSO installation are considered to be negligible.

Alternative A - Routine Operations

During routine operations, the only impacts FPSOs will produce on other uses of coastal and offshore Gulf waters will be those associated with the incremental increase in vessel traffic due to supply boat support and shuttle tankers, as well as helicopters. The incremental increase in support vessel or helicopter traffic is negligible, given the current levels being experienced in the Gulf.

The base-case scenario calls for one FPSO to be offloaded once every three days, producing a shuttle tanker total of 243 harbor transits per year during the life of the field. Relative to other commercial vessel traffic (i.e., 15,220 foreign and 1,114 domestic vessels per year), and not considering military vessel use, this incremental increase is extremely minor. Impacts to other uses are considered negligible.

Alternative A - Range of Options

None of the options identified will have an effect on either impact-producing factors or subsequent impacts to other uses.

Alternative A – Decommissioning

Activities associated with FPSO decommissioning will not directly affect other uses. There are expected to be slight increases in the number of supply and support vessel transits to and from support bases, resulting in minor incremental increases to the potential for conflict with other uses. Given the limited number of vessels required (above existing levels) and the relatively short timeframe for each phase of decommissioning, such negligible impacts are short term and extremely localized.

Alternative B (B1 through B4)

Alternative B-1, exclusion of FPSOs from designated lightering prohibited areas, will have a beneficial impact on other uses. In general, FPSO operations excluded from lightering prohibited areas could be expected to move to other deepwater prospects.

Alternatives B-2 and B-3, exclusion of FPSOs from lease areas nearest south Texas (Corpus Christi and Port Isabel lease blocks located nearest to shore) and exclusion of FPSOs from lease areas nearest the Mississippi Delta, will have a minor, beneficial impact on other uses. Commercial and military vessels using these areas would not have to consider the navigational and safety concerns associated with an FPSO placed in these areas.

Alternative B-4, requirement for an attendant vessel to be present during offloading operations, will have a minor incremental impact on other uses above what is projected for the proposed action (Alternative A). Under this alternative, there will be a slight increase in the total number of vessels supporting FPSO operations, with a corresponding increase in the potential for conflict with other uses. Overall, the impact of this alternative will be negligible.

Alternative C

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS. Furthermore, if FPSOs were eventually deployed on the OCS under Alternative C, the environmental consequences of these operations could be expected to be similar to alternatives B-1 through B-3, if the corresponding geographic exclusion areas were applied. Although, environmental consequences resulting from a decision for the No Action alternative may be the same as for alternatives A and B, any use of FPSOs under Alternative C may be delayed and/or spread out over a longer period of time. Another potential result may be the use of alternative development systems (e.g., TLPs, semi-submersibles, or spars) for some deepwater fields, where impacts would be expected to be similar to the proposed action. A decision for Alternative C may also result in some fields not being developed, or development being delayed because of issues related to technological and economic viability. In this case, the impacts otherwise associated with the proposed action would not occur.

Summary

Alternative A: Installation activities associated with FPSO commissioning will not directly affect other uses, although slight increases in the number of supply and support vessel transits will occur – a negligible impact of short duration that will be extremely localized. During routine operations, incremental increases in vessel traffic, helicopters, and shuttle tankering will produce negligible impacts on other uses. None of the options identified will have an effect on either impact-producing factors or subsequent impacts on other uses (i.e., no impacts). Activities associated with FPSO decommissioning will not directly affect other uses. Slight increases in supply and support vessel traffic will result in minor incremental increases to the potential for conflict with other uses, a negligible impact.

Alternative B: Alternative B-1 will have a beneficial impact on other uses. Alternatives B-2 and B-3 will have a minor, beneficial impact on other uses. Alternative B-4 will have a minor incremental impact on other uses above what is projected for the proposed action (Alternative A), a negligible impact.

Alternative C: Under Alternative C, the No Action alternative, the general concept of using FPSOs in the GOM OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the GOM. Operators could submit project-specific FPSO development proposals to MMS for consideration under established review and decision processes (including the NEPA process). Consequently, the environmental consequences associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or alternatives B-1 through B-3, if up to five FPSO projects were eventually approved for the Western and Central planning areas of the OCS.

4.3.15 Mitigation

The purpose of mitigation is to either eliminate a significant impact associated with a proposed action, or reduce the level of such impact on an insignificant level (e.g., reduce to adverse but not significant or negligible). Feasible mitigation measures are discussed in the following section for significant impacts associated with routine FPSO operations (i.e., installation, production and offloading [routine production operations], and decommissioning) of the proposed action (Alternative A, base-case scenario) and the range of options. Alternatives B and C are also considered.

4.3.15.1 Introduction

The following discussion summarizes the significant impacts identified previously on a resource-specific basis. Because impact-producing factors and associated impacts are resource-dependant (e.g., air quality, offshore environments, social and economic resources, etc.), mitigation measures are similarly classified.

4.3.15.2 Air Quality

Potentially significant impacts have been predicted (using USFWS significance criteria) for routine operations in the northeastern (nearshore) corner of the Mississippi Canyon lease area, offshore of a Class I nonattainment area (Breton Sound NWA) under the base-case scenario (Alternative A). Since the modeling has shown the potential impacts from FPSO operations are largely due to burning fuels with higher sulfur content, (e.g., off-road diesel, kerosene), the discussion of feasible mitigation measures are focused on this issue.

Diesel emissions are typically controlled at their source, through engine design and modifications, or by exhaust gas aftertreatment. In many cases, these approaches are complimentary. While engine modifications and exhaust catalysts work to reduce particulate matter, NO_2, and CO, they have little effect on SO_2 emissions because they are dependent on fuel-borne sulfur content. In some cases, a diesel oxidation catalyst used with high sulfur fuel will increase the total particulate matter emissions at higher temperatures because of the reaction between the catalyst and the sulfur. This is why diesel catalysts became more widespread only after the commercial introduction of low sulfur diesel fuel occurred in 1993. The sulfur content in over-the-road diesel is currently set as 500 ppm (0.05 percent), while diesel fuel for off-road sources can contain up to 0.4 percent sulfur compounds. Reducing the sulfur content of the fuel is an effective means of reducing SO_2 emissions by 90 percent or more.

4.3.15.3 Water and Sediment Quality

No significant impacts to water and sediment quality were identified for FPSO installation, routine operations, or decommissioning (Alternative A, base-case scenario), nor were impacts of significance found when considering the range of options under Alternative A. Similarly, none of the alternatives were projected to produce significant impacts. As a consequence, no mitigation measures have been identified for water and sediment quality.

It should be noted that this impact assessment was based on the assumption that operational discharges will comply with current NPDES effluent limitations. Under NPDES permit limits, periodic monitoring requirements have been established for the oil and gas extraction subcategory for production-related wastes. Non-production wastestreams would be in compliance with MARPOL and other Coast Guard requirements. Violations of permitted effluent limitations may produce significant impacts to water quality. Sediment quality is unlikely to be affected under such circumstances.

4.3.15.4 Coastal Environments

No significant impacts on coastal environments quality were identified for FPSO installation, routine operations, or decommissioning (Alternative A, base-case scenario), nor were impacts of significance found when considering the range of options under Alternative A. None of the alternatives were projected to produce significant impact. As a consequence, no mitigation measures have been identified for coastal environments under these alternatives.

Considering the number of additional vessel transits possible under Alternative B-4, is has been predicted that impacts would range from negligible to adverse but not significant, depending upon the level of vessel traffic and the susceptibility of coastal environments to erosion, turbidity effects, and resuspended sediments. As feasible mitigation, support operations should be evaluated on the basis of coastal environment shoreline characteristics. Those coastlines which are eroding should be avoided, with supply and support vessel operations based elsewhere, preferably in coastal areas less sensitive to vessel traffic.

4.3.15.5 Offshore Environments

With the possible exception of chemosynthetic communities, no significant impacts to offshore environments were identified for FPSO installation, routine operations, or decommissioning (Alternative A, base-case scenario), nor were impacts of significance found when considering the range of options under Alternative A. Similarly, none of the alternatives were projected to produce significant impacts. As a consequence, no mitigation measures have been identified for offshore environments.

Damage to or elimination of chemosynthetic communities would be a significant, long-term impact, as noted in Section 4.3.5. While identification and avoidance of chemosynthetic communities is required under current MMS regulations (i.e., NTL 98-11), it has been noted that chemosynthetic communities cannot be reliably detected directly using present geophysical techniques. Alternate methods for determining community presence should be investigated to ensure that these sensitive biological resources are avoided. Once a high-density chemosynthetic community is identified and characterized, a zone of no activity should be established around each site (e.g., no activity within 328 m [1,000 ft] radius of any verified chemosynthetic community).

4.3.15.6 Marine Mammals

With the exception of possible collision with a marine mammal, no significant impacts were identified for FPSO installation, routine operations, or decommissioning (Alternative A, base-case scenario), nor were impacts of significance found when considering the range of options under Alternative A. Similarly, none of the alternatives were projected to produce significant impacts. It is noteworthy that Alternative B-3, exclusion of the FPSO system from lease areas near the Mississippi Delta, may effectively mitigate potential impacts of FPSO activities on local deepwater marine mammal species. These waters are considered to support a population of endangered sperm whales who tend to congregate in this region.

Increased vessel traffic increases the likelihood of collision between ships and marine mammals, resulting in possible injury or death to some animals. Mortal injury to a listed marine mammal species would be a significant, long-term impact, as noted in Section 4.3.6. Though cetaceans are normally able to avoid vessels, operators should take actions to avoid moving directly at marine mammals. Vessel operators should be aware of maneuvering requirements and guidelines issued by NMFS. Operators in areas of heavy sperm whale concentrations (e.g., deepwater areas off the Mississippi River delta) should establish a buffer zone (e.g., 500 m [1,640 ft]) between their vessel and sighted animals.

4.3.15.7 Sea Turtles

With the exception of possible collision with a sea turtle, no significant impacts were identified for FPSO installation, routine operations, or decommissioning (Alternative A, base-case scenario), nor were impacts of significance found when considering the range of options under Alternative A. Similarly, none of the alternatives were projected to produce significant impacts.

Increased vessel traffic increases the likelihood of collision between ships and sea turtles, resulting in possible injury or death to some individuals. Mortal injury to any sea turtle (all species are currently listed) would be a significant, long-term impact, as noted in Section 4.3.7. No effective mitigation measures are currently available to reduce the likelihood of collision between a vessel and a sea turtle.

4.3.15.8 Coastal and Marine Birds

No significant impacts on coastal and marine birds were identified for FPSO installation, routine operations, or decommissioning (Alternative A, base-case scenario), nor were impacts of significance found when considering the range of options under Alternative A. Similarly, none of the alternatives were projected to produce significant impacts. As a consequence, no mitigation measures have been identified for this resource.

4.3.15.9 Fish Resources

No significant impacts to fish resources or EFH were identified for FPSO installation, routine operations, or decommissioning (Alternative A, base-case scenario), nor were impacts of significance found when considering the range of options under Alternative A. Similarly, none of the alternatives were projected to produce significant impacts. As a consequence, no mitigation measures have been identified for fish resources.

4.3.15.10 Commercial Fisheries

No significant impacts to commercial fisheries were identified for FPSO installation, routine operations, or decommissioning (Alternative A, base-case scenario), nor were impacts of significance found when considering the range of options under Alternative A. Similarly, none of the alternatives were projected to produce significant impacts.

Several adverse but not significant impacts were noted in the analysis. Potential conflicts with surface longlining can be reduced through effective communication between fishers and on-board FPSO personnel. Radio or cellular telephone contact is critical to allow fishers and FPSO personnel to communicate before, during, and after longline sets made in the vicinity of an FPSO. Current and wind conditions should be monitored to prevent longline gear from being set upstream of an FPSO or its attendant vessels.

Additional mitigation could be afforded through establishment of a fishermen's contingency fund. Mitigation for debris left on the seafloor following decommissioning and abandonment could be sought through the contingency fund as has been done for similar situations in shelf waters.

4.3.15.11 Social and Economic Environment

No significant impacts to the social and economic environment were identified for FPSO installation, routine operations, or decommissioning (Alternative A, base-case scenario), nor were impacts of significance found when considering the range of options under Alternative A. Similarly, none of the alternatives were projected to produce significant impact. As a consequence, no mitigation measures have been identified for social and economic resources.

4.3.15.12 Recreational Resources and Beach Use

No significant impacts to recreational resources and beach use were identified for FPSO installation, routine operations, or decommissioning (Alternative A, base-case scenario), nor were impacts of significance found when considering the range of options under Alternative A. Similarly, none of the alternatives were projected to produce significant impact. As a consequence, no mitigation measures have been identified for this resource.

4.3.15.13 Cultural Resources

No significant impacts to cultural resources were identified for FPSO installation, routine operations, or decommissioning (Alternative A, base-case scenario), nor were impacts of significance found when considering the range of options under Alternative A. In the event the gas export line is routed to shore, the potential exists for adverse but not significant impact to cultural resources in nearshore waters. Remote sensing surveys and avoidance should provide adequate mitigation to eliminate such impact. None of the alternatives were projected to produce measurable impacts to cultural resources.`

4.3.15.14 Other Uses

No significant impacts to other uses were identified for FPSO installation, routine operations, or decommissioning (Alternative A, base-case scenario), nor were impacts of significance found when considering the range of options under Alternative A. Similarly, none of the alternatives were projected to produce significant impact. As a consequence, no mitigation measures have been identified for other uses.

4.4 Environmental Impacts of the Proposed Action – Accident/Upset (Oil Spill)

4.4.1 Risk Assessment

In conjunction with preparation of the EIS, a quantitative risk assessment was performed by Det Norske Veritas (DNV, Offshore Department, Risk and Reliability Services Division, Houston, Texas) based on the specifications defined for the base-case FPSO. DNV prepared and submitted to MMS a detailed report on the methodology and results of the risk assessment (DNV, January 2001). The following sections summarize the important relevant findings contained in this report.

The overall objective of the risk assessment was to determine the potential risk of oil spills from operations unique to FPSOs operating in the Gulf of Mexico. The specific objectives of this risk assessment were to:

- Predict the frequency of accidental releases of oil from operation of the base-case FPSO in the Gulf of Mexico,
- Identify hazards that pose the greatest risks,
- Evaluate differences in risk between the base case and design options, and
- Identify and evaluate feasible risk mitigation measures.

The risk study considered all aspects of operation of the FPSO, from the wellheads through oil and gas production, and export of the oil by shuttle tanker and the gas by pipeline to shore. External and environmental risk factors (e.g., collisions with passing merchant vessels, severe weather) were considered in the assessment. Risks associated with shuttle tankers during transit to a shore terminal were also assessed. The study did not examine the risks or hazards associated with construction, installation, commissioning, and decommissioning of the FPSO, or drilling or workover of the wells. Where systems and operations are similar to existing production systems in the GOM, these were characterized as such and not considered further in the risk study.

The following sections describe the methodology used in conducting the risk assessment, the results of the oil spill frequency analysis for the base-case FPSO, potential measures to reduce risks, and the relative differences between risks associated with options (i.e., alternative locations, components, and operations) and those of the base case.

4.4.1.1 Methodology

A standard approach to risk analysis was used to quantify the risk of accidental releases of oil from the FPSO. The sequence of steps involved in the analysis methodology is shown graphically in figure 4-7 and described below.

The risks from FPSO operations were compared to those of accepted deepwater technologies for oil production to identify risk factors that are unique to FPSO operations. These risks were measured by examining each accidental event considered and comparing its frequency or outcome against that of the corresponding operation on a tension leg platform (TLP), which is taken to be representative of accepted deepwater technology for the GOM OCS. This

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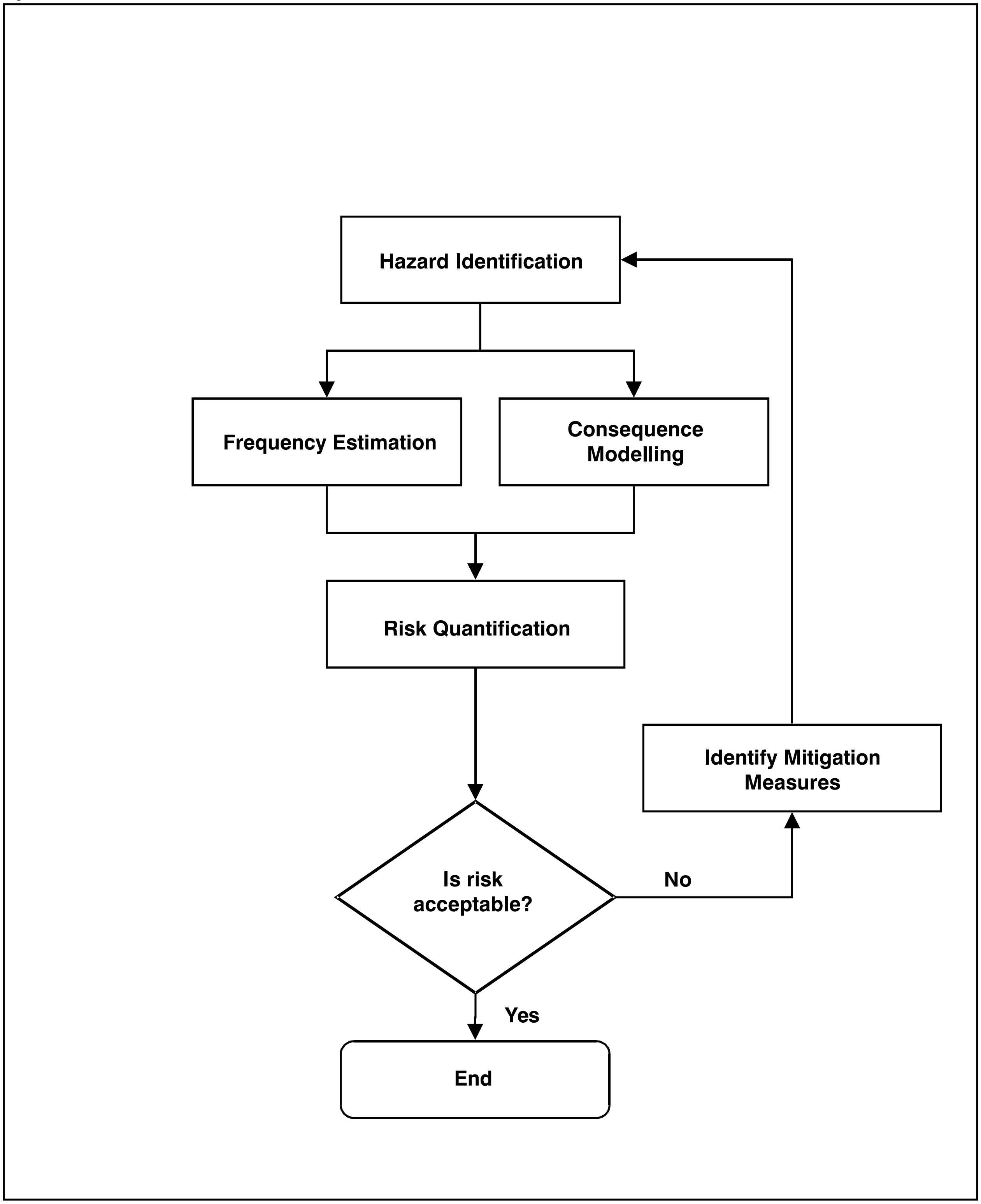

SOURCE: Det Norske Veritas 2001.

Figure 4-7 RISK ASSESSMENT METHODOLOGY

comparison is shown graphically on figure 4-8. The results of this comparison were used to predict the risks unique to FPSO operation. The study quantified risks common to both FPSOs and TLPs (yellow area on figure 4-8) and risks unique to FPSOs (blue areas), but it did not address risks unique to TLPs (red areas).

Hazard Identification

This phase of the risk assessment is intended to identify all potential sources of an accidental release of oil to the environment, characterize them in terms of the accident causes, and identify measures that help to prevent, detect, control, or mitigate the potential accident scenarios. In addition, the hazard identification assesses the direct consequences of accidents and the potential for escalation.

Hazard identification is a formal activity to examine all aspects of the operation under consideration using a pro-forma approach. It depends on the quality of the input data available and is typically performed as a table-top exercise lead by an experienced facilitator and with participation by representatives covering the full range of design and operational expertise for the system under consideration.

This process relies primarily on past experience and so it is important to consult as broad a range of expert sources as possible. Due to the conceptual nature of the design the generic FPSO addressed in the EIS, the level of detail is not available to perform this level of hazard identification. A specific hazard identification workshop would be unlikely to provide considerations beyond those already identified by DNV, and therefore, is not appropriate to this project. Instead, the combined experience from several previous studies carried out by DNV for similar developments was applied to this project. Typically, these studies included formal “hazard identification” workshops carried out with project engineers and operators and so the combination of these data sources represents actual experience and is the most appropriate source for this project available to DNV.

Eleven major categories of hazards associated with the production phase of development were identified (table 4-30). More specific hazards characteristic of FPSO operation were identified within each of these major hazard categories and examined.

Each of the specific hazards were qualitatively described according to the following characteristics:

Consequences	direct impact of an accident
Escalation potential	routes to escalation of the event
Escalation consequences	impact of the escalated events
Accident causes	human or hardware failures that would realize the accident
Accident prevention	features of the development that will prevent an accident from occurring
Accident detection	measures to detect an accident
Accident control	measures to limit the extent of an accident
Mitigation measures	measures to prevent or mitigate against the impact of escalation

This information was tabulated and used to develop the frequency and consequence calculations.

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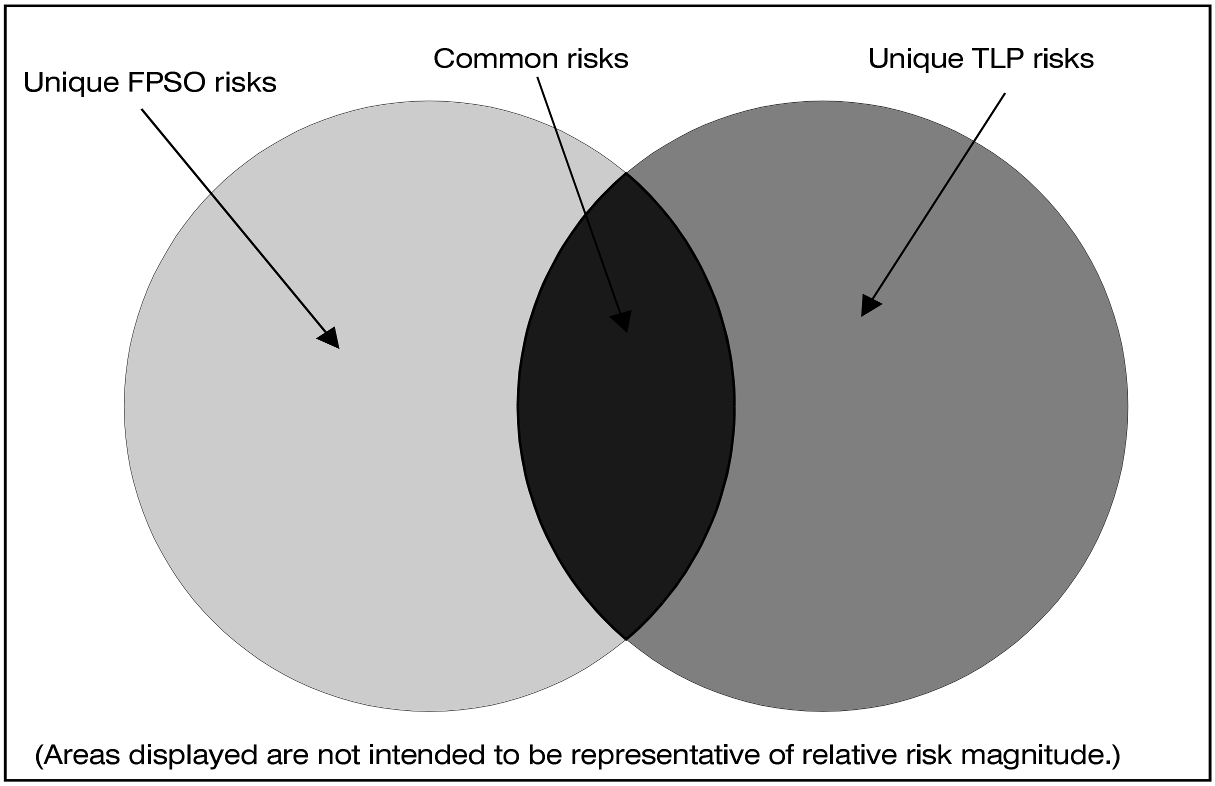

SOURCE: Det Norske Veritas 2001.

Figure 4-8 UNIQUE AND COMMON RISKS

Table 4-30

Identified Hazards

Major Hazard Category	Specific Hazards
Blowout	Wellhead leak or manifold leak
	Blowout (uncontrolled)
Riser and pipeline leaks	Gas export riser release
	Hydrocarbon leak from risers
	Hydrocarbon leak from flowline
	Gas export pipeline release
Release of hydrocarbon from the process on the FPSO	Hydrocarbon leak from the swivel
	Explosion in turret
Non-process fire and explosions	Process area fire
	Methanol leak
Cargo storage events	Cargo piping leak on deck
	Overfilling cargo tank
	Ballast tank explosion
	Cargo tank explosion
	Process gas blow-by
Marine accidents on the FPSO	Structure failure (foundering)
	Mooring failure
Offloading accidents	Leakage from transfer hose
Tanker transport	Releases during transfer in port
	Oil spill while discharging at offshore oil port
Non-process spills	
Ship collisions	Drifting vessel collision
	Visiting shuttle tanker collision (high speed)
	Passing merchant vessel collision
	Visiting supply vessel collision
Transportation (supply vessels and helicopters)	

Source: DNV 2001

Frequency Calculation

Accident event frequencies were calculated for each of the identified hazards from a statistical analysis of available experience-based data. These frequencies indicate the likelihood that a hazard will occur in any given year.

The accident frequencies were determined by a combination of the presence of accident causes and the effectiveness of appropriate preventative measures. Accident causes include those that are present continuously (e.g., fatigue loading), and those that arise spuriously (e.g., dropped objects). To be effective, a preventative measure must address the specific hazard and be reliable (in an operable condition when required).

The contribution of accident causes and preventative measures for each of the hazards are represented in “fault trees” (see figure 4-9). A fault tree is a graphical technique for showing the combinations of undesirable events that result in the specified accident (denoted the “top event”). The undesirable events represent each of the accident causes and failures of preventative measures identified by the hazard identification exercise. Evaluation of the fault trees involves the analytic combination of the likelihood that each of the undesirable events occurs.

The fault trees have been evaluated where appropriate. However, for this project there are many instances where the quality of the available data for the frequency of the top events is as good as, or better than, the data quality for the frequency of contributing undesirable events. In such cases, the top event frequencies are taken directly from the available data sources and the fault trees used to present the contributors to the accident and for the assessment of further risk reducing measures.

Consequence Calculation

Consequence calculations were used to quantify how each accident could develop and result in the loss of oil into the sea. For each accident event, the consequence calculations account for the effectiveness and reliability of measures to detect the accident, to control it once detected, and to mitigate against escalation. The calculations also consider the likelihood of escalation if mitigation is unsuccessful. The various combinations of successful detection, control, and mitigation, and potential escalation result in several possible outcomes. The likely oil spill was predicted for each outcome using professional judgement.

The likelihood of each of the possible outcomes were calculated using event trees. This is a graphical form of binary tree, which allows the development of an accident to be shown and quantified (see figure 4-10). The initiating event forms the root of the tree, and the event tree is developed using a succession of branches, each representing success or failure of a specific detect, control, mitigation, and escalation response.

Progression along each of the various branches to the “end events” thus represents a unique combination of such responses. Each end event represents a possible development of the accident. Together, all the end events are representative of all possible accident outcomes.

The initiating event is assigned a frequency and each branch node is assigned a value denoting the probability of successful operation of the response represented, and conversely the probability of failure in that operation (The sum of the probabilities of success and failure equals 1.0). Evaluation of an event tree involves multiplication of the initiating event frequency and the probabilities assigned to the decision branches to give a frequency for each end event. All end event frequencies are evaluated in this way.

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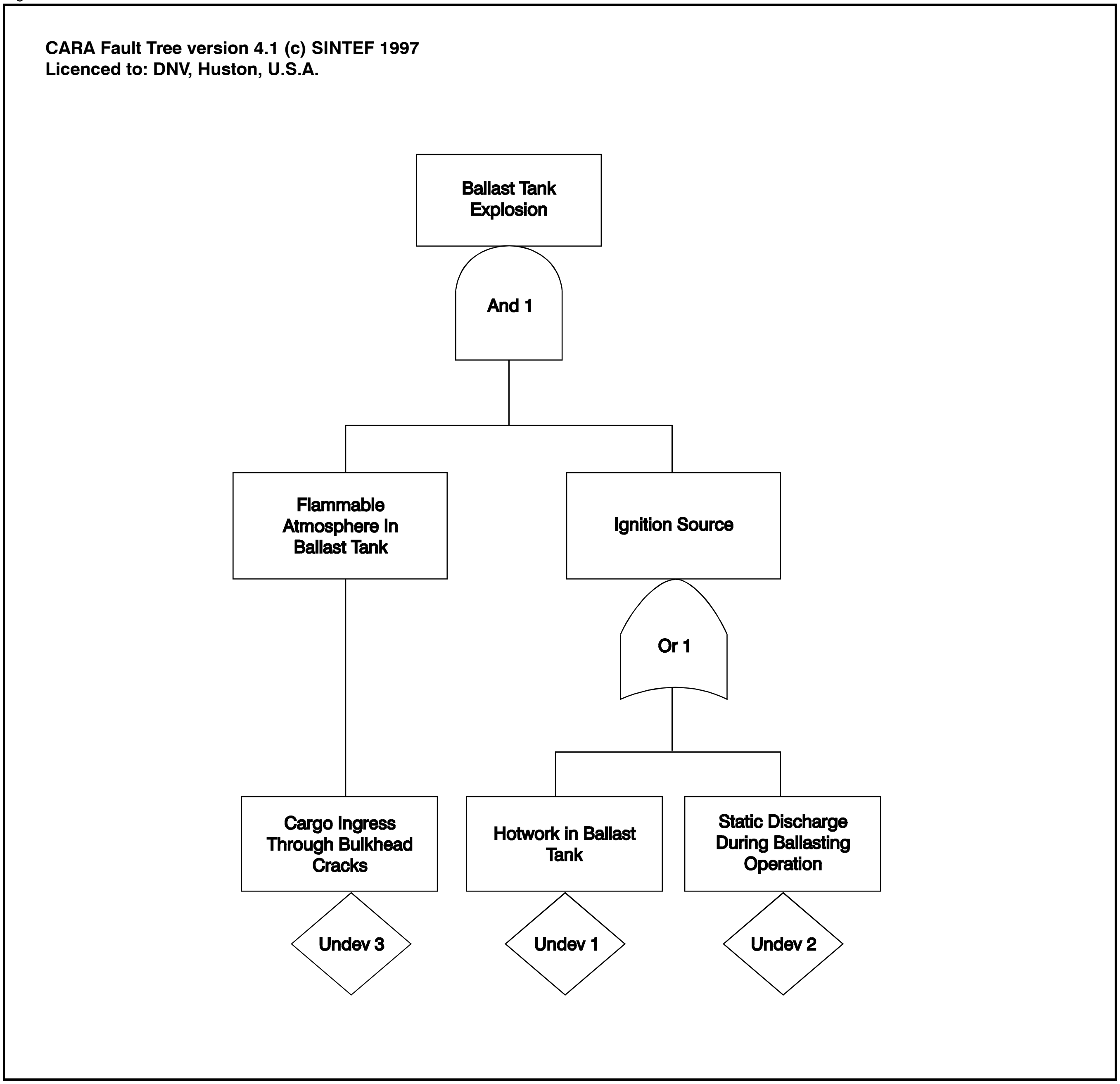

SOURCE: Det Norske Veritas 2001.

Figure 4-9 EXAMPLE FAULT TREE

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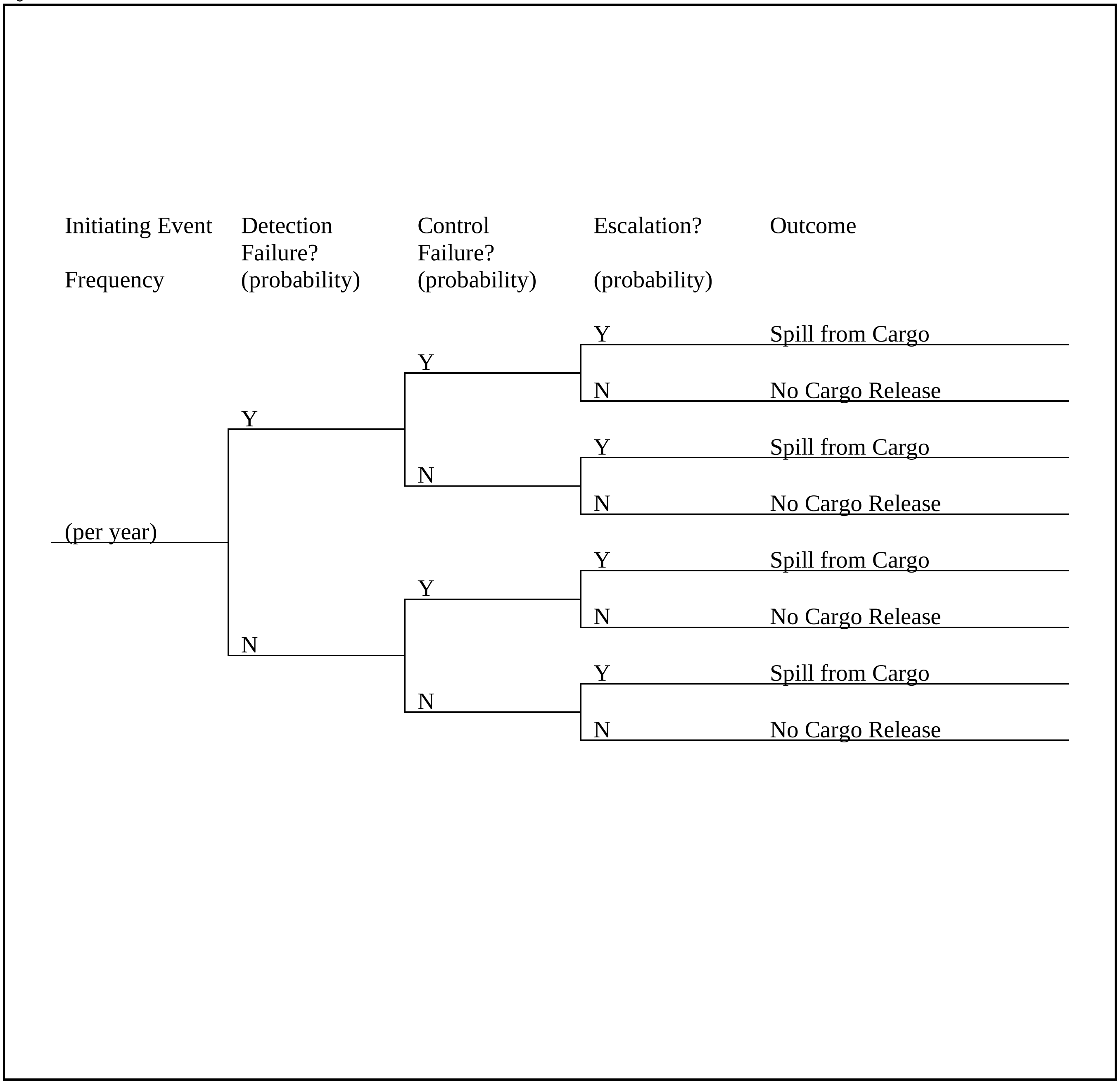

SOURCE: Det Norske Veritas 2001.

Figure 4-10 EXAMPLE EVENT TREE

End events are assigned specific consequences. For this project, this is the volume of oil spilled, assessed by consideration of the potential route that oil may be released to the marine environment. The risk for each end event is quantified by assigning the end event frequency to the specific consequences. The total risk for that accident is calculated by summing the contributions from all end events.

Event trees have been produced and evaluated for each of the significant undesirable events produced by the hazard identification. Initiating event frequencies are taken from the results of the fault tree evaluation (see above). Branch probability data for each event tree has been taken from data sources available to DNV. The sizes of oil release represented by each branch outcome were calculated on the basis of rule sets. The rule sets are fully traceable and are based on DNV's experience of consequence calculations.

Data Sources

This section describes the data sources used in the risk assessment.

Due to the conceptual nature of the design of the generic FPSO addressed in the project, information on FPSOs, their configuration, operation, hazards and risks has been taken from DNV's experience from previous analyses. Use of this information has provided additional detail and efficiency to this analysis than would otherwise have been possible. These previous analyses include confidential proprietary information belonging to other clients of DNV. The proprietary nature of these information sources prevents full references to the data from being included here. Additionally, DNV proprietary information has been used as input data to the risk assessment.

The specification for the FPSO and its operation is that provided in Section 1.3, which is a concept level description of a generic FPSO for deepwater operation. Because of the generality of the description of the FPSO systems, specific details required for the analysis were drawn from DNV's experience of similar developments.

Input data for the risk analysis of shuttle tanker transport operations were extracted from an analysis of the MMS's tanker oil spill database for tankers operating in U.S. waters (Anderson and LaBelle (1994) and DNV's ARF Technical Note 14 (DNV 1999, confidential internal document).

Input data for the offshore offloading operation from the FPSO to the shuttle tanker were taken from the Marine Board's tanker lightering study commissioned by Coast Guard (Marine Board 1998) and from MMS lease sale EISs (i.e., MMS 1997b and MMS 1998a), as well as from a client-confidential DNV study conducted for an existing FPSO operating in the North Sea.

Input data for the risk analysis of FPSO operations were taken from DNV's ARF manual (DNV 1998, confidential internal document), which is a key internal reference document for risk assessment in DNV, and forms part of DNV's documented management system. DNV's ARF manual is a constantly updated compendium of DNV's offshore risk assessment experience. The ARF manual describes good modern practice in offshore quantitative risk assessment, and addresses all major aspects of this subject. The ARF manual includes a selection of recommended data as well as recommended analytical techniques and data sources. The ARF manual is used within DNV both as a reference book and as a training manual. The ARF manual requires a significant effort on DNV's part to update and maintain, and is a proprietary commercial asset to DNV.

Input data for FPSO operations were also taken from DNV's experience on FPSO projects for other clients, including comprehensive assessments for six specific FPSO development projects in the North Sea and North Atlantic, as well as a deepwater Gulf of Mexico development project. These assessments include confidential proprietary information, which prevents full referencing of the data. As a general rule, these FPSO developments are considered by DNV to represent good practice amongst the industry, and therefore the data used are considered applicable to this study.

4.4.1.2 Results of the Oil Spill Frequency Analysis

The estimated frequencies of oil releases from the base-case FPSO are summarized in table 4-31, broken down by size and general source of the release (FPSO, offloading, or shuttle tanker). The total frequencies by release size are presented graphically in figure 4-11.

To identify the hazards with the highest risk of oil spills, the release frequencies for each type of accidental event are ranked in table 4-32 according to release volume. (The statistical volume of oil released annually for each accident type was calculated using the upper end of each range as the representative release size for each category. This conservative approach was used.) In the table, the column labeled "% Volume" shows the annual volume of oil released for that accident type as a fraction of the total released by all accidents combined. The column labeled "% Cumulative" shows the cumulative proportion of oil spilled by volume for that accident plus that of the accidents above it in the table. Table 4-32 does not include oil spill frequencies for risks common to both FPSO and TLP technologies.

The results from the risk study can be summarized as follows:

- The frequency of FPSO-unique oil releases greater than 1,000 barrels is 0.037 per billion barrels produced for FPSO-related failures, and 1.2 per billion barrels for shuttle tanker-related failures. (The production rate is assumed to be 150,000 barrels of oil per day.)
- Approximately 94.4 percent of the volume of potential FPSO-unique spills is likely to be due to the transfer of oil from the FPSO to the shuttle tanker and from the shuttle tanker transit to shore.
- 53.6 percent of the volume of potential FPSO-unique spills is likely to be from shuttle tankers near port.
- 39.0 percent of the volume of potential FPSO-unique spills is likely to be from shuttle tankers in transit to port.
- 1.8 percent of the volume of potential FPSO-unique spills is likely to be from the transfer of oil from the FPSO to the shuttle tanker. However, this volume is comprised entirely of the smaller spill sizes (<1,000 barrels).
- Process releases are the single largest FPSO-unique risk for releases on the FPSO.
- For events on the FPSO, accidents that escalate to the cargo area (which comprises escalation consequences from most of the hazard categories in table 4-30) represent the largest FPSO-unique risk. The cumulative frequency of these events is on the order of 1×10^{-3} per year.
- Collisions with passing merchant vessels are low-frequency events but account for 1.2 percent of all the FPSO-unique oil released due to the potential for large-volume spills.

Table 4-31
Frequency of Oil Releases by Release Size due to Unique FPSO Accidents

	Frequency (number releases per year)			
Barrels of Oil Released	FPSO	Offloading	Shuttle Tankers	Total
Less than 10	1.3×10^{-2}	2.4×10^{-1}	0	2.6×10^{-1}
10-100	1.7×10^{-2}	1.2×10^{-1}	0	1.4×10^{-1}
100-1,000	7.9×10^{-5}	1.2×10^{-1}	0	1.2×10^{-1}
1,000-10,000	6.9×10^{-5}	0	2.5×10^{-2}	2.5×10^{-2}
10,000-50,000	6.9×10^{-4}	0	2.3×10^{-2}	2.3×10^{-2}
50,000-100,000	6.3×10^{-4}	0	9.7×10^{-3}	1.0×10^{-2}
100,000-500,000	5.9×10^{-4}	0	9.1×10^{-3}	9.7×10^{-3}
More than 500,000	1.6×10^{-5}	0	0	1.6×10^{-5}

Source: DNV 2001.

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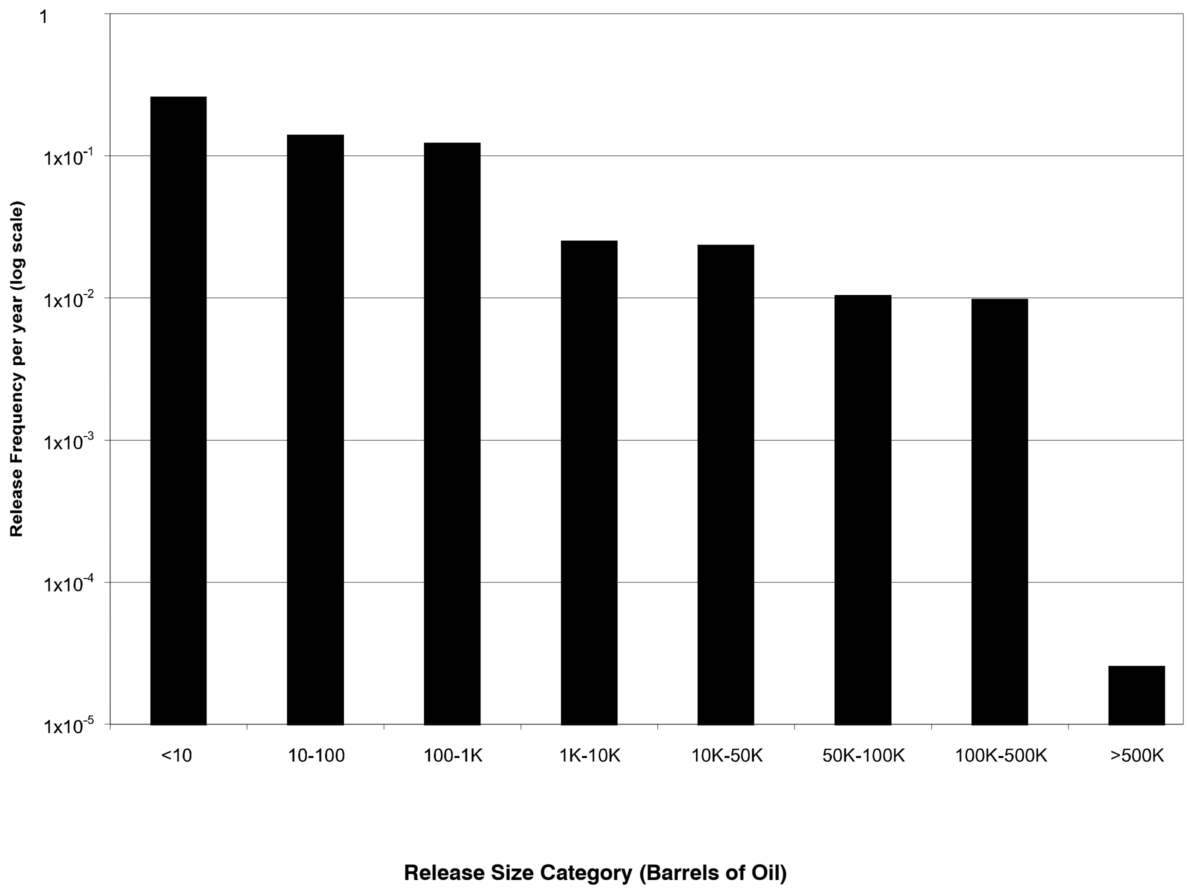

Note: A frequency of $1x10^{-2}$ per year is equivalent to an expected return period of 1 per 100 years.

SOURCE: Det Norske Veritas 2001.

Figure 4-11 FREQUENCY OF ACCIDENTAL RELEASES BY RELEASE SIZE FOR FPSO-UNIQUE ACCIDENTS

Table 4-32

Oil Spill Frequencies for Unique FPSO Risks, per Year by Hazard Category

Hazard Category	Number of Spills Per Year: <10	10-100	100-1K	1K-10K	10K-50K	50K-100K	100K-500K	> 500K	Total	Vol. %	Cum. %
Shuttle Tanker Leak Near Port	0	0	0	1.4×10^{-2}	1.3×10^{-2}	5.6×10^{-3}	5.3×10^{-3}	0	3.8×10^{-2}	53.6%	53.6%
Shuttle Tanker Leak at Sea	0	0	0	1.0×10^{-2}	9.5×10^{-3}	4.1×10^{-3}	3.8×10^{-3}	0	2.8×10^{-2}	39.0%	92.6%
Process Leak	0	0	0	0	4.4×10^{-4}	4.4×10^{-4}	3.4×10^{-4}	0	1.2×10^{-3}	3.2%	95.8%
Transfer Hose Leak	2.4×10^{-1}	1.2×10^{-1}	1.2×10^{-1}	0	0	0	0	0	4.9×10^{-1}	1.8%	97.6%
Passing Merchant Vessel	0	0	0	6.9×10^{-5}	1.3×10^{-4}	7.1×10^{-5}	1.2×10^{-4}	1.1×10^{-5}	4.0×10^{-4}	1.2%	98.8%
Production Riser Leak	0	0	0	0	5.4×10^{-5}	5.4×10^{-5}	4.3×10^{-5}	0	1.5×10^{-4}	0.4%	99.2%
Foundering	0	0	0	0	4.5×10^{-6}	4.5×10^{-6}	3.6×10^{-5}	5.0×10^{-6}	5.0×10^{-5}	0.3%	99.5%
Cargo Tank Explosion	0	0	0	0	3.0×10^{-5}	3.0×10^{-5}	2.3×10^{-5}	0	8.3×10^{-5}	0.2%	99.7%
Swivel Leak	1.0×10^{-3}	1.3×10^{-2}	0	0	2.3×10^{-5}	2.3×10^{-5}	1.8×10^{-5}	0	1.4×10^{-2}	0.2%	99.9%
Cargo Piping Leak on Deck	1.2×10^{-2}	3.4×10^{-3}	7.9×10^{-5}	0	3.6×10^{-6}	3.6×10^{-6}	2.8×10^{-6}	0	1.6×10^{-2}	0.1%	100.0%
Process Gas Blow-by	0	0	0	0	3.3×10^{-6}	3.3×10^{-6}	2.6×10^{-6}	0	9.2×10^{-6}	0.0%	100.0%
Flowline Leak	0	0	0	0	1.1×10^{-6}	1.1×10^{-6}	9.1×10^{-7}	0	3.2×10^{-6}	0.0%	100.0%
Mooring Failure	0	0	0	0	8.3×10^{-7}	8.3×10^{-7}	7.0×10^{-7}	0	2.3×10^{-6}	0.0%	100.0%
Explosion in Turret	0	0	0	0	2.3×10^{-7}	2.3×10^{-7}	1.8×10^{-7}	0	6.4×10^{-7}	0.0%	100.0%
Ballast Tank Explosion	0	0	0	0	1.6×10^{-7}	1.6×10^{-7}	1.3×10^{-7}	0	4.5×10^{-7}	0.0%	100.0%
Gas Export Riser Leak	0	0	0	0	1.4×10^{-7}	1.4×10^{-7}	1.1×10^{-7}	0	3.8×10^{-7}	0.0%	100.0%
Gas Export Pipeline Leak	0	0	0	0	1.3×10^{-8}	1.3×10^{-8}	9.9×10^{-9}	0	3.5×10^{-8}	0.0%	100.0%
Visiting Shuttle Tanker	0	0	0	5.0×10^{-9}	7.8×10^{-9}	3.5×10^{-9}	5.8×10^{-9}	5.2×10^{-10}	2.3×10^{-8}	0.0%	100.0%
Methanol Fire	0	0	0	0	3.0×10^{-9}	3.0×10^{-9}	2.3×10^{-9}	0	8.3×10^{-9}	0.0%	100.0%
Drifting Vessel	0	0	0	0	0	0	0	0	0	0.0%	100.0%
Blowout	0	0	0	0	0	0	0	0	0	0.0%	100.0%
Wellhead or Manifold Leak	0	0	0	0	0	0	0	0	0	0.0%	100.0%
Cargo Tank Overfill	0	0	0	0	0	0	0	0	0	0.0%	100.0%
	2.6×10^{-1}	1.4×10^{-1}	1.2×10^{-1}	2.5×10^{-2}	2.3×10^{-2}	1.0×10^{-2}	9.7×10^{-3}	2.5×10^{-5}	5.9×10^{-1}		

Source: DNV 2001.

Footnote: The statistical volume of oil release annually was calculated using the upper end of each range.

The assessment of oil spill risks performed for this study should be regarded as generic to the concept of using FPSOs in deep water. More detailed analysis would accompany the evaluation of specific FPSO permit applications. At that time, the locations of a proposed FPSO and associated tanker routes would be more defined, and the risk from transportation routes closer to shore would be evaluated.

Based on the risk assessment, the risk of spills unique to FPSOs operations in the Gulf of Mexico is low. Of spill risk on the FPSO itself, excluding offloading and shuttle tanker transport, FPSO-unique spill risk comprises only 5% of the total risk. The remaining 95% of spills are not unique to FPSO operations and would be equally likely and have similar outcomes on a TLP or other deepwater production alternative.

Furthermore, risk of oil spills during offloading from the FPSO to the shuttle tanker is similar to that for lightering operations in the Gulf of Mexico, where there is a history of low spill frequency and small spill volumes. The risk of shuttle tanker transport spills should be compared with the risk of spills from oil transport by offshore pipeline. Based on analysis of MMS's database of oil spills in U.S. waters (Anderson and LaBelle, 1994), it is expected that for pipeline transport there will be 1.32 spills with volumes greater than 1,000 bbls for every billion bbls transported, and for tanker transport there will be 1.21 spills with volumes greater than 1,000 bbls for every billion bbls transported. Therefore, the oil spill risk for shuttle tanker transport is comparable to and slightly less than that of pipeline transport.

The risk of shuttle tanker transport spills used in this assessment was derived from a database of tanker spills in U.S. waters with incidents extending back to the 1970s. This incident database covers a large range of years and provides a wide experience base for determining what the historic risk of tanker transport spills has been. However, the large range of years covered also means that recent regulatory and other risk-reducing measures are not well represented in the predicted risk of tanker transport spills. It is expected that these corrective actions should result in improved tanker performance in the future over the performance predicted using this database as has been observed over the last eight years. Therefore, the risk of shuttle tanker transport spills predicted in this assessment may well be conservative (overstated).

The assessments of oil spill risk performed in this study should be regarded as generic to the concept of the use of FPSOs in deep water. More detailed analysis would accompany the evaluation of specific FPSO permit applications. At that time, the location of a proposed FPSO and associated tanker routes would be more defined, and the risk from transportation routes closer to shore would be evaluated.

4.4.1.3 Risk Management

Based on these findings, measures to reduce the risk of oil spills from operation of shuttle tankers would be the most effective in reducing the total volume of oil spilled from FPSO operations. A significant fraction of shuttle tanker spills are predicted to occur closer to shore than are spills from the FPSO itself or the offloading operations. Given that shuttle tanker spills are likely to pose a greater threat of environmental damage than spills from FPSOs and offloading, measures that reduce the risk of spills from shuttle tankers would be more effective in mitigating spill-related environmental impacts than risk-reducing measures aimed at FPSOs and the offloading operations.

Measures that protect against escalation to the cargo area are likely to be the most effective means of reducing the risk of oil spills from the FPSO itself. Measures that protect against passing merchant vessel collisions are also likely to be beneficial in reducing oil spill risk, as are measures that prevent or control process releases.

Risk mitigation options that generally are technically feasible were identified. Although the economic feasibility of these measures may be questionable for at least some projects, they are potentially feasible options for some projects. These risk mitigation options were qualitatively evaluated to determine their potential effect on reducing risks. These risk mitigation measures and their effects are summarized by hazard category in table 4-33.

4.4.1.4 Consideration of Options to the Base Case

Alternative locations, designs, and operation features that are feasible or likely options to the base-case FPSO in the Gulf of Mexico were identified. A qualitative assessment of how each of these options may affect the risk of oil release was conducted and is summarized in table 4-34.

4.4.2 Oil Spill Risk Analysis (OSRA) Model and Open-Ocean Oil-Weathering Models

4.4.2.1 Description of Models

Overview

It is necessary to measure or predict the weathering behavior and trajectories of hypothetical oil slicks originating at different potential offshore FPSO locations in the Gulf of Mexico in order to estimate the ecological risk of oil spills of different sizes to coastal and offshore natural resources. Two separate computer models were used to address these needs. Spill trajectories from hypothetical spill launch points were simulated using the Oil Spill Risk Assessment (OSRA) model, while weathering behavior was simulated using the MMS Open-Ocean Oil-Weathering model. The hypothetical oil spills considered in this analysis encompass only surface releases (e.g., from aboard the FPSO, from the shuttle tanker). Subsurface spills were not considered because such spills, while possible in any deepwater development, are not unique to FPSO operations.

The OSRA model, developed and used by the MMS, was used in the present EIS to predict the movement of an oil spill that might result from operations occurring in association with FPSOs in deep offshore waters of the central and western Gulf of Mexico. Oil trajectories were predicted based on computer-model-derived surface ocean currents and wind transport. The OSRA model output was used to determine the likelihood that spills occurring at one of seven deep-water FPSO sites and along a single shuttle tanker route, would contact various offshore natural resources or shore segments within 3, 20, or 30 days.

The Open-Ocean Oil-Weathering Model, developed by Payne *et al.* (1984) and modified for wind and oceanographic conditions in the Gulf of Mexico by Kirstein (1992), was used to predict the fate of two "typical" crude oils of types assumed to be produced or stored on FPSOs in the Gulf of Mexico. Rates of evaporation, dispersion into the water column, mousse (i.e., water in oil dispersion) formation, and changes in slick area, thickness, and viscosity during weathering of crude oil on the sea surface were estimated for various spill sizes.

Table 4-33

Feasible Risk Mitigation Measures

HAZARD	BASE CASE	MITIGATIONS	MITIGATION EFFECT
Shuttle Tanker Leak Near Port	• Double hull vessel. • Compliant with Coast Guard regulations and Jones Act.	• Inert Gas System. • Firewater and foam systems.	• To minimize the potential for damage due to fires and explosions.
		• Oil spill contingency plans	• To minimize impacts of potential oil spills.
		• Continuously manned radar watch	• To minimize the potential for collisions.
		• Contingency plans in case of loss of propulsion including availability of tug assistance and possibility of using anchor to stop drifting vessel.	• To minimize the potential for groundings.
	• Tankers of opportunity will be used.	• Establish selection standards and inspections to ensure that shuttle tanker meets requirements for vessel safety, crew training, and emergency response preparedness. Alternatively, a dedicated shuttle tanker and crew could be used.	• To minimize potential for oil spill impacts.
Shuttle Tanker Leak at Sea	(items listed under Shuttle Tanker Leak Near Port above also apply)	(mitigation measures and effects listed under Shuttle Tanker Near Port also apply)	
Process Leaks	• Fire and gas detection system to shutdown and blowdown. • Firewater deluge and foam protection to prevent escalation. • Process deck elevated above the storage tanks to prevent fire impingement onto the storage tank.	• Designated process area to be classified area. • Equipment arrangement to segregate ignition and fuel sources, API-RP-14J. • Electrical system to conform with API-RP-14F.	• Current area classification practice emphasizes equipment coverage and does not cover catastrophic failure. By designating the whole process area together to comply with both API-RP-14F & 14J the potential for ignition would be minimized.

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Table 4-33

Feasible Risk Mitigation Measures

HAZARD	BASE CASE	MITIGATIONS	MITIGATION EFFECT
	• Open type process area with individual equipment area classification. • As per MMS, Coast Guard, and USEPA regulatory requirements.	• Two levels of process upset protection per API-RP-14C. • Piping system to conform with API-RP-14E. • Restrict crane operations over process area. Designate crane landing area. Require work permit for lifting equipment to or from process area.	• Lowers probability of loss of containment.
		• Limit containment of pressurized hydrocarbon and provide automatic isolation between vessels. • Optimized equipment and piping layout to reduce congestion and in turn reduce potential explosion overpressure.	• Lowers the consequences of a potential fire or explosion.
		• Deck drainage system to divert hydrocarbon spill and deluge water to adequately sized drain/slop tank.	• To control the consequence of liquid spill.
Transfer Hose Leak	• Tandem cargo offloading system. Offloading hose to be equipped with a marine breakaway coupling complete with shut-off valve.	• Use of high integrity hoses, valves and couplings and other offloading equipment and regular inspection of equipment for defects.	• To reduce potential for oil spills during offloading.
	• Isolation valve to be provided at each pump discharge line to the common manifold.	• Automated shutdown valve to be provided upstream of the hose tie-in station complete with low-pressure sensor or equivalent sensor to detect leak.	• To minimize spill size in the event of hose rupture or breakage during offloading.
		• Independent low pressure sensors to be provided at each pump discharge upstream of check valve preferably located at the tie in point of the manifold to shutdown the pump and/or the automatic isolation valve.	• To detect and shut down pump in order to minimize spill size.

Table 4-33

Feasible Risk Mitigation Measures

HAZARD	BASE CASE	MITIGATIONS	MITIGATION EFFECT
		• Oil spill control procedure.	• To minimize potential for release of hydrocarbon to the environment.
Vessel Collision	• FPSO location to be determined. • Monitor/Alarm. • Navigation aids in the form of lights, shapes and sound signal in compliance with Coast Guard Navigational Aid regulations.	• Exclusion of FPSO operations from in or near high traffic shipping lanes.	• Reduce collision risk by avoiding high traffic areas.
		• Collision avoidance radar.	• Provide advance warning for potential collision situation.
		• Attendant vessel. • FPSO with thrusters.	• Provides "active" intervention for drifting vessel or other potential vessel collision.
		• Establish vessel exclusion zone around FPSO operation.	• Reduce collision risk by excluding from the area vessels unrelated to FPSO operation.
Cargo Tank Explosion	• The cargo tanks will be provided with Inert Gas System (IGS) and Crude Oil Washing (COW) system. • Double hull vessel.	• Continuous monitoring of cargo tank oxygen level to ensure it is maintained below 5%.	• To minimize potential for explosion within the storage tank.
		• Individual venting system and a relief/vacuum valve are to be provided to each cargo tank.	• To localize potential failure.
		• Exhaust and air intake from/to the tank to be equipped with devices to prevent fire flash back.	• To minimize potential for explosion within the storage tank.

Page 3 of 5

Table 4-33

Feasible Risk Mitigation Measures

HAZARD	BASE CASE	MITIGATIONS	MITIGATION EFFECT
Production Riser Leak	• 3 subsea well manifolds connected to the FPSO through 6 flowlines and 6 production risers, providing piggable loops.	• All subsea wells tied into one manifold with a single production riser and one alternate riser to provide a pigging loop.	• Reducing the number of production risers from 6 to 3 will approximately cut in half the potential for production riser leaks (1.4% of spills by volume). • Flowline leaks (<0.1% of spill by volume) would also be reduced by about 50%. • Swivel leaks (0.6% of spills by volume) would be reduced due to a simpler design with less possible leak points. • Manifold leaks may increase if additional subsea equipment is required to allow pigging.
	• Pressure monitoring system will be used for detection of main leaks as per API RP 14C.	• Device to detect and alarm on no flow or loss of flow in order to indicate potential leakage. Pressure sensor may not effectively detect leakage especially for small leaks, especially if the sensor is located subsea where the external pressure may be about that of the riser or pipeline pressure.	• Reduces the probability of undetected sub-sea leaks.
Foundering	• To satisfy IMO and global strength requirement. • Segregated ballast system.	• Central ballast control station to control and monitor the ballast and bilge system, including heel and trim monitoring.	• To reduce the potential for human error in ballasting operation.

Table 4-33

Feasible Risk Mitigation Measures

HAZARD	BASE CASE	MITIGATIONS	MITIGATION EFFECT
	• Design for 100 years wave with associated wind and current. • Design for 100 year current with associated wave and wind.	• An FPSO is unlike other oil production facilities, where insignificant amount of oil is stored or if it is stored it can be pump into the pipeline prior to the storm. Therefore, a much higher safety factor should be considered.	• Reduces the risk due to extreme weather conditions.
		• Consider classification of FPSO including hull and mooring system. For example, the FPSO could be "overdesigned" to withstand more extreme conditions (i.e., events greater than a 100-year storm). • Real-time monitoring of loads on the hull of the FPSO.	• To ensure integrity of the unit against structural failure and eliminate potential design and fabrication errors.
Swivel Leak	• Adequate Ventilation. • Div 2 Area Classification. • Fire and gas detection to activate shutdown and blowdown. • Firewater and foam system.	• Coffer or ballast tank to be provided between turret/swivel and storage tanks.	• The additional coffer dam or ballast tank would reduce the risk of escalation from the fire or explosion in the turret/swivel area.
Cargo Piping Leak on Deck		• Provide spill containment system similar to process area.	• To reduce the probability for piping leaks to spill to sea.

Table 4-34

Qualitative Effect of FPSO Design Options on Oil Spill Risk

Variable	Base Case	Option	Effect on Oil Spill Risk
Water Depth	5,000 ft	600 – 12,500 ft	Subsea technology is currently better proven for shallower water. The amount of operational experience and failure rate data decrease with increasing water depth. Some hazards (e.g., riser and mooring failures) increase with water depth. For shallower water depths, these risks would be expected to decrease somewhat. For greater water depths, these risks would be expected to increase. It should be noted that as yet there are no floating production systems in place extending to 12,500-foot water depths. Operating production facilities in these water depths may require the use of new technologies, and greatly increase the uncertainties in estimating the risk. Increased water depth results in different wave characteristics, and this has to be considered in fatigue loading design calculations.
Location	To be determined		Location dependent risks include ship collisions, shuttle tanker operations, export pipeline risks. The passing merchant vessel collision risk (1.2% of potential base-case spills by volume) is directly impacted by the proximity of the FPSO to shipping lanes. For this analysis we have assumed an average location based on the vessel traffic in the Gulf of Mexico. Based on previous analyses, if the FPSO is located adjacent to high traffic shipping lanes the collision risk could increase by a factor of four. Conversely, if the FPSO is located far from shipping lanes the risk could drop by an order of magnitude or more. Means of reducing collision risk include collision avoidance radar, attendant vessel, thrusters, and a vessel exclusion zone around the FPSO. Proximity to other installations or shore may increase the availability of spill response equipment. Environmental impact of releases is location dependent
Subsea System			
Well Count and Drill Centers	3 drill centers each with 3 wells	No options	
Subsea Trees	Horizontal	Conventional	Reduced accessibility for intervention may increase the likelihood of blowout during intervention. Risk of major oil spills would thus be greater.
Flowlines	Dual insulated steel	Flexible	No impact, provided they are properly designed, constructed, installed, and maintained.

Table 4-34

Qualitative Effect of FPSO Design Options on Oil Spill Risk

Variable	Base Case	Option	Effect on Oil Spill Risk
		Steel	No impact, provided they are properly designed, constructed, installed, and maintained.
Subsea Manifold Type	Active	Passive	A passive manifold would reduce the number of barriers for isolation between a riser release or flowline release and the wellhead. Conversely, a passive manifold would reduce the number of potential subsea manifold leak sources.
Umbilicals	Single multiplex	Dual	There is insufficient data to suggest that use of dual subsea controls umbilicals is more reliable than use of single multiplex umbilicals. Therefore, it is assumed that provided they are properly designed, constructed, installed, and maintained for the service, the type of umbilicals used should not significantly impact the risk of oil spill.
Risers	Steel wave risers	Flexible risers Steel catenary risers Hybrid risers	Riser technology for deepwater applications is relatively new; as such, there is a limited track record for the various types of deepwater riser systems in terms of numbers of riser failures. The current data for deepwater risers is insufficient to differentiate amongst the options for this study. Therefore, it is assumed that provided they are properly designed, constructed, installed, and maintained for the service, the type of deepwater riser used should not significantly impact the risk of oil spill.
Vessel mooring			
Number of Moorings	Clustered (3 groups of 3 mooring lines)	Equally spaced	Equally spacing mooring lines reduces the available spacing for risers and thus increases the likelihood of riser-to-riser collisions. There is no clear disadvantage from clustered moorings as long as they are sized for the foreseeable environmental loads.
Configuration	Caternary	Taut	Use of taut moorings may result in a reduction in the potential for mooring line/ riser interaction, but are otherwise not expected to impact the spill rate, provided there are properly designed, constructed, installed, and maintained.
		Semi-taut	Use of semi-taut moorings may result in a reduction in the potential for mooring line/ riser interaction, but are otherwise not expected to impact the spill rate, provided there are properly designed, constructed, installed and maintained.
Material	Wire rope / chain	Polyester / chain	Polyester moorings are not expected to affect release rate provided they are properly designed, constructed, installed, and maintained.
Anchor Type	Drag	Suction pile Driven pile	No impact, provided they are properly designed, constructed, installed and maintained

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Table 4-34

Qualitative Effect of FPSO Design Options on Oil Spill Risk

Variable	Base Case	Option	Effect on Oil Spill Risk
Turret system			
Weathervaning	Passive	Active	FPSO could be brought about or moved somewhat off-station to avoid a collision or minimize damage, which may result in a major reduction in the potential for collision by passing merchant vessels (1.2% of potential base-case spills by volume). Reduced fatigue loading on process equipment and tall structures potentially resulting in a minor reduction in process releases (3.2% of potential base-case spills by volume). Improved station-keeping during offloading, reducing the potential for "fishtailing" and leak during transfer to shuttle tanker (1.8% of potential base- case spills by volume). Possibility of reduced loads on the mooring system, which may slightly reduce the likelihood of mooring failures (<0.1% of base-case spills by volume). Additional power generation requirements and possible vulnerability to failures in the drive mechanism may partially offset the benefits.
		Passive with assist	Similar impact as for active option.
Type	Permanent	Disconnectable	Increased risk of riser release (0.4% of potential base-case spills by volume) during connection and disconnection operations. Reduced risks due to foundering caused by severe weather (but this would typically be counteracted by a reduction in specification). Structural failure (foundering) accounts for 0.3% of potential base-case spills by volume. The FPSO is more vulnerable to marine hazards when disconnected (e.g., running aground, collisions while in congested waters). Disconnection is not likely to be rapid enough to protect the FPSO against ship collision or riser releases.

Table 4-34

Qualitative Effect of FPSO Design Options on Oil Spill Risk

Variable	Base Case	Option	Effect on Oil Spill Risk
Location	Internal	External	Internal turrets are universal for FPSOs in harsh environments. The turret and swivel are located farther away from the process area and the cargo tanks, resulting in a major reduction in probability of escalation from swivel and turret releases (0.2% and <0.0% of potential base-case spills by volume, respectively). Maintenance of turret and swivel components is much harder, and so release frequency (smaller releases) would increase.
Bearing System	Roller	Bogeys / sliding	Not clear that this can significantly affect environmental risks.
Fluid Transfer System	Multi-pass	Drag chain	Not clear that this can significantly affect environmental risks. Using drag chain would require that the FPSO have some means of propulsion, either active or passive with an assist. See Weathervaning above.
Hull			
Cargo Storage	1 MM bbls	2.3 MM bbls	Cargo storage should be consistent with shuttle tanker size with a contingency to allow for shuttle tanker delays. The size of the shuttle tanker depends on the destination port. Larger shuttle tankers will require fewer offloading operations, thus reducing the frequency of offloading spills, but the magnitude of shuttle spills would increase (for bigger shuttle tankers). Increasing the storage on the FPSO will also tend to increase the size of FPSO spills.
Ballast Capacity	Segregated	None	
Type	New build	Conversion	As a basis of comparison, it is assumed that a new-build FPSO and a conversion FPSO would be built to the same rules and specifications, and that both would be double-hulled (the design option of having a single-hulled FPSO is being addressed independently of the new-build/conversion design option). In comparing a new-build FPSO to a conversion FPSO with regard to the risk of oil spills, the following potential differences have been identified:

Table 4-34

Qualitative Effect of FPSO Design Options on Oil Spill Risk

Variable	Base Case	Option	Effect on Oil Spill Risk
			• Fatigue History: The uncertainty in fatigue life prediction is the same on both new-build and conversion FPSOs. In the case of a conversion FPSO there is some uncertainty as to what the fatigue history of the vessel is, and exactly how much fatigue life there is remaining. However, the fatigue assessment procedure for the conversion of oil tankers for FPSO service is generally conservative, and it can be assumed that the frequency of fatigue failure for a conversion FPSO is similar to that of a new-build. Also, not all fatigue damages will result in cargo leakage if inspections occur on a regular basis. • Layout Options: For a conversion FPSO, the layout options (locations of process, manifold, accommodations, etc) are somewhat constrained compared to a new-build FPSO. This is due to the accommodations, machinery spaces, and other features already being in place on a conversion. By optimizing the layout on a new-build FPSO, there is the potential to increase personnel safety and to increase the protection against environmental spills (e.g., by relocating manifolds, process equipment, and cargo piping to minimize the possibility of spills to sea). Even so, they both need to satisfy the same minimum requirements.

Table 4-34

Qualitative Effect of FPSO Design Options on Oil Spill Risk

Variable	Base Case	Option	Effect on Oil Spill Risk
			• Connection Details: To account for the load of the process unit and other equipment on the main deck, the connection details of a new-build FPSO may be different than on a conversion FPSO. However, in both cases the large equipment support loads are distributed to transverse bulkheads and locally strengthened as required. For the purpose of the risk of oil spills, there is likely to be little or no difference between the design options. • Frequency of Hull Cracks: The frequency of hull cracks (number of cracks per year) in tankers built after 1993 (double hull tankers) is significantly lower than for older (single hull) tankers built before 1993. If the original vessel was a single hull tanker, the frequency of hull cracks may be higher than a new-build FPSO. However, if the original vessel was a double hull tanker, the frequency of hull cracks may be the same order of magnitude as for a new-build FPSO. A conversion FPSO may potentially have a higher risk of oil spills than a new-build FPSO. Based on the current amount of historic data for FPSOs, it is difficult to quantify the difference in risk between a new-build FPSO and a conversion FPSO. Qualitatively, however, it is believed that as long as both the new-build FPSO and the conversion FPSO are built properly and to the same rules and specifications, the increased risk of oil spill for the conversion FPSO would be small. Other design options considered in this Risk Assessment (single hull FPSO, double hull width, different location of FPSO, higher production rate, etc) would have greater effects on the risk of oil spills than would use of a conversion FPSO.
		Non-ship shaped	The shape of the hull, the layout of equipment, including risers, turret system (if present), the process area, cargo storage area, accommodations, etc., all affect the risk of oil spill. Specifications of a proposed design would be needed in order to evaluate the effect on the risk of oil spill.

Table 4-34

Qualitative Effect of FPSO Design Options on Oil Spill Risk

Variable	Base Case	Option	Effect on Oil Spill Risk
Configuration	Double hull (4 m)	2 m – 5 m double hull	The main factor determining the FPSO's resistance to cargo tank breach from a vessel collision is the width of the double hull. Passing merchant vessel collisions result in 1.2% of potential base-case spills by volume. Narrowing the double-hull width to 2 m would reduce the impact energy required to cause cargo tank breach by 50% (i.e., 50% lower vessel displacement required to cause a cargo release for a given collision speed). This would result in the passing merchant vessel releases increasing to 2.5% of potential spills by volume. Widening the double-hull width to 5 m would increase the impact energy required to breach a cargo tank by 24%. This would result in the passing merchant vessel releases decreasing to 0.8% of potential spills by volume.
		Single sided single bottom	Increased vulnerability to ship collision damage. Passing merchant vessel collisions result in 1.2% of potential base-case spills by volume, and this would be expected to increase to 2.8% for a single-sided FPSO. Much more difficult to inspect hull. Increased main deck plate thickness would reduce the risk of escalation to cargo area from process leaks and other fires impacting the deck. Process leaks escalating to the cargo area result in 3.2% of potential base-case spills by volume. Changed risk of oil spill following cargo tank explosion due to change in plate thickness.
		Single sided double bottom	Increased vulnerability to ship collision damage. Passing merchant vessel collisions result in 1.2% of potential base-case spills by volume, and this would be expected to increase to 2.8% for a single-sided FPSO. Much more difficult to inspect hull. Increased main deck plate thickness would reduce the risk of escalation to cargo area from process leaks and other fires impacting the deck. Process leaks escalating to the cargo area result in 3.2% of potential base-case spills by volume. Changed risk of oil spill following cargo tank explosion due to change in plate thickness.

4-187

Table 4-34

Qualitative Effect of FPSO Design Options on Oil Spill Risk

Variable	Base Case	Option	Effect on Oil Spill Risk
		Double side, single bottom	Much more difficult to inspect ship's bottom. Increased main deck plate thickness would reduce risk of escalation to cargo area from process leaks and other fires impacting the deck. Process leaks escalating to cargo area result in 3.2% of potential base-case spills by volume. Changed risk of oil spill following cargo tank explosion due to change in plate thickness.
Propulsion	No propulsion	Propulsion	See weathervaning, above
		DP	See weathervaning, above
Production			
Oil Production Rate	150,000 bopd	300,000 bopd	The risks per barrel produced are likely to reduce as production rates increase. Releases linked to production (excluding transport and offloading) are 5.5% of base-case spills by volume. The risk per barrel offloaded or transported would remain about the same. Releases from transport by shuttle tanker at sea and in port are 53.6% and 39.0% of potential base-case spills by volume, respectively. Releases during transfer from FPSO to shuttle tanker are 1.8% of potential base-case spills by volume.
Gas Production Rate	200 MMSCFD	300 MMSCFD	The increase in gas throughput is likely to increase the risk of process fires, which are one of the larger contributors to the overall risk. Therefore, the risk is likely to increase.
Water Production Rate	70,000 BWPD	100,000 BWPD	No direct increase in the risk of accidental oil spills. However, if this requires additional production risers or additional separation equipment, the risk is liable to increase.
Trains	Single train	Dual train	The risk of process accidents would approximately double due to the increase in equipment. As the inventory in each stage is liable to be much greater than that necessary for escalation, the risk from process events is also likely to approximately double. Process events account for 3.2% of potential base-case spills by volume.
Separators	3 stage	2 stage	Reduced risk from separators due to the reduction in vessels. However, if this means there is a need to increase the number of compression stages, this may reduce or remove the risk benefit for process events. Process events account for 3.2% of potential base-case spills by volume.

Table 4-34

Qualitative Effect of FPSO Design Options on Oil Spill Risk

Variable	Base Case	Option	Effect on Oil Spill Risk
Gas disposal	Pipeline export	Injection	Shorter gas pipeline at higher pressure means that the gas pipeline risks would be affected. These are negligible in the base case. There would be an increase in the process risks as a result of the additional compression. Process events account for 3.2% of potential base-case spills by volume. MMS has indicated that gas reinjection may be an approvable option under the condition that the operator demonstrates a solid commitment and plan to eventually produce the gas.
		Conversion	Not a proven offshore technology. Therefore, conversion could potentially pose unforeseen risks. Additional process plant required for conversion is likely to increase process risks. Process events account for 3.2% of potential base-case spills by volume.
		Flaring / venting	Gas compression risks eliminated (except fuel gas), resulting in reduced process risks. Process events account for 3.2% of potential base-case spills by volume. Flaring is not likely to be acceptable, long term.
Flare	Emergency flare only	None	
Produced Water Disposal	Discharge overboard	None	
Offloading system			
Offloading Configuration	Tandem	Side by side	Not clear whether risks would be affected significantly. Side-by-side offloading would be largely similar to current lightering practice between oil tankers and shuttle tankers, which has a good safety record in the GoM. The potential for maneuvering collisions between the shuttle tanker and the FPSO are a concern with side-by-side offloading. Because of the low maneuvering speeds and the fact that both shuttle tanker and FPSO have double hulls, it is not anticipated that a cargo spill could result from a low-speed collision. However, the potential for damage to either the shuttle tanker or FPSO, potentially requiring drydock repair, could pose a significant concern.

Table 4-34

Qualitative Effect of FPSO Design Options on Oil Spill Risk

Variable	Base Case	Option	Effect on Oil Spill Risk
		Buoy based offloading system	Increased risk of oil spill from additional riser / pipeline from FPSO to buoy. Reduced potential for low-speed maneuvering collision between shuttle tanker and FPSO. However, low-speed collisions are not expected to result in a cargo spill due to the low maneuvering speeds and the fact that the shuttle tanker and the FPSO are both double hulled. The reduction in potential for low-speed maneuvering collisions would lessen the potential for damage and possible dry dock repair for the shuttle tanker or FPSO.
Cargo Pumps	Submerged pumps	pump room	A pump room introduces an additional and significant risk of cargo area explosions. Cargo tank explosions account for 0.2% of potential base-case spills by volume. The relative scarcity of experience with submerged pumps means that the risks from their operation and maintenance are not well understood; however, it is typically assumed that submerged pumps are lower risk than a pump room.
Offload Rate	50,000 BPH	30,000 BPH	The time required for offloading would be increased, which would tend to increase the potential for offloading spills; however, the volume of potential spills would likely decrease due to the lower flow rate. Therefore, it is not clear how this would affect the risk of oil spill.
Offloading Hose	Retractable	Floating	Not clear that this will affect the risks measured.
Shuttle tanker Hull Configuration	Double hull	Single hull	Increased consequences in the event of grounding, contact, or collision. These are three of the leading causes of shuttle tanker spills, and shuttle tanker spills near and at sea already account for 53.6% and 39.0% of potential base-case spills by volume. Therefore, the single-hulled shuttle tanker option would represent a major increase in oil spill risk over the base case.

Table 4-34

Qualitative Effect of FPSO Design Options on Oil Spill Risk

Variable	Base Case	Option	Effect on Oil Spill Risk
		ATB	Use of ATBs (articulated tug barges) is a relatively new development and there are little data on frequency of oil spills from ATBs. There are oil spill frequency data for tankers and barges. These data indicate that the oil spill frequency for barges is approximately four times higher than for oil tankers, and the average barge spill size is about eight times smaller than for oil tankers. However, ATBs are not very similar to inland barges, which make up the majority of the vessels in the barge data quoted. ATBs are more similar in design and operation to tankers. The main functional differences are that ATBs have a lower crew size, lower top speed than tankers and some sea-state limitations on the tub-barge coupling. Therefore, it is expected that the oil spill frequency for ATBs is best estimated using oil spill rate tanker data rather than barge data.
Capacity	500,000 bbls	no options	
Station-keeping	Hawser with thruster assist	Hawser	Increased vulnerability to hawser failure, and subsequent damage to the offloading hose and release during transfer to shuttle tanker. Transfer hose leaks account for 1.8% of potential base-case spills by volume.
		DP	Vulnerability to DP failures and subsequent damage to the offloading hose and release during transfer to shuttle tanker. Whether using a DP system would increase or decrease the potential for oil spills would depend on the reliability of the DP system. With a reliable DP system, it would be expected that loss of station-keeping and damage to the offloading hose would be much reduced. Transfer hose leaks account for 1.8% of potential base-case spills by volume.
General Layout			
Quarters/Flare Location	Quarters stern/ flare bow	Quarters bow / flare stern	It is not clear that there will be a significant difference in the risk of oil spill between these two configurations. The flare should be well clear/upwind of any potential gas release sources. If the flare is sufficiently high, it is unlikely that it will ignite a gas release.
Living Quarters Capacity	70	no options	
Life Boat Arrangements	per USCG requirements	no options	
Bow/Stern Escape Tunnels	Not required	no options	

Table 4-34

Qualitative Effect of FPSO Design Options on Oil Spill Risk

Variable	Base Case	Option	Effect on Oil Spill Risk
Collision Avoidance Warning System (CAWS)	Monitor / Alarm	Continuously manned radar watch	Reduced risk of ship collision by passing merchant vessel. Use of a continuously manned radar watch with supervision of passing vessels has been estimated to reduce collision frequency by 50-80% (ref. 3). However, this 50-80% reduction is probably too high for the base-case because there is no attendant vessel, as is assumed in this figure. Since there is no attendant vessel to act as a guard vessel, the actions of the FPSO personnel would be largely limited to trying to raise the oncoming vessel on the radio and otherwise alert them, and to prepare for collision. Passing merchant vessel collisions account for 1.2% of base-case spills by volume.
		No CAWS	Increased risk of ship collision by passing merchant vessel. Passing merchant vessel collisions account for 1.2% of base-case spills by volume.
Shuttle Tanker Destination	various		Transit routes avoiding busy shipping lanes or difficult navigation passages are likely to have lower risks. Thereafter, minimizing the distance traveled reduces risk.
Offloading Frequency	every 3 days	every day to once per ten days	More frequent offloading operations increases the risk of small leaks due to offloading, and increases the risk of shuttle tanker failures. Conversely, less frequent offloading has the opposite effect.
FPSO Thruster Assist	No thrusters	Thrusters	See 4.1 and 6.5 in above table
Shuttle Tanker Tug Assist	No tug	Tug	A tug would reduce the risk of shuttle tanker collision with the FPSO and would also be on hand to prevent collisions by other drifting vessels in the vicinity (drifting vessels are a negligible risk)
Hurricane Abandonment	No	Yes	Reduced possibility for manual mitigation of an accident if it were to occur during a hurricane. The benefit of hurricane abandonment is reduced potential for loss of life in the event of a failure during a hurricane, rather than any reduction in oil spill risk. Evacuating personnel by helicopter for hurricane abandonment is not a risk-free operation. Helicopter accidents are one of the major fatality risks of offshore operations. An FPSO should be so designed and constructed to ensure it is habitable and safe during all foreseeable weather conditions.

Source: DNV 2001.

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OSRA Model

The OSRA model generates simulated oil spill trajectories that are based on an empirical analysis of oil spill transport on the ocean surface. By generating a large ensemble of these simulated oil spill trajectories, the model then estimates probabilities of oil spill contact to various offshore resources and to small partitions of the entire Gulf shoreline.

The model generates trajectories of spilled oil from a field of analyzed winds near the sea surface and surface ocean currents. The surface ocean currents are generated by a computerized model of ocean circulations in the Gulf of Mexico. Wind fields, other meteorological forcing, and observations of river flow into the Gulf drive this ocean model. Using nine years of analyzed winds and other marine environmental data as input into the Princeton-Dynalysis Ocean Model adapted to the Gulf of Mexico, a field of realistic surface currents of the Gulf has been produced (Herring *et al.*, 1999). The nine-year wind and generated ocean current fields then serve as inputs into an OSRA model (Smith *et al.*, 1982).

The OSRA model produced approximately 2,000 trajectories of simulated oil spills from selected locations in the study area where oil production, storage, or transport may occur. The 2,000 trajectories were evenly spaced in time over the nine years of wind and ocean current data (i.e., a trajectory was started every 1.6 days approximately at every selected geographic location). Thus, weather-scale as well as longer-term variability in the winds was sampled, and a large ensemble of trajectories was generated for each selected location. The simulated trajectories persisted for up to 90 days unless they contacted shore earlier, at which point they were stopped.

The OSRA model continually monitors the location of simulated spills in relation to the designated environmental or commercial resources or to segments of coastline, counting contacts to these resources as the model "steps" through time. The oil spill contact probabilities were computed as the ratios of the number of contacts to the total number of simulated spills (2,000) from a given location. The model products are tables of probabilities tabulated for each selected geographic location and for a set of trajectory durations (e.g., 3 days, 20 days, 30 days, etc.). The results of the OSRA model run for the FPSO, which include locations and time frames beyond those analyzed in this document, can be found in Price *et al.* (2000).

There are a number of assumptions that are implicit in the OSRA model analysis results. One is the assumption that the "historical" records of nine years of winds and ocean currents statistically represent the future Gulf winds and ocean currents when the offshore activities under consideration will occur. Two, the model does not consider the volume of oil released or its weathering during transport. Three, the OSRA model assumes that oil spills remain as single, consolidated masses on the sea surface for the duration of time oil spill trajectories are computed. Thus, it is assumed that there are no clean-up operations, splitting of the oil spill into separate slicks, evaporation, spreading, or dispersion of any kind, or re-washing into the ocean after contact with shore. These simplifying assumptions avoid complex phenomena that are difficult to model and mostly err on the side of environmental caution. In reality, cleanup operations would at least partially recover spilled oil and evaporation and dispersion would further reduce the time frame that the entire slick would remain on the ocean surface, however, the model results provide the most conservative (i.e., worst case) estimation of the probability of oil spill contact.

The OSRA model output was used to determine the likelihood that hypothetical spills, occurring at one of seven deepwater FPSO sites and along a single shuttle tanker route may contact various offshore natural resources or shore segments within 3, 20, or 30 days. In addition, cluster analysis of the OSRA output was used to determine the similarity of offshore spill risk to shoreline segments. When evaluating small spills or spills of low-density, it is recognized that light oil may dissipate completely in 20 to 30 days. Further, weathering processes cause a reduction in the mass of oil in a slick. With larger spills, the acutely toxic components of oil (e.g., light aromatic compounds) dissolve, disperse, and evaporate. In consideration of these factors, and because of the wide range of potential spills sizes and several different possible oil types associated with future FPSO production in deepwater areas of the Gulf of Mexico, the time frames analyzed by the OSRA model (i.e., 3, 20, and 30 days, maximum) can be considered to be conservative.

Open-Ocean Oil-Weathering Model

The MMS Open-Ocean Oil-Weathering Model, developed by Payne *et al.* (1984), further modified by Kirstein (1992) and evaluated by Reed *et al.* (1998), was designed to simulate the physical-chemical changes and overall mass balance of an oil slick on the sea surface. The model does not consider the geographic location of the spill, spill trajectory, or shoreline interactions. The oil-weathering model predicts changes in mass balance and composition of oil remaining in the slick as a function of time and original volume of the spilled oil in response to the weathering processes of spreading, evaporation, dispersion (oil into water), and emulsification (water into oil).

Environmental variables used in the model include sea surface and air temperature and time-varying wind speed. Oil properties used in the model include: density (API gravity), viscosity (cP) at 25°C, surface tension (dynes/cm), and a distillation curve of volume fraction of oil evaporating in specified boiling point intervals. Several constants or conversion factors were used to convert parameters to the unique wind and temperature conditions modeled.

4.4.2.2 Methodology

OSRA Model

OSRA spilled oil trajectories from all 91 offshore potential FPSO sites were subjected to cluster analysis to gain a broader perspective of the shoreline segments that might be vulnerable to contact with oil released from FPSOs anywhere in the deep offshore study area. Cluster analysis is a multivariate technique that groups entities based on similar characteristics. The 91 offshore launch points were grouped based on the probabilities of spill contact with each of the shoreline segments in the Gulf of Mexico. The similarity level for the groups of launch points was set at 0.85. Similarity of launch points was measured as Euclidean distance squared based on Ward's Linkage. The cluster analysis was performed with the Minitab statistical package. The cluster analysis identified 10 offshore areas for the 30-day spill drift scenario and two areas for the 3-day drift scenario. A total of eight launch points were also selected from among all 119 candidate sites (i.e., 91 FPSO sites and 28 shuttle tanker sites) for OSRA modeling analyses, as reflected in figure 4-12. FPSO locations were selected to be representative of the geographic range and water depth interval of these facilities in the Gulf of Mexico; tankering routes were also reviewed and a single representative location selected. Water depths for the eight selected launch points were quite variable, ranging from less than 100 m (328 ft) to more than 2,500 m (4,922 ft) off Texas and Louisiana (table 4-35).

The seven selected launch points representing potential FPSO sites are distributed throughout the deepwater study area, from the Mississippi Canyon lease area in the east to the Corpus Christi lease area in the west. Distance from each of the seven FPSO sites to closest shore ranges from 85 to 354 km (53 to 220 mi) (table 4-35). The selected shuttle tanker launch point, designated T17, is relatively close to shore (approximately 121 km [75 mi]) in less than 100 m (328 ft) of water and is located along one of the projected shuttle tanker routes into Galveston Bay, Texas.

Twenty-four offshore resources in the Gulf of Mexico (figure 4-13) and 224 equidistant shoreline segments (figure 4-14) were identified because of their environmental vulnerability to oil spills or because they represent a geographical area containing sensitive environmental resources; while the OSRA model analysis was conducted using equidistant shoreline segments, the results consider both shoreline segment number and a corresponding county or parish location to facilitate consideration and analysis of sensitive shoreline resources. The OSRA model predicts the conditional probability that a hypothetical spill originating at a launch point may contact a particular resource or shore segment. Conditional probabilities provide only information about the trajectory of a hypothetical spill based on surface water currents and wind conditions and do not consider the likelihood of a spill occurrence. The conditional probabilities of contact to resources or shore segments were predicted for spill drift durations of 3, 20, and 30 days after a spill from each of the eight selected launch points. Spill drift durations were selected based on: 1) precedent established in previous MMS trajectory analyses (i.e., 3 and 30 days, as evaluated in MMS lease sale EISs); and 2) previous oil spill studies suggesting that, after two to three weeks, there is a transition of oil weathering processes from drifting, evaporation, and dispersion/dissolution (i.e., during the first two weeks) to emulsification/mousse formation resulting in breakup of slicks and stranding on the shore or sinking (Wolfe *et al.*, 1994). Twenty days was selected to represent this transition time in the modeling.

Oil Spill Frequencies

Oil spill frequencies or occurrence rates were determined separately in an FPSO-specific risk analysis through a series of steps, including hazard examination (i.e., identification of all potential sources of accidental oil release) and frequency calculation (i.e., determination of accident frequencies for each hazard). Data on accident frequencies were derived from historical accidents which have occurred aboard tension leg platforms (TLPs) worldwide (all but one TLP are located in the GOM). Results of the risk assessment are detailed in Section 4.4.1.

The objective of the risk analysis was to quantify the incremental risk of oil spills from FPSO and supporting shuttle tanker operations above the spill risks associated with development and production activities currently accepted and operating in the deepwater Gulf of Mexico. Hazards that could lead to an oil spill were identified for FPSOs and for operations on board them, including the transfer of FPSO oil to shuttle tankers, and transit of shuttle tankers to shore. The most likely spill volume or range of volumes was estimated for each hazard. A spill frequency (per year) was estimated for spills associated with each hazard. Spill frequencies from all hazards were summed to obtain a total spill frequency, as detailed in Section 4.4.1. It is possible to estimate a probability-weighted frequency of spilled oil from a deepwater FPSO launch point contacting a particular resource or shore segment. This is accomplished by

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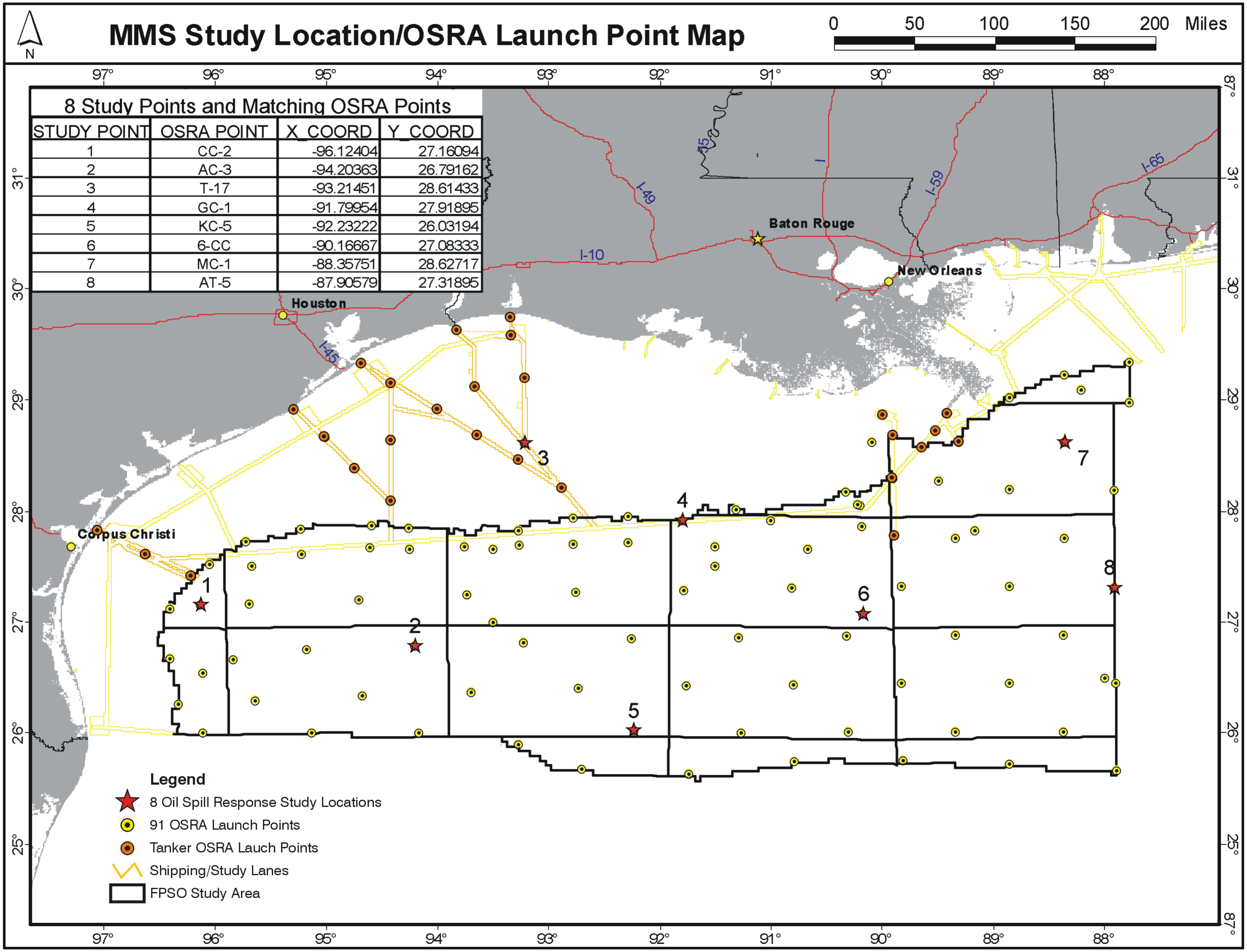

8 Study Points and Matching OSRA Points

STUDY POINT	OSRA POINT	X_COORD	Y_COORD
1	CC-2	-96.12404	27.16094
2	AC-3	-94.20363	26.79162
3	T-17	-93.21451	28.61433
4	GC-1	-91.79954	27.91895
5	KC-5	-92.23222	26.03194
6	6-CC	-90.16667	27.08333
7	MC-1	-88.35751	28.62717
8	AT-5	-87.90579	27.31895

Figure 4-12 LOCATION OF OIL SPILL LAUNCH POINTS AS EVALUATED BY THE OSRA MODEL

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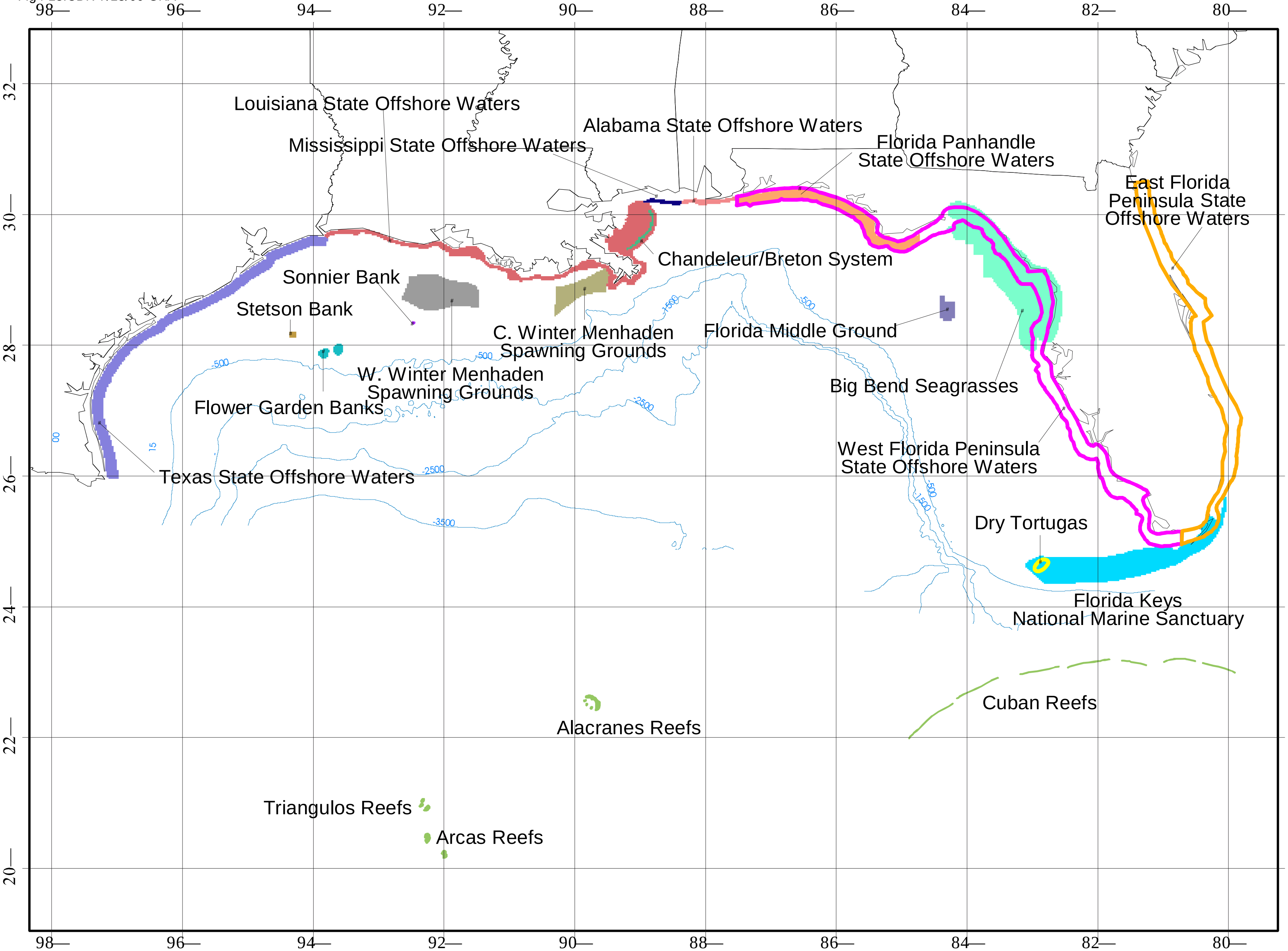

Figure 4-13. Sensitive offshore resources of the Gulf of Mexico considered in the OSRA modeling analysis.

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Minerals Management Service
Gulf of Mexico OCS Region

Table 4-35

Select Launch Points For Modeled Oil Spills from Offshore FPSOs or From Shuttle Tankers Transporting Crude Oil from FPSOs to Shore

Lease Area	OSRA Launch Point Designation	Distance to Closest Shore (km [miles])	Approximate Water Depth (m [ft])
Corpus Christi	CC2	117 (73)	500 (1,640)
Alaminos Canyon	AC3	259 (161)	1,500 (4,922)
Keathley Canyon	KC5	354 (220)	2,500 (8,202)
Green Canyon	GC1	154 (96)	200 (656)
Green Canyon	6CC[a]	214 (133)	1,500 (4,922)
Mississippi Canyon	MC1	85 (53)	500 (164)
Atwater Valley	AT5	220 (137)	>2,500 (>8,202)
West Cameron South	T17[b]	121 (75)	<100 (<328)

Footnotes:

[a] – Launch point 6CC is within the USCG lightering zone; and

[b] – Launch point T17 is within one of the shuttle tanker routes to be used in support of FPSO operations.

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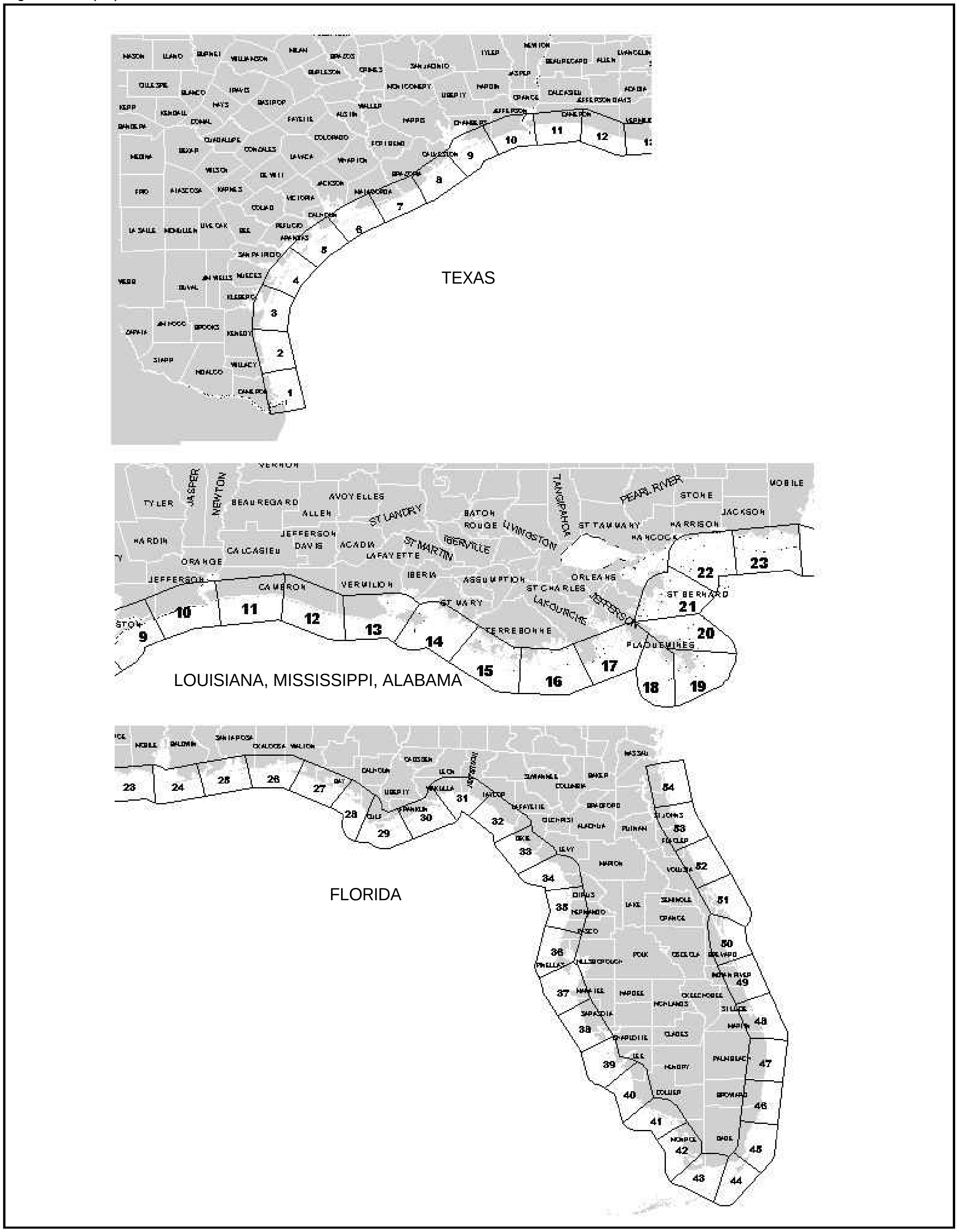

Figure 4-14 U.S. GULF COAST EQUIDISTANT LAND SEGMENTS USED IN THE OSRA MODEL

multiplying the conditional probability of shoreline (or sensitive offshore resource) contact generated by the OSRA model by the estimated frequency of occurrence of a spill of a particular size from the FPSO or shuttle tanker. A combined probability of oil spill risk can also be calculated by taking the probability-weighted frequency of spill contact and multiplying by the number of years expected for FPSO activity (i.e., 20 years). These two approaches are utilized in the current analysis.

Open-Ocean Oil-Spill Weathering Model

Ecological risks to marine or shoreline resources from a possible oil spill can not be estimated only from predictions of the probability of contact between the spilled oil and the resource. Additional information on the volume, weathering state, and composition of the spilled oil and sensitivity to oil of the contacted resources is needed for a more thorough analysis.

Weathering properties of crude oils were estimated with the Open-Ocean Oil-Weathering model (Payne *et al.*, 1984; Kirstein, 1992). It is unknown what the range of characteristics is for the oil reservoirs located in the deepwater area because there has yet to be a large amount of production. Two crude oils were assumed, for purposes of this analysis, to represent the types of crude oils that may be produced from and stored aboard deepwater FPSOs in the Gulf of Mexico. These crude oils, selected from production sites or processing facilities located within Mississippi Canyon Block 807 and Viosca Knoll Block 990, were modeled. Oil characterization data, provided by the MMS (G. Rainey, 1999, MMS Gulf of Mexico OCS Region, New Orleans, personal communication), are detailed in table 4-36.

Weathering of the two oils was modeled at a sea-surface temperature of 73°F (22.8°C) and variable winds, ranging in speed between 0.8 m/sec and 14.6 m/sec (1.8 to 32.7 miles/hr). The model was set to predict weathering properties at increments of weathering time of 1 hour for the first 51 hours and 10 hours from 51 hours to 720 hours (30 days). The weathering parameters modeled included mass fraction remaining in the slick, specific gravity of the oil, area and thickness of the slick, average molecular weight of the oil in the slick, and slick viscosity. The model also predicted the mass fraction of water in the water-in-oil dispersion (mousse), the mass fraction of oil evaporated to the atmosphere and dispersed into the water column (oil-in-water emulsion), and the total mass in metric tons of oil remaining in the surface oil slick. Spill sizes considered in the oil weathering analysis included the following:

- 1,000 barrels of oil
- 10,000 barrels of oil
- 100,000 barrels of oil
- 300,000 barrels of oil

4.4.2.3 Results

OSRA Oil Spill Trajectories - Overview

The eight selected launch points for hypothetical oil spills are distributed over the outer continental shelf and slope from a location approximately 117 km (73 mi) southeast of Corpus Christi, Texas, in the west to a location approximately 220 km (137 mi) southeast of the mouth of the Mississippi River in the east (figure 4-12). The closest launch point used in the hypothet-

Table 4-36

Physical and Chemical Characteristics of Two Crude Oils Modeled with the Open-Ocean Oil-Weathering Model[a]

Parameter	Mississippi Canyon 807	Viosca Knoll 990
Bulk API Gravity	27.6	38.2
Viscosity (cP @ 25°C)	29	5
Oil/Water Surface Tension (dynes/cm @ 25°C)	23.4	22.9
Flash Point	<-30°C	-17°C
Pour Point	-34°C	-32°C
Maximum Fraction Water in Mousse	65%	0%
Saturated Hydrocarbons	47%	73%
Aromatic Hydrocarbons	35%	22%
Resins	12%	4%
Asphaltenes	6%	1%
Total BTEX	6,006 mg/kg	13,785 mg/kg
C_3-Benzenes	5,180 mg/kg	16,437 mg/kg

Footnote:

[a] - physical and chemical characterization data provided by G. Rainey, MMS Gulf of Mexico Region, New Orleans, LA, 1999.

ical spill scenario evaluation from an FPSO was 85 km (53 mi) from the nearest shoreline, while the furthest FPSO location considered was 354 km (220 mi) offshore. The hypothetical oil spill launch site for shuttle tanker traffic was in the shipping lanes off Galveston, Texas, (location T17), approximately 145 km (90 mi) southeast of Galveston and about 121 km (75 mi) from the nearest shoreline. Water depths for the FPSO sites considered in the OSRA analysis ranged from 200 m (656 ft) to >2,500 m (8,202 ft); the tanker route location is in less than 100 m (328 ft) of water. These distances from shore and water depths provide a range of possible future locations of FPSOs and shuttle tanker operations in the Gulf of Mexico. While hypothetical oil spills from 117 launch points were modeled using the OSRA Model (i.e., 91 hypothetical FPSO sites, 28 hypothetical tankering sites), the eight selected launch points evaluated in greatest detail were selected based on 1) their location within the study area (i.e., Western and Central Gulf of Mexico Planning Areas) and to one another, 2) their proximity to shore and sensitive offshore features, and 3) water depth. Further, narrowing the analysis to eight hypothetical spill launch points allowed for the evaluation of oil spill response capabilities across a broad spectrum of possible FPSO locations.

Spills from offshore areas can be transported by longshore currents forced by winds in such a way that the nearest shoreline does not have the highest probability of contact, and the highest risk is displaced to locations farther from the spill source. In particular, the western Gulf of Mexico has a well-developed westward coastal current from Louisiana to Texas waters during September through April. Under these physical oceanographic and meteorological conditions, deepwater spills may have extremely low risk of contacting the nearest shoreline. The flow generally reverses during May through August, and is slower and more diffuse during that period.

Conditional Probabilities of Oil Spill Contact

Conditional probabilities (expressed as percent chance) that a spill of sufficient size to reach shore from one of the eight selected launch points could contact one of 24 offshore resources (figure 4-13) in the Gulf of Mexico within 30 days range from less than 0.5 percent to 86 percent (tables 4-37 through 4-44). It is important to note that these conditional probabilities do not take into consideration the likelihood that a spill will occur; in the unlikely event that a spill does occur, the conditional probabilities indicate which offshore resources or coastal segments may be at risk from spill contact. As expected, conditional probability of contact increases with time after a spill and, to a lesser extent, decreases with increasing distance from shore.

The following discussion of OSRA Model results separately considers potential oil spill contact to sensitive offshore resources and the Gulf of Mexico shoreline. The discussion of sensitive offshore resources only considers results from the eight selected launch points (i.e., no cluster analysis was conducted relative to offshore resources). The discussion of equidistant land segments and potential shoreline contact considers results from both the cluster analysis and the trajectories from the eight selected launch points.

Potential Oil Spill Contact with Offshore Resources

The potential for oil spill contact to 24 separate offshore resources were considered in the oil spill analysis. Conditional probabilities (of spill contact on these resources) were determined

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Table 4-37

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting in the Corpus Christi Lease Area, at Location CC2, and Continuing for 3, 20, or 30 Days May Contact Different Environmental Resources in the Gulf of Mexico

Environmental Resource	3 Days	20 Days	30 Days
United States Land	•	76	82
1. W. Winter Menhaden Spawning Grounds	•	•	•
2. C. Winter Menhaden Spawning Grounds	•	•	•
3. Big Bend Seagrass	•	•	•
4. Chandeleur Islands	•	•	•
5. Florida Middle Ground	•	•	•
6. Florida Keys NMS	•	•	•
7. Flower Garden Banks NMS	•	1	1
8. Texas State Offshore Waters	•	81	86
9. Louisiana Offshore State Waters	•	•	•
10. Mississippi State Offshore Waters	•	•	•
11. Alabama State Offshore Waters	•	•	•
12. Florida Panhandle State Offshore Waters	•	•	•
13. Stetson Bank	•	•	•
14. Cuban Reefs	•	•	•
15. Alacranes Reefs	•	•	•
16.Triangulose Reefs	•	•	•
17. Arcas Reefs	•	•	•
18. Dry Tortugas	•	•	•
19. Sonnier Bank	•	•	•
20. E. Half Florida Coastal Waters	•	•	•
21. W. Half Florida Coastal Waters	•	•	•
22. N. Florida Straits	•	•	•
23. S. Florida Straits	•	•	•
24. Yucatan Straits	•	•	•
International Land	•	3	5

• Less than 0.5 percent.

Table 4-38

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting in the Alaminos Canyon Lease Area, at Location AC3, and Continuing for 3, 20, or 30 Days May Contact Different Environmental Resources in the Gulf of Mexico

Environmental Resource	3 Days	20 Days	30 Days
United States Land	•	20	43
1. W. Winter Menhaden Spawning Grounds	•	3	6
2. C. Winter Menhaden Spawning Grounds	•	6	1
3. Big Bend Seagrass	•	•	•
4. Chandeleur Islands	•	•	•
5. Florida Middle Ground	•	•	•
6. Florida Keys NMS	•	•	•
7. Flower Garden Banks NMS	•	7	8
8. Texas State Offshore Waters	•	22	39
9. Louisiana Offshore State Waters	•	2	7
10. Mississippi State Offshore Waters	•	•	•
11. Alabama State Offshore Waters	•	•	•
12. Florida Panhandle State Offshore Waters	•	•	•
13. Stetson Bank	•	3	4
14. Cuban Reefs	•	•	•
15. Alacranes Reefs	•	•	•
16.Triangulose Reefs	•	•	•
17. Arcas Reefs	•	•	•
18. Dry Tortugas	•	•	•
19. Sonnier Bank	•	1	1
20. E. Half Florida Coastal Waters	•	•	•
21. W. Half Florida Coastal Waters	•	•	•
22. N. Florida Straits	•	•	•
23. S. Florida Straits	•	•	•
24. Yucatan Straits	•	•	•
International Land	•	1	4

• Less than 0.5 percent.

Table 4-39

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting in the Keathley Canyon Lease Area, at Location KC5, and Continuing for 3, 20, or 30 Days May Contact Different Environmental Resources in the Gulf of Mexico

Environmental Resource	3 Days	20 Days	30 Days
United States Land	•	6	15
1. W. Winter Menhaden Spawning Grounds	•	5	7
2. C. Winter Menhaden Spawning Grounds	•	1	2
3. Big Bend Seagrass	•	•	•
4. Chandeleur Islands	•	•	•
5. Florida Middle Ground	•	•	•
6. Florida Keys NMS	•	•	•
7. Flower Garden Banks NMS	•	4	3
8. Texas State Offshore Waters	•	4	6
9. Louisiana Offshore State Waters	•	3	6
10. Mississippi State Offshore Waters	•	•	•
11. Alabama State Offshore Waters	•	•	•
12. Florida Panhandle State Offshore Waters	•	•	•
13. Stetson Bank	•	1	•
14. Cuban Reefs	•	•	•
15. Alacranes Reefs	•	•	•
16.Triangulose Reefs	•	•	•
17. Arcas Reefs	•	•	•
18. Dry Tortugas	•	•	•
19. Sonnier Bank	•	1	1
20. E. Half Florida Coastal Waters	•	•	•
21. W. Half Florida Coastal Waters	•	•	•
22. N. Florida Straits	•	•	•
23. S. Florida Straits	•	•	•
24. Yucatan Straits	•	•	•
International Land	•	•	1

• Less than 0.5 percent.

Table 4-40

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting in the Green Canyon Lease Area, at Location GC1, and Continuing for 3, 20, or 30 Days May Contact Different Environmental Resources in the Gulf of Mexico

Environmental Resource	3 Days	20 Days	30 Days
United States Land	•	23	39
1. W. Winter Menhaden Spawning Grounds	5	36	40
2. C. Winter Menhaden Spawning Grounds	•	3	5
3. Big Bend Seagrass	•	•	•
4. Chandeleur Islands	•	•	•
5. Florida Middle Ground	•	•	•
6. Florida Keys NMS	•	•	•
7. Flower Garden Banks NMS	•	3	4
8. Texas State Offshore Waters	•	9	18
9. Louisiana Offshore State Waters	•	18	25
10. Mississippi State Offshore Waters	•	•	•
11. Alabama State Offshore Waters	•	•	•
12. Florida Panhandle State Offshore Waters	•	•	•
13. Stetson Bank	•	1	1
14. Cuban Reefs	•	•	•
15. Alacranes Reefs	•	•	•
16.Triangulose Reefs	•	•	•
17. Arcas Reefs	•	•	•
18. Dry Tortugas	•	•	•
19. Sonnier Bank	•	4	5
20. E. Half Florida Coastal Waters	•	•	•
21. W. Half Florida Coastal Waters	•	•	•
22. N. Florida Straits	•	•	•
23. S. Florida Straits	•	•	•
24. Yucatan Straits	•	•	•
International Land	•	•	•

• Less than 0.5 percent.

Table 4-41

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting in the Green Canyon Lease Area, at Location 6CC, and Continuing for 3, 20, or 30 Days May Contact Different Environmental Resources in the Gulf of Mexico

Environmental Resource	3 Days	20 Days	30 Days
United States Land	•	6	14
1. W. Winter Menhaden Spawning Grounds	•	9	13
2. C. Winter Menhaden Spawning Grounds	•	6	8
3. Big Bend Seagrass	•	•	•
4. Chandeleur Islands	•	•	•
5. Florida Middle Ground	•	•	•
6. Florida Keys NMS	•	•	•
7. Flower Garden Banks NMS	•	•	1
8. Texas State Offshore Waters	•	1	4
9. Louisiana Offshore State Waters	•	6	12
10. Mississippi State Offshore Waters	•	•	•
11. Alabama State Offshore Waters	•	•	•
12. Florida Panhandle State Offshore Waters	•	•	1
13. Stetson Bank	•	•	•
14. Cuban Reefs	•	•	•
15. Alacranes Reefs	•	•	•
16.Triangulose Reefs	•	•	•
17. Arcas Reefs	•	•	•
18. Dry Tortugas	•	•	•
19. Sonnier Bank	•	•	1
20. E. Half Florida Coastal Waters	•	•	•
21. W. Half Florida Coastal Waters	•	•	•
22. N. Florida Straits	•	•	•
23. S. Florida Straits	•	•	•
24. Yucatan Straits	•	•	•
International Land	•	•	•

• Less than 0.5 percent.

Table 4-42

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting in the Mississippi Canyon Lease Area, at Location MC1, and Continuing for 3, 20, or 30 Days May Contact Different Environmental Resources in the Gulf of Mexico

Environmental Resource	3 Days	20 Days	30 Days
United States Land	2	29	37
1. W. Winter Menhaden Spawning Grounds	•	1	4
2. C. Winter Menhaden Spawning Grounds	1	15	18
3. Big Bend Seagrass	•	•	•
4. Chandeleur Islands	•	6	7
5. Florida Middle Ground	•	•	•
6. Florida Keys NMS	•	•	•
7. Flower Garden Banks NMS	•	•	•
8. Texas State Offshore Waters	•	•	•
9. Louisiana Offshore State Waters	4	32	36
10. Mississippi State Offshore Waters	•	1	1
11. Alabama State Offshore Waters	•	1	2
12. Florida Panhandle State Offshore Waters	•	4	6
13. Stetson Bank	•	•	•
14. Cuban Reefs	•	•	•
15. Alacranes Reefs	•	•	•
16.Triangulose Reefs	•	•	•
17. Arcas Reefs	•	•	•
18. Dry Tortugas	•	•	•
19. Sonnier Bank	•	•	•
20. E. Half Florida Coastal Waters	•	•	•
21. W. Half Florida Coastal Waters	•	•	•
22. N. Florida Straits	•	•	•
23. S. Florida Straits	•	•	•
24. Yucatan Straits	•	•	•
International Land	•	•	•

• Less than 0.5 percent.

Table 4-43

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting in the Atwater Valley Lease Area, at Location AT5, and Continuing for 3, 20, or 30 Days May Contact Different Environmental Resources in the Gulf of Mexico

Environmental Resource	3 Days	20 Days	30 Days
United States Land	•	5	11
1. W. Winter Menhaden Spawning Grounds	•	1	2
2. C. Winter Menhaden Spawning Grounds	•	3	7
3. Big Bend Seagrass	•	•	•
4. Chandeleur Islands	•	1	1
5. Florida Middle Ground	•	•	•
6. Florida Keys NMS	•	1	3
7. Flower Garden Banks NMS	•	•	•
8. Texas State Offshore Waters	•	•	•
9. Louisiana Offshore State Waters	•	6	10
10. Mississippi State Offshore Waters	•	•	•
11. Alabama State Offshore Waters	•	•	•
12. Florida Panhandle State Offshore Waters	•	•	2
13. Stetson Bank	•	•	•
14. Cuban Reefs	•	1	2
15. Alacranes Reefs	•	•	•
16.Triangulose Reefs	•	•	•
17. Arcas Reefs	•	•	•
18. Dry Tortugas	•	•	•
19. Sonnier Bank	•	•	1
20. E. Half Florida Coastal Waters	•	•	2
21. W. Half Florida Coastal Waters	•	•	•
22. N. Florida Straits	•	2	5
23. S. Florida Straits	•	•	•
24. Yucatan Straits	•	•	•
International Land	•	1	2

• Less than 0.5 percent.

Table 4-44

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting in the Tankering Route of the West Cameron South Lease Area, at Location T17, and Continuing for 3, 20, or 30 Days May Contact Different Environmental Resources in the Gulf of Mexico

Environmental Resource	3 Days	20 Days	30 Days
United States Land	•	62	74
1. W. Winter Menhaden Spawning Grounds	2	8	8
2. C. Winter Menhaden Spawning Grounds	•	1	1
3. Big Bend Seagrass	•	•	•
4. Chandeleur Islands	•	•	•
5. Florida Middle Ground	•	•	•
6. Florida Keys NMS	•	•	•
7. Flower Garden Banks NMS	1	9	10
8. Texas State Offshore Waters	•	51	59
9. Louisiana Offshore State Waters	•	19	21
10. Mississippi State Offshore Waters	•	•	•
11. Alabama State Offshore Waters	•	•	•
12. Florida Panhandle State Offshore Waters	•	•	•
13. Stetson Bank	•	3	4
14. Cuban Reefs	•	•	•
15. Alacranes Reefs	•	•	•
16.Triangulose Reefs	•	•	•
17. Arcas Reefs	•	•	•
18. Dry Tortugas	•	•	•
19. Sonnier Bank	•	•	1
20. E. Half Florida Coastal Waters	•	•	•
21. W. Half Florida Coastal Waters	•	•	•
22. N. Florida Straits	•	•	•
23. S. Florida Straits	•	•	•
24. Yucatan Straits	•	•	•
International Land	•	•	1

• Less than 0.5 percent.

for spills continuing for 3, 20, and 30 days, based on hypothetical releases from each of the eight selected launch points (tables 4-37 through 4-44). As is evident in a review of these tables, very few of the offshore resources exhibited conditional probabilities greater that 0.5 percent. Each selected launch point is discussed in greater detail below.

The highest conditional probability of contact (86 percent) is for an oil spill from the selected launch point in the Corpus Christi lease area (i.e., CC2), located southeast of Corpus Christi, Texas, contacting Texas state offshore waters within 30 days (table 4-37). At 20 days, there is an 81 percent conditional probability of oil contact to Texas state offshore waters, however, at three days this offshore resource has less than a 0.5 percent chance of oil contact. The Flower Garden Banks National Marine Sanctuary is the only other offshore resource showing a conditional probability of oil contact greater than 0.5 percent at 3, 20, or 30 days.

The highest conditional probability of contact (39 percent) is for an oil spill from the selected launch point in the Alaminos Canyon lease area (AC3) contacting Texas state offshore waters within 30 days (table 4-38). At 20 days, there is a 22 percent conditional probability of oil contact to Texas state offshore waters, however, at three days this offshore resource has less than a 0.5 percent chance of oil contact. Other offshore resources with low conditional probabilities (i.e., one to seven percent at 20 or 30 days) of oil contact for a spill from AC3 include the western and central winter menhaden spawning grounds, the Flower Garden Banks National Marine Sanctuary, Louisiana state offshore waters, Stetson Bank, and Sonnier Bank. The remaining offshore resources showed a conditional probability of oil contact <0.5 percent at 3, 20, or 30 days.

The highest conditional probability of contact (7 percent) is for an oil spill from the selected launch point in the Keathley Canyon lease area (KC5) contacting the western winter menhaden spawning grounds waters within 30 days (table 4-39). Texas and Louisiana state offshore waters also showed slightly lower conditional probabilities of oil spill contact (i.e., six percent at 30 days). Other offshore resources with low conditional probabilities (i.e., one to five percent at 20 or 30 days) of oil contact for a spill from KC5 include the central winter menhaden spawning grounds, the Flower Garden Banks National Marine Sanctuary, Stetson Bank, and Sonnier Bank. The remaining offshore resources showed a conditional probability of oil contact <0.5 percent at 3, 20, or 30 days.

The highest conditional probability of contact (40 percent) is for an oil spill from the selected launch point in the Green Canyon lease area (GC1) contacting the western winter menhaden spawning grounds waters within 30 days (table 4-40). Texas and Louisiana state offshore waters also showed slightly lower conditional probabilities of oil spill contact (i.e., 18 and 25 percent at 30 days, respectively). Other offshore resources with low conditional probabilities (i.e., one to nine percent at 20 or 30 days) of oil contact for a spill from GC1 include the Flower Garden Banks National Marine Sanctuary, Stetson Bank, and Sonnier Bank. The remaining offshore resources showed a conditional probability of oil contact <0.5 percent at 3, 20, or 30 days.

The highest conditional probability of contact (13 percent) is for an oil spill from the selected launch point in the Green Canyon lease area (6CC) contacting the western winter menhaden spawning grounds waters within 30 days (table 4-41). Louisiana state offshore waters also showed a slightly lower conditional probability of oil spill contact (i.e., 12 percent at 30 days). Other offshore resources with low conditional probabilities (i.e., one to nine percent at 20 or 30 days) of oil contact for a spill from 6CC include the central winter menhanden spawning grounds, Flower Garden Banks National Marine Sanctuary, Texas state offshore waters, Florida

Panhandle state offshore waters, and Sonnier Bank. The remaining offshore resources showed a conditional probability of oil contact <0.5 percent at 3, 20, or 30 days.

The highest conditional probability of contact (36 percent) is for an oil spill from the selected launch point in the Mississippi Canyon lease area (MC1) contacting Louisiana state offshore waters within 30 days (table 4-42). At 20 and 3 days, this resource has conditional probabilities of oil contact of 32 and 4 percent, respectively. The central winter menhaden spawning grounds showed conditional probabilities of oil spill contact of 18, 15, and 1 percent at 30, 20, and 3 days, respectively. Other offshore resources with low conditional probabilities (i.e., one to seven percent at 20 or 30 days) of oil contact for a spill from MC1 include the winter menhaden spawning grounds, Chandeleur Islands, Mississippi state offshore waters, Alabama state offshore waters, and Florida Panhandle state offshore waters. The remaining offshore resources showed a conditional probability of oil contact <0.5 percent at 3, 20, or 30 days.

The highest conditional probability of contact (10 percent) is for an oil spill from the selected launch point in the Atwater Valley lease area (AT5) contacting Louisiana state offshore waters within 30 days (table 4-43). At 20 and 3 days, this resource has conditional probabilities of oil contact of 6 and <0.5 percent, respectively. The central winter menhaden spawning grounds showed conditional probabilities of oil spill contact of 7, 3, and <0.5 percent at 30, 20, and 3 days, respectively. Other offshore resources with low conditional probabilities (i.e., one to five percent at 20 or 30 days) of oil contact for a spill from AT5 include the winter menhaden spawning grounds, Chandeleur Islands, Florida Keys National Marine Sanctuary, Florida Panhandle state offshore waters, Cuban reefs, Sonnier Bank, the eastern half of Florida coastal waters, and the northern Florida Straits. The remaining offshore resources showed a conditional probability of oil contact <0.5 percent at 3, 20, or 30 days.

The highest conditional probability of contact (59 percent) is for an oil spill from the selected shuttle tanker launch point in the West Cameron South lease area (T17) contacting Texas state offshore waters within 30 days (table 4-44). At 20 and 3 days, this resource has conditional probabilities of oil contact of 51 and <0.5 percent, respectively. Louisiana state offshore waters showed conditional probabilities of oil spill contact of 21, 19, and <0.5 percent at 30, 20, and 3 days, respectively. Other offshore resources with low conditional probabilities (i.e., one to 10 percent at 3, 20, or 30 days) of oil contact for a spill from T17 include the winter menhaden spawning grounds, central winter menhaden spawning grounds, Flower Garden Banks National Marine Sanctuary, Stetson Bank, and Sonnier Bank. The remaining offshore resources showed a conditional probability of oil contact <0.5 percent at 3, 20, or 30 days.

In summary, offshore locations where the conditional probability of contact from a spill from one of the eight selected launch points within 30 days is above about 15 percent include Texas state offshore waters, Louisiana state offshore waters, and the western and central winter menhaden spawning grounds (off Louisiana), as reflected in table 4-45. Conditional probabilities that a spill may contact the Flower Garden Banks National Marine Sanctuary within 30 days range from less than 0.5 percent to 10 percent. The highest probability of oil spill contact is for a spill from an FPSO located in the Corpus Christi lease area or from a shuttle tanker in the tanker lane to Beaumont/Port Arthur, Texas. Four other offshore resources have a conditional probability of 5 percent or more of contact with an oil spill from one of the selected launch points. These are Sonnier Bank, Chandeleur Islands, Florida Panhandle state offshore waters, and northern Florida Straits (table 4-45).

Conditional probabilities that spilled oil may make contact with offshore resources are lower after 20 days than after 30 days, as expected (tables 4-37 through 4-44). For individual

Table 4-45

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting at Eight Offshore Launch Point Locations and Continuing for 30 Days May Contact Different Offshore Areas in the Gulf of Mexico. Areas with less than 0.5 percent probabilities for all eight launch points are not shown.

Offshore	Spill Location[b]							
Area No.[a]	CC2	AC3	T17	KC5	GC1	6CC	MC1	AT5
1	•	6	8	7	40	13	4	2
2	•	1	1	2	5	8	18	7
4	•	•	•	•	•	•	7	1
6	•	•	•	•	•	•	•	3
7	1	8	10	3	4	1	•	•
8	86	39	59	6	18	4	•	•
9	•	7	21	6	25	12	36	10
10	•	•	•	•	•	•	1	•
11	•	•	•	•	•	•	2	•
12	•	•	•	•	•	1	6	2
13	•	4	4	•	1	•	•	•
14	•	•	•	•	•	•	•	2
19	•	•	1	1	5	1	•	1
20	•	•	•	•	•	•	•	2
22	•	•	•	•	•	•	•	5

Footnotes:

[a] – Key to Offshore Area Numbers: 1. W. Winter Menhaden Spawning Grounds; 2. C. Winter Menhaden Spawning Grounds; 4. Chandeleur Islands; 6. Florida Keys NMS; 7. Flower Garden Banks NMS; 8. Texas State Offshore Waters; 9. Louisiana State Offshore Waters; 10. Mississippi State Offshore Waters; 11. Alabama State Offshore Waters; 12. Florida Panhandle State Offshore Waters; 13. Stetson Bank; 14. Cuban Reefs; 19. Sonnier Bank; 20. E. Half Florida State Coastal Waters; 22. N. Florida Straits.

[b] – CC2, Corpus Christi lease area; AC3, Alaminos Canyon lease area; T17, tankering route, West Cameron South lease area; KC5, Keathley Canyon lease area; GC1 and 6CC, Green Canyon lease area; MC1, Mississippi Canyon lease area; AT5, Atwater Valley lease area.

• Less than 0.5 percent.

resources, the pattern of spilled oil contact is the same after 20 days as it is after 30 days. Resource locations with the highest conditional probabilities of contact with hypothetical oil spills are the same for spill durations of 20 and 30 days.

If oil were to spill from any of the eight selected launch points, OSRA Model results suggest that oil may contact only a few offshore resources in three days (tables 4-37 through 4-44). A spill from the selected launch point in the Green Canyon lease area (i.e., GC1) has a five percent conditional probability of contacting the western winter menhaden spawning grounds within three days (table 4-41). A spill from the Mississippi Canyon lease area (i.e., MC1) has a one percent conditional probability of contacting the central winter menhaden spawning grounds within three days and a four percent conditional probability of contacting Louisiana state offshore waters in three days (table 4-42). A spill from a shuttle tanker in the transit lane within the West Cameron South lease area (i.e., at launch point T17) has a two percent conditional probability of contacting the western winter menhaden spawning grounds within three days and a one percent conditional probability of contacting the Flower Garden Banks National Marine Sanctuary within three days (table 4-44).

Conditional probabilities of a spill occurring in different seasons from one of eight offshore selected launch points contacting an offshore resource were also predicted with the OSRA Model. Seasonal contact probabilities are described only for the five offshore resource sites with the highest annual conditional probability of oil spill contact. The conditional probability of a hypothetical spill contacting Texas state offshore waters is greatest in the spring, followed by the winter (table 4-46). Probabilities are lowest in the autumn. In all seasons, the probabilities of spill contact are higher for spills originating at selected launch points in the Corpus Christi lease area (i.e., CC2, southeast of Corpus Christi, Texas) and along the tanker route (i.e., T17, tanker route southeast of Galveston, Texas). Hypothetical oil spills from the Alaminos Canyon lease area launch point (i.e., AC3, about 259 km [161 mi] southeast of the Texas coast) also have a high conditional probability of contacting Texas state offshore waters within 30 days in the spring.

The conditional probabilities that spills originating from one of the eight selected launch points may contact Louisiana state offshore waters or the western or central winter menhaden spawning areas are highest in the spring and summer and lowest in the autumn and winter (tables 4-47, 4-48, and 4-49). Spills from selected launch points in the Green Canyon and Mississippi Canyon lease areas (i.e., GC1, about 154 km [96 mi] south of the Louisiana coast, and MC1, about 85 km (53 mi) south of the mouth of the Mississippi River) have the highest probability of contacting Louisiana state offshore waters within 30 days of a spill during spring and summer. Spills from the Green Canyon lease area (GC1) also have a high conditional probability of contacting the western winter menhaden spawning grounds during these two seasons (table 4-48). During all seasons, the probabilities of spill contact with the central winter menhaden spawning grounds southwest of the Mississippi delta are generally lower than those for the western winter menhaden winter spawning grounds offshore from Vermilion and Atchafalaya Bays. Highest probabilities for spill contact with the central winter menhaden spawning grounds are for spills from the Mississippi Canyon launch point (MC1) in the winter or autumn (table 4-49). A hypothetical oil spill from the second Green Canyon launch point (i.e., 6CC, located about 214 km [133 mi] south of the Louisiana coast) would have a 20 percent conditional probability of contacting the central winter menhaden spawning grounds within 30 days in the spring.

Table 4-46

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting at Seven Possible FPSO Locations and a Single Tankering Location in Different Seasons May Contact Texas State Offshore Waters Within 30 Days

Spill Location[a]	Winter	Spring	Summer	Autumn
CC2	77	>99.5	99	69
AC3	35	72	32	18
T17	59	66	54	56
KC5	9	26	4	1
GC1	21	23	17	9
6CC	5	6	3	•
MC1	1	•	•	•
AT5	•	1	•	•

Footnote:
[a] – CC2, Corpus Christi lease area; AC3, Alaminos Canyon lease area; T17, tankering route, West Cameron South lease area; KC5, Keathley Canyon lease area; GC1 and 6CC, Green Canyon lease area; MC1, Mississippi Canyon lease area; AT5, Atwater Valley lease area.

• Less than 0.5 percent.

Table 4-47

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting at Seven Possible FPSO Locations and a Single Tankering Location in Different Seasons May Contact Louisiana State Offshore Waters Within 30 Days

Spill Location[a]	Winter	Spring	Summer	Autumn
CC2	•	•	•	•
AC3	•	18	12	•
T17	2	37	42	2
KC5	•	22	3	•
GC1	3	63	33	1
6CC	4	33	12	•
MC1	28	55	34	27
AT5	3	27	11	1

Footnote:
[a] – CC2, Corpus Christi lease area; AC3, Alaminos Canyon lease area; T17, tankering route, West Cameron South lease area; KC5, Keathley Canyon lease area; GC1 and 6CC, Green Canyon lease area; MC1, Mississippi Canyon lease area; AT5, Atwater Valley lease area.

• Less than 0.5 percent.

Table 4-48

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting at Seven Possible FPSO Locations and a Single Tankering Location in Different Seasons May Contact the Western Winter Menhaden Spawning Grounds Within 30 Days

Spill Location[a]	Winter	Spring	Summer	Autumn
CC2	•	•	•	•
AC3	•	6	17	•
T17	4	10	16	1
KC5	1	23	6	•
GC1	25	66	48	19
6CC	10	26	13	2
MC1	6	2	3	4
AT5	1	5	3	•

Footnote:

[a] – CC2, Corpus Christi lease area; AC3, Alaminos Canyon lease area; T17, tankering route, West Cameron South lease area; KC5, Keathley Canyon lease area; GC1 and 6CC, Green Canyon lease area; MC1, Mississippi Canyon lease area; AT5, Atwater Valley lease area.

• Less than 0.5 percent.

Table 4-49

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting at Seven Possible FPSO Locations and a Single Tankering Location in Different Seasons May Contact the Central Winter Menhaden Spawning Grounds Within 30 Days

Spill Location[a]	Winter	Spring	Summer	Autumn
CC2	•	•	•	•
AC3	•	1	1	•
T17	•	•	4	•
KC5	•	5	1	•
GC1	•	8	9	1
6CC	2	20	12	•
MC1	21	16	15	20
AT5	1	16	8	2

Footnote:
[a] – CC2, Corpus Christi lease area; AC3, Alaminos Canyon lease area; T17, tankering route, West Cameron South lease area; KC5, Keathley Canyon lease area; GC1 and 6CC, Green Canyon lease area; MC1, Mississippi Canyon lease area; AT5, Atwater Valley lease area.

• Less than 0.5 percent.

Conditional probabilities that a hypothetical spill from one of the eight selected launch points may contact the Flower Garden Banks National Marine Sanctuary within 30 days in different seasons varies from less than 0.5 percent to 18 percent (table 4-50). Highest probabilities are for spills from the West Cameron South tanker launch point (T17) in the autumn and winter. Spills from the Alaminos Canyon launch point (AC3, about 259 km [161 mi] southeast of the central Texas coast) and Keathley Canyon (KC5, about 354 km [220 mi] south of the Louisiana coast), are most likely to contact the Flower Garden Banks National Marine Sanctuary in the spring or summer.

Potential Oil Spill Contact with the Shoreline (Equidistant Land Segments)

Results from the Cluster Analysis

The coast of the Gulf of Mexico, including Mexico and Cuba, has been divided into equidistant shoreline segments by the OSRA Model (figure 4-14). The model predicts that an oil spill from one or more of the selected offshore launch points or one or more of the 10 offshore areas (identified during the cluster analysis) may contact one or more of 54 equidistant shoreline segments in the U.S. (table 4-51). The OSRA Model also has the potential to predict oil contact to various international shorelines (e.g., Cuba, Mexico). There is a non-zero conditional probability that an oil spill from one or more of the eight selected launch points may contact shore in all five Gulf Coast states.

Averaged probabilities that oil from a hypothetical spill from an FPSO may contact different shoreline segments in the Gulf of Mexico within 30 days were estimated for the 10 offshore areas resulting from the cluster analysis. The 10 offshore areas identified by cluster analysis encompass the entire outer shelf and slope area of the western and central Gulf of Mexico (figures 4-15 through 4-19).

The shoreline segments most likely (>11 percent) to be contacted within 30 days by oil from a spill from one of the 10 offshore areas are shoreline segments 1 through 6 (i.e., the south Texas coast, from Cameron to Matagorda County) and shoreline segment 19 (i.e., Plaquemines Parish, Louisiana, at the mouth of the Mississippi River), as reflected in table 4-52. A spill from an FPSO in area 6 has an average probability greater than 21 percent of reaching the shore of Plaquemines Parish, Louisiana (land segment 19) within 30 days; a spill from a FPSO in area 10 has an average probability greater than 21 percent of reaching shore in Aransas, Refugio, or Calhoun Counties, Texas (land segment 5), within 30 days.

The northern boundary of FPSO area 1 is about 193 km (120 mi) south of the Texas/Louisiana border (figure 4-15). Spills from this area have a two to five percent average probability of contacting the coast somewhere between land segments 4 through 13 (i.e., between Kleberg County, Texas, and Vermilion/Iberia/St. Mary Parishes, Louisiana) within 30 days. Area 2 is east of Area 1 and extends east almost to the Mississippi River delta (figure 4-15). Spills from this area have a two to five percent average probability of contacting the coast between land segments 10 through 13, 16, and 17 (Cameron through St. Mary Parishes, and Terrebonne to Plaquemines Parishes, Louisiana).

Areas 3, 8, and 10 are located off the south Texas coast in Federal waters more than about 97 km (60 mi) off Cameron to Calhoun Counties (figures 4-16, 4-18, and 4-19). These are the closest FPSO areas to the Texas coast. Average probabilities of oil from a hypothetical spill from an FPSO in these areas reaching the Texas coast are high. The coastal segments most

Table 4-50

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting at Seven Possible FPSO Locations and a Single Tankering Location in Different Seasons May Contact the Flower Garden Banks National Marine Sanctuary Within 30 Days

Spill Location[a]	Winter	Spring	Summer	Autumn
CC2	2	•	•	2
AC3	2	11	15	2
T17	18	•	2	18
KC5	5	12	4	3
GC1	6	•	2	6
6CC	1	•	1	3
MC1	•	•	1	•
AT5	•	•	•	•

Footnote:
[a] – CC2, Corpus Christi lease area; AC3, Alaminos Canyon lease area; T17, tankering route, West Cameron South lease area; KC5, Keathley Canyon lease area; GC1 and 6CC, Green Canyon lease area; MC1, Mississippi Canyon lease area; AT5, Atwater Valley lease area.

• Less than 0.5 percent.

Table 4-51

Equidistant Land Segments (as Used in the OSRA Model Analysis) and Corresponding County/Parish Names

State/ Land Segment	County or Parish	State/ Land Segment	County or Parish	State/ Land Segment	County or Parish
Texas:		Mississippi:		41	Collier, Monroe
1	Cameron, Willacy	22	Hancock, Harrison, Jackson	42	Monroe
2	Willacy, Kenedy	23	Jackson	43	Monroe, Dade
3	Kenedy, Kleberg	Alabama:		44	Dade, Monroe
4	Kleberg, Nueces, San Patricio, Aransas	23	Mobile	45	Dade
5	Aransas, Refugio, Calhoun	24	Mobile, Baldwin	46	Dade, Broward
6	Calhoun, Jackson, Matagorda	25	Baldwin	47	Palm Beach
7	Matagorda, Brazoria	Florida:		48	Palm Beach, Martin, St. Lucie
8	Brazoria, Galveston	25	Escambia, Santa Rosa	49	St. Lucie, Indian River, Brevard
9	Galveston, Harris, Chambers	26	Santa Rosa, Okaloosa, Walton	50	Brevard
10	Chambers, Jefferson	27	Walton, Bay	51	Brevard, Volusia
Louisiana:		28	Bay, Gulf	52	Volusia
10	Cameron	29	Gulf, Franklin	53	Volusia, Flagler, St. Johns
11	Cameron	30	Franklin, Wakulla	54	St. Johns, Duval
12	Cameron, Vermilion	31	Wakulla, Jefferson, Taylor		
13	Vermilion, Iberia, St. Mary	32	Taylor, Dixie		
14	St. Mary, Terrebonne	33	Dixie, Levy		
15	Terrebonne	34	Levy, Citrus		
16	Terrebonne, LaFourche	35	Citrus, Hernando, Pasco		
17	LaFourche, Jefferson, Plaquemines	36	Pasco, Pinellas, Hillsborough		
18	Plaquemines	37	Pinellas, Hillsborough, Manatee, Sarasota		
19	Plaquemines	38	Sarasota, Charlotte		
20	Plaquemines, Jefferson, Orleans, St. Bernard	39	Charlotte, Lee		
21	Jefferson, St. Bernard, Orleans, St. Tammany	40	Lee, Collier		

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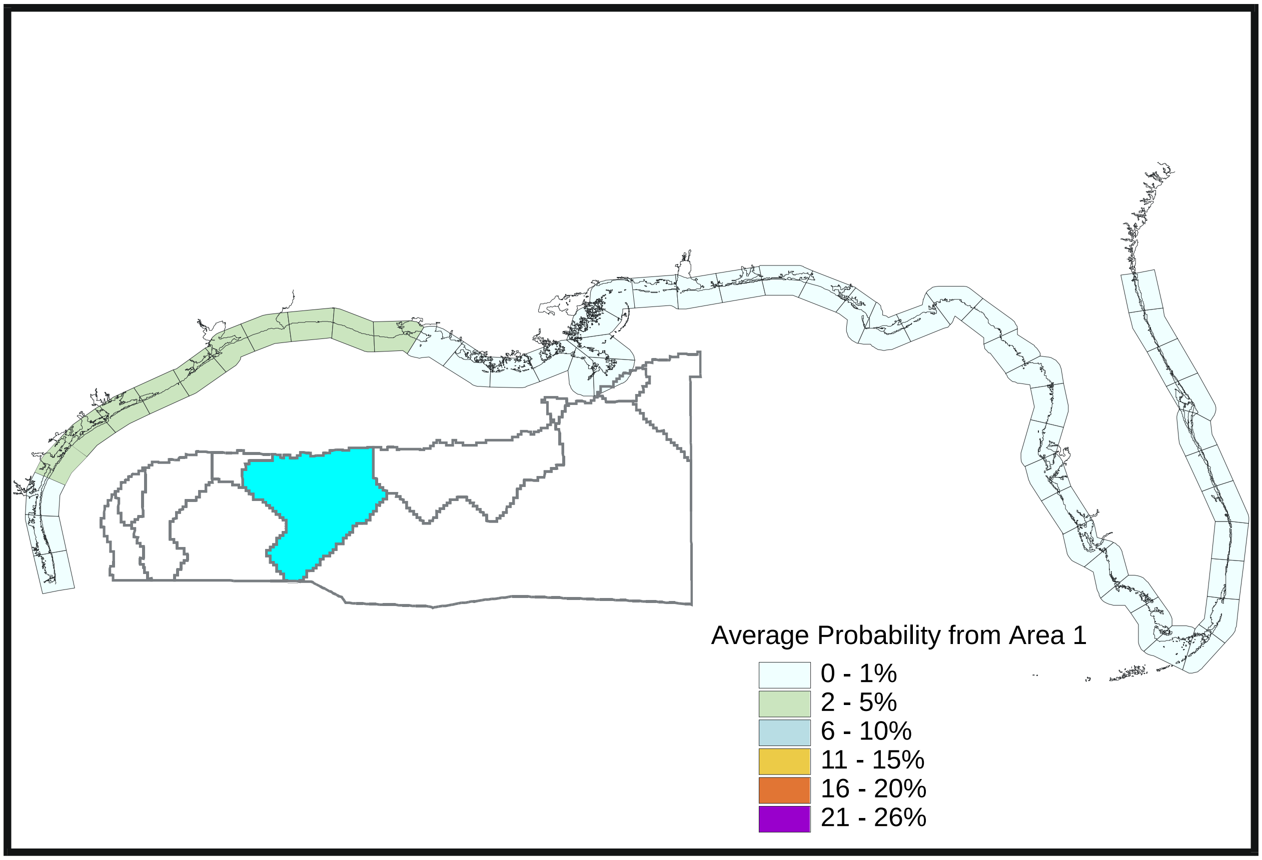


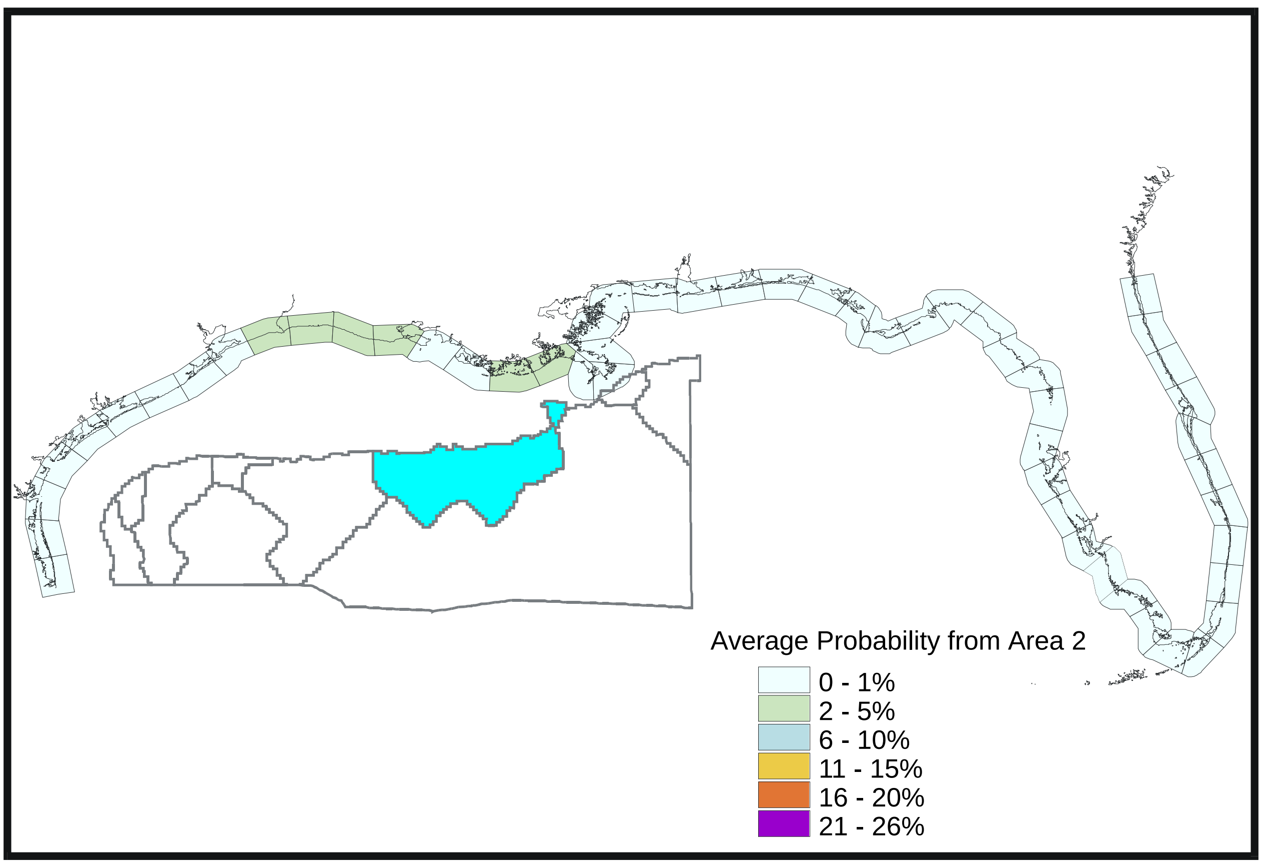
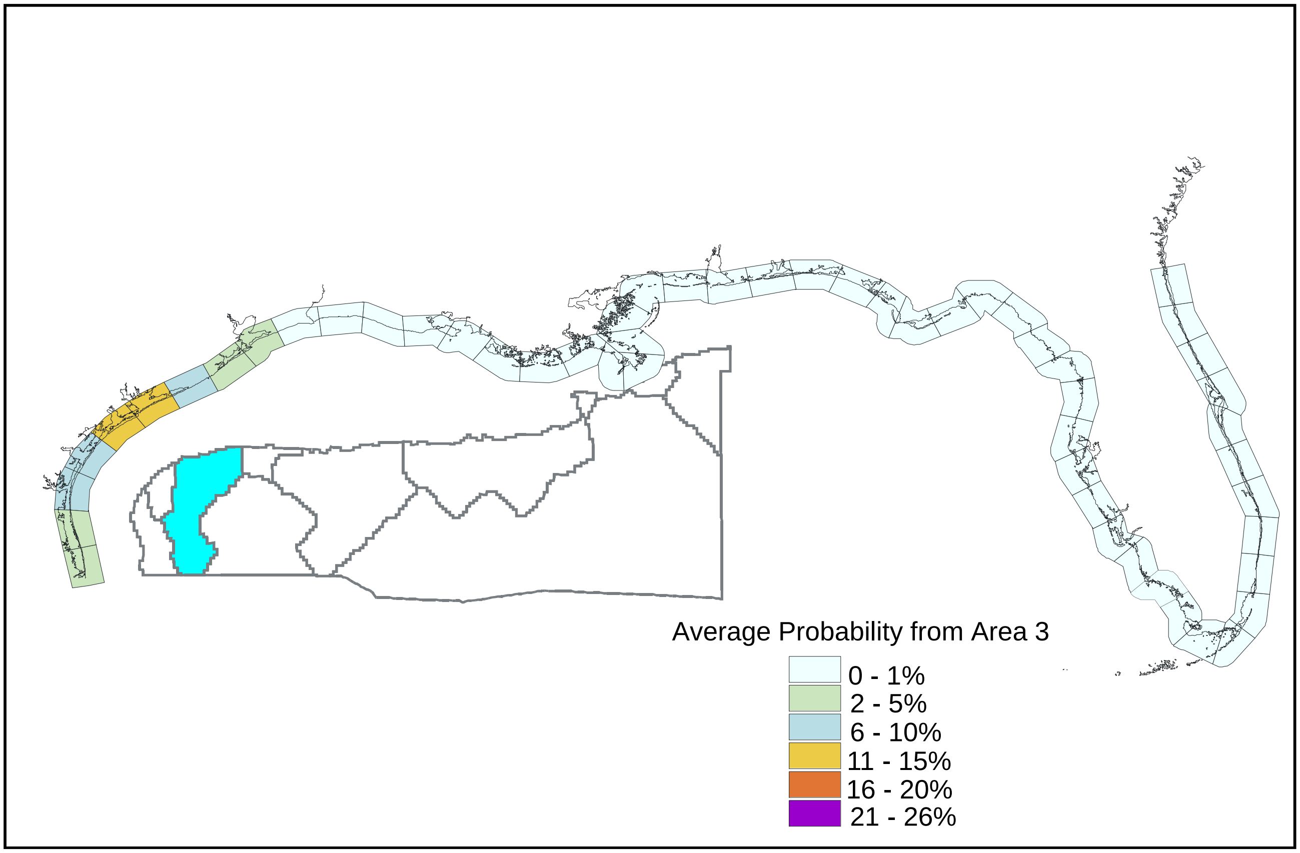


Figure 4-15 **CLUSTERING ANALYSIS RESULTS SHOWING AVERAGE PROBABILITY OF OIL CONTACT AFTER 30 DAYS ON EQUIDISTANT LAND SEGMENTS ALONG THE GULF COAST FOR HYPOTHETICAL SPILLS FROM AREAS 1 AND 2.**



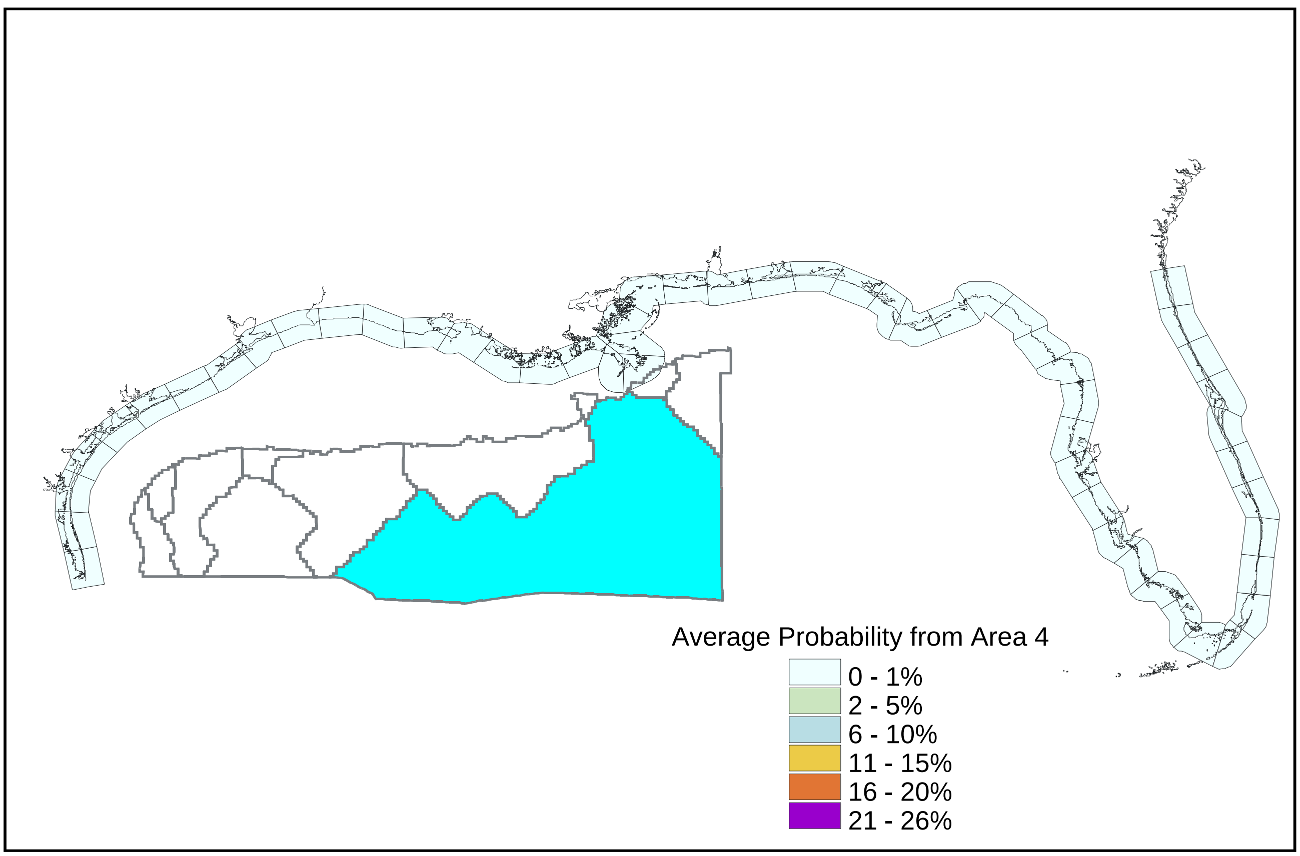
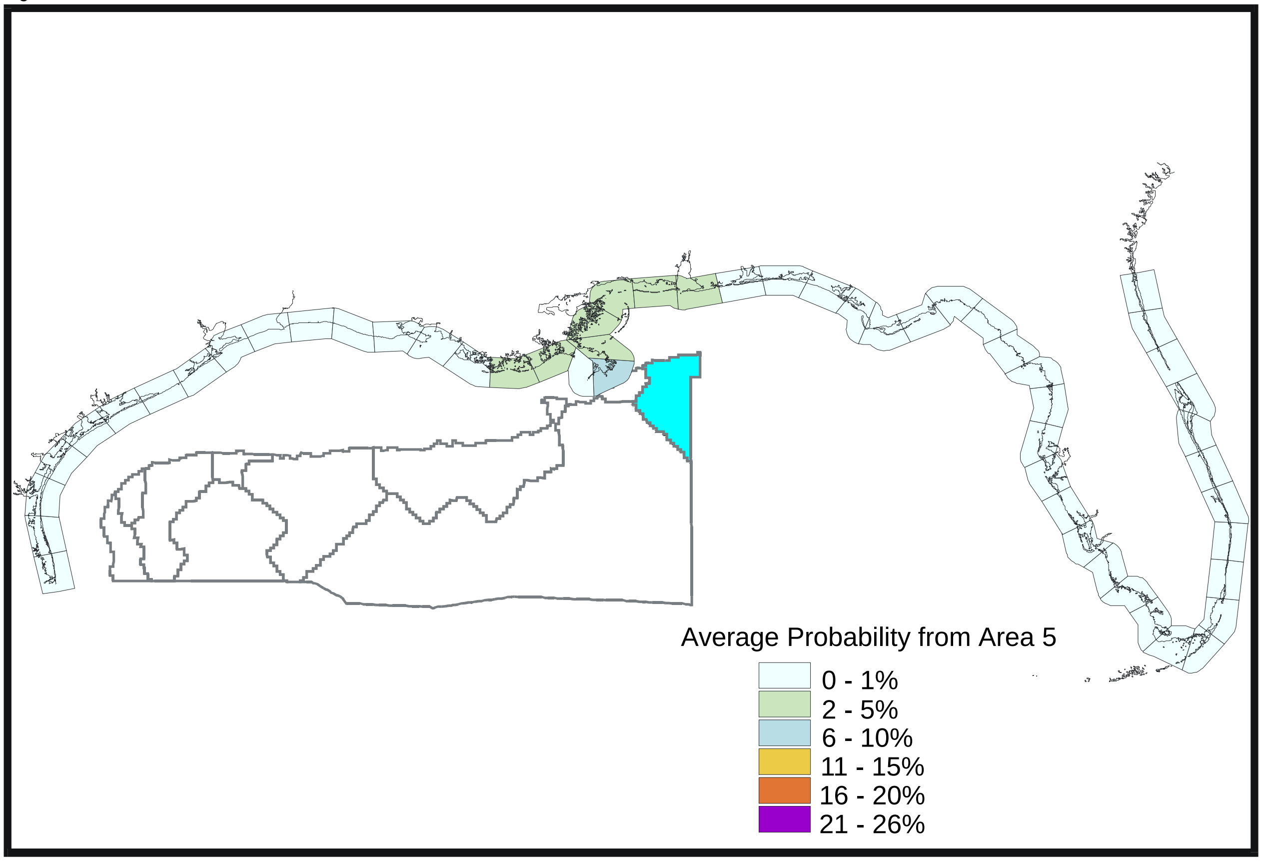


Figure 4-16 CLUSTERING ANALYSIS RESULTS SHOWING AVERAGE PROBABILITY OF OIL CONTACT AFTER 30 DAYS ON EQUIDISTANT LAND SEGMENTS ALONG THE GULF COAST FOR HYPOTHETICAL SPILLS FROM AREAS 3 AND 4.

02:001000_MM01_00_03_90-B0266
Fig4-17.CDR-7/18/00-GRA



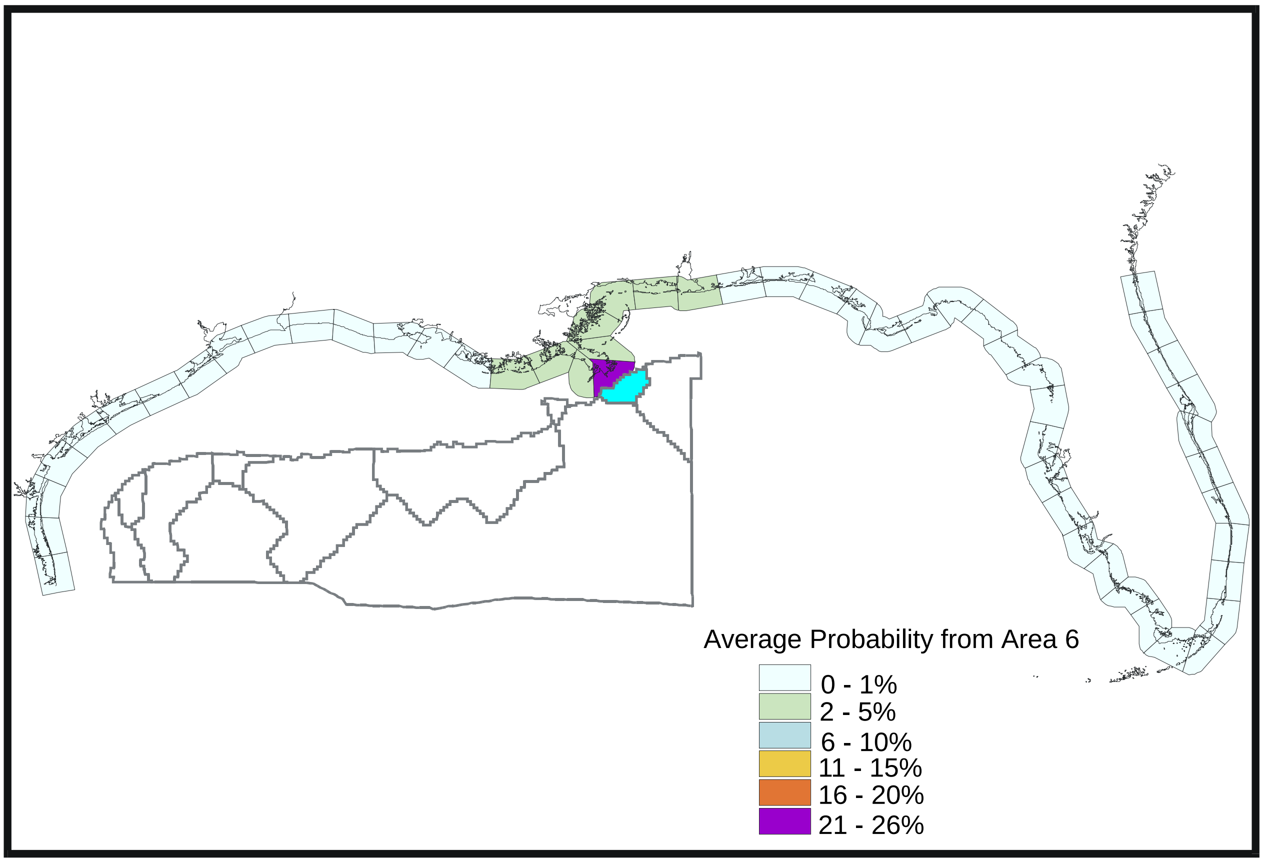
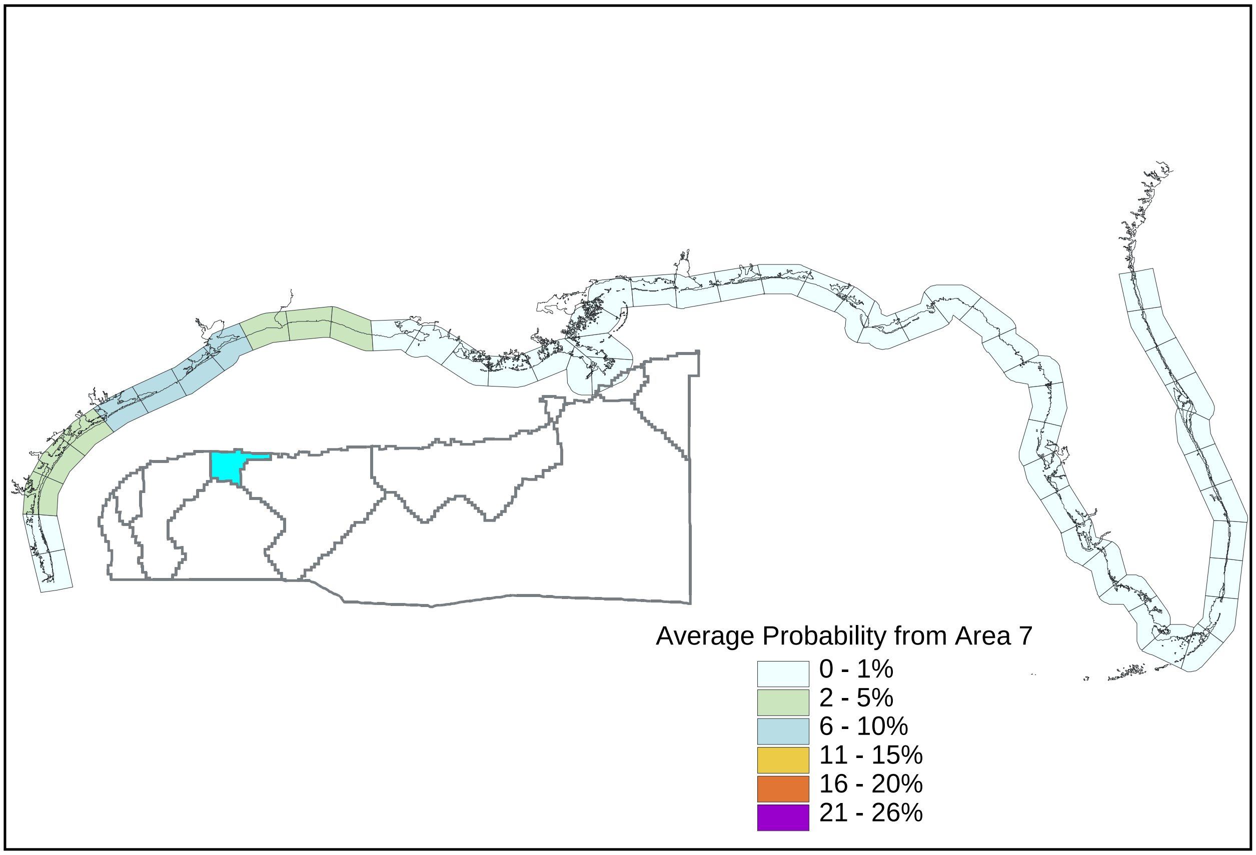


Figure 4-17 CLUSTERING ANALYSIS RESULTS SHOWING AVERAGE PROBABILITY OF OIL CONTACT AFTER 30 DAYS ON EQUIDISTANT LAND SEGMENTS ALONG THE GULF COAST FOR HYPOTHETICAL SPILLS FROM AREAS 5 AND 6.



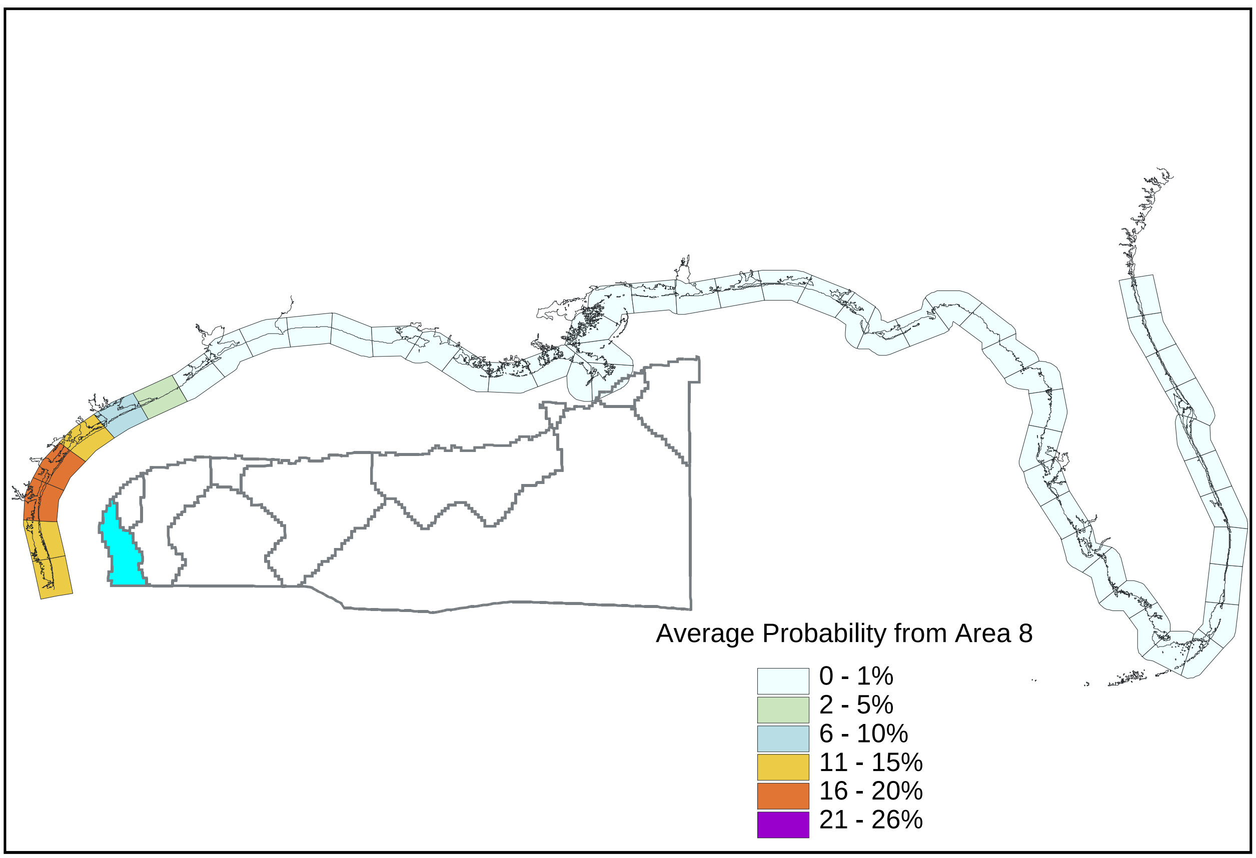
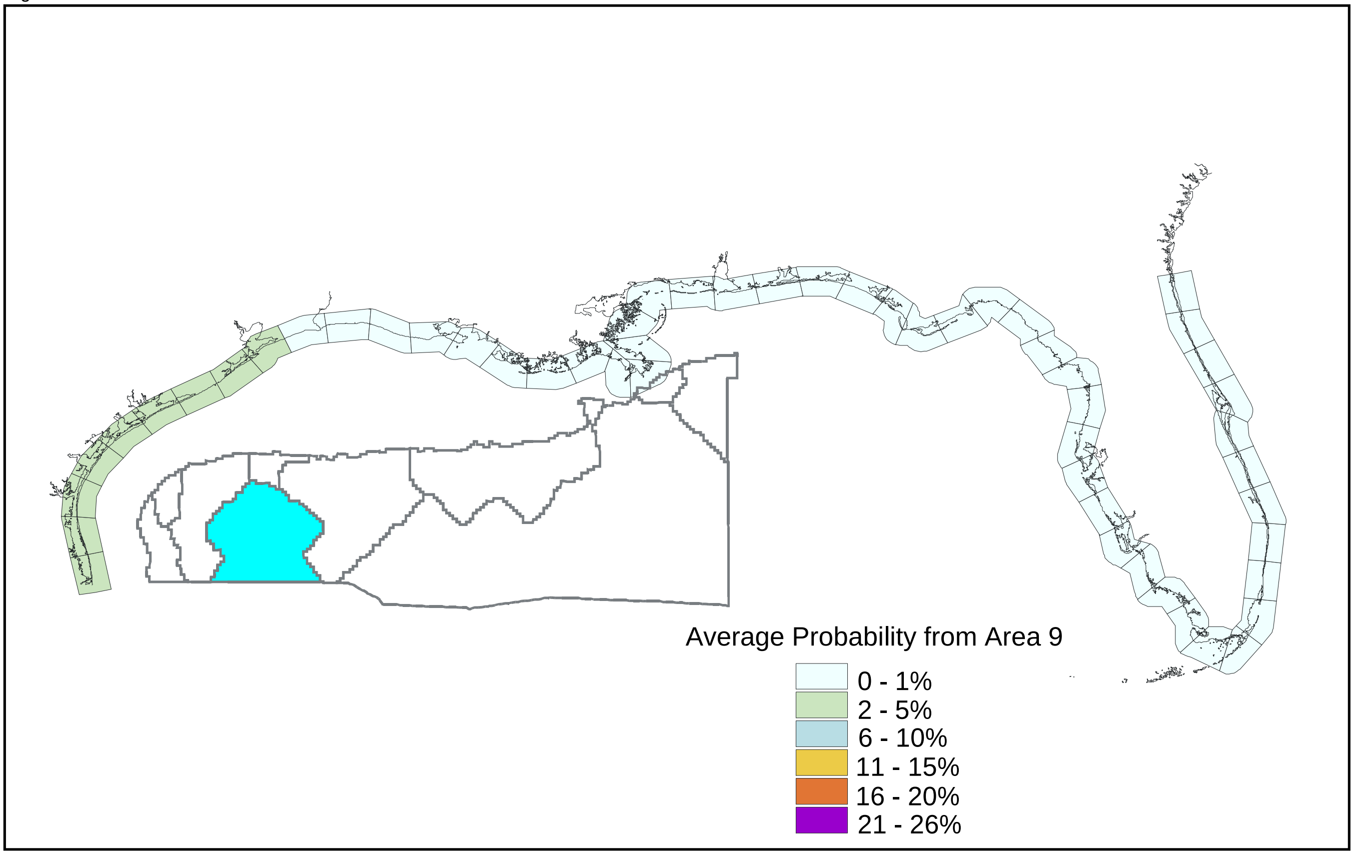


Figure 4-18 CLUSTERING ANALYSIS RESULTS SHOWING AVERAGE PROBABILITY OF OIL CONTACT AFTER 30 DAYS ON EQUIDISTANT LAND SEGMENTS ALONG THE GULF COAST FOR HYPOTHETICAL SPILLS FROM AREAS 7 AND 8.



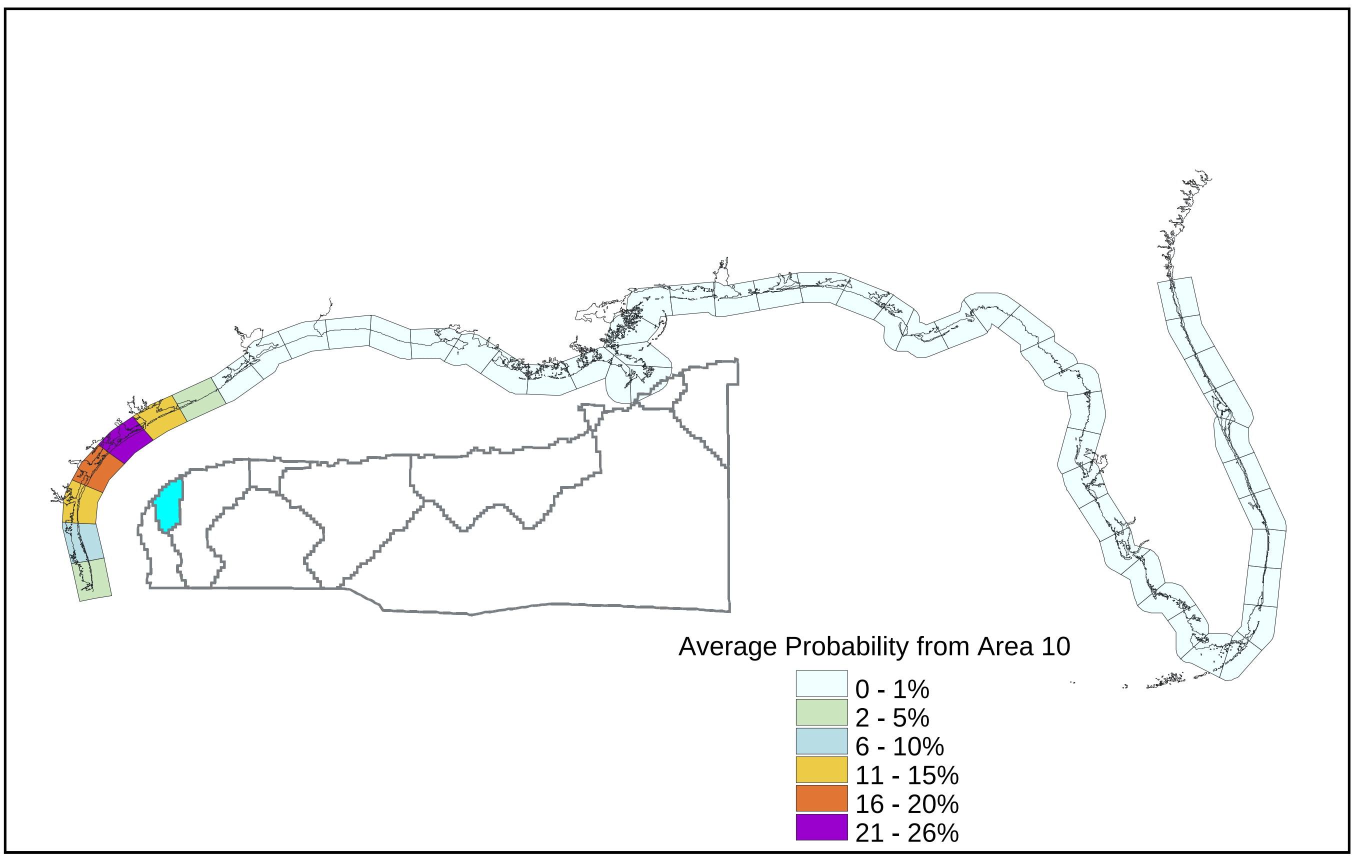


Figure 4-19 CLUSTERING ANALYSIS RESULTS SHOWING AVERAGE PROBABILITY OF OIL CONTACT AFTER 30 DAYS ON EQUIDISTANT LAND SEGMENTS ALONG THE GULF COAST FOR HYPOTHETICAL SPILLS FROM AREAS 9 AND 10.

Table 4-52

Conditional Probabilities Greater than One Percent of Oil Contact with Equidistant Land Segments Within 30 Days of Spills from FPSOs in 10 Offshore Areas of the Gulf of Mexico

FPSO Area	Average Percent Conditional Probability				
	2 – 5	6 – 10	11 – 15	16 – 20	21 – 26
	Land Segment				
1	4-13	NS	NS	NS	NS
2	10-13,16,17	NS	NS	NS	NS
3	1,2,8,9	3,4,7	5,6	NS	
4	NS	NS	NS	NS	NS
5	16,17,20-24	19	NS	NS	NS
6	16-18,20-24	NS	NS	NS	19
7	3-5,10-12	6-9	NS	NS	NS
8	7	6	1,2,5	3,4	NS
9	1-9	NS	NS	NS	NS
10	1,7	2	3,6	4	5

Footnote:

NS = No Land Segment(s).

vulnerable to spills from these areas are land segments 3, 4, and 5 (i.e., Kenedy, Kleberg, Nueces, San Patricio, Aransas, Refugio, and Calhoun Counties). Spills from FPSOs in area 4 in the deep offshore waters of the central Gulf of Mexico have an average probability less than two percent of contacting any shore segment within 30 days.

Areas 5 and 6 are located off the mouth of the Mississippi River and off Mississippi and Alabama (figure 4-17). Spills from FPSOs in these areas, particularly area 6, have a high average probability of contacting the coast of land segment 19 (Plaquemines Parish, Louisiana) within 30 days (table 4-52). Spills from FPSOs in areas 5 and 6 also have a two to five percent average probability of contacting shoreline segments 16 through 18 (Terrebonne, LaFourche, Jefferson, and Plaquemines Parishes) and 20 through 24, (Plaquemines Parish, Louisiana to Baldwin County, Alabama).

Areas 7 and 9 are located more than 161 km (100 mi) directly south of Galveston Bay, Texas (figures 4-18 and 4-19). Spills from FPSOs in these areas have a greater than two percent average probability of reaching the coast between shoreline segment 1 (Cameron and Willacy Counties, Texas) and shoreline segment 12 (Cameron and Vermilion Parishes, Louisiana). The highest average probabilities (6 to 10 percent) are for spills from FPSOs in area 7 to reach the coast in land segments 6 through 9 (between Calhoun and Chambers Counties, Texas).

Most spills from FPSOs are predicted to be small and oil slicks from them probably would not persist on the sea surface for 30 days. Thus, cluster analysis of the OSRA output was used to predict the average probabilities of shoreline contact within three days of spills from FPSO in the entire offshore study area. Spills from FPSOs in area 6 directly off the mouth of the Mississippi River have an average probability of 16 percent of reaching shore within three days. The average probability of spills from the entire remaining offshore area reaching shore in three days are less than two percent.

Results from the Eight Selected Launch Points

Similar results were obtained for hypothetical oil spills launched from the eight selected launch points when compared to results from the cluster analysis. The shoreline segments most likely (i.e., conditional probability $\geq$6 percent) to be contacted within 30 days by an oil spill from one of the eight selected offshore launch points are land segments 3 through 12 (i.e., the Texas coast [from Kenedy through Jefferson Counties] and Cameron and Vermilion Parishes, Louisiana), and land segment 19 (Plaquemines Parish, Louisiana) (table 4-53). The highest probabilities are for spills from the Corpus Christi lease area launch point (CC2, about 121 km [75 mi] southeast of Corpus Christi, Texas) which may come ashore in land segments 3 through 6 (i.e., Kenedy, Kleberg, Nueces, San Patricio, Aransas, Refugio, Calhoun, Jackson, or Matagorda Counties, Texas). Spills from the tanker route may come ashore between land segments 2 through 15 (i.e., Willacy County, Texas, to Terrebonne Parish, Louisiana). Spills from the Green Canyon launch point GC1 may come ashore at land segment 2 (Willacy and Kenedy Counties, Texas) and between land segments 5 and 18 (i.e., Aransas, Refugio, Calhoun Counties, Texas and Plaquemines Parish, Louisiana). Spills from the Alaminos Canyon launch point (AC3) may come ashore along the Texas or Louisiana coast, between land segments 1 and 13 (i.e., Cameron and Willacy Counties to Vermilion, Iberia, and St. Mary Parishes, Louisiana). Spills from the Mississippi Canyon launch point (MC1) may come ashore between land segments 16 and 28 (i.e., Terrebonne and LaFourche Parishes, Louisiana to Bay and Gulf

Table 4-53

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting at Eight Offshore Locations and Continuing for 30 Days May Contact Different Land Segments in the Gulf of Mexico. Segments with less than 0.5 percent probabilities for all eight spill sites are not shown.

Land	Spill Location[a]							
Segment	CC2	AC3	T17	KC5	GC1	6CC	MC1	AT5
1	5	2	•	•	•	•	•	•
2	7	2	1	•	1	•	•	•
3	12	3	1	•	•	•	•	•
4	20	5	2	•	•	•	•	•
5	19	4	4	1	1	•	•	•
6	12	6	6	1	1	1	•	•
7	4	5	9	1	2	1	•	•
8	2	4	9	1	2	1	•	•
9	1	3	12	1	3	1	•	•
10	•	2	11	2	5	2	•	•
11	•	2	7	1	6	2	•	•
12	•	2	7	2	6	•	•	•
13	•	1	3	1	4	•	•	•
14	•	•	1	1	2	1	•	•
15	•	•	1	•	2	1	•	•
16	•	•	•	1	2	1	3	1
17	•	•	•	•	1	1	3	1
18	•	•	•	•	1	•	3	1
19	•	•	•	•	•	•	11	2
20	•	•	•	•	•	•	2	1
21	•	•	•	•	•	•	3	1
22	•	•	•	•	•	•	2	•
23	•	•	•	•	•	•	2	•
24	•	•	•	•	•	•	1	•
25	•	•	•	•	•	•	1	•
26	•	•	•	•	•	•	1	•
27	•	•	•	•	•	•	1	•
28	•	•	•	•	•	•	1	•
45	•	•	•	•	•	•	•	1
101	2	1	1	•	•	•	•	•
102	2	1	•	•	•	•	•	•
103	1	•	•	•	•	•	•	•
156	•	•	•	•	•	•	•	1

Footnote:
[a] – CC2, Corpus Christi lease area; AC3, Alaminos Canyon lease area; T17, tankering route, West Cameron South lease area; KC5, Keathley Canyon lease area; GC1 and 6CC, Green Canyon lease area; MC1, Mississippi Canyon lease area; AT5, Atwater Valley lease area.

• Less than 0.5 percent.

Counties, Florida), with highest probability of shoreline contact (11 percent) in land segment 19 (i.e., Plaquemines County, Louisiana).

Conditional probabilities that oil spills from the eight selected offshore launch points may contact one or more shore segments are lower within 20 days of a spill (table 4-54) than within 30 days of a spill (table 4-53). The pattern of spill contact is the same for both spill durations. The highest conditional probability of shore contact is 19 percent for a spill from the Corpus Christi launch point (CC2), contacting the shore of land segments 4 and 5 (i.e., Kleberg, Nueces, San Patricio, Aransas, Refugio, and Calhoun Counties, Texas). There is a 10 to 11 percent conditional probability that a spill from the shuttle tanker route (T17) may contact the shore of land segments 9 and 10 (i.e., Galveston, Harris, Chambers, and Jefferson Counties, Texas, and Cameron Parish, Louisiana) in 20 days. A spill from the Mississippi Canyon launch point (MC1, south of the mouth of the Mississippi River) has a 10 percent conditional probability of contacting the shore of land segment 19 (i.e., Plaquemines Parish, Louisiana) within 20 days. An oil spill from this launch point has a one percent chance of reaching Plaquemines Parish in three days. This is the only scenario from an offshore launch point where spilled oil has greater than a 0.5 percent conditional probability of reaching shore within three days.

Spill Frequencies, Conditional Probabilities, and Ecological Risk

The frequencies of spills of different sizes, unique to FPSO operations, were estimated in the risk analysis (Section 4.4.1). As noted previously, the annual estimated spill frequencies can be multiplied by the conditional probabilities (as fraction of spills that contact a particular resource in a specified time interval) to derive a probability-weighted estimate of spill occurrence. The probability-weighted estimate can then be multiplied by the life expectancy of FPSO operations (i.e., 20 years) to obtain an estimate of the frequency with which spills of different volumes from different launch points may contact a particular offshore resource or equidistant coastal segment; such estimates are termed “combined probabilities of oil spill risk” and are intended to highlight the potential susceptibility of a resource over the life of the FPSO project.

Twenty-three FPSO-specific spill scenarios were considered in the risk analysis and detailed (as Hazard Categories) in table 4-32. With reference to the ecological risk assessment, they can be divided into four categories: 1) spills from all FPSO-related sources; 2) spills from the FPSO; 3) spills from the shuttle tanker at sea; and 4) spills from the shuttle tanker in or near port (table 4-55). Possible spills in or near port will not be considered further in this analysis.

Varying spills sizes were also considered in the risk analysis, ranging from <10 bbl to >500,000 bbl. Within this range, eight separate spill size categories were considered, with frequency of releases computed for each of the spill sources noted above. In the following discussion, several spill size categories have been employed (see footnotes to table 4-55):

- 1,000 bbl spill – refers to a maximum release of 1,000 bbl; spill frequency based on spills in the 100 to 1,000 bbl range;
- 10,000 bbl spill – refers to a maximum release of 10,000 bbl; spill frequency based on spills in the 1,000 to 10,000 bbl range;
- 100,000 bbl spill – refers to a maximum release of 100,000 bbl; spill frequency based on spills in the 50,000 to 100,000 bbl range; and

Table 4-54

Conditional Probabilities (Expressed as Percent Chance, from OSRA Model Output) that an Oil Spill Starting at Eight Offshore Locations and Continuing for 20 Days May Contact Different Land Segments in the Gulf of Mexico. Segments with less than 0.5 percent probabilities for all eight spill sites are not shown.

Land	Spill Location[a]							
Segment	CC2	AC3	T17	KC5	GC1	6CC	MC1	AT5
1	4	1	•	•	•	•	•	•
2	6	1	•	•	•	•	•	•
3	11	1	•	•	•	•	•	•
4	19	2	1	•	•	•	•	•
5	19	3	2	•	•	•	•	•
6	11	4	4	•	1	•	•	•
7	4	3	8	•	•	•	•	•
8	2	2	8	1	1	•	•	•
9	1	1	11	1	2	•	•	•
10	•	1	10	•	3	•	•	•
11	•	1	6	•	4	1	•	•
12	•	1	7	1	4	1	•	•
13	•	•	3	1	3	1	•	•
14	•	•	1	•	2	•	•	•
15	•	•	•	•	1	•	•	•
16	•	•	•	•	1	•	2	1
17	•	•	•	•	•	1	3	•
18	•	•	•	•	•	1	3	1
19	•	•	•	•	•	1	10	1
20	•	•	•	•	•	•	2	•
21	•	•	•	•	•	•	3	•
22	•	•	•	•	•	•	2	•
23	•	•	•	•	•	•	1	•
25	•	•	•	•	•	•	1	•
27	•	•	•	•	•	•	1	•
101	2	1	•	•	•	•	•	•
102	1	•	•	•	•	•	•	•
103	1	•	•	•	•	•	•	•

Footnote:
[a] – CC2, Corpus Christi lease area; AC3, Alaminos Canyon lease area; T17, tankering route, West Cameron South lease area; KC5, Keathley Canyon lease area; GC1 and 6CC, Green Canyon lease area; MC1, Mississippi Canyon lease area; AT5, Atwater Valley lease area.

• Less than 0.5 percent.

Table 4-55

Spill Frequency (Spills/Year) from All FPSO-Related Sources, from the FPSO, from Shuttle Tankers in Shipping Lanes, and from Shuttle Tankers in (or Near) Port. Estimates are for All Spills and Four Spill Sizes Based on Estimates Summarized in Table 4-32.

	Spill Size (barrels)				
Spill Location	<10 – >500K[a]	1,000[b]	10,000[c]	100,000[d]	500,000[e]
All Locations	$5.9x10^{-1}$	$1.2x10^{-1}$	$2.5x10^{-2}$	$1.0x10^{-2}$	$9.7x10^{-3}$
At FPSO	$5.2x10^{-1}$	$1.2x10^{-1}$	$6.9x10^{-5}$	$3.0x10^{-4}$	$6.0x10^{-4}$
Shuttle Tanker at Sea	$2.8x10^{-2}$	0	$1.0x10^{-2}$	$4.1x10^{-3}$	$3.8x10^{-3}$
Shuttle Tanker in Port	$3.8x10^{-2}$	0	$1.4x10^{-2}$	$5.6x10^{-3}$	$5.3x10^{-3}$

Footnotes:

[a] – All Locations entry taken from Total column of Table 4-32; Shuttle Tanker at Sea and Shuttle Tanker in Port entries taken from Shuttle Tanker Leak Near Port and Shuttle Tanker Leak at Sea entries within the Total column of Table 4-32; At FPSO entry derived from the All Locations entry minus the sum of both Shuttle Tanker entries;

[b] – All Locations entry taken from total for 100-1K column of Table 4-32; At FPSO entry taken from Transfer Hose Leak entry within the 100-1K column of Table 4-32; Shuttle Tanker at Sea and Shuttle Tanker in Port entries taken from Shuttle Tanker Leak Near Port and Shuttle Tanker Leak at Sea entries within the 100-1K column of Table 4-32;

[c] – All Locations entry taken from total for 1K-10K column of Table 4-32; Shuttle Tanker at Sea and Shuttle Tanker in Port entries taken from Shuttle Tanker Leak Near Port and Shuttle Tanker Leak at Sea entries within the 1K-10K column of Table 4-32; At FPSO entry derived from the All Locations entry minus the sum of both Shuttle Tanker entries;

[d] – All Locations entry taken from total for 50K-100K column of Table 4-32; Shuttle Tanker at Sea and Shuttle Tanker in Port entries taken from Shuttle Tanker Leak Near Port and Shuttle Tanker Leak at Sea entries within the 50K-100K column of Table 4-32; At FPSO entry derived from the All Locations entry minus the sum of both Shuttle Tanker entries; and

[e] - All Locations entry taken from total for 100K-500K column of Table 4-32; Shuttle Tanker at Sea and Shuttle Tanker in Port entries taken from Shuttle Tanker Leak Near Port and Shuttle Tanker Leak at Sea entries within the 100K-500K column of Table 4-32; At FPSO entry derived from the All Locations entry minus the sum of both Shuttle Tanker entries.

- 500,000 bbl spill – refers to a maximum release of 500,000 bbl; spill frequency based on spills in the 100,000 to 500,000 bbl range.

Estimated frequencies of spills of different sizes from FPSOs will be compared to conditional probabilities of a spill contact with different resources for spills originating at the seven selected FPSO launch points. Estimated frequencies of spills of different sizes from shuttle tankers at sea will also be compared to conditional probabilities of a spill contact with different resources for spills originating from the selected shuttle tanker launch point (T17, in the tanker lane off Beaumont/Port Arthur, Texas).

The probability-weighted estimate of oil spills from FPSOs (0.52/year) is much higher than the estimate of spills from shuttle tankers at sea (0.014/year) or in port (0.038/year) (table 4-55). However, the expected mean volumes of spills from FPSOs are much smaller than the mean volumes expected from shuttle tankers. As a result, the model predicts that 7.7 percent of the total volume of oil that may be spilled will be from FPSOs, 38.9 percent will be from shuttle tankers at sea, and 53.4 percent will be from shuttle tankers in port (Section 4.4.1 and table 4-32). Most of the predicted spills from FPSOs involve <10 to 1,000 barrels of oil (i.e., <420 to 42,000 gallons). All predicted spills from shuttle tankers are in the 1,000-bbl to 500,000-bbl range (i.e., 42,000 to 21,000,000 gallons), as outlined in table 4-32.

Spills of 1,000 bbl or less of crude oil are likely to dissipate on the sea surface within several days of release, depending on weather conditions and the physical-chemical properties of the oil. Thus, it is not appropriate to consider the trajectories of these small spills (using the OSRA Model) for 20 or 30 days. A small spill may persist at sea for at least three days. Therefore, spill contact frequencies from FPSOs were modeled for the three-day post-spill interval for spills of 1,000 bbl or less.

Spills from only two selected FPSO launch points and one offshore area may be expected to reach an offshore resource or shoreline segment within three days. These selected launch points include Green Canyon (GC1, about 154 km [96 mi] south of the Louisiana coast) and Mississippi Canyon (MC1, about 85 km [53 mi] south of the mouth of the Mississippi River), as reflected in table 4-56. These selected launch points are found within area 6 directly south of the mouth of the Mississippi River (figure 4-17). In any given year, the probability-weighted spill occurrence for a 1,000-bbl oil spill possibly contacting important environmental resources from these selected launch points within three days are very low, in the range of 0.0012 to 0.0060 spills. The combined probability of oil spill risk is also low, ranging from 0.024 to 0.12 for the life of an FPSO operation (table 4-56).

Predicted frequencies of spills larger than 1,000 bbl from FPSOs are much lower than frequencies of small spills (table 4-55). The frequencies of 10,000-, 100,000-, or 500,000-bbl spills from a FPSO are 6.9×10^{-5}/year, 3.0×10^{-4}/year, and 6.0×10^{-4}/year, respectively. The highest conditional probability (>99 percent) of a spill possibly contacting a resource within 30 days is for a spill from the Corpus Christi launch point (CC2) contacting Texas state offshore waters. Thus, the probability-weighted estimates of a 10,000-, 100,000-, or 500,000-bbl oil spill from a FPSO at CC2 in the spring and summer (table 4-46) which may contact Texas state offshore waters are 6.9×10^{-5} times/year, 3.0×10^{-4} times/year, and 6.0×10^{-4} times/year, respectively. (Note: It should not be assumed that FPSO-related spills will occur on an annual basis; it may be more appropriate to consider the combined probability of oil spill contact [i.e., over the life of the project].) Results from all the other spill scenarios and spill durations from FPSOs produced lower estimates of contact with offshore resources or equidistant coastal segments.

Table 4-56

Probability-Weighted Frequency (Conditional Probability x Frequency) of Oil from a 1,000-bbl or Larger Spill from a FPSO in Two Offshore Locations Contacting Offshore Resources or Equidistant Land Segments within Three Days of the Spill. Estimated Frequency is in Spills/Year. The Unweighted Frequency of Spills ≥ 1,000 bbl is 1.2×10^{-1} (Table 4-55). Parenthetic Entries are Combined Probabilities of Oil Spill Contact for the 20-Year Life of the Project

		FPSO Launch Point	
Resource	Conditional Probability of Oil Contact	Mississippi Canyon (MC1)	Green Canyon (GC1)
Land Segment 19 (Plaquemines Parish)	1 percent and 0 percent conditional probability of oil contact for spills from MC1 and GC1, respectively, based on OSRA Model results	0.0012 (0.024)	0 (0)
W. Winter Menhaden Spawning Grounds	0 percent conditional probability of oil contact for spills from MC1[a]; 5 percent conditional probability of oil contact for spills from GC1[b]	0 (0)	0.0060 (0.12)
C. Winter Menhaden Spawning Grounds	1 percent conditional probability of oil contact for spills from MC1[a]; 0 percent conditional probability of oil contact for spills from GC1[b]	0.0012 (0.024)	0 (0)
Louisiana State Offshore Waters	4 percent conditional probability of oil contact for spills from MC1[a]; 0 percent conditional probability of oil contact for spills from GC1[b]	0.0048 (0.096)	0 (0)

Footnotes:

[a] - conditional probabilities taken from Table 4-42; and
[b] - conditional probabilities taken from Table 4-40.

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Accidents at sea involving oil releases from shuttle tankers are predicted to release between 1,000 and 500,000 bbl of oil to the ocean (Section 4.4.1). The predicted frequency of offshore shuttle tanker spills of 1,000, 10,000, 100,000, or 500,000 bbl is 0, $1.0x10^{-2}$/year, $4.1x10^{-3}$/year, and $3.8x10^{-3}$/year, respectively (table 4-55). The overall frequency of spills of all sizes from shuttle tankers at sea is $2.8x10^{-2}$/year. The conditional probability of a spill from the shuttle tanker at launch point T17 contacting an equidistant shoreline segment or offshore resource within 30 days is 74 percent (table 4-44), corresponding to a probability-weighted spill occurrence estimate of 0.02 spill/year (two spills every 100 years) for spills of all sizes. Spills of 10,000, 100,000, or 500,000 bbl from tankers at T17 may be expected to reach shore or offshore resources $7.4x10^{-3}$ times/year, $3.0x10^{-3}$ times/year, and $2.8x10^{-3}$ times/year, respectively, within 30 days. These spills may come ashore most frequently in Brazoria and Chambers Counties, Texas. Given the low frequencies of spills from T17 reaching shore and the large area of the Texas coast where the OSRA model predicts that the oil may contact the shore, the likelihood of a spill from a shuttle tanker accident at sea reaching a particular location on the shore is very small.

The OSRA model also predicts that the conditional probabilities that spills from the shuttle tanker launch point T17 may contact the Flower Garden Banks National Marine Sanctuary, Texas state offshore waters, Louisiana state offshore waters, the western winter menhaden spawning grounds, or Stetson Bank are 10, 59, 21, 8, and 4 percent, respectively, within 30 days (table 4-44). These conditional probabilities, when multiplied by the spill frequencies in table 4-55, produce very low probability-weighted estimates of spill occurrence. The combined probability of spill contact with these offshore resources is also low.

Because spills of all sizes from the selected offshore launch points contact fewer offshore resources and shore segments and with lower conditional probabilities within three and 20 days than within 30 days, the frequency of spills lasting three or 20 days contacting valued resources is lower than after 30 days.

Oil Weathering and Fate

Following a spill of crude oil, several physical, chemical, and biological processes, collectively called weathering, interact to change the physical and chemical properties of the oil, and thereby influence its harmful effects on marine organisms and ecosystems. The most important weathering processes include spreading, evaporation, dissolution, dispersion into the water column, formation of water-in-oil emulsions, photochemical oxidation, microbial degradation, adsorption to suspended particulate matter, and stranding on shore or sedimentation to the sea floor (Payne *et al.*, 1987; Boehm, 1987). The timing and magnitude of each weathering process is different following an oil spill.

Combined weathering processes decrease the concentration of oil in different environmental compartments and produce dramatic changes in the chemical composition, physical properties, and toxicity of spilled oil. The more toxic, light aromatic and aliphatic hydrocarbons are lost rapidly by evaporation and dissolution from the slick on the water surface or oil stranded on the shore. Evaporated hydrocarbons are degraded rapidly by sunlight. Biodegradation of oil on the water surface, in the water column, and on the shore by marine bacteria and fungi removes first the n-alkanes and then the light aromatics from the oil. Other components of the petroleum are biodegraded more slowly. Photooxidation attacks mainly the medium and high molecular weight polycyclic aromatic hydrocarbons in the oil on the water surface and on the shore.

With the loss of the lighter fractions of the oil, the viscosity and density of the spilled oil increase. During early stages of weathering, before the viscosity rises too high, oil droplets may be physically dispersed into the water column to produce an oil-in-water emulsion. The oil may incorporate large amounts of water, forming a stable water-in-oil emulsion or mousse. The surface of the mousse may weather further, becoming hard and fragmenting to form tar balls. Oil weathering on the shore usually becomes denser and more viscous, eventually forming a solid asphalt-like coating on the substrate. Because the different weathering processes occur at different times and rates after an oil spill, the physical, chemical, and toxicological properties of the spilled oil also change with time. Natural resources are affected in different ways by the spilled oil depending on when after the spill they first come in contact with the spilled oil. Three spill durations were modeled for this risk assessment (3, 20, and 30 days) to reflect the different impact phases of a spill. In the first three days after a spill, some of the toxic fractions of the oil are being released to the environment by evaporation and dissolution. The oil remains dispersible by physical or chemical processes. This is the time when water column organisms and air-breathing animals are at greatest risk of suffering toxic responses to dissolved, dispersed, or vapor-phase hydrocarbons. Between three days and about three weeks after the spill, there are further losses of hydrocarbons from sea slicks, resulting in a marked increase in the viscosity of the oil, rendering it less amenable to dispersion but more amenable to emulsification. Although the toxicity of the oil has declined, it may cause substantial harm to animals using the sea surface or the shore through fouling and smothering. This usually is the period of greatest impact on marine birds, reptiles, and mammals and shoreline resources. After about one month, most of the oil has either stranded on the shore or has broken up into patches of emulsified oil on the sea surface. Contact with animals on the sea surface declines, but continues on the shore if cleanup has not been fully implemented.

Results from the MMS Open-Ocean Oil-Weathering model, using the heavy Mississippi Canyon 807 crude oil (°API 27.6) and the medium Viosca Knoll 990 crude oil (°API 38.2), are presented in tables 4-57 and 4-58. During simulated weathering on the sea surface, the two crude oils become slightly more dense and substantially more viscous. As the oil spreads, the area of the slick increases and the thickness of the slick decreases. The larger the volume of the spill, the slower these processes takes place. The model is conservative in estimating area and thickness of a slick because it only predicts the thickest portion of the slick. Crude oils tend to form two phases during spreading: a thick phase (1 to 20 mm thick), consisting of viscous partly emulsified oil; and a thin sheen, 0.001 to 0.01 mm thick (Audunson *et al.*, 1981). In addition, the leading edge and central axis of the drifting slick tend to be thicker than the interior (Hollinger and Mennella, 1973). A thick slick usually breaks up into small patches or streaks as the oil weathers, especially under the influence of the wind; the patches or streaks usually move downwind faster than the thinner portions of the slick, eventually leaving them behind.

Because oil slicks on the sea surface become very thin rapidly, they do not contain much oil per unit surface area. A reasonable average thickness of an oil slick undergoing moderate weathering would be 0.01 to 0.2 mm (Mackay and McAuliffe, 1988), in reasonable agreement with the modeled thickness of medium sized spills in tables 4-57 and 4-58. Such a slick would occupy 2.3 to 10 m^2 per liter of oil spilled. As an oil slick spreads, it becomes thinner, the rate depending on the sea state and the viscosity of the oil. Within a day or so after a spill, most of the oil (80 to 90 percent) remains in the thicker parts of the slick, but the largest area of the slick

Table 4-57

Properties of Viosca Knoll 990 Crude Oil During On-The-Sea Weathering for Different Times. Values were Predicted by the MMS Open-Ocean Oil-Weathering Model.

Weathering Time (Days)	Specific Gravity	Slick Area (m^2)	Slick Thickness (mm)	Viscosity (cP)
1,000-bbl Spill:				
3	0.83	$1.8x10^5$	0.35	$1.7x10^6$
20	0.84	$3.2x10^5$	0.12	$4.9x10^8$
30	0.85	$3.7x10^5$	0.09	$1.6x10^9$
10,000-bbl Spill:				
3	0.83	$8.8x10^5$	0.79	$2.6x10^5$
20	0.84	$1.6x10^6$	0.28	$7.6x10^7$
30	0.84	$1.9x10^6$	0.21	$2.8x10^8$
100,000-bbl Spill:				
3	0.83	$4.4x10^6$	1.8	$4.0x10^4$
20	0.84	$8.3x10^6$	0.64	$1.1x10^7$
30	0.84	$9.5x10^6$	0.50	$4.2x10^7$
300,000-bbl Spill:				
3	0.83	$4.4x10^6$	1.8	$4.0x10^4$
20	0.84	$8.3x10^6$	0.64	$1.1x10^7$
30	0.84	$9.5x10^6$	0.50	$4.2x10^7$

Table 4-58

Properties of Mississippi Canyon 807 Crude Oil During On-The-Sea Weathering for Different Times. Values were Predicted by the MMS Open-Ocean Oil-Weathering Model

Weathering Time (Days)	Specific Gravity	Slick Area (m^2)	Slick Thickness (mm)	Viscosity (cP)
1,000-bbl Spill:				
3	0.90	$1.9x10^5$	0.43	$6.2x10^5$
20	0.91	$3.9x10^5$	0.14	$1.2x10^8$
30	0.92	$4.5x10^5$	0.12	$3.8x10^8$
10,000-bbl Spill:				
3	0.90	$9.3x10^5$	0.97	$1.4x10^5$
20	0.91	$1.9x10^6$	0.33	$1.9x10^7$
30	0.91	$2.3x10^6$	0.26	$6.7x10^7$
100,000-bbl Spill:				
3	0.90	$4.6x10^6$	2.2	$4.1x10^4$
20	0.90	$9.7x10^6$	0.75	$3.0x10^6$
30	0.91	$1.1x10^7$	0.58	$1.0x10^7$
300,000-bbl Spill:				
3	0.89	$9.8x10^6$	3.2	$2.5x10^4$
20	0.90	$2.1x10^7$	1.1	$1.3x10^6$
30	0.90	$2.4x10^7$	0.86	$4.3x10^6$

is represented by iridescent sheens. An iridescent sheen is about 0.3 to 5 µm thick and has a concentration on the sea surface of about 1,000 liters/km^2 (National Research Council, 1985).

As a crude oil weathers on the sea surface, its viscosity and pour point increase. If the oil forms a stable emulsion, the emulsion usually is more viscous than the unemulsified weathered oil (Lewis *et al.*, 1995; Daling *et al.*, 1997). Mississippi Canyon 807 crude oil forms a stable emulsion with a viscosity of 17,850 cP at 25°C when it has lost 16 percent of its volume by evaporative weathering. Viosca Knoll 990 crude oil does not form a stable emulsion until it has lost 35 percent of its volume by evaporation. The viscosity of the emulsion is 9,339 cP. The maximum oil or emulsion viscosity that allows easy dispersion with chemical dispersants varies widely for different crude oils, but usually falls in the range of 500 cP to 10,000 cP (Daling *et al.*, 1997). Thus, three days after a spill of either of the model crude oils, they can not be dispersed effectively with chemical dispersants. Viosca Knoll 990 crude oil may remain dispersible for 30 to 35 hours after a spill; Mississippi Canyon 807 crude oil may remain dispersible for about 24 hours after a spill. The pour points of the two crude oils remain low enough during weathering that the oils could be chemically dispersed at ambient water temperatures of the Gulf of Mexico if their viscosities do not rise as rapidly as predicted.

When spilled oil is exposed to air at the water surface, the weathering process most affecting its fate in the environment is evaporation (Strain, 1986). Compounds in petroleum that boil at temperatures below about 250°C, or have vapor pressures greater than about 0.1 mm Hg, tend to evaporate from the surface of the oil. Included in this category are alkanes from methane to n-dodecane (C_{12}) and aromatic hydrocarbons from benzene through naphthalene (Bobra *et al.*, 1979). Evaporation of higher molecular weight alkanes and aromatic hydrocarbons is slow. Evaporation of an Alberta (Canada) sweet crude oil blend until it lost 44.5 percent of its mass resulted in a loss of 52 percent of the total naphthalenes, and 5.7 percent of the total fluorenes (Wang and Fingas, 1995). Less than one percent of the total phenanthrenes, dibenzothiophenes, and chrysenes were lost by evaporation.

The rate of evaporation of monocyclic aromatic hydrocarbons from slicks of the two oils decrease with increasing molecular weight (tables 4-59 and 4-60). Benzene is lost completely when 24 percent of the mass of Viosca Knoll 990 crude oil or 16 percent of the mass of Mississippi Canyon 807 crude oil is evaporated. Essentially all the toluene and C_2-benzenes (ethylbenzene and xylenes) are lost from the two oils when they are evaporatively weathered by 35 percent and 26 percent, respectively. C_3-benzenes are more persistent but also are lost during weathering. Nearly all the BTEX compounds (i.e., benzene, toluene, ethylbenzene, and xylenes) will be lost from the surface slick within 10 days of a spill.

The Open-Ocean Oil-Weathering model predicts that a 1,000-bbl slick of Viosca Knoll 990 crude oil will lose 11 percent of its volume by evaporation in 24 hours at a sea-surface temperature of 73°F (22.8°C) (figure 4-20). After 30 days, the oil will have lost 28 percent of its mass by evaporation. By comparison, a 1,000-bbl slick of Mississippi Canyon 807 crude oil will lose about 17 percent of its mass by evaporation in 24 hours and 24 percent of its mass in 30 days at 73°F (figure 4-21). The rate of hydrocarbon evaporation and the total relative mass (as percentage of the original mass) evaporated decrease with increasing slick volume.

The Open-Ocean Oil-Weathering model does not predict the dissolution of hydrocarbons from the oil slick into the water column. Dissolution is not as important quantitatively as evaporation in removing hydrocarbons from spilled oil (Harrison *et al.*, 1975). Rarely more than two-2 to five percent of the mass of oil in a slick on the sea surface goes into solution in the water phase (McAuliffe, 1977; Payne *et al.*, 1987). Harrison *et al.* (1975) estimated that the ratio

Table 4-59

Decline in Concentrations of Monocyclic Aromatic Hydrocarbons in Viosca Knoll 990 Crude Oil During Evaporative Weathering. Concentrations are in Units of mg/kg.

% Oil Evaporated	Benzene	Toluene	C_2-Benzenes	C_3-Benzenes
0	440	2,268	11,076	16,437
12	214	1,293	10,033	14,881
24	0	3	1,564	8,187
35	0	0	1	22

Table 4-60

Decline in Concentrations of Monocyclic Aromatic Hydrocarbons in Mississippi Canyon 807 Crude Oil During Evaporative Weathering. Concentrations are in Units of mg/kg.

% Oil Evaporated	Benzene	Toluene	C_2-Benzenes	C_3-Benzenes
0	220	994	4,792	5,810
9	160	659	4,594	6,264
16	0	126	1,626	4,832
26	0	0	0	13

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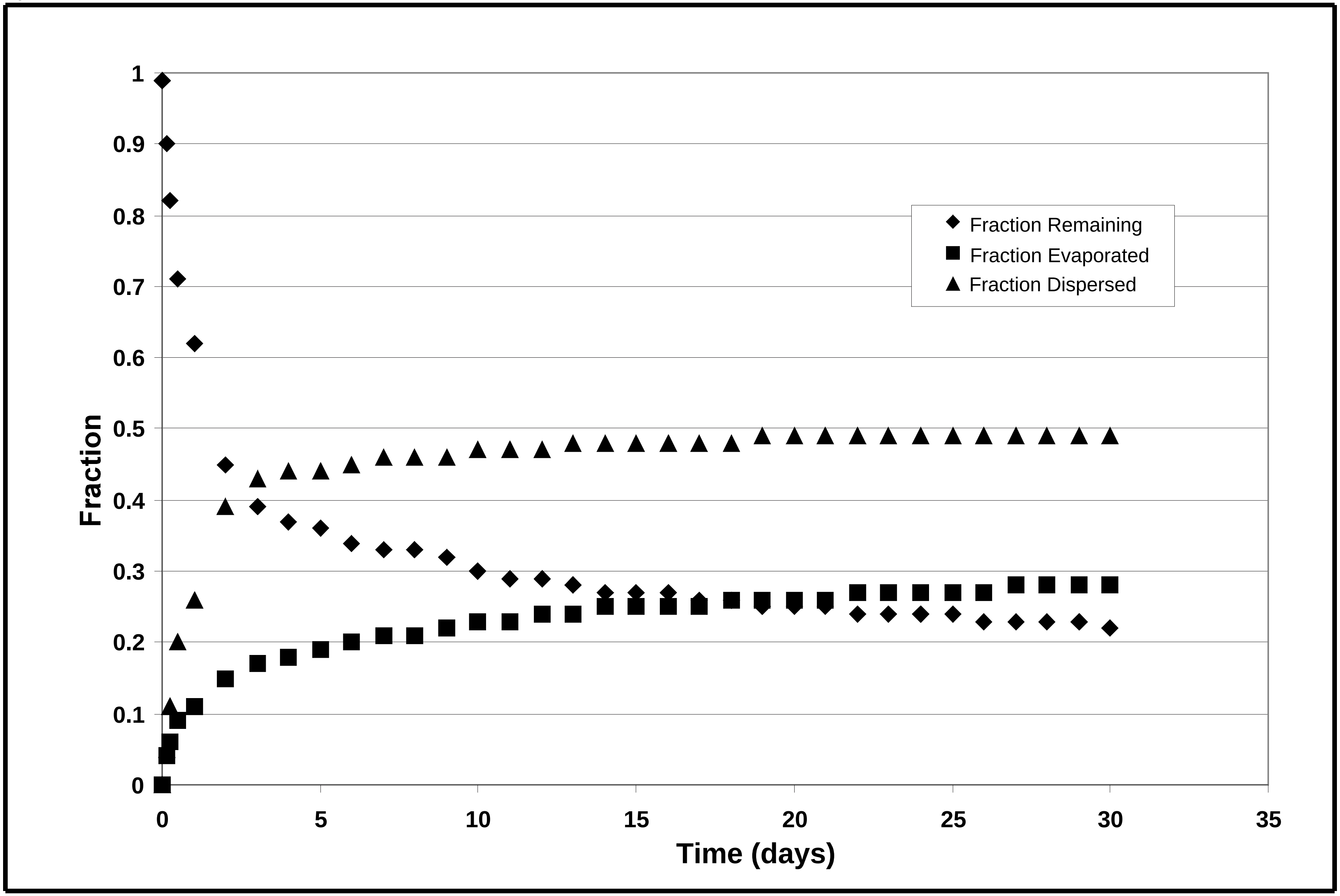

Fig. 4-20. Results of oil weathering analyses of a 1,000-bbl release of Viosca Knoll 990 crude oil.

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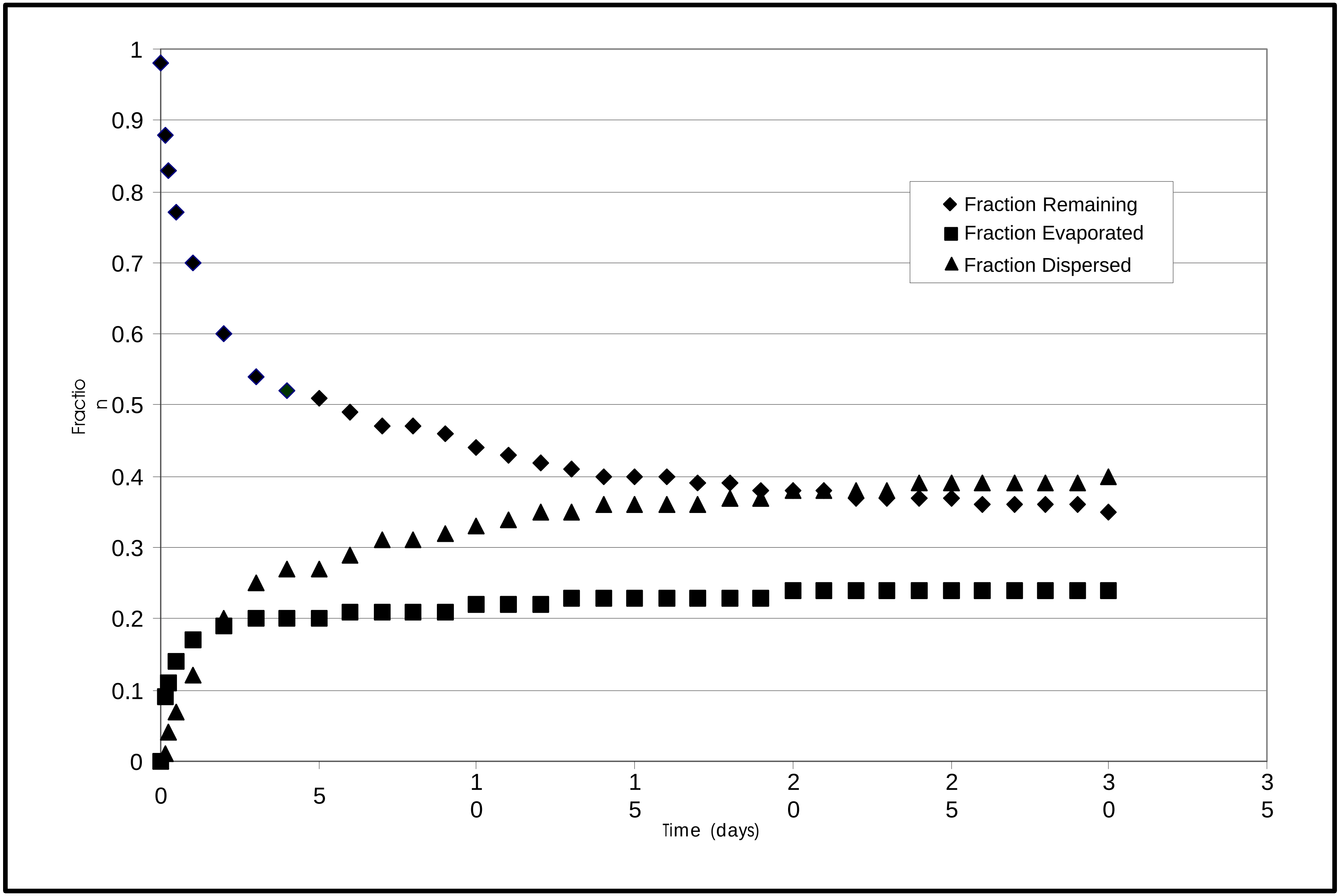


Figure 4-21. Results of oil weathering analyses of a 1,000-bbl release of Mississippi Canyon 807 crude oil.

of evaporation to solution for low molecular weight aromatic hydrocarbons (BTEX) from oil is about 100 to 1 and for light alkanes (C_1-C_8), the ratio is about 10,000 to 1. Dissolution involves primarily the volatile hydrocarbons that are subject to rapid evaporation, so there is not a significant incremental loss of mass from a spill if dissolution is modeled. However, dissolution is important with respect to potential toxic effects of the spilled oil to water column marine organisms. The dissolved fraction of oil is the most bioavailable and, therefore, the most toxic fraction of spilled oil (Wells and Sprague, 1976; Neff and Anderson, 1981).

The weathering model also estimates physical dispersion of oil droplets from a surface slick into the water column (figures 4-20 and 4-21). Dispersion is rapid during the first three days after a release of both oils; it then slows considerably as viscosity increases. The fraction of a 1,000-bbl slick of Viosca Knoll 990 crude oil that is physically dispersed into the water column is 26 mass percent after 24 hours, 39 percent after 48 hours, and 49 percent after 30 days. By comparison, Mississippi Canyon 807 crude oil is less dispersible. After 24 hours on the sea surface, 12 percent of the mass of a 1,000-bbl slick of Mississippi Canyon 807 crude oil has dispersed. After 48 hours, only 20 percent has dispersed, and after 30 days, approximately 40 percent has dispersed.

If oil droplets are small enough (less than about 0.1 mm), their rising velocity through the water column is sufficiently low that they remain in the water column indefinitely (Mackay and McAuliffe, 1988). Physical dispersion of crude oil by wave action drives large droplets down into the water column (Shaw and Reidy, 1979). Large oil droplets tend to coalesce and rise rapidly to the sea surface. Because of this behavior, the concentration of dispersed oil and the average size of individual physically dispersed oil droplets decrease sharply with distance below the surface slick (Forrester, 1971). Droplets rarely sink to depths greater than about 10 m (33 ft) and concentrations of dissolved and dispersed oil 10 to 20 m (33 to 66 ft) under a slick are very low.

The two weathered crude oils have high viscosities, decreasing their dispersibility and increasing the size of the oil droplets dispersed (Payne *et al.*, 1991). Concentrations of dissolved and dispersed oil in the water column below slicks of these oils will be low. Wolfe *et al.* (1994) estimated that about 3.5 percent of the total volume of crude oil released from the *Exxon Valdez* was physically dispersed in the water column during the first three days after the spill, and a total of about 23 percent was dispersed after about 50 days. The maximum estimated concentration of dissolved and dispersed oil in the water column in the week after the spill was 0.8 mg/L. Oil concentrations in the water column decreased rapidly with time after the spill. The dispersibility of the two crude oils modeled in this investigation appears to be similar to that of the Alaskan North Slope crude oil spilled from the *Exxon Valdez*. Thus, it is likely that concentrations of dissolved and dispersed oil under weathering slicks of these two crude oils will be very low.

Formation of a stable mousse (water-in-oil dispersion) decreases the rate of other weathering processes and inhibits physical and chemical oil-in-water dispersion. The water droplets in a mousse usually are 5 to 20 μm in diameter, small enough to remain in the oil phase indefinitely (Mackay, 1982). Mousse may contain 70 to 80 percent water by volume. Viosca Knoll 990 crude oil does not form a stable mousse until at least 35 percent of its volume has been lost by evaporation. However, Mississippi Canyon 807 crude oil does form a stable, high viscosity mousse even after evaporative loss of only 16 percent of its mass. The mousse forms gradually (figure 4-22). After 10 hours, the mousse contains about 25 percent water; after 40 hours, it contains about 65 percent water. Weathering for longer periods of time does not increase the amount of water in the mousse.

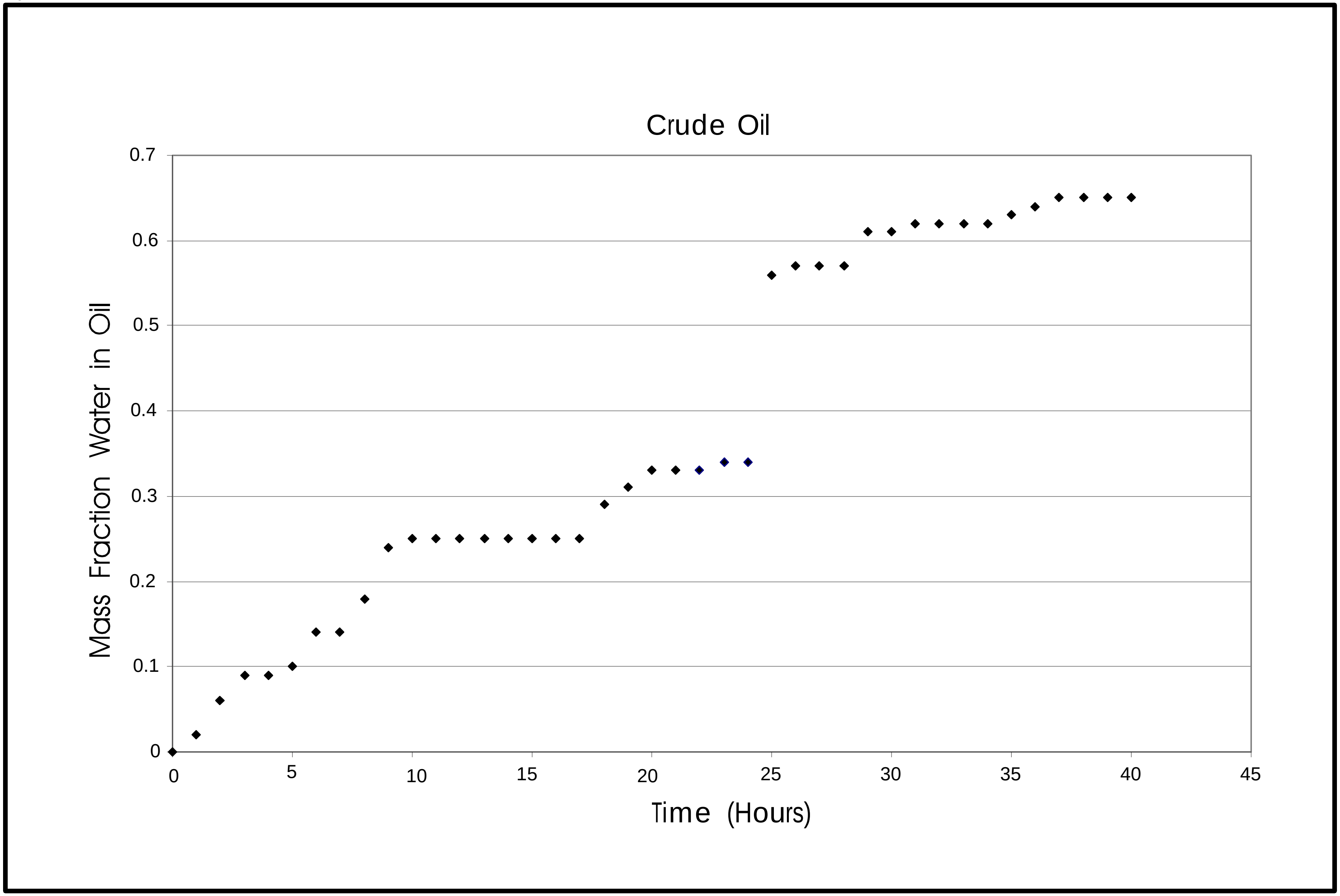


Figure 4-22. Predicted formation of mousse for Mississippi Canyon 807 crude oil.

The total mass of oil on the sea surface decreases with time after an oil spill, mainly through evaporation and dispersion (figures 4-20 and 4-21). After a week or so, other weathering processes, such as microbial degradation, photooxidation, and stranding on the shore play an increasingly important role in removing oil from the sea surface (Neff, 1990). These processes are not modeled by the Open-Ocean Oil-Weathering model.

A 1,000-bbl slick of Viosca Knoll 990 crude oil loses approximately 60 percent of its mass in three days, mainly through dispersion of droplets in the water column (table 4-61; figure 4-20). Between 75 and 78 percent is lost from the surface slick in 20 to 30 days. The mass of oil in a 1,000-bbl slick of Mississippi Canyon 807 crude oil declines more slowly. Approximately 45 percent of the mass is lost in three days, and 62 to 65 percent is lost in 20 to 30 days (table 4-61; figure 4-21). The weathering model predicts that the rate and mass of oil lost from a spill on the sea surface decreases as the volume of oil spilled increases. Thus, an estimated 66 to 69 percent of a 300,000-bbl spill of Viosca Knoll 990 crude oil or 49 to 53 percent of a 300,000-bbl spill of Mississippi Canyon 807 crude oil is lost in 20 to 30 days.

These weathering losses decrease the amount of oil that might contact offshore resources and shore segments in 3, 20, or 30 days following a spill. Should a spill occur, the maximum volume of oil in a slick that might contact an offshore resource or shoreline segment within 30 days of the release ranges from 220 bbl for a 1,000-bbl spill to 93,000 bbl for a 300,000-bbl spill of Viosca Knoll 990 crude oil (table 4-62). By comparison, following a spill of Mississippi Canyon 807 crude oil, between 350 bbl (for a 1,000-bbl spill) and 141,000 bbl (for a 300,000-bbl spill) of oil might contact an offshore resource or coastline segment within 30 days. Some of the physically dispersed oil might also contact the various resources, particularly offshore resources. The dispersed and dissolved fractions of spilled oil are likely to have a different trajectory than the surface oil slick. The trajectory of subsurface oil was not modeled.

4.4.3 Oil Spill Response Capability Assessment

4.4.3.1 Overview

This section evaluates current oil spill response capabilities for possible FPSO operations in the GOM and shuttle tankering activities in support of FPSO production. Oil spill response capabilities are evaluated primarily for the Gulf coast; however, nationwide resources are also considered in this analysis. Of specific interest are the capabilities available to respond to a large oil spill that might occur during FPSO operations in deepwater regions of the Central and Western Planning Areas of the GOM. Available resources for chemical treatment, mechanical recovery, and *in situ* burning of spilled oil are summarized, and possible spill response scenarios are evaluated. The general approach used in this analysis was to include all response resources that could be quantified. This approach allows limiting factors to be identified (Section 4.4.3.4, Discussion of Findings, and Section 4.4.3.5, Summary). The variables that could not be quantified within the scope of this analysis were as follows:

- Contractual access to resources: Existing contractual arrangements are known to change over time. Because one or more specific FPSO operators have not yet been identified, this aspect was not allowed to limit available response capability resources. In the absence of a designated operator, it is not possible to identify which combination of Oil Spill Response Organizations (OSRO's) will be referenced in an

Table 4-61

Mass Fraction of Two Gulf of Mexico Crude Oils Lost from Surface Slicks During Weathering on the Sea Surface of Different Volumes of Spilled Oil. Estimated Mass Fractions are Based on the Open-Ocean Oil-Weathering Model

	Weathering Time (Days)		
Crude Oil Type/Volume	3	20	30
Viosca Knoll 990:			
1,000 bbl	0.61	0.75	0.78
10,000 bbl	0.56	0.71	0.74
100,000 bbl	0.49	0.66	0.69
300,000 bbl	0.49	0.66	0.69
Mississippi Canyon 807:			
1,000 bbl	0.46	0.62	0.65
10,000 bbl	0.40	0.57	0.61
100,000 bbl	0.33	0.52	0.56
300,000 bbl	0.30	0.49	0.53

Table 4-62

Estimated Volume (in Barrels) of Oil Contacting Offshore Resources and Shoreline Segments at 3, 20, and 30 Days After Spills of Different Volumes of Two Crude Oils from an FPSO or Shuttle Tanker

	Weathering Time (Days)		
Crude Oil Type/Volume	3	20	30
Viosca Knoll 990:			
1,000 bbl	390	250	220
10,000 bbl	4,400	2,900	2,600
100,000 bbl	51,000	34,000	31,000
300,000 bbl	153,000	102,000	93,000
Mississippi Canyon 807:			
1,000 bbl	540	380	350
10,000 bbl	6,000	4,300	3,900
100,000 bbl	67,000	48,000	44,000
300,000 bbl	210,000	153,000	141,000

FPSO operator's response plan. In addition, experience during actual responses has shown that all necessary response resources will be activated, regardless of contract limitations or additional cost.

- Offshore vessel availability: Vessel availability was not considered a limiting factor in this analysis. While it was considered important to quantify how many vessels would be needed to support a full response, it is not practical to predict how many vessels will be available to an operator at any given point in time.
- Dispersant application: Dispersant application capability was determined in barrels of oil dispersed, based on certain assumptions on dispersant effectiveness (see assumptions below). This study recognizes that the effectiveness of dispersants would vary depending upon several factors (e.g., what type of oil is produced from future FPSO operations, how much the oil has weathered, slick thickness, weather conditions, pilot accuracy, etc.).

Study Sites

FPSO activities involve the storage of produced oil aboard a moored tanker, offloading (or lightering) of stored oil from the FPSO onto a shuttle tanker, and tanker transport of oil to port. Potential spills unique to FPSO activities could occur during any of these operations. The risk assessment detailed in Section 4.1.1 considers the various spill sizes and the potential of such spills (i.e., frequency of occurrence) at the FPSO, during offloading, and during tanker transit. A total of eight selected spill launch points were considered in this analysis (i.e., seven FPSO locations and a single tankering location), based primarily on a consideration of oil spill trajectory modeling (OSRA modeling), the latter of which was summarized in Section 4.4.2. Selected launch spill locations are shown on figure 4-12. Oil spill launch points were selected from a total of 91 possible spill launch points representing potential FPSO locations, and 28 spill launch points representing potential transit routes for FPSO-related shuttle tankers. While selected oil spill launch points were chosen as examples of potential future FPSO and shuttle tanker locations, these eight selected launch points also provide a range of distances from existing offshore oil spill response resources, and provide a basis for spill response scenarios.

In this evaluation, the amount of oil that can be chemically dispersed over the first 48 to 72 hours following a hypothetical spill was determined for each of the eight selected potential oil spill launch points. Likewise, the amount of oil that can be recovered by mechanical means over the first 96 hours following the spill was determined.

Response Methods

Several different response methods are currently available for offshore oil spills, including application of oil dispersants, mechanical containment and recovery, and *in situ* burning. All three of these response methods are considered in this analysis.

When dispersants are applied to spilled crude oil, the surface tension of the oil is reduced. This allows normal wind and wave action to break the oil into tiny droplets, which are dispersed into the upper portion of the water column. Natural processes then break down these droplets much quicker than they would if the oil were allowed to remain on the surface.

Mechanical recovery is the process of using booms and skimmers to pick up oil from the water surface. In a typical offshore oil spill scenario, a boom is deployed in a V, J, or U configuration to gather and concentrate oil on the surface of the water. The oil is gathered in the wide end of the boom (front) and travels backward toward the narrow apex of the boom (back). The skimmer is positioned at the apex of the boom, where the oil is the thickest. The skimmer recovers the oil by sucking in the top layer via a weir skimmer, or the oil adheres to and is removed from a moving surface (i.e., an oleophylic skimmer). The oil is then pumped from the skimmer to temporary storage on an attendant vessel or barge, the latter of which serves as the skimming platform. When this on-board storage is full, the oil must be pumped into a larger storage vessel. These larger storage vessels can include offshore storage barges, lightering vessels, or available tankage on the FPSO.

In situ burning involves the same oil collection process used in mechanical recovery. However, instead of going to a skimmer the oil is funneled into a fire-boom, a specialized boom that has been constructed to withstand the high temperatures from burning oil. The oil in the fire-boom is then ignited and allowed to burn. While *in situ* burning is another method for disposing of oil that has been collected in a boom, this method is typically more effective than skimmers when the oil is highly concentrated. However, in situ burning was determined to be less effective than skimmers for the scenarios evaluated in the present analysis, given that oil would spread for at least 24 hours before burn operations could commence.

4.4.3.2 Assumptions and Methodology

This analysis considered feasible oil spill response capabilities relative to potential FPSO or shuttle tanker spills in the Central and Western Planning Areas of the GOM. Based on the hazards and spill frequencies identified in the FPSO risk assessment (Section 4.4.1), crude oil spills associated with FPSO operations are possible. Spills of different sizes will occur at different frequencies, with smaller spills (<10 bbl, 1,000 bbl) more likely than larger, catastrophic releases (e.g., 100,000 to >300,000 bbl). The level of oil spill response is dependent on spill size: smaller spills will likely be handled using a small amount of nearby spill containment and cleanup equipment, whereas larger spills will prompt appropriate mobilization of additional response resources. For the purpose of this response capability analysis, spills are assumed to involve a large amount of oil released over a short period of time.

All eight selected spill launch points were evaluated in this analysis, and launch point-specific discussions are provided below. Several assumptions are inherent in this analysis, including:

- Start time – each spill occurred at 0800 hours,
- Location – each of eight launch points were evaluated to calculate projected arrival time(s) for response equipment on site, and
- Weather – weather was suitable for dispersant application and skimming operations.

Dispersants

Aerial application of dispersants was chosen as the preferred method for treatment of a large spill area in the shortest amount of time. The results are reported in terms of the number of barrels of oil dispersed. Given that the type of oil to be produced from deepwater FPSO operations is not firmly established, several assumptions regarding dispersant effectiveness are discussed further below. Assumptions pertinent to dispersant use included:

- Start time – approval for dispersant use was given at 0900 hours (1 hour after the spill was reported);
- Operational time – daylight hours during the first three days was viewed as the optimal time for dispersant application;
- Dispersant stockpile – all existing stockpiles in the GOM area were available, including 154,900 gallons of Corexit in Texas, Louisiana, and Florida;
- Dispersant application systems – eight dispersant-spraying aircraft were considered to be available, including 1) one DC-4 and two DC-3 aircraft operated by Airborne Support, Inc. (ASI) and based in Houma, Louisiana; 2) one C-130 operated by Coast Guard with a Clean Caribbean Cooperative (CCC) spray system, based in Fort Lauderdale, Florida; and 3) four C-130 aircraft operated by the U.S. Air Force (USAF) and based in Youngstown, Ohio;
- Dispersant logistics – the Houma (ASI) and Fort Lauderdale (CCC-USCG) aircraft would leave their home base full during their first dispersant application flight, or sortie. Youngstown (USAF) aircraft would leave their home base empty and fill at the staging airport. All other dispersant would be transported to the staging airport;
- Application ratio – a 20:1 oil-to-dispersant ratio was used to calculate the amount of oil treated with each application; and
- Staging areas – Houma, Louisiana, and Galveston and Corpus Christi, Texas, were the three dispersant-capable airports identified as being closest to the spill launch points.
- Dispersant effectiveness – during the first 24 hours, it is assumed that dispersant effectiveness will be 75 percent, dropping to 60 percent during subsequent 24 hour periods (see further discussion below);
- Application duration – while results of oil weathering model analyses of two candidate deepwater oils suggest dispersant effectiveness may decrease appreciably 24 to 35 hours following a spill, the current analysis projects "conditional" dispersant application beyond 35 hours post-spill. This approach accounts for oils that will remain dispersible for longer periods, and uncontrolled releases that may continue to put fresh, unweathered oil on the ocean surface for a day or more.

The time necessary for each aircraft to complete their first sortie was calculated using the following variables:

- Crew mobilization time,
- Aircraft preparation time,
- Transit time to loading (only for USAF aircraft out of Youngstown, Ohio),
- Dispersant loading time,
- Flight time to the spill location (i.e., spill launch point, or leading edge of the slick), and
- Time to spray dispersant (application time).

Turnaround time for each aircraft to refill and complete their next sortie was calculated using the following variables:

- Flight time to return to the staging airport,
- Aircraft preparation/refueling time,
- Dispersant loading time,
- Flight time to the spill location (spill launch point, or leading edge of the slick), and
- Time to spray dispersant.

Based on these assumptions, a series of calculations were completed (combined with the payload of each aircraft) to produce a timeline of how much dispersant could be applied in every hour of the response. A graphic presentation of study site locations, dispersant-capable airports and aircraft, dispersant application characteristics, and dispersant stockpiles are provided in figure 4-23.

Regarding dispersant effectiveness, researchers have conducted both laboratory and field tests to determine the physical and chemical behavior of dispersants and oil dispersant mixtures (e.g., Fingas *et al.*, 1989, 1991b). Previous evaluations were intended to characterize the effects of a series of variables (e.g., temperature, salinity, dispersant quantity, testing mechanisms and procedures) on dispersant effectiveness, among other factors. Results indicate that dispersant effectiveness is strongly and positively correlated with saturated hydrocarbon concentration of the oil (Fingas *et al.*, 1991b). The two test oils considered in this analysis (i.e., Mississippi Canyon crude, Viosca Knoll crude) exhibit variable saturated hydrocarbon concentrations ranging from 47 to 73 percent (table 4-36). Further, for the two dozen test oils evaluated by Fingas *et al.* (1991b), dispersant effectiveness was extremely variable, ranging from one to 96 percent. Prior research also suggests that dispersants may alter the oil weathering process. Consequently, for the purposes of this analysis, it has been assumed that dispersant effectiveness during the first 24 hours post-spill will be 75 percent, with a subsequent drop to 60 percent thereafter. It must be noted that these dispersant effectiveness percentages have been derived from a review of salient literature, in consideration of only two possible deepwater oils to be developed using FPSOs, and in the absence of specific data on hypothetical FPSO spill conditions. Ultimately, dispersant effectiveness will be affected by the nature and physical characteristics of the oil spilled, ambient oceanographic and meteorological conditions, and various aspects of dispersant application methods.

Mechanical Recovery

This aspect of the analysis focused on all dedicated offshore oil spill response vessels (OSRVs), dedicated oil spill response barges (OSRBs), vessel of opportunity skimmers (VOSS), and dedicated storage barges that can operate effectively in offshore conditions. The primary sources of dedicated OSRVs in the Gulf region is Clean Gulf Associates (CGA), Marine Spill Response Corporation (MSRC), and National Response Corporation (NRC). The assumptions applied to the analysis of mechanical recovery capabilities included:

- Start time – resource activation begins immediately at spill time (0800 hrs);
- Operational time – skimming systems were operated on a 24-hour basis (assuming the use of infrared cameras for night support);
- Resource availability – the existing stockpile in the GOM area was available (i.e., 100 offshore skimmers and five dedicated offshore storage barges), with no contractual limitations on resource use;

Dispersant Application at Study Site #1	At 24 Hours	At 48 Hours	At 72 Hours
Dispersant applied in each period	49,800 gals	105,000 gals	
Dispersant effectiveness factor	75%	60%	
Oil Dispersed (gals) in each period at 20:1 ratio	747,000 gals	1,260,000 gals	
Oil Dispersed in each period	17,786 bbls	30,000 bbls	
Cumulative Oil Dispersed	17,786 bbls	47,786 bbls	47,786 bbls

Dispersant Application at Study Site #2	At 24 Hours	At 48 Hours	At 72 Hours
Dispersant applied in each period	47,600 gals	79,600 gals	27,200 gals
Dispersant effectiveness factor	75%	60%	60%
Oil Dispersed (gals) in each period at 20:1 ratio	714,000 gals	955,200 gals	326,400 gals
Oil Dispersed in each period	17,000 bbls	22,743 bbls	7,771 bbls
Cumulative Oil Dispersed	17,000 bbls	39,743 bbls	47,514 bbls

Dispersant Application at Study Site #3	At 24 Hours	At 48 Hours	At 72 Hours
Dispersant applied in each period	51,800 gals	102,800 gals	
Dispersant effectiveness factor	75%	60%	
Oil Dispersed (gals) in each period at 20:1 ratio	777,000 gals	1,233,600 gals	
Oil Dispersed in each period	18,500 bbls	29,371 bbls	
Cumulative Oil Dispersed	18,500 bbls	47,871 bbls	47,871 bbls

Dispersant Application at Study Site #4	At 24 Hours	At 48 Hours	At 72 Hours
Dispersant applied in each period	49,800 gals	91,800 gals	13,000 gals
Dispersant effectiveness factor	75%	60%	60%
Oil Dispersed (gals) in each period at 20:1 ratio	747,000 gals	1,101,600 gals	156,000 gals
Oil Dispersed in each period	17,786 bbls	26,229 bbls	3,714 bbls
Cumulative Oil Dispersed	17,786 bbls	44,014 bbls	47,729 bbls

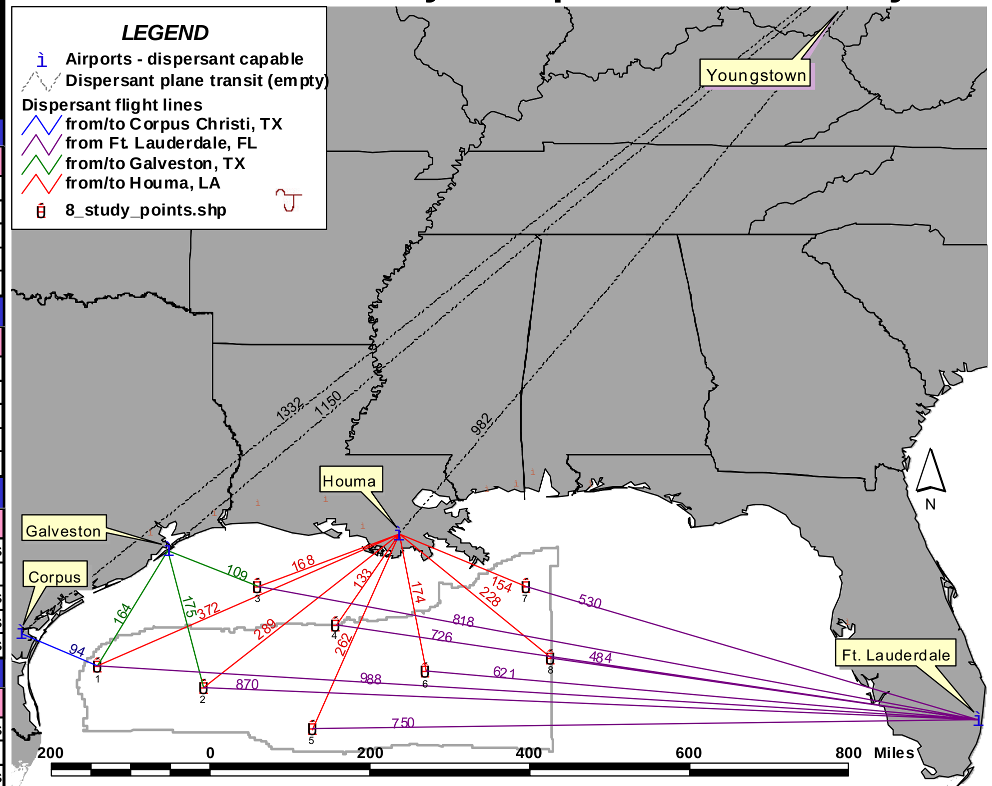
Dispersant Application at Study Site #5	At 24 Hours	At 48 Hours	At 72 Hours
Dispersant applied in each period	41,400 gals	64,600 gals	48,500 gals
Dispersant effectiveness factor	75%	60%	60%
Oil Dispersed (gals) in each period at 20:1 ratio	621,000 gals	775,200 gals	582,000 gals
Oil Dispersed in each period	14,786 bbls	18,457 bbls	13,857 bbls
Cumulative Oil Dispersed	14,786 bbls	33,243 bbls	47,100 bbls

Dispersant Application at Study Site #6	At 24 Hours	At 48 Hours	At 72 Hours
Dispersant applied in each period	47,600 gals	79,600 gals	27,700 gals
Dispersant effectiveness factor	75%	60%	60%
Oil Dispersed (gals) in each period at 20:1 ratio	714,000 gals	955,200 gals	332,400 gals
Oil Dispersed in each period	17,000 bbls	22,743 bbls	7,914 bbls
Cumulative Oil Dispersed	17,000 bbls	39,743 bbls	47,657 bbls

Dispersant Application at Study Site #7	At 24 Hours	At 48 Hours	At 72 Hours
Dispersant applied in each period	49,800 gals	89,800 gals	15,000 gals
Dispersant effectiveness factor	75%	60%	60%
Oil Dispersed (gals) in each period at 20:1 ratio	747,000 gals	1,077,600 gals	180,000 gals
Oil Dispersed in each period	17,786 bbls	25,657 bbls	4,286 bbls
Cumulative Oil Dispersed	17,786 bbls	43,443 bbls	47,729 bbls

Dispersant Application at Study Site #8	At 24 Hours	At 48 Hours	At 72 Hours
Dispersant applied in each period	45,600 gals	72,600 gals	36,700 gals
Dispersant effectiveness factor	75%	60%	60%
Oil Dispersed (gals) in each period at 20:1 ratio	684,000 gals	871,200 gals	440,400 gals
Oil Dispersed in each period	16,286 bbls	20,743 bbls	10,486 bbls
Cumulative Oil Dispersed	16,286 bbls	37,029 bbls	47,514 bbls

MMS FPSO Study - Dispersant Summary



Aircaft Used for Dispersant Application

AIRCRAFT	SUPPLIER	HOME BASE	PAYLOAD
DC-4	ASI	Houma, LA	2,000 gals
DC-3	ASI	Houma, LA	1,100 gals
DC-3 (#2)	ASI	Houma, LA	1,100 gals
C-130 (ADDS)	CCC/USCG	Ft. Lauderdale, FL	5,000 gals
C-130 (USAF #1)	USAF-MASS	Youngstown, OH	2,000 gals
C-130 (USAF #2)	USAF-MASS	Youngstown, OH	2,000 gals
C-130 (USAF #3)	USAF-MASS	Youngstown, OH	2,000 gals
C-130 (USAF #4)	USAF-MASS	Youngstown, OH	2,000 gals

Assumptions

* Entire dispersant Gulf Of Mexico stockpile (154,900 gal.) was used.
* Spill started at 0800 hrs.
* Dispersant approval given by 0900 hrs. on Day 1
* Dispersant effectiveness may be reduced after 24-35 hrs. (see text)

Flight Distance From Airport to Site

FROM	TO	DISTANCE
Corpus Christi, TX	FPSO #1	94 miles
Ft. Lauderdale, FL	FPSO #1	988 miles
Galveston, TX	FPSO #1	164 miles
Houma, LA	FPSO #1	372 miles
Ft. Lauderdale, FL	FPSO #2	870 miles
Galveston, TX	FPSO #2	175 miles
Houma, LA	FPSO #2	289 miles
Ft. Lauderdale, FL	FPSO #3	818 miles
Galveston, TX	FPSO #3	109 miles
Houma, LA	FPSO #3	168 miles
Ft. Lauderdale, FL	FPSO #4	726 miles
Houma, LA	FPSO #4	133 miles
Ft. Lauderdale, FL	FPSO #5	750 miles
Houma, LA	FPSO #5	262 miles
Ft. Lauderdale, FL	FPSO #6	621 miles
Houma, LA	FPSO #6	174 miles
Ft. Lauderdale, FL	FPSO #7	530 miles
Houma, LA	FPSO #7	154 miles
Ft. Lauderdale, FL	FPSO #8	484 miles
Houma, LA	FPSO #8	228 miles

Fig. 4-23. Summary of dispersant application and treatment capability.

- De-rated capacity – appropriate de-rated recovery capacity was used for each skimming system;
- Adjustment factor – it was assumed skimmers could recover at their de-rated capacity 50% of the time (to allow for offloading time and night operations); and
- Staging areas – different combinations of staging areas for each spill launch point (considering work boat availability) were considered, resulting in selection of the fastest "expected time of arrival" of response resources on site.

There are two assumptions used in this analysis that require additional study and verification, including:

- Offshore vessel availability – it has been assumed that enough suitable vessels (~80) were available for VOSS-type skimming systems. Vessel availability would limit the response, but a comprehensive vessel tracking system or additional research is required to quantify those limits.
- Trained operator availability – it was assumed that there is a sufficient number of trained operators available to crew all offshore skimming systems. The availability of trained operators would limit the response, but additional research is required to quantify those limits.

The time necessary for each skimming/storage system to initiate operations at each spill launch point was calculated using the following variables:

- Over-the-road transport – used for components not staged at their warehouse;
- Loadout time for transport (if needed);
- Transit time to staging (road miles at 56 km/hr [35 mph]);
- Vessel transit time to staging – assumed to be 4 hours for vessels designated to carry VOSS-type systems;
- Crew activation/transit time – assumed to be the greater of either two hours or the time necessary for the slowest component;
- Equipment loadout time – time required to load VOSS skimmer and boom on the appropriate vessel;
- Transit time to the spill launch point – vessel speed was assumed to be 18.5 km/hr (10 kn) for most vessels, 37 km/hr (20 kn) for new rapid-response vessels (CGA-57 and CGA-58), and 11 km/hr (6 kn) for barges; and
- On-site deployment time – assumed to be 30 minutes to a full hour for deployment of skimmers.

On the basis of these assumptions, the maximum available response to a large offshore oil spill from an FPSO or shuttle tanker was determined. A graphic presentation of study site locations, offshore skimmer locations, mechanical recovery capability (e.g., de-rated capacity on site, oil recovered every 24 hours, cumulative oil recovered – all by study site), and transit times to each site is provided on figure 4-24.

4.4.3.3 Results

Study Site 1 – Corpus Christi Lease Area

Study Site 1, or OSRA launch point CC2, is located in the Corpus Christi lease area, approximately 117 km (73 mi) southeast of Aransas Pass, Texas (lat. 27.16094^o N, long. 96.12404^o W). Water depth at this location is approximately 500 m (1,640 ft). Figure 4-25 summarizes the response capability for a large spill occurring at this site.

Based on available shore-based aerial assets (ASI's DC-4), oil accidentally released at this site would be initially treated four hours after the spill. Skimming vessel response to the site would be provided by activation of all available resources, with initial skimming commencing eight hours after the spill by NRC and its ID boat (i.e., vessel from the "Identified Boat Program").

During the first 24 hours after a spill, oil removal by skimmers would recover 35,870 bbl of spilled oil. Using the 75 percent dispersant effectiveness factor, dispersants applied during the first 24 hours are projected to disperse 17,786 bbl of oil. After 48 hours, the total amount of oil potentially removed by dispersants and skimmers would be 308,726 bbl. Based on results from the oil-weathering analysis, dispersant use may become appreciably less effective after 24 to 35 hours, depending upon the nature of the oil spilled, whether the spill is an instantaneous or continual release, and ambient conditions. The total amount of oil potentially removed after 72 and 96 hours would be 598,158 and 817,270 bbl, respectively.

Study Site 2 – Alaminos Canyon Lease Area

Study Site 2, or OSRA launch point AC3, is located in the Alaminos Canyon lease area, approximately 259 km (161 mi) south-southeast of Freeport, Texas (lat. 26.79162^o N, long. 94.20363^o W). Water depth at this location is approximately 1,500 m (4,922 ft). Figure 4-26 summarizes the response capability for a large spill occurring at this site.

Based on available shore-based aerial assets (ASI's DC-4), oil accidentally released at this site would be initially treated four hours after the spill. Skimming vessel response to the site would be provided by activation of all available resources, with initial skimming commencing 10 hours after the spill by CGA's ID boat.

During the first 24 hours after a spill, dispersant application and oil removal by skimmers would remove 24,612 bbl of oil, comprised of 17,000 bbl of dispersed oil and 7,612 bbl of recovered product. After 48 hours, the total amount of oil potentially removed by dispersants and skimmers would be 233,005 bbl. Based on results from the oil-weathering analysis, dispersant use may become appreciably less effective after 24 to 35 hours. The total amount of oil potentially removed after 72 and 96 hours would be 529,773 and 777,490 bbl, respectively.

Study Site 3 – West Cameron South Lease Area, Tanker Traffic Lane

Study Site 3, or OSRA launch point T17, is located in the West Cameron South lease area, within a possible shuttle tanker traffic lane 121 km (75 mi) south-southwest of Pecan Island, Louisiana (lat. 28.61433^o N, long. 93.21451^o W). Water depth at this location is approximately 100 m (328 ft). Figure 4-27 summarizes the response capability for a large spill occurring at this site.

Fig.4-24.PDF

Mechanical Recovery at Site #1	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Derated Capacity X hrs skimming	71,740 bbls	450,140 bbls	578,865 bbls	605,534 bbls
Oil recovered (Adjusted by 50%)	35,870 bbls	225,070 bbls	289,433 bbls	302,767 bbls
Cumulative Oil Recovered	35,870 bbls	260,940 bbls	550,373 bbls	817,270 bbls
Number of Skimmers	44 skimmers	99 skimmers	105 skimmers	108 skimmers
Total De-Rated Capacity On-scene	250,510 bbls/day	532,175 bbls/day	603,121 bbls/day	606,741 bbls/day
Barrels of Storage (non-tanker) On-scene	129,365 bbls	154,179 bbls	218,979 bbls	275,879 bbls

Mechanical Recovery at Site #2	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Derated Capacity X hrs skimming	15,224 bbls	371,300 bbls	577,995 bbls	605,685 bbls
Oil recovered (Adjusted by 50%)	7,612 bbls	185,650 bbls	288,998 bbls	302,843 bbls
Cumulative Oil Recovered	7,612 bbls	193,262 bbls	482,259 bbls	777,490 bbls
Number of Skimmers	22 skimmers	100 skimmers	110 skimmers	110 skimmers
Total De-Rated Capacity On-scene	107,545 bbls/day	557,307 bbls/day	606,741 bbls/day	606,741 bbls/day
Barrels of Storage (non-tanker) On-scene	68,664 bbls	213,979 bbls	316,179 bbls	316,179 bbls

Mechanical Recovery at Site #3	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Derated Capacity X hrs skimming	88,718 bbls	495,614 bbls	598,285 bbls	606,741 bbls
Oil recovered (Adjusted by 50%)	44,359 bbls	247,807 bbls	299,143 bbls	303,371 bbls
Cumulative Oil Recovered	44,359 bbls	292,166 bbls	591,309 bbls	850,320 bbls
Number of Skimmers	70 skimmers	106 skimmers	110 skimmers	110 skimmers
Total De-Rated Capacity On-scene	331,251 bbls/day	603,121 bbls/day	606,741 bbls/day	606,741 bbls/day
Barrels of Storage (non-tanker) On-scene	119,046 bbls	263,679 bbls	316,179 bbls	316,179 bbls

Mechanical Recovery at Site #4	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Derated Capacity X hrs skimming	56,685 bbls	513,695 bbls	597,913 bbls	606,741 bbls
Oil recovered (Adjusted by 50%)	28,343 bbls	256,848 bbls	298,956 bbls	303,371 bbls
Cumulative Oil Recovered	28,343 bbls	285,190 bbls	584,147 bbls	859,174 bbls
Number of Skimmers	64 skimmers	106 skimmers	110 skimmers	108 skimmers
Total De-Rated Capacity On-scene	309,619 bbls/day	603,121 bbls/day	606,741 bbls/day	606,741 bbls/day
Barrels of Storage (non-tanker) On-scene	28,790 bbls	263,679 bbls	316,179 bbls	280,179 bbls

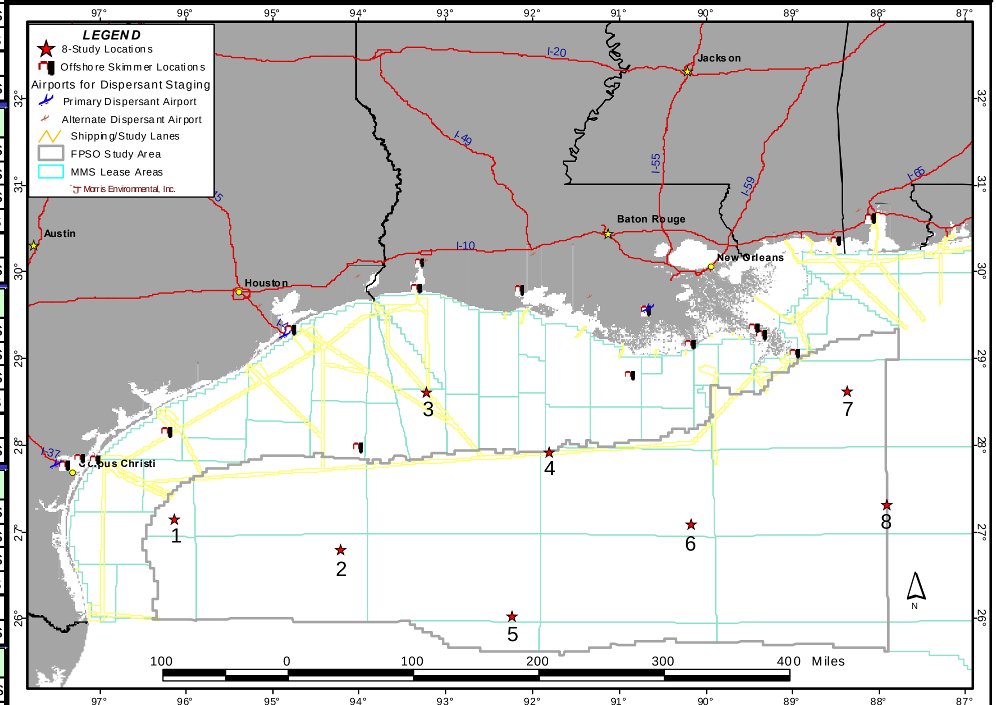
Mechanical Recovery at Site #5	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Derated Capacity X hrs skimming	4,595 bbls	331,049 bbls	590,897 bbls	606,741 bbls
Oil recovered (Adjusted by 50%)	2,297 bbls	165,525 bbls	295,448 bbls	303,371 bbls
Cumulative Oil Recovered	2,297 bbls	167,822 bbls	463,270 bbls	764,343 bbls
Number of Skimmers	4 skimmers	100 skimmers	110 skimmers	110 skimmers
Total De-Rated Capacity On-scene	12,294 bbls/day	567,807 bbls/day	606,741 bbls/day	606,741 bbls/day
Barrels of Storage (non-tanker) On-scene	263 bbls	217,979 bbls	316,179 bbls	316,179 bbls

Mechanical Recovery at Site #6	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Derated Capacity X hrs skimming	25,155 bbls	432,444 bbls	606,741 bbls	606,741 bbls
Oil recovered (Adjusted by 50%)	12,577 bbls	216,222 bbls	303,371 bbls	303,371 bbls
Cumulative Oil Recovered	12,577 bbls	228,799 bbls	532,170 bbls	822,963 bbls
Number of Skimmers	45 skimmers	107 skimmers	108 skimmers	110 skimmers
Total De-Rated Capacity On-scene	208,101 bbls/day	603,121 bbls/day	606,741 bbls/day	606,741 bbls/day
Barrels of Storage (non-tanker) On-scene	17,368 bbls	263,679 bbls	280,179 bbls	316,179 bbls

Mechanical Recovery at Site #7	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Derated Capacity X hrs skimming	78,963 bbls	487,976 bbls	601,861 bbls	606,741 bbls
Oil recovered (Adjusted by 50%)	39,482 bbls	243,988 bbls	300,931 bbls	303,371 bbls
Cumulative Oil Recovered	39,482 bbls	283,470 bbls	584,400 bbls	848,289 bbls
Number of Skimmers	60 skimmers	107 skimmers	110 skimmers	110 skimmers
Total De-Rated Capacity On-scene	307,015 bbls/day	577,461 bbls/day	606,741 bbls/day	606,741 bbls/day
Barrels of Storage (non-tanker) On-scene	125,278 bbls	259,287 bbls	316,179 bbls	316,179 bbls

Mechanical Recovery at Site #8	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Derated Capacity X hrs skimming	22,648 bbls	397,628 bbls	596,844 bbls	606,741 bbls
Oil recovered (Adjusted by 50%)	11,324 bbls	198,814 bbls	298,422 bbls	303,371 bbls
Cumulative Oil Recovered	11,324 bbls	210,138 bbls	508,560 bbls	800,606 bbls
Number of Skimmers	34 skimmers	106 skimmers	110 skimmers	110 skimmers
Total De-Rated Capacity On-scene	191,320 bbls/day	577,461 bbls/day	606,741 bbls/day	606,741 bbls/day
Barrels of Storage (non-tanker) On-scene	65,862 bbls	259,287 bbls	316,179 bbls	316,179 bbls

MMS FPSO Study - Mechanical Recovery Summary



Assumptions

* All 105 skimmers/storage systems were from Gulf of Mexico stockpile.
* Assumed skimmers could recover at De-rated capacity 50% of the time on-scene (to allow for offloading time & night operations).

Assumptions Requiring Study

* Assumed enough vessels (~80) were available for VOSS-type skimmers. (vessels were not a limiting factor)
* Assumed enough trained operators were available to crew all offshore skimming systems. (operators were not a limiting factor)

Time for First Skimmer to Arrive

SITE	HOURS	COMING FROM
# 1	8	Matagorda Island 604
# 2	10	High Island 571
# 3	9	High Island 571
# 4	9	Houma, LA
# 5	14	Houma, LA
# 6	10	Venice, LA
# 7	7	South Pass 60
# 8	10	Venice, LA

Fig. 4-24. Summary of mechanical recovery capability

Study Site #1 Response Summary

Assumptions

Dispersants:

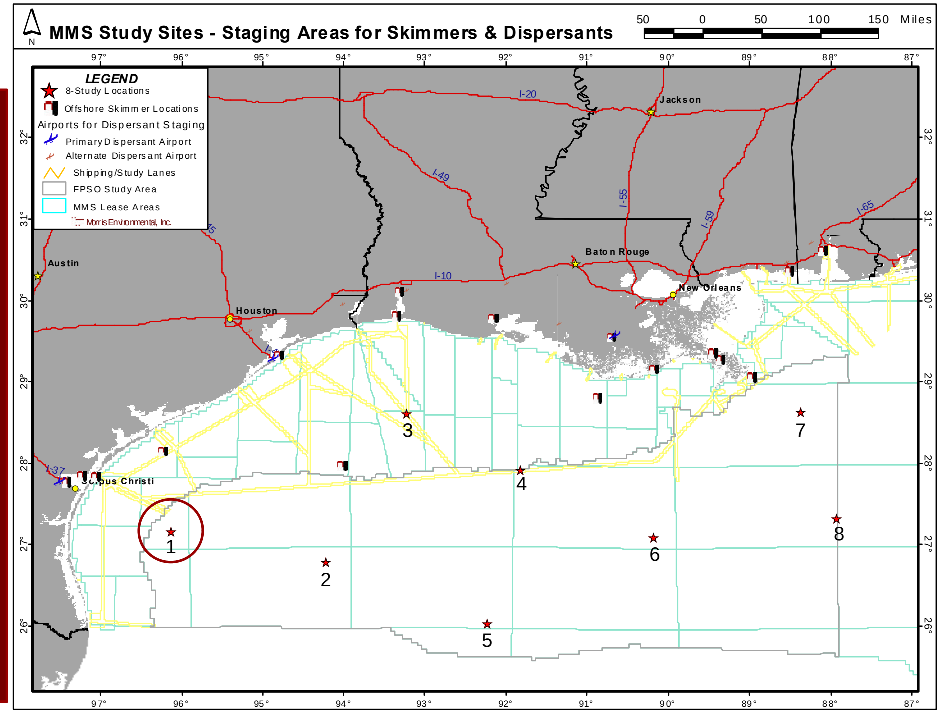
* Entire dispersant Gulf Of Mexico stockpile was used in 48 hrs.
* 8 dispersant application aircraft (with correct ETA's) were used
  - included one DC-4, two DC-3's, & five C-130's.
* Effectiveness may be reduced after 24-35 hrs. (see text)

Mechanical Recovery:

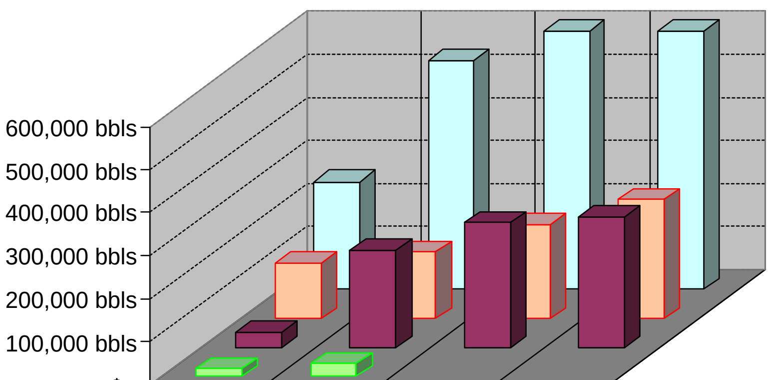
* All 105 skimmers and storage systems were from Gulf of Mexico
* Assumed skimmers could recover at De-rated capacity 50% of time they were on-scene (to allow for offload time & night ops).

Assumptions requiring additional study

* Assumed enough suitable vessels (~80) were available for VOSS-type skimming systems.
* Assumed enough trained operators were available to crew all offshore skimming systems.

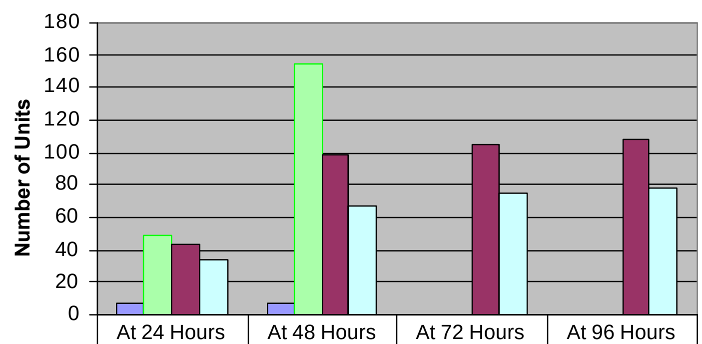


Oil Removed vs. OPA-90 Criteria



	24 Hours	48 Hours	72 Hours	96 Hours
Oil Dispersed in each period	17,786	30,000		
Oil Recovered (Adjusted)	35,870	225,070	289,433	302,767
Barrels of Storage On-scene (not including tanker or FPSO)	129,365 bbls/day	154,179 bbls/day	218,979 bbls/day	275,879 bbls/day
Total De-rated Recovery Capacity On-scene	250,510 bbls/day	532,175 bbls/day	603,121 bbls/day	606,741 bbls/day

Response Resources Used



	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Dispersant Application Aircraft	8	8		
Dispersant Applied (thousands of gallons)	49.8	154.8		
Number of Skimmers	44	99	105	108
Boom On-scene (thousands of feet)	34.2	67.6	75.0	77.7

Fig. 4-25. Response summary for Study Site #1, Corpus Christi lease area

Study Site #2 Response Summary

Assumptions

Dispersants:

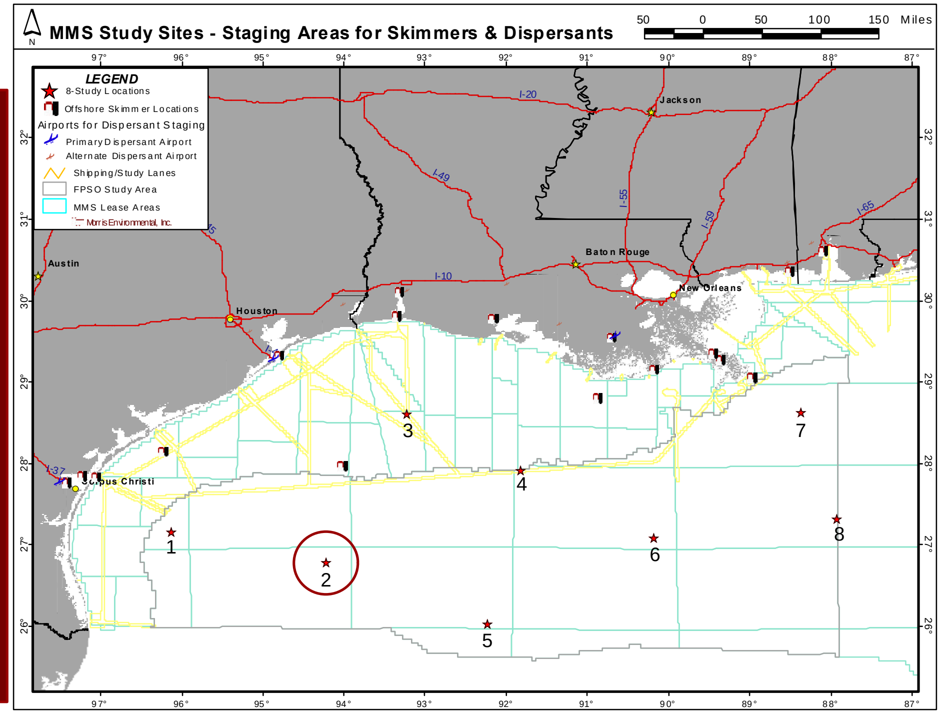
* Entire dispersant Gulf Of Mexico stockpile was used in 54 hrs.
* 8 dispersant application aircraft (with correct ETA's) were used
  - included one DC-4, two DC-3's, & five C-130's.
* Effectiveness may be reduced after 24-35 hrs. (see text)

Mechanical Recovery:

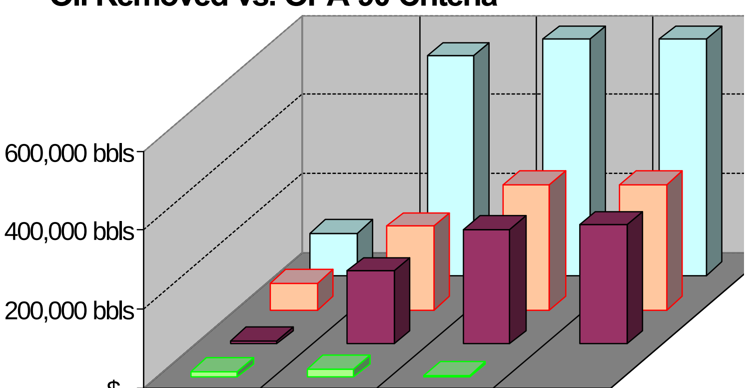
* All 105 skimmers and storage systems were from Gulf of Mexico
* Assumed skimmers could recover at De-rated capacity 50% of time they were on-scene (to allow for offload time & night ops).

Assumptions requiring additional study

* Assumed enough suitable vessels (~80) were available for VOSS-type skimming systems.
* Assumed enough trained operators were available to crew all offshore skimming systems.

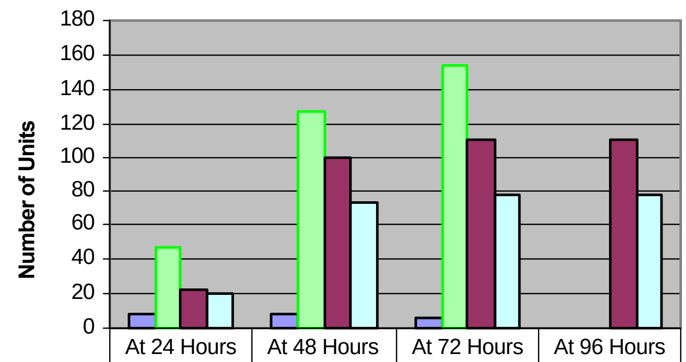


Oil Removed vs. OPA-90 Criteria



	24 Hours	48 Hours	72 Hours	96 Hours
Oil Dispersed in each period	17,000	22,743	7,771 bbls	
Oil Recovered (Adjusted)	7,612 bbls	185,650	288,998	302,843
Barrels of Storage On-scene (not including tanker or FPSO)	68,664 bbls/day	213,979 bbls/day	316,179 bbls/day	316,179 bbls/day
Total De-rated Recovery Capacity On-scene	107,545 bbls/day	557,307 bbls/day	606,741 bbls/day	606,741 bbls/day

Response Resources Used



	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Dispersant Application Aircraft	8	8	6	
Dispersant Applied (thousands of gallons)	47.6	127.2	154.4	
Number of Skimmers	22	100	110	110
Boom On-scene (thousands of feet)	20.4	73.0	77.7	77.7

Fig. 4-26. Response summary for Study Site #2, Alaminos Canyon lease area

Study Site #3 Response Summary

Assumptions

Dispersants:

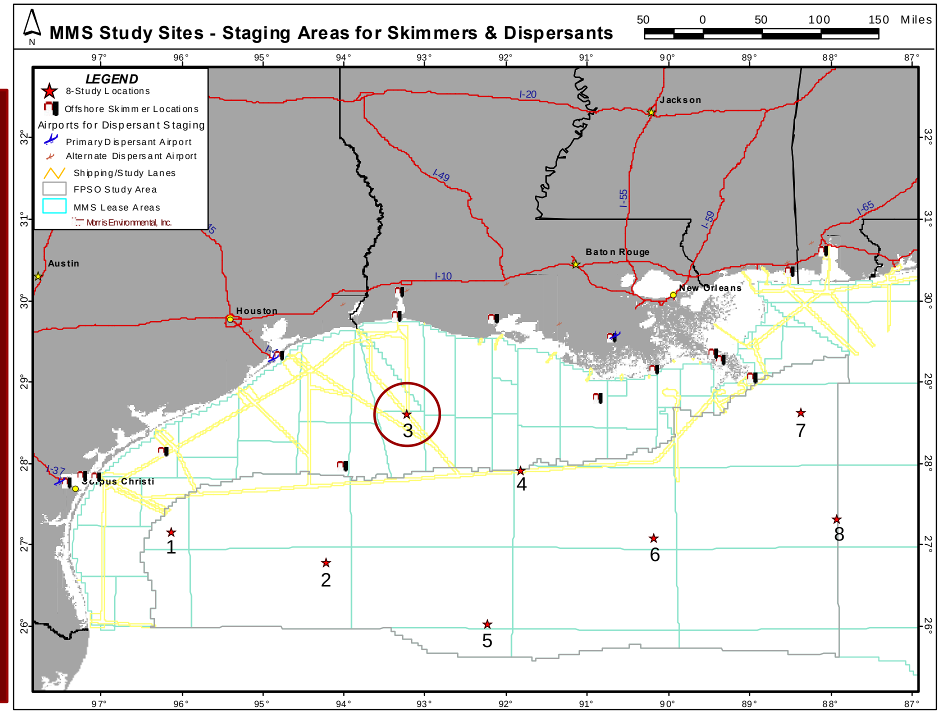
* Entire dispersant Gulf Of Mexico stockpile was used in 48 hrs.
* 8 dispersant application aircraft (with correct ETA's) were used
  - included one DC-4, two DC-3's, & five C-130's.
* Effectiveness may be reduced after 24-35 hrs. (see text)

Mechanical Recovery:

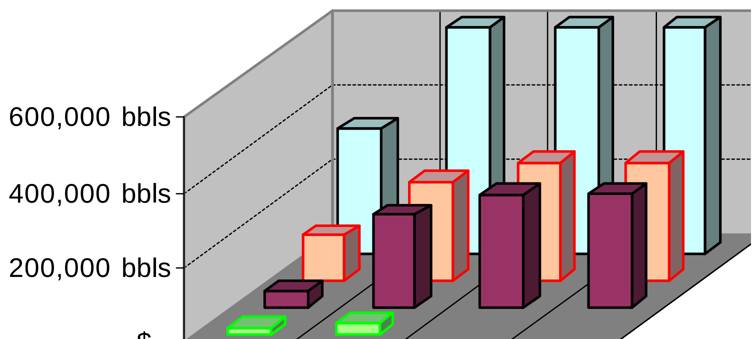
* All 105 skimmers and storage systems were from Gulf of Mexico
* Assumed skimmers could recover at De-rated capacity 50% of time they were on-scene (to allow for offload time & night ops).

Assumptions requiring additional study

* Assumed enough suitable vessels (~80) were available for VOSS-type skimming systems.
* Assumed enough trained operators were available to crew all offshore skimming systems.

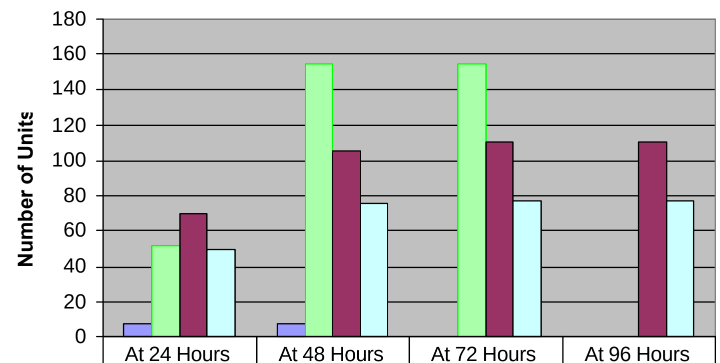


Oil Removed vs. OPA-90 Criteria



	24 Hours	48 Hours	72 Hours	96 Hours
Oil Dispersed in each period	18,500	29,371		
Oil Recovered (Adjusted)	44,359	247,807	299,143	303,371
Barrels of Storage On-scene (not including tanker or FPSO)	119,046 bbls/day	263,679 bbls/day	316,179 bbls/day	316,179 bbls/day
Total De-rated Recovery Capacity On-scene	331,251 bbls/day	603,121 bbls/day	606,741 bbls/day	606,741 bbls/day

Response Resources Used



	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Dispersant Application Aircraft	8	8	0	
Dispersant Applied (thousands of gallons)	51.8	154.6	154.6	
Number of Skimmers	70	106	110	110
Boom On-scene (thousands of feet)	50.3	75.0	77.7	77.7

Fig. 4-27. Response summary for Study Site #3, West Cameron South lease area

Based on available shore-based aerial assets (ASI's DC-4), oil accidentally released at this site would be initially treated three hours after the spill. Skimming vessel response to the site would be provided by activation of all available resources, with initial skimming commencing nine hours after the spill by CGA's ID boat.

During the first 24 hours after a spill, dispersant application and oil removal by skimmers would remove 62,859 bbl of oil, comprised of 18,500 bbl of dispersed oil and 44,359 bbl of recovered product. After 48 hours, the total amount of oil potentially removed by dispersants and skimmers would be 340,037 bbl. Based on results from the oil-weathering analysis, dispersant use may become appreciably less effective after 24 to 35 hours. The total amount of oil potentially removed after 72 and 96 hours would be 639,180 and 850,320 bbl, respectively.

Study Site 4 – Green Canyon Lease Area

Study Site 4, or OSRA launch point GC1, is located in the Green Canyon lease area, approximately 154 km (96 mi) south-southwest of Isle Dernieres, Louisiana (lat. 27.91895^o N, long. 91.79954^o W). Water depth at this location is approximately 200 m (656 ft). Figure 4-28 summarizes the response capability for a large spill occurring at this site.

Based on available shore-based aerial assets (ASI's DC-4), oil accidentally released at this site would be initially treated three hours after the spill. Skimming vessel response to the site would be provided by activation of all available resources, with initial skimming commencing nine hours after the spill by the CGA-58 boat.

During the first 24 hours after a spill, dispersant application and oil removal by skimmers would remove 46,129 bbl of oil, comprised of 17,786 bbl of dispersed oil and 28,343 bbl of recovered product. After 48 hours, the total amount of oil potentially removed by dispersants and skimmers would be 329,204 bbl. Based on results from the oil-weathering analysis, dispersant use may become appreciably less effective after 24 to 35 hours. The total amount of oil potentially removed after 72 and 96 hours would be 631,875 and 859,174 bbl, respectively.

Study Site 5 – Keathley Canyon Lease Area

Study Site 5, or OSRA launch point KC5, is located in the Keathley Canyon lease area, approximately 354 km (220 mi) south-southwest of Isle Dernieres, Louisiana (lat. 26.03194^o N, long. 92.23222^o W). Water depth at this location is approximately 2,500 m (8,202 ft). Figure 4-29 summarizes the response capability for a large spill occurring at this site.

Based on available shore-based aerial assets (ASI's DC-4), oil accidentally released at this site would be initially treated three hours after the spill. Skimming vessel response to the site would be provided by activation of all available resources, with initial skimming commencing nine hours after the spill by the CGA-58 boat.

During the first 24 hours after a spill, dispersant application and oil removal by skimmers would remove 17,083 bbl of oil, comprised of 14,786 bbl of dispersed oil and 2,297 bbl of recovered product. After 48 hours, the total amount of oil potentially removed by dispersants and skimmers would be 201,065 bbl. Based on results from the oil-weathering analysis, dispersant use may become appreciably less effective after 24 to 35 hours. The total amount of oil potentially removed after 72 and 96 hours would be 510,370 and 764,343 bbl, respectively.

Study Site 6 – Green Canyon Lease Area

Study Site 6, or OSRA launch point 6CC, is located in the Green Canyon lease area, approximately 214 km (133 mi) south-southwest of Southwest Pass, Louisiana (lat. 27.08333° N, long. 90.16667° W). Water depth at this location is approximately 1,500 m (4,922 ft). Figure 4-30 summarizes the response capability for a large spill occurring at this site.

Based on available shore-based aerial assets (ASI's DC-4), oil accidentally released at this site would be initially treated three hours after the spill. Skimming vessel response to the site would be provided by activation of all available resources, with initial skimming commencing nine hours after the spill by the CGA-58 boat.

During the first 24 hours after a spill, dispersant application and oil removal by skimmers would remove 29,577 bbl of oil, comprised of 17,000 bbl of dispersed oil and 12,577 bbl of recovered product. After 48 hours, the total amount of oil potentially removed by dispersants and skimmers would be 268,542 bbl. Based on results from the oil-weathering analysis, dispersant use may become appreciably less effective after 24 to 35 hours. The total amount of oil potentially removed after 72 and 96 hours would be 579,827 and 822,963 bbl, respectively.

Study Site 7 – Mississippi Canyon Lease Area

Study Site 7, or OSRA launch point MC1, is located in the Mississippi Canyon lease area, approximately 85 km (53 mi) south-southeast of South Pass, Louisiana (lat. 28.62717° N, long. 88.35751° W). Water depth at this location is approximately 500 m (1,640 ft). Figure 4-31 summarizes the response capability for a large spill occurring at this site.

Based on available shore-based aerial assets (ASI's DC-4), oil accidentally released at this site would be initially treated three hours after the spill. Skimming vessel response to the site would be provided by activation of all available resources, with initial skimming commencing nine hours after the spill by the CGA-57 boat.

During the first 24 hours after a spill, dispersant application and oil removal by skimmers would remove 57,268 bbl of oil, comprised of 17,786 bbl of dispersed oil and 39,482 bbl of recovered product. After 48 hours, the total amount of oil potentially removed by dispersants and skimmers would be 326,913 bbl. Based on results from the oil-weathering analysis, dispersant use may become appreciably less effective after 24 to 35 hours. The total amount of oil potentially removed after 72 and 96 hours would be 632,129 and 849,289 bbl, respectively.

Study Site 8 – Atwater Valley Lease Area

Study Site 8, or OSRA launch point AT5, is located in the Atwater Valley lease area, approximately 220 km (137 mi) southeast of South Pass, Louisiana (lat. 27.31895° N, long. 87.90579° W). Water depth at this location is greater than 2,500 m (8,202 ft). Figure 4-32 summarizes the response capability for a large spill occurring at this site.

Based on available shore-based aerial assets (ASI's DC-4), oil accidentally released at this site would be initially treated three hours after the spill. Skimming vessel response to the site would be provided by activation of all available resources, with initial skimming commencing 12 hours after the spill by the CGA-57 boat.

Study Site #4 Response Summary

Assumptions

Dispersants:

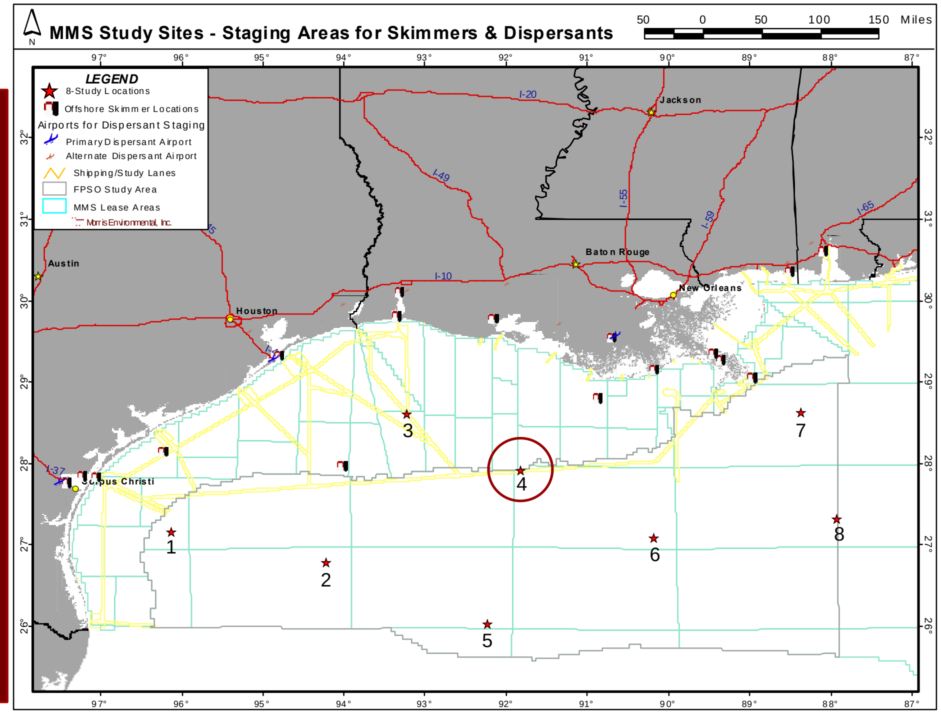
* Entire dispersant Gulf Of Mexico stockpile was used in 50 hrs.
* 8 dispersant application aircraft (with correct ETA's) were used
  - included one DC-4, two DC-3's, & five C-130's.
* Effectiveness may be reduced after 24-35 hrs. (see text)

Mechanical Recovery:

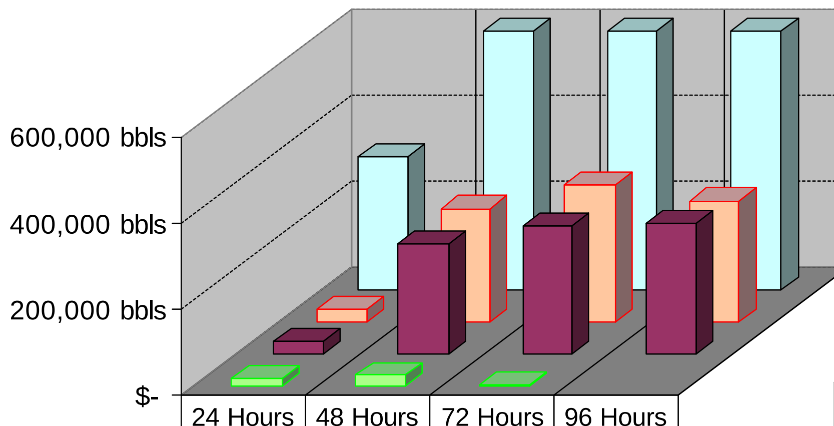
* All 105 skimmers and storage systems were from Gulf of Mexico
* Assumed skimmers could recover at De-rated capacity 50% of time they were on-scene (to allow for offload time & night ops).

Assumptions requiring additional study

* Assumed enough suitable vessels (~80) were available for VOSS-type skimming systems.
* Assumed enough trained operators were available to crew all offshore skimming systems.

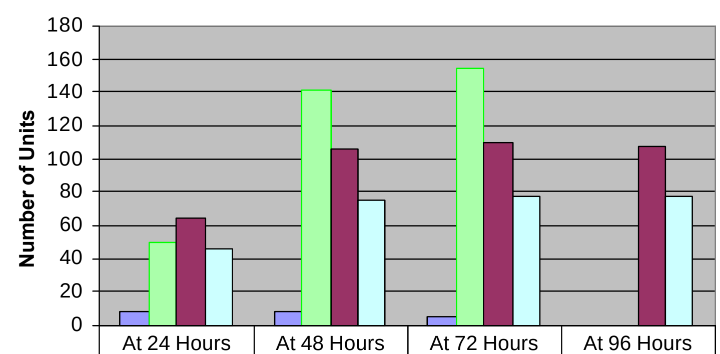


Oil Removed vs. OPA-90 Criteria



	24 Hours	48 Hours	72 Hours	96 Hours
Oil Dispersed in each period	17,786	26,229	3,714 bbls	
Oil Recovered (Adjusted)	28,343	256,848	298,956	303,371
Barrels of Storage On-scene (not including tanker or FPSO)	28,790 bbls/day	263,679 bbls/day	316,179 bbls/day	280,179 bbls/day
Total De-rated Recovery Capacity On-scene	309,619 bbls/day	603,121 bbls/day	606,741 bbls/day	606,741 bbls/day

Response Resources Used



	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Dispersant Application Aircraft	8	8	5	
Dispersant Applied (thousands of gallons)	49.8	141.6	154.6	
Number of Skimmers	64	106	110	108
Boom On-scene (thousands of feet)	45.7	75.0	77.7	77.7

Fig. 4-28. Response summary for Study Site #4, Green Canyon lease area

Study Site #5 Response Summary

Assumptions

Dispersants:

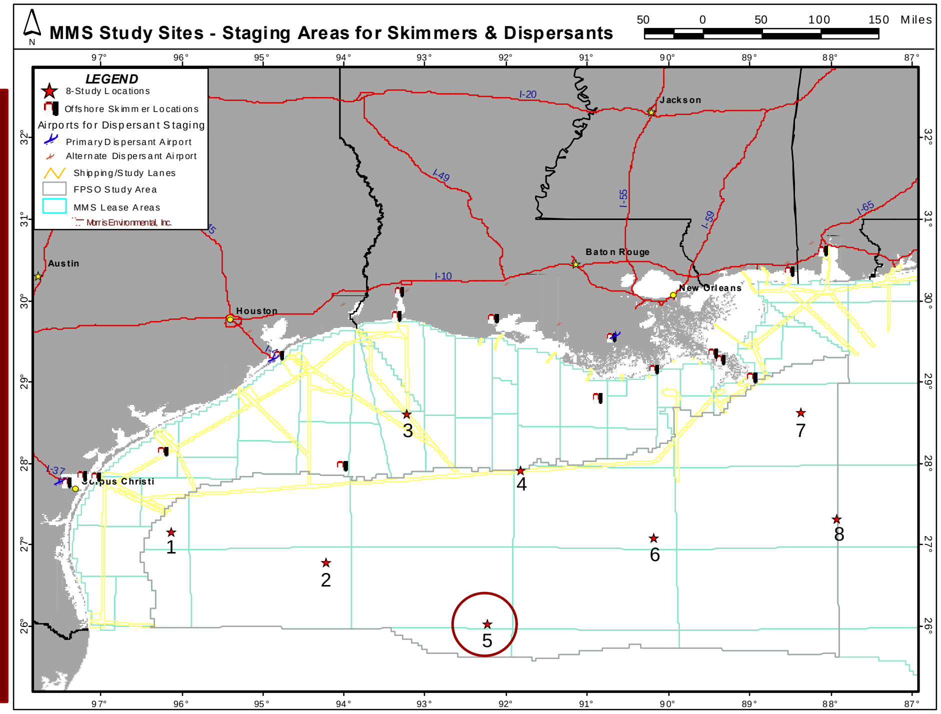
* Entire dispersant Gulf Of Mexico stockpile was used in 58 hrs.
* 8 dispersant application aircraft (with correct ETA's) were used
  - included one DC-4, two DC-3's, & five C-130's.
* Effectiveness may be reduced after 24-35 hrs. (see text)

Mechanical Recovery:

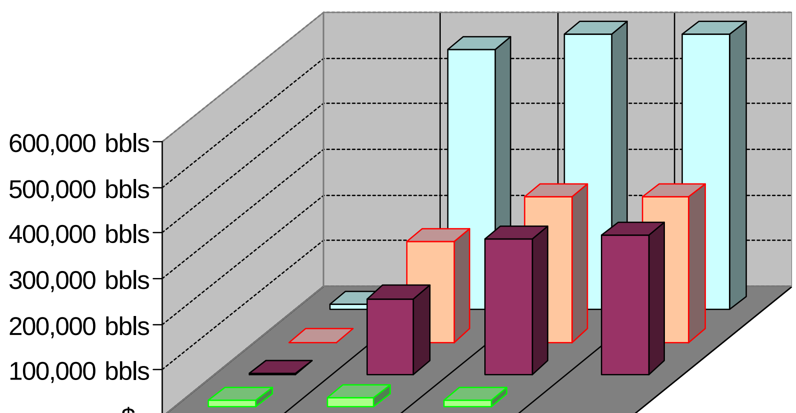
* All 105 skimmers and storage systems were from Gulf of Mexico
* Assumed skimmers could recover at De-rated capacity 50% of time they were on-scene (to allow for offload time & night ops).

Assumptions requiring additional study

* Assumed enough suitable vessels (~80) were available for VOSS-type skimming systems.
* Assumed enough trained operators were available to crew all offshore skimming systems.

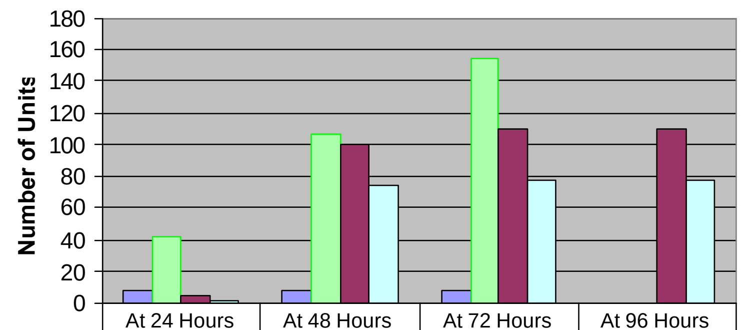


Oil Removed vs. OPA-90 Criteria



	24 Hours	48 Hours	72 Hours	96 Hours
Oil Dispersed in each period	14,786 bbls	18,457 bbls	13,857 bbls	
Oil Recovered (Adjusted)	2,297 bbls	165,525	295,448	303,371
Barrels of Storage On-scene (not including tanker or FPSO)	263 bbls/day	217,979 bbls/day	316,179 bbls/day	316,179 bbls/day
Total De-rated Recovery Capacity On-scene	12,294 bbls/day	567,807 bbls/day	606,741 bbls/day	606,741 bbls/day

Response Resources Used



	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Dispersant Application Aircraft	8	8	8	
Dispersant Applied (thousands of gallons)	41.4	106.0	154.5	
Number of Skimmers	4	100	110	110
Boom On-scene (thousands of feet)	0.7	74.3	77.7	77.7

Fig. 4-29. Response summary for Study Site #5, Keathley Canyon lease area

Fig.4-30.PDF

Study Site #6 Response Summary

Assumptions

Dispersants:

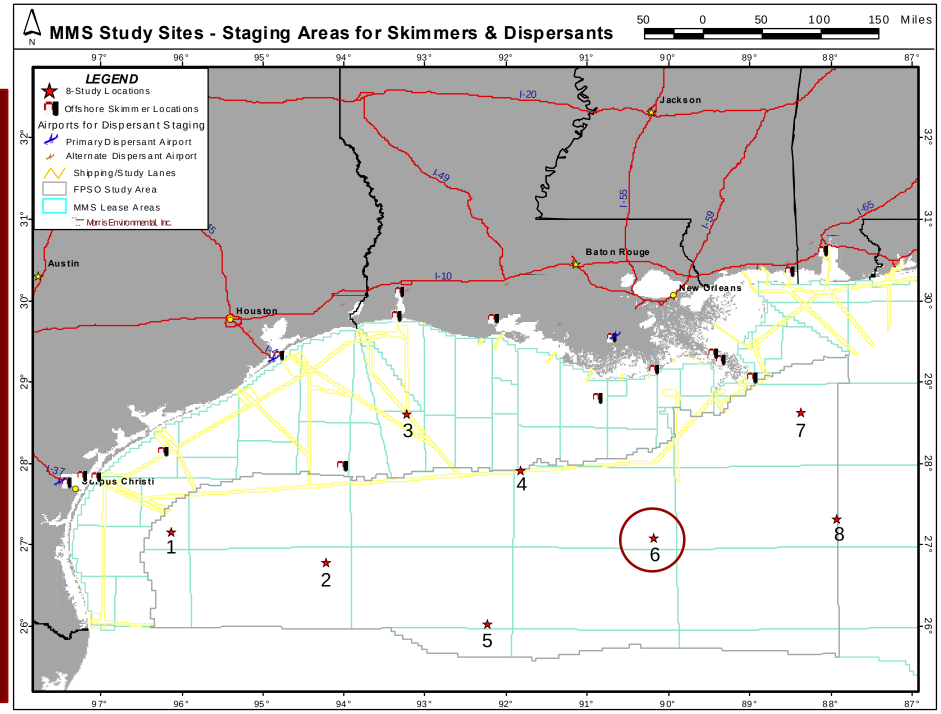
* Entire dispersant Gulf Of Mexico stockpile was used in 53 hrs.
* 8 dispersant application aircraft (with correct ETA's) were used
  - included one DC-4, two DC-3's, & five C-130's.
* Effectiveness may be reduced after 24-35 hrs. (see text)

Mechanical Recovery:

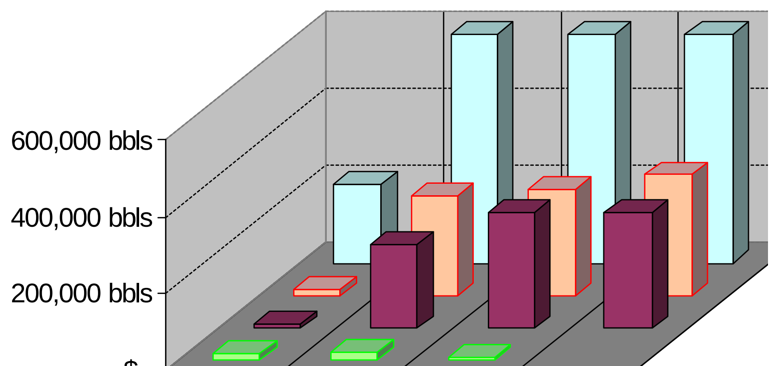
* All 105 skimmers and storage systems were from Gulf of Mexico
* Assumed skimmers could recover at De-rated capacity 50% of time they were on-scene (to allow for offload time & night ops).

Assumptions requiring additional study

* Assumed enough suitable vessels (~80) were available for VOSS-type skimming systems.
* Assumed enough trained operators were available to crew all offshore skimming systems.

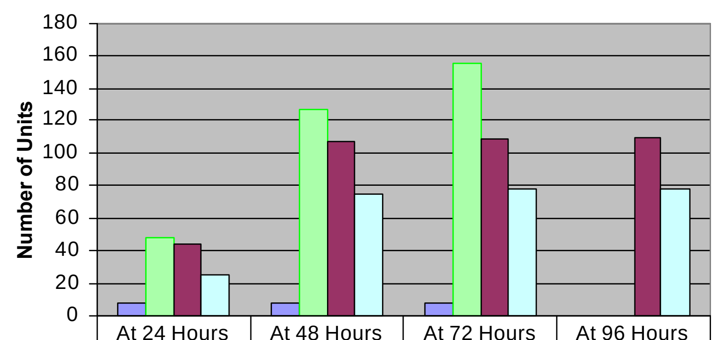


Oil Removed vs. OPA-90 Criteria



	24 Hours	48 Hours	72 Hours	96 Hours
Oil Dispersed in each period	17,000	22,743	7,914 bbls	
Oil Recovered (Adjusted)	12,577	216,222	303,371	303,371
Barrels of Storage On-scene (not including tanker or FPSO)	17,368 bbls/day	263,679 bbls/day	280,179 bbls/day	316,179 bbls/day
Total De-rated Recovery Capacity On-scene	208,101 bbls/day	603,121 bbls/day	606,741 bbls/day	606,741 bbls/day

Response Resources Used



	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Dispersant Application Aircraft	8	8	8	
Dispersant Applied (thousands of gallons)	47.6	127.2	154.9	
Number of Skimmers	45	107	108	110
Boom On-scene (thousands of feet)	25.1	75.0	77.7	77.7

Fig. 4-30. Response summary for Study Site #6, Green Canyon lease area

Fig.3-31.PDF

Study Site #7 Response Summary

Assumptions

Dispersants:

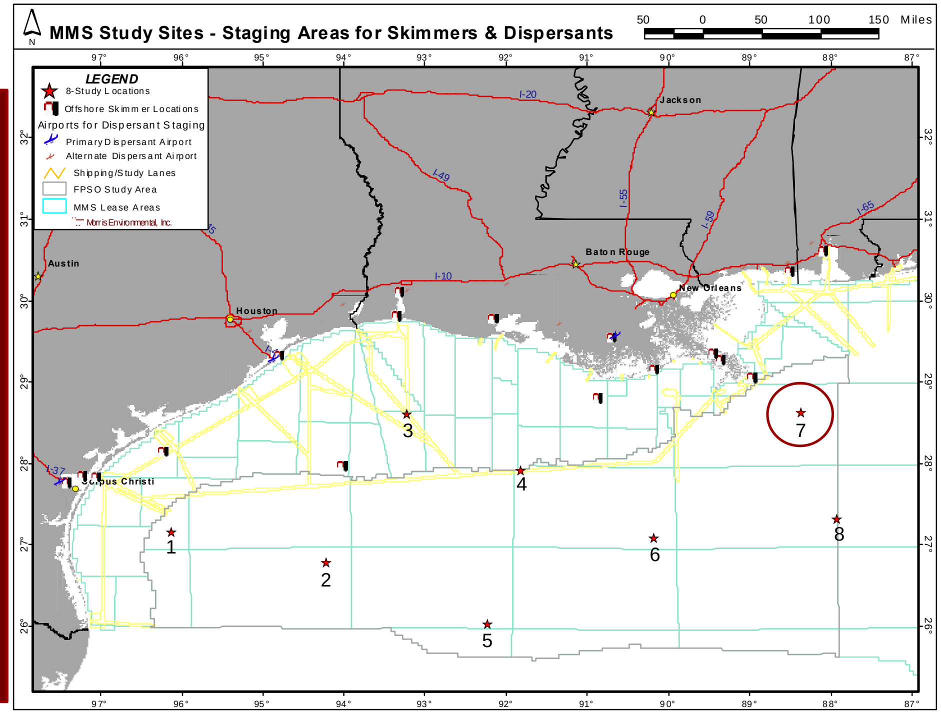
* Entire dispersant Gulf Of Mexico stockpile was used in 51 hrs.
* 8 dispersant application aircraft (with correct ETA's) were used
  - included one DC-4, two DC-3's, & five C-130's.
* Effectiveness may be reduced after 24-35 hrs. (see text)

Mechanical Recovery:

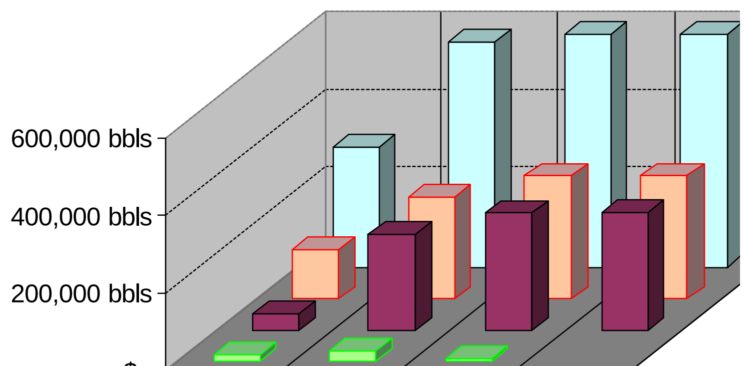
* All 105 skimmers and storage systems were from Gulf of Mexico
* Assumed skimmers could recover at De-rated capacity 50% of time they were on-scene (to allow for offload time & night ops).

Assumptions requiring additional study

* Assumed enough suitable vessels (~80) were available for VOSS-type skimming systems.
* Assumed enough trained operators were available to crew all offshore skimming systems.

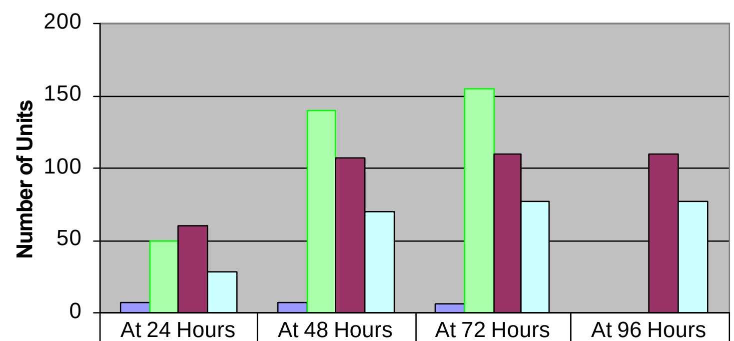


Oil Removed vs. OPA-90 Criteria



	24 Hours	48 Hours	72 Hours	96 Hours
Oil Dispersed in each period	17,786	25,657	4,286 bbls	
Oil Recovered (Adjusted)	39,482	243,988	300,931	303,371
Barrels of Storage On-scene (not including tanker or FPSO)	125,278 bbls/day	259,287 bbls/day	316,179 bbls/day	316,179 bbls/day
Total De-rated Recovery Capacity On-scene	307,015 bbls/day	577,461 bbls/day	606,741 bbls/day	606,741 bbls/day

Response Resources Used



	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Dispersant Application Aircraft	8	8	6	
Dispersant Applied (thousands of gallons)	49.8	139.6	154.6	
Number of Skimmers	60	107	110	110
Boom On-scene (thousands of feet)	29.3	70.1	77.7	77.7

Fig. 4-31. Response summary for Study Site #7, Mississippi Canyon lease area

Study Site #8 Response Summary

Assumptions

Dispersants:

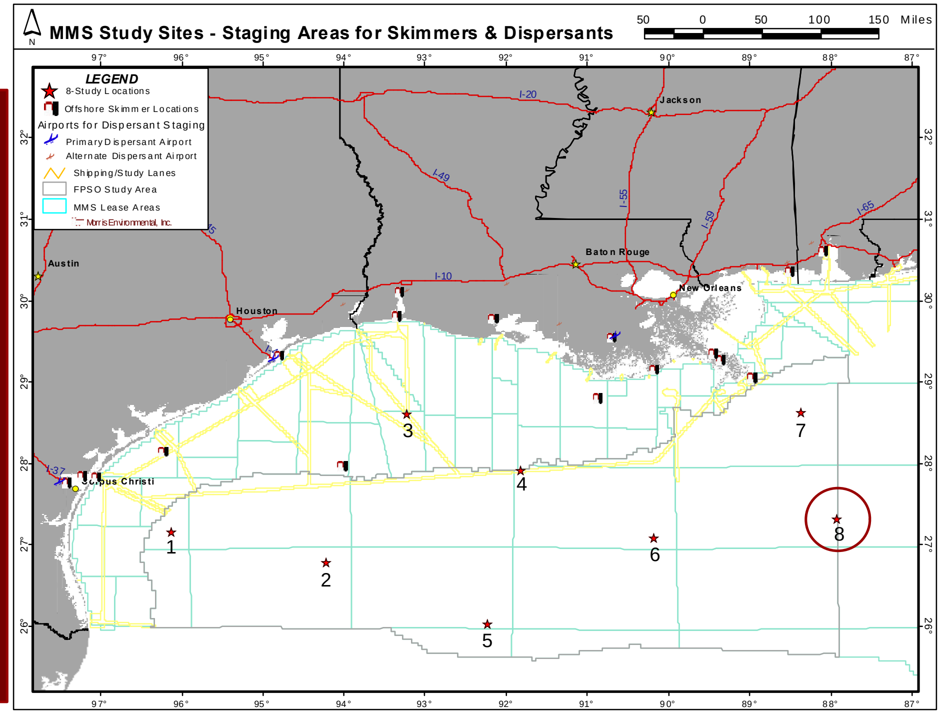
* Entire dispersant Gulf Of Mexico stockpile was used in 55 hrs.
* 8 dispersant application aircraft (with correct ETA's) were used
  - included one DC-4, two DC-3's, & five C-130's.
* Effectiveness may be reduced after 24-35 hrs. (see text)

Mechanical Recovery:

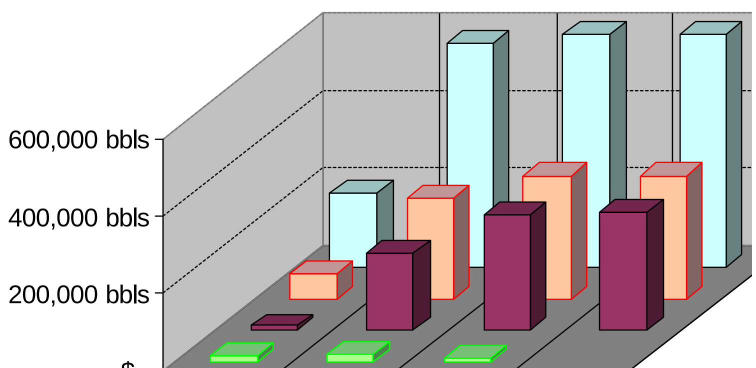
* All 105 skimmers and storage systems were from Gulf of Mexico
* Assumed skimmers could recover at De-rated capacity 50% of time they were on-scene (to allow for offload time & night ops).

Assumptions requiring additional study

* Assumed enough suitable vessels (~80) were available for VOSS-type skimming systems.
* Assumed enough trained operators were available to crew all offshore skimming systems.

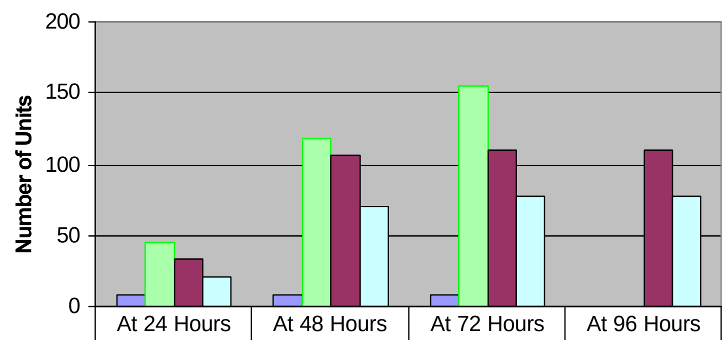


Oil Removed vs. OPA-90 Criteria



	24 Hours	48 Hours	72 Hours	96 Hours
Oil Dispersed in each period	16,286	20,743	10,486	
Oil Recovered (Adjusted)	11,324	198,814	298,422	303,371
Barrels of Storage On-scene (not including tanker or FPSO)	65,862 bbls/day	259,287 bbls/day	316,179 bbls/day	316,179 bbls/day
Total De-rated Recovery Capacity On-scene	191,320 bbls/day	577,461 bbls/day	606,741 bbls/day	606,741 bbls/day

Response Resources Used



	At 24 Hours	At 48 Hours	At 72 Hours	At 96 Hours
Dispersant Application Aircraft	8	8	8	
Dispersant Applied (thousands of gallons)	45.6	118.2	154.9	
Number of Skimmers	34	106	110	110
Boom On-scene (thousands of feet)	20.3	70.1	77.7	77.7

Fig. 4-32. Response summary for Study Site #8, Atwater Valley lease area

During the first 24 hours after a spill, dispersant application and oil removal by skimmers would remove 27,610 bbl of oil, comprised of 16,286 bbl of dispersed oil and 11,324 bbl of recovered product. After 48 hours, the total amount of oil potentially removed by dispersants and skimmers would be 247,167 bbl. Based on results from the oil-weathering analysis, dispersant use would become appreciably less effective after 24 to 35 hours; however, mechanical recovery would continue. The total amount of oil potentially removed after 72 and 96 hours would be 556,074 and 800,606 bbl, respectively.

4.4.3.4 Discussion of Findings

Existing Dispersant Stockpiles

Adequate dispersant stockpiles are in place in the GOM to support at least the first two days of dispersant application. At a 20:1 application ratio, these stockpiles could be applied to approximately 73,000 bbl of oil on the surface of the water. Using the assumed dispersant effectiveness factors cited previously (i.e., 75 percent during the first 24 hours; 60 percent during subsequent 24-hour periods), existing GOM dispersant stockpiles may be expected to disperse up to almost 48,000 bbl of oil. (Note: Should dispersant effectiveness be different than that predicted, more or less spilled oil could be dispersed. Further, depending upon the oil spilled, dispersant effectiveness may diminish appreciably as early as 24 to 35 hours after an instantaneous release; a continuous, uncontrolled release over one or more days might be expected to prompt continued dispersant application.) Additional logistics work may also be required to ensure that the stockpile can be transported quickly from its present locations to the staging airport, and subsequently applied within the timeframes considered in this analysis.

Dispersants are also stockpiled in other locations in the U.S. (e.g., Alaska, California, Hawaii, New Jersey) and around the world. However, remaining stockpiles worldwide would only support two additional days of dispersant application, and operators in regions other than the GOM also have response plans that depend on the availability of those regional stockpiles. Thus, depleting the stockpiles in other areas would leave those regions potentially exposed to an inadequate response capability should another spill occur. While such resources could be used in an emergency, depleting the stockpiles of other regions is not an acceptable planning practice.

Dispersant Manufacturing Capability

The manufacturing facility in Sugarland, Texas, can begin producing additional dispersant after approximately 48 hours. However, the facility's current capacity can only produce an estimated one-quarter of the daily requirement for dispersants in the scenarios evaluated in this analysis. In order to disperse a major catastrophic spill (i.e., over ~100,000 bbl), the following options should be considered:

- The GOM stockpile of dispersants could be increased to be able to treat a spill of the maximum planning volume (maximum size spill).
- The dispersant manufacturing facility/process could be modified to begin producing dispersant more quickly.
- The dispersant manufacturing facility/process could be modified to produce the daily requirement of dispersant each day.

Dispersant Application Capability

The existing aerial dispersant application capabilities available through ASI in Houma, Louisiana, have proven adequate for recent spills in the GOM. This analysis also considered the addition of dispersant application capabilities of several other sources, including CCC in Florida and the USAF Reserve in Ohio. This combination of support aircraft was able to effectively use the existing stockpile of dispersant for the GOM within 48 to 58 hours at any of the study sites reviewed. If more dispersant were available, any of the following steps could further improve the ability to apply more dispersant early in the spill:

- Acquire aircraft with faster airspeed to shorten transit time from the staging airport to the spill site.
- Install larger payloads for the aircraft applying dispersant.
- Increase the number of dispersant application aircraft available in the GOM area.
- For nearshore spills, add the use of “crop dusters” to supplement larger aircraft.

Existing Skimmer Stockpile

The stockpile of skimmers in the GOM has more than enough de-rated recovery capacity (i.e., >600,000 bbl/day) to theoretically recover an extremely large spill. Additional skimmers would not be required.

Skimmer Deployment Time

Numerous dedicated skimming systems are available in the GOM, including CGA, Marine Spill Response Corporation, and National Response Corporation. These groups have dedicated oil spill response vessels available, each of which has been equipped with skimmer, boom, and onboard storage for recovered product. These systems are pre-positioned in various offshore and shore-based locations around the GOM, allowing for rapid response time with the first skimming system.

The VOSS are systems that require components of a skimming package to be loaded aboard a suitable offshore vessel. Offshore vessels must be located and deployed to the staging area, where they are then loaded with the skimming package and crew. Vessel availability is somewhat unpredictable and depends on the status of other offshore work being conducted at the time of a spill. The scenarios evaluated in this analysis would require the rapid availability of numerous (up to 80) offshore vessels. While many vessels could be located quickly, there would be a delay in some of the skimming packages being deployed due to vessel availability (e.g., time necessary to get the vessel to a staging area). A vessel-tracking network, which includes all offshore boat companies, would speed up the ability to locate available vessels.

Operator Availability for Skimmers

There are not enough trained operators currently available to man the offshore skimmers in the GOM if they were all deployed at the same time. This may cause some delay in skimmer deployment, or less efficient skimmer operations. Ultimately, on-site recovery capability could be diminished in the absence of sufficient numbers of trained operators.

Dedicated Storage for Recovered Oil

Most skimming systems have on-board storage, or bladder storage, to store recovered oil. The capacity of these storage containers will usually allow the skimmer to operate for several hours before offloading of storage containers is required. These containers are typically offloaded into a larger barge or storage vessel. There are several dedicated storage barges in the GOM for use in oil spills.

4.4.3.5 Summary

Several noteworthy points were evident following this analysis that are pertinent to dispersants (e.g., stockpiles, application efficiency, dispersant effectiveness) and mechanical recovery, as well as on-site storage capability. The results must also be qualified to a certain extent, given the assumptions upon which the findings were derived.

It has been projected that the entire dispersant stockpile found along the GOM coast could be applied to a large spill within approximately 48 hours, given the air support capabilities noted. Results of the oil-weathering model suggest that dispersant effectiveness, for the test oils evaluated, diminishes appreciably within 24 to 35 hours following release. Given available GOM dispersant stockpiles, oil weathering characteristics, and dispersant effectiveness factors, it is estimated that only about 48,000 bbl of spilled oil can be dispersed. Therefore, the remainder of a large spill would have to be removed by mechanical recovery or natural processes. In instances where other domestic or international dispersant sources are to be used after 48 hours post-spill (i.e., under conditions of an uncontrolled oil release), total worldwide dispersant stockpiles would be exhausted within a maximum of approximately two additional days.

For the eight study sites considered, application of dispersants within the first 24 hours after a spill was rather uniform; by inference, the amount of spilled oil that was dispersed did not vary appreciably from site to site. The results of the analysis indicated that between 14,786 and 18,500 bbl of spilled oil could be removed via dispersants during the first day, assuming 75 percent dispersant effectiveness. This underscores the importance of reaching and treating an oil spill quickly, regardless of its distance from shore.

As expected, on-site recovery of spilled oil during the first 24 hours was extremely variable and dependent primarily upon the location of the spill and its distance from shore. Recovery during the first day after a spill varied nearly 20-fold between the eight sites considered, ranging from a low of 2,297 bbl to a high of 44,359 bbl. After the first 24 hours, however, on-site oil recovery capability increased significantly. After 48 hours, mechanical recovery becomes the primary mode of oil spill response.

During the first 24 hours following a spill, the on-site recovery capability for each of the eight sites is low (i.e., recovery capability is considerably less than storage capacity for recovered oil) but increases quickly as additional resources arrive on site. At 48 hours after the spill, on-site recovery normally exceeds storage capacity of response vessels, exclusive of either shuttle tanker or FPSO storage. To keep pace with recovery, shuttle tanker and/or FPSO storage should be made available as repositories for recovered oil. Lightering vessels or available tankage on other vessels of opportunity could also provide additional storage, if necessary (e.g., if the FPSO or shuttle tanker cannot accept recovered oil).

While on-site recovery capacities increase as more skimmers arrive, effective use of offshore skimmers requires that the oil encounter rate of the skimmers be maximized (i.e., skimmers should be located within the heavier streamers of oil). After a spill has been spreading for 48 hours, it is difficult to get a good encounter rate. At best, this requires considerable coordination by aerial observers who have good communications with the skimmers. When balanced against the “reality check” that skimmers recover less than ten percent of most offshore spills, expectations of how effective skimming operations will be are lowered after oil has been spreading for two or three days. As a consequence, there is an increased emphasis on maximizing the amount of oil dispersed or recovered early in an oil spill incident.

4.4.4 Impacts and Mitigation

This impact discussion addresses the accidental release of oil associated with FPSO operations (including shuttle tankering of FPSO oil into Gulf of Mexico ports). It focuses on the potential impacts of various spill sizes and locations on various environmental and socioeconomic components of the environment. Feasible mitigation measures to reduce or eliminate those impacts are also presented. Impacts may be classified into one of three impact levels (i.e., degree of impact), including:

- Significant impact
- Adverse (but not significant) impact
- No (or negligible) impact

The threshold for determining a significant impact, termed ***significance criteria***, varies depending upon several factors, including a) the resource affected; and b) the spatial and temporal attributes (or scope) of each impact-producing factor (i.e., local vs. regional; short- vs. long-term). Significance criteria cited previously for routine operations (Section 4.3) remain applicable to the resources potentially affected by accidental oil spills. Whenever applicable, the historical aspects of previous oil spills in the marine environment (e.g., fate) and their observed or measured impacts are discussed as a basis for further prediction of FPSO-related oil spill impacts.

It is important to underscore the fact that the oil releases evaluated in this analysis are not real, rather they are reasonably estimated given the characteristics of offshore oil and gas operations and the risks associated with FPSO-based oil and gas production and transport activities. The quantitative risk assessment (Section 4.4.1) details the predicted frequencies of accidental releases of oil from FPSO operations.

It is also important to note that shuttle tanker operations may result in accidental oil spills in nearshore waters. While such an accident places oil in closer proximity to potentially sensitive coastal and nearshore resources, the volume of oil that may contact such resources is dependant upon a series of factors (i.e., spill size, on-site spill response capability, spill location, weather and sea state, timing and effectiveness of spill response). Further, spills occurring closer to shore may not be subjected to the extensive weathering processes more characteristic of spills occurring further offshore (i.e., because nearshore spills typically contact land or sensitive resources before adequate weathering occurs). Conditional probabilities for FPSO-related shuttle tanker spills over the shelf or in nearshore waters (i.e., in transit to port) would be similar to those noted for hypothetical spills evaluated in previous MMS multi-sale EISs (USDOI, MMS, 1997b, 1998a).

4.4.4.1 Air Quality

When oil is spilled on the sea surface, volatile and semi-volatile hydrocarbons in it begin to evaporate immediately into the atmosphere. These vapor-phase hydrocarbons in the air over the sea surface can, if they reach high enough concentrations or persist long enough, represent a risk to the health of air-breathing animals at or near the sea surface, such as sea turtles, birds, and marine mammals. The vapor-phase hydrocarbons themselves decrease air quality; they also are photooxidized to products that may be toxic or cause environmental damage (e.g., ozone).

Volatility of petroleum hydrocarbons is directly proportional to vapor pressure and inversely proportional to molecular weight. Most of the hydrocarbons evaporating from an oil slick are low molecular weight C_1-C_{10} alkanes and C_0-C_3-benzenes (mostly BTEX). The theoretical analysis of Stiver *et al.* (1989) suggests that some naphthalene, alkylnaphthalenes, and fluorene may evaporate relatively rapidly from an oil slick. There is little or no evaporation of higher molecular weight polycyclic aromatic hydrocarbons (PAHs) from oil slicks.

Under environmental conditions that are likely to occur offshore in the Gulf of Mexico, where the background partial pressures of hydrocarbons in air are negligible, the rate of evaporation of the slick is proportional to the average vapor pressure of the crude oil (which increases with temperature), the mass transfer coefficient of the hydrocarbons (which is proportional to the rate of air movement over the oil slick), and the area of the air/oil interface. Thin slicks evaporate more rapidly than thick slicks.

Approximately 38 percent of the mass of Viosca Knoll 990 crude oil and 29 percent of the mass of Mississippi Canyon 807 crude oil boils at temperatures below 250°C. Included with these volatile hydrocarbons are 13,785 mg/kg and 6,006 mg/kg, respectively, of BTEX. These volatile hydrocarbons can be expected to evaporate from an oil slick into the atmosphere. Mass emissions of total volatile hydrocarbons to the atmosphere from 1,000-bbl or 300,000-bbl spills of Viosca Knoll 990 crude oil are 50 metric tons and 15 thousand metric tons, respectively. Mass emissions of total volatile hydrocarbons to the atmosphere from 1,000-bbl or 300,000-bbl spills of Mississippi Canyon 807 crude oil are 41 metric tons and 12 thousand metric tons, respectively. These emissions would be to a large volume of air overlying the slick. Concentrations of individual and total hydrocarbons in the atmosphere over the slick are likely to decrease rapidly through wind-driven dispersion and dilution.

There have been relatively few measurements of concentrations of volatile hydrocarbons in the air over oil slicks from large oil spills. Hanna and Drivas (1993) modeled the time/concentration patterns of BTEX and several saturated hydrocarbons in the air over the oil spilled in the *Exxon Valdez* oil spill in Prince William Sound, Alaska Concentrations of most volatile hydrocarbons reached highest concentrations in the air over the spreading slick within the first three hours after the spill. Highest concentrations in the air ranged from 0.00186 parts per million by volume (ppmv) for pentadecane to 8.24 ppmv for toluene. Mass emission rates of toluene to the atmosphere from the spilled oil increased rapidly after the spill, reaching a maximum in excess of 20,000 kg/hour between 8 and 10 hours after the spill. The maximum evaporation rate for benzene was about 10,000 kg/hour 9 hours after the spill. The large surface area of the rapidly spreading slick can explain the relatively low predicted concentrations of volatile hydrocarbons in the air, despite the high mass emission rates shortly after the spill. No data are available for evaporative emissions of PAHs from the *Exxon Valdez* slick. It is probable that low concentrations of naphthalene and alkyl naphthalenes were present in the hydrocarbon vapor plume over the oil slick from the *Exxon Valdez* for at least a few days after the spill.

The evaporative emissions of hydrocarbons from the oil slick were modeled under the environmental conditions that existed shortly after the spill: low wind speed and ambient air and water temperatures of 0 to 3°C. Evaporation rates would be higher at higher ambient temperatures typical of the offshore Gulf of Mexico and under windy, rough sea conditions. Under warm, windy conditions, the duration of rapid emissions of volatile hydrocarbons to the atmosphere would be decreased.

Following a spill from a FPSO or shuttle tanker to offshore waters of the Gulf of Mexico, the mass emission rates of volatile hydrocarbons to the atmosphere are likely to be higher than those predicted for oil from the *Exxon Valdez* spill, while average concentrations of hydrocarbons in the vapor phase over the spill are likely to be lower than those predicted for the Alaska spill. These predictions are due to the lower expected volume of oil spilled in the Gulf and the higher ambient water temperatures. Hydrocarbon concentrations in the air may remain high enough to be toxic to air-breathing animals using the sea surface in the immediate vicinity of the slick for one or two days at most. Any potential adverse effects of an offshore 1,000-bbl to 300,000-bbl crude oil spill from a FPSO or shuttle tanker are expected to be rare, very localized, and of short duration. All modeled spill launch points and offshore areas except those immediately off the Mississippi River delta are more than 80 km (50 mi) from shore. Hydrocarbon vapors from a spill at the launch points or offshore areas would be dispersed and diluted to the point where they do not exceed onshore ambient air quality standards by the time they reached land.

Summary: On a regional basis, oil spills from FPSO operations are expected to produce adverse but not significant impacts to ambient air quality. Impacts will be relatively short term (i.e., duration of the spill). During the first few days, localized significant impacts may be realized, depending upon spill location and relative position of sensitive onshore receptors (e.g., Class I areas) and environmental conditions.

4.4.4.2 Water and Sediment Quality

Water Quality

Water quality of coastal and oceanic marine waters is based on the ability of the water body to support designated uses and the extent to which the water body attains water quality standards (USDOI, MMS, 1998b). An oil slick or sheen on the water surface and petroleum hydrocarbons dissolved and dispersed in the water column adversely affect water quality. Slicks from spills at the eight launch points and 10 offshore areas modeled in this analysis are predicted to move through coastal and offshore waters between south Texas and the Florida panhandle, with some oil possibly drifting as far as the Straits of Florida or international waters of Mexico and Cuba. The frequency of spills associated with FPSOs and shuttle tankers is very low (Section 4.4.1) so oil slicks and sheens from this source will be rare.

Oil slicks and sheens move continuously in the general direction of prevailing wind and surface water currents. Thus, surface oil does not persist for more than a few days at any location at sea. Sheens of crude oil from natural submarine oil seeps along the outer continental shelf off the Mississippi River delta have half-lives of 0.5 to 8 days (MacDonald *et al.*, 1993).

Slicks of crude oil from the *Exxon Valdez* oil spill had moved through offshore waters of Prince William Sound and into the Gulf of Alaska, a distance of about 110 km (68 mi), in about one week. Thus, slicks and sheens adversely affect water quality of a particular water mass for only a short period of time. Therefore, rare oil spills from FPSO operations will adversely affect surface water quality, but degraded water quality will not persist for more than a few weeks.

Between two and five percent of the mass of crude oil in a slick dissolves in the underlying water column. Some oil also is physically dispersed into the water column as fine droplets. The Open-Ocean Oil-Weathering Model predicts that between 40 and 50 percent of Viosca Knoll 990 crude oil or Mississippi Canyon 807 crude oil would disperse within 30 days. The trajectory of the dissolved and dispersed oil is controlled by near-surface water currents and often is different from the trajectory of the surface oil slick.

As discussed previously, dispersed oil droplets usually are not mixed very deeply into the water column. Dispersed oil droplets tend to coalesce and return to the sea surface to form nonpersistent sheens. As a result, hydrocarbon concentrations under an oil slick are low. Concentrations of total petroleum hydrocarbons under an oil slick that has been dispersed by moderate wave action rarely exceed about 1 to 2 mg/L (Mackay and McAuliffe, 1988). Wolfe *et al.* (1994) estimated that about 3.5 percent of the total volume of oil released from the *Exxon Valdez* was physically dispersed into the water column during the first three days after the spill, and a total of about 23 percent was dispersed after about 50 days. The maximum estimated concentration of dissolved and dispersed oil in the water column in the week after the spill was 0.8 mg/L.

Concentrations of dissolved BTEX in the upper water column of Prince William Sound in the path of the drifting oil slick from the *Exxon Valdez* oil spill rarely exceeded 10 μg/L in the weeks immediately after the spill (Neff and Stubblefield, 1995). Concentrations quickly fell below 1 μg/L as these volatile aromatic hydrocarbons evaporated from the water column.

Concentrations of total PAHs in the upper water column outside the path of the drifting slick usually were in the range of 0.015 to 0.050 μg/L during the spring and summer after the *Exxon Valdez* spill (Neff and Stubblefield, 1995; Neff and Burns, 1996). In the most heavily oiled areas in the spill path, concentrations of total PAHs in the upper water column were in the range of 0.1 μg/L to occasionally as high as 10 μg/L in the first few weeks after the spill. Concentrations decreased to 0.05 μg/L or less (essentially background) within a few months (Neff and Stubblefield, 1995). The maximum estimated total PAH concentration in the upper water column under the spreading slick in the first few days after the spill was 12 μg/L (Wolfe *et al.*, 1994). PAH concentrations probably also were elevated for a short time after the spill in nearshore waters off heavily oiled shores, due to energetic mixing of shoreline oil into the water column by wave action. Much of the petroleum in nearshore waters probably was in the form of dispersed oil droplets. Thus, concentrations of the toxic fractions of oil, the BTEX and PAHs, rarely reach high, potentially toxic concentrations in solution in the water column under an oil slick.

Spills to offshore waters from FPSOs and shuttle tankers will degrade water quality in the water column under and adjacent to the drifting oil slick through dispersion and dissolution of hydrocarbons in the water column. As demonstrated from studies performed after the *Exxon Valdez* oil spill or during experimental oil spills, concentrations of hydrocarbons in the water column rarely reach concentrations high enough to cause harm to populations of plants and animals which may be present. Effects, when they occur, usually occur within the first few days after the spill when BTEX and other slightly soluble hydrocarbons are present at highest concentrations in the water column. Adverse effects in water column organisms in offshore or open coastal waters are unlikely after about one week because of the rapid decline in concentrations of dissolved and dispersed petroleum in the water column. Because all the modeled launch points for oil spills are 85 km (53 mi) or more from shore, it is unlikely that the water quality of the water column in nearshore and coastal waters where the slick might drift will be seriously degraded. This is because the more soluble and toxic fractions of the oil will have been lost from the surface slick by the time it drifts into coastal waters.

Summary: On a regional basis, oil spills from FPSO operations are expected to produce adverse but not significant impacts to ambient water quality. Impacts will be relatively short term (i.e., duration of the spill).

Sediment Quality

Sediment quality may be degraded following an oil spill if some of the spilled oil is deposited in and contaminates the sediments. Some heavy crude and residual oils have a density approaching or even exceeding that of seawater. Sometimes, the density of a heavy crude oil may increase through weathering to a point where its density exceeds that of ambient seawater and it sinks, however, this is rare. Most crude oils are less dense than seawater (density about 1.01 g/cm^3); although weathering increases the density of the oil, density rarely increases to more than about 1.0 g/cm^3. The two crude oils evaluated in this risk assessment have densities of 0.83 g/cm^3 (Viosca Knoll 990 crude oil) and 0.89 g/cm^3 (Mississippi Canyon 807 crude oil) at 15°C (°API of 38.2 and 27.6, respectively; table 4-36). In 30 days, the two crude oils weather to a density of 0.85 g/cm^3 and 0.92 g/cm^3, respectively. Oil densities would be slightly lower at the higher average temperatures of surface waters in the Gulf of Mexico. These oils would not sink, even after 30 days of weathering on the sea surface.

However, if the oil burns, particularly if the fire is in the cargo or storage tanks of the FPSO or shuttle tanker, evaporative/combustion loss of the lighter fractions of the oil may be so great that the density of the residue increases to a point that it sinks when released from the hull. This happened in the *Haven* oil spill off the coast of Genoa, Italy (Martinelli *et al.*, 1995). Between 25,000 and 30,000 metric tons of oil residues were released to the sea from the burning tanker and between 13,500 and 18,000 tons of this sank and accumulated in large tar mats on the bottom at depths of 100 to 500 m (328 to 1,640 ft).

Some of the oil washing ashore may be washed offshore again by tidal or wave action. Some of the oil washing off the shore may be sorbed to fine-grained sediments and be deposited with them in offshore sediments. Studies of the Baffin Island experimental oil spill (Boehm, 1987), the *Amoco Cadiz* oil spill (Gundlach *et al.*, 1983), and the Arabian Gulf oil spill (Readman *et al.*, 1996) have shown that concentrations in excess of 100 mg/kg of oil can be deposited in subtidal sediments if oil comes ashore and subsequently erodes from the beach. In the year after the *Exxon Valdez* oil spill, nearshore (<1,000 m [3,281 ft]) subtidal sediments from spill-path areas of Prince William Sound contained mean concentrations of 0.08 to 1.2 mg/kg (dry weight) total PAHs, of which 0.3 mg/kg or less was derived from a North Slope crude oil resembling that released from the tanker (Page *et al.*, 1995; Bence *et al.*, 1996). Most of the remaining PAHs were derived from crude or refined oils from other sources or from combustion-derived particles. Concentrations of North Slope crude oil-derived PAHs always were at least 20 times lower than the “effects range low” (ERL) sediment threshold concentration of 4,022 μg/kg total PAH (Long *et al.*, 1995).

Most of the shores in the U.S. Gulf of Mexico are coastal barrier beaches and wetlands (Sections 3.2.1.1 and 3.2.1.2). Any crude oil slick coming ashore from a FPSO or shuttle tanker spill would be moderately to highly weathered, given that such oil typically would be exposed to weathering for more than three days on the sea surface. A viscous, weathered oil or mousse does not mix well with shoreline sediments. However, some mixing does occur. Oil/sediment mixtures washing off beaches or finer-grained wetlands may be deposited in nearshore bottom sediments. Sediment contamination would tend to decrease with distance from shore and water depth. With increasing distance from shore, or under oceanographic conditions where oil remains offshore for a month or more, oil remaining on the sea surface will form tar balls, which are subject to further transport by surface currents or sinking. Tar balls sinking to the seafloor will have lost their acute toxicity (due to weathering) and should not appreciably change sediment quality. Given the low probability that a spill from a FPSO or shuttle tanker may contact shore and the fact that most spills will involve a small volume that will decrease further by weathering before reaching shore, the risk that oil spills from FPSOs and shuttle tankers will significantly degrade sediment quality is low. It is unlikely that sufficient oil from an offshore spill will accumulate in nearshore sediments to be toxic to benthic organisms.

Summary: On a regional basis, oil spills from FPSO operations are expected to produce adverse but not significant impacts on sediment quality (i.e., from sinking oil, tar balls). Only significant impacts would be realized if oil was ignited prior to release (i.e., where spilled oil density greatly exceeds that of seawater), resulting in sinking oil reaching the benthos where it will affect sediment quality.

4.4.4.3 Coastal Environments

Coastal Barrier Beaches

As discussed in Section 3.2.1.1, coastal barrier beaches are a prominent feature of the coastline of the Gulf of Mexico from the Texas/Mexico border in the west to Baldwin County, AL, in the east. Barrier beaches also are a prominent feature of much of the west (Gulf) coast of Florida. Barrier beaches are longer and better-developed along the Texas coast than along the Louisiana coast.

Based on the results of the OSRA model analysis, oil spills from the seven offshore FPSO launch points and ten offshore areas have the highest probability of coming ashore within 30 days along the Texas coast in land segments 2 through 12 and 19 (i.e., between Willacy County, Texas, and Cameron, Vermilion, and Plaquemines Parishes, Louisiana), as reflected in table 4-53. Most of this coast consists of barrier beaches. Conditional probabilities of oil coming ashore on these barrier beaches within 30 days of release are predominantly less than 0.5 percent, with only a few instances where conditional probabilities of oil contact exceed five percent (table 4-53). As discussed previously, most oil spills from FPSOs are expected to be small, ranging from <10 to 1,000 bbl. The frequency of larger spills from FPSOs is very low. Spills of less than about 1,000 bbl are expected to dissipate rapidly and would not reach shore unless they did so within the first several days after a spill. Given the distance of the FPSO launch points and offshore areas from shore, no spills are expected to contact shore within three days. The combined probability of oil spill risk (based on the probability-weighted spill occurrence [conditional probability x frequency] x 20-year life of the project) that a larger, more persistent oil spill from an offshore FPSO may contact a particular shore segment in Texas or western Louisiana within 30 days is 1.0×10^{-2}. Given this low probability of a spill contacting a barrier beach, the risk of spills from FPSOs to barrier beaches in the Gulf of Mexico is low.

Spills from shuttle tankers at sea are likely to involve 1,000 to 500,000 bbl of oil. Spills from a shuttle tanker (i.e., from launch point T17, in the West Cameron South lease area) may be expected to reach land, mostly along land segments 7 through 12, encompassing the barrier beaches between Matagorda and Jefferson Counties, Texas, and Cameron and Vermilion Parishes, Louisiana. The combined probability of oil spill risk (over the life of the project) for the accidental release of 10,000, 100,000, or 500,000 bbl of oil from T17 is estimated to be 5.4×10^{-2}, 1.6×10^{-2}, and 2.0×10^{-3}, respectively. These low probabilities indicate that the risk to barrier beaches from oil spills from shuttle tankers is low.

Most barrier beaches in the Gulf of Mexico contain medium to coarse sand sediments. They are low- to moderate-energy environments with relatively low biological diversity. However, birds, wildlife, and humans make extensive use of them. Oil coming ashore on a sandy beach may penetrate into the sand, the depth of penetration depending on the viscosity of the oil and the porosity of the sandy sediments. The oil may be buried by new sand or eroded from the surface of the beach, depending on whether the beach is building or receding.

Oil that comes ashore on a sandy beach is usually removed easily from the shoreline with mechanical equipment. Removal of oil-contaminated sand from the shore may alter the shore profile. The natural shore profile may be restored naturally by along-shore transport of sand or it may require beach renourishment. Thus, spilled oil on the sandy shore usually is less persistent and damaging than oil on other types of shorelines. Impacts from spilled oil on coastal habitats is expected to range from adverse but not significant to significant, depending upon the volume of spilled oil, distance from the spill site to shore, and the nature of coastal habitats.

Summary: On a local basis, oil spills from FPSO operations will produce either adverse (but not significant) or significant impacts on coastal barrier beaches, depending upon spill size, the nature of the oil coming ashore (e.g., highly vs. lightly weathered) and location and the characteristics of the barrier beach. Impacts may be long term, depending upon spill location and relative position of sensitive resources. Spill frequencies are low (i.e., probability of large, nearshore spills is low). At all offshore locations modeled, smaller spills are not predicted to reach shore.

Wetlands

Wetlands, consisting primarily of salt marshes, may be located shoreward of barrier beaches in bays, or they may be in direct contact with the open coastal waters. Wetlands located behind barrier beaches provide a wide variety of habitats important to terrestrial, estuarine, and marine organisms and are common along most of the Texas coast. Coastal wetlands are encountered more frequently along the Louisiana coast. Barrier beaches become more prominent again to the east along the coasts of Mississippi, Alabama, and Florida, and many wetlands have developed behind the barrier beaches of this region.

The highest probability of crude oil from an FPSO or shuttle tanker spill coming ashore in a coastal wetland is within land segments 3 through 10 and 19, including shores between Kenedy County, Texas, and Cameron Parish, Louisiana, and Plaquemines Parish, Louisiana (tables 4-52 and 4-53). The probability of spill contact with a coastal wetland generally decreases from west to east, with the exception of a spill from the Mississippi Canyon launch point (MC1) or offshore area 6 contacting land segment 19, the shore in Plaquemines Parish, Louisiana. The highest probability for oil contact is from a 10,000 bbl spill of crude oil from a shuttle tanker (i.e., at launch point T17) reaching land segment 10 (the shoreline of Chambers and Jefferson Counties, Texas) within 30 days. The combined probability of oil spill risk (over the life of the project) for this event is 8.0×10^{-3}. The highest probability of a spill from a FPSO contacting a coastal wetland is for a spill of 1,000 bbl of crude oil from launch point MC1 coming ashore in land segment 19 (Plaquemines Parish, Louisiana). The combined probability of oil spill risk for this event is 0.26. These probabilities of a spill contacting a coastal wetland are low; thus, the risk of damage to these important resources from a spill is low.

Wetlands located behind barrier beaches are much less vulnerable to offshore oil spills than coastal wetlands. Much of the oil drifting toward shore will be intercepted by the barrier beach. Net water flow through the channels between the ocean and protected waters behind the barrier beach often is toward the sea, impeding inward drift of an oil slick. However, oil slicks can enter bays and estuaries on the incoming tide. Because any spill from a FPSO or offshore shuttle tanker will require several days to drift to shore, spill response personnel are likely to have adequate time to deploy booms across entrance channels or treat the spill in various ways to remove it from the sea surface before it reaches shore.

Wetland habitats are more sensitive than barrier beaches to adverse effects from oil spills. Should oil from a spill on a FPSO or shuttle tanker reach a coastal wetland or wetlands located behind a barrier beach, it is probable that the wetland would be harmed. Although there have been many studies of the effects of oil spills on coastal wetlands, particularly salt marshes, there is little consensus about the long-term effects of the oil and the rate of recovery of the affected wetland. Oil may come into the marsh on the incoming tide and coat the surface of marsh grasses, particularly near the edge and channels. The coated grass may suffer some above-ground die-back. If oiling of the marsh is heavy, some of the oil, particularly if it is relatively fresh, may contaminate the marsh sediments, damaging the roots of marsh grasses. Marsh sediments often contain a high concentration of organic matter that tends to bind to the oil, slowing its release from the sediments. The persistence of oil in marsh sediments is directly related to the concentration of organic matter in the sediments. Oil may persist in high-organic matter marsh sediments for decades. If oiling of marsh sediment is high, marsh grasses may be killed outright. Destruction of the marsh grasses renders the marsh sediments vulnerable to erosion. Marsh grasses will recolonize affected sediments only if the tidal height of the sediment surface is optimal for the species of marsh grass. Thus, destruction of marsh grass by oil may cause erosion and permanent loss of part of the salt marsh.

The amount of oil required to cause injury to salt marsh habitat varies with the type of oil and its extent of weathering. MMS (1998b) assumed that 0.1 liter/m^2 of oil would cause long-term impacts to Louisiana salt marshes. Texas salt marshes are considered more stable and an estimated 1.0 liter/m^2 may be required to cause long-term damage. Concentrations lower than these are expected to cause die-back of the above-ground vegetation for one growing season, but limited mortality. Higher concentrations may cause mortality of the oiled grasses, but 35 percent of the affected area can be expected to recover within four years. Oil may persist in the wetland soil for at least five years. After 10 years, permanent loss of about 10 percent of the affected wetland area is expected as a result of accelerated land loss indirectly caused by the spill. Accelerated erosion of wetland soils is possible along the exposed boundaries of coastal wetlands.

MMS (1998b) proposed the following model based on these assumptions. For every 50 bbl of oil contacting the wetland, approximately 2.7 hectares (ha) of wetland vegetation will experience die-back. Thirty percent of these damaged wetlands may recover within four years, while 85 percent of affected wetland areas will recover within 10 years. About 15 percent of the contacted wetland are expected to be converted to open-water habitat.

A 1,000-bbl oil spill from a FPSO (the most likely size) would weather to a volume of 220 to 350 bbl (table 4-62) by the time it reached a coastal wetland in Louisiana in 30 days. The oil would probably be weathered to the point where it would not be able to penetrate far into the marsh. However, if it did, as much as 19 ha of marsh grass may suffer at least temporary die-back. About 16 ha of the affected marsh grass would recover within 10 years, and nearly 3 ha (about 7.4 acres) would not recover, reverting instead to open-water habitat. As discussed above, the combined probability of oil spill risk (over the life of the project) for a spill of this size from an offshore FPSO contacting a coastal marsh is about 0.26 or less. Thus, the ecological risk to coastal marshes of oil spills from FPSOs is very low.

Summary: On a local basis, oil spills from FPSO operations will produce either adverse (but not significant) or significant impacts to wetlands, depending upon spill size, the nature of the oil coming ashore (e.g., highly vs. lightly weathered) and location of the wetland. Impacts may be long term, depending upon several factors including spill location, degree of oil weathering, and organic content of marsh sediments. Spill frequencies are low (i.e., probability of large, nearshore spills is low). At all offshore locations modeled, smaller spills are not predicted to reach wetlands.

Seagrass Beds

Seagrass beds occur in the western Gulf of Mexico, mainly in bays behind barrier islands where they are protected from offshore oil spills. In the eastern Gulf of Mexico, there are extensive shallow offshore seagrass beds stretching from the Florida panhandle south along the coast intermittently to the Straits of Florida. The probability of an oil spill from a FPSO or shuttle tanker drifting into the seagrass beds off the west Florida coast is very low (i.e., <0.5 percent; see tables 4-37 through 4-44). Thus, the ecological risk to the seagrass also is low.

Summary: On a local basis, oil spills from FPSO operations are not expected to produce either adverse (but not significant) or significant impacts to seagrass beds. Probabilities for spilled oil reaching Florida seagrass beds are very low. Smaller spills from FPSO locations offshore are not predicted to reach shore.

4.4.4.4 Offshore Environments

As discussed previously in Section 4.4.4.2, the risks of adverse impacts on water and sediment quality from oil spills from offshore FPSOs and shuttle tankers are low; impacts, if they do occur, will be minor (i.e., adverse but not significant) and of short duration.

Offshore environments of concern include state coastal waters (5 to 19 km [3 to 12 mi] from shore, depending upon the jurisdiction), important offshore habitat areas (menhaden spawning grounds, Big Bend seagrass beds, Chandeleur/Breton Sound, Florida Middle Ground, Florida Keys, Florida and Yucatan Straits), and offshore banks and reefs. Deep-water chemosynthetic communities also are of concern; however, there is no risk that oil from a spill from a FPSO will come in direct contact with a deep-sea chemosynthetic community. It is important to protect these habitats because of their unique features and high habitat quality and importance.

State Offshore Waters

The offshore habitats most likely to be contacted by crude oil from a spill from a FPSO or shuttle tanker are (in order of decreasing frequency) Texas state offshore waters, Louisiana state offshore waters, western and central menhaden spawning grounds, and Flower Garden Banks National Marine Sanctuary (table 4-45). Stetson and Sonnier Banks and Florida panhandle state offshore waters may be contacted less frequently Texas state offshore waters lie within 19 km (12 mi) of the coast; Louisiana state offshore waters lie within 5 km (3 mi) of the coast (Section 4.4.2, figure 4-13). These coastal waters are important habitat to a large number of invertebrates, fish, reptiles, and birds of commercial or intrinsic value to the people of Texas and Louisiana. Oil drifting through these state offshore waters may harm local marine plants and animals if the organisms are exposed directly to the oil or oil fractions.

The highest conditional probability (86 percent) of a spill from an offshore launch point contacting state offshore waters is for a spill from the FPSO launch point off Corpus Christi (CC2) contacting Texas state offshore waters within 30 days (table 4-37). The frequency of spills of all sizes from FPSOs is 0.52/year. Thus, the combined probability of oil spill risk (over the life of the project) for a spill from CC2, approximately 117 km (73 mi) southeast of Corpus Christi, Texas, may contact Texas state waters within 30 days is 9.0. Most of these spills will be smaller than 1,000 bbl.

By the time the slick from such as spill drifted into Texas state offshore waters (a distance of at least 101 km [63 mi]), dissolution or dispersion of petroleum into the water column would be complete. There would be very little oil dissolving or dispersing from a surface slick into the water column of Texas state offshore waters. Thus, water column organisms are unlikely to be exposed to potentially toxic concentrations of petroleum hydrocarbons in the water column. A spill from the FPSO launch point in Mississippi Canyon (MC1) has a four percent chance of reaching Louisiana state offshore waters in three days. Some petroleum could still be dissolving and dispersing from the surface slick after three days. Thus, petroleum hydrocarbon concentrations in the water column in the vicinity of a slick in Louisiana state offshore waters, probably off Plaquemines Parish, probably would be elevated above background concentrations. owever, it is highly likely that concentrations would be well below those known to be toxic to marine plants and animals.

Menhaden Spawning Grounds

The Gulf menhaden (*Brevoortia patronus*) is extremely abundant in coastal and offshore waters of the western Gulf of Mexico where is supports a large commercial fishery. Menhaden spawn in offshore waters, mostly during the winter months. Two winter spawning areas have been designated for menhaden, both off the coast of Louisiana. The western winter menhaden spawning grounds is located off central Louisiana and the central winter menhaden spawning grounds is located closer to shore southwest of the Mississippi River delta (figure 4-13).

There is concern that an oil spill could cause serious harm to local menhaden populations, particularly to eggs and larvae, at the times of the spawning aggregations. Gulf menhaden spawn in offshore waters, particularly off Louisiana, in the winter.

The conditional probability that a spill from one of the eight launch points may contact the western winter menhaden spawning grounds ranges from less than 0.5 percent to 40 percent. The conditional probability that a spill may contact the central winter menhaden spawning grounds ranges from less than 0.5 percent to 18 percent (table 4-45). The highest probabilities of spilled oil contact with the spawning grounds are for spills from 1) the FPSO site in the Green Canyon lease area (i.e., GC1), about 154 km (96 mi) south of the central Louisiana coast; and 2) the FPSO site in the Mississippi Canyon lease area (i.e., MC1), about 85 km (53 mi) southeast of the mouth of the Mississippi River. There is a five percent conditional probability that a spill from GC1 may contact the western winter menhaden spawning grounds within three days (table 4-40), and a one percent conditional probability that a spill from MC1 may contact the central winter menhaden spawning grounds within three days (table 4-42). Spills from GC1 may be expected to contact the western winter menhaden spawning grounds more frequently in the spring and summer than in the autumn and winter (table 4-48). However, spills from MC1 are expected to contact the central winter menhaden spawning grounds most frequently in the autumn and winter, and less frequently in the spring and summer (table 4-49). The conditional probabilities that a spill from Green Canyon or Mississippi Canyon lease areas (GC1 or MC1) may contact the western or central winter menhaden spawning grounds within three days in the winter (spawning season) are five percent and one percent, respectively.

The most likely spill size from FPSOs is <10 to 1,000 bbl. Spills of this volume have a high likelihood of persisting on the sea surface for at least three days, but probably not for 20 or 30 days. The estimated frequency of 1,000-bbl spills from FPSOs is $1.2x10^{-1}$/year (table 4-55). Thus, the combined probability of oil spill risk that a spill from these two FPSO sites may contact one of the winter menhaden spawning grounds is 0.024 to 0.12. This low probability indicates that the risk to spawning menhaden and their eggs and larvae of exposure to potentially toxic concentrations of petroleum spilled from a FPSO is very low.

Spills from the modeled shuttle tanker launch point (i.e., T17, in the West Cameron South lease area) are most likely to contact the western or central winter menhaden spawning grounds in the spring or summer (tables 4-48 and 4-49). A spill at T17 has a four percent conditional probability of contacting the western winter menhaden spawning grounds within 30 days. The combined probability of oil spill risk (over the life of the project) for spills of 10,000 bbl, 100,000 bbl, or 500,000 bbl reaching the western winter menhaden spawning area within 30 days in the winter are 2.8×10^{-3}, 8.8×10^{-4}, and 1.1×10^{-4}, respectively. Thus, spills from shuttle tankers do not represent a significant risk to the winter menhaden spawning grounds.

As discussed previously, even after a large spill, very little petroleum gets into the upper water column in dissolved or dispersed form. Most dissolution and dispersion from a surface oil slick occurs in the first few days after a spill occurs. Oil from an FPSO spill or from a shuttle tanker transporting crude oil from a FPSO to shore will require several days to drift to the winter menhaden spawning grounds, by which time dissolution and dispersion from the surface slick will be minimal. Thus, concentrations of dissolved and finely dispersed petroleum hydrocarbons in the water column under an oil slick reaching the winter spawning grounds from a FPSO or shuttle tanker will be very low, probably well below concentrations that might be harmful to the sensitive early life stages of menhaden.

Topographic Features

Topographic features or topographic highs occur along the outer edge of the continental shelf in the western and central Gulf of Mexico (Section 4.4.2, figure 4-13). They are geologic features elevated above the general seafloor and support diverse reef communities. The best-known of these topographic features are the East and West Flower Garden Banks that were recently designated as a national marine sanctuary.

Spills from the eight launch points have a conditional probability of less than 0.5 percent to ten percent of contacting the Flower Garden Banks National Marine Sanctuary within 30 days (table 4-45). The conditional probability of oil spill contact with Stetson Bank, Cuban reefs, or Sonnier Banks are lower, in the range of less than 0.5 percent to 5 percent. The highest conditional probability is for a spill from the shuttle tanker route launch point (T17) contacting the Flower Garden Banks within 30 days.

The combined probability of oil spill risk (over the life of the project) for 10,000-bbl, 100,000-bbl, or 500,000-bbl oil spills from T17 contacting the Flower Garden Banks within 30 days are 7.2×10^{-3}, 2.2×10^{-3}, and 2.8×10^{-4}, respectively. Spills from the FPSO launch points are unlikely to reach any of the topographic features of concern within three days. Because spills from FPSOs are likely to involve less than 1,000 bbl of crude oil and are likely to dissipate within a few days, the risk to topographic features from spills from FPSOs is very low.

Although spills from shuttle tankers may reach the topographic features on rare occasions, there is little risk of harm to the reef communities they support from the spilled oil. The tops of the topographic features usually are more than 15 m (49 ft) below the sea surface. Weathered oil rarely if ever can be driven that deep into the ocean by wave action. Thus, exposure concentrations of petroleum hydrocarbons to reef plants and animals, if a spill occurs and drifts over a topographic feature, will be very low, substantially lower than concentrations required to harm reef organisms.

Summary: Oil spills from FPSO operations will produce either negligible or adverse but not significant impacts to offshore environments, including state offshore waters, menhaden spawning grounds, and topographic features. Oil will not reach topographic features, while oil reaching state offshore waters or menhaden spawning grounds will be weathered. Any impacts are projected to be short term.

4.4.4.5 Marine Mammals

A total of 29 species of marine mammals have been reported from the U.S. waters of the Gulf of Mexico, including 28 cetaceans and one sirenian. Six of the cetaceans (all "great whales") are listed as Federally endangered species. The sperm whale is the most common of the endangered whales in the Gulf and the only endangered toothed whale. The five remaining endangered baleen whales (i.e., right, blue, fin, sei, and humpback whales) are extremely rare in the Gulf of Mexico and probably are accidental strays to Gulf waters. Most sightings (including strandings) of endangered baleen whales have been of individuals in coastal and offshore waters between Galveston, Texas, and Tampa, Florida (Jefferson *et al.*, 1992). They probably are stragglers from the migratory populations in the Atlantic Ocean and Caribbean Sea.

Two non-endangered baleen whales, the minke and Byrde's whales, also have been sighted in the Gulf of Mexico. While minke whales sighted in the Gulf may be strays from the Atlantic populations, there appears to be a resident population of Byrde's whales that congregates along the shelf edge in the northern Gulf of Mexico. All the other cetaceans in the Gulf are odontocetes (toothed whales), including dolphins and beaked whales.

The one predominant sirenian in the Gulf, the West Indian manatee, is listed as endangered. It is distributed in the Gulf all along the west coast of Florida from about Cedar Key south to the Florida Straits in shallow coastal waters. Occasional sightings of manatees have been noted westward along the coast, occasionally as far as Texas. Manatee sightings in Texas waters may represent strays from the Antillean manatee population. West Indian manatees are restricted in the Gulf, primarily to Florida coastal waters where the risk of contact with oil from a spill on a FPSO or shuttle tanker is very low.

Different cetacean species are widely distributed in coastal and offshore waters throughout the Gulf of Mexico. Some species, including the endangered sperm whale, may occur seasonally along the shelf edge in the general area where FPSOs and shuttle tankers may operate, although more precise determinations of seasonal distribution for these species remain to be established . Other species that occupy outer shelf and slope waters include the dwarf and pygmy sperm whales, several species of beaked whales, short-finned pilot whales, Risso’s dolphins, melon-headed whales, false killer whales, pantropical spotted dolphins, rough-toothed dolphins, striped dolphins, spinner dolphins, and bottlenose dolphins. Should an oil spill occur from a FPSO or shuttle tanker, there is a high likelihood that some individuals of one of more of these species would be exposed to the resulting oil slick on the sea surface, hydrocarbon vapors in the air over a fresh oil slick, or petroleum dispersed and dissolved oil in the water column.

Cetaceans and sirenians may be exposed to oil in several ways, including inhalation of hydrocarbon vapors, direct contact between oil and the skin, ingestion of oil droplets or contaminated prey, and fouling of baleen plates (Geraci and St. Aubin, 1987; Geraci, 1990; Volkman *et al.*, 1994; Loughlin *et al.,* 1996). Whales and dolphins apparently can detect oil slicks on the sea surface, but do not always avoid them; the behavioral responses of sirenians to oil is not known.

Following the *Mega Borg* crude oil spill in the western Gulf of Mexico, bottlenose dolphins did not consistently avoid the oil slicks (Smultea and Würsig, 1995). Several species of cetaceans were observed swimming and feeding in oiled areas of Prince William Sound, Alaska, shortly after the *Exxon Valdez* oil spill (Harvey and Dahlheim, 1994). Humpback whales were abundant in spill-path areas of southwestern Prince William Sound during the summer after the spill, but were not observed to come in direct contact with oil slicks (Von Ziegesar *et al.,* 1994). Because cetaceans apparently do not avoid oil slicks, they may be vulnerable to inhalation of hydrocarbon vapors.

Cetacean skin is highly impermeable to oil and is not seriously irritated by brief exposure to environmentally realistic amounts of oil (Geraci, 1990). However, if a cetacean surfaces in a slick of fresh oil, it may inhale hydrocarbon vapors, possibly leading to irritation and congestion of the lungs and bronchi, with the further possibility of developing pneumonia. Absorption of volatile hydrocarbons through the lungs can lead to liver damage and may be a greater hazard to cetaceans than ingestion of oil or oil-contaminated prey (Geraci, 1990). Vapor concentrations of volatile hydrocarbons may be high enough just above a fresh slick (particularly if the oil is a light crude, a condensate, or a light or middle distillate fuel) to cause systemic damage for a few hours after a spill (see Section 4.4.4.1). Between September 1988 and March 31, 1989, seven days after the *Exxon Valdez* oil spill, the size of the AB pod of resident killer whales in southwestern Prince William Sound decreased from 36 to 29 individuals. An additional six killer whales were missing between September 1989 and June 1990 (Dahlheim and Matkin (1994). Loughlin *et al.* (1996) hypothesized that the initial loss of killer whales was caused by sudden death from inhalation of toxic vapors. They also hypothesized that the subsequent whale deaths could have been caused by complications associated with mucus membrane damage, including damage to airways. However, there is no direct evidence that any of the killer whales were killed by the spill, and alternative explanations of their disappearance have been suggested (Dahlheim and Matkin, 1994; Spies *et al.,* 1996).

There is no evidence that ingestion of oil as droplets or contaminated prey represents a significant risk to baleen and toothed cetaceans. Fouling of the baleen feeding apparatus of baleen whales has not been observed; if it does occur, it is probably transitory and not debilitating to the whale. Preferred prey items are not likely to be heavily contaminated enough to pose a significant health risk to cetaceans. Zooplankton are likely to become more heavily contaminated than fish. Thus, there is a higher likelihood that plankton-feeding baleen whales will ingest larger amounts of oil with their food than odontocetes will (Würsig, 1990). As discussed above, baleen whales, other than Byrde’s whale, are extremely rare in the Gulf of Mexico and so are unlikely to encounter oil-contaminated zooplankton prey. Byrde’s whales feed primarily inshore (i.e., over the shelf) on a mixed fish and zooplankton diet; as a result, this species has a low risk of ingesting a harmful amount of oil in its food. Most of the deepwater odontocetes feed primarily at great depths on cephalopods and fish. Their prey is unlikely to become contaminated with oil following a spill.

The predicted frequency of crude oil spills from FPSOs is about 0.5/year (table 4-55). However, most FPSO spills involve less than 1,000 bbl of oil. Such small spills are unlikely to pose a serious risk to cetaceans, because the animals can easily avoid them, and concentrations of hydrocarbon vapors over the spill are unlikely to get very high. Predicted frequencies of larger spills from FPSOs are very low. The expected low frequency of larger offshore FPSO spills coupled with the relatively low abundance of cetaceans in deep offshore shelf edge and slope waters indicates that the risk to cetaceans from large spills from FPSOs is low. Risks from shuttle tanker accidents also are low. Should they occur, however, larger catastrophic spills may seriously affect marine mammals that may be present and pass through the slick. Loss of a single individual from a listed species is considered significant.

There is very little information about the effects of spilled oil on manatees or their close relatives, dugongs (St. Aubin and Lounsbury, 1990). Dugongs were found dead along the shores of the Persian Gulf (Arabian Gulf) following the Nowruz oil spill of 1983 and the massive oil spill into the gulf during the 1991 Gulf War (Preen, 1991, as cited in MMS, 1997b; Sadiq and McCain, 1993), however, it is uncertain if they succumbed as a result of oil exposure. Some dugongs were observed alive in contact with sheens from the Gulf war (Pellew, 1991). Like cetaceans, sirenians are likely to be harmed by spilled oil through inhalation of hydrocarbon vapors, ingestion of oil or oil-contaminated food, and dermal contact with floating oil. Oil contamination and destruction of the aquatic vegetation that they consume could also lead to nutritional stress. Manatees congregate in shallow estuarine and freshwater areas along the central to south coasts of Florida, habitats that are not likely to be oiled by an offshore oil spill. However, should oil from a spill from a FPSO or shuttle tanker drift into manatee habitat, the manatees and their preferred foods are likely to become oiled. It is unlikely that such encounters would be lethal to the manatees unless the amount of oil was very large.

Crude oil slicks from spills on FPSOs and shuttle tankers in the eastern and central Gulf of Mexico are unlikely to drift into the preferred habitat of manatees. There is a low conditional probability (1 to 2 percent) that a spill from a FPSO at the launch point in the Atwater Valley Lease area (i.e., AT5; about 220 km (137 mi) southeast of the mouth of the Mississippi River) would reach coastal waters of south Florida in 20 to 30 days (table 4-43). However, for those FPSO spills that are large enough to persist on the sea surface until they drift into Florida waters are very rare. Therefore, the risk to manatees of spills from FPSOs is very low.

Summary: Mysticetes (baleen whales) are considered more likely to be affected by an oil spill than odontocetes due to feeding mechanisms and preferred prey. Manatees are distributed well east of the projected trajectories of FPSO-related spills and live in shallow estuarine and freshwater habitats that are unlikely to be heavily oiled by a spill from a FPSO. Small oil spills are unlikely to produce significant impacts to marine mammals. While larger spills are very rare, should they occur, impacts are potentially significant, of regional importance, and long term. Spill frequencies for larger spills are very low, reducing the risk of impact to marine mammals from an oil spill.

4.4.4.6 Sea Turtles

Five species of sea turtles have been reported from U.S. waters of the Gulf of Mexico. These species are the leatherback sea turtle, Kemp's ridley sea turtle, loggerhead sea turtle, green sea turtle, and hawksbill sea turtle. The U.S. Department of the Interior, under the authority of the Endangered Species Act, lists loggerhead and green sea turtles as threatened. (Note: Nesting populations of green turtles in Florida and Pacific Mexico are listed as endangered). The remaining three sea turtle species, leatherback, Kemp's ridley, and hawksbill, are listed as endangered throughout their range. Each of the five species has a unique distribution and natural history in the Gulf of Mexico. Therefore, risks of injury to populations of different species from oil spills from FPSOs and shuttle tankers are different.

Loggerhead sea turtles are the most abundant sea turtles in the Gulf of Mexico and occur all along the coast of the Gulf of Mexico, particularly in the summer. Largest numbers are in coastal waters of central west Florida. Most nesting in the Gulf occurs between the end of April and the beginning of October along the west coast of Florida between the Florida panhandle (especially in Gulf and Franklin Counties) and south Florida. Some nesting also occurs on barrier beaches in Alabama and Mississippi, in the Chandeleur Islands, and along the south Texas coast. Subadult and adult loggerhead turtles occupy shallow coastal and estuarine waters as well as outer continental shelf waters, including the banks off the Louisiana coast (USDOI, MMS, 1996) where they forage primarily on demersal prey.

Green sea turtles are quite rare in the Gulf of Mexico. They are associated primarily with shallow (about 4 m) seagrass beds, their primary diet, along the south Texas and west Florida coasts. Important feeding areas for green sea turtles on the west coast of Florida include Florida Bay, Homosassa, Crystal River, and Cedar Key (NMFS and USFWS, 1991a). The largest population of green turtles in Texas is found in the lower Laguna Madre near Port Isabel; they also frequent the seagrass beds in Matagorda Bay. During more than 7,000 monitoring hours at 131 explosive removals of offshore oil and gas platforms in the northwestern Gulf of Mexico, 16 turtles were observed, of which one was identified as a green turtle (Gitschlag *et al.*, 1997), giving an indication of the low abundance of green turtles in offshore waters of the northwestern Gulf of Mexico. Limited nesting of green turtles occurs on exposed sandy beaches in southwest Florida and northwest Florida, particularly in Okaloosa County (Lewis *et al.*, 1996).

Hawksbill turtles are the most tropical of the sea turtles and only occur in U.S. waters of the Gulf of Mexico as stragglers from more southerly waters of the Gulf of Mexico, Mexico, and Caribbean Sea (USDOI, MMS, 1996b). Strandings of hatchlings and yearling hawksbill turtles are common along the south Texas coast and occasionally as far north as Louisiana. They undoubtedly were carried north into U.S. waters by the northward coastal currents in the western Gulf.

Kemp's ridley sea turtle, probably the most severely endangered sea turtle in the world, is found mainly in the Gulf of Mexico (Hildebrand, 1982). The northern and northeastern Gulf of Mexico are prime foraging areas for juvenile, sub-adult, and post-nesting female ridleys (Marquez, 1994). They often are associated with portunid crabs, *Callinectes* spp., their favorite prey. Adults are restricted almost entirely to the Gulf of Mexico, where they range widely between northern (U.S.) and southern (Mexico) regions, but rarely east of Alabama in the northern Gulf (Pritchard and Marquez, 1973). Juveniles frequent coastal waters of the U.S. Gulf from Texas to Florida. In Texas, Kemp's ridley turtles are most abundant in coastal waters of the central and northeast coast, where they occur both landward of the barrier islands and offshore.

Leatherback sea turtles are a wide-ranging oceanic species that is sighted rarely in the Gulf of Mexico. Aerial and shipboard surveys performed by the NMFS in the Gulf of Mexico have reported sightings of 33 leatherbacks in offshore waters and 22 in nearshore waters (Mitchell *et al.*, 1994). Turtle stranding data suggest that leatherback sea turtles are more abundant in offshore waters of the eastern than the western Gulf of Mexico.

Hatchlings and early juveniles of all five species of sea turtles are pelagic/planktonic and usually seek out floating plant material (e.g., *Sargassum*) for cover and foraging. They drift with the seaweed for a year or longer before moving into coastal waters as late juveniles to feed.

Given the distribution of the five sea turtle species in the Gulf of Mexico and the predicted trajectories of oil spills from FPSOs and shuttle tankers, the most likely exposure scenarios involve oil slicks contacting Texas and Louisiana state offshore waters or coastal segments from south Texas to western Louisiana (land segments 1 through 12) during the summer. The highest conditional probability of a spill from a FPSO contacting one of these offshore or coastal resources is for a spill from the Corpus Christi lease area (i.e., launch point CC2) in the spring or summer (table 4-46). There is nearly a 100 percent conditional probability that such as spill may contact Texas state offshore waters within 30 days. The conditional probability decreases to 99 percent in 20 days and one percent in three days. There are similar conditional probabilities of spills from CC2 contacting land segments (all in Texas) in 3, 20, or 30 days. The estimate of probability-weighted spill occurrence of a 1,000-bbl spill (the most frequent spill size from a FPSO) reaching Texas state offshore waters or the Texas coast in 20 to 30 days is 0.12 spills/year (about 1 spill every 10 years). However, a 1,000-bbl spill is not expected to persist for 20 to 30 days on the sea surface. The estimate of probability-weighted spill occurrence of a spill reaching Texas state waters in the spring in three days is 0.001 spills/year.

Conditional probabilities of spills from the shuttle tanker spill launch point in West Cameron South (i.e., T17) contacting offshore waters or the coasts of Texas or Louisiana in the spring are lower (highest probability about 66 percent). The combined probability of oil spill risk (over the life of the project) of 10,000 bbl, 100,000 bbl, or 500,000 bbl of crude oil from a shuttle tanker reaching Texas state waters within 30 days are 0.04, 0.014, and 0.0018, respectively. Thus, the probability of contact between turtles in coastal waters of Texas and Louisiana and oil spills from FPSOs and shuttle tankers is very low.

If a sea turtle does encounter a large oil slick on the sea surface or a deposit of fresh or moderately weathered oil on the shore, there is a high probability that the turtle will suffer injury or death (Lutcavage *et al.*, 1995, 1996). Sea turtles usually do not avoid contact with oil on the sea or shore and may even seek out and ingest tar balls (Odell and MacMurray, 1986; Lohoefener *et al.*, 1989). A loggerhead turtle in the western Gulf of Mexico was observed to surface repeatedly within an oil slick for more than an hour (Lohoefener *et al.*, 1989). Leatherback sea turtles, in particular may ingest tar balls, mistaking them for their preferred prey of gelatinous zooplankton.

All species and life stages of sea turtles are vulnerable to injury from encounters with oil. Oil can adhere to the body surface and cling to the nares, eyes, and upper esophagus of sea turtles, causing contact dermatitis (Lutcavage *et al.*, 1995). When juvenile loggerhead turtles were exposed to a south Louisiana crude oil in the laboratory, they experienced acute contact dermatitis (Lutz *et al.*, 1986; Lutcavage *et al.*, 1995). Mucus membranes around the eyes, nose, and mouth were irritated and damaged by contact with the oil. Short-term contact with or ingestion of the oil caused significant changes in respiration, blood chemistry, energy metabolism, and diving behavior. Salt gland function was inhibited immediately after exposure to oil but returned to normal within two weeks. In the field, these responses to oil would cause a variety of sublethal physiological effects that may lessen the ability of the turtle to cope with normal environmental stresses. Inhalation of hydrocarbon vapors may cause respiratory pathology and systemic toxicity.

A total of 180 hawksbill turtles were reported killed by the 1983 Nowruz oil spill in the Arabian Gulf (Oil Spill Intelligence Report, 1983). About one percent of the sea turtle strandings identified on U.S. shores by the Seaturtle Stranding Network are attributed, all or in part, to oil (Lutcavage *et al.*, 1996). Approximately three percent of the turtle strandings in south Florida and three to more than six percent of the turtle strandings in Texas are attributed to oil fouling.

Turtle eggs incubating in nests in the supratidal sands of coastal beaches are sensitive to oil, and may suffer high mortalities if the oil covers the nest site or penetrates the sand and comes in contact with the eggs. Some of the crude oil from the Ixtoc I blowout in the Bay of Campeche, Mexico washed ashore at Rancho Nuevo, the only significant nesting beach for Kemp's ridley turtles (Fritts and McGehee, 1981). Eggs incubating in the oily sand hatched at about the same rate as unoiled control eggs. The oil washing ashore at Rancho Nuevo was highly weathered. When ridley turtle eggs were incubated in sand contaminated with fresh Ixtoc I oil, survival to hatching was greatly reduced. Because of the severely depleted status of Kemp's ridley sea turtles and the restricted nesting area and nesting season of the species, spilled oil that contaminates a nesting beach during the annual nesting period could decimate a year class of turtles, severely harming the dwindling ridley turtle population. Because of the direction of prevailing water currents, a spill from a FPSO in offshore waters of the U.S. Gulf of Mexico is not likely to reach Rancho Nuevo, about 300 km (186 mi) south of the U.S./Mexican border in Tamaulipas. The other species of sea turtles that nest along the shores of the Gulf of Mexico (i.e., loggerhead and green turtles) nest over a wider area, mostly along the west coast of Florida, and over a long nesting season. A spill from a FPSO that reached a nesting beach would not threaten an entire year class of turtles.

Shoreline cleanup activities may harm turtle nests and emerging hatchling turtles. Heavy vehicular traffic on nesting beaches, sand removal, berm relocation, and application of beach-cleaning agents can all adversely affect turtle eggs and nests (Lutcavage *et al.*, 1996). Shoreline cleanup activities may deter female turtles from coming ashore to nest, which may prevent eggs from becoming oiled. Female turtles can delay egg laying for a period of time without seriously affecting hatching success.

Newly hatched turtles are particularly vulnerable to oil. Because newly hatched early pelagic stages of three species (ridley, loggerhead, and green turtles) often congregate and feed in rafts of *Sargassum* weed, they are vulnerable to floating oil and tar balls that tend to collect in drift lines and convergence zones with the *Sargassum* (Carr, 1987). As part of the Sea Turtle Head Start Program, 1,325 newly hatched ridley turtles were released in 1982 at locations ranging from 6 to 10 km (3.7 to 6.2 mi) off the Texas coast in floating patches of *Sargassum* weed. More than 28 percent of the turtles washed ashore within 14 days of release, and most were coated with oil or had ingested tar balls, probably associated with the *Sargassum.* Plotkin and Amos (1990) estimated that more than 50 percent of young Kemp's ridley sea turtles are fouled by oil or tar.

Summary: If exposed to oil or tar balls, sea turtles and their eggs are at high risk of suffering significant injury or death, a significant impact given the listed status of all Gulf sea turtle species. The probability of exposure to oil from accidents on FPSOs and shuttle tankers is low. Thus, risk of significant impact is correspondingly low. Small oil spills are unlikely to produce significant impacts to sea turtles well inshore of FPSO operations. While larger spills are very rare, should they occur, impacts are potentially significant (i.e., affecting adults in coastal waters, smothering nests on nesting beaches), of regional importance, and long term. Spill frequencies for larger spills are very low, reducing the risk of impact to sea turtles from an oil spill.

4.4.4.7 Coastal and Marine Birds

Coastal and marine birds are considered among the most vulnerable animals to marine oil spills. Their use of the sea surface and intertidal zone where spilled oil tends to accumulate makes them vulnerable to exposure to oil following a spill. An estimated 250,000 marine and shore birds were killed by oil from the *Exxon Valdez* (Piatt and Ford, 1996). The *Braer* and *Sea Empress* spills in Great Britain, though much smaller than the *Exxon Valdez* spill, killed thousands of sea birds (Edwards and White, 1999; Kingston, 1999). There is no relationship between the volume (above a certain minimum amount) of oil spilled and the numbers of seabirds killed (Burger, 1993).

The main determinant of the effects of oil spills on sea and shore birds is contact. Birds that congregate in large numbers on the sea surface or in shore-side rookeries or that forage in large numbers in the intertidal zone are most vulnerable to marine oil spills. At least 42 seabird species and a similar number of coastal bird species inhabit offshore and coastal waters of the U.S. Gulf of Mexico on a permanent or seasonal basis. Most are migrants or seasonal visitors to the Gulf. None of the species typically congregate in vast numbers on the sea surface or in large rookeries on the shore.

There are four waterbirds and two shorebirds living along the coast of the Gulf of Mexico currently listed as endangered, including the eastern brown pelican, the Mississippi sandhill crane, the whooping crane, the wood stork, the eskimo curlew, and the piping plover. Of these endangered species, the pelican and the piping plover are the most vulnerable to harm from offshore oil spills from FPSOs. The pelican is a diving bird that can become contaminated with oil while diving for food; the piping plover may encounter oil from an offshore spill as it forages in the intertidal zone.

All the seabirds in the Gulf of Mexico tend to be dispersed over vast areas of the Gulf; none congregate in large numbers on the sea surface. Therefore, the risk of a massive bird kill from an oil spill in the Gulf of Mexico is much less than it is in more northerly climates where some seabirds form large rookeries. However, the wide distribution in oceanic and coastal waters of marine birds assures that, if there is a spill, some birds will be affected. There is insufficient information about seasonal distributions of marine and shore birds in the Gulf of Mexico to predict areas where the risk of contact between the birds and oil spilled from a FPSO or shuttle tanker is greatest. Generally, near-coastal and inner continental shelf waters of the central and western Gulf of Mexico support larger more diverse populations of marine birds than deep offshore waters of the outer continental shelf and slope. Bird populations in the immediate vicinity of FPSOs will be low. Locations where the probability of contact between spilled oil and marine and shore birds are highest are in state offshore waters and land segments of Texas and Louisiana.

The highest conditional probability of a spill from a FPSO contacting Texas or Louisiana state offshore waters or a land segment in these states is for a spill from the Corpus Christi lease area (i.e., launch point CC2) in the spring and summer (table 4-46). Spills from this source have a low probability of contacting Texas state offshore waters within three days and are not predicted to reach shore in three days. Thus, the combined probability of oil spill risk (over the life of the project) of a 1,000-bbl spill reaching Texas state waters or the Texas shoreline within three days is 0.02 or less. Spills from shuttle tankers, though expected to be larger than those from FPSOs, are expected to reach Texas or Louisiana state offshore waters or the coast even less frequently. Thus, the probability of contact between marine and coastal birds in coastal waters or shores of Texas and Louisiana and oil from spills on FPSOs or shuttle tankers is very low.

If marine or shore birds come in direct contact with crude oil on the sea surface or on the shore, there is a high likelihood that they will be seriously harmed or killed by the encounter. Direct contact with liquid oil usually is fatal; oiling of the plumage reduces the insulative and buoyancy properties of the feathers, causing the bird to lose body heat and die of hypothermia or sink and drown. Inhalation of hydrocarbon vapors causes serious and often fatal pathology of the lungs and upper respiratory tract. Ingestion of fresh crude oil during preening or feeding may cause a variety of systemic toxic effects. Weathered oil, such as that that birds might encounter from a spill from a FPSO, is less toxic (Stubblefield *et al.*, 1995). Bird embryos are extremely sensitive to fresh crude and refined oil applied to the shell (Leighton, 1990). Weathered crude oil is much less toxic.

Although direct contact with oil from a spill on a FPSO or shuttle tanker is likely to be harmful or lethal to marine and shore birds, the low probability that such encounters will occur reduces the risk of deepwater crude oil spills to these birds. Although the likelihood is high that some marine birds will be killed by a spill from a FPSO or shuttle tanker, it is highly unlikely that an ecologically significant fraction of the total local population will be affected.

Summary: If exposed to oil, coastal and marine birds might realize significant impacts. Large congregations, rookeries, and foraging are particularly sensitive. Endangered waterbirds and shorebirds are extremely susceptible to oil in the coastal and intertidal zones, where oil contact resulting in serious injury or mortality is a significant impact. The probability of exposure to oil from accidents on FPSOs and shuttle tankers is low. Thus, risk of significant impact is correspondingly low. Small oil spills are unlikely to produce significant impacts on coastal and marine birds inshore of FPSO operations. While larger spills are very rare, should they occur, impacts are potentially significant, of regional importance, and long term. Spill frequencies for larger spills are very low, reducing the risk of impact to birds from an oil spill.

4.4.4.8 Fish Resources

A great many species of marine and estuarine fish live in coastal and offshore waters of the Gulf of Mexico (Hoese and Moore, 1977, 1998). Many of them are of commercial or recreational importance. Oil spills may cause large fish kills in enclosed fresh and brackish waters. However, there have been no reports of large fish kills attributable to oil in open, well-mixed coastal and ocean waters (Teal and Howarth, 1984). As discussed previously, concentrations of petroleum hydrocarbons rarely reach high enough values or remain high for long enough in the water column, even under a surface oil slick, to cause serious harm to populations of adult fish.

Pelagic eggs and larvae, particularly those that float at or just below the sea surface, are vulnerable to oil pollution. These early life stages of fish are usually much more sensitive than the adults to toxic effects of crude oil (Capuzzo, 1987). Contact with oil on the surface or with dissolved or dispersed hydrocarbons in the upper water column may kill large numbers of embryos and larvae. Longwell (1977) reported increased mortality of floating cod and pollock eggs collected from the path of spreading Bunker C residual oil from the wreck of the *Argo Merchant* off Nantucket. Small specks of viscous oil adhered to may of the eggs, but not all died or produced deformed larvae. Pearson *et al.* (1985) reported that small oil droplets adhering to the surface of herring eggs were nearly always lethal to the embryos. However, natural mortality among planktonic eggs and larvae of marine fish and invertebrates is very high (McGurk, 1986). Oil-induced mortality is likely to be among the eggs and larvae that would have succumbed to environmental stresses, and will not be reflected in a decrease in the population size of adult fish.

Populations of open ocean pelagic fish are widely dispersed in offshore waters of the Gulf of Mexico. Numbers of pelagic and demersal fish of several species are much more abundant in coastal marine waters and estuaries of the Gulf. There is a low probability that crude oil spilled from offshore FPSOs and shuttle tankers will spread quickly into coastal and estuarine waters where fish are most abundant. As discussed in Section 4.4.2, dissolution and dispersion of petroleum from a surface slick of crude oil can adversely affect the quality of the underlying water. However, after the oil has weathered for several days, the viscosity of the oil increases to the point where oil droplets no longer are readily dispersed into the water column, and slightly soluble hydrocarbons become depleted in the slick so little is left for dissolution into the water column. Thus, by the time an oil slick from a deep offshore FPSO or shuttle tanker reaches nearshore waters, it has weathered to the point where little additional oil partitions or disperses into the water column under the slick. Fish in nearshore waters, even under a slick of weathered crude oil, will not be exposed directly to potentially toxic concentrations of petroleum hydrocarbons. Adverse impacts of an oil spill from a FPSO or shuttle tanker on fish populations in the Gulf of Mexico are expected to be low.

EFH Assessment

The proposed action, as detailed in Sections 1 and 2, encompasses the potential placement of one or more (up to five) FPSOs in the deepwater (i.e., >200 m [>656 ft]) areas of the Central and Western GOM. FPSO-produced oil will be tankered to one or more select Gulf ports, as detailed further in Sections 1 and 2. As noted in Section 4.4.1, there are risks associated with deepwater oil production and transport. While the probabilities of a medium- to large-sized spill associated with FPSO operations (i.e., FPSO production and storage, tanker transport) are extremely small, hypothetical oil spill impacts on EFH must be evaluated.

EFH encompasses both benthic and water column habitats and range from shelf to deeper slope depths, depending upon the species of interest (see table 3-16). As a consequence, potential degradation of these habitats is directly related to possible degradation of EFH. As discussed previously in Sections 4.4.4.2 (Water and Sediment Quality) and 4.4.4.4 (Offshore Environments), the risks of adverse impacts on water and sediment quality from oil spills from offshore FPSOs and shuttle tankers are low; impacts, if they do occur, will be minor (i.e., adverse but not significant) and of short duration.

For sediment quality, accidental oil spills from FPSO operations are expected to produce adverse but not significant impacts on a regional basis. Significant impacts would only be realized if oil were ignited prior to release (i.e., where spilled oil density greatly exceeds that of seawater), resulting in sinking oil reaching the benthos, where it could affect sediment quality. Given that sediment quality is an important component of EFH, similar impacts are predicted for EFH on the seafloor.

Oil spills from FPSO operations are expected to produce adverse but not significant impacts on ambient water quality on a regional basis. Impacts will be relatively short term (i.e., for the duration of the spill). Noting that water quality is also an important component of EFH, similar impacts are predicted for both water column and near-bottom EFH.

Summary: Because pelagic eggs and larvae of Gulf fishes are vulnerable to oil exposure, the loss of large numbers of embryos and larvae is an adverse but not significant impact, localized and short term in nature. Impacts to adults from oil exposure are not as severe. The probability of exposure to oil from accidents on FPSOs and shuttle tankers is low. Thus, risk of significant impact is correspondingly low.

4.4.4.9 Commercial Fisheries

Because approximately 46 percent of the wetlands and estuaries in the southeastern U.S. are located along the coast of the Gulf of Mexico (Mager and Ruebsamen, 1988), most of the commercial fish and shellfish resources in the Gulf are estuary-related. Estuaries and wetlands serve as nursery and growth areas for several species of commercial fish and shellfish. Estuary-related species of commercial importance include menhaden, sciaenids, mullets, shrimp, crabs, and oysters. Most of the offshore species of commercial importance are demersal, often reef-associated species. Estuary-related species are most abundant between east Texas and western Florida, with the center of abundance in coastal waters of central Louisiana (Darnell and Kleypas, 1987). Reef-associated fish are common in association with topographic features off Texas and Louisiana and around offshore oil platforms.

Populations of commercially harvestable fish in open well-mixed ocean waters are not particularly vulnerable to oil spills, as discussed previously. There have been no reports of economically significant adverse impacts of an oil spill on any commercial fishery (Teal and Howarth, 1984). Commercial catches of pink salmon and Pacific herring in Prince William Sound were higher in the years immediately after the *Exxon Valdez* oil spill than in the years preceding the spill (Pearson *et al.*, 1999; Wiens *et al.*, 1999). Although the oil killed some eggs, larvae, and juveniles, it had no effect of the size of the adult, harvestable stocks.

There was an immediate kill of a few thousand kilograms of fish, mostly of little economic value, in the vicinity of the wreck of the *Amoco Cadiz* on the northwest coast of

Brittany, France (Maurin, 1981). In the year after the spill, there were declines in the commercial catches for some species, such as mullet. However, this was due in part to decreased fishing effort by commercial fishermen who were worried about contaminating their boats and fishing gear with oil. Demersal fish, particularly several species of flounders and sole, in small estuaries (abers) where large amounts of oil collected after the spill were adversely affected by the spill (Desaunay, 1981). Commercial catches of these species were depressed for a short time after the spill, but returned to normal within one year. The surviving flatfish suffered impaired reproduction for about one year (Friha and Conan, 1981; Brule, 1987), and a variety of histopathological lesions for more than two years (Haensly *et al.*, 1982). However, this did not seem to adversely affect recruitment to the fishery stocks.

The abers affected by the oil spill are important mariculture areas for oysters. Although the oysters in the abers became heavily contaminated with oil, very few died. However, because of the heavy contamination, 1.6 million kg of surviving oysters were transferred to clean areas on the south coast of Brittany for depuration and an additional 6 million kg of oysters were destroyed (Maurin, 1984).

The National Research Council (1985) concluded, based on the scientific literature, that massive fish kills during oil spills probably have not occurred. Some mortalities have been observed at a number of spills, but generally only in limited areas, and then not in large amounts. Fish have the ability to move away from an impacted area, either laterally or by moving to a greater depth (whether in fact this occurs is still not known). If any large mortalities do occur, they probably occur in the egg and larval stages found in surface waters. However, natural mortality among pelagic eggs and larvae of fish is very high and additional mortality caused by oil or another agent of stress rarely is observed as a decrease in the year-class strength for that species in the commercial fishery (McGurk, 1986).

Mielke (1990) reviewed long-term effects of several oil spills. With respect to the *Argo Merchant* spill on Nantucket Shoals, he concluded that there is general agreement among post-spill investigations on the absence of serious economic damages (aside from the ship and cargo) resulting from the *Argo Merchant* incident. Persons in the area who were economically dependent on tourism, water transportation, and commercial fishing generally reported a good year. Mielke (1990) also reported that, following the Ixtoc I blowout and massive oil spill in the Bay of Campeche (Mexico), there were no reports of long-term impacts on fisheries resources in the U.S. or Mexico.

Mielke (1990) concluded that the short-term impact of a major spill can be devastating to the organisms in the immediate vicinity, including shellfish, finfish, marine mammals, and waterfowl. Experience thus far, however, would indicate that this has not made a noticeable impact on world population levels of any species. For species of shellfish, finfish, and waterfowl that are harvested, the mortality from on oil spill, so far as is known, has never come close to approaching the magnitude of the annual harvests. Recolonization of an area temporarily polluted from oil appears to be rapid for most species.

A major conclusion of the review of the *Impact of Oil and Related Chemicals on the Marine Environment* by the International Maritime Organization (IMO, 1993) was that oil spills have low or negligible impacts on fish populations. Significant impacts on local populations generally occur only in shallow waters with poor circulation. In such locations, only small proportions of total regional populations are usually affected.

Commercial fisheries often are closed by local fishery agencies following an oil spill because of a fear that the fish and shellfish will become heavily contaminated with oil residues (tainted), rendering them unpalatable or even hazardous to consumers. Significant tainting of commercial finfish resources rarely occurs, even after massive oil spills. However, bivalve molluscs may become heavily contaminated with oil residues, as occurred after the *Amoco Cadiz* oil spill.

The U.S. Food and Drug Administration (1990) has set a taste and odor threshold for low molecular weight PAHs (i.e., two- and three-ring) in edible fish tissues of 1,000 µg/kg (ppb). Threshold concentrations in water of petroleum compounds or products that can lead to tainting in finfish and shellfish range from about 100 ppb for kerosene and naphtha, to 250 ppb for toluene and ethylbenzene, to 1,000 ppb for naphthalene (Connell and Miller, 1981). These concentrations generally are much higher than concentrations found in the water column after a spill.

Tainting of fish was reported following a few large spills. Most of the accounts were anecdotal and there are few well-documented, scientifically rigorous observations (IMO, 1993). IMO (1993) concluded that, although large and small spills often result in closure of fisheries by regulatory authorities, there is little or no evidence of tainting of fish or shellfish, even by major spills. Where tainting has occurred, it usually has involved intertidal bivalve molluscs over a small area and for a short time (a few years at most) after the spill. This was the case after the *Amoco Cadiz* oil spill (Berthou *et al.*, 1987) and the *Exxon Valdez* oil spill (Hom *et al.*, 1996). Pelagic and demersal fish in the area affected by the *Exxon Valdez* oil spill never became heavily contaminated with petroleum PAHs (Hom *et al.*, 1996). Contamination of edible tissues of salmon and walleye pollock never reached levels that might pose a health risk to the salmon and pollock themselves or to human consumers of these fishery products.

As discussed previously, most of the commercially important fish and shellfish in the Gulf of Mexico are estuary-related during at least part of their life cycles. They usually remain in coastal waters where most of the fishery is concentrated. Many of the commercial species are demersal or benthic. Thus, they are at low risk for being exposed to potentially toxic concentrations of crude oil from a FPSO or shuttle tanker spill. Crude oil from a FPSO or shuttle tanker spill will undergo substantial weathering with loss of substantial mass and toxic fractions of hydrocarbons before contacting any commercial fishery areas. Any impact of a deep offshore oil spill on commercial fisheries species is expected to be small and short-lived; it is not expected to affect the harvestable populations or commercial fish and shellfish landings. The main impact of an offshore spill on commercial fisheries is likely to be closure of a local fishery by state agencies because of concern about contamination of the commercial fisheries resource.

Summary: Nearshore waters and estuarine environments are important habitat to commercially-important species. While pelagic eggs, larvae, and juveniles of commercially important fishery species are vulnerable to oil exposure, there are no apparent impacts to adult, harvestable stocks of those species where early life stages have been exposed to oil. Similarly, recruitment does not appear to be affected by oil exposure. Contamination of tissues of select fish species has minimal impact on health risk. Impacts to commercial fisheries from oil spills are adverse but not significant impact, localized, and short term in nature. The probability of exposure to oil from accidents on FPSOs and shuttle tankers is low. Thus, risk of significant impact is correspondingly low. Impacts to commercial fisheries associated with closure of a local fishery by state agencies following an oil spill are adverse but not significant, localized, and of relatively short duration.

4.4.4.10 Social and Economic Environment

The employment impacts of oil spills which reach landfall can vary widely. Such factors as total volume of oil reaching land, land area affected, and sensitivity of local environmental conditions to oil impacts can augment or moderate employment impacts. Overall, however, there are two industries that are most sensitive to the direct effects of landfall oil spills - primary resource extraction (excluding oil and mining activities) and tourism. Primary resource extraction (i.e., primarily fishing and supportive agricultural services) is directly impacted by environmental conditions. The specific effects of an oil spill on these activities are variable. However, jobs in this industrial category are clearly at risk from oil spills. Similarly, tourism is affected by the perceived aesthetics and recreational opportunities of the coastal environment. Landfall oil spills can have both short and long term effects on recreational coastal activities.

Areas that are projected to generate more jobs in these industries between 2000 and 2020 are considered be at a higher risk from oil spills, while areas with less employment growth potential in tourism and primary resource activity are less likely to be impacted. Potential oil spill impacts on labor markets have been determined through further analysis of potential employment growth through 2020 in oil impact sensitive industrial categories.

Projected employment in agricultural services, forestry and fisheries was derived from the labor force projection series detailed in Section 3.3.2. Projections of tourism and travel, which includes public transportation, auto transportation, lodging, food service, entertainment and recreation, general retail trade, and travel planning, is an extension of these projections.

Data estimates for employment growth trends in travel and tourism were reviewed for the period 1990 to 1997 as a means of projecting travel/tourism employment through 2020. Texas land segments (and corresponding counties) where oil spill contact (landfall) was projected to occur were evaluated, based on results of the OSRA modeling. For Louisiana, land segments (and corresponding parishes) were considered, however, parish-level tourism estimates were not developed. Instead, tourism employment projections were based on the average proportions of travel/tourism employment observed in the study of Texas counties. These proportions were used to estimate tourism employment in affected Louisiana parishes in 1990 and 1997. These estimates of growth were then extrapolated to 2020.

Figure 4-33 shows potential impacts on associated labor markets, based on equidistant land segments (and corresponding counties/parishes) where oil spills may make landfall. Table 4-63 shows projected employment in oil sensitive industries for each labor market. For the agricultural services, forestry and fisheries labor category, projected employment includes the entire multi-county labor market; within this industrial labor category, coastal impacts are likely to affect related jobs throughout the labor market area. For tourism and travel, however, projected employment growth was only evaluated for the affected coastal county since landfall oil spill impacts on tourism are likely to be highly localized.

On figure 4-33, labor markets that are not at risk of an oil spill reaching the coastline are categorized as “No impact.” Those labor market areas projecting one to four percent of future employment growth in these industries are categorized as being at risk of a slight employment impact; those labor market areas with five to 10 percent of future employment growth in these industries are categorized as being at risk of a moderate employment impact. Any labor market area with more than 10 percent of future employment growth in tourism and, agricultural services, forestry and fisheries are categorized as potentially at risk of a large employment impact.

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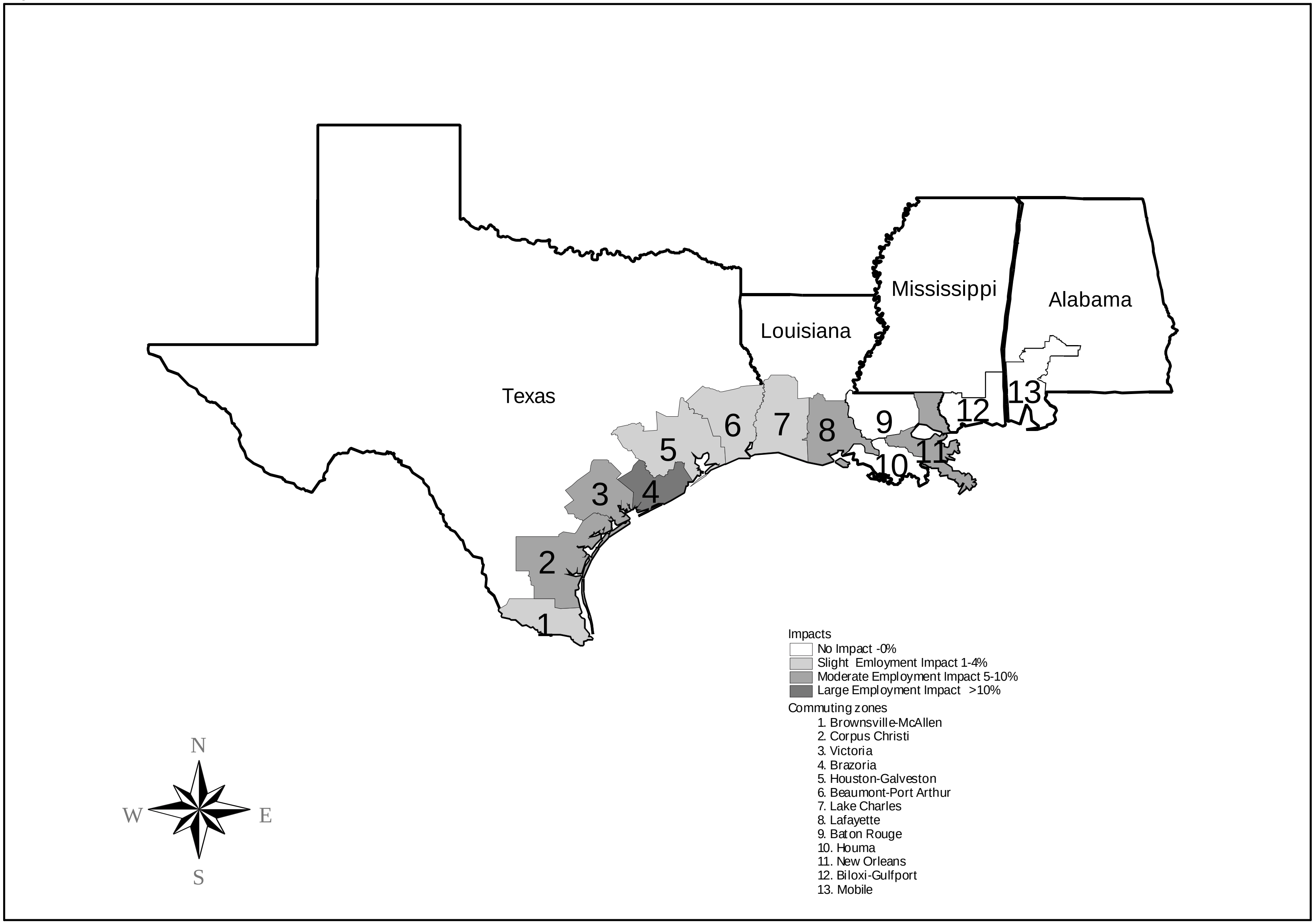

Figure 4-33 GULF COAST LABOR MARKET AREAS POTENTIALLY AFFECTED BY AN FPSO-RELATED OIL SPILL.

Table 4-63

Summary of coastal communities and impact sensitive employment sectors potentially affected by an oil spill from FPSO operations.

Coastal Commuting Zone	2000	2020	Change to 2020	% Change to 2020	Proportion of Change
New Orleans					
All-Industry Total	736,530	774,230	37,700	5.12%	100.00%
Ag Services, Forestry, Fisheries	10,000	12,670	2,670	26.70%	7.08%
Coastal Tourism/Travel	430	790	360	83.72%	0.95%
Impact Sensitive Employment	10,430	13,460	3,030	29.05%	8.04%
Percent Impact Sensitive	1.42%	1.74%			
Lafayette					
All-Industry Total	283,700	308,990	25,290	8.91%	100.00%
Ag Services, Forestry, Fisheries	3,250	3,860	610	18.77%	2.41%
Coastal Tourism/Travel	320	470	150	46.88%	0.59%
Impact Sensitive Employment	3,570	4,330	760	21.29%	3.01%
Percent Impact Sensitive	1.26%	1.40%			
Lake Charles					
All-Industry Total	180,430	191,690	11,260	6.24%	100.00%
Ag Services, Forestry, Fisheries	2,010	2,470	460	22.89%	4.09%
Coastal Tourism/Travel	60	60	0	0.00%	0.00%
Impact Sensitive Employment	2,070	2,530	460	22.22%	4.09%
Percent Impact Sensitive	1.15%	1.32%			
Beaumont-Port Arthur					
All-Industry Total	263,400	335,330	71,930	27.31%	100.00%
Ag Services, Forestry, Fisheries	3,530	5,670	2,140	60.62%	2.98%
Coastal Tourism/Travel	3,140	3,860	720	22.93%	1.00%
Impact Sensitive Employment	6,670	9,530	2,860	42.88%	3.98%
Percent Impact Sensitive	2.53%	2.84%			

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Table 4-63

Summary of coastal communities and impact sensitive employment sectors potentially affected by an oil spill from FPSO operations.

Coastal Commuting Zone	2000	2020	Change to 2020	% Change to 2020	Proportion of Change
Houston-Galveston					
All-Industry Total	2,400,990	2,983,930	582,940	24.28%	100.00%
Ag Services, Forestry, Fisheries	27,460	41,540	14,080	51.27%	2.42%
Coastal Tourism/Travel	9,080	14,970	5,890	64.87%	1.01%
Impact Sensitive Employment	36,540	56,510	19,970	54.65%	3.43%
Percent Impact Sensitive	1.52%	1.89%			
Corpus Christi					
All-Industry Total	274,640	327,200	52,560	19.14%	100.00%
Ag Services, Forestry, Fisheries	4,680	6,870	2,190	46.79%	4.17%
Coastal Tourism/Travel	440	780	340	77.27%	0.65%
Impact Sensitive Employment	5,120	7,650	2,530	49.41%	4.81%
Percent Impact Sensitive	1.86%	2.34%			
Brownsville-McAllen					
All-Industry Total	515,960	746,320	230,360	44.65%	100.00%
Ag Services, Forestry, Fisheries	15,190	20,390	5,200	34.23%	2.26%
Coastal Tourism/Travel	8,080	11,851	3,772	46.68%	1.64%
Impact Sensitive Employment	23,270	32,241	8,972	38.56%	3.89%
Percent Impact Sensitive	4.51%	4.32%			
Victoria					
All-Industry Total	83,800	97,660	13,860	16.54%	100.00%
Ag Services, Forestry, Fisheries	1,430	2,050	620	43.36%	4.47%
Coastal Tourism/Travel	540	1,060	520	96.30%	3.75%
Impact Sensitive Employment	1,970	3,110	1,140	57.87%	8.23%
Percent Impact Sensitive	2.35%	3.18%			

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Table 4-63

Summary of coastal communities and impact sensitive employment sectors potentially affected by an oil spill from FPSO operations.

Coastal Commuting Zone	2000	2020	Change to 2020	% Change to 2020	Proportion of Change
Brazoria					
All-Industry Total	168,790	206,020	37,230	22.06%	100.00%
Ag Services, Forestry, Fisheries	1,930	2,870	940	48.70%	2.52%
Coastal Tourism/Travel	11,440	21,310	9,870	86.28%	26.51%
Impact Sensitive Employment	13,370	24,180	10,810	80.85%	29.04%
Percent Impact Sensitive	7.92%	11.74%			

Of the 13 labor market areas considered in this analysis, four are not at risk of landfall oil spills: Mobile, Baton Rouge, Biloxi-Gulfport and Houma. Two other areas have been characterized as being low employment impact areas. The Lafayette area is projected to add relatively few jobs (760) between 2000 and 2020 in these potential impacted industries. Similarly, Lake Charles is projected to add a modest 460 jobs in these industries. Both labor market areas are projected to grow slowly over the next 20 years, with most of this growth concentrated in industries that are unlikely to be impacted by landfall oil spills. Therefore, a total of five labor markets are considered either zero or low employment impact areas.

In Texas, three labor market areas (i.e., Brownsville-McAllen, Houston-Galveston and Beaumont-Port Arthur) are expected to add considerable employment in these oil spill-sensitive industries. However, there is also rapid employment growth in other industries in these labor markets. As a result, oil spill-sensitive jobs contribute less than four percent to potential employment growth over the next 20 years. For these labor markets, therefore, the potential impacts on the economy of FPSO-related oil spills are slight.

Three labor markets have projected employment trends that make their economies moderately vulnerable to landfall oil spills, including New Orleans, Victoria, and Corpus Christi. In New Orleans, primary resource growth is an important part of its modest five percent total employment growth. Similarly, Corpus Christi, with much higher overall growth rates, has much of this projected growth concentrated in primary resource jobs. Victoria, with more than eight percent of its projected 13,860 job growth split relatively evenly between primary resource jobs and travel/tourism jobs, is similarly at risk of a moderate impact associated with FPSO-related oil spills.

The only high risk labor market identified in this analysis is Brazoria. The Brazoria labor market is heavily invested in travel/tourism employment. The approximately 11,000 current tourist-related jobs are expected to nearly double by 2020. These jobs are sensitive to oil spill-related impacts. With five of its constituent counties on the Gulf (i.e., Kenedy, Kleberg, Nueces, Aransas and San Patricio), the Brazoria labor market is more likely to be impacted by oil spills than other labor markets. Together, oil spill-sensitive employment constitutes nearly a third of Brazoria's potential employment growth over the next 20 years. For these reasons, Brazoria more than any other coastal labor market has the highest potential for oil spill impacts.

Based on employment statistics cited by MMS (1997b), shoreline cleanup operations along the Gulf coast require the temporary employment (i.e., six weeks, estimated) of 100 people for every kilometer of shoreline heavily oiled. Based on the results of oil spill modeling, several Texas coastal counties and Louisiana parishes may be affected by a large FPSO-based oil spill, although the severity of the oiling is difficult to predict. In addition, it is not possible to predict the linear extent of coastline potentially affected by a spill. As a result, total temporary employment caused by a spill cannot be predicted. Specific communities that could be affected by the temporary presence of spill cleanup workers cannot be identified. Given the relatively short duration of anticipated cleanup operations (e.g., six weeks), only adverse but not significant, relatively short term, and localized impacts are predicted on local infrastructure.

Summary: Of the 13 labor market areas evaluated, only the Brazoria area has a high potential for adverse but not significant impacts on oil spill-sensitive employment sectors. Oil spills are expected to have only negligible impacts on other LMAs. In the absence of definitive data regarding the extent and location of oiling along Gulf coast, impacts upon local infrastructure from cleanup operations is expected to be adverse but not significant, relatively short term, and localized.

4.4.4.11 Recreational Resources and Beach Use

As noted in Section 3.3.3, the coastal zone of Texas, Louisiana, and Mississippi is considered a major U.S. recreational region. Prominent recreational resources within this area include coastal beaches, barrier islands, estuaries, bays and sounds, river deltas, and tidal marshes, as well as nearshore and offshore marine waters. Such resources offer coastal visitors or residents exceptionally diverse opportunities for beach and waterways use.

Beaches are a major resource that attracts tourists and residents to the Gulf coast for a variety of activities. Beach use is a major economic component for many of the Gulf's coastal communities, especially during the peak use seasons (i.e., spring, summer). Tourism in the Gulf's coastal zone (i.e., Texas, Louisiana, Mississippi, Alabama, and Florida) has been estimated at $20 billion/year (USEPA, 1991, as cited in USDOI, MMS, 1997b). The scenic and aesthetic value of Gulf coast beaches plays an important role in attracting both residents and tourists to the coastal zone.

Oil spills from the seven offshore FPSO launch points and single shuttle tanker launch point have the highest probability of coming ashore within 30 days (table 4-53) along the Texas coast between land segments 1 through 11 (i.e., Willacy County in the south and Jefferson County in the north). Along the Louisiana coast, land segment 12 (Cameron Parish) had the highest conditional probability of shoreline contact at seven percent (table 4-53). Within the Texas coastal zone, there are 28 different recreational areas (Section 3.3.3 and table 3-38), the most prominent of which includes 1) Padre Island National Seashore (extending nearly 129 km [80 mi] along the coast, with visitation of approximately 900,000 people per year), and 2) nine separate National Wildlife Refuges (i.e., Aransas, Big Boggy, San Bernard, Brazoria, Moody, Anahuau, McFaddin Marsh, and Texas Point). In Cameron Parish, Louisiana, there are seven recreation areas noted, including the Sabine and Lacassine National Wildlife Refuges. Of greatest concern are those recreation areas located along barrier beaches, while estuarine areas or embayments are afforded some degree of protection from offshore oil spills by the presence of barrier islands.

Conditional probabilities of oil coming ashore on barrier beaches of Texas and Louisiana within 30 days are generally one percent or less; highest conditional probabilities are 20 percent or less (table 4-53). As discussed previously, most oil spills from FPSOs are expected to be small, ranging from <10 to 1,000 bbl. The frequency of larger spills from FPSOs is very low. Spills of less than about 1,000 bbl are expected to dissipate rapidly and would not reach shore unless they did so within the first several days after a spill. Given the distance of the FPSO launch points from shore, no spills are expected to contact shore within three days. As a result, impacts from small spills on coastal recreational resources are negligible.

The combined probability of oil spill risk (over the life of the project) that a larger, more persistent oil spill from an offshore FPSO may contact a particular shore segment in Texas or western Louisiana within 30 days is less than 0.01. Given this low probability of a spill contacting a barrier beach, the risk of spills from FPSOs to barrier beaches and associated recreational resources in the Gulf of Mexico is low.

Spills from shuttle tankers at sea are likely to involve 1,000 to 500,000 bbl of oil. Spills from a shuttle tanker (i.e., from launch point T17, in the West Cameron South lease area) are expected to reach land, mostly on barrier beaches between land segments 7 through 10 (i.e., Matagorda through Jefferson Counties, Texas, and Cameron Parish, Louisiana). Of the recreational resources present in this region, the most susceptible to offshore oil spills include several WMAs (i.e., Matagorda Island WMA, Guadalupe Delta WMA, Peach Point WMA, and J.D. Murphree WMA), NWRs (i.e., Big Boggy NWR, San Bernard NWR, Brazoria NWR, Moody NWR, Anahuau NWR, McFaddin Marsh NWR, Sabine NWR, and Lacassine NWR), and a series of state parks, beaches, and a single historical site. The combined probability of oil spill risk (over the life of the project) for accidental releases of 10,000, 100,000, or 500,000 bbl of oil from T17 is 0.054, 0.016, and 0.002, respectively. These low probabilities indicate that the risk to barrier beaches from oil spills from shuttle tankers is low.

Most barrier beaches in the Gulf of Mexico contain medium to coarse sand sediments. They are moderate- to high-energy environments with relatively low biological diversity, however, the aesthetic and recreational value of these areas is high. Oil coming ashore on a sandy beach may penetrate into the sand, the depth of penetration depending on the viscosity of the oil and the porosity of the sandy sediments. The oil may be buried by new sand or eroded from the surface of the beach, depending on whether the beach is building or receding. While oil beach sediments are usually easily removed via mechanical means, such shoreline activity is expected to effectively close the beach to public use for the duration of cleanup operations. If beach restoration is required (i.e., to restore the proper beach profile), additional time may be required before public access is allowed.

Impacts from spilled oil on recreational resources located along these barrier beaches is expected to range from adverse but not significant to significant, depending upon the volume of spilled oil, distance from the spill site to shore, season, and the nature and extent of beach cleanup operations, including the amount of time the beach may be closed. While protected areas inshore of barrier beaches may be less susceptible to oil spill impacts, should spilled oil reach into recreational areas within wetlands or protected embayments, impacts are expected to be significant, localized, and potentially long term.

One of the major recreational activities occurring on the OCS is offshore marine recreational fishing and diving. Recreational fishing is a major industry from Texas to Mississippi, accounting for an estimated $769 million in sales in the central and western Gulf (Sports Fishing Institute, 1988, as cited in MMS, 1997b). Impacts of oil spills on fishery resources has been evaluated in Section 4.4.4.8. In the case of a large offshore spill, skimming and support vessels will preclude access to a portion of offshore waters which may normally be used to support fishing activities. Such preclusion is expected to be relatively short term and localized; impacts are expected to be adverse but not significant.

Summary: On a local basis, oil spills from FPSO operations will produce negligible, adverse (but not significant), or significant impacts to recreational resources located along coastal barrier beaches and within protected embayments and wetlands of the western and central Gulf coast. Impact severity will depend upon spill size, the nature of the oil coming ashore (e.g., highly vs. lightly weathered), the location and characteristics of the recreational resource, season, the nature and extent of cleanup operations, and the amount of time a particular recreational area is closed due to cleanup and/or restoration activities. Impacts may be long term, depending upon spill location and relative sensitivity of the recreational resource affected (e.g., impacts to affected wetlands generally greater than similar spill exposure on a barrier beach). Spill frequencies are low (i.e., probability of large, nearshore spills is low). At all offshore locations modeled, smaller spills are not predicted to reach shore.

4.4.4.12 Cultural Resources

An oil spill driven by wind and currents may be deposited on a section of the coast containing various historical properties. This deposition may have an adverse effect on historical resources (e.g., historical piers, esplanades, boardwalks, landings, port structures, etc.). Furthermore, an oil spill may severely affect archaeological sites, particularly fragile prehistoric shell midden sites that frequently occur along the Gulf Coast. In 1997 several Federal agencies signed a Programmatic Agreement (PA) on Protection of Historic Properties During Emergency Response Under the National Oil and Hazardous Substances Pollution Contingency Plan. Under this PA, the Federal On-Scene Coordinator (OSC) is authorized to make decisions pertaining to specific protection measures. These decisions will be arrived at in consultation with state and tribal historic preservation officers. When the location of a spill threatening the nearshore zone is identified, relevant State Historic Preservation Offices and/or state oil spill coordination offices (OSCOs) should be notified by OSC. Upon consulting the records of distribution of cultural resources in the area of the oil spill, these agencies will advise OSC if specific cultural resources are threatened and which of these warrant specific mitigation measures (Rivet 2000; Guidry, 2000, personal communication).

4.4.4.13 Other Uses

Deepwater portions of the Central and Western Gulf of Mexico are utilized by several other marine interests, including commercial shipping and military use. Commercial shipping activity occurs throughout the Gulf, with nearshore vessel operations conducted within safety fairways or vessel traffic lanes. Military operations may be conducted within nearshore or offshore waters throughout the Gulf of Mexico, staged either from onshore facilities (e.g., from an air station or air base) or as part of offshore fleet operations (e.g., routine fleet activities, special or joint maneuvers). The Coast Guard also conducts routine activities and search and rescue operations using both surface vessels and aircraft.

Oil spill cleanup operations will mobilize both aircraft and surface vessels (e.g., skimmers), as detailed in Section 4.4.3, potentially creating conflict with other uses. The level of oil spill response is directly proportional to the size of the spill and, thus, is an important consideration in determining potential conflict with other uses. The most likely spill size from FPSOs is <10 to 1,000 bbl. The estimated frequency of 1,000-bbl spills from FPSOs is $1.2x10^{-1}$/year (table 4-55). Spills of this volume have a high likelihood of persisting on the sea surface for at least three days, but probably not for 20 or 30 days, suggesting that cleanup operations for spills of this size will last one to two weeks. Spills in this range are not expected to result in complete mobilization of oil spill response equipment. Impacts to other uses from small spills (i.e., <10 to 1,000 bbl) will be negligible and or short duration.

Spills from shuttle tankers at sea are likely to involve 1,000 to 500,000 bbl of oil. Large spills will result in mobilization of all available dispersant aircraft and skimmers. Impacts to other uses from medium to large spills will be adverse but not significant, localized, and of relatively short term (i.e., duration of spill cleanup operations).

Summary: Oil spills from FPSO operations will produce negligible to adverse (but not significant) impacts to other uses, primarily through limited preclusion of offshore waters prompted by the presence of oil spill response equipment. Such impacts are expected to be localized and relatively short term.

4.4.4.14 Mitigation

The most effective mitigation against environmental harm from oil spills is prevention. Mitigation measures to minimize of prevent oil spills, or control them, should they occur, from FPSOs and shuttle tankers were discussed in Section 4.4.1.3. Mitigation measures to avoid or minimize environmental harm from oil spills are discussed in the following section.

Oil spills from FPSOs and most spills from shuttle tankers will occur many miles offshore, allowing time for effective spill response to be initiated before the oil reaches important offshore resources or the shore. Oil spill response and cleanup technologies are designed to efficiently remove oil from the environment with minimal additional harm to the physical environment and biological resources. Details of current oil spill response capabilities are outlined in Section 4.4.3.

Several different response methods are currently available for offshore oil spills, including application of oil dispersants, mechanical containment and recovery, and *in-situ* burning. Each of these response methods represents, in effect, available mitigation which may serve to reduce or eliminate oil spill-related impacts. The critical time period for spill response (i.e., mobilization of spill response manpower, transportation, materials, and supplies) is within the first one or two days following an accidental release of oil. The extent and location of a spill (and the relative location of potentially sensitive shoreline or offshore resources) are important considerations that influence the nature of a spill response. While it is recognized that the MMS and Coast Guard will require limited spill response capability on site (e.g., spill response plans for the FPSO and shuttle tankers, limited supplies for cleanup of small spills), it may also be possible to pre-position spill equipment and supplies as mitigation. Section 4.4.3 considered current spill response capability for the Gulf of Mexico region, recognizing that there is no reliable method of estimating what resources may be available when the first FPSO begins operation. Further, there is no reliable means of determining what spill response contractual arrangements may be in place when the first FPSO is installed in the Gulf of Mexico. It is recommended that pre-positioning of supplies be considered on a project by project basis, considering the proposed FPSO location, shuttle tanker routes, and sensitive resources. Under the proper circumstances, the enhanced readiness afforded through pre-positioning for an accidental release of oil may provide sufficient mitigation to protect sensitive resources from significant impact. The details of spill response strategies are detailed further below.

It is widely accepted that crude and refined oil spilled at sea does the greatest harm and is the most persistent if it is allowed to wash ashore (National Research Council, 1989; Mearns, 1997). Therefore, the primary spill response strategy usually is to recover oil from the sea surface with various mechanical recovery devices. If oil recovery equipment can not be deployed because of weather or the availability nearby of suitable equipment, the second option often is to apply chemical dispersants to the oil on the water surface and disperse the oil into the water column. Other at-sea response strategies, including controlled *in situ* burning of spilled oil on the sea surface and application of sinking agents to hasten deposition of the oil on the sea bottom, have been evaluated but not used extensively to date in a real ocean spill situation.

Mechanical recovery of oil from the sea surface is most effective when the oil is still present as a thick slick near the spill source (Daling and Indrebø, 1996). Crude oil usually spreads rapidly on the sea surface and the slick rapidly becomes thinner as the oil spreads. The point is reached within a short time after the spill when the slick is so thin that mechanical recovery is very inefficient. However, a thin slick is dispersed with chemical dispersants more efficiently than a thick slick. After a few days or weeks, the oil slick weathers to a viscosity that can not be treated efficiently with dispersants. The two Gulf of Mexico crude oils evaluated in this assessment are moderately viscous and become more viscous rapidly during weathering. They should be amenable to mechanical recovery with skimmers for at least a few days after a spill. As the oils become more viscous, they become more difficult to disperse with chemical dispersants. The optimal "window of opportunity" for dispersing these oils, particularly Mississippi Canyon 807 crude oil that readily forms a viscous mousse, is one or two days, based on the results of the weathering model.

Controversy has surrounded the use of chemical dispersants to combat spilled oil on the sea surface ever since the *Torrey Canyon* oil spill off southwest England in 1967 when toxic, high-aromatic solvents were used to clean oil from the shore and disperse it into the water column. Dispersant application was acknowledged to have caused more environmental damage than the oil itself (Southward and Southward, 1978). However, considerable advances have been made in dispersant technology in the last 30 years (National Research Council, 1989). Modern oil spill dispersants have low toxicity to marine organisms and are highly effective in dispersing fresh oil under laboratory conditions. There is controversy concerning whether modern dispersants are sufficiently effective for combating a spill at sea to warrant their use as a first response option (Fingas *et al.*, 1991a; Lunel, 1995). The current consensus is that dispersants can be effective if applied early while the oil still is dispersable. Dispersant use is the first choice for response to offshore oil spills in much of Europe.

Dispersant application may substantially decrease the overall environmental consequences of an oil spill by reducing damage to sensitive nearshore and shoreline habitats, and by decreasing exposure of sea-surface living animals, such as marine birds and mammals, to floating oil. However, the decision to use dispersants involves environmental tradeoffs that must be considered. Use of dispersants involves trading the potential short-term environmental effects of dispersed oil in the water column on water column organisms, possibly including commercially important fishery species, against the possible long-term impacts on the shoreline and on animals that use the sea surface (U.S. Office of Technology Assessment, 1990; Baker, 1995).

Therefore, a decision is required, preferably before a spill occurs, concerning the initial spill response strategy: containment and skimming, or chemical dispersion. In the U.S., the decision to use a particular response method is at the discretion of 1) a unified command composed of Federal and state on-scene coordinators and the spiller; and 2) regional response teams composed of resource trustee agencies (Mearns, 1997). In some cases, chemical dispersant use has either been pre-approved or banned for certain geographic areas or habitats. For the deepwater study area of the Gulf of Mexico, pre-approval of dispersant use has already been made. Pre-approval allows more effective spill response planning and implementation.

Rarely more than 10 to 15 percent of the spilled oil is recovered or removed from the sea surface by recovery devices, chemical dispersants, or *in situ* burning. In the month or so after the *Exxon Valdez* spill, between 7 and 10 percent of the spilled oil was recovered at sea with skimmers and an additional 0.2 percent (estimated) was burned on the sea surface (Wolfe *et al.*, 1994). Approximately 40 percent of the spilled oil came ashore in Prince William Sound and an additional 10 percent (approximately) washed ashore along the coast of the northwestern Gulf of Alaska. Chemical dispersants were not approved for use until after the "window of opportunity" had passed and dispersants were no longer effective.

If mechanical recovery, chemical dispersion, or *in situ* burning are not completely effective and some oil washes ashore, a variety of shoreline cleanup methods may be applied to remove oil from the shore. Most shoreline cleanup methods produce damage to shoreline resources, in addition to the damage produced by the oil alone (Southward and Southward, 1978; Broman *et al.*, 1983; Houghton *et al.*, 1996). Shoreline cleanup methods include mechanical pickup and removal of oily debris, hot and cold water washing, application of beach cleaning chemicals, tilling and berm relocation to expose buried oil to natural weathering processes, and bioremediation to enhance microbial degradation of the oil on the shore. Shoreline cleanup methods should be selected to the extent possible that recover or destroy the oil efficiently with minimal damage to biological resources that use or occupy the shore (Foster *et al.*, 1990). Tradeoffs often have to be made between, for example, leaving oil in place to possibly contaminate and harm birds and wildlife that may use the shore, or removing the oil with aggressive cleanup methods that destroy some of the intertidal biota (Neff *et al.*, 1995).

To the extent possible, cleanup methods for different shore types in a geographic region should be pre-selected to optimize effectiveness and minimize environmental harm. The two main shoreline types in the Gulf of Mexico, sandy barrier beaches and coastal wetlands, require different approaches to spill cleanup. If oil has come ashore on a sandy beach and has not penetrated deep into the substrate, often the best cleanup strategy is manual pickup with shovels or heavy equipment, depending on the extent of shoreline oiling. However, removal of oiled saltmarsh sediments usually results in severe damage or destruction of the marsh (Gilfillan *et al.*, 1995). Foot and vehicular traffic on oiled marshes and intertidal mud flats will drive the oil deeper into the sediments and slow natural recovery. Such habitats often are best left alone.

Chemical shoreline treating agents (beach cleaners) may be used to improve the efficiency of water washing of hard and soft shore substrates (Walker *et al.*, 1993). In some cases, use of beach cleaners may make it possible to remove heavy oil deposits without resorting to very intrusive high-pressure, hot-water washing or steam-cleaning. This combined approach may cause less environmental harm than use of high pressure and hot water (Lees *et al.*, 1996). Modern shoreline cleaners, such as Corexit 9580, consist of a hydrophilic surfactant in a carrier solvent (Fiocco *et al.*, 1991). They lift the weathered oil off the substrate during water-washing, but do not disperse the oil in the nearshore water column. The floating oil usually can be recovered with booms and skimmers deployed off the shore being cleaned. Beach cleaners seem to be effective in removing weathered oil from rocky shores, mangroves, and marsh grasses (Fiocco *et al.*, 1991; Teas *et al.*, 1993; DeLaune *et al.*, 1993).

Bioremediation has been shown to be effective in removing oil from sandy and rocky shores (Prince, 1993; Bragg *et al.*, 1994; Atlas, 1995). Application of inorganic fertilizers to oiled salt marshes increases plant growth; it is uncertain if it substantially increases the rate of disappearance of the oil from the marsh substrate (Mendelssohn *et al.*, 1995). Application of a slow-release, oleophilic fertilizer to shores oiled by the *Exxon Valdez* spill increased the rate of petroleum hydrocarbon biodegradation by three to five times (Atlas, 1995). The effectiveness of the bioremediation varied from one site to another and depended on the amount of nitrogen applied and the amount and extent of weathering of the oil.

4.5 Cumulative Impacts

Cumulative impacts are the combined and/or incremental effects upon the environment (marine, coastal, terrestrial, and air resources; and socioeconomic systems) that potentially could occur as a result of past, present, and reasonably foreseeable future actions, including the proposed action. Cumulative impacts are addressed in the context of this EIS in order to assess the incremental contribution of the proposed action to impacts on affected resources from all factors. The proposed action for use of FPSOs on the OCS in the Western and Central Planning Areas is projected to include the potential installation, startup, and operation of as many as five FPSOs during the ten-year period of 2001 through 2010. The first FPSO would be installed as early as 2001, and the remaining four FPSOs would be installed as late as 2010. Section 4.2 of this DEIS identifies a set of past, present, and reasonably foreseeable future actions that are relevant to and within the area being considered for use of FPSOs.

This section assesses whether the proposed action could significantly contribute toward cumulative impacts as a result of having as many as five FPSOs operating on the OCS by the year 2010. Section 4.5.1 addresses the potential for cumulative effects associated with FPSO routine operations, as well as installation and decommissioning activities. Section 4.5.2 addresses the potential for cumulative effects associated with the temporary storage of produced oil at sea and the transportation of oil from the FPSO to refinery ports and terminals. Section 4.5.3 addresses cumulative impacts by resource category.

4.5.1 FPSO Installation, Production, Decommissioning

FPSOs are similar to other types of production facilities (e.g., TLPs, spars, and semi-submersibles) in many aspects and different in others. FPSOs are essentially the same with respect to the associated well completions, well control and maintenance activities, subsea systems, use of mooring lines and anchors, production throughput volumes, production processing and maintenance, and export gas compression and pipeline facilities; and produced water, domestic discharge, and solid waste generation and management. As in the case of other deepwater developments, short-term flaring or reinjection of produced gas may be approved by MMS under limited circumstances. Installation and decommissioning activities associated with FPSO facilities and associated subsea systems are also essentially the same as those associated with other OCS production facilities, and like other OCS production facilities would be subject to applicable regulatory requirements governing those activities.

Installation, decommissioning, and routine operations for the above FPSO components and activities would involve impacts on air quality and the marine and coastal environments, and potentially could affect commercial fisheries. However, these impacts are expected to be minimal in magnitude and localized and/or of short duration (e.g., during periods of installation and decommissioning activities) and therefore less than significant. Approximately 55 deepwater production startups will have commenced on the OCS by the end of 2000, and an additional 88 deepwater start-ups are projected to be added during the 10-year period of 2001 through 2010. Of the projected 143 deepwater production facilities to be installed on the OCS during this time period, up to five, or 3.5 percent, would be FPSO systems. Consequently, the incremental contribution of installation, decommissioning, and routine operations for the above FPSO components and activities toward any cumulative adverse impacts in the GOM region is not expected to be significant.

Among the range of potential variations in FPSO components and configurations that were identified in developing the base-case scenario for analysis in this EIS, the dynamic-positioning (DP) system method for FPSO stationkeeping was raised as potentially relevant for the GOM OCS. Rather than using mooring lines and anchors to position an FPSO at a production site, servo-activated thrusters would be employed in conjunction with a geographic positioning system (GPS) to maintain the FPSO station over the production site. Essentially, through satellite navigation, the location of the FPSO is precisely monitored, and thrusters positioned at various locations about the ship's hull are activated to provide any required stationkeeping adjustment. Compared to the passive weathervaning method of moored-turret stationkeeping (requiring no thruster assist) analyzed as part of the base-case scenario, or a moored FPSO with thruster assist, DP stationkeeping could generate potentially significant power plant emissions from thrusters that are frequently activated. The degree to which these emissions would be significant and/or could potentially contribute to a significant and adverse cumulative impact is likely to be location-dependant. For example, the use of one or more DP FPSOs in Viosca Knoll lease area, or in the northern portion of the Mississippi Canyon lease area, alone or in combination with other offshore activities, may generate emissions that cumulatively exceed Class I air quality standards (under the Wilderness Act of 1964) in the Breton Sound NWA. The degree to which a cumulative effect would be observed depends on several factors, including meteorological conditions, fuel characteristics (e.g., natural gas or diesel), horsepower, emissions controls, FPSO location, distance from sensitive receptors, and the emissions associated with other activities in the region.

As with other offshore developments, FPSO systems would require the support of onshore service bases and other shore facilities. As offshore development continues to migrate into the deepwater regions of the GOM OCS, various ports and coastal communities will evolve to cater to the needs of deepwater development activity. Port Fourchon, Louisiana, is one such port. FPSOs are projected to represent approximately 3.5 percent of the OCS production facilities that will exist in the GOM by 2010. FPSO developments would incrementally contribute to the demand for support services and, therefore, to the cumulative beneficial and adverse impacts that could be realized at locations for ports and service bases serving deepwater development operations.

FPSOs would comprise up to five of the projected 143 deepwater developments that are projected to be installed on the OCS in the Western and Central Planning Areas by the year 2010. The GOM, including portions of the OCS in these planning areas, contain military warning areas (MWAs), water test areas, and other undesignated areas and lanes of air space and open water where oil and gas development activities and DoD (Air Force and Navy) testing and training activities have long coexisted. Navy vessels use GOM waters for training and testing and as access into Gulf bases and ports. Operators must coordinate with DoD regarding the location and timing of any proposed development activities in the military use areas of the GOM. The potential for any incremental encroachment upon military use areas would not exist because each of the developments that may be proposed (as many as five FPSOs) would have to satisfy DoD requirements prior to proceeding.

4.5.2 FPSO System Oil Storage, Offloading, and Transportation

4.5.2.1 FPSO System Oil Storage

Notable differences between FPSOs and the other production facilities presently employed and projected to occur on the OCS are related to the on-site storage, offloading, and shuttle tanker transport of produced crude oil, and the lack of export oil pipeline infrastructure.

As discussed in Section 4.4.1, spill risk unique to FPSOs is low. Excluding offloading and shuttle tanker transport, FPSO-unique spill risk makes up only 5 percent of the total risk. The remaining 95 percent of the risk is not unique and would be equally as likely, and have similar outcomes, as for a TLP or other deepwater platform. The FPSOs would be stationed in deepwater and are not likely to be involved in groundings or collisions with vessels engaged in coastal transits. However, large volumes of oil would be stored onboard a facility that also incorporates processing systems. These systems would present a degree of risk in the form of fire or explosion. Certain design features, strictly enforced operational practices, and regulatory controls will be employed to lessen the frequency of spill occurrence, but there still would be a very small risk that a large spill event could occur. Any large-volume spill (i.e., 1,000 bbl or greater, depending on location) has the potential to significantly contribute to cumulative adverse impacts on GOM marine life, coastal resources, and socioeconomic systems (e.g., commercial fisheries and coastal communities) that are within and/or dependant on the region impacted.

4.5.2.2 FPSO Offloading and Transportation

With respect to the transportation of produced crude oil from the development site to destination ports and terminals, FPSOs differ from conventional GOM offshore development, as well as other existing and planned types of OCS production facilities, in that:

- FPSOs would not involve the installation, operation, and eventual decommissioning of oil export pipelines on the sea floor; and
- FPSOs would temporarily store large volumes of crude oil at sea, periodically offloading it to shuttle tankers for transport to refinery ports and terminals on the GOM coast.

From an environmental standpoint (and potentially an economic standpoint for the operator), a beneficial effect of FPSO system installation activities on the OCS would be that the systems do not involve extensive installation of oil export pipelines. Oil pipelines, especially when large-diameter pipe is required, are heavy and difficult to install in deepwater. The use of FPSOs would allow relief from issues associated with oil pipelines and pipeline construction such as subsea and landfall siting constraints and potential impacts on coastal wetlands and barrier beaches. Emissions from pipeline-installation vessels (potentially high but of short duration) may not be as high as for other deepwater developments because only a gas pipeline, not both oil and gas pipelines, will be installed. Without an oil export pipeline, FPSOs would involve fewer bottom-disturbing activities and have less impact on water quality and marine life, although these effects would otherwise be temporary and of short duration. There would be significant reductions in the need for oil pipeline maintenance and repair, line replacement activities, potential occurrence of leaks and spills, and issues associated with eventual abandonment. The use of flow-assurance chemicals may also be decreased. Consequently, an incremental increase in OCS oil production would be possible without otherwise contributing to the cumulative impacts associated with GOM pipeline infrastructure expansion.

The risk of spills during offloading from the FPSO to the shuttle tanker is low, comparable to the risk associated with lightering operations in the GOM. Lightering activity in the GOM has a history of low spill frequency and small spill volumes. Although the risk would be low, the potential for an oil spill associated with FPSO offloading operations would exist.

Any large-volume spill (i.e., 1,000 bbl or greater, depending on location) has the potential to significantly contribute to cumulative adverse impacts on GOM marine life, coastal resources, and socioeconomic systems (e.g., commercial fisheries and coastal communities) that are within and/or dependant on the region impacted.

During the offloading of crude oil from an FPSO to a shuttle tanker, increased emissions from the development site would be expected primarily because of the idling engines of the shuttle tanker during the approximately 12-hour process. Combined with the emissions from routine FPSO operations, the emissions that occur during the offloading period may represent a significant incremental contribution to cumulative adverse impacts on air quality (i.e., exceedance of Class I criteria [e.g., Breton Sound NWA] and/or noncompliance with NAAQS). Furthermore, additional on-site sources, potentially including DP stationkeeping, use of attendant vessels during offloading, and/or any MMS-approved flaring, would cause additional emissions that could exacerbate the degree to which FPSO operations contribute to cumulative impacts on air quality.

The potential for any significant contribution to a cumulative adverse impact on air quality would be highly dependant on the location of FPSOs on the OCS, their proximity to each other and other emission sources, their orientation to sensitive receptors, and meteorological conditions. In remote areas of the OCS that are distant from the Gulf coast, it is expected that FPSOs would not result in significant incremental impacts on air quality, because the emissions would disperse into a substantial volume of the atmosphere. Given the extent to which offshore development has occurred, and is projected to continue to occur, in the Mississippi delta area, it is possible that one or more FPSO operations located in the region could significantly contribute to cumulative air quality impacts. For example, the use of one or more FPSOs in the northern portion of the Mississippi Canyon lease area could result in a significant incremental impact on air quality in the Breton Sound NWA, a Class I area under the Wilderness Act of 1964.

Offloading of crude oil by shuttle tankers in ports potentially could generate VOC emissions that would be additional to existing sources. This would be a concern especially for those ports that are identified as being within ozone nonattainment areas. The potential for FPSO shuttle tanker offloading to be a significant incremental contribution to air quality in refinery ports and terminals is considered to be low because ports in nonattainment areas would likely incorporate vapor recovery systems. Ports would also have state-issued air quality permits with established limits for emissions.

At present there are approximately 15,330 foreign and 1,114 domestic tanker transits into GOM ports annually. The U.S. Department of Energy projects that domestic oil production will steadily decrease during the next ten-year period, while demand for petroleum products will steadily increase. Consequently, imports of crude oil and petroleum products are expected to increase significantly during this period (U.S. Department of Energy 1999). Given the projected increases of imported crude oil and products that will pass through GOM ports during this period, foreign and domestic tanker transits at these ports may increase from the current 16,334 transits to between 20,000 and 22,000 transits annually. If approved for use by MMS, the use of five FPSOs on the OCS would be expected to generate between 365 and 685 shuttle tanker transits to GOM ports in 2010, and would represent between 1.8 and 3.4 percent of all tanker transits in that year.

The projected increase in demand for petroleum products in the U.S. and the decrease in domestic crude oil production that is expected over the next ten years are projected to result in steep increases in imports of crude oil, intermediate feedstocks, and finished products. The steady increase of imported petroleum during the next ten years will primarily be responsible for the projected increase in tanker transits through GOM waters and ports. This increased traffic will bring with it greater demand for infrastructure and services, increasing the potential for both beneficial and adverse environmental and socioeconomic impacts. It is expected that demands on infrastructure and services and impacts of routine operations will increase relative to the total number of expected tanker transits in the GOM and its ports. The shuttle tanker transits associated with up to five FPSO operations on the OCS would represent a small percentage of annual tanker transits into Gulf ports during the ten-year period of 2001 through 2010. Consequently, the incremental impact of routine FPSO shuttle tanker operations would not be expected to be a significant portion of the potential cumulative effects.

The projected increase in tanker traffic during the period 2001 through 2010, both in terms of vessel transits and the total volume of petroleum to be transported in the GOM on an annual basis, brings with it an increased potential for accidents resulting in oil spills. The projected continued increase in demand for petroleum products, and the required increase in imports in order to meet that demand, will be the principal controlling factor in determining the degree to which oil will be transported to U.S. refinery ports and terminals by tankers. The annual production rate in the GOM is expected to remain relatively flat during the ten-year period. FPSO and shuttle tanker risks are comparable to the risks associated with existing deepwater production platforms and oil pipelines; therefore, the net increase in risk would be negligible. Consequently, it is the increases in oil imports, in the form of increased tanker transits into GOM refinery ports and terminals, that will drive the cumulative increase for risk of oil spills.

4.5.3 Cumulative Impacts (by Resource Category)

MMS addressed the cumulative impacts of OCS- and non-OCS-related activities for the Western and Central Planning Areas and the Gulf Coast region for the years 1996 through 2036 as part of the NEPA documentation recently completed for proposed multi-sale lease activities. (These documents are the published FEIS for *"Gulf of Mexico OCS Oil and Gas Lease Sales 171, 174, 177, and 180, Western Planning Area, OCS EIS/EA MMS 98-0008, May, 1998,"* and *"Gulf of Mexico OCS Lease Sales 169, 172, 175, 178 and 182, Central Planning Area, OCS EIS/EA MMS 97-0033, November 1997."*) The following subsections discuss cumulative impacts associated with resources in the U.S. Gulf region, as well as the expected incremental contribution of the proposed action to those impacts.

4.5.3.1 Coastal Barrier Beaches

Coastal barrier beaches have experienced severe adverse cumulative impacts from natural processes and human activities. Natural processes are considered the major contributor to these impacts, whereas human activities cause both direct impacts as well as significant accelerations of natural processes that deteriorate coastal barrier features. Human activities that have had the greatest adverse impacts on barrier beaches and dunes are pipeline canals, channel stabilization structures, beach stabilization structures, recreational use of vehicles on dunes and beaches, and other human activities that disturb coastlines, including removal of coastal vegetation. Deterioration of Gulf barrier beaches is expected to continue in the future. Federal, state, and parish governments have made efforts over the last 10 years to slow the landward retreat of Gulf shorelines. The contribution of the proposed action compared to cumulative impacts on coastal barrier beaches and dunes is expected to be very small.

4.5.3.2 Wetlands

Conversion of wetlands to agricultural, residential, and commercial uses has generally been the major cause of wetland loss. Loss of wetlands is projected to continue in the Gulf Coast states. Deltaic Louisiana will continue to experience the greatest losses; wetland loss is also expected to continue in coastal Texas, Mississippi, Alabama, and Florida, but at slower rates. Approximately 2.1 to 2.4 percent of coastal wetland losses can be attributed to OCS oil and gas activities. The proposed action would represent a fraction of a percent contribution to these impacts.

4.5.3.3 Benthic Communities

Oil- and gas-related activities that may impact deepwater benthic communities include pipeline and platform emplacement activities, anchoring, accidental seafloor blowouts, drilling discharges, and explosive structure removals. The most serious impact-producing factor threatening chemosynthetic communities is physical disturbance of the seafloor, which would destroy the organisms of these communities. Such disturbance would be associated with pipelaying, anchoring, structure emplacement, and seafloor blowouts. Drilling discharges and resuspended sediments have the potential to cause minor, mostly sublethal, impacts to chemosynthetic communities. Seafloor disturbance is considered to be a threat only to high-density (i.e., Bush Hill-type) communities; the widely distributed low-density communities would not be at risk.

Impact-producing activities unrelated to the OCS Program include fishing, trawling, and anchoring. Because of the water depths in these areas, these activities are not expected to impact chemosynthetic communities. Cumulative impacts are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities.

The incremental contribution of the proposed action to the cumulative impact is expected to be slight and will result from possible impacts caused by physical disturbance of the seafloor and minor impacts from sediment resuspension. Negative impacts will be limited but not completely eliminated by adherence to NTL 88-11 (i.e., an MMS Notice to Leesees that is currently in effect).

4.5.3.4 Topographic Features

Non-OCS activities are believed to have the greatest potential for impacting seafloor topographic features, particularly those that could mechanically disrupt the bottom. Potential non-OCS-related factors include vessel anchoring, treasure hunting activities, ocean dumping, tankering of imported oil, heavy storms and hurricanes, collapse of the tops of topographic features (due to dissolution of the underlying salt structure), fishing, and recreational scuba diving. Natural events such as hurricanes or the collapse of the tops of the topographic features could cause severe impacts. Impacts from scuba diving, fishing, ocean dumping, and discharges or oil spills from tankers are likely to have little or no impact on the topographic features.

OCS activities that cause mechanical disturbance represent the greatest threat to live bottoms and topographic features. Potential OCS-related impacts include anchoring of vessels, structure and pipeline emplacement, operational discharges (drilling muds and cuttings, and produced waters), blowouts, oil spills, and structure removal. The incremental contribution of the proposed to the cumulative impact is slight.

4.5.3.5 Water Quality

The Gulf Coast has been heavily used by people and is now showing some signs of environmental stress. Large areas experience nutrient overenrichment, low-dissolved oxygen, toxin and pesticide contamination, shellfish ground closures, and loss of wetlands. Contaminant inputs to coastal waters bordering the GOM will continue as a result of the large volumes of water entering the Gulf from rivers draining over two-thirds of the contiguous U.S., from both municipal and industrial point- and nonpoint-source discharges, and from numerous spill events. Major sources expected to contribute to the contamination of Gulf coastal waters include the petrochemical industry (inclusive of oil and gas development and processing), agriculture, urban expansion, municipal and camp sewerage treatment processes, marinas, commercial fishing, maritime shipping, and hydromodification activities. Lesser sources of contamination are likely to be forestry, recreational boating, livestock farming, manufacturing industries, nuclear power plant operations, and pulp and paper mills. Runoff and wastewater discharges from these sources will impact water quality to the extent that a significant percentage of coastal waters will not attain Federal water quality standards.

The onshore service industry supporting the OCS oil and gas industry will have a minor contribution (less than 10%) to cumulative water quality degradation. Vessel traffic will degrade coastal water quality through routine releases of bilge and ballast waters, chronic fuel and tank spills, trash, and domestic and sanitary discharges. The greatest impacts from commercial vessel traffic will occur in two types of areas: first, along navigation channels as a result of elevated levels of hydrocarbons and tributyltin compounds found in bilge waters and marine paints; and second, within highly populated, confined harbors and anchorages as a result of increased BOD and pathogens from sanitary and domestic waste discharges. Increased turbidity from extensive dredging operations projected to continue within the Gulf coastal zone constitutes another considerable type of nonpoint-source pollution in the Gulf's coastal waters. Analysis of historical data shows that maintenance dredging, the dominant dredging activity in the Gulf area, will continue to increase each year and is likely to displace approximately 4 billion m^3 of sediment in the next 35 years, with about 55 million m^3 of dredged materials being disposed of directly into Gulf estuarine waters annually at USEPA-designated dredged material disposal areas. Dredging will also take place for pipeline emplacement, state oil and gas well access, and commercial developments, many in support of the OCS oil and gas industry. Dredged sediments will enter coastal waters either directly by open-water dumping, or indirectly if the sediments originally dredged and placed onto spoil banks and into wetlands are washed and eroded away.

Considering the cumulative frequency, large number, and widespread locations of anticipated spills from all sources, a large percentage of coastal waters could be affected by petroleum-derived contamination inputs. The contamination should be primarily localized and not sufficient duration to preclude designated uses of the waters. In areas where oil spills are most likely to be a recurring problem, coastal waters could be subject to low-level and chronic regional petroleum contamination. Spill events from OCS-support operations constitute about 10 percent of the total spill events estimated to occur. The incremental contribution of the proposed action is expected to be minimal.

4.5.3.6 Environmental Contamination

Contamination of the GOM is occurring from offshore, coastal, and land-based sources. Atmospheric and riverine inputs transport contaminants from sources outside of the Gulf coastal zone into Gulf waters. Most offshore sources of contamination result from man's activities in the Gulf and include: discharges from oil and gas drilling, of production wastes, and from vessels; bottom disturbances resulting from emplacement and removal of oil and gas structures and pipelines; anchoring; dredged material disposal; and spills of oil and hazardous substances. A major offshore source of petroleum hydrocarbons into Gulf waters is natural seepage. Sediment disturbances caused by installation of OCS platforms and associated pipeline systems, removal of platforms and some associated pipelines, drilling of exploratory development wells, commercial fishing trawler operations, and vessel anchoring are assumed to result in localized, short-term increases in water-column turbidity in offshore waters. The water quality degradation would increase if these operations occur frequently in proximity to each other. Given the projected low levels of these activities, it is assumed that resuspension of sediments will have minimal impact on water quality.

Waste discharges from OCS operations are assumed to not degrade offshore water and sediment quality sufficiently to cause any acute, toxic effects to any living organism beyond 100 m from the discharge. Some bioaccumulation may be occurring. The effect on the food web is unknown but unlikely to be a major impact because of the extremely low levels of uptake and the low bioavailability of these compounds.

In the long term, contaminant inputs from OCS discharges, combined with spill incidents related to OCS operations, could be adding to the regional degradation of Gulf waters and sediments. Municipal, agricultural, and industrial discharges along the coast and land runoff will continue to impact the long-term health of marine waters of the GOM. Coastal sources are assumed to exceed all other sources, with the Mississippi River continuing to be the major source of contaminants to marine waters. Offshore vessel traffic would contribute, in a small way, to regional degradation of offshore waters through spills and waste discharges. All spill incidents (both OCS-related and non-OCS-related) are assumed to cause local water quality changes for up to three months for each incident and to make a small addition to the regional petroleum contamination of Gulf waters.

As the assimilative capacity of coastal waters is exceeded, there will be a subsequent gradual movement of the area of degraded waters farther offshore over time. This degradation will cause short-term loss of the designated uses of large areas of shallow offshore waters due to hypoxic and red tide impacts and to levels of contaminants in some fish exceeding human health standards. The incremental contribution of the proposed action is expected to be minimal.

4.5.3.7 Air Quality

OCS-related emissions are projected to either remain at present levels or decrease in future years because of expected declines in OCS activities in the GOM and advances in control technology. Future impacts are intrinsically related to the continuation of trends in energy consumption and technological developments in fuel and engine efficiency. Emissions of pollutants into the atmosphere from OCS activities are not projected to have significant effects on onshore air quality because of prevailing atmospheric conditions, emission rates and heights, and the resulting pollutant concentrations.

Oil spills would result in small impacts on air quality because the emission rate of pollutants would be low and of short duration. Air quality impacts from spills would be dependent on a variety of factors, including location, meteorological conditions at the time, and duration of the spill. Pollution concentrations reaching shore will generally be low due to dispersion of the emissions with distance over water and the fact that emissions decrease with time and become more diffuse as the spill spreads over a larger area. Cumulative impacts on onshore air quality resulting from emissions associated with OCS activities are estimated to be within Class II PSD allowable increments.

Other than potential impacts from proposed action activities that would occur near the Breton Class I area, the incremental contribution of the proposed action are not regionally significant, nor are they expected to alter onshore air quality classifications.

4.5.3.8 Marine Mammals

Factors that could affect nonendangered and nonthreatened cetaceans include degradation of water quality from operational discharges, helicopter and vessel traffic and noise, platform and drillship noise, explosive platform removals, seismic surveys, oil spills, oil-spill response activities, loss of debris from service vessels and OCS structures, commercial fishing, capture and removal, and pathogens. The cumulative impact on cetaceans is expected to result in a number of chronic and sporadic sublethal effects that may serve to stress and/or weaken individuals of a local group or population and make them more susceptible to infection from natural or anthropogenic sources. Few lethal effects are expected from oil spills, chance collisions with service vessels or shuttle tankers, ingestion of plastic material, commercial fishing, and pathogens. Oil spills of any size are estimated to be recurring events that will periodically contact cetaceans. Deaths as a result of structure removals are not expected to occur due to mitigation measures (NMFS observer program). Disturbance (e.g., noise) and/or exposure to sub-lethal levels of biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal.

The net result of any disturbance would depend on the size and percentage of the population affected; ecological importance of the disturbed area; environmental and biological parameters that influence an animal’s sensitivity to disturbance and stress; and the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980). Collisions between cetaceans and ships, though expected to be rare events, could cause serious injury or death.

The incremental contribution of the proposed action is minimal and is unlikely to have significant long-term adverse impacts on the size and productivity of any marine mammal species or population stock in the northern GOM.

4.5.3.9 Sea Turtles

Factors that have potential to impact sea turtles include structure installation, dredging, water quality and habitat degradation, OCS-related trash and debris, vessel traffic, explosive platform removals, oil spills, oil-spill response activities, natural catastrophes (e.g., hurricanes), pollution, dredging operation, vessel traffic, commercial and recreational fishing, consumption by human, beach lighting, and entrainment in power plants. Small numbers of turtles could be killed or injured by chance collision with service vessels and shuttle tankers, or by eating indigestible trash, particularly plastic items, accidentally lost from drill rigs, production facilities, and service vessels. Deaths due to structure removals are not expected due to mitigation measures (NMFS observer program). The presence of service vessels and the noise they produce could disrupt normal behavior patterns and physiologically stress the turtles, making them more susceptible to disease. Contaminants in waste discharges and drilling muds could indirectly affect turtles through food-chain biomagnification; there is uncertainty concerning the possible effect. Oil spills and oil-spill response activities are potential threats that may be expected to cause turtle deaths, but the risks are greatly reduced by spill contingency planning and the habitat protection requirements of the Oil Pollution Act of 1990. Contact with oil and consumption of oil and oil-contaminated prey may seriously impact turtles.

Most OCS-related impacts are estimated to be sublethal. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or productivity, resulting in either acute or gradual population declines. The incremental contribution of the proposed action is minimal and is unlikely to have significant long-term adverse effects on the size and productivity of any sea turtles species or population stock in the northern GOM.

4.5.3.10 Coastal and Marine Birds

Factors that may detrimentally affect coastal and marine birds include OCS activities; state oil and gas activities; crude oil imports transported by tanker; and other commercial, military, recreational offshore, and coastal activities that may occur and adversely affect populations of nonendangered/nonthreatened and endangered/threatened birds. Sources of potential adverse impacts include air emissions; oil spills and spill-response activities; degradation of water quality; aircraft and vessel traffic and noise, including OCS helicopter and service-vessels; habitat loss and modification resulting from coastal construction and development; OCS pipeline landfalls and coastal facility construction; and accidentally discarded and beached trash and debris. It is expected that the majority of effects from the major impact-producing factors on coastal and marine birds are sublethal (behavioral effects and nonfatal exposure to or intake of contaminants or discarded debris) and will cause primarily temporary disturbances and displacement of localized inshore groups. Chronic sublethal stress is often undetectable in birds, but it can weaken individuals (especially serious for migratory species) and expose them to infection and disease. Lethal effects, resulting primarily from uncontained coastal oil spills and associated spill-response activities in wetlands and other biologically sensitive coastal habitats, are expected to remove a number of individuals from any or all groups through primary effects from physical oiling and the ingestion of oil, and secondary effects resulting from the ingestion of oiled prey. Recruitment of birds through successful reproduction is expected to take up to many years, depending upon the species and existing conditions. The net effect of habitat loss from oil spills, new construction, and maintenance and use of pipeline corridors and navigation waterways will alter species composition and reduce the overall carrying capacity of disturbed area(s) in general.

The cumulative impact on coastal and marine birds, which will result from net decreases in preferred and/or critical habitats, is expected to result in discernible declines in the numbers of birds that form localized groups or populations, with associated changes in species composition and distribution. Based on historic census data, some of these changes are expected to be permanent. The incremental contribution of the proposed action to the cumulative impact is expected to be negligible. It is expected that there will be little interaction between OCS-related oil spills and coastal and marine birds.

4.5.3.11 Fisheries

Impact-producing factors that are expected to substantially affect commercial fisheries in the GOM include coastal environmental degradation, commercial fishing techniques and practices, overfishing, oil spills and subsurface blowouts, emplacement of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, pipeline trenching, and offshore discharges of drilling muds and produced waters. The cumulative impact on fisheries is expected to be substantial and easily distinguished from effects due to natural population variations. The cumulative impact is expected to result in less than a 10 percent decrease in commercial fishery populations, in essential habitat, or in commercial fishing. It will require 3 to 5 years for fishing activity and 2 to 3 generations for fishery resources to recover from 99 percent of the impacts. The incremental contribution of the proposed action is expected to be inconsequential.

4.5.3.12 Recreational Beach Use

Factors that may adversely affect major recreational beaches and recreational use of the Gulf coast include OCS activities, state offshore oil and gas activity, tankering of crude oil imports, oil spills, oil-spill response activities, merchant shipping, commercial and recreational fishing, military operations, other offshore and coastal activities that result in debris, litter, trash, and pollution. Factors such as land development, civil works projects, and natural phenomena have affected, and will continue to affect, beach stabilization, which ultimately affects the recreational use of beaches.

A large oil spill that contacts shore may preclude short-term recreational use of some Texas or Louisiana beaches at the park or community levels. Small spills may preclude short-term use of the small segments of contacted recreational beaches, but will have little effect on local recreational use or tourism. Debris and litter derived from both offshore and onshore sources are likely to diminish the tourist potential of beaches and to chronically degrade the ambience of shoreline recreational beaches, thereby affecting the enjoyment of recreational beaches throughout the Gulf coast. The additional contribution of beach trash from the proposed action is expected to be minimal.

4.5.3.13 Historic Resources

The loss of several tens of thousands of tons of ferromagnetic debris associated with oil and gas exploration and development could result in the masking of historic shipwrecks. It is expected that dredging, sport diving, commercial treasure hunting, and tropical storms have impacted and will continue to impact historic shipwrecks. In addition, it is possible that explosive seismic surveys within state waters could impact historic-period shipwrecks. Such impact will likely result in the loss of significant or unique archaeological information. An impact could result from contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a historic shipwreck located on the continental shelf.

The archaeological surveys and subsequent archaeological analysis and clearance that are required prior to an operator beginning oil and gas activities in a lease are estimated to be 90 percent effective at identifying possible historic shipwrecks in areas with a thick blanket of unconsolidated sediments and a high probability for the existence of historic-period shipwrecks. Onshore development could result in direct physical contact between a historic site and new facility construction and pipeline trenching. It is assumed that archaeological investigations conducted prior to construction will serve to mitigate these potential impacts. The expected effects of oil spills on historic coastal resources are temporary and reversible. No loss of significant or unique historic archaeological information is expected to occur as a result of commercial fishing (trawling). The effects of the various impact-producing factors discussed in this analysis have likely resulted in the loss of significant or unique historic archaeological information. The incremental contribution of the proposed action is expected to be very small due to the efficacy of the required remote-sensing survey.

4.5.3.14 Prehistoric Resources

Impact-producing factors that may threaten prehistoric archaeological resources of the GOM include an OCS activity (pipeline and platform installation, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric archaeological site located on the continental shelf. The archaeological surveys and subsequent archaeological analysis and clearance that are required prior to an operator beginning oil and gas activities in a lease are estimated to be 90 percent effective at identifying possible prehistoric sites. Dredging and tropical storms are assumed to have caused the loss of significant archaeological information. It is possible that explosive seismic surveys in state waters could result in impacts on a submerged prehistoric site. Contact by an oil spill and resulting cleanup activities could result in the loss of significant or unique information. Onshore development could result in direct physical contact between a prehistoric site and new facility construction and pipeline trenching. It is assumed that archaeological investigations conducted prior to construction will serve to mitigate these potential impacts. The shallow depth of sediment disturbance caused by commercial fishing activities (trawling) is not expected to exceed that portion of the sediments that have been disturbed by wave-generated forces. Cumulatively, these various impact-producing factors have likely resulted in the loss of significant or unique prehistoric archaeological information. Most of the impacts related to OCS Program activities would have occurred prior to 1973 (the date of initial archaeological survey and clearance requirements). The incremental contribution of the proposed action is expected to be very small due to the efficacy of the required remote-sensing survey and concomitant archaeological report and clearance.

4.5.3.15 Socioeconomic Systems

The oil and gas industry (including both OCS and state production, and foreign and domestic imports) plays an important role in the socioeconomic systems of Gulf Coast communities. On a regional level, the cumulative impact from the OCS Program on the population and employment is minimal for the Western Gulf coastal impact area and significant for the Central Gulf coastal impact area. Employment needs in support of OCS oil and gas activity are likely to be met with the existing population and available labor force.

Employment levels in the OCS and state tideland oil and gas industries are expected to decline modestly over the next 35 to 40 years as existing hydrocarbon resources become depleted. While the overall decline in OCS-related employment is expected to impact communities, families, and individuals, OCS-related employment is expected to provide jobs that would not exist without the OCS Program and, therefore, would provide some positive impacts.

It is assumed for the purpose of this analysis that jobs created in the service sector will be lower paying than jobs in OCS-related industries. The quality of family life, in some individual cases, could be adversely affected by layoffs in the OCS oil and gas industry, resulting in stress from decreased family income and loss of security. If, as has been suggested, there is a relationship between OCS activity and educational attainment, there may be a decline in the rate of high school completion and a concomitant increase in the rate of high school graduates attending college. As the level of employment in OCS-related industries decreases, it is likely that more persons will engage in traditional occupations (such as trapping and shrimping) to supplement their income. This could result in overfishing the resources, which could pose a threat to the continued existence of specific traditional occupations.

Little to no in-migration is expected to occur in support of the proposed action, though some in-migration of skilled labor is possible. To the extent that in-migration does occur, impacts on community cohesion are expected, the level of impact dependent on the relative size of the communities in which it occurs. The amount of in-migration may be affected by the "shadow effect." Out-migration resulting from the overall modest decline in OCS-related employment could result in a loss of population, particularly in OCS-related staging centers and administrative centers. As OCS-related employment declines, impacts on small business supported by the higher wages associated with OCS employment will decline as well. It is expected that, in a small number of cases, successful adaptation of the family to the extended work schedule will not occur. In these cases, some deleterious impacts on family life are expected. Community and family life, as well as the practice of traditional occupations, could be affected by impact-producing factors associated with activities in state waters.

Deepwater activities have resulted in focused stresses to local (e.g., Port Fourchon) infrastructure. OCS Program activities will continue to have a significant impact on infrastructure in south Lafourche Parish due to increases in deepwater activity over the short term. There is also the possibility that other ports or service bases, particularly those servicing deepwater activity, could see stresses placed on port and local infrastructure. Economic growth is expected to occur in offshore drilling for the short term and may result in importation of some skilled labor. Increased stresses on local infrastructure and public services are expected to occur in those communities experiencing in-migration. It is assumed that some out-migration will coincide with moderately declining levels of OCS-related employment and that this will occur primarily from OCS-staging areas and administrative centers.

The cumulative impact of the OCS Program is expected to result in the potential for increased educational strain, deteriorating conditions of existing infrastructure, some deleterious impacts to comprehensive land use plans, and difficulties in delivering satisfactory levels of public services. Projected OCS-related infrastructure construction is anticipated to be in accordance with appropriate land use plans, zoning regulations, and other state/regional/local regulatory mechanisms. Non-OCS-related development may result in some deleterious impacts on comprehensive land use plans.

Wetlands loss may result in impacts on the practice of traditional occupations (e.g., trapping) as coastal marsh is converted to open water. The direct impact of oil on wetlands could result in the relocation of traplines or recreational fishing activity for the period of time necessary for the marsh to regenerate. Community infrastructure in the coastal counties/parishes is linked to the region's physiography. Continued subsidence and erosion are expected to require expanded maintenance of roads, bridges, and railroads, particularly in coastal marsh areas.

Socioeconomic and cultural impacts from oil-spill cleanup activities would be temporary; however, impacts such as housing shortages, social dysfunction, heightened sense of threat, and other impacts associated with a large influx of workers into small communities could occur for the period of the cleanup activities.

Tropical storms have occurred in the past and will occur in the future. These storms could have major impacts on public services and community infrastructure. Temporary disruption of traditional occupations and severe impairment of community and family life can result from the effects of tropical storms.

The incremental contribution of the proposed action to socioeconomic and cultural impacts in the Gulf coastal region is expected to be minimal.

4.6 Environmental Justice

On February 11, 1996, President Clinton signed Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.* This Executive Order requires each Federal Agency to make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations in the United States and its territories and possessions. "Environmental justice" seeks to ensure that no population is forced to shoulder a disproportionate burden of negative human health and environmental impacts of pollution or other environmental hazards.

Low-income communities, which can be found across the Gulf Coastal Plain, would include multi-ethnic as well as homogenous communities and neighborhoods. Minority communities that fall under the focus of Executive Order 12898, and who are within the potential impact area that is analyzed in this EIS, would include:

- Primarily Hispanic communities and neighborhoods found in Texas;
- African-American communities and neighborhoods found across the northern Gulf rim;
- Two federally recognized American Indian tribal lands found in Louisiana; and

- Asian-American communities and neighborhoods found primarily in Texas, Louisiana, and Alabama.

During the period of 2001 through 2010, the proposed use of FPSOs in the Western and Central Planning Areas of the GOM OCS would include the installation of up to five FPSOs and associated natural gas transmission pipelines, transport of produced crude oil to refinery ports and terminals in Texas and Louisiana, and would require the services provided by OCS support facilities located on the GOM coast. To a large extent, existing facilities would be utilized to support the proposed action; however, it is expected that new infrastructure and coastal support facilities would be established during the 10-year period of the propose action.

The location of any new onshore infrastructure is based on economic and logistic considerations outside of the purview and regulatory authority of MMS. It is possible that new onshore infrastructure could be located proximate to minority or low-income populations or communities. Each facility proposed for construction must be approved by the pertinent Federal and state agencies, county/parish, and/or local governments having jurisdiction. Should inconsistencies or potentially adverse effects be identified through these development approval processes, it is assumed that approval would either not be granted or that appropriate mitigation measures would be enforced by the responsible jurisdictional entity.

The proposed use of FPSOs on the OCS, and the associated infrastructure and shore-side support that would be required, is not expected to cause disproportionately high and adverse human health or environmental effects on minority populations or low-income populations.

4.7 Unavoidable Adverse Impacts of the Proposed Action

Unavoidable adverse impacts are expected during installation, routine operations, and decommissioning of the base-case FPSO and associated components (e.g., shuttle tanker, support vessels, etc.). The proposed action (i.e., the base-case FPSO) also considers several variants termed the “range of options,” the latter of which are also considered in this summary. While the vast majority of the identified impacts are either negligible or adverse but not significant, there are several instances where significant impacts may be realized, as detailed below.

4.7.1 Installation

During installation, it is expected that there will be adverse but not significant impacts on air quality, water and sediment quality, offshore environments, marine mammals, and sea turtles. However, under certain circumstances, installation activities also may produce significant impacts on marine mammals, sea turtles, and coastal and marine birds. Only those resource areas where adverse or significant impacts are expected are discussed below.

Only negligible, localized impacts on coastal environments (i.e., barrier beaches, dunes, and wetlands), fish resources, commercial fisheries, social and economic environments, cultural resources, and other uses are expected from installation activities, with the following two exceptions: 1) negligible impacts on coastal and marine birds, with the exception of pipeline installation; and 2) no negative impacts on the social and economic environment, although short-term beneficial impacts may be realized if FPSO fabrication occurs in the GOM region.

4.7.1.1 Air Quality

Because installation emission sources are diesel-fired (with higher SO_2 emissions), the possibility exists that localized, short-term exceedances of the SO_2 standard, which is considered a significant impact, could be realized during installation activities in the Mississippi Canyon lease area. In other deepwater areas, all emissions are expected to produce only adverse but not significant impacts to ambient air quality.

4.7.1.2 Water and Sediment Quality

Discharges produced during installation are expected to result in short-term degradation of offshore and coastal water quality, an adverse but not significant impact. Emplacement operations (e.g., anchors, mooring lines) during installation will cause relatively small, localized areas of seafloor disturbance, an adverse but not significant impact. Gas export pipeline installation activities will avoid sensitive habitats and produce only adverse but not significant impacts on sediment quality along the pipeline corridor (e.g., through sediment disturbance and resuspension associated with pipelaying, and anchoring). During installation, an increase in turbidity within transit channels is expected. If dredging of channels is necessary to provide for the increase in support vessel traffic, water quality will be affected and sediments in and around the channel will be disturbed. Turbidity levels may temporarily increase as a result of dredging operations. Mixing of anaerobic sediments into the water column could affect oxygen levels and metal concentrations. All these impacts are considered to be adverse but not significant.

4.7.1.3 Offshore Environments

Installation operations will have minimal impact on the water column environment. Surface discharges of sanitary and domestic waste and bilge water will be rapidly diluted in receiving waters, resulting in a negligible impact on the water column environment.

While soft-bottom communities will realize only negligible impacts from minor increases in sedimentation and turbidity associated with seafloor-related operations, soft-bottom benthic and chemosynthetic communities could be impacted by installation activities that occur on the seafloor, including those associated with anchoring, structure emplacement, and pipelaying. Anchors from support vessels and pipelaying vessels, as well as the mooring anchors themselves, will cause severe disturbance to small areas of the seafloor; the areal extent of such disturbance will depend on the dimensions of the anchors being used and the amount (length) of anchor chain resting on the seafloor. In all cases, such impacts to soft-bottom benthos will be adverse but not significant.

Chemosynthetic communities represent unique assemblages. Damage to or elimination of chemosynthetic communities from seafloor-related installation activities would be a significant, long-term impact. Though impacts to chemosynthetic communities from bottom-disturbing activities are expected to be relatively rare, if they occur such impacts would be quite severe to the immediate area affected. Identification and avoidance of high-density chemosynthetic communities is required under current MMS requirements (NTL 98-11). There is concern that chemosynthetic communities cannot be reliably detected directly using current geophysical techniques.

During installation, it is possible that equipment or supplies might be lost overboard, resulting in a negligible and localized impact to the benthos.

4.7.1.4 Marine Mammals

Negligible impacts on marine mammals will occur as a consequence of water quality degradation and debris that has been accidentally lost overboard from OCS service and construction vessels. Noise from helicopters and OCS support vessels also are expected to produce adverse but not significant short-term impacts. The impacts associated with helicopter and vessel traffic appear to be transient and highly variable in degree, and may cause short-term behavioral changes such as disruption of activities or departure from the area of disturbance. The expected increase in OCS service vessel and construction vessel traffic associated with installation of the FPSO system also may increase the likelihood of collisions between these vessels and marine mammals. The risk of collisions may vary, depending upon the species of marine mammal, behavioral attributes, location, and whether vessel operations are conducted at night or during other periods of reduced visibility. Marine mammals that spend extended periods of time at the surface (e.g., deep-diving cetaceans such as sperm whales) may be particularly vulnerable to collisions with offshore vessels in oceanic waters. Within inshore waterways and coastal waters, the manatee, when present, may also be particularly vulnerable. Operations within certain OCS areas also may pose greater risk for collision with the aforementioned groups. For example, the continental slope and submarine canyon areas south of the Mississippi River delta may support a resident population of sperm whales. Collision with a single marine mammal that is currently listed as an endangered species, such as the sperm whale, would constitute a significant impact. A collision with a nonlisted species would be considered adverse, but not locally or regionally significant.

4.7.1.5 Sea Turtles

Only negligible impacts on sea turtles are expected to result from major operational discharges, noise (from OCS logistic support helicopters and service and construction vessels), and accidental loss of debris. However, the expected increase in OCS service vessel and construction vessel traffic associated with installation of the FPSO system may increase the likelihood of collisions between these vessels and sea turtles. The risk of collisions varies, depending on location and whether vessel operations are conducted at night and during other periods of reduced visibility. Data indicate that most turtle sightings occur within coastal waters and waters of the continental shelf. Any collision with a single sea turtle resulting in mortality would constitute a significant impact, as all sea turtle species are currently listed as endangered or threatened species.

It is possible that the gas export pipeline will come ashore at an as yet undetermined location along the Gulf coast. Impacts on sea turtles resulting from installation of an OCS pipeline are expected to be short term and locally adverse but not significant.

4.7.1.6 Coastal and Marine Birds

The greatest potential impact on coastal and marine birds resulting from installation of the FPSO system would be the extent of coastal habitat loss or alteration resulting from new OCS pipeline landfalls. Impacts from these landfalls are highly variable and the significance of the impacts depends on which species are affected, the nature of the landfall location (e.g., whether the proposed landfall location is classified as critical or preferred habitat for activities such as nesting or feeding), and the timing of installation operations (e.g., the extent and duration of operations which have the potential to cause damage to sensitive inshore habitats). Some listed species of coastal birds, including several endangered species, utilize shoreline habitats of the GOM during certain seasons of the year. Impacts involving loss or alteration of coastal habitat may range from adverse but not significant to significant.

4.7.2 Routine Operations

During routine operations, adverse but not significant impacts are expected to occur to air quality, water and sediment quality, coastal environments, marine mammals, coastal and marine birds, fish resources, and commercial fisheries. Significant impacts from routine operations are projected for air quality, marine mammals, and sea turtles.

Only negligible, localized impacts on offshore environments, sea turtles, social and economic environments, recreational resources and beach use, cultural resources, and other uses are expected from routine operations. Beneficial impacts may be realized to offshore environments (i.e., presence of seafloor structures providing hard bottom substrate for epifauna).

4.7.2.1 Air Quality

Air quality modeling was conducted utilizing a conservative approach through the selection of a potential FPSO site close to shore within the deepwater study area, proximate to sensitive onshore receptors. Air quality impacts from routine operations are expected to be adverse but not significant for emissions of NO_x, PM_{10}, and CO, based on air quality modeling conducted at a site within the Mississippi Canyon lease area. However, 3-hour and 24-hour emission levels for SO_2 exceeded the USFWS Class I significance level for Breton Sound NWA on several occasions, which is a significant impact. Most of the remaining portion of the deepwater study area lies further offshore, where emissions will be subject to further dispersion. Emissions of SO_2 in these areas (i.e., areas exclusive of the northern Mississippi Canyon area) are expected to create only adverse but not significant impacts.

4.7.2.2 Water and Sediment Quality

During routine operations, produced water and wastewater discharged from the FPSO, and wastewater discharged from supply and support vessels, will cause localized degradation of offshore water quality for the duration of production operations, an adverse but not significant impact. During routine operations, shuttle tankers traversing between the FPSO and port, as well as supply boats moving from shorebase to the FPSO, could adversely affect coastal water quality. If dredging of channels is necessary to support increased vessel traffic at the shorebase, water quality and sediment quality could also be degraded, an adverse but not significant impact.

4.7.2.3 Coastal Environments

During routine operations, the only impacts FPSOs will have on sensitive coastal environments will be those associated with the incremental increase in vessel traffic due to the shuttle tankers. The significance of these incremental increases in impacts varies depending upon the location of the shuttle tanker destinations. The incremental increases in channel and coastal erosion associated with increased vessel traffic can be expected to be more significant in those areas currently undergoing transgression. However, the maximum impact level resulting from increased tanker harbor and channel transits would be adverse but not significant.

4.7.2.4 Offshore Environments

Routine operations will have few and negligible impacts on the water column environment because continuous or frequent intermittent discharges (i.e., produced water, sanitary and domestic waste, minor discharges) will comply with NPDES permit-based effluent limits or Coast Guard regulations, and will be rapidly diluted in the water column. Once installation of bottom-founded structures has been completed, seafloor impacts will have already occurred, though anchor scraping and scouring of the seafloor will continue throughout routine operations, a negligible impact. The presence of structures on the seafloor during routine operations will only have negligible impacts on soft- bottom benthos, as epifauna and infauna immediately beneath such structures will have already been crushed during installation. Bottom-founded structures may provide hard substrate for epifaunal attachment, a potentially beneficial impact. During routine operations, periodic inspection of FPSO components on the seafloor is expected (via ROV), which may cause limited, localized bottom disturbance, a negligible impact.

Discharges from the FPSO and associated vessels will be rapidly diluted, with minimal impact on the water column and benthic environments. In the immediate vicinity of a discharge, minor and localized impacts to planktonic communities could be expected, a negligible impact. During routine operations, it is possible that equipment or supplies will be lost overboard during transport, transfer, or daily operations. Impacts on the benthos resulting from such losses would be negligible and very localized.

4.7.2.5 Marine Mammals

Water quality degradation from operational discharges and accidental loss of debris from OCS service and construction vessels will result in negligible impacts on marine mammals. Noise from helicopters and OCS support vessels are expected to produce longer-term adverse but not significant impacts for the duration of FPSO operations. The degree of impact associated with helicopter and vessel traffic appears to be highly variable and transient, and may cause short-term behavioral changes such as disruption of activities or departure from the area of disturbance. The expected increase in OCS service vessel traffic associated with routine FPSO operations also may increase the likelihood of collisions between these vessels and marine mammals. The risk of collisions may vary, depending upon the species of marine mammal, behavioral attributes, location, and whether vessel operations are conducted at night and during other periods of reduced visibility. Marine mammals that spend extended periods of time at the surface, such as deep-diving cetaceans (e.g., sperm whales), may be particularly vulnerable to collisions with offshore vessels in oceanic waters. Within inshore waterways and coastal waters, the manatee (when present), may also be particularly vulnerable. Operations within certain OCS areas also may pose greater risk for collision with the aforementioned groups. For example, the continental slope and submarine canyon areas south of the Mississippi River delta may support a resident population of sperm whales. Collision with a single marine mammal that is currently listed as an endangered species, such as the sperm whale, would constitute a significant impact. Collision with a nonlisted species would be considered adverse, but not locally or regionally significant.

4.7.2.6 Sea Turtles

Only negligible impacts on sea turtles are expected from major operational discharges, noise (from OCS logistic support helicopters and support vessels), and accidental loss of debris. However, the expected increase in OCS service vessel traffic associated with routine FPSO operations will increase the likelihood of vessel collision with sea turtles. The risk of collisions varies depending on the location and whether vessel operations are conducted at night and during other periods of reduced visibility. Collision with a single sea turtle resulting in mortality would constitute a significant impact, as all species are currently listed as endangered or threatened species.

4.7.2.7 Coastal and Marine Birds

Operational discharges from routine FPSO operations will produce adverse but not significant impacts on coastal and marine birds. Discharges from support vessels, noise from helicopters and support vessels, and accidental loss of debris are expected to have only negligible impacts on coastal and marine birds, given the discharge volumes and flight altitude restrictions.

4.7.2.8 Fish Resources

The physical presence of FPSO components may interfere with natural migratory routes, as the FPSO and its attendant mooring lines will act as a fish attraction device (FAD). The FAD effect would be most pronounced for epipelagic fishes such as tunas, dolphin, billfishes, and jacks. The concern is that highly migratory species would be diverted from traditional migratory routes and, consequently, from traditional spawning or feeding areas. Because of the highly migratory nature of many epipelagic species, these effects could extend to a regional scale. The disruption of migrations could result in short- or long-term effects on the feeding behavior of deepwater fishes. Such impacts are considered to be adverse but not significant.

The FAD effect would possibly enhance feeding opportunities of epipelagic predators by attracting and concentrating smaller prey species. Vertical migrations undertaken by mesopelagic fishes usually are feeding episodes, and an FPSO could disrupt these migrations and have local-scale effects on mesopelagic food webs. Effects of an FPSO on food resources and feeding behavior would be prevalent in benthic species. Deepwater benthic-feeding fishes would be displaced from small areas by seafloor structures (i.e., anchors, manifolds, wellheads). Some minor loss of benthic (epifaunal and infaunal) food items also would occur. These effects would be adverse but not significant and would occur only on a local scale.

In addition to displacement of migratory species from spawning grounds by FAD effects, the spawning products (i.e., eggs and larvae) from epipelagic and mesopelagic fishes could be exposed to contaminants discharged from an FPSO. Eggs and larvae of these epi- and mesopelagic fishes are commonly found in the surface waters of the open GOM. Discharges of produced water and domestic wastes could be lethal to fishes whose early life history stages occur close to an FPSO. Greater impacts would occur if eggs and larvae were unusually concentrated. However, effects on population levels would not be likely given the total volumes of discharges expected and the ability of receiving waters to quickly and effectively dilute the discharges to ambient levels within several thousand meters of the discharge point. Impacts associated with routine discharges are expected to be negligible.

4.7.2.9 Commercial Fisheries

Bottom trawling and bottom longline activities will be precluded (i.e., seafloor rendered untrawlable or unfishable) by the placement of an FPSO and its associated facilities, effectively encompassing a 16-mi^2 area around a single FPSO. Impacts associated with areal preclusion are considered to be adverse but not significant.

Surface (pelagic) longlines used in the GOM also will be precluded by the presence of an FPSO. Depending upon the oceanographic conditions when longlines are set, the estimated area to be precluded may range from 7 to 51 nmi^2, a very small area relative to the total fishable area of the Central and Western GOM. Such preclusion is considered an adverse but not significant impact.

4.7.3 Range of Options

Implementation of most of the options identified under the range of options will have no effect on either impact-producing factors or subsequent impacts on resources. In some cases, only incremental increases in impacts would be realized, though impact levels would remain the same. Notable exceptions are discussed below.

4.7.3.1 Air Quality

Several options to the base-case FPSO have potential impacts on air quality. While the base-case studies one FPSO location, there is an option for up to five geographically dispersed FPSOs. The extent to which implementation of this option would impact air quality depends on the definition of “geographically dispersed.” If the five FPSO were dispersed throughout the FPSO study area (i.e., separated by approximately 320 km), it is not likely that five FPSOs would have significantly more impact on any receptor than one FPSO, because the emissions from each FPSO would disperse into a substantial volume of the atmosphere. However, if the five FPSOs were placed near a sensitive receptor (e.g., Mississippi Canyon) in an area with a 50-km radius of one another, the FPSOs may be considered “geographically dispersed” yet their emissions would have a potentially cumulative impact on sensitive receptors. While the extent of this potential impact cannot be precisely determined without further modeling, it can be stated that significant impacts would be expected (i.e., a higher number of exceedances of the SO_2 threshold would be expected).

Options for increased storage capacity and increased production may produce a slightly greater impact on air quality because the potential for greater VOC emissions from storage, offloading, and fugitives could be more than for the base case. The extent of this impact cannot be precisely determined in the absence of additional modeling (i.e., emissions from a larger vessel; emissions associated with a higher level of production).

The use of flaring/venting, as allowed on a temporary basis under strict MMS requirements during the initial start-up phase of FPSO operations, could have significant impacts on air quality. The addition of thrusters to the FPSO vessel will adversely impact air quality if additional horsepower is required aboard the vessel to operate the thrusters. In addition, the use of a tug in offloading operations would have either positive or negative impacts on air quality, depending on the method of operation.

4.7.3.2 Water and Sediment Quality - Coastal

Additional FPSOs and/or additional shuttle tanker traffic under the range of options would increase vessel traffic in coastal areas, with a corresponding increase in adverse impacts on coastal water and sediment quality. If channel dredging is required, significant localized impacts could be realized.

4.7.3.3 Offshore Environments

Only one of the options has potential to affect the benthic environment. Alteration of vessel mooring characteristics may reduce impacts on the benthos. The selection of drag anchors under the base case produces the greatest impacts to the seafloor and associated infaunal and epifaunal communities. Use of either suction pile or driven-pile anchoring techniques may slightly reduce impacts by reducing the total amount of seafloor area affected.

4.7.3.4 Marine Mammals

Survey data suggest that marine mammals known to occur within the GOM show marked depth preferences in their distributions, with shelf waters representing a preferred depth regime for a majority of the Gulf's marine mammal species. FPSO activities established within the shallowest depths indicated in the range of operations (i.e., 200 m [656 ft]) would be located on the deeper portions of the continental shelf. Therefore, operations in these areas may be slightly shallower than the preferred depth range of many marine mammal species that occur in the GOM.

4.7.3.5 Sea Turtles

Survey data suggest that the majority of sea turtle species known to occur within the GOM show marked depth preferences in their distributions. With the possible exception of the leatherback turtle, most species are predominantly distributed within waters of the continental shelf. FPSO activities established within the shallowest depths indicated in the range of operations (i.e., ~600 ft) would be located on the OCS. Therefore, operations in these areas may be within the preferred depth range of most of the sea turtle species that occur in the GOM, effectively increasing the potential for impacts. Of particular concern are the potentially significant impacts associated with vessel collision with a listed species.

4.7.3.6 Fish Resources

While most of the FPSO location or vessel/system options would not appreciably increase or decrease impacts previously identified for the base case, the question of FPSO water depth is problematic. Given the limited database available for deepwater fish species, particularly in regard to life history information, it is possible that slightly increased impacts might be realized from FPSO production-related discharges in deeper water. However, under a worst-case scenario, such impacts would only increase from negligible to adverse but not significant.

4.7.3.7 Commercial Fisheries

Placement of FPSOs in water depths of greater than 305 m (1,000 ft) would greatly lessen the chance for conflicts with bottom longlining. If optional scenarios involve shallower waters (e.g., along the 183-m [600-ft] isobath), the potential for impacts would increase; however, the impacts would only be classified as significant if the FPSO were located on or near a known fishing area.

4.7.3.8 Social and Economic Environment

Several options to the base-case FPSO have potential to adversely impact the socioeconomic environment. If the five FPSO were dispersed throughout the FPSO study area (i.e., separated by approximately 320 km), it is not likely that five FPSOs would have significantly more impact on socioeconomic resources than one FPSO, since the labor and support demands associated with each FPSO would be distributed to ports and shorebase facilities closest to each FPSO. However, if the five FPSOs were placed proximate to one another, it is possible that one or two port facilities would realize the bulk of the socioeconomic impact. While the extent of this potential impact cannot be precisely determined without further project-specific details, only adverse but not significant impacts would be realized.

4.7.3.9 Recreational Resources and Beach Use

Several options to the base-case FPSO have the potential to affect recreational resources and beach use above the impact levels identified for the base case, primarily as it relates to those resources in proximity to port facilities and associated vessel traffic. If the five FPSO were dispersed throughout the FPSO study area (i.e., separated by approximately 320 km), it is not likely that five FPSOs would have significantly greater impact on recreational resource and beach use, given the assumption that FPSO-related vessel traffic would be expected to use several different port facilities. However, if the five FPSOs were placed proximate to one another, it is possible that one or two port facilities would realize the bulk of the shuttle tanker and support vessel traffic. While the extent of this potential impact cannot be precisely determined without further project-specific details, it is projected that impacts associated with the bases case versus the range of options would increase slightly from negligible to adverse but not significant.

4.7.4 Decommissioning

During decommissioning, adverse but not significant impacts are expected to occur to water and sediment quality, marine mammals, and sea turtles. Negligible impacts on air quality, coastal environments, offshore environments, coastal and marine birds, fish resources, commercial fisheries, social and economic environments, recreational resources and beach use, cultural resources, other uses are projected occur to.

4.7.4.1 Water and Sediment Quality

Decommissioning-related discharges are expected to produce short-term degradation of offshore and coastal water quality, an adverse but not significant impact. Removal operations will cause relatively small, localized areas of seafloor disturbance, an adverse but not significant impact. During decommissioning, an increase in turbidity within transit channels is expected from support and supply vessels. If dredging of channels is necessary to provide for the increase in support vessel traffic, water quality will be affected, and sediments in and around the channel will be disturbed. Turbidity levels could temporarily increase as a result of dredging operations. Mixing of anaerobic sediments into the water column could affect oxygen levels and metal concentrations. All these impacts are considered to be adverse but not significant.

4.7.4.2 Marine Mammals

Negligible impacts on marine mammals will occur as a consequence of water quality degradation and accidental loss of debris from OCS service vessels involved in decommissioning. Noise from these sources is expected to produce short-term adverse but not significant impacts. The impacts associated with vessel traffic appear to be transient, highly variable in degree, and may cause short-term behavioral changes such as disruption of activities or departure from the area of disturbance. The expected increase in OCS service vessel and decommissioning traffic associated with the removal or abandonment of the FPSO system also may increase the likelihood of collision between these vessels and marine mammals. The risk of collisions may vary depending on the species of marine mammal, behavioral attributes, location, and other factors. Deep-diving cetacean species may be particularly vulnerable to collisions with offshore vessels in oceanic waters. Within inshore waterways and coastal waters, the manatee (when present), may also be particularly vulnerable. Operations within certain OCS areas also may pose greater risk of collision. Collision with a single marine mammal that is currently listed as an endangered species, such as the sperm whale, would constitute a significant impact. Collision with a nonlisted species would be considered adverse, but not locally or regionally significant.

4.7.4.3 Sea Turtles

Only negligible impacts on sea turtles are expected from major operational discharges, noise (from OCS logistic support helicopters, and service vessels), and accidental loss of debris. However, the expected increase in OCS service vessel and decommissioning traffic associated with installation of the FPSO system may increase the likelihood of collisions between these vessels and sea turtles. The risks of collisions vary depending on the location and other factors. Collision with a single sea turtle resulting in mortality would constitute a significant impact, as all sea turtle species are currently listed as endangered or threatened.

4.8 Irreversible and Irretrievable Commitment of Resources

The FPSO base case and range of options will involve a large commitment of labor and capital from oil and gas operators pursuing deepwater development using FPSO technology. During routine operations in all phases (i.e., installation, production, and decommissioning), non-renewable materials will be consumed or utilized, including:

- fuels (e.g., diesel, natural gas, aviation fuel) used by the FPSO, shuttle tankers, support and supply vessels, and helicopters;
- food, water, and various expendable items used by personnel; and
- water and various chemicals used during FPSO, shuttle tanker, and support operations.

While mitigation will minimize the effects of the proposed action on the environment, no irreversible or irretrievable commitment of marine resources is expected. Only very limited, permanent loss of soft-bottom seafloor habitat will be realized as a result of the expected abandonment in place of pipelines, flowlines, and umbilicals.

4.9 Relationship Between the Short-term Use of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

Short-term refers to the duration of oil and gas production activities, whereas long-term refers to an indefinite period beyond the termination of oil and gas production. FPSO production activities and sporadic periods of well workover activities would occur throughout the life of the proposed action, resulting in impacts that would be largely short term and localized. Activities during the production of an FPSO may result in chronic impacts over a longer period of time (25 to 35 years), potentially punctuated by more severe impacts as a result of accidental events. Decommissioning would also be a short-term activity with localized impacts; the impacts of site clearance may be long lasting. Over the long term, several decades to several hundreds of years, the localized natural environmental balances would be expected to be restored.

After the completion of oil and gas production, the marine environment would generally be expected to remain at or return to its long-term productivity levels. To date, there has been no discernable decrease in long-term marine productivity in OCS areas where oil and gas have been produced for many years. However, some risk of long-term adverse environmental impact would exist due to the potential for accidents.

No long-term productivity or environmental gains are expected as a result of the proposed action; the benefits of the proposed action are expected to be principally those associated with a medium-term increase in supplies of domestic oil and gas. While no reliable data exist to indicate long-term productivity losses as a result of using FPSOs in deepwater OCS development, such losses are possible.

5. CONSULTATION AND COORDINATION

Public and agency participation played a major role throughout the preparation of this EIS and will also be an integral part of the FEIS. Public participation and agency consultation processes were conducted in compliance with NEPA and the CEQ guidelines that implement NEPA. MMS invited affected Federal, State, and local agencies and other interested parties to participate in the EIS process. Methods of consultation and coordination focused on the scoping process, and communication with involved agencies was facilitated by letters, telephone conversations, and meetings.

A total of 883 interested parties, including applicable regulatory agencies, were notified of the proposed action and invited to provide comments. Five scoping meetings, which were held in locations near major Gulf ports, provided forums for interested parties and agencies to voice issues and concerns regarding the proposed action. Notices of the intent to prepare an EIS and the locations of the scoping meetings also provided an address for written comments. The MMS web page provided the name, address, and phone number of the project manager to whom written and verbal comments could be sent. The intent of this consultation was to ensure that the EIS provided an adequate analysis of the proposed action and its potential environmental consequences.

5.1 The Scoping Process

The NOI was published in the *Federal Register* on June 10, 1999 (Appendix C). A scoping notification letter, also dated June 10, 1999, was sent to 883 interested parties, as identified on the project mailing list, to inform them of the upcoming scoping meetings and the purpose of the project.

Notices announcing the scoping meetings and MMS' intent to prepare an EIS were published in the *Houston Chronicle* and the *Corpus Christi Caller Times* on Tuesday, June 15, 1999; the *Beaumont Enterprise* on Wednesday, June 16, 1999; the *New Orleans Times Picayune* on Friday, June 18, 1999; and the *Lake Charles American* on Sunday, June 20, 1999.

The public scoping meetings were held on: Monday, June 21, 1999, at the Natural Resources Center at Texas A&M University, Corpus Christi, Texas; Tuesday, June 22, 1999, at the Radisson Hotel and Conference Center, Houston, Texas; Wednesday, June 23, 1999, at the Beaumont Hilton, Beaumont, Texas; Thursday, June 24, 1999, at the Players Island Hotel, Lake Charles, Louisiana; and Monday, June 28, 1999, at the Radisson Inn New Orleans Airport, in Kenner, Louisiana. Introductory remarks, including the purpose of the meeting and the public involvement process under NEPA, were given by Ms. Deborah Cranswick, the MMS Project Manager. The agenda, the meeting procedures, and an overview of the EIS process were provided by Mr. Gerard Gallagher, the Project Manager for Ecology and Environment, Inc. (E & E). A description and details of the proposed use of FPSOs in the GOM OCS were presented by representatives of DeepStar, an industry group consisting of 23 oil and gas operating companies that are involved in exploring and developing the deepwater GOM oil and gas reserves. A fact sheet was distributed to all attendees (Appendix C). Transcripts of the meetings were prepared by a court reporter; no transcripts were prepared for the June 23, 1999, meeting in Beaumont because all members of the general public who were present had attended previous meetings.

The project mailing list, which was generated from a database developed by MMS, was updated based on the sign-in sheets from the scoping meetings. For ease of use, each name on the mailing list was assigned to one of nine categories—one for the general public and eight for the various types of agencies and organizations. The database also tracked the manner in which comments were received (e.g., via scoping meetings, scoping letter). Written comments in response to the NOI, newspaper notices, and/or the scoping meetings were received through July 26, 1999.

5.1.1 The Scoping Meetings

The public scoping meetings were held on June 21, 22, 23, 24, and 28, 1999. Twelve people signed in at the meeting in Corpus Christi on June 21, 1999; 43 at the meeting in Houston on June 22, 1999; 11 at the meeting in Beaumont on June 23, 1999; 14 at the meeting in Lake Charles on June 24, 1999; and 36 at the meeting in Kenner on June 28, 1999.

During the Corpus Christi meeting, two members of the public asked questions; at the Houston meeting, four people asked questions and one person made a comment; at the Beaumont meeting, the presentation was not given because all members of the general public who were present had attended previous meetings; at the Lake Charles meeting, four people asked questions and three provided comments; at the Kenner meeting, one person asked a question and four people provided comments.

5.1.2 Public and Agency Comments

A list of issues was developed based on public statements to the record presented at the scoping meetings and/or provided in writing.

During the scoping meeting in Corpus Christi, comments were received regarding oil spills that occur during the lightering process, the impact these spills may have on natural resources, and the contingency plans for the occurrence of oil spills. Attendees also expressed concern over protecting the natural banks and reefs in the area, storms in the Gulf, and the use of double-hulled versus single-hulled vessels for the transport of oil to port facilities.

Issues raised at the Houston meeting included the use of double-hulled versus single-hulled vessels, the use of hydrocarbon pipeline systems, flag requirements for the FPSOs, and the current safe use of FPSOs in the North Sea.

Issues raised at the Lake Charles meeting included the safety of the lightering process, the importance of oil spill response or contingency plans and whether MMS would create these plans for the FPSOs, the overall quality of the environment in the GOM given Mexico's oil recovery operations, the potential for increased risk of terrorist attacks, and contingency plans for multiple spills occurring simultaneously. In addition, comments addressed the current safe use of FPSOs in the North Sea and the economic effects associated with construction of FPSOs.

Issues raised at the Kenner meeting included the type and intensity of storms and hurricanes that FPSOs could safely withstand, the safety of the lightering process and the potential economic impacts of this operation, the potential harmful effects on endangered species, the increased infrastructure needed to provide support for this type of project, and the possibility of submerged storage tank usage. In addition, information was provided on the current safe use of FPSOs in the North Sea.

5.1.3 Scoping Response Letters

MMS received six letter responses from the public scoping meetings, the scoping notices in local newspapers, and the scoping notification letters (Appendix C).

In a letter dated June 30, 1999, Mr. Ted Falgout, the Executive Director of Port Fourchon, located in Galliano, Louisiana, stated that the Draft EIS should discuss landside impacts of FPSOs and address proper mitigation of these impacts, as necessary.

In a comment letter dated July 6, 1999, the United States Department of the Interior Fish and Wildlife Service indicated its concern over large oil spills and recommended that each FPSO have its own contingency plan/action. Under this plan, equipment would be available at all times, even in the event of a hurricane. In addition, the agency stated that the possibility of adding or expanding handling facilities for the port areas should be addressed in the EIS.

In a letter dated July 14, 1999, a representative from Shell Offshore, Inc., made several points in response to the oil spill record of FPSOs. Shell made the comment that the use of FPSOs in the GOM would result in a decrease in the amount of oil potentially released into the environment. Shell also notes that the regulatory framework for management of FPSOs is already in place. The letter also addressed the issue of lightering in prohibited areas of the GOM, which Shell believes should be decided on a case-by-case basis. Shell indicated that the use of lightering from an FPSO involves stationary vessels, which reduces risks associated with the typical lightering process (e.g., avoiding sensitive environmental areas and other vessels). Shell also addressed potential socioeconomic impacts, indicating that the use of FPSOs would not result in significant changes to the current support infrastructure, and the acceptance of FPSOs would permit continued development of local businesses.

A comment letter dated July 14, 1999, was received from the LA 1 Coalition, a non-profit organization that is working for road improvement from Port Fourchon to U.S. Route 90 in Raceland, Louisiana. The Coalition expressed concern over the increase in infrastructure associated with use of the FPSOs. They would like the EIS to address the overburdened infrastructure in that area.

In a letter dated July 20, 1999, the State of Louisiana Department of Wildlife and Fisheries stated that Louisiana's fragile coastal marshes and sensitive environments are at risk from oil spills, additional shuttle tanker traffic, and the possible use of single-hulled vessels, and that addressing these risks is a priority. The agency also expressed concern about secondary issues such as the increased infrastructure, shoreline development, impacts on ports, and the possibility of increased erosion along the channels traveled by the shuttle tankers. The agency also noted an inconsistency concerning the use of pipelines. As stated in the NOI, the "base-case" scenario indicates pipelines would be used to transport gas to shore while oil would be transported via shuttle tanker. However, the Department is under the impression that the FPSOs need to be used because the use of pipelines is not feasible in the marginal fields. They also are concerned that the safety of lightering operations is overestimated and a more realistic estimate of the spill potential should be conducted. The estimate should include a risk analysis of the possibility of catastrophic failure of one or more of the FPSO's systems. The safety of FPSOs during storms was also mentioned, and the Department believes this issue should be addressed with respect to local weather conditions. In closing, it was suggested that data gathering should be used as a means of mitigating the impacts of FPSO development. This would include monitoring the physical, chemical, and biological oceanography and measuring real-time wind and currents from various stations in the GOM.

In a comment letter dated July 26, 1999, Mr. Todd Marse emphasized the importance of a complete and comprehensive EIS, as it will set a precedent for future assessments in the oil and gas industry. He also recommended that a worst-case spill scenario be developed instead of using the current average annual accidental releases method. In addition, he suggested the analysis of the cumulative effects on port infrastructure and the possible effects on living organisms.

5.2 Agency Consultation

Formal consultation was initiated with Coast Guard to determine their jurisdictional authority over FPSO operations. The Coast Guard maintains regulatory jurisdiction over a number of parameters relating to OCS operations. As a result, a MOU was developed between MMS and Coast Guard concerning responsibilities for offshore facilities on the OCS. Section 1.5.3 identifies the regulatory position of Coast Guard with respect to the proposed FPSOs. Consequently, a coordinated effort was made to involve Coast Guard during the preparation of this DEIS. Representatives were invited to attend the project team kick-off meeting and public scoping meetings, participate in EIS team meetings, and review draft documents. Their comments were solicited and incorporated into the DEIS. The Coast Guard reviewed the DEIS as well as the review comments on the DEIS that were received from the agencies and public. Several DEIS review comments received by MMS were relevant to, and/or entirely within Coast Guard jurisdiction. Coast Guard provided a written response addressing these matters, and it is provided in Appendix B of this EIS.

Other agencies were consulted for input and comment on the document, including the USFWS and NMFS. The notice of intent to prepare an EIS and the locations of the scoping meetings were mailed to USFWS and NMFS. These agencies were invited to prepare written comments. USFWS offices in Panama City and Jacksonville, Florida, and Washington, D.C. were consulted by telephone. NMFS offices in Pascagoula, Mississippi, Miami and St. Petersburg, Florida, and Silver Spring, Maryland, were also contacted by telephone. Impact analysis criteria for coastal and marine birds were requested from USFWS, and potential impacts on marine mammals and sea turtles were discussed with NMFS.

To comply with the Marine Mammal Protection Act, consultation with NMFS was conducted to obtain a listing and baseline description of the 29 species of marine mammals known to occur in the GOM. Potential impacts on marine mammals that could result from the proposed action were analyzed. Based on consultation with the NMFS, the following impact-producing factors were identified: degradation of water quality resulting from discharges from OCS service and construction vessels; noise from helicopters and OCS support vessels; collisions with OCS vessel traffic; ingestion of, or entanglement in, discarded debris; and sickness and/or mortality from oil spills.

In accordance with the Magnuson Fishery Conservation and Management Act of 1976 and the Magnuson–Steven Act of 1996, the NMFS and the Gulf of Mexico Fishery Management Council were contacted. Baseline descriptions of the important commercial fisheries in the deep waters of the Gulf and EFHs of the Central and Western Planning Areas of the Gulf were obtained. The important commercial fisheries were identified as bottom trawling for royal red shrimp, trapping for golden crab, bottom longlining for grouper and tilefish, and surface longlining for yellowfin tuna, sharks, and swordfish. A listing of EFHs that might be present both inshore and offshore of the 200-m (656-ft) isobath was also provided. As part of the consultation process, a review of the document by the NMFS EFH team was completed during public and agency DEIS review.

In compliance with the Endangered Species Act (ESA), consultation with USFWS and NMFS provided a listing of threatened and endangered species that may potentially occur in the project area. Both USFWS and NMFS reviewed the DEIS and provided comments to MMS. NMFS attended the public hearing that was conducted in Houston, Texas on September 20, 2000. USFWS and NMFS comments on the DEIS, and MMS responses to these comments are provided in Section 5.6. Documentation of MMS consultation with USFWS and NMFS under Section 7 of the ESA is provided in Appendix D.

The Offshore and Coastal Dispersion (OCD) model was used to simulate the effects of emissions from the production phase of the proposed project. Potentially significant impacts were identified for routine operations in the northeastern (nearshore) corner of the Mississippi Canyon lease area, and offshore of a Class I nonattainment area (Breton Sound NWA). USFWS was consulted regarding the Breton Sound NWA.

In compliance with the National Historic Preservation Act, the Louisiana Division of Archaeology and the State Oil Spill Coordinator were consulted. Several Federal agencies signed a Programmatic Agreement (PA) on Protection of Historic Properties During Emergency Response Under the National Oil and Hazardous Substances Pollution Contingency Plan in 1997. This agreement allows the Federal On-Scene Coordinator to make decisions pertaining to implementing specific protection measures. These decisions will be made in consultation with the State and tribal historic preservation officers. The Louisiana Division of Archaeology and/or the Alabama Historical Commission will be consulted to provide information on known cultural resources in the GOM as part of the NEPA documentation required when and if a specific proposal to locate FPSOs is submitted to MMS.

5.3 Distribution of the DEIS for Review and Comment

MMS published a Notice of Availability for the DEIS in the *Federal Register* on August 15, 2000. Following is a list of the federal and state agencies and libraries that received copies of the document for review. The list does not include the numerous individuals that requested and received bound copies of the DEIS. As an additional measure for providing public access to the document, MMS made the DEIS available for review and downloading on the World Wide Web (WWW). The MMS agency homepage on the WWW provided a direct link to the DEIS web site. In addition, the Notices of Public Hearing that were placed in community newspapers in advance of the hearings provided the DEIS web site address. The DEIS web site received numerous visits by individuals reading and downloading sections of the document. No reports of user difficulty were reported to the webmaster for the site.

Table 5-1

Distribution of the DEIS for Review and Comment

Federal Agencies

Congress
- Congressional Budget Office

House Resources Subcommittee on Energy and Mineral Resources
Senate Committee on Energy and Natural Resources
Department of Commerce
- National Marine Fisheries Service
- National Oceanic and Atmospheric Administration

Department of Defense
- Department of the Air Force
- Department of the Army
  - Corps of Engineers
- Department of the Navy

Department of Energy
- Strategic Petroleum Reserve

Department of the Interior
- Fish and Wildlife Service
- Geological Survey
- Minerals Management Service
- National Park Service
- Office of Environmental Policy and Compliance
- Office of the Solicitor

Department of State
- Office of Environmental Protection

Department of Transportation
- Coast Guard
- Office of Pipeline Safety

Environmental Protection Agency
- Region 4
- Region 6

Marine Mammal Commission

Table 5-1

Distribution of the DEIS for Review and Comment

State and Local Agencies
Texas
Governor's Office
Attorney General of Texas
Coastal Coordination Council
General Land Office
Southeast Texas Regional Planning Commission
State Legislature Natural Resources Committee
State Senate Natural Resources Committee
Texas Commission on Natural Resources
Texas Historical Commission
Texas Parks and Wildlife Department
Texas Water Board Department
Louisiana
Governor's Office
Department of Culture, Recreation, and Tourism
Department of Environmental Quality
Department of Natural Resources
Department of Transportation and Development
Department of Wildlife and Fisheries
State Legislature Natural Resources Committee
Alabama
Governor's Office
Alabama Geological Survey
Department of Environmental Management
Department of Conservation
Department of State Docks
State Legislature Natural Resources Committee
State Legislature Oil and Gas Committee
Mississippi
Governor's Office
Department of Archives and History
Department of Environmental Quality
Department of Marine Resources
Department of Natural Resources
State Legislature Oil, Gas, and Other Minerals Committee

Table 5-1

Distribution of the DEIS for Review and Comment

Florida

Governor's Office
Department of Community Affairs
Department of Environmental Protection
Department of State
Florida Coastal Zone Management Office
Office of Planning and Budget, Environmental Policy Coordinator
State Legislature Natural Resources and Conservation Committee
State Legislature Natural Resources Committee
West Florida Regional Planning Council

Libraries

Alabama

Auburn University Library, Montgomery
Dauphin Island Sea Lab, Marine Environmental Science Consortium Library, Dauphin Island
Gulf Shores Public Library, Gulf Shores
Mobile Public Library, Mobile
Montgomery Public Library, Montgomery
Thomas B. Norton Public Library, Gulf Shores
University of South Alabama, Mobile

Florida

Bay County Public Library, Panama City
Charlotte-Glades Regional Library System, Port Charlotte
Collier County Public Library, Naples
Florida A&M, Coleman Memorial Library, Tallahassee
Florida Northwest Regional Library, Fort Walton Beach
Florida State University, Strozier Library, Tallahassee
Fort Walton Beach Public Library, Fort Walton Beach
Leon County Public Library, Tallahassee
Marathon Public Library, Marathon
Monroe County Public Library, Key West
Port Charlotte Public Library, Port Charlotte
Selby Public Library, Sarasota
St. Petersburg Public Library, St. Petersburg
Tampa-Hillsborough Public Library, Tampa
University of Florida, Holland Law Library, Gainesville
University of Miami Library, Miami
University of West Florida, Pensacola

Table 5-1

Distribution of the DEIS for Review and Comment

Louisiana

Calcasieu Parish Library, Lake Charles
Cameron Parish Library, Cameron
Grand Isle Branch Library, Grand Isle
Iberville Parish Library, Plaquemines
Jefferson Parish Lobby Branch Library, Metairie
Jefferson Parish West Bank Outreach Branch Library, Harvey
Lafayette Public Library, Lafayette
Lafitte Branch Library, Lafitte
Lafourche Parish Library, Thibodaux
Louisiana State University Library, Baton Rouge
Louisiana Tech University Library, Ruston
Loyola University, Government Documents Library, New Orleans
LUMCON Library, Chauvin
McNeese State University Library, Lake Charles
New Orleans Public Library, New Orleans
Nicholls State University Library, Thibodaux
Plaquemines Parish Library, Buras
St. Bernard Parish Library, Chalmette
St. Charles Parish Library, Luling
St. John the Baptist Parish Library, Laplace
St. Mary Parish Library, Franklin
St. Tammany Parish Library, Covington
St. Tammany Parish Library, Slidell
Terrebonne Parish Library, Houma
Tulane University, Howard Tilton Memorial Library, New Orleans
University of New Orleans Library, New Orleans
University of Southwestern Louisiana Library, Lafayette
Vermilion Parish Library, Abbeville
West Bank Regional Library, Harvey

Mississippi

Gulf Coast Research Laboratory, Gunter Library, Ocean Springs
Hancock County Library System, Bay St. Louis
Harrison County Library, Gulfport
Jackson State University, Eudora Welty Library, Jackson

5.4 Public Hearings

In accordance with 30 CFR 256.26, MMS held public hearings soliciting comments on the DEIS for the proposed use of FPSOs on the GOM OCS. Four public hearings were conducted by MMS. A representative of Coast Guard took part in the first three of the MMS public hearings. The hearings provided a forum for public expression of verbal statements regarding the proposed action and the content and findings of the DEIS. Provisions were also made so that comments could be written on comment cards and provided to MMS at the hearing. Each public hearing was advertised in local newspapers approximately one week to 10 days in advance of the hearing. Each of the public meetings was held from 6:00 p.m. to 8:00 p.m. The public hearings were held at the following locations:

<u>September 18, 2000</u>
Adam’s Mark Hotel
64 South Water Street
Mobile, Alabama
(Public hearing was advertised in the *Mobile Register*)
28 attendees signed in; four individuals offered testimony; one comment card was submitted.

<u>September 19, 2000</u>
Radisson Inn New Orleans International Airport
2150 Veterans Blvd
Kenner, Louisiana
(Public hearing was advertised in the *New Orleans Times-Picayune, Baton Rouge Advocate, Port Fouchon Daily Comet* and *Lafourche Gazette*)
40 attendees signed in; two individuals offered testimony; no comment cards were submitted.

<u>September 20, 2000</u>
Radisson Hotel Hobby Airport Houston
9100 Gulf Freeway
Houston, Texas
(Public hearing was advertised in the *Houston Chronicle* and *Corpus Christi Caller Times*)
79 attendees signed in; ten individuals offered testimony; two comment cards were submitted.

<u>September 21, 2000</u>
Best Western Richmond Suites
2600 Moeling St.
Lake Charles, Louisiana
(Public hearing was advertised in the *Lake Charles American Press, Baton Rouge Advocate, Port Fouchon Daily Comet* and *Lafourche Gazette*)
Seven attendees signed in; two individuals offered testimony; no comment cards were submitted.

A court reporter recorded (using stenography and tape recorder) each of the public hearings and provided MMS with a written transcript of each hearing record. Comment cards are addressed in Section 5.6. A summary of the testimony recorded for each public hearing is summarized below.

Mobile, Alabama Public Hearing

- Four speakers offered testimony at the public hearing in Mobile, Alabama.
- Mr. Charles Williams inquired as to whether there would be opportunities for employment and income as a result of the proposed action. Mr. Williams also submitted a comment card at the meeting that posed these issues (see Section 5.6 for comment/response [response number CGW01).
- The Offshore Operators Committee (OOC) and the industry consortium Deepstar each provided testimony for advocating the selection of Alternative A in the EIS.
- National Response Corporation expressed that FPSOs are a viable means for production in the GOM.

New Orleans (Kenner), Louisiana Public Hearing

- Two speakers offered testimony at the public hearing in Kenner, Louisiana.
- The OOC and Deepstar each provided testimony for advocating the selection of Alternative A in the EIS.

Houston, Texas Public Hearing

- Ten speakers offered testimony at the public hearing in Houston, Texas.
- Mr. Joe Key spoke in favor of the proposed action and advocated the selection of Alternative A.
- SBM-IMODCO suggested to MMS that double-side single-bottom hull FPSOs would be appropriate for production in areas greater than 2,000-feet water depth, and that MMS should consider deepwater production systems other than FPSOs as viable options.
- Texas General Land Office (TGLO) expressed concern with respect to oil spills from vessels, and urged developers to use caution, and to implement pollution prevention measures. TGLO also advocated community and State involvement in the development approval process.
- OOC provided testimony for advocating the selection of Alternative A in the EIS.
- The Texas State Pilot's Association and the Houston Pilots expressed concerns regarding pilotage for vessels that are presently not required to have State-licensed pilots onboard while operating in ports. This concern was also expressed in a number of comment letters received by MMS. See Section 5.6 for the MMS response to this concern (see General Response No. 2).
- Mr. Rick Felder advocated sound decisions regarding the use oil and gas reserves.
- The industry consortium Deepstar provided background information on the purpose and need for FPSOs on the GOM OCS, and expressed some of the advantages afforded by these systems. The Deepstar representative also expressed an observation that the consideration of FPSOs has been a long process, and noted that there still remains issues with respect to regulatory overlap "stumbling blocks".

- Paragon Engineering Services, Inc. testified to the benefits of FPSO development projects on employment within their industry.
- Risk, Reliability and Safety Engineering, Inc. testified that the risk of FPSOs is less than for other current industrial activities in Houston and elsewhere, and advocated the use of FPSOs on the GOM OCS.
- Response Management Associates asked a question as to what provisions were being made for Flower Garden Banks. MMS responded by pointing out that one of the alternatives (B-1) analyzed in the DEIS considered not permitting the use of FPSOs in the Coast Guard Lightering Prohibited Zone. It was elaborated by MMS that these zones were established specifically to protect the Flower Garden Banks as well as other sensitive topographic features. This area was pointed out on a poster-sized map at the back of the hearing room.

Lake Charles, Louisiana Public Hearing

- Two speakers offered testimony at the public hearing in Lake Charles, Louisiana. The OOC and Deepstar each provided testimony for advocating the selection of Alternative A in the EIS.

5.5 Major Differences Between the DEIS and the FEIS

Federal and State agencies, elected officials, private citizens, oil and gas companies, industry organizations, professional organizations and other interested parties presented their comments on the DEIS at public meetings and in written correspondence. Several of the comments received by MMS warranted revisions be made to the body of the DEIS in order to complete the FEIS. Revisions to the text included minor clarifications and inclusion of updated and additional information. No major changes to the document content were warranted or conducted as a result of public comment and review. None of the changes that were made to the text are believed to have any profound effect on the findings and conclusions that were presented in the DEIS.

The FEIS is a larger document than the DEIS given the inclusion of sections describing the outcome of the public involvement process, including: the distribution of the DEIS; the public hearings that were conducted; the receipt of comments from the public; and the responses from MMS that were provided (i.e. Sections 5.3 through 5.6).

5.6 Written Comments to MMS on the DEIS, and MMS Responses

The DEIS for the proposed use of FPSOs on the GOM OCS was filed with USEPA on August 9, 2000. The public comment period on the document ended on October 10, 2000. Written correspondence and public hearing comment cards were received from the following:

Federal Agencies

United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS)
United States Environmental Protection Agency (USEPA)
United States Department of Interior, Fish and Wildlife Service (FWS)
United States Geological Survey (USGS)

State Agencies

Florida Department of Environmental Protection (FDEP)
Louisiana Department of Natural Resources (LADNR)
Coastal Coordination Council (CCC), Texas General Land Office
Texas General Land Office (TGLO), Oil Spill Prevention and Response
Texas Natural Resource Conservation Commission (TNRCC)

Elected Officials

Office of the Governor of Alabama
Representative John E. Davis, Texas House of Representatives
Senator Mike Jackson, State of Texas
Representative Robert E. Talton, Texas House of Representatives

Local Entities

Port of Freeport
Port of Houston Authority

Citizens

Bob Acker
S. Danscuk
Thomas Hudson
G.M. Richards
Allen J. Verret
Louis Vest
Captain Robert Webbon
Henry C. Williams

Organizations

American Bureau of Shipping
Bay County Audubon Society
Greater Houston Port Bureau, Inc.
Houston Pilots
Offshore Operators Committee (OOC)
Shipbuilders Council of America

Industry

Conoco
Noble Drilling Services, Inc.
SBM-IMODCO, Inc.
Shell Exploration and Production Company
Stolt-Nielson Transportation Group, Ltd.
Texaco Exploration and Production, Inc.
Unocal

The remainder of Section 5 includes copies of all the comment letters and comment cards received on the DEIS and provides responses to these comments, including indication of where the document was modified, if appropriate, in response to these comments.

Note that Attachment B of the comment letter received from OOC was identical to Attachment B of the comments received from Unocal. Given the length of this attachment, only the Attachment B received from OOC is incorporated in the FEIS. However, the MMS responses provided to address OOC comments (i.e. OOC11 through OOC64) are also provided by MMS as official responses to Unocal Attachment B comments.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9721 Executive Center Drive N.
St. Petersburg, Florida 33702
(727) 570-5317, FAX 570-5300

October 10, 2000 F/SER4:WJ:rr

Regional Director (MS 5410)
Gulf of Mexico OCS Region
Minerals Management Service
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Dear Sir:

The Minerals Management Service (MMS), Gulf of Mexico Outer Continental Shelf (OCS) Region, by notice of August 2000, requested National Marine Fisheries Service (NMFS) review of the Draft Environmental Impact Statement (DEIS) on the Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico OCS, Western and Central Planning Areas. The proposed action involves the use Floating Production, Storage, and Offloading Systems (FPSO), which are platforms for the storage of crude oil in tanks located in the hull of the system and are capable of offloading the crude to shuttle tankers or ocean-going barges for transport to shore. FPSOs may be used as production facilities to develop oil fields in the deepwater areas of the Gulf OCS.

According to the MMS, "This DEIS is programmatic in that it examines the concept of, and fundamental issues associated with, industry's proposed use of FPSOs in the Western and Central Planning Areas of the OCS. Therefore, this DEIS addresses the proposed action generically and does not constitute a review of any site-specific development proposal. In addition, the DEIS comprises only the National Environmental Policy Act review process. On the basis of the analysis in the final environmental impact statement, the MMS will decide whether FPSO systems will be an acceptable option for use on the Gulf OCS; however, the decision will not constitute approval for the use of any particular FPSO at any specific site. Subsequent site-specific FPSO proposals would be subject to established MMS and Coast Guard review and decision processes, U.S. Environmental Protection Agency water quality permitting, and any applicable review by states for coastal zone consistency."

NMFS01

The NMFS has completed its review of the DEIS prepared by MMS. We find that the description of fishery resources and habitats in the Gulf of Mexico OCS, Western and Central Planning Areas, and the assessment of potential adverse impacts associated with the operation of FPSOs are adequately described in the document. However, the Essential Fish Habitat (EFH) consultation requirements [Sec. 305(b)(2)] of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) have not been met by the MMS. Sec. 305(b)(2) of the MSFCMA requires consultation with the NMFS by any Federal agency authorizing, funding, or undertaking an action that may adversely affect any EFH identified under this Act. For your reference, the detailed consultation requirements of the MSFCMA are specified at 50 CFR 600.920.

NMFS01, continued

While the MMS has not yet met its EFH consultation obligations mandated by the MSFCMA and implementing regulations, we believe that the implementation of Alternative B [*Conditional Approval of FPSOs (The Proposed Action with General Restrictions or Conditions: B1, B2, B3, and B4)]* by MMS would minimize potential adverse impacts to EFH and other NMFS trust resources. Accordingly, NMFS recommends the following.

EFH Conservation Recommendations

NMFS02

1. The standard conservation measures required as a part of the authorizations granted by MMS, and Alternative B and General Restrictions or Conditions B1, B2, B3, and B4, should be incorporated in any future FPSO authorizations.

NMFS03

2. Any future site-specific FPSO proposals should be coordinated with the NMFS pursuant to the requirements of the MSFCMA.

NMFS04

Please be advised that Section 305(b)(4)(B) of the MSFCMA requires your office to provide a written response to this letter. That response must be provided within 30 days of your receipt of this letter and at least 10 days prior to final agency action. A preliminary response is acceptable if final action cannot be completed within 30 days. Your final response must include a description of the measures to be required to avoid, mitigate, or offset the adverse impacts of the activity. If your response is inconsistent with our EFH Conservation Recommendations, you must provide an explanation of the reasons for not implementing these measures [(50 CFR 600.920(j)].

Thank you for the opportunity to review and comment on the DEIS. If you have any questions or wish to discuss issues related to this action you may contact Mr. William Jackson at (404) 766-3699. Issues regarding EFH consultations should be coordinated with Mr. Rickey Ruebsamen, EFH Coordinator, at (727) 570-5317.

Sincerely,

Andreas Mager, Jr.
Assistant Regional Administrator
Habitat Conservation Division

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

OCT 06 2000

Mr. Chris Oynes
Director
Mineral Management Service
Gulf of Mexico
OCS Region (MS5410)
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Dear Mr. Oynes.:

In accordance with our responsibilities under Section 309 of the Clean Air Act, the National Environmental Policy Act (NEPA), and the Council on Environmental Quality (CEQ) Regulations for Implementing NEPA, the Region 6 Office of the U.S. Environmental Protection Agency (EPA) has completed the review of the Draft Environmental Impact Statement (SEIS) prepared by the U.S. Minerals Management Service (MMS) for the proposed use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico Outer Continental Shelf, Western and Central Planning Areas.

Detailed comments on the Draft EIS have been prepared and are enclosed with this letter for your consideration in preparation of the Final EIS. If you should have any questions, please contact Mike Jansky of my staff at (214) 665-7451.

EPA classifies your Draft EIS and proposed action as "EC-2," i.e., EPA has "Environmental Concerns and Requests Additional Information". EPA suggests Alternative B (Alternative A with General Restrictions or Conditions) be considered as the MMS perferred alternative in the NEPA decision making process. Our classification will be published in the Federal Register according to our responsibility under Section 309 of the Clean Air Act, to inform the public of our views on proposed Federal actions.

We appreciate the opportunity to review the Draft EIS. We request that you send our office five (5) copies of the Final EIS at the same time that it is sent to the Office of Federal Activities (2251A), EPA, 1200 Pennsylvania Avenue, N.W., Washington, D.C. 20044.

Sincerely yours,

for Robert D. Lawrence, Chief
Office of Planning and Coordination

Enclosure

DETAILED COMMENTS
U.S. DEPARTMENT OF THE INTERIOR
MINERALS MANAGEMENT SERVICE
DRAFT ENVIRONMENTAL IMPACT STATEMENT
FOR
PROPOSED USE OF FLOATING PRODUCTION, STORAGE, AND OFFLOADING SYSTEMS ON THE GULF OF MEXICO OUTER CONTINENTAL SHELF

Background

The United States Department of Interior (DOI) Minerals Management Service prepared a Draft Environmental Impact Statement (DEIS) to evaluate potential environmental effects of the proposed use of Floating Production, Storage, and Offloading (FPSO) Systems in the deepwater portions (areas deeper than 650 feet) for the Outer Continental Shelf (OCS) in the Central and Western Planning Areas of the Gulf of Mexico.

The DEIS is a programmatic document to examine the concept of, and fundamental issues associated with the petroleum industry's proposed use of floating production, storage, and offloading systems on the OCS of the Gulf of Mexico. The DEIS addresses the proposed action generically and does not constitute a review of any site-specific development proposal. In addition, the DEIS addresses only the National Environmental Policy Act (NEPA) review process. Subsequent site-specific FPSO proposals would be subject to established MMS and U.S. Coast Guard review and decision processes (addressing engineering, oil spill, air quality, water quality, under site-specific documentation under NEPA.

The proposed use of FPSOs on the Gulf of Mexico OCS would provide industry with a deepwater production and transportation option in lease areas that are beyond the reach of current oil pipeline infrastructure and possibly technically and/or economically beyond the reach of existing means for extending oil pipeline infrastructure into these lease areas. Offshore leases in areas that present technological and/or economic barriers to development (e.g., great distances from existing infrastructure, extreme depth, highly irregular ocean bottom terrain, fields with marginal production potential, etc.) could potentially become viable candidates for development with the use of FPSOs.

Alternatives Description

Alternative A (Conceptual approval of FPSOs [**The Proposed Action**]) is the implementation of a policy accepting the conceptual use of the base-case FPSO system in the deepwater OCS areas of the Western and Central Planning Areas of the Gulf of Mexico within the range of design and operational variations considered in the EIS. Under this alternative, FPSOs would be considered an acceptable deepwater development technology for use in the Gulf of Mexico.

Alternative B (Conditional Approval of FPSOs **[The Proposed Action with General Restrictions or Conditions]**) is the implementation of a policy accepting the conceptual use of the base case FPSO system and a range of options in the Gulf of Mexico OCS with general restrictions on the design, operation, or geographic location as conditions of approval. Certain restrictions were identified for consideration based on existing regulatory requirements and the findings of the risk assessment and/or impact assessment performed for this EIS. These restrictions or conditions are analyzed as variations of Alternative B and are described as follows:

Alternative B-1 considers that FPSOs would be prohibited in the portions of the project area in which lightering-prohibited areas have been established by the U.S. Coast Guard (under 33 CFR Part 156 Subpart C).

Alternative B-2 considers that FPSOs would not be permitted in the Corpus Christi or Port Isabel map protraction areas. Alternative B-3 considers the exclusion of FPSOs from lease areas near the Mississippi Delta, specifically the Viosca Knoll and Mississippi Canyon map protraction areas. Alternative B-4 considers the requirement for an attendant vessel to be present during offloading operations, as a measure to enhance safety and provide a level of immediate oil spill response capability.

Alternative C (**No Action**) is that the concept of not using FPSOs in Gulf of Mexico.

Alternative Impact Comparison

Alternative A, the proposed action, would generally have limited impacts on most environmental resources, although significant impacts could occur under certain circumstances. Resources that could be significantly impacted by Alternative A include air quality, water and sediment quality, offshore environments, marine mammals, sea turtles, and commercial fisheries. As discussed in table 1, these significant impacts would only occur under specific conditions, most of which can be protected against by proper planning and regulatory restrictions.

Alternatives B-1, B-2, and B-3 would have less impact than the proposed action on some of the resources due to the exclusion of FPSO operations from areas near sensitive resources. Under Alternative B-3, the potential for significant impacts on air quality in Breton Sound NWA would be eliminated by excluding FPSOs from nearby areas. Alternatives B-1, B-2 and B-3 would have greater beneficial on fishery resources and commercial fishing than those projected for Alternative A due to limiting locations for FPSO operations.

Alternative C would have negligible impacts on environmental resources, though it has the potential to impact the socioeconomic environment along the Gulf Coast if the absence of FPSOs leads to an industry downturn. If individual FPSOs were permitted under Alternative C, adverse impacts similar in nature to those described for Alternative A would occur.

Air Quality Impacts

The analysis for considering potentially significant air quality impacts determined that the potential effects are largely location dependent. A permanently moored FPSO/shuttle tanker offloading operation in the northeast quadrant of the Mississippi Canyon protraction area would generate sulfur dioxide emissions and impact the Class 1 standards in the Breton Sound National Wilderness Area (NWA) in offshore Louisiana. The use of low sulfur fuels for these operations may be an effective measure for ensuring sulfur dioxide emissions will remain below Class 1 standards. Alternative B-3 would exclude the use of FPSOs in the Mississippi Canyon lease area, in effect mitigating the potential for significant impacts on air quality at Breton Sound NWA that would be attributed to FPSOs and their support activities. Consideration of this concern should be given by the MMS in the final alternative selection and the Record of Decision process. USEPA01

Conformity

The Final EIS needs to address general conformity and the general conformity rule at 40 CFR Part 93 Subpart b. We understand that this is programmatic EIS document and subsequent NEPA analysis will have to occur to fully satisfy NEPA and relevant Federal, State, and local permitting requirements for site specific operations. Please address general conformity as it applies to the FPSO process. USEPA02

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1875 Century Boulevard
Atlanta, Georgia 30345

October 11, 2000

In Reply Refer To:
FWS/R4/ES

Mr. Chris Oynes
Regional Director, Minerals Management Service
Gulf of Mexico Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123

Re: Draft Environmental Statement (EIS) for the Proposed Use of Floating Production, Storage and Offloading (FPSO) Systems on the Gulf of Mexico Outer Continental Shelf

Dear Mr. Oynes:

The Fish and Wildlife Service has reviewed the above referenced document as requested in a July 20, 2000, letter from the Associate Director for Offshore Minerals Management. We would like to offer the following comments.

Detailed Comments

Page 1-7, Section 1.2 - This section discusses historic spill information and references events occurring in the North Sea. What parallels can be applied to weather conditions in the Gulf of Mexico as have occurred with these historical spill events? FWS01

Page 1-13. Section 1.4.2 - This section describes the FPSO configuration and components. As we understand it, the basic configuration is for no propulsion capability and a storage capacity up to 2.3 billion barrels. Is it possible that a catastrophic level 5 hurricane event could spill the oil stored in a FPSO? FWS02

Page 4-7, Section 4.1.1.3 - This section describes manifold installation. Apparently the manifolds and wellheads will be a minimum of 12,000 feet from the FPSO. The undersea watercolumn will be filled with pipelines, flowlines, and moorings. The document should describe what emergency contingencies are built into the system to deal with ruptures. FWS03

Page 4-30, Section 4.1.3 - This section discusses decommissioning and states that subsea wells will be plugged in accordance with 30 CFR 250, subpart G. What requirements are in place to check on these well heads over time to determine if leaks exist, especially given the pressures at greater depths. FWS04

Mr. Chris Oynes

We appreciate the opportunity to provide these comments. Should you have questions regarding these comments, please contact Mr. Mike Morgan at our Clear lake Ecological Services Field Office at 281-286-8282.

Sincerely yours,

for Judy Jones

Sam D. Hamilton
Regional Director

Cranswick, Deborah

From: Melancon, Archie
Sent: Tuesday, October 03, 2000 12:13 PM
To: Cranswick, Deborah
Subject: FW: Draft EIS for the Proposed Use of Floating Production, Storage and Offloading Systems on the Gulf of Mexico Outer Continental Shelf

-----Original Message-----
From: periley@usgs.gov [mailto:periley@usgs.g~v]
Sent: Tuesday, October 03, 2000 11:28 AM
To: Archie.Melancon@mms.gov
Subject: Draft EIS for the Proposed Use of Floating Production, Storage and Offloading Systems on the Gulf of Mexico Outer Continental Shelf

Archie,

I couldn't locate a "name" and e-mail address to send this to. Since your name was mentioned as the contact person, I assume you can forward this to the appropriate person.

The USGS has no comments to offer for the subject EIS. Thanks. USGS01

Trish Riley

1

Department of Environmental Protection

Jeb Bush
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

David B. Struhs
Secretary

October 20, 2000

Mr. Chris C. Oynes
Regional Director
Minerals Management Service
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Re: Draft Environmental Impact Statement proposing Floating Production, Storage and Offloading Systems for use in the Gulf of Mexico

Dear Mr. Oynes:

The Florida Department of Environmental Protection (DEP) has coordinated a statewide review of the referenced Draft Environmental Impact Statement (DEIS) as the Governor's point of contact regarding mineral resource exploration and development in Federal waters. The DEIS evaluates the potential effects of using Floating Production, Storage and Offloading Systems (FPSOs) to produce oil and gas in the deepwater (>200m depths) portions of the Western and Central Planning Areas of the Gulf of Mexico (GOM). The introduction of FPSOs into the GOM would bring in technologies that have not been used in this region before. We appreciate this opportunity to review this programmatic document to assess potential risks posed to Florida's natural resources by the use of these technologies. Individual development projects may differ, however the base-case FPSO evaluated in this DEIS included the following characteristics:

- A double-hulled FPSO with an internal moored turret configuration that provides a strong connection point and a swiveling attachment for risers and anchoring cables.
- Risers that bring oil, gas and water from the manifolds on the seafloor to the FPSO. Three deepwater wells per manifold, three manifolds per FPSO for a total of 9 wells per FPSO in the base-case evaluation.
- Onboard storage for up to one million barrels of oil with maximum production and onboard processing of 150,000 barrels of oil per day.
- Onboard treatment of produced water to NPDES standards for overboard discharge (up to 70,000 barrels per day).
- Offloading capability to shuttle tankers for transport of oil to shore (once every three days at full capacity).

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- Offloading would be in a tandem configuration with the tanker tied to the stern of the FPSO. This configuration is considered to be safer than side by side offloading.
- Produced gas would be transported via pipelines (up to 200 million cubic feet per day).
- Flaring may be allowed on a case by case basis.

Alternatives in this evaluation included:

A) Conceptual approval of FPSOs. FPSOs would be considered acceptable deepwater development technology for use in the GOM.
B) Conditional approval of FPSOs with general restrictions or conditions on the design, operation or geographic locations
C) No Action. The concept of using FPSOs would not be accepted.

Under alternative B, four restrictions were identified based on existing regulatory requirements, risk, and impact assessments. Alternative B-3 includes prohibiting FPSOs from the Mississippi Delta area, specifically the Mississippi Canyon and Viosca Knoll map protraction areas. Alternative B-4 includes a requirement to have an attendant vessel present during all offloading operations. This attendant vessel would assist in the offloading activity, warn or fend off other vessels as needed, and carry oil spill response equipment.

FDEP01

If MMS determines that FPSOs are suitable for the Western and Central Planning Areas of the GOM, Florida recommends implementation of Alternative B-3 – Prohibiting FPSO operations in the Mississippi Canyon and Viosca Knoll areas. As the OSRA Model (OCS Report, MMS 2000-059) shows, risk of contact to Florida's offshore waters and natural resources by an oil spill in the Mississippi Delta area can be as high as 33%, depending upon the season. The size of oil spills has the potential to be much larger from FPSOs than spills from other types of production technology. Alternative B-3, prohibiting use of FPSOs in the Mississippi Delta area would minimize risk to Florida's natural resources from an oil spill in the Central Planning Area. Alternative B-3 would have the additional benefit of minimizing risks to the population of endangered sperm whales that reside in that area. Should alternative B-3 not be accepted, Florida requests that any proposed development plans using FPSOs in the eastern portion of the Central Planning Area be submitted to the state for review under the Coastal Zone Management Act, the National Environmental Policy Act and the Outer Continental Shelf Lands Act.

FDEP02

FDEP03

Florida resource managers also favor Alternative B-4, which requires an attendant vessel during offloading operations. As the DEIS points out, this alternative increases the safety of offloading operations and decreases response time if an oil spill does occur. The incremental increases in impacts listed in the DEIS are offset by the benefits of using the attendant vessel as described.

FDEP04

During our review, DEP staff and members of the scientific community raised a number of concerns about information contained in the DEIS. Minerals Management Service included data from 20 FPSO operations spanning from 1970 to the present time, although there was a total of 97 FPSOs operating during this same time period. These data were used to compare spill rates of other technologies and to assess the magnitude of risks to natural resources around the GOM. Our concerns stem from using this subsample of 20 FPSO operations, which may include only the best FPSO operational records. The voluntary nature of reporting FPSO spill data from the past era and from other countries may underestimate the spill rate for this technology and compromise the integrity of the analyses. We recognize data may not be available for those other FPSO operations and that MMS may be using all of the available information. This potential for bias and the confidence level of using this subset should be addressed in the DEIS.

FDEP05

FDEP06

The DEIS states that operators may propose single hulled or double sided/single bottom FPSOs. We understand that shuttle tankers serving the operation would have to be U.S. flagged vessels. Since there is not an excess of U.S. flag vessels available, new vessels would most likely be required which would have to be double-hulled under the Oil Pollution Act (OPA) of 1990 and Coast Guard regulations. If the shuttle tankers are most likely to be double-hulled vessels, we recommend that MMS also require FPSOs in the GOM to be of a double-hulled design. This requirement could mitigate the added risk of shuttle tankers colliding with an FPSO at sea. If Alternative C is not selected, Florida would prefer that purpose-built, double-hulled FPSOs be used in the GOM as opposed to converted tankers that have been used in some applications in the past.

FDEP07

Deficiencies were found in descriptions of Biological Resources (Section 3.2) of the Central and Western Planning Areas. Since very little is known about the baseline biological information for the deepwater areas of the GOM, it is imperative to use all of the current body of knowledge. For example, the DEIS does not mention that some deepwater groupers, such as Warsaw and speckled hind, are protected because their population numbers are dangerously low. Changes in migratory patterns of demersal species as well as the pelagic species listed in the DEIS should be evaluated. The document states that demersal species do not migrate extensively but tagging studies show extensive migrations of gag, red snapper and other demersal species in the GOM. During a University of Florida study, gag were tagged in a seagrass bed near the mouth of the Suwannee River in Florida. Some of these tagged fish were later recaptured off the coast of Texas.

The Fish Resources section (3.2.6) discussed in the Description of the Affected Environment only includes species with a demonstrated commercial value. There is no mention of vertebrate or invertebrate species that contribute to the maintenance of these managed fisheries species. For example, what kinds of ecosystem considerations are important to protect essential food organisms of the commercially important species? Presumably, (as required in the Magnuson-Stevens Fishery Conservation and Management Act) consideration of prey species upon which managed species depend is

FDEP07, continued

as important as protection of the managed species themselves. Therefore, some consideration of life cycle requirements of the managed species should be made.

FDEP08

There is little mention of the habitat type associated with the few species discussed. It is pointed out that the Gulf of Mexico Fishery Management Council has addressed Essential Fish Habitat (EFH) in its Fishery Management Plan (FMP), but little has been done in the DEIS with these data. For example, what proportion of the area that might be considered for FPSO deployment overlies candidate EFH areas? What species are most likely to be influenced by FPSO deployment? Which of these are considered the most troubled populations? It is probable that such summary information may be gleaned from the FMP.

The FMP mentioned above apparently provides locations and areal extent of EFH for fisheries species. One must ask how these data reflect the primary fishing grounds for the managed species. A particular EFH may be necessary for young life cycle stages, but not for mature organisms that are targeted by the fishery.

There is little discussion of the vigor of the managed fisheries populations. Is the reader left to infer that all of these fisheries are healthy, or is one or more of them troubled? If the latter, what are the problems – over fishing, habitat loss, water quality problems, low reproductive potential, etc? How would FPSOs and increased tanker traffic affect these problems?

FDEP09

A deficiency with section 4.4.4 regarding the Open-Ocean Oil Weathering model was found. The Gulf of Mexico Deep Water Operations and Activities Environmental Assessment (OCS EIS/EA, MMS 2000-001) refers to the potential for the asphaltene content of deepwater produced oil to cause tar balls, form a concrete on bottom sediments and have other impacts to coastal ecosystems and beaches (summary on page ix). This information is not discussed in the DEIS and is needed for a thorough assessment of risk, impacts and response options.

FDEP10

The DEIS provided information in tabular form on anticipated landfalls within Florida from a potential offshore spill. The predictions in the DEIS were generally very low. Seasonal impacts on these predictions showed increased risks to Florida's natural resources in the OSRA model (OCS Report, MMS 2000-059). There are times of the year when prevailing offshore currents move eastward along the Mississippi and Alabama coast with a far greater potential for a Florida coastline impact. These seasonal variations were not presented in the DEIS. These "worst-case" risks should be considered, particularly for operations in the eastern portion of the Central Planning Area (Mississippi Canyon and Viosca Knoll). Accepting Alternative B-3 would minimize many of these risks to Florida.

FDEP11

The potential impacts from hurricanes of various strengths should be assessed. Precautions that would be taken for hurricane situations should be described in better

FDEP11, continued

detail. Would oil spill response be possible if an FPSO were damaged or sank during a storm? How would delaying oil spill response affect response options? Many of the locations where FPSOs are currently operated (e.g. Brazil and North Sea) are not subject to the level of hurricane activity observed in the GOM. If data from past FPSO use are from locations that are not subject to the level of storm activity common in the GOM, then weather related hazards should be given greater consideration.

FDCEP12

A number of other deficiencies were found throughout the document. Over a dozen publications were cited in the text but were not included in the bibliography. Examples include Neff 1985 and 1997 on page 3-47, Jackson et al. 1994 on page 3-49 and MacDonald 1998 on page 3-67. The age of many of the cited works is also of concern. Citations that are over ten years old diminish the analyses of the socio-economic impacts (Sport Fishing Institute 1988). We recommend contacting the American Sportfishing Association and the Recreational Boating and Fishing Foundation for more recent socio-economic information regarding these segments of the economy.

FDEP13

Another concern raised during review of the DEIS is the value placed on fisheries resources. The value of fisheries is of significantly greater importance to the economies of coastal states than just the ex-vessel value or landings would indicate. Consider, for example, the restaurants and retail stores that depend on fresh seafood and the tourists who decide to visit an area because of the seafood and/or marine recreational opportunities afforded by healthy fish populations. Ex-vessel values or landings would be more useful if a socio-economic multiplier were used to estimate the actual economic impact to states, both direct and indirect, from these natural resources.

While we understand that many of the impacts from the proposed activity will occur far from the majority of recreational fishing activity, tankering activities will pose risks to these recreational resource uses. Impacts to the recreational fishing sector and the economic magnitude of recreational fishing were largely ignored in this document. Economic impact of recreational fishing is of a much higher magnitude than ex-vessel values associated with commercial fishing. The effects of an oil spill could have long lasting negative effects on local fishing communities due to changes in angler perceptions regarding catch rates, toxins in fish, etc. Many of the small Gulf coastal communities depend on recreational fishing and associated tourism to drive their local economy. These issues are not adequately addressed in this DEIS.

FDEP14

The need for additional information about deepwater ecosystems and the impacts that oil and gas production may have on them is acknowledged throughout this document. So much is unknown about deepwater benthic ecology and the biology of species living in these habitats. Because of this, MMS should encourage collection and reporting of biological data gathered in conjunction with other deepwater activities being conducted. Conducting "multi-missions" could significantly increase the body of knowledge available to resource mangers. We recommend that future studies relating directly to deepwater oil and gas operations focus on:

FDEP14, continued

Sediment and water quality impacts of muds and cuttings to deep-water benthic communities.

Remote sensing techniques for locating chemosynthetic communities.

Safe buffer distance to chemosynthetic communities. How was it determined a 1000' buffer is adequate protection for chemosynthetic benthic resources? What studies were conducted to develop this guideline? Should the buffer distance be increased for riserless drilling operations?

Operational technologies which can be used to protect structures from "energetic high frequency currents".

FDEP15

The Final EIS evaluating FPSOs on the GOM Outer Continental Shelf will provide the basis for tiering off EIS documents for future development projects. It is critical that all available information be used in this evaluation and that the evaluation be complete and accurate. Resolution of the noted concerns should be addressed. We request that the final document be submitted to the state for review. Depending on the decisions in the final document, the state may request that specific development plans using FPSOs in the Central Planning Area closest to the Eastern Gulf Planning Area be reviewed for federal consistency.

FDEP16

The State of Florida appreciates the opportunity to comment on this programmatic document. If you have any questions regarding the enclosed comments, please contact Kurtis Gregg at (850) 487-2231.

Sincerely,

Carliane D. Johnson
Environmental Supervisor
Office of Intergovernmental Programs

CJ/kg

cc: Cherie Trainor
Dennis Chew
Deborah Cranswick
Joe Christopher

OCT-11-2000 15:36 DNR-OS 225 342 5861 P.02/08

State of Louisiana

M.J. "MIKE" FOSTER, JR.
GOVERNOR

JACK C. CALDWELL
SECRETARY

DEPARTMENT OF NATURAL RESOURCES
OFFICE OF THE SECRETARY

October 11, 2000

Chris C. Oynes
Regional Director
Minerals Management Service
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

RE: C000474, Coastal Zone Consistency
Minerals Management Service
Direct Federal Action
Draft Programmatic Environmental Impact Statement (DPEIS) on potential effects of floating production, storage, and offloading (FPSO) systems in the Central and Eastern Gulf of Mexico OCS areas

Dear Mr. Oynes:

Thank you for your letter of August 10, 2000, conveying the above referenced DPEIS to Governor Foster and inviting the Governor to meet with you to discuss our comments on this project. As Secretary of the Department of Natural Resources, Governor Foster has designated me to respond with our State's concerns regarding FPSOs in the Gulf of Mexico. Below are our comments on issues of significance to Louisiana for your consideration on this important matter.

LADNR01

It is a top priority for Louisiana that the Federal government provide revenue sharing relief for the many incremental direct and indirect adverse impacts Louisiana has suffered from diverse aspects of OCS development, and that are likely to be increased with the current proposed FPSO action. For this reason, we strongly support the OCS Conservation and Reinvestment Act (CARA) bill now under review in Congress for increased revenue sharing by states and local governments most affected by OCS development activities, including the FPSO activity proposed in this DPDEIS. We recommend that MMS support Louisiana and other affected states in obtaining Federal impact assistance to help offset the environmental and infrastructure costs of continued OCS development.

P.O. BOX 94396 • BATON ROUGE, LA 70804-9396 • 625 N. 4TH STREET • 13TH FLOOR • BATON ROUGE, LA 70802
PHONE (225) 342-4500 • FAX (225) 342-5861 • WEB http://www.dnr.state.la.us

October 11, 2000
Mr. Chris C. Oynes
Page 2

LADNR02

There are three FPSO project alternatives under consideration, including Alternative A) the conceptual FPSO alternative, Alternative B) the conceptual alternative with certain restrictions which minimize impacts, and Alternative C) the no action alternative. The draft EIS is a programmatic document in that it addresses the proposed FPSO action generically, and thus, does not review any site-specific FPSO system. Subsequent site-specific FPSO proposals will be subject to established Federal and State review and decision processes, and will require submittal of a Consistency Determination to the State of Louisiana (as well as adjacent Gulf states).

LADNR03

The Final Environmental Impact Statement should fully address potential secondary impacts of land based support services, infrastructure and traffic resulting from the FPSO action on coastal wetlands in Louisiana.

The "base case" evaluated for the FPSO action is a permanently moored, double-hulled, ship-shaped FPSO with up to one million barrels of crude oil storage capacity. The seafloor well equipment and on-board production equipment will be the same as for conventional deepwater facilities. Produced oil will be offloaded to shuttle tankers for transport to ports in Louisiana and Texas, or to the Louisiana Offshore Oil Port (LOOP). Associated or produced gas will be transferred to shore by gas pipeline. If approved by MMS, this FPSO action would be expected to result in the deployment of 5 FPSOs on the Outer Continental Shelf (OCS) by 2010, and would be expected to generate between 365 and 685 shuttle tanker transits to Gulf of Mexico ports in 2010.

LADNR04

It is our concern that the new types of equipment and operations which would be deployed for the first time in the Gulf of Mexico with the FPSO action, may increase the likelihood and magnitude of accidental and storm-related oil spills compared to traditional modes of petroleum production, storage and transport in

October 11, 2000
Mr. Chris C. Oynes
Page 3

LADNR04, continued

the Gulf of Mexico, with consequent adverse impacts on Louisiana's coastal wetlands and waters. To minimize potential impacts on Louisiana's coastal wetlands, we will expect MMS to explore all possibilities for minimizing the potential for oil spills and to insist that industry utilize best practical techniques and technologies in minimizing the size and frequency of oil spills with any future development in the Gulf of Mexico OCS.

LADNR05

Among FPSO operations, MMS has concluded (page 4-175) that 94.4 percent of the volume of potential FPSO-unique spills is likely, to be due to the transfer of oil from the FPSO to the shuttle tanker and from the shuttle tankers to shore, with 53.6 percent of the volume likely to be from shuttle tankers near port and 39.0 percent likely to be from shuttle tankers in transit to port. Thus, tankering of oil from deepwater operations will have the potential to result in large oil spills that could occur close to or directly in coastal habitats. Such spills could result in heavily oiled wetlands, waterways, and beaches and would include irreversible wetland loss and large reductions in habitat productivity for extended periods.

To put the oil spill risk of FPSOs in perspective, the risk of shuttle transport spills was compared with the risk of spills from oil transport by offshore pipelines which they would replace. MMS estimates (page 4-175) that for tanker transport, there will be 1.21 spills of volumes greater than 1,000 bbls for every billion bbls transported, whereas with pipeline transport, there would be 1.32 spills. Therefore, it is concluded that the oil spill risk for shuttle tanker transport is comparable to and slightly less than that of conventional pipeline transport.

LADNR06

With regards to the alternatives under consideration here, and with oil spill risks in mind, we recommend that MMS restrict FPSO activity to a combination of three of the options under Alternative B. These include B-1, which excludes lightering-prohibited areas in the Gulf of Mexico, B-3, which excludes the Mississippi

October 11, 2000
Mr. Chris C. Oynes
Page 4

LADNR06, continued

Canyon/Viosca Knoll Area that is located near the Mississippi River Delta and Breton Islands, and B-4, which requires that an attendant vessel be present during offloading operations. This measure would enhance safety and provide a level of immediate oil spill response capability. Within the Study Area, the areas excluded by Alternative B options B-1 and B-3, are the deepwater areas nearest the coast of Louisiana, and thus, the areas from which oil spills are most likely to reach coastal Louisiana marshes.

LADNR07

The U. S. Coast Guard has designated the lightering-prohibited areas excluded in option B-1 to protect the Flower Garden Banks and other ecologically sensitive topographic features from ship anchoring damage, direct impact of accidental spills, and ecological hazards of a potential sunken vessel damaging these areas. The FPSO proposal could potentially adversely affect these same sensitive resources in the same ways as determined by the Coast Guard. Thus, we believe FPSO activities should also be prohibited from the lightering-prohibited areas designated in option B-1.

Option B-3, consisting of the Mississippi Canyon and Viosca Knoll Areas of the OCS, is closest to the Louisiana coast of all deepwater areas, and has the greatest potential for oil spills reaching coastal marshes as determined by the MMS oil spill analysis presented on page 4-225 of the DPEIS. There is also a resident population of endangered sperm whales in the waters of these lease areas.

LADNR08

FPSO activities could also have long-term significant impact in air quality at Breton Sound National Wilderness Area due to potential exceedances of the Class I sulfur dioxide standard. In fact, air quality impacts present one of the least well understood and potentially significant issues of oil and gas development in the OCS. In preparation of the Final EIS, air quality issues should be closely coordinated with Louisiana Department of Environmental Quality.

October 11, 2000
Mr. Chris C. Oynes
Page 5

LADNR09

Further, there are numerous navigational activities in these waters, due to the close proximity to the Southwest Pass Navigational Channel, which could increase the potential for ship collisions if FPSO activities are allowed in this area. Thus it is prudent and reasonable to exclude these areas from FPSO activities, which is our recommendation.

LADNR10

Option B-4, involving an attendant vessel during all offloading operations, provides an immediate spill response capability. We believe this is a best practical technique, and thus strongly recommend this option be selected for implementation. Option B-2 involves prohibiting FPSOs in the Gulf of Mexico near Corpus Christi, Texas. This option should have no effect on Louisiana; thus we offer no opinion on this option.

Under Alternative C, the No Action alternative, the general concept of using FPSOs in the Gulf of Mexico OCS would not be accepted by MMS. The alternative would not necessarily prohibit the use of FPSOs in the Gulf of Mexico because operators could submit project-specific FPSO development proposals to MMS and federal and state agencies for their approval under existing review processes. As a consequence, the environmental effects associated with Alternative C could potentially be the same as for the proposed action (Alternative A) or options B-1 through B-3 of Alternative B. Another negative effect is that some deepwater petroleum resources would probably remain undeveloped in areas where conventional pipeline transport options would not be viable from a technological and/or economic standpoint. The No Action Alternative C would thus limit some potential economic benefits that could be realized with FPSO activity.

LADNR11

It is our further concern that FPSO vessels and equipment be designed to standards at least as high as that for oil platform systems currently operating in the Gulf. Specifically, the operation of FPSO facilities should have hurricane shut down and evacuation plans that meet or exceed those which conventional

October 11, 2000
Mr. Chris C. Oynes
Page 6

LADNR11, continued

platforms must adhere to (i.e., operation shutdown and evacuation 3 days prior to a hurricane event). In addition, FPSOs should be pumped dry and hydrocarbons tankered to shore prior to hurricane events to minimize oil spill risk. A related concern during hurricane periods is to have adequate, heavy weather capable oil spill response equipment readily available in the Gulf, as well as adequate numbers of tankers to empty FPSOs prior to hurricanes. The FPSO vessels should be equipped with devices to easily locate them after a hurricane should they sink or come adrift.

LADNR12

Another aspect of the oil spill problem with deepwater development and FPSOs, should they be used, is that the physical and chemical properties of deepwater oils may differ substantially from oils typically produced in shallow waters of the Gulf, and may require different spill countermeasures than typically employed for shallow water oil and gas wells. Spills of heavy, high asphaltene oils may cover water bottoms, thereby impacting submerged vegetation, oysters, and other benthic habitats in the Louisiana Coastal Zone. Such spills might greatly increase the occurrence and volume of tar on barrier beaches and could exacerbate the anoxic zone that forms each summer off the Louisiana coast. We believe that MMS should continue to study the characteristics of these hydrocarbons and the potential of this type of oil spill to adversely affect the coastal estuarine ecosystem of Louisiana. Particularly with regards to FPSOs, MMS should continue to encourage industry to develop and utilize the best practical techniques to respond to, minimize, and control oil spills within the Gulf environment. With the final EIS, we recommend including a section describing the existing oil spill response capability in the Gulf, and an analysis of it's potential shortcomings (if any) under the FPSO scenarios selected for approval.

Finally, we appreciate the opportunity to provide our comments to MMS on the proposed use of FPSOs alternatives in the Central and Western Planning Areas of the Gulf of Mexico. Thank you for the offer to meet and discuss our comments. I or my staff will be in

October 11, 2000
Mr. Chris C. Oynes
Page 7

contact as the need for discussion or coordination on this important matter arises, to arrange meetings at our mutual convenience. If you should have any questions with regards this matter, please call me at 504-342-2710.

Very truly yours,

Jack C. Caldwell

Jack C. Caldwell

cc: Governor M. J. "Mike" Foster, Jr.

TOTAL P.08

Coastal Coordination Council

P.O. Box 12873 ♦ Austin, Texas 78711-2873 ♦ (512) 463-5385 ♦ FAX (512) 475-0680

Gulf of Mexico OCS Region
MMS
OCT 0 2000
Office of the Regional Director

October 2, 2000

Mr. Chris C. Oynes
Regional Director
Minerals Management Service
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Re: Draft Environmental Impact Statement, Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico Outer Continental Shelf

Dear Mr. Oynes:

Pursuant to Section 506.20 of 31 TAC of the Coastal Coordination Act, the project referenced above has been reviewed for consistency with the Texas Coastal Management Program (CMP).

CCC01

It has been determined that there are no significant unresolved consistency issues with respect to the project. Therefore, this project is consistent with the CMP goals and policies.

Sincerely,

Thomas R. Calnan
Consistency Review Coordinator
Texas General Land Office

TRC/cm

Texas General Land Office

David Dewhurst
Commissioner

Stephen F. Austin Building
1700 North
Congress Avenue
Austin, Texas
78701-1495
512-463-5001

October 10, 2000

Regional Director (MS 5410)
Gulf of Mexico OCS Region
Mineral Management Service
1201 Elmwood Park Blvd.
New Orleans, Louisiana 70123-2394

Subj: Comments on the DEIS for FPSOs

Dear Sir or Madam:

The Texas General Land Office (GLO) respectfully submits the following comments pursuant to the Minerals Management Service's Draft Environmental Impact Statement (DEIS) to evaluate potential environmental effects of the proposed use of Floating Production, Storage, and Offloading Systems (FPSO) in the Central and Western Gulf of Mexico.

In accordance with Chapter 40 of the Texas Natural Resources Code, also known as the Oil Spill Prevention and Response Act, the Texas General Land Office is designated as the lead state agency for coastal oil spill prevention and response policy. Additionally, the GLO is a designated natural resource trustee agency and coordinates natural resource damage assessments with the appropriate state and federal agencies.

TGLO01

The GLO recognizes the significant economic contribution that renewed oil exploration in the Gulf of Mexico can bring to both Texas and the nation. As demand for petroleum products continues to grow, the introduction of new streams of crude oil from the Outer Continental Shelf has the potential to exert positive forces on the national petroleum market. However, the introduction of new production, storage and transportation technology also presents a challenge to ensure that operations are conducted in a manner consistent with basic environmental tenets. As such, the GLO offers the following specific comments.

TGLO02

- The GLO believes that the development of the FPSO concept extends to inland waterway refineries where the new production will be delivered. Whether it be an increase in the traffic in the Houston Ship Channel or a rise in the number of transits and fuel transfers throughout the Intracoastal Waterway system, there will inevitably be an increase in the vulnerability of the environment that extends well beyond the immediate area

Regional Director
October 10, 2000
Page 2

TGLO02, continued

of the FPSO. Recognizing and planning for this increased risk should be of utmost importance in the development of FPSO operations.

TGLO03

- It is the GLO's understanding that shuttle tankers have been the preferred method of bringing the production from FPSOs operating in other parts of the world. It is also the GLO's understanding that some companies are considering using "super barges" as a less costly alternative to shuttle tankers. This alternative should be explored with great caution, since this mode of moving crude oil in such large quantities has yet to be proven.

TGLO04

- It has long been recognized that the existing dispersant delivery capability in the Gulf of Mexico is less than adequate. Prior to commencing any FPSO operation in the Gulf, dispersant regulations currently contemplated by the U.S. Coast Guard must be adopted. This linkage is critical to ensure rapid oil spill response capability.

TGLO05

- Because of the unique nature of FPSOs, existing spill prevention, response and contingency planning requirements may not be well suited for their operations. The GLO strongly encourages a complete evaluation of existing requirements, and a commitment to restructure them as necessary.

TGLO06

FPSOs have been successfully operating in other parts of the world for a number of years, including the inhospitable waters of the North Sea. By all accounts, they have proven to be a safe and environmentally sound method of crude oil production. The GLO endeavors to play a role in the development of this technology, and intends to exert the necessary influence to protect Texas coastal waters and promote the economic well being of the Texas economy.

Thank you for the opportunity to comment on this important initiative. Please feel free to contact me if you have any questions or need additional information.

Sincerely,

Greg Pollock

Greg Pollock
Deputy Land Commissioner
Oil Spill Prevention and Response Division

Robert J. Huston, *Chairman*
R. B. "Ralph" Marquez, *Commissioner*
John M. Baker, *Commissioner*
Jeffrey A. Saitas, *Executive Director*

THE STATE OF TEXAS

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

August 31, 2000

U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region (MS 5410)
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

Re: Minerals Management Service

Dear Sirs:

The following staff of the Texas Natural Resource Conservation Commission (TNRCC) have reviewed the above-referenced project and offer the following comments:

TNRCC01

Staff recommends the environmental assessment address action that will be taken to prevent surface and groundwater contamination during and after construction.

If you have questions regarding water quality comments, please feel free to contact Mr. Clyde Bohmfalk, Policy and Regulations Division, at (512) 239-1315.

The Office of Border Affairs has reviewed the above-referenced project and has no comments, based on the material provided. If you have any questions regarding these comments, please feel free to contact Mr. Steve Niemeyer, Office of Border Affairs, at (512) 239-3605.

Thank you for the opportunity to review this project. If I may be of further service, please call me at (512) 239-1454.

Sincerely,

Mary Lively

Mary Lively
Office of Environmental Policy, Analysis, & Assessment
Texas Natural Resource Conservation Commission

P.O. Box 13087 • Austin, Texas 78711-3087 • 512/239-1000 • Internet address: www.tnrcc.state.tx.us

printed on recycled paper using soy based ink

OFFICE OF THE GOVERNOR
STATE OF ALABAMA

DON SIEGELMAN
GOVERNOR

STATE CAPITOL
600 DEXTER AVENUE, ROOM N-104
MONTGOMERY, ALABAMA 36130

(334) 242-7100
FAX: (334) 242-0937

Gulf of Mexico OCS Region
MMS
AUG 31 2000
Office of the Regional Director

August 28, 2000

SEP 5 2000

Mr. Chris C. Oynes
Regional Director
United States Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123

Dear Chris:

Thank you for your recent letter regarding the draft environmental impact statement concerning the potential effects of floating production, storage and offloading systems in the Gulf of Mexico. I appreciate your contacting my office to share your concerns with me, and I welcome the opportunity to respond.

ALABAMA01

I have forwarded your correspondence to Sabra Barnett, director of my Policy Department, to explore this matter on my behalf. Should you need to contact Ms. Barnett, she may be reached at 334-353-1159. Feel free, too, to contact my office with any further questions or thoughts you may have.

Thanks, again, for your thoughtful correspondence, and best regards.

Sincerely,

Don Siegelman
Governor

DS/me/ar

cc: Ms. Sabra Barnett

REPRESENTATIVE
JOHN E. DAVIS

CAPITOL OFFICE
P.O. BOX 2910
AUSTIN, TEXAS 78768-2910
(512) 463-0734

DISTRICT 129 OFFICE
1350 NASA RD. 1, SUITE 212
HOUSTON, TEXAS 77058
(281) 333-1350
FAX: (281) 335-9101

TEXAS HOUSE OF REPRESENTATIVES

October 9, 2000

Gulf of Mexico OCS Region
MMS
OCT 13 2000
Office of the Regional Director

Regional Director
Gulf of Mexico, OCS Region
Minerals Management Service
1201 Elmwood Park Blvd.
MS-4510
New Orleans, LA 70123-2394

Dear Sir:

DAVIS01

I was very pleased to hear of the prospective FPSO system that may be utilized in the Gulf of Mexico. I applaud these companies which are interested in seeking ways to increase production and, of course, support any increased business into the Port of Houston.

DAVIS02

As the State Representative for a significant number of constituents who reside along the Galveston Bay complex and the Houston Ship Channel, I do have serious concerns regarding the safety of vessels, which may be piloted by inexperienced mariners.

The Houston Ship Channel is known as the most difficult pilotage in the world because of the very long and narrow channel and the heavy load of traffic, and yet Houston has one of the finest safety records in the country. It is my belief we have an obligation to make each individual passage as safe as possible and I would strongly encourage the use of State Licensed Pilots on all shuttle tankers which may carry petroleum products from the FPSO's into the Port of Houston.

The Galveston Bay Complex and the Houston Ship Channel are tremendous resources for our state and it is my responsibility to do all that I can to protect them from any unnecessary environmental harm. I would greatly appreciate your consideration of this matter as your office undergoes the permitting process for the FPSO's.

Respectfully,

John E. Davis
State Representative
District 129

EMAIL: JOHN.DAVIS@HOUSE.STATE.TX.US

THE SENATE OF THE STATE OF TEXAS

CAPITOL OFFICE
P.O. BOX 12068
AUSTIN, TEXAS 78711
512/463-0111
TDD: 1-800-735-2989

DISTRICT 11
1109 FAIRMONT PARKWAY
PASADENA, TEXAS 77504
713/948-0111
FAX: 713/948-0004

MIKE JACKSON

October 10, 2000

Gulf of Mexico OCS Region
MMS
OCT 1 3 2000
Office of the Regional Director

EIS
Regional Director
Gulf of Mexico, OCS Region
Minerals Management Service
1201 Elmwood Park Boulevard
MS-4510
New Orleans, Louisiana 70123-2394

Dear Sir:

I was pleased to hear Floating Production Storage and Offloading Systems (FPSOS) may be utilized in the Gulf of Mexico. I heartily support the efforts to bring increased business into the Port of Houston. SMJ01

A significant number of my constituents live and work in the Galveston Bay-Houston Ship Channel complex. Because I want to do everything I can to insure their safety and to protect the area from environmental harm, I have serious concerns regarding the use of mariners with only a federal license to pilot large, deep-draft vessels in the Houston Ship Channel.

The Port of Houston is an enormous complex of private and public docks located along a narrowly dredged channel known for its difficulty in navigating. It maintains one of the best safety records in the country, however, by utilizing pilots who--in addition to a federal license--must hold a state license granted only after completion of a rigorous and very specialized training program. It is these state licensed pilots who are responsible for our excellent safety record. SMJ02

I ask that you consider my concerns as you continue with the FPSOS permitting process.

Sincerely,

Mike Jackson

Mike Jackson
State Senator, District 11

MJ:dc:ls

Robert E. Talton

CAPITOL OFFICE:
P.O. Box 2910
AUSTIN, TEXAS 78768-2910
(512) 463-0460

DISTRICT OFFICE:
P.O. Box 5661
PASADENA, TEXAS 77508
(713) 472-0539

District 144
House of Representatives

Carswick

October 2, 2000

Gulf of Mexico OCS Region
MMS
OCT 0 6 2000
Office of the Regional Director

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OCT 1 0 2000

EIS
Regional Director, Gulf of Mexico
OCS Region
Mineral Management Service
1201 Elmwood Park Blvd.
MS-5410
New Orleans, Louisiana 70123-2394

Dear Gentlemen:

The Port of Houston is an enormous complex of private and public docks connected by a narrow dredged channel. More than 18,000 ships and 100,000 barges will navigate the Houston Ship Channel this year and yet Houston has one of the finest safety records in the country. We want to keep the Port one of the nation's safest.

I am very supportive of attracting new business to the Port of Houston. However, I have concerns about mariners with only a federal license piloting large deep-draft vessels in the Houston Ship Channel as seems will be the case with Floating Production Storage and Offloading Systems. State licensed pilots are the navigators responsible for our fine safety record and those pilots should continue to oversee navigation in the channel. RRET01

Thank you for your attention to this matter.

Sincerely,

Robert E. Talton

Robert E. Talton
State Representative

RET:ch

CRIMINAL JURISPRUDENCE COMMITTEE

ENVIRONMENTAL REGULATION COMMITTEE

PORT FREEPORT

P.O. BOX 615 ★ FREEPORT, TX 77542-0615
(979) 233-2667 ★ 1 (800) DOCKSIDE(E) ★ FAX: (979) 233-5625

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October 12, 2000

Regional Director (M55410)
Gulf of Mexico OCS Region
Minerals Management Services
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

RE: Floating Production, Storage and Offloading Systems on the Gulf of Mexico, Outer Continental Shelf-(FPSO) Draft Environmental Impact Statement and Period for Written Comments.

Gentlemen:

Port Freeport wishes to comment on the Floating Production, Storage and Offloading System contemplated for the Gulf of Mexico, off the Texas coastline.

PF01

PF02

Our main areas of concern are, first of all, should the shuttle vessels not require a state pilot, but rather rely on a federal pilot, the issue of communication and vessel traffic control needs to be addressed. Port Freeport is a rather small compact port with well over 1500 sailings per year, most of which is either crude oil or chemical related. To date, we've not had any serious accidents as a result of pilot error or mechanical problems with vessels, due largely in part to the expert pilotage offered by the Brazos Pilots Association. We do not have a VTS system in place, which I believe should be mandatory for such operations in small ports such as Freeport. Secondly, the criteria for becoming a federal pilot seems rather shallow at best. It is our understanding that a simple 12 passages and passing a written test is all one needs to obtain a federal license, which may be well for other ports, but not Freeport. Port Freeport has established Port Safety Rules which address both daylight only passage on large vessels as well as one-way traffic. All of these issues would come into play and need to be addressed prior to implementing any such program at Port Freeport.

Very truly yours,

A. J. Reixach, Jr.,
Executive Port Director

/lvm

cc: R. H. Van Borssum, President
Texas Ports Association

John Gunning, President
Texas Pilots Association

PORT OF HOUSTON AUTHORITY

EXECUTIVE OFFICES: 111 EAST LOOP NORTH • HOUSTON, TEXAS 77029
MAILING ADDRESS: P.O. BOX 2562 • HOUSTON, TEXAS 77252-2562
TELEPHONE: (713) 670-2400 • FAX: (713) 670-2697

CAPT. JOHN T. SCARDASIS
Director of Operations
(713) 670-2676

October 5, 2000

EIS
Regional Director, Gulf of Mexico
OCS Region
Mineral Management Service
1201 Elmwood Park Blvd.
MS-5410
New Orleans, La. 70123-2394

Dear Sir:

It has been called to the Port of Houston Authority's attention that consideration is being given to the development of Floating Production Storage and Offloading Systems in the Gulf of Mexico.

PHA01

There are aspects of this program which give us some cause for concern. Our primary concern is with regard to the transport of the accumulated product from the FPSO System to the shoreside receiving facilities within the confines of the Houston Ship Channel. We understand that vessels engaged in this trade will not be required to use the services of the Houston Pilots. If this in fact is the case, then our concern is raised to a level of alarm.

The Houston Ship channel is one of the most heavily trafficked waterways in the United States with thousands of ship and barge transits annually. Our channel is narrow and difficult to navigate in comparison to many other port waterways. We feel that the excellent safety record the channel now enjoys is directly attributable to the skill of our Houston Pilots who with intimate knowledge of the Houston Ship Channel, years of experience and skill development, are able to safely navigate this demanding waterway under all possible conditions.

To inject a new element of pilotage into this coordinated system will at best be disruptive and at worst possibly lead to a catastrophic event causing irreparable damage to the environment and loss of human life.

We trust you will give this matter your most serious consideration.

Your very truly,

Captain John Scardasis

c: H. T. Kornegay, Executive Director - PHA

COMMENT CARD

Draft Environmental Impact Statement for the Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico OCS – Western and Central Planning Areas

Name (please print) BOB ACKER

Agency/Organization INDEPENDENT CONSULTANT

Address 4511 HONEYWOOD CT., HOUSTON, TX 77059

COMMENTS It would be useful to know more details about the ~~[illegible]~~ oil spill record from FPSO-related activity in the world. How many from shuttle vessels; from transfers; from storms, etc? This would better flesh out the risk & prevention issues.

ACKER01

Please provide written comments above (use back of this page or additional sheets, if necessary) and return to the sign-in desk, or mail to:

Regional Director
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Written comments must be postmarked by October 11, 2000.

Houston 9/20/00

---

24 August 2000

Regional Director, Gulf of Mexico OCS Region
Minerals Management Service
1201 Elmwood Park Boulevard, MS-5410
New Orleans, LA 70123-2394

Re: Draft EIS on the Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico Outer Continental Shelf

To Whom It May Concern:

As I am unable to attend the public hearings on this draft Environmental Impact Statement (dEIS), I am submitting these written comments for your consideration:

1. Executive Summary, Mitigation for Oil Spill Response Readiness. The EIS makes the statement that "there is no reliable means of determining what spill response contractual arrangements may be in place then the first FPSO is installed in the GOM." The Oil Pollution Act of 1990 requires an owner of an OCS facility to prepare and submit a plan for responding, to the maximum extent practicable, to a worst chase discharge, or threat of such discharge of oil from a covered facility. In this case, the plan is required to be submitted for approval by MMS prior to the facility commencing operation. If the submitted plan is not a "reliable means of determining the contractual arrangements" then it should not be approved by the MMS. SD01

2. Section 1.4. "Consideration of the proposed action is limited to a 10-year period, 2001 through 2010.

   Given the planning times necessary for development of such an offshore facility, this hardly seems adequate. If a commitment were made in 2002 to construct such a facility, given the history of recent shipyard projects in the U.S., it is likely that it would not be fully operational until 2006. SD02

3. Section 1.4.2.9. The statement is made that certain firefighting systems would meet Coast Guard requirements. I am unable to identify any Coast Guard requirements applicable to either Helideck fire-fighting systems or Process deluge systems on FPSOs. If no such requirements exist, how can the public be assured they will be applied and enforced? SD03

4. Table 1-1. Marine operations manning. What is the basis for the proposed marine operations manning level? This is only two more persons than are typically required on an offshore supply vessel when operating for more than 12 hours. It doesn't seem adequate, particularly if a radar watch is to be maintained. SD04

SD05

5. Section .1.5.3. The dEIS fails to consider the differences between the regulatory controls that the U.S. Coast Guard can assert over U.S. flag vessels and those registered in other nations. While it may be appropriate to conclude that the Jones Act requires the shuttle tankers to be U.S. flag, the same cannot be said of the FPSOs.

SD06

6. Section 4.1.2.5. "Domestic wastes will be discharged directly to the ocean in accordance with a USCG discharge permit." The Coast Guard does not issue such permits.

7. Table 4-5. Waste discharges.
   a. The EIS implies that these discharges are unavoidable. I do not believe this to be the case. It should be possible to apply controls to some or all of these discharges to further ameliorate their effects. SD07
   b. It might be preferable to incinerate, rather than transport to shore for disposal, most of the FPSO's trash. SD08
   c. The EIS implies that ALL deck drainage will be captured and treated. Given the possible volumes of rainwater in the Gulf of Mexico, and the possibility of collecting seawater on deck under some conditions, this hardly seems to be a credible statement – nor should it be necessary. Such treatment should be limited to the decks in the process areas. SD09

8. Section 4.1.2.8 and Table 4-7.
   a. The statement is made that a vapor recovery system MAY be employed. However, it does not appear that the EIS considers fugitive vapors from either the FPSO or the shuttle tankers during cargo loading operations. Either the vapor system must be mandated, or the vapor loading included in the impact calculations. SD10
   b. The calculations also appear to omit any inert gas generator to maintain an inert and positive pressure atmosphere in the cargo tanks during offloading operations. SD11
   c. The use of AP-42 (1998) may be overly conservative. Additional regulatory controls on many of the named engines have been imposed since those factor were developed. SD12

9. Table 4-34.
   a. Produced water. To summarily state that no further options for ameliorating the effect of produced water discharges is inappropriate. Because, unlike most platforms, the FPSO has a storage capacity, the capability exists to apply treatment options for produced water that cannot be reasonably applied on other production facilities. These processes should be investigated. SD13

   b. Articulated Tug Barges. The statement is made that these units are relatively new developments and no historical data exists. This is not the case. The concept is at least 25 years old. It has been used in the U.S. for oceangoing tank barges and its record is NOT good. The use of an ATB might also enable, under certain circumstances, the unit to be operated without Coast Guard licensed personnel. SD14
   c. If the FPSO isn't going to be abandoned during hurricanes, a severe weather operations plan needs to be mandated to define what steps are to be taken both for protection of the environment, and protection of personnel. SD15

10. Section 4.4.3. Several areas of concern are identified regarding oil spill response shortfalls. I believe these should be deemed to be outside the scope of the EIS. The FSPO itself is a relatively small tanker, as are the shuttle tankers. The well risks are identical with or without the FSPO. Given that far larger tankers are presently operating in the Gulf of Mexico, it would seem that these areas of concern should be addressed by MMS and the Coast Guard with respect to current operations and response plan approvals. If any shortfalls exist, they exist NOW. SD16

The dEIS also fails to address two macro-economic issues. The acceptance of the preferred alternative in the dEIS will better serve to stimulate the development of this technology than would case-by-case evaluation of the FPSO operations. This will have two effects: SD17

a) It will bring hands-on experience with FSPOs to the U.S. The U.S. is clearly lagging in this regard. Such experience will serve to stimulate interest in this technology by U.S. companies worldwide.

b) To the extent that domestic oil and gas production is stimulated by the operation of FPSOs, U.S. importation of foreign petroleum products will be reduced. Oil imports appear to account for more than 80% of the current U.S. trade deficit. SD18

SJ Danscuk

SJ. Danscuk
6767 Basin Ave
Portland, OR

COMMENT CARD

Draft Environmental Impact Statement for the Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico OCS – Western and Central Planning Areas

Name (please print) Thomas W. Hudson

Agency/Organization

Address 23 Ripple Rush Ct
The Woodlands Tx 77381

COMMENTS

TWH01

I am concerned that Noone has spoken to the industry magazine articles Proposing ATB's for use as Shuttle Vessels. That proposal is extremely dangerous as those types of vessels are less maneuverable and present serious navigational hazards to themselves & other vessels. These vessels are proposed because they are less expensive to build & operate. Any vessel proposed shall be examined and commented on by the various Pilot Associations. They have The most experience in evaluating vessels and are Knowledgable on The conditions in each port

Please provide written comments above (use back of this page or additional sheets, if necessary) and return to the sign-in desk, or mail to:

Regional Director
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Written comments must be postmarked by October 11, 2000.

Houston 9/20/00

G.M. RICHARDS ENTERPRISES, INC.
MARINE OPERATIONS - CONSULTANTS - SHIPPING AGENTS
GULF COAST OFFICE

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FAX: (281) 486-1778

TLX: 247552 GMRE UR
E-MAIL: gmrehou@gmreshipagent.com
WEBSITE: www.gmreshipagent.com

October 10, 2000

EIS
Regional Director, Gulf of Mexico
OCS Region
Mineral Management Service
1201 Elmwood Park Blvd.
MS-5410
New Orleans, LA 70123-2394

SUBJECT: FPSO system.

Dear Sir:

I, Gordon M. Richards, Sr., have some concern about the above subject.

GMR01

I have been associated with various state pilot groups along the east and Gulf Coast of the U.S. and feel that with vessel traffic presently traversing the waters of the various Gulf Coast ports it would highten the chances of incidents happening on the channels that would be too enormous to cope with.

GMR02

At this time as in the past the state pilots that now assist the Masters on their respective vessels have a day to day knowledge of what is taking place in that particular tributary as to channel closures; markers; buoys not being on station and therefore have a great advantage over a Federal Pilot that only traverses those areas whenever the occasion arises.

The State Pilots are continously working with the U S C G V T S regarding any instant changes in the waterways that are being worked.

The prospective State Pilots come in with the merchant vessel knowledge as they have served on them possibly from Third Officer thru Chief Officer/Master and then they serve their time in the association which I believe is three years before they are assigned to a vessel. At that time they ride those vessels with a seasoned pilot for numerous voyages before they are assigned a vessel.

I do feel that the difference in fees between a Federal Pilot and State Pilot would be minimal if you should consider the consequences of an incident taking place and the final cost of same.

Very truly yours,

Gordon M. Richards, Sr.
For/On Behalf of G. M.
Richards Enterprises, Inc.

EAST COAST
The Robert F. Senseny Bldg., 1 Hausel Road, Suite 208, Wilmington, DE 19801 Off: (302) 654-5460
CORPUS CHRISTI OFFICE
711 N. Carancahua, Suite 1107, Corpus Christi, TX 78475 Off: (361) 887-7442

COMMENT CARD

Draft Environmental Impact Statement for the Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico OCS – Western and Central Planning Areas

Name (please print) Allen J. Verret

Agency/Organization N/A

Address 62 Kebb St
Abita Springs, LA 70420

AJV01

COMMENTS I suggest the MMS's efforts on the FPSO-EIS and the alternative 'A' of that document

Please provide written comments above (use back of this page or additional sheets, if necessary) and return to the sign-in desk, or mail to:

Regional Director
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Written comments must be postmarked by October 11, 2000.

OCT 10 2000

Louis & Emilce Vest
2922 Jobville
Seabrook, Texas 77586

Phone: 281-474-7008
Fax: 281-474-4590

Regional Director
Gulf of Mexico OCS Region
Mineral Management Service

Oct. 2, 2000

LV01

My name is Louis C. Vest. I am a pilot in the Port of Houston. I graduated from the U.S. Naval Academy in 1971, spent three years in the navy on ships and two years as officer-in-charge at a navy tugboat facility. After the navy I continued to work in the towing industry until becoming a pilot in 1986. My last position before Houston was captain of integrated tug/barge units (now called ATBs) of up to 200,000 barrel capacity. While working as a pilot in Houston I am frequently called on to provide pilot services for ATBs coming in and out of port. The majority of my work as a pilot has been with ships of all types and sizes. I am qualified to compare the maneuvering characteristics of both ships and ATBs. I am also impartial, not being affiliated with any company that will operate either type of vessel. I am paid according to the size and draft of the vessel piloted. Since carrying capacity governs the dimensions of both types of vessels my remuneration as a pilot will be about the same either way.

I am writing to express concern about the possibility of 500,000 barrel ATB units being used to shuttle oil to Gulf of Mexico ports from the planned floating platforms. The maneuvering characteristics of these vessels are markedly inferior to those of properly designed ships of equal cargo capacity. Stated another way, a 200,000 bbl ATB maneuvers like a 500,000 bbl ship.

According to an article in the shipping magazine Fairplay (Sept. 14, 2000), the project will require the building of 30-50 units. The interest in ATB vessels is generated by their low cost. A 500,000 bbl ATB can be built for about $80 million versus $116-150 million for an equal capacity ship. Crew manning requirements for ATBs are much lower as well.

There is a reason ATB units cost less to build. They are cheaper to build because they are built to lower standards. They are cheaper to man because their manning requirements are lower. Many of them are built as uninspected vessels so they are not even subject to regular safety inspections. ATBs are basically cheap evasions of laws designed to make ships safer on the high seas and in our ports.

Before a major program gets underway to construct the units necessary for the shuttle operation I urge you to sponsor a study to compare the safety record of ATBs with the safety record of similar sized ships. Insist that ATBs be built and manned to the same standards as ships and we will see interest in these vessels evaporate.

As I make my way around the docks and refineries in Houston the most frequent slogan I see on banners and signs is "SAFETY FIRST". Let's make sure that slogan is in place in the executive offices and boardrooms of the United States when the decisions about our tanker fleets are being made. Don't handicap us with marginal equipment and then hang the mariners out to dry when the inevitable accident occurs.

Sincerely,

L. Vest

October 5,2000

Regional Director
Gulf of Mexico OCS Region
Mineral Management Service
1201 Elmwood Park Blvd.
MS-5410
New Orleans, La 70123-2394

Gulf of Mexico OCS Region MMS Office of the Regional Director

RECEIVED OCT 12 2000 LE-ENVIRONMENTAL

Dear Sir,

CRGW01

I have received a copy of the Draft EIS for the Gulf of Mexico FPSO and have a couple of comments. Under the "Back Ground" portion, you state that FPSO systems have not been used in the US Gulf of Mexico, which is indeed correct but you fail to mention that a FPSO was used for some time off the coast of California by Exxon for years with much success. I'm sure some of your staff may be familiar with this project by the name of HONDO. I was personally involved with that project from the marine side both afloat and ashore. This delivery system proved viable based on the use of US Flag Shuttle Tankers. These vessels frequented ports on the West Coast and the Gulf Coast but mostly called on the Port of Houston. These vessels were built to a high standard and some to US Navy standards with high horsepower and superior handling qualities and much redundancy of safety equipment. These vessels always employed the services of a State Pilot to safeguard the cargos in these very confined and restrictive ports.

CRGW02

What I see being described in you EIS seems to be a very similar type of operation with the exception of the type of shuttle vessels. I am surprised that considering the growing environmental concerns for the US Gulf area, that a cheap alternative to a state of the art shuttle tanker would be considered. All of the sources that I have read on this issue seem to be pushing very large ATBs. It seems ironic that at the same time the United States Corps of Engineers is considering a study on the ship handling characteristics of large tankers within the Houston Ship Channel to better understand the safety concerns of these vessel, that industry would consider inferior ATBs. It has been my experience that these ATBs do not handle nearly as well as the shuttle tankers that Exxon employed for their FPSO operations. As a Houston Pilot, and a former FPSO operator who understands these issues and as a resident of the Great State of Texas I encourage you to demand the highest standard of care for this operation.

Sincerely,

Captain Robert G. Webbon

HCW01

COMMENT CARD

Draft Environmental Impact Statement for the Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico OCS – Western and Central Planning Areas

Name (please print) Henry C. Williams Sr.

Agency/Organization Williams Welding & Industrial Trade Center

Address 428 E Chinst Plateau (Africatown USA, AL 36610

COMMENTS We on Mon Louis have been left out of the total Oil and gas finding in the Gulf Are: Question Will we (NEGROES) benefit in any Major way from this. New approach of harvesting Oil and/or other new products?

Since "I" set up the first Welding School on this very site (1942) No."I" Government st, may I ask "Where will my expertese fit.

For one of Dr. George W. Carver's close students an understudent.

Please provide written comments above (use back of this page or additional sheets, if necessary) and return to the sign-in desk, or mail to:

Regional Director
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

9-18-2000

Written comments must be postmarked by October 11, 2000.

Mobile, AL 9/18/00

American Bureau of Shipping

10 October 2000 Refer to: mms-eis 02.doc

Regional Director (MS 5410)
Gulf of Mexico OCS Region, Minerals Management Service
201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Subject: Draft EIS on the Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico Outer Continental Shelf, Western and Central Planning Areas

Gentlemen:

The American Bureau of Shipping has closely participated in the development of Floating Production Storage and Offloading Systems (FPSOs) over the last 25 years. As a result we have amassed a cumulative 170 years of classification and certification operational experience with FPSOs. This has earned us the reputation for providing industry with an independent and unique perspective on the safe operation of these installations. In our opinion, the technology has matured into a field development concept appropriate for the Gulf of Mexico.

Furthermore, it is our experience that the prudent designers, builders, owners and operators of these installations have developed solutions to successfully implement FPSO applications offshore, which are not only fit-for-purpose structurally and mechanically but also safe for the environment and the people working aboard these vessels.

Since initiating our involvement offshore 50 years ago, ABS has built extensive, recognized expertise that is best represented by our involvement to-date in the classification and/or certification of 73 Floating Production Systems, including Tension Leg Platforms, Spars, Semisubmersibles and FPSOs. Of particular interest is the fact that of these installations, 34 are FPSOs classed, or presently being classed, by ABS. Related to FPSOs are those vessels operating in Floating Storage and Offloading (FSO) service. ABS classification presently covers 30 FSO installations worldwide. This represents the most diverse and significant share of classification of worldwide floating production systems.

ABS01

We recognize the global scope of our offshore work while keeping in mind unique regional issues. ABS has worked with FPSO projects in the South China Sea, Australia, West Africa and Brazil that possess many of the same technical issues focused on in the Gulf of Mexico. Among these are the issues of deep water installations and environmental loads. ABS has specific experience with such issues with more than a dozen FPSO projects in deep water over 1,000 feet -

ABS PLAZA, 16855 NORTHCHASE DRIVE, HOUSTON, TX 77060-6008 USA
TEL: 1-281-877-6564 FAX: 1-281-877-6851 EMAIL: tgrove@eagle.org

ABS01, continued

five of which are in water depths of over 3,000 feet. Additionally, a number of ABS classed projects have been designed and are operating in the South China Sea and Australia, areas with tropical cyclonic storm activity similar to conditions in the Gulf. We feel that these and other issues have been appropriately addressed from a safety point of view in these other areas and can contribute to the development of similar applications in the Gulf.

ABS02

We would also like to point out that integral to FPSO operations are offloading operations. ABS is actively developing new standards to enhance the tools available for designers in response to the potential need for Jones Act shuttle tankers for the Gulf of Mexico. This involves the newer Articulated Tug-Barge concept. With the application of recognized appropriate design and construction standards, ABS is confident that such vessels will be appropriate for their service and operate safely, similar to their counterparts worldwide.

As the only classification society based in the United States, ABS is devoted to promoting the security of life, property and the marine environment through the development and verification of standards for the design, construction and operational maintenance of marine-related facilities. Today, more than 90 governments worldwide recognize ABS to act on their behalf to issue statutory certifications. And the offshore industry has worked with ABS over the years to develop our independent review responsibilities into one that has become a valued role in the development of new standards and technology to meet the ever-increasing challenges of the offshore industry.

We recognize and appreciate the efforts of Minerals Management Service to thoroughly investigate and evaluate the viability and ramifications of introducing FPSOs into the Gulf of Mexico – and also the cooperative nature of its approach with industry. Efforts such as the Offshore Operators Committee on the development of a regulatory model for FPSOs, the comparative risk study as well as the development of the draft Environmental Impact Statement (EIS) are all major efforts that will move industry toward the safe implementation of this technology in the Gulf of Mexico.

We continue to support this cooperative philosophy and the MMS.

Very truly yours,

Todd W. Grove
Director
Offshore Project Development

BAY COUNTY AUDUBON SOCIETY
P.O. Box 1182
Panama City, FL 32404-1182

Gulf of Mexico OCS Region MMS NOV 0 6 2000 Office of the Regional Director

RECEIVED NOV - 7 2000 LEASING & ENVIRONMENTAL MS 5400

October 31, 2000

Regional Director
Gulf of Mexico OCS Region
Minerals Management Service
1201 Elmwood Park Boulevard, MS-5410
New Orleans, Louisiana 70123-2394

Re: Floating Production Storage and Offloading Systems

Dear Regional Director:

BCAS01

We are taking no action at this time based on your representation that the area under consideration by MMS for use of the FPSO's applies only west of Florida and no waters off the coast of Florida are involved. The map in your Informational Brochure is unclear but at this time we believe the area in question is in the deep waters between Texas and Mississippi and none to the east. We appreciate your keeping all activity west of our state.

Very truly yours,

BAY COUNTY AUDUBON SOCIETY

Jacalyn N Kolk

Jacalyn N. Kolk

JNK/tj

"FROM BIRDWATCHING TO THE TOTAL ENVIRONMENT"

Greater Houston Port Bureau, Inc.
111 East Loop North,
Houston TX 77029 U.S.A.
(Tel) 713.678.4300
(Fax) 713.678.4839

October 10, 2000

Gulf of Mexico OCS Region MMS OCT 1 5 2000 Office of the Regional Director

EIS
Regional Director, Gulf of Mexico,
OCS Region,
Mineral Management Service,
1201 Elmwood Park Blvd.,
MS-5410,
New Orleans LA 70123-2394

Dear Sir,

Pilotage and Traffic Management,
Galveston Bay and the Houston Ship Channel.

The Greater Houston Port Bureau represents the private sector port user, ship channel terminal operator, and tenant which together with our associated organizations, the Marine Exchange of the West Gulf, the Houston Customhouse Brokers and Freight Forwarders, the U.S. Gulf International Commerce Club, and the Greater Houston Coffee Association, have a very intimate and direct interest in the management of ship and barge traffic all the way from the Sea Buoy off Galveston to the Head of Navigation at the Turning Basin in Houston.

Above all, we desire safety. We also require efficient and businesslike traffic management and we look for these two requirements to coexist. Our very economic livelihoods depend on getting our ships into port and back out to sea again with the minimum of delay and the maximum of safety.

Today's informal traffic management system is in the capable hands of the Houston Pilots who have taken on much of the responsibility and burden of ensuring that the interests of the communities and facilities lining Galveston Bay and the Houston Ship Channel are adequately protected by making each individual vessel passage and the Ship Channel itself, as safe as possible.

In the event that traffic grows to the extent that our present system requires to be restructured in some way, then Houston's overall maritime community is ready to take up the challenge to introduce whatever steps are necessary to maintain transit safety. Already, a committee that includes the Houston Pilots, the Port Authority, private terminal proprietors, the Marine Exchange, towboat and barge companies, and the U.S. Coast Guard, has been formed for this purpose.

HOUSTON PILOTS

8150 SOUTH LOOP EAST / HOUSTON, TEXAS 77017-1747

Gulf of Mexico OCS Region MMS SEP 2 [illegible] 2000 Office of the Regional Director

RECEIVED OCT 2 2000

September 25, 2000

EIS
Regional Director, Gulf of Mexico
OCS Region
Mineral Management Service
1201 Elmwood Park Blvd.
MS-5410
New Orleans, LA 70123-2394

Dear Sir:

These comments address pilotage issues that could be affected by the FPSO system.

HP01

The Port of Houston is an enormous complex of over two hundred public and private docks connected by a narrow ribbon of dredged channel that was laid out for vessels much smaller than those regularly calling in Houston today. More than 18,000 ships and 100,000 barges will transit the Houston Ship Channel this year. They make those transits 24 hours a day, 365 days a year, in all kinds of weather and traffic conditions. In spite of the configuration of the channel and the density of traffic, Houston has one of the finest safety records in the country.

The members of the Houston Pilot's Association serve the commercial interests of the port by making it possible for ships and seagoing barges from all over the world to enjoy an expeditious passage to and from the many docks lining the ship channel. Even more importantly, we have a responsibility to the communities and facilities lining Galveston Bay and the ship channel; an obligation to make each individual passage as safely as possible and to make the ship channel itself as safe as it can be.

In order to discharge these responsibilities effectively, the Houston Pilot's Association recruits men and women who have a proven track record in the shipping industry. Before even being allowed to begin this training, the recruit must obtain a Federal pilot's license for Houston. All deputy pilots are then required to complete a comprehensive three-year training program under the tutoring of the whole association and an appointed master pilot. Before being allowed to make a transit with a 500,000 barrel vessel, the pilot would be expected to complete over 800 trips. That pilot would be rigorously trained and able to perform his or her duties to the individual ship and to the community at large.

Federal law does not require a state pilot on shuttle tankers. It is possible for large FPSO vessels to come into this complex system with only a Federal pilot's license. This kind of license can be obtained by making as few as 12 round trips on the channel. The trips can be made in a vessel as small as 1600 tons. It can be obtained by a helmsman or "observer" who receives no practical training at all. The person holding this Federal license would then be allowed to navigate the Houston Ship Channel in any size vessel. We are understandably concerned about this.

The presence of a state pilot on board a vessel means that vessel will be acting as though it were part of the community. It will be participating in the port's informal traffic management system which (in the absence of a formal Harbor Master) organizes sailings and arrivals, allows vessels to meet or overtake each other in the safest areas of the channel, and ensures that oversize vessels will meet in appropriate areas. It means that the pilots

GHPB01

The committee's work, however, depends on the participation of *all* parties and we are somewhat disturbed at the news that vessels operating under a federal pilotage arrangement might be introduced into our waterways without finding it necessary to be properly integrated into our own informal or formal traffic management system. As you will readily understand, the traffic management success that Houston has enjoyed over these many years has come entirely from *cooperation* among the many interested parties.

We would not like to see this arrangement eroded and some of the proposals of handling the FPSO system of shuttle tankers, apparently outside our existing way of controlling traffic here in Houston, would be unacceptable to us as port users.

GHPB02

As the Nation's top seaport in international tonnage terms and the eighth busiest seaport in the World, please be assured that we take traffic management seriously here in Houston and do not expect outside agencies to suggest or permit the introduction of additional traffic, unless and until it is safely integrated with what we now have in place. The very safety and reputation of the Houston Ship Channel and the ports of Houston, Texas City, and Galveston depend on the continuing proactive, unified, and coordinated management of *all* Ship Channel traffic.

Your kind attention to our concerns and opinions will be greatly appreciated.

Yours sincerely,

Alistair M. Macnab,
Executive Vice President.

September 25, 2000
EIS
Regional Director, Gulf of Mexico
Page 2

making these arrangements has worked together and are familiar with the intricacies of the channel and the characteristics of the wide variety of ships involved. It also insures that every piloted vessel on the channel will be fully apprised of changes to local conditions, the traffic situation, USCG regulations, meteorological and tidal conditions and any precaution areas on the channel.

A shuttle tanker or barge with only a federally licensed pilot on board would be an outsider and a hazard to navigation on the Houston Ship Channel. The cost of a state pilot on a 500,000 barrel vessel is approximately $0.01/bbl for a round trip. I can't imagine anyone trying to bring a vessel of this size and draft into Houston without a state pilot. It simply would not be safe and in the long run it wouldn't be cost effective.

HP01, continued

Yours very truly,

Lance A. Miller

Miller,ShuttleTanker

OFFSHORE OPERATORS COMMITTEE

RECEIVED
OCT 10 2000

October 4, 2000

Gulf of Mexico OCS Region
MMS
OCT 06 2000
Office of the Regional Director

Regional Director (MS 5410)
Gulf of Mexico OCS Region
Minerals Management Service
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

Re: Draft Environmental Impact Statement
Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico Outer Continental Shelf, Western and Central Planning Areas.

Gentlemen:

The Offshore Operators Committee (OOC) appreciates this opportunity to provide written comments on the Draft Environmental Impact Statement (Draft EIS) for the Proposed Use of Floating Production, Storage and Offloading Systems (FPSO) on the Gulf of Mexico (GOM) Outer Continental Shelf (OCS) in the Western and Central Planning Areas. The OOC is an organization of some 70 operating companies who conduct essentially all of the offshore oil and gas exploration and production activities in the GOM. Additionally, we have some 29 companies as associate members who are non-producers and supply services such as transportation, contract engineering or consulting, drilling, well and other services. The following comments made on behalf of the OOC are provided without prejudice to an individual member's right to have or express different views.

The OOC has been interacting with groups concerned with OCS development in the GOM, including the various agencies responsible for managing or regulating OCS leases, for over 40 years now. We feel it is important to state our support for the MMS allowing the use of FPSOs on the GOM OCS. The Draft EIS is a very thorough and realistic study of the probable environmental impacts resulting from FPSO operations on the GOM OCS. The Draft EIS is organized in an appropriate and efficient manner with the potential impacts from operations set out distinctly from the potential impacts from accidents. The OOC appreciates the willingness of MMS to prepare this programmatic EIS on the broad issue of FPSO operations on the GOM OCS.

The OOC supports the proposed action, Alternative A, for acceptance of the conceptual use of the base-case FPSO system in the deepwater OCS areas of the Western and Central Planning Areas of the GOM OCS and recommends MMS adopt Alternative A in it's Record of Decision. Attachment A to this letter outlines the reasons why OOC believes the EIS supports the adoption

OOC01

Post Office Box 50751, New Orleans, Louisiana 70150-0751 • 504-561-2427 • Fax 504-561-2700

OOC01, continued

of Alternative A over Alternatives B and C. Attachment B to this letter provides detailed comments on the Draft EIS with changes we request to be included in the Final EIS.

Again, thank you for the opportunity to provide comments on the Draft EIS. If you have any questions concerning our comments, please contact me at (504) 561-2427.

Respectfully submitted,

Allen J. Verret, PE

Allen J. Verret, PE
Executive Director
Offshore Operators Committee

Attachment A
Draft EIS—Discussion of Alternatives

OOC02

The Offshore Operators Committee (OOC) supports the adoption of Alternative A, the acceptance of the conceptual use of the base-case FPSO system in the deepwater OCS areas of the Western and Central Planning Areas of the GOM OCS. Please find below a discussion of the Alternatives considered in the Draft EIS.

OOC03

Alternative A

The OOC believes that the analysis in the draft EIS supports the adoption of Alternative A, the acceptance of the conceptual use of the base case FPSO system in the GOM. No significant, adverse impacts were identified for the operational phases of the proposed action, except for the potential for long term significant impact at Breton NWA due to exceedance of the FWS SO_2 standard. While this should serve as a warning flag to any company who proposes to utilize a FPSO in an area which could have significant adverse impacts on the air quality at Breton NWA, it should be recognized that each specific project will have to meet the requirements of 30 CFR 250.303. The potential air emissions for a specific project may be different from those for the generic project proposed in the base case. The only negligible impacts that were identified for the operational phases of the proposed action were to commercial fisheries, socio-economic, recreational and beach use and other uses. The impacts to commercial fisheries and recreational resources and beach use were localized.

The draft EIS recognizes that the risk of a large, catastrophic spill is extremely low. In the event a spill should occur, the potential impacts due to oil spills were primarily adverse, but not significant. Under the extremely unlikely event a large, catastrophic spills should occur; only limited significant impacts were identified depending on the location of the spill and presence of marine mammals, sea turtles and coastal and marine birds. Significant impacts were not identified for water and sediment quality, offshore environment, fish resources, commercial fisheries, socio-economics, cultural or other uses.

The OOC believes that the Draft EIS supports the adoption of Alternative A since no significant impacts were identified for the operation phase of the proposed action (except for potential impacts on air quality at Breton NWA). The risk of a large, catastrophic spill is extremely low and even in the unlikely event one should occur, only limited potential significant impacts were identified. The draft EIS states that FPSO-unique spill risk comprises only 5% of the total risk of a spill; therefore, it is extremely small. The draft EIS states that the greatest risk of a spill occurs from the shuttle tanker operations. Shuttle tankers are used routinely in the GOM to lighter tankers bringing in foreign imported oil and their use is acceptable to transporting foreign imported oil from a tanker to shore, and should be acceptable for use in transporting OCS oil from an FPSO to shore. Further, the draft EIS states that the risk of a spill from a shuttle tanker is slightly less than from an oil pipeline. Therefore, shuttle tankers should be an acceptable alternative to an oil pipeline.

OOC04

Alternative B1

Alternative B1 would prohibit the use of FPSOs in the deepwater portions of the no lightering zones established by the USCG. The OOC believes the analysis in the draft EIS does not support

OOC04, continued

the adoption of Alternative B1. No significant differences in impacts from Alternative A were identified for Alternative B1; therefore, the adoption of Alternative B1 is not warranted. The draft EIS determined that in the unlikely event oil is spilled, it would not reach topographic features. Therefore, the analysis in the draft EIS does not support the adoption of Alternative B1.

OOC05

Alternative B2

Alternative B2 would prohibit the use of FPSOs in the Corpus Christi or Port Isabel map projection areas. The OOC believes the analysis in the draft EIS does not support the adoption of Alternative B2. Alternative B2 was proposed to mitigate potential increased risk of oil spill impacts on coastal areas and the shorter time to implement response actions before oil spills reach the coast. The oil spill trajectory analysis showed that spills from operations in this area would not reach shore within 3 days. Therefore, there is sufficient time to effectively implement response actions before spills reach the coast. The risk of a larger, more persistent spill contacting the coast is very small. Therefore, the analysis in the draft EIS does not support the adoption of Alternative B2.

OOC06

Alternative B3

Alternative B3 would prohibit the use of FPSOs in the Viosca Knoll and Mississippi Canyon map protraction areas. This alternative was proposed to mitigate potential increased risk of oil spill impacts on the Mississippi Delta before spill containment could be implemented. From Table 4-42 in the EIS, a spill from launch point MC-1, which is 53 miles from shore and located in the northern portion of Mississippi Canyon, has only a 2% chance of reaching shore within 3 days, so there is ample time to implement a response effort to a spill from this point. The cluster oil spill trajectory analysis showed that spills from the small area directly off the mouth of the Mississippi River have only a 16% chance of reaching shore within 3 days. Spills from the remainder of the Mississippi Canyon/Viosca Knoll area have less than 2% chance of reaching shore within 3 days. Therefore, there is sufficient time to effectively implement response actions before spills reach the coast. The risk of a larger, more persistent spill contacting the coast is very small. Therefore, the analysis in the draft EIS does not support the adoption of Alternative B3 due to the increased risk of oil spill impacts on the Mississippi Delta before spill containment could be implemented.

OOC07

During the course of conducting the draft EIS, two additional potential impacts were identified. In the course of conducting the air quality modeling for the base case, it was discovered that FPSO and the associated shuttle tanker and vessel operations located at point MC-1 in the northeastern portion of the Mississippi Canyon area could result in a long-term significant impact at Breton NWA due to the exceedance of the FWS SO_2 standard. Additionally, if five FPSO were placed in this area within a 50-km radius, significant air quality impacts from SO_2 emissions could occur. Venting and flaring could also lead to significant impacts. The Mississippi Canyon/Viosca Knoll area covered under Alternative B3 is a large area, covering over 8000 square miles. It is not anticipated that air quality modeling results would be the same for FPSO operations located in the southern portion of the area as those located in the northeastern portion of the area. Therefore, condemning the entire Mississippi Canyon/Viosca Knoll area based on the analysis in the draft EIS from a theoretical operation at one theoretical location is not warranted. Each project as it is proposed will have to meet the requirements of 30

OOC07, continued

CFR 250.303 and the project will be appropriately mitigated, if required. It is extremely unlikely that all five of the FPSOs considered in the cumulative analysis would be located within a 50-km radius in this area. Therefore, the adoption of Alternative B-3 on this basis is not warranted. Additionally, MMS has the authority in 30 CFR 250.303 to consider cumulative impacts when reviewing individual projects.

OOC08

The second potential impact identified is to sperm whales. There have been consistent sightings of sperm whales in the vicinity of the Mississippi River Delta. It is estimated that a total of 387 individual sperm whales may inhabit the northern GOM. The Mississippi Canyon/Viosca Knoll area is very large, in excess of 8000 square miles. It is very unlikely that concentrated populations of sperm whales exist over this entire area, given the small number of individuals. Depending on the location of the FPSO, the port or ports the shuttle tankers would travel to and the location of sperm whale at any given time, the probability of significant impact on sperm whales is low. It should also be noted that to date there have been no restrictions on vessel traffic, exploration or development drilling, or developing reserves with fixed or floating platforms in this area. Therefore, to prohibit the use of FPSOs over this entire area would not be warranted based on the analysis in the EIS.

OOC09

Alternative B-4

Under Alternative B-4, an attendant vessel would be required during offloading operations. The purpose of the attendant vessel would be to assist in the transfer of the offloading hose, maintain designated safety distance between marine traffic and the FPSO/shuttle tanker during offloading operations by warning or fending off other vessels and carry oil spill response equipment and provide first response in the event an oil spill occurs during offloading operations. The base case scenario does not require the use of an attendant vessel to assist in transferring the offloading hose, but rather the hose will be hooked up by use of a messenger line, which is a common practice in the North Sea. Systems that require such an attendant vessel to assist in the hose transfer operations limit the operational envelop during which offloading activities can occur. No operational benefits are gained by utilizing an attendant vessel. Therefore, the requirement to have an attendant vessel is not warranted for offloading activities.

The draft EIS suggests that an attendant vessel can be utilized to warn or fend off other vessels that may encroach too close to the FPSO/shuttle tanker during offloading. While this is possible, no rational has been presented in the EIS that suggests this is needed. We submit the following information that suggests that the requirement to have an attendant vessel is not warranted for this purpose. In current GOM practices, attendant vessels are not required to be on hand to warn vessels that encroach too close to high volume production hubs or high volume floating production systems. In addition, attendant vessels are not required to be on hand during lightering operations that occur on a frequent basis in the GOM. A study on collision avoidance prepared for NOSAC, showed that the wide variety of potential collision scenarios result in "no one size fits all" solution. Industry is currently using a wide variety of effective collision avoidance schemes including the establishment of safety zones around selected facilities, collision avoidance radar, training of crews to communicate effectively with ships, and the use of white spotlights to gain the attention of passing vessels. Therefore, the requirement to have an attendant vessel is not warranted.

Attachment B
Specific Comments: MMS DEIS FPSOs - Section 1- Proposed Action

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
Executive Summary p. iii OOC11	This DEIS is a programmatic document to examine the concept of, and fundamental issues associated with, the petroleum industry's proposed use of FPSOs on the OCS of the Gulf.	This DEIS is a programmatic document to examine the concept of, and fundamental issues associated with, the petroleum industry's proposed use of FPSOs on the OCS of the GOM.	Reword for consistency.
Executive Summary p. iv OOC12	Alternative B-2 considers that FPSOs would not be permitted in the Corpus Christi or Port Isabel map protraction areas. Alternative B-3 considers the exclusion of FPSOs from lease areas near the Mississippi Delta, specifically the Viosca Knoll and Mississippi Canyon map protraction areas.	Alternative B-2 considers that FPSOs would be prohibited in the Corpus Christi or Port Isabel map protraction areas. Alternative B-3 considers the prohibition of FPSOs from lease areas near the Mississippi Delta, specifically the Viosca Knoll and Mississippi Canyon map protraction areas.	Clarifies that FPSOs would be prohibited from these areas. The current language could mislead the reader into thinking that these areas would be treated similar to Alternative C.
Executive Summary p. iv OOC13		Add after Alternative C Summary of Overall Environmental Impacts. Copy language from Section 2.3 (p. 2-10) will appropriate modification.	Due to the length of the Executive Summary, a succinct summary of the overall environmental impact for each alternative should be added.
FPSO Installation and Routine Operations p iv OOC14		However, it should also be noted that this area is very large and a permanently moored FPSO/shuttle tanker offloading operation in a location away from the northeast quadrant may not generate sulfur dioxide emissions that could exceed Class I standards in the Breton NWA.	Add sentence following first paragraph.
FPSO Installation and Routine Operations p iv OOC15		However, the Mississippi Canyon and Viosca Knoll area is very large and there may not be resident endangered sperm whales over the entire area. Also, in the event FPSOs are located in this area, it should be recognized that vessel traffic may not pass through the area where sperm whales may reside, depending on the ports the vessels will travel to and the routes these vessels may take.	Add sentence following the 2nd paragraph
Risk-reducing Measures p v OOC16	In addition, it should be noted that the selection of Alternative B-4 would represent a risk-reducing measure for providing an additional level of safety during FPSO/shuttle tanker offloading and for on-site first-response capability in the event of an oil spill.	In addition, it should be noted that the selection of Alternative B-4 would represent a risk-reducing measure since it could potentially warn other vessels in the vicinity of the FPSO during shuttle tanker offloading and provide for limited on-site first-response capability in the event of an oil spill during offloading activities..	It is not clear in the EIS that having an onsite vessel would actually provide an additional level of safety. The oil response capability would be limited.
Air Quality	If the five FPSOs were placed near sensitive	In the extremely unlikely event that all five of the	Given that the EIS only considers that 5 FPSOs

OOC09, continued

The draft EIS also suggests that this vessel could carry oil spill response equipment and provide first response in the event an oil spill occurs during offloading operations. The EIS shows that spills from offloading to a shuttle tanker are comprised entirely of the smaller spill sizes, and they make up only a small percentage (1.8%) of the total volume of potential spills. The majority of the deepwater area is located far from shore. The oil spill trajectory analysis in the draft EIS indicates that oil will not reach shore from any location outside of the mouth of the Mississippi River within 3 days of a spill. Thus, there is ample time to mount a spill response effort in the event of a spill during offloading. Therefore, having limited early response capability on site is of questionable value, particularly when balanced against the negatives of having an additional vessel on location. The draft EIS indicates that having an attendant boat would exacerbate the air quality impacts, provide incremental negative impacts relative to Alternative A in the areas of water quality and sediment impacts, the offshore environment, marine mammals, sea turtles, fish resources, socio economics and other uses. It should also be noted that an attendant vessel is not required during the lightering operations currently being conducted in the GOM where imported foreign oil is offloaded from tankers to shuttle tankers to be brought to shore. Therefore, the adoption of Alternative B-4 is not supported by the analysis in the draft EIS.

OOC10

Alternative C
Alternative C is the "no action" alternative required to be evaluated by NEPA. In this case, "no action" means that the general concept of using FPSOs in the GOM OCS would not be accepted, but it would not prohibit the use of FPSOs in the GOM. If individual FPSO projects were approved, impacts similar to Alternative A would occur. Further, if FPSOs are not allowed to be used or are significantly delayed, significant adverse socioeconomic impacts could occur. The adoption of Alternative C is not supported by the analysis in the draft EIS.

Attachment B
Specific Comments: MMS DEIS FPSOs - Section 1- Proposed Action

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
p vii OOC17	receptors (e.g. in the Mississippi Canyon area) in an area with a 50-km radius, significant air quality impacts are expected from SO_2 emissions.	FPSOs were placed near sensitive receptors (e.g. in the Mississippi Canyon area) in an area with a 50-km radius, significant air quality impacts are expected from SO_2 emissions.	will be installed in the GOM over the 10-year period, it is misleading to assume they will all be placed in one area. Issue is also moot since MMS retains authority to consider cumulative impacts.
Marine Mammals p. ix OOC18	Ingestion of, or entanglement with, discarded solid debris associated with normal operations would produce a negligible impact on marine mammals.	Ingestion of, or entanglement with, any solid debris accidentally lost overboard would produce a negligible impact on marine mammals.	Solid debris is not discarded into the ocean during normal operations!
Marine Mammals p. ix OOC19	Alternative B-3 may effectively mitigate potential impacts of FPSO activities on local deepwater marine mammal species, especially the endangered sperm whale.	Alternative B-3 may mitigate potential impacts of FPSO activities on local deepwater marine mammal species, especially the endangered sperm whale.	Vessel traffic associated with FPSO operations may not pass through areas where sperm whales are located.
1.4.2.4 p. 1-14 OOC20	Spread mooring has limited shallow-water applications and is not considered within the range of potential mooring configurations on the OCS.	Spread mooring has limited applications and is not considered within the range of potential mooring configurations on the OCS since there is an absence of a mild, unidirectional environment.	More accurate statement.
1.5.3 p 1-47 OOC21	• Because FPSOs are considered to be tank vessels, FPSOs must comply with OPA 90 double-hull requirements presented in Title 46 USC, Section 3703a. According to this section, tank vessels constructed after June 30, 1990, are, with limited exception, required to have double hulls.	• Because FPSOs are considered to be tank vessels, FPSOs must comply with OPA 90double-hull requirements presented in Title 46 USC, Section 3703a. This law prescribes double hulls for all tank vessels contracted for on or after June 30, 1990, or delivered on or after January 1, 1994. This law also sets operational limitations and establishes mandatory phase-out dates for single hull tank vessels contracted for or delivered outside the specified cutoff dates.	Date cutoffs are mis-stated. The law applies to all tank vessels. Wording implies some new builds might not be double hulled. Revised language more clearly states OPA 90 scope.
4.1.1.2 **p. 4-5** OOC22	Each of the preinstalled mooring segments will consist of a fabricated steel drag anchor (weighing several hundred thousand tons)…	Each of the preinstalled mooring segments will consist of a fabricated steel drag anchor (weighing several hundred thousand pounds)…	Typo

Attachment B
Specific Comments: MMS DEIS FPSOs - Section 4- Environmental Consequences

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
4.1.2.5 p 4-20 OOC23		Add a table similar to the following to summarize FPSO water discharges.	Adding a summary table would clarify the anticipated water discharges from FPSOs, and clarify the applicable federal permit.

Water Discharges - Summary

Section	Discharge	Permit	DEIS Comment
4.1.2.1	Completion Fluids	EPA NPDES	While it is clear that discharges directly associated with oil and gas exploration production will be covered under the EPA NPDES permit, other types of discharges may either be covered under the EPA NPDES permit or under USCG regulations. Note: 1. The EIS recognizes current policy which places these discharges under NPDES for fixed and floating facilities and considers the NPDES Permit appropriate for FPSOs permanently moored on location. 2. USCG regulations would apply to FPSOs while in navigation and to shuttle tankers and support vessels at all time.
	Workover fluids	EPA NPDES	
	Produced Water	EPA NPDES	
4.1.2.5 and Table 4-5	Produced Water	EPA NPDES	
	Domestic - Grey Water	EPA NPDES or USCG Regulations[1,2]	
	Sanitary - Black Water	EPA NPDES or USCG Regulations[1,2]	
	Deck Drainage	EPA NPDES or USCG Regulations[1,2]	
	Washdown Water	EPA NPDES or USCG Regulations[1,2]	
	Fire Control Water	EPA NPDES	

	Miscellaneous (including):
	• Blowout preventer fluid;
	• Desalinization unit discharges;
	• Diatomaceous earth filter media;
	• Uncontaminated ballast water;
	• Uncontaminated bilge water;
	• Uncontaminated freshwater;
	• Uncontaminated seawater;
	• Boiler blowdown;
	• Source water and sand;
	• Excess cement slurry;
	• Chemically treated water
	  • Fire control water;
	  • Utility Lift Pump water;
	  • Pressure test water;
	  • Ballast water;
	• Non-contact cooling water.
		EPA NPDES or USCG Regulations[1,2]	

	Clean Ballast Water	EPA NPDES or USCG Regulations	

Attachment B

Specific Comments: MMS DEIS FPSOs - Section 4- Environmental Consequences

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
	Trash (including): • Glass; • Metal; • Paper; • plastic; • wood.	Discharge Prohibited	
	Biodegradable Food Waste	EPA NPDES or USCG Regulations	
	Support Vessel Discharges	USCG/MARPOL	
The following additional FPSO discharge to water is not addressed in the DEIS.	Cargo Tank Wash Water	EPA NPDES or USCG Regulations	Production related discharges are covered by the NPDES Permit. It is envisioned that this discharge would be treated to NPDES standards by hydrocyclone or gravity separation, such as through the wet oil tank and production sumps.

Attachment B

Specific Comments: MMS DEIS FPSOs - Section 4- Environmental Consequences

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
4.1.2.5 p. 4-20 OOC24	Sanitary waste, or black water, is composed of human body wastes from toilets and urinals. Domestic waste, or gray water, originates from showers, sinks, laundries, and galleys, as well as from safety shower and eye-wash stations. All sanitary wastes will to be processed through an on-site waste treatment plant before being discharged overboard. Domestic wastes will be discharged directly to the ocean in accordance with a USCG discharge permit.	Sanitary waste, or black water, is composed of human body wastes from toilets and urinals. Domestic waste, or gray water, originates from showers, sinks, laundries, and galleys, as well as from safety shower and eye-wash stations. All sanitary wastes will to be processed through an on-site waste treatment plant before being discharged overboard. Domestic wastes will be discharged directly to the ocean in accordance with <u>the USEPA NPDES discharge permit or USCG regulations.</u>	See discussion above.
4.1.2.5 p. 4-23 OOC25	The term "miscellaneous discharges" is defined by the U.S. Environmental Protection Agency (USEPA, 1999) to include point source discharges such as blowout preventer fluid, desalinization unit discharge, diatomaceous earth filter media, uncontaminated ballast water, uncontaminated bilge water, uncontaminated freshwater, uncontaminated seawater, boiler blowdown, source water and sand, and excess cement slurry. USEPA (1999) also defines separately a series of miscellaneous discharges of seawater and freshwater which have been chemically treated, including fire control and utility lift pump water, pressure test water, ballast water, "once through" non-contact cooling water, and desalinization unit discharges. Uncontaminated ballast water will be discharged in large volumes on a routine basis to maintain proper draft during production and offloading. Small volume discharges from remaining sources are expected to occur during the course of FPSO production operations. While the NPDES permit will cover production-related discharges, other FPSO- or vessel-related discharges are expected to be regulated under a USCG permit; in the absence of informal or formal discussions with the USCG regarding future permit requirements, the following discussion has	The term "miscellaneous discharges" is defined by the U.S. Environmental Protection Agency (USEPA, 1999) to include point source discharges such as blowout preventer fluid, desalinization unit discharge, diatomaceous earth filter media, uncontaminated ballast water, uncontaminated bilge water, uncontaminated freshwater, uncontaminated seawater, boiler blowdown, source water and sand, and excess cement slurry. <u>It is envisioned that the term uncontaminated seawater would also include cargo tank washwater that has been treated so that it will pass the NPDES Permit requirements or USCG requirements.</u> USEPA NPDES Permit (1999) also defines separately a series of miscellaneous discharges of seawater and freshwater which have been chemically treated, including fire control and utility lift pump water, pressure test water, ballast water, "once through" non-contact cooling water, and desalinization unit discharges. Uncontaminated ballast water will be discharged in large volumes on a routine basis to maintain proper draft during production and offloading. Small volume discharges from remaining sources are expected to occur during the course of FPSO production operations. <u>All discharges from the FPSO will be regulated by</u>	Cargo tank wash water should be included. Production related discharges are covered by the NPDES Permit. It is envisioned that this discharge would be treated to NPDES standards by hydrocyclone or gravity separation, such as through the wet oil tank and production sumps. Delete the last sentence and reword the last paragraph in this section. The idea is repeated in the last paragraph of this section. All discharges that are covered by the EPA NPDES Permit will be applicable to the base case FPSO proposed action. Shuttle tankers and other support vessels will conform to USCG and MARPOL regulations since the discharges are not covered by the EPA NPDES Permit.

Attachment B
Specific Comments: MMS DEIS FPSOs - Section 4- Environmental Consequences

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
	assumed that effluent limitations similar to the existing NPDES permit are applicable.	either the USEPA NPDES permit or under USCG regulations as appropriate.	
4.1.2.5 p. 4-23 OOC26	In all cases, the discharge of produced water and other production-related wastes will conform to NPDES permit limitations. Discharges from the FPSO and associated vessels that are not production related (e.g., domestic and sanitary waste, miscellaneous discharges, and food waste) are expected to conform to limitations to be established by the USCG (e.g., under applicable MARPOL limitations).	In all cases, the discharge of produced water and other production-related wastes from the FPSO will conform to NPDES permit limitations. Discharges from the shuttle tanker and associated vessels that are not production related are expected to conform to limitations to be established by the USCG (e.g., under applicable MARPOL limitations).	The last sentence of Section 4.1.2.5 should be rewritten: remove the "(e.g., domestic and sanitary waste, miscellaneous discharges, and food waste)". These discharges are all covered under the EPA NPDES Permit for the FPSO; however, a supporting vessel would be covered under the USCG and MARPOL regulations.
4.1.2.8 p. 4-25 OOC27	The proposed action includes the potential for up to five FPSOs to be operating on the GOM OCS by the year 2010. When considering the cumulative scenario for five concurrent base-case scenario FPSO operations operating at peak capacity on an annual basis, the combined 273.75 million bbl produced would require 548 offloading events and shuttle tanker transits to port. However, there are certain variables with respect to production rates and shuttle tanker capacities that could result in either more or fewer shuttle tanker transits. For example, as a group, the five FPSOs might average less than a 150,000 bbl/day production rate over the course of a year, or shuttle tanker capacity might average less than 500,000 bbl. If the five FPSOs average, as a group, 100,000 bbl/day production and are served by 500,000 bbl capacity shuttle tankers, the result would be 265 offloading events and shuttle tanker transits to port. On the other hand, if the five FPSOs average, as a group, 150,000 bbl/day production, but shuttle tanker capacity averages only 400,000 bbl, the result would be 684 offloading events and transits to port.	Delete or move this discussion.	This discussion appears to be out of place in this section. All of the other discussion under 4.1.2 covers only the single FPSO base case, not the cumulative five FPSO scenario. Also, the calculations for volume produced and number of offloading events assumes that all five are operating at peak capacity. This may not be realistic and may be misleading. Under the cumulative scenario, one FPSO is installed every 2 years. So, only under the last year would all five FPSO be operating. Although there may not be any production decline associated with these developments, historically, over a 10 year period, an individual development has experienced some decline. If this discussion is included in the EIS, the calculations need to reflect the cumulative scenario as described.
4.1.2.10 Table 4-7 p.4-29 OOC28			Please explain the control methond for the Dry Oil Storage? For example, The Wet Oil Tank is Controlled by VRU.

Attachment B
Specific Comments: MMS DEIS FPSOs - Section 4- Environmental Consequences

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
4.2.2.4 p. 4-45 OOC29	In order to accommodate oil and gas exploration activities on the many active leases in the Eastern GOM, an agreement between MMS and the Air Force provides for five groups of leases to open for exploration activities for three months on a rotating basis. Military operations will avoid the lease areas during the three-month period, allowing exploration activities to be conducted. If more than three months is needed for the exploration activities, the Air Force and MMS can usually work out an agreement that extends the open window, allowing the activities to be completed. To date, this agreement has worked to the satisfaction of all parties. However, because of potential new military requirements in the area, the window's agreement is currently under review by the Air Force and a request to modify it may be forthcoming.		Delete the extensive discussion of the eastern GOM planning area since the EIS only covers FPSOs located in the Western and Central planning areas.
4.3.1 p. 4-48 OOC30	Alternative B-2-Exclusion of FPSO's from Lease Areas Nearest South Texas: FPSO's would not be permitted within the Corpus Christi and Port Isable map protraction areas, which are the lease areas located nearest to shore.	Alternative B-2-Exclusion of FPSO's from Lease Areas Nearest South Texas: FPSO's would be prohibited within the Corpus Christi and Port Isable map protraction areas, which are the lease areas located nearest to shore.	Clarify that the intent of Alternative B-2 is to prohibit FPSOs from these map protraction areas. The current wording could lead the reader to believe that they would not be accepted based on the findings in the EIS, but not necessarily prohibited.
4.3.1 p. 4-48 OOC31	Alternative B-3-Exclusion of FPSO's from Lease Areas Nearest Mississippi Delta: FPSO's would be excluded from lease areas near the Mississippi Delta, specifically the Viosca Knoll and Mississippi Canyon map protraction areas.	Alternative B-3-Exclusion of FPSO's from Lease Areas Nearest Mississippi Delta: FPSO's would be prohibited from lease areas near the Mississippi Delta, specifically the Viosca Knoll and Mississippi Canyon map protraction areas	Clarify that the intent of Alternative B-3 is to prohibit FPSOs from these map protraction areas. The current wording could lead the reader to believe that they would not be accepted based on the findings in the EIS, but not necessarily prohibited.
4.3.2 p. 4-50 OOC32	Furthermore, the OCD model includes treatments of plume dispersion over complex terrain and a routine to calculate downwash effects from platform structures.	Furthermore, the OCD model includes treatments of plume dispersion over complex terrain and a routine to calculate downwash effects from platform structures. However, the OCD model does not include the wet or dry deposition of pollutants, which is a very conservative approach to modeling.	Not including the wet or dry deposition of pollutants is considered a very conservative approach to modeling actual atmospheric dispersion.
4.3.2			The use of FWS "modeling significance levels" is

Attachment B

Specific Comments: MMS DEIS FPSOs - Section 4- Environmental Consequences

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
Table 4-11 p. 4-50 OOC33			an additive "more conservative" approach to the EIS making the statement that short term exceedances of the SO_2 standard.
4.3.2 p. 4-51 OOC34	The proposed action was modeled at a single location offshore of the Breton Sound NWA.	The proposed action was modeled at a single location offshore of the Breton Sound NWA. It should be recognized that the use of a single location is a very conservative approach since modeling at more than one location may have yielded different results.	Use of the OSRA Spill Launch Point MC1, while a valid modeling scenario, represents just one possible location. Modeling could have been conducted at other more distant locations to depict the non-exceedance of the EPA and FWS modeling significance levels.
4.3.2.1 p 4-55 OOC35			It should be noted the the BAMP Phase II meteorological data will greatly improve the modeling of activities in and around the BNWA and when BAMP Phase II is completed, this data will be available to be utilized for individual projects.
4.3.2 Table 4-12 p. 4-52 OOC36		9	The modeling results listed in Table 4-12 reveal that the FWS SO_2 modeling significance level was exceeded for the 3-hr and 24-hr averages for a 100m and 300 m mixing height for receptor No. 5. Receptor No. 5 is located south of Triumph, Louisiana and north of the Delta National Wildlife Refuge on the Delta of the Mississippi River. This receptor is not in the Class I BNWA. Although the footnote on the table indicates that Receptors 9-12 are located in the BNWA, it is misleading to include 5 in this context. Either 5 should be removed, or the appropriate modeling significance levels for 5 should be listed. The use of a 100 m mixing height is very, very conservative. On page 3-11 Offshore Climatology section that "transient mid-latitude cold fronts can occasionally bring mixing heights below 100 m during frontal passage. The EIS states in numerous places that short term exceedances of the SO_2 standard are likely in the BNWA when in fact the modeled exceedances were derived from unrealistic mixing heights. It should also be pointed out in the text that only 2

Attachment B

Specific Comments: MMS DEIS FPSOs - Section 4- Environmental Consequences

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
			of the four receptors in the BNWA area show exceedances of the modeling significance level.
4.3.2.5 p. 4-57 OOC37	The SO_2 three-hour modeled impact is greater than or equal to the USFWS Class I significance level of 1 g/m^3 two times in the two-year period. The modeled concentrations of SO_2 compared with the 24-hour significance level indicate four exceedances in the two-year period. The model did not indicate concentrations of PM10 or CO greater than the Class I significance levels.	The SO_2 three-hour modeled impact is greater than or equal to the USFWS Class I significance level of 1 g/m^3 two times in the two-year period at a mixing heights of 100 m at two of the four receptors in the BNWA. No exceedances were modeled at any of the other five mixing heights utilized in the study. In no case was the annual significance level exceeded. The modeled concentrations of SO_2 compared with the 24-hour significance level indicate four exceedances in the two-year period at mixing heights of 100m and 300m at two of the four receptors in the BNWA. No exceedances were modeled at any of the other four mixing heights utilized in the study. In no case was the annual significance level exceeded. The model did not indicate concentrations of PM10 or CO greater than the Class I significance levels. Further, no exceedances of the MMS significance levels were modeled under any conditions for any pollutant at any receptors in the study.	Additional language is needed to help convey the results of the study.
Alternative A- Range of Options p. 4-59 OOC38	However, if the five FPSOs were placed near sensitive receptors (e.g. Mississippi Canyon) in an area with a 50-km (31-mi) radius, the FPSOs may be considered "geographically dispersed" yet their emissions have a potential cumulative impact on sensitive receptors.	However, in the unlikely event the five FPSOs were placed near sensitive receptors (e.g. Mississippi Canyon) in an area with a 50-km (31-mi) radius, the FPSOs may be considered "geographically dispersed" yet their emissions have a potential cumulative impact on sensitive receptors.	It is extremely unlikely that all five FPSOs would be placed within the Mississippi Canyon area.
4.3.3 p. 4-63 OOC39	At this time, it is expected that production-related discharges (e.g. produced water) will conform to NPDES permit limitation, as established by USEPA. Non-production-related discharges (e.g., domestic and sanitary wastes) are expected to be regulated by the USCG (e.g. under applicable MARPOL limitations.)	At this time, it is expected that production-related and other discharges from an FPSO moored on location will conform to NPDES permit limitation, as established by USEPA. Non-production-related discharges (FPSOS in navigation, shuttle tankers and support vessels) would be regulated by the USCG (e.g. under applicable MARPOL limitations.)	Clarify the difference between FPSO and shuttle tankers and support vessels. EIS should establish NPDES as the preferred option for all discharges from the FPOS moored on location.

Attachment B
Specific Comments: MMS DEIS FPSOs - Section 4- Environmental Consequences

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
4.3.3.1 p. 4-66 OOC40	Produced Water Discharges For normal oil and gas operations in the Gulf of Mexico, produced water is the largest individual source of discharges.	Based on the experience of typical oil and gas operations in the Gulf of Mexico, produced water is the largest individual source of discharges.	Reword sentence.
4.3.3.1 p. 4-75 OOC41	Vessel-Related Discharges Further, permit stipulations may require periodic testing of ballast water to ensure that free oil is not being discharged into the marine environment. … Some oil will be associated with bilge water discharges. Discharges from supply boats and shuttle tankers vessels are not expected to affect the seafloor in the offshore Gulf of Mexico because of the water depths.	Vessel-Related Discharges Permit stipulations require periodic monitoring of ballast water to ensure that free oil is not being discharged into the marine environment. … Some oil will be associated with bilge water discharges; however, any such discharge will need to be treated to meet either the USCG/MARPOL 15 ppm maximum oil content or the USEPA NPDES Permit no sheen requirements. Discharges from supply boats and shuttle tankers vessels are not expected to affect the seafloor in the offshore Gulf of Mexico because of the water depths.	Clarifies the permit requirement for monitoring for free oil. It is not clear from the proposed language that the FPSO bilge discharges must meet the requirements of either the USCG/MARPOL or USEPA NPDES Permit.
4.3.3.1 p. 4-75 OOC42	Lost Equipment During routine operations, it is quite likely that equipment or supplies might be accidentally lost overboard during transport, transfer, or daily operations. Impacts to offshore water and sediment quality would be negligible and very localized.	Lost Equipment During routine operations, it is quite likely that equipment or supplies might be accidentally lost overboard during transport, transfer, or daily operations. Under current MMS regulations an FPSO Operator is required to make every possible attempt to recover any equipment that is lost overboard. Impacts to offshore water and sediment quality would be negligible and very localized.	It is not clear from the proposed language that under current MMS regulations an FPSO Operator is required to make every possible attempt to recover any equipment that is lost overboard.
4.3.4.1 p. 4-85 OOC43	Alternative A-Routine Operations The base-case scenario calls for one FPSO to be stationed at an unspecified location in the northwestern Gulf of Mexico, with an offloading frequency of once every three days.	Alternative A-Routine Operations The base-case scenario calls for one FPSO to be stationed at an unspecified location in the Western or Central planning areas of the Gulf of Mexico, with an offloading frequency of once every three days.	Current language is too broad.
4.3.4.1 p. 4-85 OOC44	Alternative A-Range of Options Optional scenarios call for as many as five FPSOs to be operating at geographically dispersed areas throughout the northwestern Gulf of Mexico.	Alternative A-Range of Options Optional scenarios call for as many as five FPSOs to be operating at geographically dispersed areas throughout the Western and Central planning	Current language is too broad.

Attachment B
Specific Comments: MMS DEIS FPSOs - Section 4- Environmental Consequences

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
		areas of the Gulf of Mexico.	
4.3.4.1 p. 4-88 OOC45	Alternative B (B1 through B4) The only additional impacts, which might result from implementing Alternative B1, would occur is exclusions from specific lightering areas concentrated shuttle tanker traffic in specific ports. Under the circumstances this seems unlikely. In general, FPSO operations excluded from lightering prohibited areas could be expected to move to other deepwater prospects.	Alternative B (B1 through B4) Exclusion from these areas will not in and of itself reduce or eliminate shuttle tanker traffic to any specific port. In general, FPSO operations excluded from lightering prohibited areas could be expected to move to other deepwater prospects.	There should be no difference between Alternative B-1 and Alternative B-2 or B-3. Shuttle traffic may or may not be to the nearest port to the FPSO site; therefore, it can not be assumed that shuttle traffic will be concentrated in a specific port.
4.3.4.2 p. 4-90 OOC46	Alternative A-Routine Operations Under the base-case scenario an increase of 110 one-way harbor transits per year can be expected at one of the seven possible shuttle tanker destination ports listed above.	Alternative A-Routine Operations Under the base-case scenario an increase of 110 one-way harbor transits per year can be expected to one or a combination of the seven possible shuttle tanker destination ports listed above.	All of the tanker trips may not be to a single port. A combination of ports could be utilized.
4.3.6 p. 4-107 OOC47	…Each shuttle tanker may also require a tug to assist in mooring.		Delete Sentence. In Alternative A, it is assumed that tug assist is not needed.
4.3.7 p. 4-119 OOC48	Alternative B (B1 through B4) However, it is assumed that the lease blocks in consideration under Alternative B-2 lie outside of these near coastal waters which, in some areas, appear to be preferred habitat and a common transitory pathway for this endangered species.	Alternative B (B1 through B4) However, the lease blocks in consideration under Alternative B-2 lie outside of these near coastal waters which, in some areas, appear to be preferred habitat and a common transitory pathway for this endangered species.	Restate.
4.3.7 p. 4-121 OOC49	Summary However, it is assumed that the lease blocks in consideration under Alternative B-2 lie outside of these near coastal waters which, in some areas, appear to be preferred habitat and a common transitory pathway for this endangered species.	Summary However, the lease blocks in consideration under Alternative B-2 lie outside of these near coastal waters which, in some areas, appear to be preferred habitat and a common transitory pathway for this endangered species.	Restate
4.3.8 p. 4-124 OOC50	Each shuttle tanker may also require a tug to assist in mooring		Delete Sentence. In Alternative A, it is assumed that tug assist is not needed.
4.3.14 p.4-155 OOC51	Alternative B (B1 through B4) Alternative B-1, exclusion of FPSOs from designated lightering prohibited areas, will have a beneficial impact on other uses. Under this alternative, other tankering/lightering operations	Alternative B (B1 through B4) Alternative B-1, exclusion of FPSOs from designated lightering prohibited areas, will have a beneficial impact on other uses. In general, FPSO operations excluded from lightering	No lightering operations are allowed in the designated lightering prohibited areas.

Attachment B
Specific Comments: MMS DEIS FPSOs - Section 4- Environmental Consequences

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
OOC51, continued	being conducted within the lightering zone will not have to consider the navigational and safety concerns associated with an FPSO placed in close proximity to current offloading operations. In general, FPSO operations excluded from lightering prohibited areas could be expected to move to other deepwater prospects.	prohibited areas could be expected to move to other deepwater prospects.	
Data Sources p. 4-168 OOC52		Since the spill statistics are based on historical data bases, it is reasonable to provide additional information on the data bases, such as the number of spills and the size range of spills that have historically occurred. For example, in the Marine Board's tanker lightering study, the average spill volume was only 26 barrels and the largest spill was 1500 barrels. The largest spill from an FPSO that have occurred is 3900 barrels and was due to operational error on the process system, unrelated to it being an FPSO. MMS' data base shows that the average size tanker spill is 26,000 barrels.	Providing this type of information would assist the reader in weighing the theoretical frequencies against actual history. For spill ranges that are larger than historical spills, it should be explained that these are theoretically projected frequencies and that spills of this size have not occurred.
4.4.1.2 **p. 4-170** OOC53	(The statistical volume of oil released annually for each accident type was calculated using the upper end of each range as the representative release size for each category.)	(The statistical volume of oil released annually for each accident type was calculated using the upper end of each range as the representative release size for each category. This is a very conservative approach and may lead to the over estimation of the amount of oil that may be accidentally released.)	A common approach is to use the mid point of a range for these types of calculations. The very worst case has been assumed for these calculations and may be misleading.
4.4.1.2 **Table 4-32** p. 4-172 OOC54		Add a footnote to Table 4-32: The statistical volume of oil release annually was calculated using the upper end of each range, not the mid point of the range.	Reader's may simply look at the Table and not read the entire text in 4.4.1.2. Since a common approach is to use the mid-point of the range for these types of calculations, it should be specifically pointed out that the upper range was used.
4.4.1.3 **Table 4-33** p. 4-179	HAZARD: Passing Merchant Vessel OOC55	Mitigation Measure: Add A safety zone around the FPSO if proposed by the operator should be designated by the USCG.	Based on the recent establishment of safety zones around the high volume FPS in the GOM, it is anticipated that safety zones will be requested to be established around FPSO's.
4.4.1.3 **Table 4-33**	OOC56		Industry has not made a detailed technical or economic review of all of the potential feasibility

Attachment B
Specific Comments: MMS DEIS FPSOs - Section 4- Environmental Consequences

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
p 4-176 OOC56, continued			measures. As pointed out in the text, these may not be appropriate for all projects and their may be other measures that provide better mitigation than those in the table; therefore, caution should be used in imposing any of the proposed mitigation measures either globally or to an individual project.
4.4.1.3 **Table 4-33** p.4-180 OOC57	HAZARD: Production Riser Leak BASE CASE: 3 subsea manifold connected to the FPSO through 6 flowlines and 6 production risers, providing piggable loops. MITIGATION MEASURES: Use of three single flowlines with three single risers with alternate means of pigging lines.	Mitigation Measures: Consider the use of three single flowlines with three single risers with alternate means of pigging lines, if flow assurance analysis indicates that alternate methods of pigging will be acceptable.	Eliminating pigging loops may not technically or economically feasible due to flow assurance issues.
4.4.1.3 **Table 4-33** p 4-181 OOC58	HAZARD: Foundering BASE CASE: Design for 100-year wave with associated wind and current MITIGATION MEASURE: Consider having the FPSO fully classified including hull, mooring system, and production facility. MITIGATION MEASURE: Online monitoring of hull stress.	HAZARD: Foundering BASE CASE: Design for 100-year wave with associated wind and current MITIGATION MEASURE: Consider requiring that the design environmental conditions meet 100-year storm criteria; and requiring the FPSO hull and mooring system to be verified through the existing hull structural and stability approval processes. MITAGATION MEASURE: Online monitoring of loads on the hull.	Classification would seem to unrelated to the hazard of foundering. This appears to be a biased recommendation made by DnV. A better approach would seem to be to require the design environmental conditions to include 100-year storm criteria. Structural and stability review processes are already stipulated in the regulations and MOU fo rvarious hull types. The EIS should nott modify these regulatory processes. Classification of the process facility for 100-year wave is an operability issue, not a survivability issue. It is more feasible to monitor the loads than the stresses.
Results from the Cluster Analysis p. 4-225 OOC59		A Table similar to 4-52 should be added for the conditional probabilities greater than one percent of oil contact with equidistant land segments within 3 days of spills from FPSOs in 10 offshore areas of the GOM.	Although this is discussed in the last paragraph on pg 4-225, it is important to show the results for 3 days in a consistent format as for 30 days since it allows the reader an easy reference and comparison between the two timeframes.
Results from the Eight Selected Launch Points p. 4-237 OOC60		A Table similar to 4-53 and 4-54 should be added for results within 3 days of a spill.	Although this is discussed on pg 4-237, it is important to show the results for 3 days in a consistent format as for 30 days and 20 days since it allows the reader an easy reference and comparison between the timeframes.

Attachment B
Specific Comments: MMS DEIS FPSOs - Section 4- Environmental Consequences

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
Spill Frequencies, Conditional Probabilities and Ecological Risk p. 4-237	OOC61	Discussion should be added on the volume of spills that have actually historically occurred and how these volumes relate to the probability-weighted estimates.	The reader may be mislead into thinking that the large, catastrophic spills commonly occur.
Spill Frequencies, Conditional Probabilities and Ecological Risk p. 4-242	Accidents at sea involving oil releases from shuttle tankers are expected to release between 1,000 and 500,000 bbl of oil to the ocean (Section 4.4.1) OOC62	Accidents at sea involving oil releases from shuttle tankers are <u>predicted</u> to release between 1,000 and 500,000 bbl of oil to the ocean (Section 4.4.1)	Use of the word "expected" in this context may mislead the reader into thinking these large spills occur frequently.
4.4.3.1 p. 4-257 OOC63	However, in situ burning was determined to be less effective than skimmers for the scenarios evaluated in the present analysis, given that oil would spread for at least 24 hours before burn operations could commence.	However, in situ burning was determined to be less effective than skimmers for the scenarios evaluated in the present analysis, given that oil would spread for at least 24 hours before burn operations could commence. <u>However, it should be recognized that in the event of a spill, oil spill responders will consider if in-situ burning should be utilized.</u>	Language in the EIS seems to dismiss In-situ burning as an option.
4.4.3.5 p.4-286 OOC64	Given available GOM dispersant stockpiles, oil weathering characteristics, and dispersant effectiveness factors, it is estimated that only about 48,000 bbl of spilled oil can be dispersed.	Given available GOM dispersant stockpiles, oil weathering characteristics, and dispersant effectiveness factors, it is estimated that 73,000 bbl of oil could be treated with dispersant resulting in about 48,000 bbl of spilled oil being dispersed. <u>Add the following paragraph:</u> <u>Given available GOM dispersant stockpiles (195,000 gallons within 36 hours delivery, dispersant-to-oil ratio of 1:25, oil weathering characteristics, and dispersant effectiveness factor of 0.9), it is estimated that about 105,000 bbl of spilled oil would be dispersed. Other dispersant stock is available in other parts of the U.S. and internationally; and additional dispersant can be manufactured to meet demand. Evaporation and natural dispersion will disperse an additional 20-30 percent (approximate) of the released oil. Mechanical recovery will also be used in addition</u>	The current wording could be misleading. The assumptions to dispersant-to-oil ratio, oil weathering characteristics and dispersant effectiveness factor are conservative and may not apply for an individual project, depending on the characteristics of the oil to be dispersed. This should be clarified in the EIS and a range of the estimate of oil that can be dispersed should be given.

Attachment B
Specific Comments: MMS DEIS FPSOs - Section 4- Environmental Consequences

Section	DEIS Proposed Language	Recommended Language/Comments	Rational
OOC64, continued		<u>to dispersant application. Additional mechanical recovery equipment can be cascaded from other locations in the U.S.</u>	

Note: Page numbers refer to the printed version of the document, not the internet version.

Proposed changes to the text are underlined.

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1600 Wilson Blvd.
Arlington, Virginia 22209
Tel: 703-351-6734 • Fax: 703-351-6736

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MS 5400

SCA Shipbuilders Council of America

Allen Walker
President

October 11, 2000

Regional Director (MS 5410)
Gulf of Mexico OCS Region
Minerals Management Service
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

Dear Regional Director:

Thank you for the opportunity to comment on the Department of Interior (DOI) Minerals Management Service (MMS) Draft Environmental Impact Statement (DEIS), which evaluates the potential environment effects of the proposed use of Floating Production, Storage, and Offloading (FPSO) Systems in the deepwater portions of the Outer Continental Shelf (OCS) in the Central and Western Planning areas of the Gulf of Mexico (GOM).

SCA01

The Shipbuilders Council of America (SCA) has reviewed the DEIS and strongly supports Alternative A, because the research determines that usage of FPSOs would have only negligible environmental impacts while offering significant socioeconomic benefits. We would point out; however, that the research fails to quantify the economic benefits of shuttle tanker construction in U.S. shipyards and the potential benefits of FPSO construction in the U.S.

SCA02

SCA03

Furthermore, SCA strongly supports the U.S. Customs Service conclusion that vessels servicing FPSOs be Jones Act qualified in full compliance with OPA 90 double-hull requirements. We also support double-hulls for FPSOs to minimize potential oil releases.

The national trade association for U.S. shipbuilders, ship repairers, and shipyard suppliers.
Founded in 1920

SCA is the national trade association representing the commercial shipyard industry that builds, services and repairs America's fleet of commercial and small government vessels. SCA represents 50 shipyard companies that own and operate over 120 shipyards in 23 states. Our members employ approximately 35,000 shipyard workers. SCA also represents 32 affiliate members who supply goods and services to the shipyard industry.

Again, thank you for the opportunity to comment. Please feel free to contact me with any questions.

Sincerely,

Allen Walker

Allen Walker

CONOCO

Glen Y.S. Bishop
General Manager
Gulf of Mexico Deepwater

Conoco Inc.
400 E. Kaliste Saloom Rd. (70508)
P. O. Box 51266
Lafayette, LA 70505
(318) 269-2000

October 9, 2000

Regional Director (MS 5410)
Gulf of Mexico OCS Region
Minerals Management Service
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

Re: Draft Environmental Impact Statement
Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico OCS, Western and Central Planning Areas

Gentlemen:

Conoco Inc. appreciates this opportunity to provide written comments on the draft EIS for the Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico OCS, Western and Central Planning Areas. Conoco operates a large number of deepwater oil and gas leases in the Gulf of Mexico, the development of which could be affected by this Environmental Impact Statement.

Conoco has successfully operated FPSOs and shuttle tankers around the world for many years and would like to have the option of using FPSOs and shuttle tankers to develop reserves in the deepwater Gulf of Mexico. We appreciate the willingness of the MMS to prepare this programmatic EIS on the broad issue of FPSO operations in the deepwater GOM. The draft EIS is a very thorough and realistic study of the probable environmental impacts resulting from FPSO and shuttling operations in the deepwater Gulf.

COMMENTS

Alternative A

CONOCO01

Conoco supports the adoption of Alternative A, the conceptual approval for FPSOs and shuttling in the deepwater areas of the Western and Central Planning Areas of the GOM.

In addition, we oppose the adoption of Alternatives B-3 and B-4 and provide the following reasons for opposing those alternatives.

Alternative B-3: No FPSOs in Lease Areas Nearest the Mississippi Delta

CONOCO02

The Viosca Knoll/Mississippi Canyon (VK/MC) area covered by Alternative B-3 is a huge area, covering over 8000 square miles. It should be recognized that restrictions which might be applicable to the northern part of this vast area do not necessarily apply to the southern part. Based on the analysis in the draft EIS, excluding FPSOs from the entire VK/MC area is not warranted.

Alternative B-3 was initially proposed because of the proximity of some of the Viosca Knoll and Mississippi Canyon lease blocks to sensitive coastal and nearshore habitats of the Mississippi Delta, which might potentially result in oil spills reaching these areas before spill containment could be implemented. While that rationale might apply to FPSOs located close to the coastal and nearshore habitats, it certainly does not apply to the entire VK/MC area. From Table 4-42 of the draft EIS, a spill from launch point MC1, which is 53 miles from shore and located in the northern portion of the Mississippi Canyon area, has only a 2% chance of reaching shore within three days, so there is ample time to implement a response effort to a spill from this point. From page 4-225 of the draft EIS, "Spills from FPSOs in Area 6 directly off the mouth of the Mississippi River have an average probability of 16 percent of reaching shore within three days. The average probability of spills from the entire remaining offshore area reaching shore in three days are less than two percent." Therefore, except for Area 6 at the mouth of the Mississippi River, there is ample time to implement a response effort for an oil spill in the entire offshore study area. To prohibit the use of FPSOs over the entire VK/MC area, especially the southern parts of Mississippi Canyon which are far from shore, would not be warranted based on the analysis in the draft EIS.

During the course of preparing the draft EIS, two additional potential impacts were identified.

CONOCO03

(1) It was noted that FPSO operations in the northeastern portion of the VK/MC area could result in a long-term significant impact on air quality at Breton Sound NWA due to exceedance of the FWS SO_2 standard. It is anticipated that air quality modeling results for FPSO operations located in the southern portion of this area would not be the same as the results for FPSO operations located in the northeastern portion of the area. While the analysis in the draft EIS might support condemning some of the northeastern leases in the VK/MC area, it does not support condemning the southern part of Mississippi Canyon which is far removed from the Breton Sound NWA.

CONOCO04

(2) Also, during the course of preparing the draft EIS, another potential impact that was identified is that to sperm whales. There have been sightings of sperm whales in the vicinity of the Mississippi River Delta, and it has been estimated that a total of 387 individual sperm whales may inhabit the northern GOM. The MC/VK area is very large, in excess of 8000 square miles. It is very unlikely that concentrated populations of sperm whales exist over this entire area, given the small number of individuals. Depending on the location of the FPSO, the ports to which the shuttle tankers would travel, and the location of sperm whales at any given time, the

CONOCO04, continued

probability of significant impact to sperm whales is low. Therefore, to prohibit the use of FPSOs over this entire area would not be warranted based on the analysis in the EIS. It should also be noted that to date there have been no restrictions on vessel traffic, exploration and development drilling, or on developing reserves with fixed platforms or floating production systems in this area.

Alternative B-4: Requirement for Attendant Vessel During Offloading Operations

Under Alternative B-4, an attendant vessel would be required during offloading operations. The stated purpose of the attendant vessel would be (1) to assist in offloading activities (transfer of offloading hose), (2) to maintain designated safety distance between marine traffic and the FPSO/shuttle tanker by warning or fending off other vessels, and (3) to carry oil spill response equipment and provide first response in the event of an oil spill.

CONOCO05

(1) The base case scenario for offloading FPSOs in the GOM is that the offloading hose will be hooked up to the shuttle tanker by use of a messenger line. The base case does not assume that an attendant vessel is going to be used to assist in transferring the offloading hose. In fact, the use of an attendant vessel instead of a messenger line would limit the operational envelope during which offloading activities can occur. Therefore, no operational benefits are gained by using an attendant vessel, and the requirement to have an attendant vessel is not warranted for operational needs.

CONOCO06

(2) The draft EIS suggests that an attendant vessel can be utilized to warn or fend off other vessels that may encroach too close to the FPSO/shuttle tanker during offloading. While this is possible, no rationale has been presented in the EIS that suggests this is needed. We submit the following information which suggests that the requirement to have an attendant vessel for this purpose is not warranted. In current GOM production operations, attendant vessels are not required to be on hand to warn vessels that encroach too close to high volume production hubs or high volume floating production systems. In addition, attendant vessels are not required to be on hand to warn or fend off other vessels during lightering operations which occur on a frequent basis in the GOM. A study on collision avoidance prepared for NOSAC showed that the wide variety of potential collision scenarios does not have a "one size fits all" solution. Industry is currently using a wide variety of effective collision avoidance schemes including the establishment of safety zones around selected facilities, collision avoidance radar, training of crews to communicate effectively with ships, and the use of white spotlights to gain the attention of passing vessels.

CONOCO07

(3) The draft EIS suggests that another use for the attendant vessel would be to carry oil spill response equipment and provide initial response in the event an oil spill occurs during offloading operations. From page 4-175 of the draft EIS, spills from offloading to a shuttle tanker are comprised entirely of the smaller spill sizes, and they make up only a small percentage (1.8%) of the total volume of potential oil spills. Also from the draft EIS (Tables 4-37 through 4-44), there is 0% chance that an oil spill from seven of the launch sites will reach land in 3 days, and there is only a 2% chance that an oil spill from launch site MC1 will reach land in 3 days. Thus, in the event that a spill which occurs during offloading does necessitate a response

CONOCO07, continued

effort, there is ample time to mount a spill response effort with shore-based equipment. Therefore, the adoption of Alternative B-4 is not supported by the analysis in the draft EIS. It should also be noted that an attendant vessel is not required to be on hand to clean up spills that occur during lightering operations currently being conducted in the GOM where imported foreign oil is offloaded from tankers to shuttle tankers to be brought to shore.

Conoco Recommends Double Hull Tankers

CONOCO08

From Table 4-32, one observes that the attendant vessel described in Alternative B-4 would be on hand during offloading to provide first response for 3.0% of the total spill volume (fending off passing merchant vessels—1.2%; transfer hose leaks—1.8%). Rather than focus on mitigation that covers only a small percentage of the total spill volume identified in Table 4-32 and is of questionable value, Conoco recommends that this effort be focused on mitigation which has a significant impact. Conoco recommends that double hull tankers be required for transporting all crude oil that is produced in the deepwater GOM and transported by tanker. By adopting this pollution prevention measure, the MMS would be taking a proactive measure to prevent 92.6% of the total spill volume identified in Table 4-32 of the draft EIS.

Again, Conoco appreciates the opportunity to provide comments on the draft EIS. Should you have any questions regarding these comments, please contact me at (337)269-3388.

Respectfully submitted,

Glen Y.S. Bishop
General Manager
Gulf of Mexico Deepwater

OCT-10-00 TUE 6:31 N O DISTRICT FAX NO. 2 P. 01

OCT. 9. 2000 2:48PM NO. 3956 P. 1

NDSI01

Noble Drilling Services Inc.

13135 South Dairy Ashford, Suite 800, Sugar Land, TX 77478
Phone: (281) 276-6235; Fax: (281) 491-3284

FACSIMILE TRANSMISSION

DATE: 09 October 2000 **Time:** 2:35 PM

Please deliver the following pages to: Regional Director, Gulf of Mexico OCS Region

LOCATION/COMPANY: Minerals Management Service

FROM: JIM GORMANSON **Number of pages:** 1

REGARDING: Draft EIS for Floating Production, Storage and Offloading (FPSO) Systems for the Central and Western GOM OCS

This fax is in reference to the Notice of Availability of the Draft Environmental Impact Statement on the proposed use of FPSO systems in the Gulf of Mexico as stated in the Federal Register of 15Aug00 (65 FR 49829-49831).

Noble Drilling Corporation and its subsidiaries own and operate 49 Mobile Offshore Drilling Units, 12 of which are capable of drilling in water depths suitable for FPSO activity. Noble supports the use of FPSOs in deepwater development outside areas of traditional infrastructure. As documented in the Draft EIS, FPSOs have been successfully used in various parts of the world without incident. Furthermore, FPSOs are reusable once the necessary infrastructure is developed to support a particular site/field. The technology is proven and will allow the industry to continue exploring for and developing fields to provide oil to our economy.

Noble supports Alternative A for Conceptual Approval as contained in the draft EIS and urges the MMS to formally issue the Environment Impact Statement allowing the use of FPSOs offshore.

Sincerely,

James W. Gormanson
Compliance Manager

cc: Dave Beard
Danny Adkins

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SBMI01

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Gulf of Mexico OCS Region
MMS
NOV 09 2000
Office of the Regional Director

October 31, 2000

Ref: 00-lhs-10-064ltr.doc

Minerals Management Service
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard, MS-5410
New Orleans, LA 70123-2394

Attn: Mr. Chris C. Oynes, Regional Director

Gentlemen:

Thank you for hosting the public hearing in Houston on September 20, 2000. Further to what I said during the public comment section, I would like to add the following.

In MMS' write-up "Floating Production Storage and Offloading Systems", it is mentioned that the spill rate associated with oil production by pipelines in the Gulf of Mexico amounts to some 11.2 barrels per million barrels of oil produced. You compared this with a study comprising of 20 FPSOs with 119 years of accumulated service and 1.6 billion barrels of oil produced. The spill rate here was 2.9 barrels per million with one major spill of 3900 barrels. When one removes this spill (?), the spill rate reduces to some .44 barrels per million produced.

I checked with our sister company, SBM Production Contractors, whose production record may not have been included in the MMS study referred above, and was advised as follows:

> SBM Production Contractors has eleven units in the field with an accumulated production record of some 55 years. During this period an amount of around 450 million barrels of oil was produced with a total spillage of less than 200 barrels or less than .44 per million barrels produced.

In conclusion, the record of FPSOs with respect to environmental protection is excellent as already concluded in your information booklet.

Thank you once again for hosting a very informative public hearing.

Very truly yours,

SBM-IMODCO

Louis H. Smulders
President

Shell Exploration & Production Company

One Shell Square
PO Box 61933
New Orleans LA 70161-1933
(504) 728-6161

October 3, 2000

Regional Director (MS 5410)
Gulf of Mexico OCS Region
Minerals Management Service
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

SUBJECT: Draft Environmental Impact Statement
Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico Outer Continental Shelf, Western and Central Planning Areas.

Shell Exploration & Production Company, and other affiliates of Shell Oil Company (all referred to as "Shell"), appreciates the opportunity to comment on the Draft Environmental Impact Statement (Draft EIS) for the Proposed Use of Floating Production, Storage and Offloading Systems (FPSO) on the Gulf of Mexico (GOM) Outer Continental Shelf (OCS) in the Western and Central Planning Areas. Being actively involved in oil and natural gas development projects, Shell is very interested in the opportunity for FPSOs to be an additional system development option for use in the Gulf of Mexico. Shell supports the forethought of MMS and industry in reviewing these issues in advance of specific projects of this type. Shell also acknowledges the other EIS efforts by MMS in assessment of deepwater issues, as well as the USCG study on lightering. The current EIS will complement and expand the data already available and will serve to advance responsible development of domestic oil and natural gas reserves.

SHELL01

Shell supports and has participated in the development of the oral and written comments provided by the Offshore Operators Committee (OOC). Shell also supports the proposed action, Alternative A, for acceptance of the conceptual use of FPSO systems in the deepwater OCS areas of the Western and Central Planning Areas of the GOM OCS. We believe that the MMS has provided a thorough and realistic study of the probable environmental impacts resulting from FPSO operations.

SHELL02

We would like to point out that the potential future use of FPSOs in the Gulf of Mexico for oil and natural gas development projects would most likely result in only a few FPSO systems being actually installed. We believe that MMS' projection of five FPSO systems being installed in the next 10 years is realistic. If installed in the future, these systems would most likely be widely distributed in the ultra-deepwater areas of the Central and Western GOM, for development at locations far from existing pipeline infrastructure.

SHELL03

Shell also would like to suggest that it is important for the EIS to be as specific as possible regarding the federal agencies that have jurisdiction and established regulations and requirements for discharges to water. It is our contention that the existing NPDES Permit for the Central and Western GOM covers all discharges from FPSOs that are permanently moored; and also addresses all production and drilling related discharges for FPSOs that are not permanently moored. Discharges to water for FPSOs that are underway, shuttle tankers, and other support vessels are addressed by existing USCG regulations in 33 CFR Subchapter 'O'.

SHELL04

Shell supports the completion of the Environmental Impact Statement as an appropriate and proactive step that will, by leading to the acceptance of FPSOs in the GOM, increase the number of options available to operators involved in Deepwater development. MMS' prior EIS efforts have served to increase the body of knowledge available to all stakeholders, including industry and other regulators alike, and it is our expectation that this effort will emulate your past performance.

We appreciate the opportunity to provide comments on the Draft EIS. If you need any further information, please contact me at (504) 728-6982, or Mr. Rick Meyer at (504) 728-6393.

Very Truly Yours,

Peter Velez

Peter K. Velez
Manager, Regulatory Affairs and Incident Command

BD100300.DOC

SNTG(A)01

Stolt-Nielsen Transportation Group Ltd.

A subsidiary of
Stolt-Nielsen S.A.

Stolt Parcel Tankers Division
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MS 5400

29 September 2000

EIS
Regional Director, Gulf of Mexico
OCS Region
Mineral Management Service
1201 Elmwood Park Blvd.
MS-5410
New Orleans, LA 70123-2394

Dear Sir:

These comments are concerning pilotage and navigation issues that could be affected by the FPSO system.

As a major parcel chemical shipper, we are one of the largest users of the Houston Ship Channel. We have nearly 400 port calls in Houston a year. Therefore, the safe operation of the Ship Channel is a large concern of ours.

Federal law does not require a state pilot on shuttle tankers. It is possible for large FPSO vessels to come into this complex system with only a Federal pilot's license. This kind of license can be obtained by making as few as 12 round trips on the channel. The trips can be made in a vessel as small as 1600 tons. A helmsman or "observer" who receives no practical training at all can obtain it. The person holding this Federal license would then be allowed to navigate the Houston Ship Channel in any size vessel. We are understandably concerned about this. We are aware of a recent major incident in a US port that we believe was caused by the inexperience and inattention of a federally licensed pilot.

Our ships are all under the command of experienced unlimited tonnage Master Mariners who are assisted by state licensed pilots, also experienced seafarers. We expect that vessels such as the FPSO vessels would also be under the command of experienced Masters who are assisted by experienced licensed state pilots. The presence of a state pilot on board a vessel means that vessel will be acting as though it were part of the community. It will be participating in the port's informal traffic management system which (in the absence of a formal Harbor Master) organizes sailings and arrivals, allows vessels to meet or overtake each other in the safest areas of the channel, and ensures that oversize vessels will meet in appropriate areas. It means that the pilots making these arrangements has worked together and are familiar with the intricacies of the

SNTG(A)01, continued

channel and the characteristics of the wide variety of ships involved. It also ensures that every piloted vessel on the Channel will be fully apprised of changes to local conditions, the traffic situation, USCG regulations, meteorological and tidal conditions and any precaution areas on the channel.

A shuttle tanker or barge with only a federally licensed pilot on board would be an outsider and a hazard to navigation on the Houston Ship Channel. This would represent a serious hazard not only to those vessels but also to any other ship or vessel navigating the Ship Channel. As prudent managers, we try to manage our risk and minimize any controllable hazards. We do not think that the increased cost to the shuttle tanker operators would be worth the additional risk and hazard to them or any other vessels.

I would be happy to discuss this issue or answer any questions you may have on our opinions.

Sincerely,

William Boehm
Assistant Manager,
Marine and Safety Services

Stolt-Nielsen Transportation Group Ltd.

A subsidiary of
Stolt-Nielsen S.A.

Stolt Parcel Tankers Division
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Gulf of Mexico OCS Region
MMS
NOV 1 6 2000
Office of the Regional Director

Chris Oynes
Regional Director
Gulf of Mexico OCS Region
Mineral Management Service
International Square Office Complex
4141 N. Sam Houston Pkwy. E., Suite 202
Houston Texas 77032

8 November 2000

Mr. Chris Oynes,

I am the Safety Manager for Stolt-Nielsen Transportation Group, ShipOwning Division.

Stolt-Nielsen Transportation Group is a parcel chemical tanker shipping company. We have 75 ships operating worldwide. Many of our ships have opportunity to call in Houston and other Gulf ports. We consider ourselves to be an extremely environmental and safety conscious company. We care about the environment and we care about safety.

SNTG(B)01

I am writing to express my concern about the proposed construction and use of 50,000 barrel ATB's. I think that it would be unwise to allow construction and operation of any type of vessel that is capable of carrying that quantity of oil in that volume and not require it to be held to the highest standards. The size and nature of these ships makes them a certain hazard to people and the environment unless they are built, maintained and operated to the highest standards. They should not be allowed to operate as Uninspected vessels and thus held to a lower standard than oil and chemical tankers of that capacity. The Officers and crew must be well-trained and experienced. In addition, they must be sufficiently manned to allow them to perform their jobs safely.

The strength and safety of this industry is only as good as the weakest performer. I urge you to hold these vessels to the same standards of similar size and capacity vessels operating in this area.

Sincerely,

William Boehm
Assistant Manger,
Marine & Safety Services

MMSLetter/Nov.08.00/Pg 1

Texaco

P O Box 60252
New Orleans LA 70160

October 6, 2000

Regional Director (MS 5410)
Gulf of Mexico OCS Region
Minerals Management Service
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Re: **GOV – DEPARTMENT OF THE INTERIOR**
Minerals Management Service
Draft Environmental Impact Statement
Proposed Use of Floating Production, Storage, and Offloading Systems
on the Gulf of Mexico Outer Continental Shelf, Western and Central Planning Areas

Gentlemen:

Texaco Exploration and Production Inc. (Texaco) appreciates this opportunity to comment on the Draft Environmental Impact Statement (Draft EIS) for the Proposed Use of Floating Production, Storage and Offloading Systems (FPSO) on the Gulf of Mexico (GOM) Outer Continental Shelf (OCS) in the Western and Central Planning Areas. Texaco supports Alternative A of the Draft EIS for acceptance of the conceptual use of FPSO systems in deepwater OCS areas of the Central and Western Planning Areas.

TEXACO01

We believe the analysis of the base-case FPSO system provided in the Draft EIS supports acceptance of Alternative A and does not support acceptance of the other alternatives analyzed. No significant adverse impacts were identified for operational phases of the proposed action except for potential long-term impacts to Breton National Wilderness Area (NWA) due to possible exceedance of SO_2 standards. Potential air emissions for a specific project must meet the requirements of 30 CFR 250.303. Any significant adverse impacts on air quality at Breton NWA or elsewhere would be identified and mitigated as part of project-specific approvals. FPSO systems have been and are currently in use throughout the world and have been show to be a safe and environmentally sound system.

TEXACO02

Texaco has been involved in the preparation of comments by the Offshore Operators Committee and also support their comments.

Again, thank you for the opportunity to comment on the Draft EIS. If you have any questions concerning our comments, please let us know.

Sincerely,

Robert S. Lane, Vice-President
Texaco Exploration and Production Inc.

VFC:

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A Unocal Business Unit
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Telephone (281) 491-7600

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Office of the Regional Director

October 6, 2000

Chris Oynes
Regional Director (MS 5410)
Gulf of Mexico OCS Region
Minerals Management Service
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

Draft Environmental Impact Statement Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico Outer Continental Shelf, Western and Central Planning Areas

Dear Chris,

Union Oil Company of California (dba Unocal) appreciates the opportunity to provide written comments on the Draft Environmental Impact Statement (Draft EIS) for the Proposed Use of Floating Production, Storage and Offloading Systems (FPSO) on the Gulf of Mexico (GOM) Outer Continental Shelf (OCS) in the Western and Central Planning Areas. Unocal is one of the world's leading independent natural gas and crude oil exploration and production companies. Unocal holds 459 OCS leases in the GOM, comprised of 229 exploratory leases in deep water, 116 developed shelf leases, and 101 exploratory leases on the shelf.

UNOCAL01

Unocal has been actively operating OCS leases and interacting with groups concerned with OCS development in the GOM, including the various agencies responsible for managing or regulating OCS leases, for over 50 years. We support the proposed use of FPSOs on the GOM OCS. The Draft EIS is a very thorough and realistic study of the probable environmental impacts resulting from FPSO operations on the GOM OCS. The Draft EIS is organized in an appropriate and efficient manner with the potential impacts from operations set out distinctly from the potential impacts from accidents. Unocal appreciates the willingness of MMS to prepare this programmatic EIS on the broad issue of FPSO operations on the GOM OCS.

Unocal supports the proposed action, Alternative A, for acceptance of the conceptual use of the base-case FPSO system in the deepwater OCS areas of the Western and Central Planning Areas of the GOM OCS. Attachment A to this letter outlines the reasons why Unocal believes the EIS supports the adoption of Alternative A over Alternatives B and C. Attachment B to this letter provides detailed comments on the Draft EIS with proposed changes to be included in the Final EIS. If you have any questions concerning our comments, please contact David Saylor at (281) 287-5781.

Respectfully submitted,

Michael S. Bell
Vice President Deepwater Gulf of Mexico

Attachments

Attachment A
Draft EIS—Discussion of Alternatives

UNOCAL02

Unocal supports the adoption of Alternative A, the acceptance of the conceptual use of the base-case FPSO system in the deepwater OCS areas of the Western and Central Planning Areas of the GOM OCS. Please find below a discussion of the Alternatives considered in the Draft EIS.

UNOCAL03

Alternative A

Unocal believes that the analysis in the draft EIS supports the adoption of Alternative A, the acceptance of the conceptual use of the base case FPSO system in the GOM. No significant, adverse impacts were identified for the operational phases of the proposed action, except for the potential for long-term significant impact at Breton Sound NWA due to exceedance of the SO_2 standard. While this should serve as a warning flag to any company who proposes to utilize a FPSO in an area that could have significant adverse impacts on the air quality at Breton Sound NWA, it should be recognized that each specific project will have to meet the requirements of 30 CFR 250.303. The potential air emissions for a specific project may be different from those for the generic project proposed in the base case. The only negligible impacts that were identified for the operational phases of the proposed action were to commercial fisheries, socio-economic, recreational, beach use and other uses. The impacts to commercial fisheries, recreational resources and beach use were localized.

The draft EIS recognizes that the risk of a large, catastrophic spill is extremely low. In the event a spill should occur, the potential impacts due to oil spills were primarily adverse, but not significant. Under the extremely unlikely event a large catastrophic spill should occur, only limited significant impacts were identified depending on the location of the spill and presence of marine mammals, sea turtles and coastal and marine birds. Significant impacts were not identified for water and sediment quality, offshore environment, fish resources, commercial fisheries, socio-economics, cultural or other uses.

Unocal believes that the Draft EIS supports the adoption of Alternative A since no significant impacts were identified for the operation phase of the proposed action (except for potential impacts on air quality at Breton Sound NWA). The risk of a large, catastrophic spill is extremely low and even in the unlikely event one should occur, only limited potential significant impacts were identified. The draft EIS states that FPSO-unique spill risk comprises only 5% of the total risk of a spill; therefore, it is extremely small. The draft EIS states that greatest risk of a spill occurs from the shuttle tanker operations. Shuttle tankers are used routinely in the GOM to lighter tankers bringing in foreign imported oil and their use is acceptable to transporting foreign imported oil from a tanker to shore, and should be acceptable for use in transporting OCS oil from an FPSO to shore. Further, the draft EIS states that the risk of a spill from a shuttle tanker is slightly less than from an oil pipeline. Therefore, shuttle tankers should be an acceptable alternative to an oil pipeline.

UNOCAL04

Alternative B1
Alternative B1 would prohibit the use of FPSOs in the deepwater portions of the no lightering zones established by the USCG. Unocal believes the analysis in the draft EIS does not support the adoption of Alternative B1. No significant differences in impacts from Alternative A were identified for Alternative B1; therefore, the adoption of Alternative B1 is not warranted. The draft EIS determined that in the unlikely event oil is spilled, it would not reach topographic features. Therefore, the analysis in the draft EIS does not support the adoption of Alternative B1.

UNOCAL05

Alternative B2
Alternative B2 would prohibit the use of FPSOs in the Corpus Christi or Port Isabel map projection areas. Unocal believes the analysis in the draft EIS does not support the adoption of Alternative B2. Alternative B2 was proposed to mitigate potential increased risk of oil spill impacts on coastal areas and the shorter time to implement response actions before oil spills reach the coast. The oil spill trajectory analysis showed that spills from operations in this area would not reach shore within 3 days. Therefore, there should be sufficient time to effectively implement response actions before spills reach the coast. The risk of a larger, more persistent spill contacting the coast is very small. Therefore, the analysis in the draft EIS does not support the adoption of Alternative B2.

UNOCAL06

Alternative B3
Alternative B3 would prohibit the use of FPSOs in the Viosca Knoll and Mississippi Canyon map protraction areas. This alternative was proposed to mitigate potential increased risk of oil spill impacts on the Mississippi Delta before spill containment could be implemented. The oil spill trajectory analysis showed that spills from the area directly off the mouth of the Mississippi River have only a 16% chance of reaching shore within 3 days. Spills from the remainder of this area have less than 2% chance of reaching shore within 3 days. Therefore, there should be sufficient time to effectively implement response actions before spills reach the coast. The risk of a larger, more persistent spill contacting the coast is very small. Therefore, the analysis in the draft EIS does not support the adoption of Alternative B3.

UNOCAL07

During the course of conducting the draft EIS, two additional potential impacts were identified. In the course of conducting the air quality modeling for the base case, it was discovered that FPSO and the associated shuttle tanker and vessel operations located in the northeastern portion of the Mississippi Canyon area could result in a long-term significant impact at Breton Sound NWA due to the exceedance of the SO_2 standard. Additionally, if five FPSO were placed in this area within a 50-km radius, significant air quality impacts from SO_2 emissions could occur. Venting and flaring could also lead to significant impacts. The Mississippi Canyon/Viosca Knoll area covered under Alternative B3 is a large area, covering over 8,000 square miles. It is not anticipated that air quality modeling results would be the same for an FPSO operation located in the southwestern portion of the area as those located in the northeastern portion of the area. Therefore, condemning the entire the Mississippi Canyon/Viosca Knoll area based on the analysis in the draft EIS is not warranted. Each project as it is proposed will have to meet the requirements of 30 CFR 250.303 and the project will have to be appropriately mitigated, if required. It is extremely unlikely that all five of the FPSOs considered in the cumulative

UNOCAL07, continued

analysis would be located within a 50-km radius in this area. Therefore, the adoption of Alternative B-3 on this basis is not warranted. Additionally, MMS has the authority in 30 CFR 250.303 to consider cumulative impacts when reviewing individual projects.

UNOCAL08

The second potential impact identified is to sperm whales. There have been consistent sightings of sperm whales in the vicinity of the Mississippi River Delta. It is estimated that a total of 387 individual sperm whales may inhabit the northern GOM. The Mississippi Canyon/Viosca Knoll area is very large, in excess of 8,000 square miles. It is very unlikely that concentrated populations of sperm whales exist over this entire area, given the small number of individuals. Depending on the location of the FPSO, the port or ports the shuttle tankers would travel to and the location of sperm whale at any given time, the probability of significant impact on sperm whales is low. It should also be noted that to date there have been no restrictions on vessel traffic, exploration or development drilling, or developing reserves with fixed or floating platforms in this area. Therefore, to prohibit the use of FPSOs over this entire area would not be warranted based on the analysis in the EIS.

UNOCAL09

Alternative B-4
Under Alternative B-4, an attendant vessel would be required during offloading operations. The need for an attendant vessel should be driven by the offloading system design (FPSO and shuttle vessels combined) and operational requirement. Existing offloading systems have performed reliably without attendant vessels. The base case scenario does not require the use of an attendant vessel to assist in offloading activities. Systems that require such an attendant vessel limit the operational envelope during which offloading activities can occur. No operational benefits are gained by utilizing an attendant vessel. Therefore, the requirement to have an attendant vessel is not warranted and should not be prescriptively required for all FPSOs.

The draft EIS suggests that an attendant vessel can be utilized to warn or fend off other vessels that may encroach too close to the FPSO. While this is true, no rationale has been presented that suggests this is needed. Attendant vessels are not required to warn vessels that encroach too close to fixed or floating platforms or to tankers/shuttles while they are conducting lightering operations. A study on collision avoidance prepared for NOSAC showed that the wide variety of potential collision scenarios result in "no one size fits all" solution. Industry has used a wide variety of collision avoidance schemes including the establishment of safety zones around selected facilities, collision avoidance radar, training of crews to communicate effectively with ships, and the use of white spotlights to gain the attention of passing vessels. Therefore, the requirement to have an attendant vessel is not warranted.

The draft EIS also suggests that this vessel could carry oil spill response equipment and provide first response in the event an oil spill occurs. The majority of the deepwater area is located far from shore. The oil spill trajectory analysis in the draft EIS indicates that oil will not reach shore from any location outside of the mouth of the Mississippi River within 3 days of a spill. Therefore, having limited early response capability on site is of questionable value, particularly when balanced against the negatives of having an additional vessel on location. The draft EIS indicates that having an attendant boat would exacerbate the air quality impacts, provide incremental negative impacts relative to Alternative A in the areas of water quality and sediment impacts, the offshore environment, marine mammals, sea turtles, fish resources, socio economics

UNOCAL09, continued

and other uses. It should also be noted that an attendant vessel is not required during the lightering operations currently being conducted in the GOM where imported foreign oil is offloaded from tankers to shuttle tankers to be brought to shore. Therefore, the adoption of Alternative B-4 is not supported by the analysis in the draft EIS.

UNOCAL10

Alternative C

Alternative C is the "no action" alternative required to be evaluated by NEPA. In this case, "no action" means that the general concept of using FPSOs in the GOM OCS would not be accepted, but it would not prohibit the use of FPSOs in the GOM. If individual FPSO projects were approved, impacts similar to Alternative A would occur. Further, if FPSOs are not allowed to be used or are significantly delayed, significant adverse socioeconomic impacts could occur. The adoption of Alternative C is not supported by the analysis in the draft EIS.

NOTE: Please refer to Attachment B of the letter from the Offshore Operators Committee (OOC). Unocal submitted this same attachment with their letter.

Unocal
Draft EIS comments
Attachment A

4

10/06/00

General Responses. Several issues were commented on by many commentors. Rather than repetitive responses on these issues, the following general responses were developed to address all aspects of comments on each issue.

Comment No.	Response
General Response No. 1:	Comments that express the endorsement recommendation of a particular alternative, or a preference against or in opposition to a particular alternative in the EIS are noted. These expressed positions regarding alternatives A, B (including B-1, B-2, B-3, and B-4), and C as presented in the EIS will be forwarded to the MMS decision-maker for consideration. The basis for these expressed positions regarding the alternatives analyzed in the EIS will be carefully considered, as will all public comments received, so that an informed decision can be made by the MMS.
General Response No. 2:	Several comment letters expressed concerns regarding the use of federally licensed pilots on-board U.S. flag vessels shuttling crude oil from FPSOs in the Gulf of Mexico. Overall, the comments reflected a position that state-licensed pilots were preferable to federally licensed pilots for navigating shuttle vessels in designated pilotage waters. The MMS has forwarded all letters received on this matter to Coast Guard for their consideration. The Coast Guard provided the following information. Title 46 U.S. Code, Chapter 85 provides the statutory basis for federal pilotage. The Coast Guard has published comprehensive regulations regarding professional requirements for pilots' licenses at 46 CFR Subchapter B, Part 10, Subpart G (46 CFR 10.701-713). These regulations specify the minimum requirements an individual must meet to obtain a federal first-class pilot license. 46 CFR 15.812 describes the specific manning requirements for various types and sizes of vessels while underway in the navigable waters of the U.S. A U.S. flag shuttle tanker calling on a U.S. port from an FPSO located on the U.S. Outer Continental Shelf (OCS) would not require a state pilot. The vessel would be considered to be on a "coastwise" voyage (as opposed to on a "register" or foreign voyage). As a U.S. flag vessel over 1,600 gross tons, not sailing on register, the vessel must be under the direction of a federal first-class pilot whenever operating in designated pilotage waters (see 46 CFR 15.81). Likewise, a federal first-class pilot would be required aboard a vessel towing or pushing a U.S. flag tank barge over 10,000 gross tons not sailing on register, whenever the vessel was within designated pilotage waters. Other pilotage requirements apply to specific types and sizes of vessels operating on particular waters (see 46 CFR 15.812).
General Response No. 3:	Several comment letters expressed concern regarding the possible use of articulated tug/barges (ATBs) as a shuttle vessel for crude oil from FPSOs, and whether appropriate standards were in place for a large 500,000 barrel ATB. The MMS has forwarded all letters received on this matter to Coast

Comment No.	Response
	Guard for their consideration. The Coast Guard provided the following information.
	Coast Guard Navigation and Vessel Inspection Circular (NVIC) 2-81 (Change 1) describes current Coast Guard policies regarding integrated tug barges (ITBs). The Coast Guard considers an ATB to be a specialized type of ITB. Thus, Coast Guard will likely use NVIC 2-81 (Change 1) as the starting point for regulating these units. In addition, Coast Guard's FPSO project team will be considering whether current ITB requirements satisfactorily address the safety and environmental issues surrounding the design, construction and operation of large ATBs. Adjustments to the requirements in NVIC 2-81 (Change 1) are possible as the evaluation of these large shuttle vessels moves forward. Some of the provisions of NVIC 2-81 (Change 1) regarding vessel manning may need to be modified after considering the statutory changes in work hour limitations imposed by the Oil Pollution Act of 1990 (OPA 90).
General Response No. 4:	All development plans that propose use of FPSO technology development activities will be sent to the affected States for Federal consistency review. A determination regarding "affected State" status will be made per the requirements at 30 CFR 250.105. Any comments made by an affected State as part of its consistency review will be taken into consideration prior to MMS decision on the plan (FDEP02, TGLO06, LADNR02).
General Response No. 5:	The results of the FPSO risk assessment completed in conjunction with this EIS are presented in Section 4.4.1 of the EIS. The risk assessment did not find that FPSO systems would increase the likelihood and magnitude of oil spills in the GOM when compared to traditional modes of crude oil production, storage and transportation. Rather, the risk assessment found that the base case scenario FPSO system (including associated shuttle tanker operations) would present a level of risk comparable to the existing modes of activity. In considering the proposed action and its associated oil spill risk, MMS is evaluating various risk reducing measures that may be appropriate and feasible for the use of these FPSO and shuttle tankers in the GOM. Risk reducing measures are described in Section 4.4.1.3 of the EIS and in table 4-33.
	The data used to support the FPSO oil spill history analysis was obtained from the report titled "FPSO Historical Record And Offshore Incident Study, CTRS 4102 & 4103" prepared in 1999 by Intec Engineering, Inc. The report is based on the only available survey and compilation of worldwide FPSO historical data that includes information on oil spill history. Although the report identified 97 ongoing or completed FPSO operations, only 28 of the 97 FPSOs responded with historic oil spill data. The survey depended on voluntary reporting of oil spill data by the FPSO

Comment No.	Response

operators, not all operators returned completed surveys. The 28 FPSO operators that did respond represent an adequate cross section of the type, location, and ownership of FPSOs in operation from 19981 to 1997. Therefore, the Intec Engineering report represents an appropriate set of data for assessing FPSO oil spill history. The FPSO oil spill analysis of the DEIS is based on this subset of 28 FPSOs.

In the EIS, the frequency of shuttle tanker spills is based on data from Anderson and LaBelle (1994) for spills in U.S coastal and offshore waters. The dataset covers tanker spills over a 19-year period (1974-1992). The spill frequency (6.6 x 10-2) is based on the number of barrels transported (number of spills >1,000 bbl per billion bbls transported) regardless of the type of vessel transporting the oil. Spill size distribution is based on an analysis by Det Norske Veritas, Inc. (DNV) of Lloyd's Maritime Information Service (LMIS) proprietary database for worldwide tanker spills over a 3-year period (1992-1994). The spill size distribution correlates spill size as the percentage of cargo capacity (e.g. 0.01%, 0. 1%, 1%,…100%). Spill size is the fraction of cargo spilled multiplied by the cargo capacity of the base-case EIS shuttle tanker.

Concurrent with the preparation of the EIS, the MMS funded a Comparative Risk Assessment (CRA) to determine if FPSO risks would be comparable to those of existing deepwater production systems. The CRA compares the overall risks associated with a prototypical FPSO and supporting shuttle tankering to the risks associated with existing deepwater systems (i.e., spar, TLP, conventional fixed platform as a hub/host for deepwater) and their supporting pipelines. The CRA addresses three measures of risk – total fatalities, total volume of oil spills, and maximum volume of oil spill in a single incident. In the CRA, the frequency of spills of <10,000 bbl is based on Coast Guard dataset for crude oil tanker spills occurring in the Gulf of Mexico post-OPA 90 (1992-1999). For spills >10,000 bbl, the CRA used post-OPA 90 data for crude tankers worldwide. The spill frequency is based on the number of port visits (spill per port visit).

The EIS analysis shows a higher spill frequency than the CRA study partly because the EIS analysis is based on a worldwide database that included older (pre-OPA 90) spill data for U.S. waters. At present, the spill rates calculated in Anderson and LaBelle (1994) are being updated. In this new study, tanker rates appear to have dropped significantly in the years following the implementation of OPA 90 (Anderson, 2000, personal communication).

As discussed in Sections 4.2.2.1 and 4.5.2.2 of the FEIS, tanker port calls in the GOM are expected to increase during the coming ten-year period (2001 through 2010). An increase in tanker and other vessel traffic in GOM ports

Comment No. **Response**

may pose an increased risk for accidents that could result in oil spills. This increased risk cannot be attributed to the use of shuttle tankers serving FPSOs in the GOM. Rather, the increased risk would be attributable to increased maritime transport required to meet the increasing demand for petroleum products in the U.S. With the expected decrease or flat growth in U.S. domestic oil production during the next ten years, and increasing U.S. demand for petroleum products, imports of foreign oil will necessarily increase from 51 percent of domestic petroleum consumption (1997) to over 62 percent in 2010 (see Section 4.2.1 of the FEIS). These increasing volumes of imported oil will enter U.S. ports and terminals via tanker transport. As is the current practice, many of these tankers will be lightering vessels that essentially shuttle crude oil from foreign "super tankers" into GOM ports. The risks associated with FPSO shuttle tanker transport of crude oil are expected to be comparable to those for the lightering tanker transport described above (see Section 4.4.1 of the FEIS). As discussed in Section 1.2, based on the North Sea shuttle tanker experience (10,000 offloadings, 8 billion barrels of oil shipped, less than 300 bbls spilled since the 1970s), it is can be justifiably stated that the risks associated with FPSO shuttle tanker transport would be comparable to or better than the risks associated with lightering. In the event that deepwater leases are not developed using FPSOs, and requirements for meeting domestic demand for oil are to be met, the inherent risks associated with transport would be transferred to the use of pipelines, or to tankers carrying imported oil into U.S. ports.

Also, if a shuttle tanker offloads at the Louisiana Offshore Oil Port (LOOP), there would be no risk of spill at or near a landside port, within navigation channels, or adjacent to wetlands. LOOP as the destination port for the shuttle tanker is addressed in the EIS (see Sections 1.4.2.7 and 4.2.2.3) as one of the destination options of the proposed action.

Responses to comments from the United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS).

NMFS01: The EIS is a programmatic document addressing the concept of FPSOs for potential use in the deepwater areas of the Western and Central Planning Areas on the GOM OCS. The MMS does not believe that an EFH consultation is appropriate at this stage of the NEPA process. By agreement with NMFS, formal EFH consultation will occur when individual operators submit site- and equipment-specific FPSO project proposals. The MMS has prepared and submitted a letter to NMFS, as requested, that addresses issues raised by the agency. A copy of this correspondence is included in this FEIS as Appendix C.

Comment No.	Response
NMFS02:	See General Response No. 1.
NMFS03:	The MMS concurs with this recommendation. See the copy of the written correspondence from the MMS to NMFS (incorporated into this FEIS in Appendix D).
NMFS04:	In accordance with Section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) of 1996, the MMS has provided a written response to the NMFS letter that addresses the issues raised. A copy of the MMS letter to NMFS is incorporated in Appendix D.

Responses to comments from United States Environmental Protection Agency (USEPA).

USEPA01: Comment noted. See General Response No. 1.

USEPA02: The general conformity rule at 40 CFR Part 93, Subpart B requires that responsible agencies (Federal agencies conducting or permitting an action) must ensure that proposed activities do not interfere with state(s) implementation plan(s) (SIP[s]) for air quality attainment. As this EIS is a programmatic document addressing a generic FPSO system, the MMS believes that a conformity analysis is not appropriate at this stage. The USEPA correctly notes in their comment that "subsequent NEPA analysis will have to occur to fully satisfy NEPA and relevant Federal, State, and local permitting requirements for site specific operations." All OCS plans go through the established MMS site- and project-specific engineering, safety, and environmental review process. If an OCS Plan for an FPSO with tankering of OCS-produced oil to a port or ports affected by a SIP is submitted to the MMS, a conformity analysis will be required in support of the MMS review and decision process. Consultation and coordination with the affected state(s) will occur in conjunction with the conformity analysis. The MMS believes that it is appropriate to address general conformity during the site/project-specific review because detailed information on the proposed frequency of offloading, shuttle tanker equipment, offloading procedures, and destination ports is necessary to complete the conformity analysis.

There are significantly less potential emissions from unloading operations (in port) than there are from loading (at the FPSO). This is because the bulk of the volatile organic compound (VOC) emissions come from vapor displacement in the tanks during loading. Thus, the emissions from unloading tankers at a port terminal would be accounted for in the oil storage tanks, which normally operate under a permit. The DEIS addressed emissions associated with FPSO production and offloading. In order to fully address the comment regarding conformity for FPSO systems, we have expanded the discussion in the FEIS to include an emissions profile

Comment No. Response

for a base case scenario shuttle tanker in port. See Section 4.1.2.10 and table 4-8.

Responses to comments from the United States Department of the Interior, Fish and Wildlife Service (FWS).

FWS01: This discussion in Section 1.2 addresses the reported oil spill history for 28 FPSO operations worldwide. This information was obtained from a report prepared by Intec Engineering, Inc. in 1999. Seven of the 28 developments consist of ongoing FPSO operations in the North Sea (i.e. six near the United Kingdom and one near Norway). These operations combined represent 13.6 years of FPSO operation (as of mid-1999), and have resulted in a combined total crude oil production of 309 million bbls. During the period, there have been five reported FPSO-related oil spills, for a total of 4742 bbls. As discussed in Section 1.2 of the EIS, the majority of this spill volume (3,900 bbl) was attributed to a single release from the *FPSO Captain* in 1997. This accidental release was attributed to human error during the startup process and therefore was not operational or weather-related.

FPSOs operating in the North Sea, generally considered to be one of the harshest operating environments, have incurred only minor damage from storms. In all cases, there have been no spills from floating FPSOs and the associated shuttle tanker transport from the FPSO to shore attributed to any severe weather event. In comparing the North Sea and the GOM, the North Sea is noted for extreme weather conditions and unidirectional, rough sea-state conditions that occur on a frequent basis (in addition to the occasional threat of floating ice masses), whereas the GOM is more noted for the extreme weather and sea-state conditions associated with tropical storms that are seasonal; thus it is difficult to draw parallels between these two environments.

Specific to cyclonic weather events such as hurricanes, FPSOs have operated in the South China Sea where frequent typhoons occur. One of the most notable occurrences was the track of Super Typhoon Sally in 1996. The eye of Super Typhoon Sally approached within 11 miles of the FPSO Liuhua, a permanently-moored FPSO that is comparable in size to those considered for the GOM. Sustained winds measured at Liuhua were 128 mph; wave heights were estimated at 88 feet, exceeding the worst case 100-year storm criteria used to design the FPSO. Damage was limited to minor topsides equipment such as ladders and antennas, demonstrating the ability to design an FPSO for GOM hurricane conditions.

Approval of an FPSO-based development will only come after a project-specific review addressing site-specific design and environmental

Comment No.	Response
	conditions. Both MMS and Coast Guard regulations require the operator to demonstrate that the production facility can withstand the environment in which operations are intended. An independent third-party agent is typically used to verify a particular facility's capabilities.
FWS02:	The base-case scenario addresses permanently-moored FPSOs with no propulsion capability as being a likely configuration choice by operators in the GOM. However, it is possible that an operator may propose the use of an FPSO with propulsion (disconnectable system). The range of options considered for FPSOs in this EIS includes onboard storage capacity for up to 2.3 million barrels crude oil. Approval of FPSO-based development in the GOM will only come after a project-specific review addressing site-specific conditions and design. Both MMS and Coast Guard regulations require the operator to demonstrate that the proposed production facility can withstand the environment in which operations are intended. An independent third-party agent typically is used to verify the capabilities of a particular facility.
FWS03:	The MMS project-specific engineering safety review ensures that the equipment proposed for use is designed to withstand the operational and environmental condition in which the it will operate. Any deepwater development requires the submittal of a Deepwater Operations Plan (DWOP) in accordance with Notice to Lessees (NTL) 2000-N06. The DWOP outlines the design, fabrication and installation of the proposed development (production) system and its components. Any new technologies or equipment planned that represent an alternative compliance or departure from existing MMS regulation must be fully described and justified before such will be approved for use in deepwater. A DWOP will include the design basis for the equipment, including the factors that control the design, and how the equipment will be operated safely to prevent pollution. The MMS has recently completed a review of several industry-developed recommended practices that address the mooring and risers for floating production facilities. The recommended practices address such things as riser design, mooring system design (stationkeeping), and hazard analysis. The MMS is in the process of incorporating these recommended practices into the existing regulations. Hazard analyses will allow MMS to be assured that the operator has anticipated emergencies and is prepared to address such, either through their design or through the operation of the equipment in question. Pollution prevention is addressed through proper design and requirements for safety devices to prevent continued flow from a well should a rupture in one of the pipelines or risers occur. Redundancy is provided for critical

Comment No. **Response**

safety devices that will shut off flow from the well if, for example, a riser were to rupture. Deepwater wells, particularly subsea wells, include a number of sensors that help in detecting pressures and the potential for leaks in the production system. Safety devices are monitored and tested frequently to ensure their operation should an incident occur. Other barriers are monitored to provide for an early warning about the potential for loss containment. Contingency plans for dealing with a spill are addressed as part of the project-specific OCS development plan, which also requires MMS review and approval before development begins.

FWS04: This EIS addresses FPSO-unique operations and potential impacts. Thus the framework for the analyses is from installation to decommissioning of the FPSO. The exploration and post-decommissioning phases are not included in this EIS as they are common to all leases that are explored and eventually developed. Thus this comment addresses issues that are for the most part outside of the scope of this EIS.

MMS regulations at 30 CFR 250.702 address the requirements for permanent abandonment of a well on the OCS. A permanent abandonment includes the isolation of zones in the open wellbore, plugging of perforated intervals, plugging the annular space between casings (if they are open), setting a surface plug, and cutting and retrieving the casing at least 15 feet below mudline. All plugs must be tested in accordance with the regulations. There are no routine surveys of permanently abandoned well locations. If a well is found to be leaking, MMS would require the operator of record to perform an intervention to repair the abandonment. If a well is temporarily abandoned at the seafloor, an operator must provide MMS with an annual report summarizing plans to permanently abandon the well or to bring the well into production. Part of the annual report for a temporarily abandoned well is a survey of the well location to ensure the temporary abandonment is intact and adequately restricting any reservoir fluids from migrating out of the well. All equipment such as well heads, production trees, casing, manifolds, etc., must be designed to withstand the pressures of the deepwater areas. These designs are verified by MMS through multiple levels of engineering safety reviews prior to the equipment being placed into service.

Response to comment from United States Geological Survey (USGS).

USGS01: Comment noted.

Comment No. Response

Responses to comments from the Florida Department of Environmental Protection (FDEP).

FDEP01: See General Response No. 1.

FDEP02: The comment by the Florida Department of Environmental Protection will be taken into consideration by the MMS in preparing the Record of Decision for this EIS.

The Gulf Coastal States have multiple opportunities for NEPA review and comment on OCS activities during the scoping and public review of the 5-Year Leasing Program EIS and Lease Sale EIS processes. In addition, the MMS has ongoing dialogue with many agencies and departments within the Gulf Coastal States.

FDEP03: See General Response No. 1.

FDEP04: See General Response No. 5.

FDEP05: The MMS defers to Coast Guard on hull requirements for FPSOs. Rear Admiral North, Coast Guard Assistant Commandant for Marine Safety and Environmental Protection, sent a letter dated November 16, 1998 to MMS Associate Director Kallaur stating that FPSOs are classified as tank vessels, and that as such they must comply with Oil Pollution Act (OPA) of 1990 requirements, including double hull construction and spill response plans.

FDEP06: See response to comment FDEP05.

FDEP07: We do not agree with the assessment that the DEIS is deficient in descriptions of Biological Resources (Section 3.2). Experienced members of the academic community and professional fisheries scientists contributed to the Affected Environment sections with the express directive to include pertinent and applicable data sources appropriate for a programmatic environmental document to assess the conceptual use of FPSOs in the Central and Western Gulf of Mexico. In that regard, the body of knowledge for a particular resource was reviewed and salient references were incorporated (e.g., as study specific results, or conceptually as general statements of species or group habitat preference, life habits, sensitivity to perturbation, recovery capability, etc.). This level of detail is appropriate within a programmatic document. Once a specific project is proposed, a more detailed, site-specific analysis is warranted.

It should also be recognized that no formal EFH consultation occurred as part of this EIS effort. This was a conscious decision, given the broad area considered (i.e., deepwater areas of the Central and Western Gulf of

Comment No.	Response
	Mexico), the extreme variability possible in future FPSO projects, and the generic nature of the base-case scenario. By agreement with NMFS, The MMS will request formal EFH consultation when individual operators submit site- and equipment-specific FPSO project proposals. At that time, several of the valid comments offered by FDEP should, and will, be considered. The NMFS and MMS will review the results of the initial EFH consultations to determine if site-specific consultations will continue or if NMFS will respond to a programmatic consultation request. Specific responses to components of this comment are provided below.
FDEP08:	Essential fish habitat (EFH) has yet to be established for Warsaw grouper, as noted in table 3-16 (see table 3-16 Note), based in part on the need for NMFS to gather and summarize important deepwater habitat information on this species. Speckled hind was not noted by NMFS personnel as an EFH species candidate, as of winter 1999-2000, yet was cited as one of numerous deepwater species landed off Gulf coast states (see tables 3-14 and 3-15). To our knowledge, speckled hind EFH has not been designated; however, it may be possible that this species is now being considered a candidate. In either case, its inclusion in table 3-16 is not yet warranted. While it is true that the EFH discussion does not identify species-specific reasons for species protection, the document does recognize the general habitat requirements and water depth ranges considered important to each species (see table 3-16). In addition, appropriate summary discussions of life history, feeding (prey species), spawning, and preferred habitat characterizations were noted for major fish groups (see Section 3.2.6) under Fish Resources. Similarly, summary information (life history, etc.) for commercial fisheries was also provided (see Section 3.3.1). A fundamental consideration for a species being included under an EFH assessment is whether that species is currently being managed. One or more factors may provide the rationale for development of a fishery management plan for a particular species – habitat loss or degradation, overfishing, interference with natural movement, feeding, and/or spawning. The DEIS identifies and characterizes those factors considered important for major fish groups. A discussion of species-specific factors is more appropriately presented in a site-specific analysis. Potential changes in migratory patterns was recognized as one of several primary concerns with respect to fishes (e.g., see Section 4.3.9, Fish Resources), along with interference with feeding and spawning, contamination (e.g., from oil spills and produced water discharges), abandonment, and effects on regional diversity. While considered in a programmatic context within the DEIS, these concerns should be considered in greater detail in a site-specific environmental analysis. In

Comment No.	Response

general, benthic and bathypelagic species are not known to undergo extensive migrations, while exceptions do exist, as noted in the comment.

The impact analysis also involved consideration of other biological and physical resources that play a role in maintaining EFH – water and sediment quality, benthic communities, fish resources in general, and commercial and recreational fishery components. Impact determinations for these ancillary resources were considered when establishing EFH impact level.

The content of the Fish Resources and Commercial Fisheries sections should be considered jointly, even though the nature of the discussions are fundamentally different (i.e., Biological Resources vs. Other Relevant Activities and Resources [socioeconomic resources]). It is recognized that fish resources in general, and managed fish species in particular, rely on healthy and available food or prey sources, among other factors. For managed species with established fishery management plans (FMPs), such factors should be considered within the context of a site-specific project analysis. In a programmatic context, it is only necessary to identify this requirement and provide a broad characterization. Discussions of other resources (e.g., benthic community structure, topographic features, etc.) also provide peripheral information in this regard.

FMP data pertinent to EFH has been incorporated in a programmatic context. For example, as cited above, general habitat requirements and water depth ranges considered important to each species were noted in table 3-16. In addition, appropriate summary discussions of life history, feeding (prey species), spawning, and preferred habitat characterizations were noted for major fish groups in Section 3.2.6. Total area affected by an FPSO, subsea completions, and associated components (e.g., flowlines, pipelines) was considered under the base case and range of options during impact assessment. Species most likely to be influenced by FPSO deployment were broadly described in Section 4.3.9 (Fish Resources). Given the programmatic nature of the DEIS, a determination of the "most troubled populations" was not made. Such a determination should occur when a site-specific FPSO project is proposed and evaluated. Similarly, data on the areal extent and geographic location of EFH and the vigor for managed species must be considered in a site-specific context.

FDEP09: The MMS GOM Deepwater Operations and Activities Environmental Assessment stated that the physical and chemical properties of deepwater oils may differ from the oils typically produced on the continental shelf. To address the full range of potential impacts from deepwater operations, the coastal habitats section included an analysis of contact by heavy, high-asphaltene oils. As indicated in the comment, the FPSO EIS did not include an analysis specifically for high-asphaltene oil spill impacts, for three

Comment No.	Response
	reasons. The known API gravities and more detailed characterizations of deepwater OCS oils to-date do not indicate any heavy oils that might have high asphaltene content. If such oil reservoirs were to be discovered in the deepwater OCS, development and production systems would not be limited to FPSOs; i.e., would not be unique to FPSO operations. In fact, FPSOs would not likely be used to develop such fields because high viscosity oil is not conducive to storage and transfer at the standard sea level temperatures and pressures of FPSO operations. As a condition of approval for deepwater operations plans (DWOP), additional physical and chemical properties (specifically, API gravity, pour point, and viscosity) are required to be reported to the MMS within 60 days of the beginning of production. If this data indicates oil outside of the expected range of characteristics, the spill response plan will be reviewed to ensure that it is appropriate for the type of oil being produced. In addition, these data will support future environmental analyses.
FDEP10:	Seasonal aspects of oil spill trajectories were considered as part of the OSRA Model runs and subsequent analyses (see EIS tables 4-37 through 4-50 and the corresponding text in Section 4.4.2.3). Further, the seasonal differences in spill trajectories were discussed in Section 4.4.2.3). In conducting this analysis as part of the EIS, the greatest interest rested with those offshore and shoreline resources exhibiting the highest probability of oil contact (i.e., worst case situations). It was recognized that Florida and other coastal and offshore resources in the GOM could, under certain oceanographic situations, be affected by oil spilled in the Central Gulf Planning Areas. In response to this concern, both offshore and shoreline resources located within the entire rim of the GOM (along with the east coast of Florida) were included within the domain of the model run. A portion of the model domain that includes the entire Florida coastline is shown in Figure 4-13. Spill launch points were also selected for the OSRA model run, and subsequently evaluated, with this concern in mind, as detailed below. Section 4.4.2.1 of the EIS provides a detailed explanation of the methodology employed in running the OSRA Model, including the process of oil spill launch point selection. Specifically, surface ocean currents and wind fields for the Gulf of Mexico were utilized by the model during completion of approximately 2,000 trajectories. These trajectories were evenly spaced in time over the nine years of wind and ocean current data utilized in the analysis. Thus, trajectories were completed repeatedly for each season. While a total of 91 potential FPSO launch points and 24 tanker route launch points were modeled (see Figure 4-12), a discrete set of eight hypothetical launch points were analyzed and discussed in greatest detail within the DEIS. The set of eight launch points were distributed

Comment No.	Response
	throughout the deepwater study area (i.e., from the 200 m contour out to the EEZ boundary, within the Central and Western Planning Areas of the GOM). Within the Central Planning Area, a total of four launch points were analyzed, including one site in Mississippi Canyon (Site 7, designated MC-1) and one site in Atwater Valley (Site 8, designated AT-5). As reflected in Figure 4-12, these two sites are located either directly on or very close to the boundary of the Central Planning Area. Given the duration of the modeling runs (i.e., nine years of wind and current data, including repetitive seasonal considerations) and the location of several hypothetical launch points in the eastern portion of the Central Planning Area, it it should be noted that the analysis did incorporate extreme wind and current scenarios.
FDEP11:	Specific to cyclonic weather events such as hurricanes, FPSOs have operated in the South China Sea where frequent typhoons occur. One of the most notable occurrences was the track of Super Typhoon Sally in 1996. The eye of Super Typhoon Sally approached within 11 miles of the FPSO Liuhua, a permanently-moored FPSO that is comparable in size to those considered for the GOM. Sustained winds measured at Liuhua were 128 mph; wave heights were estimated at 88 feet, exceeding the worst case 100-year storm criteria used to design the FPSO. Damage was limited to minor topsides equipment such as ladders and antennas, demonstrating the ability to design an FPSO for GOM hurricane conditions. Approval of an FPSO-based development will only come after a project-specific review addressing site-specific design and environmental conditions. Both MMS and Coast Guard regulations require the operator to demonstrate that the production facility can withstand the environment in which operations are intended. An independent third-party agent is typically used to verify a particular facility's capabilities. Should an oil spill occur during a storm, spill response from shore would occur under following the storm. Spill response would not be possible while storm conditions continued, given the sea state limitations for skimming vessels and containment boom deployment(see Section 4.4.3). However, oil released onto the ocean surface during a storm event would be subject to accelerated rates of weathering and dissolution (i.e., oil and water would be agitated, forcing oil into smaller droplets and facilitating dissolution of the high end aromatic compounds present). Appropriateness of spill response options would be affected should a spill occur during a severe storm or hurricane. Given the timeframe limitations pertinent to oil dispersant effectiveness (estimated to be 39 to 48 hours as a general rule), dispersant use options would be reduced or eliminated depending upon storm duration. Use of skimmers and containment boom

Comment No.	Response
	would not be practical until the sea state conditions returned to acceptable levels.
FDEP12:	The DEIS has been reviewed to address this comment. The missing citations have been included in the revised references section (Section 6) in the FEIS. Regarding the comment on the age of some of the references cited in this EIS, it is important to consider the quality and nature of the older references cited. To summarily dismiss a data source because of the age of the publication is not a valid criticism. One must consider all available data sources which are relevant to a particular resource or impact factor being characterized. Many older citations represent landmark publications whose content still represents the best information available. However, the reference noted in the socioeconomic analysis pertinent to sportsfishing has been updated.
FDEP13:	It is recognized that the value of fisheries extends beyond just the ex-vessel value or landings data. For that reason, detailed information regarding all employment and labor categories was presented as part of the socioeconomic profiles of the 13 commuting zones, or labor market areas, along the Texas, Louisiana, Mississippi, and Alabama coasts (see Section 3.3.2). We also recognize that there are limitations to landings data. For example, an area fished might not be properly represented by landings data from a particular port. Further, fishermen interested in protecting prime fishing areas might not be as forthcoming with landings or fish block information. However, the use of landings data represents a standard and time-tested approach in preparation of environmental impact assessments. When coupled with a thorough consideration of regional and local labor and employment statistics (and projections), recreation and tourism, the use of landings data provides an excellent insight into the relative value of such fisheries. The DEIS did recognize the risk of tankering operations to recreational fisheries from both a routine operations and accidental oil spill perspective. Sections 4.3.9 and 4.3.10 consider possible impacts to fisheries resources from routine operations, while Sections 4.4.4.8 and 4.4.4.9 provide an analysis of possible oil spill impacts. Additional fisheries information is found in other related sections (e.g., menhaden spawning grounds are discussed in Section 4.4.4.4). Oil spill discussions were developed which not only addressed the impacts of accidental releases at the FPSO but from a shuttle tanker as well, including the possible effects of nearshore release of oil. The potential for changes in public perception, including local fishermen, due to oil contamination was considered in Sections 4.4.4.10 (e.g., consideration of coastal tourism/travel and impact sensitive

Comment No. **Response**

employment) and 4.4.4.11. The potential for long lasting impacts to this resource was noted in Section 4.4.4.

FDEP14: The MMS, other Federal agencies (e.g., USGS, National Biological Survey), academia, and the private sector (e.g., Offshore Operators Committee, American Petroleum Institute) recognize the need for additional data on the GOMs deepwater environment, and there are ongoing programs for meeting the need.MMS, through its Environmental Studies Program (ESP), is funding a variety of studies to address specific data needs or deficiencies. While attempting to expand our understanding of the functions and variability evident in deepwater ecosystems, such information will also provide better reference data upon which environmental planning, impact assessment efforts, and consideration for appropriate mitigation measures can be based. The realm and status of current MMS ESP projects can be determined through contact with the MMS GOM OCS Region or through the MMS website.

FDEP15: The MMS agrees that complete and accurate information and evaluation are essential for the purpose of this programmatic EIS. This EIS will be used as a planning reference tool, and for tiering subsequent NEPA documentation for any proposed FPSO systems in the Central and Western GOM. A considerable effort has been put forth by MMS and its contractors to achieve the primary objectives for this EIS. These objectives include the comprehensive and accurate assessment of the risks and environmental consequences associated with the proposed use of FPSOs on the GOM OCS.

FDEP16: See General Response No. 4.

Responses to comments from the Louisiana Department of Natural Resources (LADNR).

LADNR01: The legislation referred to by the commentor is H.R. 701 which is directly under the purview of the Congress of the United States. As such, comments and concerns related to the enactment of that legislation can not be adequately addressed by the MMS as part of the EIS process currently underway to assess potential impacts associated with FPSO use in the GOM. However, MMS notes that Congress recently passed legislation that included, among other things, a coastal impact assistance program. As part of that legislation, they authorized (for one year only – FY 2001) $150 million for the program. The President signed the bill into law on December 21, 2000 (P.L. 106-553).

Specifically, the coastal impact assistance provision is part of H.R. 5548 – a bill making FY 2001 appropriations for the Departments of Commerce/Justice/State – as as enacted by H.R. 4942. Title IX of the

Comment No.	Response
	legislation establishes the "Wildlife, Ocean and Coastal Conservation Program." Section 903 adds a new section 31 to the OCS Lands Act and sets up a formula whereby the Department of Commerce will distribute $150 million in FY 2001 to the 7 coastal States (including Louisiana) that are impacted by OCS oil and gas activities. Under the provisions of the Act, the monies will be shared with coastal states/subdivisions located within 200 miles of an OCS lease, excluding leased tracts located in areas where a moratorium on new leasing was in effect prior to January 1, 2000 (unless the lease was in effect prior to that time). Sixty percent of the $150 million would be divided evenly by the eligible States and 40 percent would be based on a State's proximity to OCS production. Since the legislation has been enacted into law, coastal states, such as Louisiana, stand to receive OCS impact assistance revenues during FY 2001. It is important to note that the legislation allows a State to use a portion of the monies it receives under the program (up to 23 percent) to mitigate the environmental impacts of OCS activities through funding onshore infrastructure projects and other public service needs.
LADNR02:	See General Response No. 4.
LADNR03:	The FEIS addresses the potential environmental impacts of the proposed action upon the coastal wetlands of the GOM in Sections 2.3 "Comparison of Environmental Impacts" [alternatives], 4.3.3.2 [coastal] "Water and Sediment Quality", 4.3.4 "Coastal Environments", 4.3.12 "Recreational Resources and Beach Use", 4.3.15 "Mitigation [for impacts of routine operations]", 4.4.2.3 "Results [of determining the conditional probabilities for oil spills impacting specific coastline segments], 4.4.4.3 "Coastal Environments" [for environmental and socioeconomic impacts of oil spills], 4.5 "Cumulative Impacts", and 4.7 "Unavoidable Adverse Impacts of the Proposed Action." The EIS is programmatic in that it addresses the concept of FPSOs generically and in a broad regional context. Although a site-specific development scenario is not considered by the document, every effort was made to identify potential site-specific issues and concerns and to assess the potential for adverse and significant impacts, as well as potentially applicable mitigation measures.
LADNR04:	See General Response No. 5.
LADNR05:	The DEIS (Section 4.4.1.2) does note that about 95 percent of the volume of potential FPSO-unique spills is likely to be due to the transfer of oil from the shuttle tanker and from the shuttle tanker transit to shore. It also states that about 54 percent of the volume of FPSO-unique spills is likely to be from shuttle tankers near port, and that 39.0 percent of the volume of FPSO-unique spills is likely to be from shuttle tankers in transit to port. An

Comment No.	Response

important consideration in these statements is the relative proportion of spill sizes, as reflected in table 4-32. Of particular note is that spills near port, or for shuttle tankers in transit, are expected to range from 1,000 bbl to 500,000 bbl, with highest probabilities evident for spills in the 1,000 to 10,000 and 10,000 to 50,000 bbl ranges; much lower probabilities are projected for the larger spills (table 4-32). Given that an FPSO location could occur in any deepwater area of the Central or Western GOM (figure 4-12), and that shuttle tankers may use one or more of five separate Gulf ports, it is possible that coastal habitats, including wetlands, waterways, and beaches could be fouled by spilled oil. It is also possible that such spills may occur much further offshore, in closer proximity to the FPSO.

Also, if a shuttle tanker offloads at the Louisiana Offshore Oil Port (LOOP), there would be no risk of spill at or near a landside port, within navigation channels, or adjacent to wetlands. LOOP as the destination port for the shuttle tanker is addressed in the EIS as part of the range of options for the proposed action.

Given the programmatic nature of the DEIS, it was not possible to model spill trajectories for all possible FPSO locations. However, a series of potential sites and a single tankering route were modeled and summarized in Section 4.4.2, using GOM oceanographic and meteorological historical data as forcing factors. Oil weathering was also considered separately and presented in this analysis; spill risk probabilities presented in table 4-32 do not account for spill weathering (or oil spill response, see below). Spills occurring further offshore can be expected to undergo more weathering than those that occur closer to shore, with reduction by physical and chemical modification (e.g., evaporation or dissolution of a significant portion of acutely toxic crude oil components).

Further, spill probabilities do not take into account any form of spill response, whether it might be from the FPSO, from the shuttle tanker, or from shore-based oil spill response organizations. Spill response capabilities, including mechanical recovery capability and dispersant capacity, are discussed in Section 4.4.3. It is presumed that, given a spill of the volume ranges considered in this analysis, a formidable spill response will be mobilized.

The potential for spills to reach shore, and the effects of such contact, are discussed in Section 4.4.2, while ecological risk is evaluated later in the same section. These discussions highlight the determination that FPSO-related spills have a very low probability of shoreline contact.

Finally, it is not a foregone conclusion that spills will result in heavily oiled wetlands, waterways, and beaches, and would include irreversible wetland loss and large reductions in habitat productivity for extended periods. Such

Comment No.	Response
	impacts are possible, although they are considered highly unlikely. Separate impact discussions pertinent to oil spill impact are presented in Section 4.4.4.3. Irreversible loss of wetlands would only occur under circumstances where: (1) a large amount of oil is accidentally released close to shore and close to a sensitive wetland; (2) current and wind conditions push the oil towards shore; and (3) spill response cannot be mobilized from either the shuttle tanker or from shore in time to protect the shoreline or sensitive resource. Specific characteristics of the resource (e.g., organic content of marsh sediments) may also influence resource sensitivity. As noted in Section 4.4.4.3, the probability of large, nearshore spills is low.
LADNR06:	See General Response No. 1.
LADNR07:	See General Response No. 1.
LADNR08:	Recognizing that the DEIS is a programmatic document, the MMS will require that such coordination would occur when an operator proposes a site-specific FPSO project. It is possible, at that stage, that mitigation could include emissions thresholds. Further, there may also be an opportunity for the operator to equip a proposed FPSO such that emissions thresholds will not be exceeded.
LADNR09:	FPSO proximity to shipping lanes and fairways can affect the level of risk for a collision to occur as a result of the proximity of merchant vessel traffic. The MMS is considering the issue of FPSO proximity to shipping lanes in the context of risk reducing measures addressed in Section 4.4.1.3 and table 4-33 in the EIS. The Coast Guard has the authority to establish charted safety zones of 500 meters around offshore facilities, in accordance with 33 CFR Part 147. Another potential mitigation being considered is a required set-back from established fairways. In addition, the MMS is considering the effectiveness of an attendant vessel as a mitigative measure under Alternative B-4. The Louisiana Offshore Oil Port (LOOP) has voluntarily provided an attendant vessel to enhance safety and pollution response at their offshore oil terminal on the Louisiana Gulf Coast. Although current Coast Guard regulations do not require an attendant vessel for offshore lightering operations, the Coast Guard FPSO project team will carefully consider the issue of attendant vessel use at FPSOs as they conduct their review.
LADNR10:	See General Response No. 1.
LADNR11:	Regarding design criteria for potential FPSO's, an operator must submit for MMS review and approval a Deepwater Operations Plan (DWOP) for all deepwater developments, including FPSO-based projects. The DWOP addresses a proposed development project from a total system perspective,

Comment No. **Response**

focusing on a characterization of the production system; and from a component perspective, focusing on how each component of the production system interfaces. Included in the DWOP are the following: structural aspects of the facility (fixed, floating, subsea); stationkeeping (includes mooring system); wellbore, completion, riser systems; safety systems; offtake; and hazards and operability of the production system. The DWOP provides us with the ability to determine that the operator has designed and built sufficient safeguards into the production system to prevent the occurrence of significant safety or environmental incidents. The DWOP in conjunction with other permit applications provides MMS the opportunity to assure that the production system is suitable for the conditions in which it will operate.

Some of the significant issues that must be addressed in a DWOP include mooring and fluid transfer to a proposed FPSO from the subsea production equipment, marine and production system interfaces, offloading safety procedures, verification and classification of the FPSO, and hazards analysis. Imbedded within these discussions are issues such as manning during hurricanes, offloading intentions in advance of a hurricane, and critical operations contingencies (for example, shutdown based on environmental conditions).

Before any FPSO would be allowed to operate in the GOM OCS, a detailed analysis would be performed of the site-specific proposed system with relevance to the same safety considerations given to other GOM OCS production systems. The operator must demonstrate to both MMS and Coast Guard that the FPSO, if allowed, could withstand the site-specific environmental loads. As with other OCS production systems, we will review the design of a proposed FPSO to ensure that accepted engineering standard would be met or exceeded. A certified verification agent would provide an independent third-party review of the adequacy of the FPSO design for its intended service.

The MMS has been working with Coast Guard and the offshore industry since early 1999 to assess the adequacy of design standards and regulations. Several industry standards are currently being evaluated by the MMS for applicability in our regulatory review and will likely be incorporated by reference in the MMS regulations at 30 CFR 250.

Neither the MMS nor Coast Guard mandate that an operator must evacuate a production facility for a hurricane; it is a decision that rests solely with the operator. The Coast Guard does require the submittal of an emergency evacuation plan that addresses egress routes on the production facility, lifesaving and personnel safety devices, firefighting equipment, etc. Plans for shutting in production from the subsea wells associated with an FPSO

Comment No.	Response
	will be addressed as part of the Deepwater Operations Plan submitted to MMS for review. In that plan, an operator will be required to specify the various alerts and shutdown criteria linked to both weather and vessel performance data, with the intent to have operations suspended and the well secured in advance of the hurricane. Details of the shut-in criteria and various alerts will be addressed on a case by case basis since they will be dependent on the FPSO design. The MMS believes the decision to offload an FPSO in advance of a hurricane is better addressed in a project-specific design and operational review of a proposed FPSO and the hazards analysis for the project. This will allow site-specific requirements to be adequately addressed to ensure an overall safe and minimal-risk operation. The decision to offload and transport oil to shore at the time of an approaching hurricane will be made in conjunction with Coast Guard on a case by case basis, again subject to the site-specific design of the FPSO.
	See also the response to comment FWS01.
LADNR12:	Please see response to comment FDEP09.

Response to comment from the Coastal Coordination Council (CCC), Texas General Land Office.

CCC01	Comment noted.

Responses to comments from Texas General Land Office (TGLO), Oil Spill Prevention and Response.

TGLO01:	Comment noted. The MMS agrees with the comment by Texas General Land Office that FPSO operations, if approved for use in the GOM, must be conducted in a manner consistent with basic environmental tenets.
TGLO02:	See General Response No. 5.
TGLO03:	The EIS addresses the full range of transportation options, including articulated tug barges (ATBs), also referred to as integrated tug barges (ITBs). See General Response No. 3.
TGLO04:	The MMS agrees that adequate response capability is a critical component of OCS operations. Project-specific spill response plans will be reviewed by MMS and USCG for adequacy before any approval for use of an FPSO is granted
	The MMS has forwarded the comment to the USCG for their consideration. The USCG provided the following information regarding this issue. The possibility of an oil spill from an FPSO must be comprehensively evaluated,

Comment No.	Response
	including developing appropriate pollution response strategies and tools. There is no Coast Guard regulatory requirement that mandates the use of dispersants. However, dispersants are often the best and most logical tool to respond to a large oil spill in an offshore environment. The supply and availability of dispersants needed for a major oil spill from an FPSO should not deplete the regional supply, but supplement current supplies. Minimum requirements should be addressed through the Regional Response Teams. Also see response to TGLO05 below. In addition, the MMS, as a principal United States government agency involved in funding offshore oil spill research, is currently funding numerous studies that could result in improvements in oil spill response preparedness in the GOM. The MMS Oil Spill Research Program is participating in the following major topic areas of research: remote sensing; oil properties; in-situ burning; deepwater releases; operation of OHMSETT (the National Oil Spill Response Test facility in Leonardo, New Jersey); mechanical containment and recovery; fate and behavior of oil; chemical treating agents; and shoreline cleanup countermeasures. Of the six studies on oil spill chemical treating agents conducted for MMS in 2000, one of these studies ("Technology Assessment of the Use of Dispersants on Oil Spills from MMS Regulated OCS Platforms") is directly tied to providing a comprehensive assessment of the operational and environmental factors associated with the use of chemical dispersants to treat oil spills from MMS-regulated GOM platforms. This recently completed study was conducted with the goal of expediting dispersant use planning and decision making in the GOM.
TGLO05:	Project-specific spill response plans will be reviewed by MMS and USCG for adequacy before any approval for use of an FPSO is granted. The capability and adequacy of existing oil spill response resources for new and larger volume deepwater petroleum systems being developed in the GOM is addressed in the EIS in Section 4.4.3. The MMS and the USCG are working cooperatively to develop an appropriate regulatory scheme for FPSOs. The Coast Guard has now formed a project team at Coast Guard Headquarters to address specific Coast Guard regulatory issues associated with FPSOs and to interface with MMS. The goal of this project team is to clarify current Coast Guard regulations applicable to FPSOs and develop necessary additional regulations should they be needed. Among other considerations, this Coast Guard FPSO project team will carefully consider the issue of attendant vessel use at FPSOs to enhance safety and pollution response. Also see response to comment TGLO04 above.
TGLO06:	See General Response No. 4.

Comment No. **Response**

Response to comment from Texas Natural Resource Conservation Commission (TNRCC).

TNRCC01: Emplacement of an FPSO in the deepwater region of the Central and Western GOM will not affect onshore surface and groundwater resources. Given that no new onshore facilities were considered nor necessary in the FPSO base-case scenario, programmatic environmental assessment of such potential impacts was not warranted. In the event that a site-specific FPSO project is proposed, and an operator propose construction of new FPSO-related facilities onshore, it will be necessary for the operator to evaluate surface and groundwater contamination concerns as part of a site-specific environmental assessment.

Response to comment from the Office of the Governor of Alabama.

ALABAMA01: The MMS did not receive further correspondence from the State of Alabama regarding the review and comment on the DEIS.

Responses to comments from Representative John E. Davis, Texas House of Representatives.

DAVIS01: See General Response No. 1.

DAVIS02: See General Response No. 2.

Responses to comments from Senator Mike Jackson, State of Texas.

SMJ01: See General Response No. 1.

SMJ02: See General Response No. 2.

Response to comment from Representative Robert E. Talton, Texas House of Representatives.

RRET01: See General Response No. 2.

Responses to comments from the Port of Freeport.

PF01: See General Response No. 2.

PF02: See General Response No. 2.

Comment No. **Response**

Response to comment from the Port of Houston Authority.

PHA01: See General Response No. 2.

Response to comment from Bob Acker.

ACKER01: Available historic information regarding the oil spill record for FPSOs is addressed in the EIS in Section 1.2. DNV completed the risk assessment in support of this EIS. This risk assessment included a hazard evaluation and frequency analysis. The analysis considered data for reported incidents and accidents involving FPSO operations world-wide. It also considered available data on the historic tanker spills in the GOM.

Responses to comments from S. Danscuk.

SD01: See response to comment FDEP05.

SD02: The opinion is noted. Industry has indicated that the cycle time for startup of an FPSO development could conceivably occur within timeframes shorter than those used in the example provided in the comment. This timeframe suggested by industry has been demonstrated worldwide.

SD03: The Coast Guard has helideck firefighting requirements for MODUs in 46 CFR, Subchapter IA. It is not currently clear whether these or similar requirements will be applied to FPSOs. The Coast Guard does not have independent regulations regarding process area deluge systems. In the past, and until such time as Coast Guard has independent regulations on this issue, the MMS and Coast Guard agree that the MMS regulations in 30 CFR 250 provide appropriate requirements for process area deluge systems.

SD04: The manning levels shown in table 1-1 were obtained from typical FPSO operations in other regions of the world. The Coast Guard will be responsible for designating specific and/or minimum manning requirements appropriate for FPSOs should they be approved for use in the U.S. GOM. The Coast Guard would limit its manning requirements to that required to adequately man the marine operations including navigation and dynamic positioning operators, and other deck and engineering watchstanders. The Coast Guard would also consider the marine personnel needed to respond to shipboard emergencies including firefighting and lifesaving equipment operations. The Coast Guard has yet to consider an actual manning scale for an FPSO operating in the Gulf of Mexico. Therefore, the manning described for the base case in table 1-1 is somewhat speculative, but believed to be within the range of “typical” for purposes of this programmatic EIS. The actual marine crew manning of the FPSO will be

Comment No. **Response**

determined by Coast Guard for U.S. flag FPSOs. If foreign flag FPSOs are allowed to operate on the U.S. OCS, it is expected that Coast Guard will require foreign flag units to demonstrate an equivalent level of marine crew manning to that required on a similarly built and operated U.S. flag unit.

SD05: The Department of the Treasury, U.S. Customs Service, has indicated that they consider a platform or production facility attached to the seafloor by any means to be fixed or attached to the Outer Continental Shelf of the Untitled State, and therefore a point in the United States, within the meaning of 43 U.S.C. 1333(a). Transportation of merchandise between such a platform or vessel and shore may only be legally provided by U.S. registered vessels that are endorsed for coastwise trade under the laws of the U.S. (i.e., Jones Act vessels). Thus the shuttle tankers must be Jones Act vessels. The Coast Guard has indicated that the decision on flagging requirements for the FPSO itself also ultimately falls to the U.S. Customs Service.

SD06: Vessel discharges, exclusive of production related discharges, should be "in accordance with Coast Guard regulatory authority and MARPOL limits (MARPOL 7378)."

SD07: The table referenced in the comment was provided for purposes of describing the expected waste streams associated with the base case scenario FPSO. Waste streams of both vessels and facilities operating on the OCS are regulated. These regulations provide discharge constraints and limits, and disposal methods as appropriate. Compliance with regulations for waste stream treatment and disposal would be expected to satisfactorily ameliorate waste stream impacts. Table 4-4 has been revised in the FEIS to include information on the compliance framework. See also response to comments OOC23 through OOC26.

SD08: Incineration of trash onsite at a production facility is rare. Current practice by industry is trash compaction and transport to shore.

SD09: Language in the DEIS was not intended to imply that all deck drainage would be retained and treated. Consistent with good oil field practice and current requirements, machinery areas and other possible leak locations will be properly designed so as to include such retention, including decks in the process area.

SD10: The use of a vapor recovery system for crude vapors during loading operations was assumed in the scenario modeled for this EIS. No decision has been made as to whether such would be required for all FPSO projects in the GOM.

Text in Section 4.1.2.8 has been revised to reflect that the base case

Comment No.	Response
	assumed vapor recovery would be employed.
SD11:	During development of the modeling scenario, it was assumed that a small portion of the power plant exhaust aboard the FPSO would be diverted, scrubbed, rendered inert, and used as blanket gas. This is currently a common practice for oil tankers. Likewise, the shuttle tanker exhaust would be employed for blanket gas aboard that vessel.
SD12:	AP-42 emission factors represent the best available emissions information for each equipment type because other readily available factors are typically formulated for a specific engine model or manufacturer. While it is true the updated AP-42 emission factors for natural gas fired turbines (April 2000) reduce emissions of NOx and CO, the primary emissions issue for the FPSO is SO_2, and those factors have not changed. The comment mentions "additional regulatory controls on the engines." There are no additional regulatory requirements for off-road diesel or stationary gas-fired sources (although there are proposed standards for marine diesels to take place in 2004 and proposed low-sulfur diesel standards). Additionally, engines aboard the vessels used for commissioning/decommissioning activities may be grandfathered from the new standards.
SD13:	Table 4-34 does not address produced-water output or treatment/discharge options. It addresses potentially feasible risk-reducing measures associated with the base-case FPSO.
	In terms of the concern noted over produced-water volumes and fate, several points of response are warranted. As noted in Section 4.3.3.1, maximum produced-water discharges from a single FPSO could be as high as 70,000 bbl/day, or approximately 4 percent of the total volume of produced water discharged into the GOM. This rate would likely not be realized until late in the production life of a field, consistent with historical produced-water production (i.e., produced-water volumes are low during early production, steadily decreasing as the producing reservoir is depleted). Effects of produced-water discharge are also very localized, as dilution and dispersion act effectively to quickly reduce effluent to near background levels. Produced water could also be used as reinjection water for reservoir pressure maintenance or enhanced recovery.
SD14:	See General Response No. 3. In addition, we are not aware of the circumstances in which an ATB towing vessel (over 26 feet in length) could be operated without Coast Guard-licensed personnel.
SD15:	See response to comment LADNR11.
SD16:	Oil spills and the ability to respond effectively to oil spills are directly related to the scope of the EIS. The EIS would be incomplete without

Comment No.	Response
	considering any potential response shortfalls. The response planning criteria need to be considered within the context of mandated facility and/or vessel response plans and a decision/judgement made as to whether FPSOs require any special pollution response planning measures.
SD17:	Comment noted.
SD18:	Comment noted.

Response to comment from Thomas Hudson.

TWH01: See General Response No. 3.

Responses to comments from G.M. Richards.

GMR01: See response to comment TGLO02.

GMR02: See General Response No. 2.

Response to comment from Allen J. Verret.

AJV01: See General Response No. 1.

Response to comment from Louis Vest.

LV01: See General Response No. 3.

Responses to comments from Captain Robert G. Webbon.

CRGW01: Comment noted. The EIS provides background information on the Exxon's offshore storage and treating (OS&T) vessel experience in Section 1.2. Captain Webbon is correct that oil produced from Exxon's Hondo Field was tankered to the Port of Houston. In addition, crude oil produced from the Alaskan OCS is also tankered to Gulf coast refiners. Regarding the issue of pilotage for U.S. flag tankers visiting U.S. ports, see General Response No. 2.

CRGW02: See General Response No. 3.

Response to comment from Henry C. Williams.

HCW01: The anticipated effects of the proposed action on the social and economic environment of Gulf Coast communities, including projected employment trends, is addressed in Section 4.3.11 of the EIS. This EIS is

Comment No. **Response**

"programmatic" in that it addresses the concept of FPSOs operating on the OCS in the GOM. The analysis presented in the EIS finds that deepwater oil and gas development (including FPSO systems if approved) creates both direct and indirect employment in the region. However, it is not possible to contemplate specific labor market effects at the local community level until a site-specific development proposal is presented by industry. Skilled workers, including those in the welding trade mentioned in the comment from Mr. Williams, are a necessary component of this kind of development. Employment for skilled workers in support of deepwater development and production activities would be in the areas of offshore infrastructure (including pipeline) construction, operation and maintenance; fabrication yards; ports and service bases; shipyards; among other construction and support functions.

Responses to comments from the American Bureau of Shipping.

ABS01: See General Response No. 1.

ABS02: See General Response No. 3.

Responses to comments from the Greater Houston Port Bureau, Inc.

GHPB01: See General Response No. 2.

GHPB02: See General Responses No. 2 and No. 5.

Response to comment from the Bay County Audubon Society.

BCAS01: Comment noted.

Response to comment from the Houston Pilots.

HP01: See General Response No. 2.

Responses to comments from the Offshore Operators Committee.

OOC01: See General Response No. 1.

OOC02: See General Response No. 1.

OOC03: The MMS is required to address a broad range of issues in the EIS, and to identify and assess the potential for environmental impacts that could result from the proposed action. This document is a programmatic EIS addressing a generic FPSO scenario (including consideration for the range of potential

Comment No.	Response
	components and configurations [also generic]). As observed in the analysis of air quality impacts for the vicinity of Breton Sound NWA, the potential for adverse impacts (including significant impacts) are in some cases location-dependent. The comparison of oil spill risk for shuttle tankers versus pipelines and lightering operations in the GOM is also generic. The proposed location for a FPSO development system (including the use of shuttle tankers), and any risk-reducing measures incorporated as part of a site-specific development proposal, would also factor in the risk of a significant impact resulting from oil spill. Additionally, it should be noted that there are aspects of the proposed action that are under Coast Guard jurisdiction.
OOC04:	Discussion of oil spill impacts to topographic features is noted in Section 4.4.4.4 (Topographic Features) of the EIS. Supporting analyses to this impact determination is provided from several sources. For example, the EIS addresses OSRA Model results (i.e., conditional probability of shoreline or offshore resource contact; Section 4.4.2), and combined conditional probability of oil spill risk (Section 4.4.2.3). Topographic features at depth would not be affected by oil spills originating either from the shuttle tanker or the FPSO. Although spills from shuttle tankers may reach waters overlying topographic features on rare occasions, reef communities are at “little risk” to either acute or chronic toxic exposure to hydrocarbon contamination due to their depth, and the lack of physical mechanisms that would allow the oil (released at the ocean surface) to reach these bottom features. Similarly, possible oil spills from FPSOs (e.g., during transfer operations) are expected to be small (<1,000 bbl) and readily dissipated within a few days.
OOC05:	The oil spill trajectories evaluated in Section 4.4.2 considered eight selected and hypothetical “spill launch points” throughout the deepwater areas of the Central and Western Gulf of Mexico. Spills from operations in the Corpus Christi lease area (location CC2) have a conditional probability of <0.5 percent of reaching shore within three days (table 4-37), in contrast to the comment which states that spills would not reach shore within three days. At 20 and 30 days, spills from CC2 have a much higher probability of reaching shore than spills from the other launch point (e.g., see tables 4-38 through 4-44 for Texas shoreline). Alternative B2 does mitigate potential increased risk of oil spill impacts on coastal areas in this regard.
	Spill response capability must also be taken into consideration in the evaluation of the potential mitigation offered by Alternative B2. Results presented in Section 4.4.3 suggest that, under optimal conditions, more than a quarter of a million barrels of oil spilled at or near CC2 could be recovered within the first 72 hours, although this exceeds total de-rated storage capacity on-scene (see Figure 4.24). Dispersant application, if

Comment No.	Response
	allowed, may also be capable of treating an additional 47,786 bbl of oil. A key concern lies with whether optimal conditions will occur during an actual spill. A large tanker spill realized under less than optimal conditions would leave coastal resources at higher risk, even at three days post-spill.
OOC06:	The logic of this comment is sound, however, the conclusion that there is insufficient information to support Alternative B3 rests on the assumption that optimal conditions will exist at the time of (and immediately following) a spill. As noted in the previous response, optimal spill response conditions were assumed (see Figure 4-31). Also as noted in the previous response, a key concern lies with whether optimal conditions will occur during an actual spill. A large tanker spill realized under less than optimal conditions would leave coastal resources at higher risk, even at three days post-spill.
OOC07:	It is accepted that a single FPSO operation located in the southern portion of the Mississippi Canyon/Viosca Knoll lease area may produce dissimilar results from the air quality modeling conducted at MC1. It is also recognized that conservative assumptions were made in the air quality modeling analysis. However, given the finding of significant air quality impact onshore (associated with modeled exceedances of the USFWS SO2 standard by a single FSPO at MC1), there is justifiable concern in the event of possible close proximity of several FPSOs in this portion of the Gulf of Mexico. A formal decision on prohibition of FPSOs, either singly or in a multiple FPSO configuration, rests with the MMS. Regardless of the outcome of Alternative B3, project-specific emissions impacts will be determined, and feasible mitigation measures considered, pursuant to existing regulatory requirements.
OOC08:	While it is true that "it is unlikely that concentrated populations of sperm whales" will occur over the entire Mississippi Canyon/Viosca Knoll area, the movements of this species are not well known. Based on summary information developed by Continental Shelf Associates, Inc. (CSA, in prep.) for evaluation of geophysical operations in the Gulf, the following text provides a summary of sperm whale abundance and distribution in the areas of interest: "The minimum number of sperm whales in the northern Gulf of Mexico is estimated to be 411 (Waring *et al.*, 1997). GulfCet II ship surveys for the oceanic northern Gulf of Mexico yield a figure of 387 sperm whales, with a confidence interval from 164 to 914. The mean density was estimated to be 0.097 individuals/100 km2. However, sperm whales are not uniformly distributed in the northern Gulf of Mexico. Generally, they are found in deep waters of the continental slope and beyond. They are not expected to be present on the continental

Comment No.	Response
	shelf. Further, the distribution of sperm whales is highly clumped, with congregations being most common along the shelf edge and slope in the vicinity of the Mississippi River Delta in water depths of 500-2,000 m. The main risk (of OCS operations) would be in these "focal areas" where a resident population of sperm whale may exist (Davis *et al.*, 2000)." CSA (in prep.) also noted that Davis *et al.* (2000) analyzed correlations of environmental factors, such as physical and biological oceanographic variables, with seasonal cetacean sightings data acquired from the Gulf. Based on large body size and deep-diving ability, Davis *et al.* (2000) found sperm whales throughout the northern Gulf, with typical sightings along the lower slope and, in some cases, in eddies with highly productive cyclonic circulation. An unusual aggregation of sperm whales was sighted along the 1,000-m isobath in proximity to the Mississippi River Delta, which may provide preferred habitat for this stock. This species' apparent affinity for mesoscale oceanographic features (frontal zones, eddies with cyclonic circulation) and waters over the 500-2,000 m isobath suggest the importance of these physical parameters to sperm whale distribution. Data deficiencies remain, including how long individual animals or groups remain within an area, their movement patterns throughout the central Gulf region and Gulf proper. Continuing work by the MMS and other research groups over the next several years should provide additional insight into movement patterns and preferred feeding areas.
OOC09:	It is acknowledged that an attendant vessel is not required for transfer and hookup of the offloading hose between the FPSO and shuttle tanker, although this is a method used by some existing FPSO operations. Some operations use the "messenger line" method of transferring the offloading hose between the two tankers. OOC suggests in this comment that the use of an attendant vessel as a collision avoidance measure is not warranted for FPSOs in the GOM. The comment suggests that there are other means to warn approaching vessels of the presence of the FPSOs (i.e., establishing safety zones, collision avoidance radar, radio, and use of white spotlights). All of these are passive measures, and none of them could provide assistance for coping with a drifting ship that has lost power or steering, or a ship that is simply not paying attention. An attendant vessel is the only "active" system available to intervene and potentially prevent a collision and any resulting fire, explosion, or oil spill. The Coast Guard provided the following comment on this issue. Current Coast Guard regulations do not require an attendant vessel for offshore

Comment No.	Response
	lightering operations. The Coast Guard is aware that the Louisiana Offshore Oil Port (LOOP) has voluntarily provided an attendant vessel to enhance safety and pollution response at their offshore oil terminal on the Louisiana Gulf Coast. The Coast Guard FPSO project team will carefully consider the issue of attendant vessel use at FPSOs as they conduct their review.
OOC10:	The socioeconomic analysis does not conclude that significant adverse impacts could occur if FPSOs are not allowed to be used or are significantly delayed within the Gulf of Mexico OCS (i.e., Alternative C). Rather, the conclusions pertinent to socioeconomics under Alternative C (see Section 4.3.11) note that impacts "could potentially be the same as for the proposed action" (Alternative A). Expected FPSO-based contributions to local and coastal labor markets (either in toto or individually) were projected to be minimal, resulting in negligible impacts (Section 4.3.11). Adverse but not significant impacts could be realized to one or two port facilities under a multiple FPSO scenario (Range of Options).
OOC11:	The text has been changed as recommended.
OOC12:	The MMS is satisfied with the description of this alternative as written; consequently the recommended changes to the document are not adopted.
OOC13:	The Executive Summary text has been expanded as recommended.
OOC14:	Additional text has been added to acknowledge that the potential for a significant impact from emissions may be location-dependent.
OOC15:	As noted in response to OOC08, sperm whales are not uniformly distributed in the northern Gulf of Mexico, showing an apparent preference for deep waters of the continental slope and beyond. Davis *et al.* (2000) characterized sperm whale distribution as being highly clumped, with congregations being most common along the shelf edge and slope in the vicinity of the Mississippi River Delta in water depths of 500-2,000 m. The main risk (of OCS operations) would be in these "focal areas" where a resident population of sperm whale may exist (Davis *et al.*, 2000)." CSA (in prep.) has also noted, per the findings of Davis *et al.* (2000), that sperm whales were sighted along the 1,000-m isobath in proximity to the Mississippi River Delta, which may provide preferred habitat for this stock. While showing affinity for specific isobaths, data deficiencies relevant to sperm whales remain, including how long individual animals or groups remain within an area and their movement patterns throughout the central Gulf region and Gulf proper. The recommended text addition is not warranted.

Comment No.	Response
OOC16:	The text has been modified to describe the potential utility of an attendant vessel for FPSO operations. See the response to comment OOC09 regarding the use of an attendant vessel as an "active" collision avoidance measure.
OOC17:	The text has been changed as recommended, except for use of the word "extremely."
OOC18:	The text has been changed as recommended.
OOC19:	The text has been changed as recommended.
OOC20:	The text has been changed as recommended.
OOC21:	The following text has been added for clarification. "However, the Act allows existing single-hull tank vessels to be operated until they reach their mandatory retirement age. These retirement dates vary depending upon the age of the vessel and hull configuration. A single-hull FPSO could conceivably operate until the mandatory retirement date for that particular vessel. All non-OPA-90 compliant vessels must be retired by the year 2015."
OOC22:	The text has been changed as recommended.
OOC23:	Table 4-5 has been revised to reference the current regulatory authority over various FPSO discharges.
OOC24:	Regulatory authority for individual effluents has been added to table 4-5, along with a new table footnote. Given that domestic wastes are considered non-production related, jurisdiction over these discharges remains to be resolved by MMS, Coast Guard, and USEPA. This is one of the issues that will be addressed at the MMS/Coast Guard Team meeting in early 2001.
OOC25:	The text has been revised to address this comment.
OOC26:	The intent of this comment has been addressed with the revisions to table 4-5 (see response to comment OOC23). No further text revision is warranted.
OOC27:	It is important that information regarding the potential level of shuttle tanker traffic be addressed in this section, along with other information on FPSO operations, so that the impacts of routine operations can be fully addressed in Section 4.3. The assumptions made in this discussion are intended to assist in providing an approximation of the range in FPSO shuttle tanker activity that could be expected in the GOM by the year 2010, when up to five FPSOs might be in operation. The base-case scenario (for which DeepStar provided input on expected operational parameters)

Comment No.	Response
	assumes that a typical FPSO would operate at a maximum production rate of 150,000 bbls/day crude oil. In addition, the range of options considered in this EIS included the possibility that an FPSO could operate on the GOM OCS at a maximum production rate of as high as 300,000 bbls/day crude oil. Given that one or more FPSOs could operate at production rates greater than the base-case scenario, five FPSOs averaging a production rate of 150,000 bbl/day was considered potentially achievable, and used in the analysis to determine a possible high end of the range for annual production. However, it is very unlikely that all five FPSOs would be producing at peak rates simultaneously. Also, peak production rates would not be sustained over the life of the facilities. Once the estimated annual upper limit for production was established, the number of shuttle tanker trips required to keep pace with production would be a function of shuttle tanker cargo capacity. The base-case scenario considers that the typical shuttle tanker will have 500,000 bbls crude oil capacity. This typical shuttle tanker cargo volume is also expected to represent the largest size practical for entering GOM ports. Lesser production rates and smaller shuttle tanker cargo capacities were assumed in the analysis as well, in order to develop a range of potential trips by shuttle tankers to port. The analysis determined that five FPSO operations in the GOM may require between 265 and 684 shuttle tanker trips per year. It should be noted that the more closely the five FPSOs collectively resemble the base-case scenario, the more unrealistic the upper and lower ends of the range for shuttle tanker traffic would be.
OOC28:	The text has been modified to note the control method for “Dry Oil Storage” as “inert gas blanket.”
OOC29:	The MMS agrees that the text regarding coordination with the Department of Defense for OCS activities in the Eastern Planning Area is not relevant for this EIS and it has been deleted from the document.
OOC30:	The MMS is satisfied with the description of this alternative as written; consequently the recommended changes to the document are not adopted.
OOC31:	The MMS is satisfied with the description of this alternative as written; consequently the recommended changes to the document are not adopted.
OOC32:	It is true that the OCD model does not include wet or dry deposition of pollutants. Text stating this fact has been added to the EIS. The MMS does not agree that the exclusion of wet and dry deposition of pollutants in the modeling is a very conservative approach. While the exclusion of wet or dry deposition of pollutants may be considered by some as “very conservative,” deposition algorithms are typically not allowed in the

Comment No.	Response
	regulatory use of air quality models (unless approved by the agency on a case-by-case basis). The impact of SO_2 emissions could be reduced by using chemical transformation algorithms, which are available in OCD but but only approved for regulatory use on a case-by-case basis.
OOC33:	New projects located within 100 km of a Class I area must satisfy the Federal Land Manager that the project has no significant impact before the project is approved. Large projects beyond 100 km that may significantly impact a Class I area must also comply with Federal Land Manager criteria. While an FPSO may locate in an area that does not impact a Class I area, the modeled location has potential impacts on the Breton Sound NWA. Therefore, the use of FWS modeling significance levels is not unreasonable for this modeled location, and in fact would be required by FWS, the Federal Land Manager. The MMS significance thresholds would typically be applied to locations outside of 100 km from a Class I area.
OOC34:	The suggested additional text is not accurate. Modeling at any other location would be expected to give different results – some locations higher, some locations lower. The deepwater area of the western and central Gulf is extensive. Given the programmatic approach taken in this assessment, air quality modeling could have been conducted across a broad spectrum of conditions (e.g., water depth, distance from shore, proximity to sensitive onshore receptors or areas of non-attainment). A nearshore deepwater location in Mississippi Canyon represents a valid modeling scenario, as noted in the comment. It also represents just one of a possible multitude of air quality modeling locations.
OOC35:	The comment is warranted, however, no changes to the DEIS text are required. The use of BAMP Phase II meteorological data will not necessarily impact Gaussian modeling such as OCD, but should improve the quality of and confidence in trajectory or grid modeling analyses. Thus the BAMP Phase II data may reasonably be expected to improve the modeling of activities in and around the Breton Sound NWA. Pending the availability and regulatory acceptance of BAMP Phase II data, air quality modeling near the mouth of the Mississippi River will likely incorporate this more recent data set.
OOC36:	The comment incorrectly notes that the FWS SO_2 3-hr and 24-hr standards were exceeded only at Receptor No. 5. A closer look at table 4-12 in the DEIS (which is renumbered as table 4-13 in the FEIS) reveals that the table's column format is presented on the basis of pollutant first (e.g., NO_x, SO_2, PM_{10}, CO), within which average duration criterion and receptor location(s) are sequentially noted. For example, NO_x columns reflect "annual" and "receptor location" columns, whereas SO_2 columns reflect "3-hour", "24-hour", and "receptor locations" columns. Under the SO_2 entries,

Comment No. **Response**

3-hr and 24-hr exceedances are evident at the 100 m mixing heights at Receptor Locations 5, 9, and 11; the latter two receptors are located in the Breton Sound NWA.

Table 4-12 (in the DEIS; table 4-13 in the FEIS) clearly notes the FWS Class I significance level and the highest modeled impact. The text (Section 4.3.2) clearly states that two separate significance criteria (i.e., MMS and FWS) are potentially applicable, and impact results clearly note exceedance of the FWS Class I standard on two and four occasions for the 3-hr and 24-hr standards, respectively. The summary discussion of air quality impacts (Section 4.3.2.5) notes that MMS standards were not exceeded, nor were any of the other criteria pollutants under either MMS or FWS significance criteria.

Use of the 100 m mixing height may be conservative. However, since SO_2 exceedances typically occur after cold frontal passage, the mixing height at the time of exceedances is typically between 100 and 300 m. Exceedances are not typical under “normal” conditions with 500-1,000 m mixing heights. Therefore, when mixing height data is unavailable, the MMS usually recommends using 500 m for annual averages and 100-300 m for detection of potential short-term averaging period exceedances. Using 100-300 m for short-term averages avoids not detecting post-frontal events and more accurately depicts the meteorological conditions of concern.

OOC37: While the comment may further explain the modeling results, the recommended text additions complicate the existing text and offer no information not already provided. A review of table 4-12 in the DEIS (renumbered to be table 4-13 in the FEIS), offering a similar opportunity for a reader to interpret the modeling results, provides a concise presentation of under what conditions exceedances were realized. This table is the preferred mechanism for the reader to determine which mixing heights and criteria pollutants resulted in either exceedance or non-exceedance of the two regulatory significance levels. Addition of the recommended text is not warranted.

OOC38: The text has been changed as recommended.

OOC39: Given the discussions that have occurred between the MMS and Coast Guard regarding permitting responsibilities, the generic statement offered in Section 4.3.3 is adequate. At this time, jurisdiction over FPSO non-production discharges once the FPSO has been moored on site remains to be resolved by MMS, Coast Guard, and USEPA. Addition of the recommended text is not warranted, and may further confuse the reader.

OOC40: The text has been changed as recommended.

Comment No.	Response
OOC41:	The text has been changed as recommended.
OOC42:	The text has been revised to more clearly explain that operators are required to make every possible attempt to recover equipment lost overboard.
OOC43:	The text has been changed as recommended.
OOC44:	The text has been changed as recommended.
OOC45:	The text has been changed as recommended.
OOC46:	The text has been changed as recommended.
OOC47:	The text has been changed as recommended.
OOC48:	The text has been changed as recommended.
OOC49:	The text has been changed as recommended.
OOC50:	The text has been changed as recommended.
OOC51:	The text has been changed as recommended.
OOC52:	Additional information on the databases used in support of the spill risk analysis is included in General Response No. 5.
OOC53:	A conservative approach was used for assessing oil spill risk in the EIS. The statement in parentheses has been expanded to include "This conservative approach was used."
OOC54:	An additional footnote has been added to this table that reads "The statistical volume of oil release annually was calculated using the upper end of each range."
OOC55:	This table has been modified to incorporate potentially feasible mitigation measures for addressing the vessel collision hazard.
OOC56:	Comment noted. See General Response No. 1.
OOC57:	The text has been revised. The issue of a production riser leak is a design issue that cannot be resolved as easily as indicated in the proposed mitigating measure. There are many engineering design factors and reviews that will affect the suitability of a riser and must be addressed with the engineering review for a site-specific FPSO development. To facilitate the evaluation of a particular riser design, the MMS is proposing to incorporate API Recommended Practice 2RD (Designing Marine Risers for Floating

Comment No.	Response
	Production Systems) into the existing 30 CFR 250 regulations.
OOC58:	The hazard addressed here is foundering, and the issue of classification for the production facility is not relevant. The text has been revised to remove this component. After further reviewing the issue of classification, the MMS agrees with the concerns expressed by OOC in this comment. The MMS does not intend to require "full classification" of an FPSO (i.e., classification of the production and well systems associated with the FPSO in addition to the hull and mooring systems). Specific to the hull, the environmental conditions used to design the hull must meet the extreme environmental conditions anticipated at the site. The FPSO hull and mooring systems will be verified to meet approved MMS/Coast Guard hull structural criteria and Coast Guard stability design criteria. We believe the current review requirements established by the MMS and Coast Guard accomplish the intended purpose of classification. The MMS may invoke review by a certified classification agent for some aspects of the FPSO system (e.g., mooring, production risers) in addition to the review that required to satisfy the structural requirements of the hull. The recommended revision to the "Mitigation Measure" text for design measures includes measures that are already assumed for the proposed action and would therefore not constitute mitigation. The text has been revised to incorporate the clarification for "online monitoring of loads on the hull" as mitigation.
OOC59:	The suggested modification of table 4-52 to include conditional probabilities (greater than one percent) of oil contact with equidistant land segments within three days is not warranted. As noted on in Section 4.4.2.3, area 6 off the Mississippi River mouth had an average probability of shoreline contact of 16 percent. Average probabilities of spill contact from the entire remaining offshore area reaching shore in three days were less than two percent.
OOC60:	The suggested modification of tables 4-53 and 4-54 to include conditional probabilities of oil contact within three days of a spill is not warranted. Similar comparisons are currently found in tables 4-37 through 4-44, and associated text (see Section 4.4.2.3).
OOC61:	Additional information on the databases used in support of the spill risk analysis is included in General Response No. 5.
OOC62:	The text has been changed as recommended.
OOC63:	The language in the EIS does not dismiss in situ burning as an option, it simply states that in situ burning is less effective than the use of skimmers.

Comment No.	Response
	The additional text has not been added to the EIS. The MMS has no way of knowing or predicting whether an oil spill responder will or will not consider in situ burning in the event of a spill.
OOC64:	The MMS believes that the 75 percent effectiveness of dispersants used in the EIS analysis was generally realistic. Preliminary results of an MMS study on dispersant capability and effectiveness indicates that value, in fact, may be optimistic.

Responses to comments from the Shipbuilders Council of America.

SCA01: See General Response No. 1.

SCA02: Comment noted.

SCA03: Comment noted.

Responses to comments from Conoco.

CONOCO01: See General Response No. 1.

CONOCO02: See General Response No. 1.

CONOCO03: See General Response No. 1.

CONOCO04: See response to comment OOC08.

CONOCO05: See response to comment OOC09.

CONOCO06: See response to comment OOC09.

CONOCO07: See response to comment OOC09.

CONOCO08: See General Response No.1.

Response to comment from Noble Drilling Services, Inc.

NDSI01: See General Response No. 1.

Response to comment from SBM-IMODCO, Inc.

SBMI01: Comment noted.

Comment No. **Response**

Responses to comments from Shell Exploration and Production Company.

SHELL01: See General Response No. 1.

SHELL02: Comment noted.

SHELL03: See response to comment OOC24.

SHELL04: See General Response No. 1.

Response to comment from Stolt-Nielson Transportation Group, Ltd. (Letter A)

SNTG(A)01: See General Response No. 3.

Response to comment from Stolt-Nielson Transportation Group, Ltd. (Letter B)

SNTG(B)01: Comment noted.

Responses to comments from Texaco Exploration and Production, Inc.

TEXACO01: See General Response No. 1.

TEXACO02: Comment noted.

Responses to comments from Unocal.

UNOCAL01: See General Response No. 1.

UNOCAL02: See response to comment OOC02.

UNOCAL03: See response to comment OOC03.

UNOCAL04: See response to comment OOC04.

UNOCAL05: See response to comment OOC05.

UNOCAL06: See response to comment OOC06.

UNOCAL07: See response to comment OOC07.

UNOCAL08: See response to comment OOC08.

UNOCAL09: See response to comment OOC09.

Comment No.	Response
UNOCAL10:	See response to comment OOC10.

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8 GLOSSARY

Accident event frequency – Indication of the likelihood that an accidental event will occur in any given year.

Acute – Sudden, short-term, severe, critical, crucial, intense, but usually of short duration.

Adverse impact – The negative effect that is imposed by a given action upon the natural environment or human society.

Anaerobic – Capable of living in the absence of dissolved molecular oxygen (free oxygen).

Anthropogenic – Coming from human sources, relating to the effect of humankind on nature.

Aphotic zone – Zone where the levels of light entering through the surface are not sufficient for photosynthesis or for animal response.

API gravity – A standard adopted by the American Petroleum Institute for expressing the specific weight of oil. The API gravity equals [(141.5/specific gravity at 60^{o}F) - 131.5].

Aromatic – Applied to a class of organic compounds containing benzene rings or benzenoid structures.

Attainment area – An area that is shown by monitored data or by air-quality modeling calculations to be in compliance with primary and secondary ambient air quality standards established by the USEPA.

Attendant vessel – Additional vessel present during offloading operations to assist with offloading activities (e.g., transfer of offloading hose); maintain designated safety distance between marine traffic and the FPSO/shuttle tanker; and provide first-response assistance in the event of an oil spill during offloading operations.

Barrel (bbl) – A volumetric unit used in the petroleum industry; equivalent to 42 U.S. gallons or 158.99 liters.

Base-case scenario FPSO – Generic description of an FPSO system and operations developed for this EIS, for purposes of analyzing potential risks and environmental consequences associated with use of FPSOs in the GOM OCS. It incorporates the components, configuration, and types and levels of activities that would reasonably be expected to represent industry's intended application of these systems.

Beneficial impact – Positive effect of an action that would be realized in the natural environment and/or human society.

Benthic – Organisms living on or in the bottom of the sea; associated with live bottoms, hard-bottom banks, patch reefs, and reef complexes.

Bilge water – Water that collects in the lowest inner part of ship's hull (the bilge).

Biological Opinion – FWS or NMFS evaluation of the impact of a proposed action on endangered and threatened species.

Block – A geographical area, as portrayed on an official MMS protraction diagram or leasing map, measuring approximately 2,331 ha (9 mi^2).

Blowout – An uncontrollable flow of fluids from a wellhead or wellbore. Unless otherwise specified, a flow of fluids from a flowline is not considered a blowout as long as the wellhead control valves can be automatically or manually activated. If the wellhead control valves become inoperative, the flow is classified as a blowout.

Central Planning Area (CPA) – The GOM OCS area south from the territorial sea at approximately 87°45' W. longitude to approximately 29° N. latitude, thence west to approximately 87°55' W. longitude, thence south to approximately 26° N. latitude, thence west to approximately 91°55' W. longitude (except that between approximately 88°23' W. longitude and 91°0' W. longitude, the boundary is the U.S.-Mexico provisional maritime boundary), thence north to approximately 27°55' N. latitude, thence generally west to approximately 93°25' W. longitude, thence northwest to the juncture of the territorial sea at approximately 93°50' W. longitude, thence east along the territorial sea to the point of origin.

Cetacean – An aquatic mammal of the order Cetacea (e.g., whales, dolphins, and porpoises).

Chemosynthetic – Organisms that obtain their energy from the oxidation of various inorganic chemical compounds rather than from light (photosynthetic).

Coastal waters – Inshore waters within the geographical areas defined by each State's Coastal Zone Management Program.

Coastal wetlands – Forested and nonforested habitats, mangroves, and all marsh islands that are exposed to tidal activity. Included in forested wetlands are hardwood hammocks, mangrove swamps, spoil banks, cypress-tupelo gum swamps, and bottomland hardwoods. Nonforested wetlands include fresh, brackish, and salt marshes. These areas directly contribute to the high biological productivity of coastal waters by input of detritus and nutrients, by providing nursery and feeding areas for shellfish and finfish, and by serving as habitat for many birds and other animals.

Coastal zone – The coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including inshore waters) strongly influenced by each other and in proximity to the shorelines of the several coastal states; the zone includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches and extends seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject to the discretion of or which is held in trust by the Federal Government, its officers, or agents.

Condensate – Liquid hydrocarbons produced with natural gas; they are separated from the gas by cooling and various other means. Condensate generally has an API gravity of 50°-120° and is water-white, straw, or bluish in color.

Conditional probability – The probability that a hypothetical oil spill will contact a specific location within a given time, the condition being that the spill is assumed to occur at a particular location. Conditional probabilities do not consider the likelihood of spill occurrence.

Continental margin – The ocean floor that lies between the shoreline and the abyssal ocean floor, includes the continental shelf, continental slope, and continental rise.

Continental shelf – The continental margin province that lies between the shoreline and the abrupt change in slope called the shelf edge, which generally occurs around a water depth of 200 m. The shelf is characterized by a gentle slope (ca. 0.1°).

Continental slope – The continental margin province that lies between the continental shelf and continental rise, characterized by a steep slope (ca. 3°-6°) from the shelf edge at 200 m to around depths of 3,000-4,000 m.

Converted FPSO – A vessel originally designed and constructed as an ocean-going oil tanker that has been structurally modified and equipped for FPSO service.

Critical habitat – Specific areas essential to the conservation of a protected species and that may require special management considerations or protection.

Crude oil – Petroleum in its natural state as it emerges from a well or after it passes through a gas-oil separator but before refining or distillation. An oily, flammable, bituminous liquid that occurs in many places in the upper strata of the earth, either in seepages or in reservoirs; essentially a complex mixture of hydrocarbons of different types with small amounts of other substances; as distinguished from refined oil manufactured from it.

Cycle time – Period from first oil discovery to first oil production at a given location.

Decommissioning – Removal or in-place abandonment of all production site structures and equipment, including removal of the FPSO vessel from the field, either for salvage or for reuse at another field.

Deferral – Action taken by the Secretary of the Interior at the time of the Area Identification to remove certain areas/blocks from a proposed sale.

Delineation well – A well that is drilled for the purpose of delineating the extent of an oil or gas reservoir, thereby enabling the lessee to determine whether to proceed with development and production.

Demersal – Living at or near the bottom of the sea.

Designated environmental preservation areas – Gulf of Mexico shorefront areas recognized for the quality and significance of their natural environments. They have been legislatively, administratively, or privately protected from development and are managed solely for the preservation, understanding, and appreciation of their natural attributes. Included are National Parks and Preserves, National and State Wilderness Areas, National Marine and Estuarine Sanctuaries, National Landmarks, Wildlife Sanctuaries, Florida Aquatic Preserves, and Environmentally Endangered Lands.

Development – Activities that take place following discovery of economically recoverable mineral resources, including geophysical surveying, drilling, platform construction, operation of onshore support facilities, and other activities that are for the purpose of ultimately producing the resources.

Development Operations Coordination Document (DOCD) – A document that must be prepared by the operator and submitted to MMS for approval before any development or production activities are conducted on a lease in the Western Gulf. The DOCD meets the requirements of 30 CFR 250.34. Environmental information, an archaeological report, a biological report (monitoring and/or live-bottom surveying), or other information, as determined, may be required in support of the DOCD.

Development well – A well drilled to a known producing formation to extract oil or gas; a production well; distinguished from a wildcat or exploratory well and from an offset well.

Direct employment – Consists of those workers involved in the primary industries of oil and gas exploration, development, and production operations, including geophysical and seismic surveying, exploratory drilling, well operation, maintenance, and other contract support services (Standard Industrial Classification Code 13–Oil and Gas Extraction).

Discharge – To pour forth fluid or other substance ; discharge rate is the flow rate of a fluid at a given instant expressed as volume per unit of time.

Dispersion – A suspension of finely divided particles in a medium; a system consisting of a disperse substance and the medium in which it is dispersed (e.g., oil droplets in water).

Drilling mud – A special mixture of clay, water or refined oil, and chemical additives pumped continuously downhole through the drill pipe and drill bit, and back up in the annulus between the pipe and the walls of the hole to a surface pit. The mud lubricates and cools the rapidly rotating bit, lubricates the drill pipe as it turns in the well bore, carries rock cuttings to the surface, serves to keep the hole from crumbling or collapsing, and provides the weight, or hydrostatic head, to prevent extraneous fluids from entering the well bore and to control downhole pressures that may be encountered; drilling fluid.

Eastern Planning Area (EPA) – The GOM OCS area south from the territorial sea at approximately 87°45' W. longitude to approximately 29° N. latitude, thence west to approximately 87°55' W. longitude, thence south to approximately 26° N. latitude, thence east to approximately 85°55' W. longitude, thence south to the limit of U.S. jurisdiction, thence southeast to approximately 83°55' W. longitude at 24° N. latitude, thence east to 83° W. longitude, thence north to the limits of the territorial sea, thence east to approximately 82°25' W. longitude, thence north and east along the territorial sea abutting the Florida Keys, thence north and east to approximately 81°55' W. longitude, thence north to the limits of the territorial sea, thence north and west along the territorial sea to the point of origin.

Economically recoverable resources – An assessment of hydrocarbon potential that takes into account the 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.

Effluent – Waste material (such as produced water) discharged into the environment.

Effluent limitations – Any restriction established by a State or the USEPA on quantities, rates, and concentrations of chemical, physical, biological, and other constituents discharged from point sources into U.S. waters, including schedules of compliance.

Endemic – Native, or confined to a certain region.

Environmental Justice – Per Executive Order 12898, signed by President Clinton in February, 1994, to ensure that disproportionately high and adverse environmental and health effects experienced by low-income and minority populations are addressed, as appropriate, in the programs of federal agencies, and that these programs encourage the full involvement of affected parties.

Epifaunal – Animals living on the surface of hard substrate.

Escalation potential – Possible routes for the escalation (increase or intensification) of an event that could lead to an oil spill or other accident event.

Essential habitat – Specific areas crucial to the conservation of a species and that may necessitate special considerations.

Estuary – Semi-enclosed coastal body of water that has a free connection with the open sea and where freshwater meets and mixes with seawater.

Eutrophication – Enrichment of nutrients in the water column by natural or artificial methods accompanied by an increase of respiration, which may create an oxygen deficiency.

Exclusive Economic Zone (EEZ) – The maritime region adjacent to the territorial sea, extending 200 nautical miles from the baseline of the territorial sea, in which the United States has exclusive rights and jurisdiction over living and nonliving natural resources.

Exploration well – A well drilled in unproven or semi-proven territory for the purpose of ascertaining the presence of a commercial petroleum or natural gas deposit; exploratory well.

Fairway – Established corridors for maritime traffic, generally located inshore of the deepwater region considered in this analysis, in which no fixed structure, whether temporary or permanent, is permitted.

Flaring – Combustion of produced natural gas during crude oil production at an offshore site.

Floating production systems (FPS) – Universal term referring to all production facilities that float rather than those systems that are supported by the sea floor; includes TLP's, spars, semisubmersibles, ship-shape vessels, etc. Also frequently used to describe floating production facilities that do not have on-site storage.

Floating production, storage, and offloading system (FPSO) – A floating production facility used for oil and gas development in the offshore environment; incorporates processing facilities for produced hydrocarbons and onboard storage of crude oil. Crude oil is offloaded to shuttle tankers for transport to refinery ports and terminals.

Gathering lines – A pipeline system used to bring oil or gas production from a number of separate wells or production facilities to a central trunk pipeline, storage facility, or processing terminal.

Geochemical – The related chemical and physical properties of substances in the crust of the earth such as crude oil. Of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.

Geophysical survey – A method of exploration in which geophysical properties and relationships are measured by one or more remote-sensing, geophysical methods.

Habitat – The specific type of environment that is occupied by an organism, a population, or a community.

Harassment – an intentional or negligent act or omission that has the potential to injure a protected species by causing disruption of normal behavioral patterns that include, but are not limited to, migration, breathing, breeding, feeding, and sheltering.

Hawser – A cable system used in mooring or towing a ship.

Hermatypic coral – Reef-building corals that produce hard, calcium carbonate skeletons and that possess symbiotic, unicellular algae within their tissues.

Hydrocarbons – Any of a large class of organic compounds containing primarily carbon and hydrogen. Hydrocarbon compounds are divided into two broad classes: aromatic and aliphatic. They occur primarily as petroleum, natural gas, coal, and bitumens.

Hydrology – As used in relation to river development and flood control projects, means alteration of the physical configuration of the drainage basin and channels, including dredging of channels to deepen or widen them; construction of dams, levees, or canals; and addition of irrigation or municipal waters to the natural runoff.

Hypoxia – Depressed levels of dissolved molecular oxygen (free oxygen) in water (< 2 mg/L), usually resulting in decreased metabolism of inhabiting organisms.

Incidental take – Takings that result from, but are not the purpose of, carrying out an otherwise lawful activity (e.g., fishing) conducted by a Federal agency or applicant (see Taking).

Indirect employment – Secondary or supporting oil- and gas-related industries, such as the processing of crude oil and gas in refineries, natural gas plants, and petrochemical plants.

Induced employment – Tertiary industries that are created or supported by the expenditures of employees in the primary or secondary industries (i.e., direct and indirect employment, respectively), including consumer goods and services such as food, clothing, housing, and entertainment.

Infrastructure – The facilities associated with oil and gas development, e.g., refineries, gas processing plants, etc.

Landfall – The site where a marine pipeline comes ashore.

Lay barge or lay vessel – A shallow-draft, barge-like vessel used in the construction and laying of underwater pipelines.

LC_{50} – The concentration at which 50 percent of the test organisms have succumbed after a prescribed period of exposure.

Lease – Any form of authorization that is issued under Section 8 or maintained under Section 6 of the Outer Continental Shelf Lands Act and that authorizes exploration for, and development and production of, minerals.

Lease sale – The competitive auction of leases granting companies or individuals the right to explore for and develop certain minerals under specified conditions and periods of time.

Lease term – The initial period for oil and gas leases, usually a period of 5, 8, or 10 years (a longer period is necessary to encourage exploration and development in areas that are unusually deep water or other adverse conditions).

Lessee – A party authorized by a lease, or an approved assignment thereof, to explore for and develop and produce the leased deposits in accordance with regulations at 30 CFR 250.

Lightering – Offloading oil from a large tanker onto smaller tank vessels or barges for transport to coastal facilities.

Loop current – The streamlines or flow paths of surface currents entering the Gulf through the Yucatan Channel, turning clockwise, and then exiting the Gulf into the Straits of Florida.

Metocean data – Meteorological (climate and weather) and physical oceanographic data.

Military warning area – An established area within which military activities take place.

Minerals – As used in this document, minerals include oil, gas, sulphur, and associated resources, and all other minerals authorized by an Act of Congress to be produced from public lands as defined in Section 103 of the Federal Land Policy and Management Act of 1976.

Nepheloid – A layer of water near the sea bottom that contains significant amounts of suspended sediment.

Nonattainment area – An area that is shown by monitored data or by air-quality modeling calculations to not meet primary or secondary ambient air quality standards established by the USEPA.

Nonhazardous oil-field wastes (NOW) – Wastes that are generated by exploration, development, or production of crude oil or natural gas that are exempt from hazardous waste regulation under the Resource Conservation and Recovery Act (RCRA), as per *Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes*, dated June 29, 1988 (53 FR 25446; July 6, 1988). These wastes may contain hazardous substances.

Non-ship-shaped – Lacking the characteristic streamlined shape of a ship hull.

NORM – Naturally occurring radioactive materials; any naturally occurring material that emits low levels of radioactivity, originating from processes not associated with the recovery of radioactive material. The radionuclides of concern in NORM are radium-226, radium-228, and other isotopes in the radioactive decay chains of uranium and thorium.

OCS Program activities – All OCS oil and gas activities occurring Gulfwide during the life of the proposal.

Offloading – Another name for unloading; offloading refers more specifically to liquid cargo, crude oil, and refined products.

Operational discharge – Any incidental pumping, pouring, emitting, emptying, or dumping of wastes generated during routine offshore drilling and production activities.

Operator – An individual, partnership, firm, or corporation having control or management of operations on a leased area or portion thereof. The operator may be a lessee, designated agent of the lessee, or holder of operating rights under an approved operating agreement.

Outer Continental Shelf (OCS) – All submerged lands that comprise the continental margin adjacent to the United States and seaward of State offshore lands and extending from state waters to the limit of the U.S. Exclusive Economic Zone.

Pelagic – Of or pertaining to the open sea; associated with open water beyond the direct influence of coastal systems.

Plankton – Passively floating or weakly motile aquatic plants (phytoplankton) and animals (zooplankton).

Platform – A steel or concrete structure from which offshore development wells are drilled.

Precommissioning – Testing equipment at as close to operating conditions as possible.

Produced hydrocarbons – Product obtained from a well containing crude oil, gas fractions, and water.

Produced water – Total water discharged from the oil and gas extraction process; production water or production brine.

Production – Activities that take place after the successful completion of any means for the extraction of resources, including bringing the resource to the surface, transferring the produced resource to shore, monitoring operations, and drilling additional wells or workovers.

Purpose-built FPSO – A vessel or floating facility designed and constructed specifically for the purpose of operating as an FPSO.

Recoverable reserves – The portion of the identified hydrocarbon or mineral resource that can be economically extracted under current technological constraints.

Recoverable resource estimate – An assessment of hydrocarbon or mineral resources that takes into account the fact that physical and technological constraints dictate that only a portion of resources can be brought to the surface.

Recreational beaches – Those frequently visited sandy areas along the shorefront exposed to the Gulf of Mexico that support multiple recreational activities, most of which are focused at the land-water interface. Included are National Seashores and other selected areas in the National Parks System, State Park and Recreational Areas, county and local parks, urban beachfronts, and private resort areas.

Recreational fishing (marine) – Hook-and-line sportfishing for fun, food, and occasional incidental profit, inclusive of spearfishing, from a boat seaward of the beach.

Refining – Purifying of crude oil by fractional distillation, usually followed by other processing (e.g., cracking).

Relief – The difference in elevation between the high and low points of a surface.

Reserves – Proved oil or gas resources.

Rig – A structure used for drilling an oil or gas well.

Riser – The length of pipe that extends from a subsea production system up to a fixed or floating production platform in the offshore environment. Risers are the conduit for transferring the hydrocarbons produced by the subsea system to the processing facilities on the platform.

Risk-reducing measures – Measures or activities that could be undertaken to reduce the potential for, the frequency of, or the severity of an undesirable event.

Royalty – A share of the minerals produced from a lease paid in either money or in kind to the land owner by the lessee.

Seagrass beds – Generally continuous mats of submerged, rooted, marine, flowering vascular plants occurring in shallow tropical and temperate waters. Seagrass beds provide habitat, including breeding and feeding grounds, for adults and/or juveniles of many of the economically important shellfish and finfish. As such, this habitat type is especially sensitive to oil-spill impacts.

Sediment – Solid material (e.g., rock or shell fragments) that has been transported and deposited by water, wind, glacier, precipitation, or gravity; a mass of deposited material.

Seeps (hydrocarbon) – Gas or oil that reaches the surface along bedding planes, fractures, unconformities, or fault planes.

Semi-submersible – Either a mobile offshore drilling rig (MODU) or a production platform that is characterized by large, vertical columns connected to a main deck above and to large, horizontal pontoons below. The systems floats with about half the structure above the water line and half below. The elevation can be varied by altering the water level in the ballast tanks. This structure is fairly stable in adverse sea conditions.

Sensitive area – An area containing species, populations, communities, or assemblages of living resources that is susceptible to damage from normal OCS-related activities. Damage includes interference with established ecological relationships.

Ship-shaped– Having the characteristic streamlined shape of a ship hull.

Shunting – The disposal of drill cuttings or produced water via a vertical section of pipe attached to a drilling rig or production structure. The discharge end of the pipe extends below the sea surface.

Shuttle tanker – Vessel used to transport processed crude oil from an FPSO to a terminal or refinery port.

Significant impact – Notable adverse impact associated with the accidental release of oil. The threshold for determining a significant impact depends on several factors, including the resource affected and the spatial and temporal attributes of each impact-producing factor.

Spar – A deep-draft floating caisson, characteristically a hollow cylindrical structure similar to a very large buoy. Spars are a type of floating production platform used in the offshore environment.

Structure – Any OCS facility that extends from the seafloor to above the waterline; in petroleum geology, any arrangement of rocks that may hold an accumulation of oil or gas.

Subarea – A discrete analysis area.

Subsea system – The components of an offshore production system located on the seabed, including wells, wellhead equipment, flowlines, manifolds, umbilicals, and risers.

Supply vessel – A boat that ferries food, water, fuel, and drilling supplies and equipment to an offshore rig or platform and returns to land with refuse that cannot be disposed of at sea.

Symbiont – Either of two organisms of different species living together in intimate association with each other.

Taking – To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any endangered or threatened species, or to attempt to engage in any such conduct, including actions that induce stress, adversely impact critical habitat, or result in adverse secondary or cumulative impacts. Harassment is the most common form of taking associated with OCS Program activities.

Tension leg platform (TLP) – A floating production structure that consists of a buoyant platform tethered to the seafloor with multiple steel tubulars connected to concrete pilings. In the GOM OCS, assumed to be at water depths greater than 450 m.

Total dissolved solids – The total amount of solids dissolved in water.

Total suspended particulate matter – The total amount of suspended solids in water.

Total suspended solids – The total amount of suspended solids in water.

Trunk line – A large-diameter pipeline receiving oil or gas from many smaller tributary gathering lines that serve a large area; common-carrier line; main line.

Turbidity – Reduced water clarity due to the presence of suspended matter.

Turret system or turret mooring system – A system for securing anchor lines to an FPSO that allows the FPSO to weathervane (i.e., allowing the ship to take the position of least resistance based on prevailing wind, waves, and currents) around the mooring system, thus minimizing the loading of natural forces upon the system.

Umbilical – Piping, tubing and/or cables that alone or in bundled configuration extend from the production platform downward to the subsea system and provide for remote operation, monitoring, and maintenance activity. An umbilical may include electrical power cables, electronics, optical fiber, hydraulic lines, and/or conduits for flow-assurance chemicals.

Volatile organic compound (VOC) – Any organic compound that is emitted to the atmosphere as a vapor.

Water test areas – Areas established within the Eastern Gulf where research, development, and testing of military planes, ships, and weaponry take place.

Weathering (of oil) – The aging of oil due to its exposure to the atmosphere, causing marked alterations in its physical and chemical makeup.

Weathervane (weathervaning) – The ability of the FPSO or other moored vessel to pivot on the mooring system and take the position of least resistance with respect to prevailing wind, waves, and current.

Western Planning Area (WPA) – The GOM OCS area east from the territorial sea along the U.S.-Mexico provisional maritime boundary to approximately 25°45' N. latitude, thence along approximately 26° N. latitude to approximately 91°55' W. longitude, thence north to approximately 27°55' N. latitude, thence generally west to approximately 93°25' W. longitude, thence northwest to the juncture of the territorial sea at approximately 93°50' W. longitude, thence along the territorial sea to the point of origin.

A

Memorandum of Understanding Between the Minerals Management Service and the United States Coast Guard

DEPARTMENT OF THE INTERIOR

Bureau of Land Management

[CA-067-1990; CA-40204]

Amendment

AGENCY: Bureau of Land Management, Interior.

ACTION: Amendment.

SUMMARY: In the **Federal Register** of December 28, 1998 (Vol. 63, Number 248), a notice was published. This amends that notice. Because of expressed interest, the public comment period is extended to March 1, 1999.

FOR FURTHER INFORMATION CONTACT: Kevin Marty or Thomas Zale at (760) 337-4400.

Dated: January 8, 1999.

Elayn Briggs,

Acting Field Manager.

[FR Doc. 99-989 Filed 1-14-99; 8:45 am]

BILLING CODE 4310-40-M

DEPARTMENT OF THE INTERIOR

Bureau of Land Management

[WY-930-1060-04]

Intent To Remove Wild Horses

AGENCY: Bureau of Land Management, Interior.

ACTION: Notice of intent to remove wild horses.

SUMMARY: Periodic removals of wild horses are necessary in order to maintain a thriving natural ecological balance on the public rangelands. These removals are intended to bring the populations down to the established AML (Appropriate Management Levels). These AML's were established through the planning process as a result of monitoring and analysis of data in accordance with the National Environmental Policy Act and BLM Policies. This document serves as a Notice of Intent to remove excess wild horses from the following Herd Management Areas (HMA) and from areas outside Herd Management Areas.

Rock Springs Field Office

HMA Divide Basin—remove 266 of an estimated 681. AML is 500 with a range of 415-600. This action would reduce the population to the lower end of the range. Begin approximately February 15, finish November 15. Decision Record EA# WY-048-EA3-87 dated May 19, 1993.

Salt Wells Creek HMA—remove 362 from an estimated population of 888. AML is 365 and this action would bring the population closer to AML. Begin approximately February 15, finish November 15. Decision Record EA# WY-048-EA3-87 dated May 19, 1993.

Little Colorado HMA—remove 70 of an estimated population of 147. AML is 100 and this action would reduce the herd to 77 horses or 23 below AML. Begin approximately February 15, finish approximately November 15. Decision record EA# WY-048-EA3-87 dated May 19, 1993.

White Mountain HMA—remove 150 of an estimate population of 376. AML is 250 and this action would reduce the herd to 226 horses or 24 below AML. Begin approximately February 15, finish approximately November 15. Decision Record EA# WY-048-EA3-87 dated May 19, 1993.

Areas Outside HMAs—remove 152 of 152 horses. This action would remove all horses outside HMAs. Begin approximately February 15, finish approximately November 15. Decision Record EA# WY-048-EA3-87 dated May 19, 1993.

Weather conditions and other logistical considerations may dictate when actual removal operations take place. The dates indicated are approximate, and removal may take place in any of the HMAs listed above during anytime of the year with the exception that gathers will not take place between April 16 and July 7, since this is foaling season in Wyoming. Numbers are approximate and will be finalized by aircraft census to be conducted during January/February 1999. All actions are in conformance with Bureau of Land Management Policy, documents listed above, and current monitoring data. These actions represent no new decisions.

FOR FURTHER INFORMATION CONTACT: Bernie Weynand, Assistant Field Manager, Rock Springs Field Office, 280 Hwy. 191 North, Rock Springs, Wyoming 82901, (307) 352-0246.

John S. McKee,

Field Manager.

[FR Doc. 99-6 Filed 1-14-99; 8:45 am]

BILLING CODE 4310-22-P

DEPARTMENT OF THE INTERIOR

Minerals Management Service

Memorandum of Understanding (MOU) Between the Minerals Management Service and the United States Coast Guard

AGENCY: Minerals Management Service, Interior.

ACTION: Notice.

SUMMARY: Minerals Management Service (MMS) and the United States Coast Guard (USCG) have updated their MOU concerning responsibilities for offshore facilities. The update was necessary to add responsibilities associated with floating facilities, the Oil Pollution Act (OPA), and civil penalties.

DATES: The effective date of the MOU is December 16, 1998.

FOR FURTHER INFORMATION CONTACT: Greg Gould, MMS at (703) 787-1616 or Rajiv Khandpur, USCG at (202) 267-0494.

SUPPLEMENTARY INFORMATION: In August, 1989 the MMS and the USCG signed an MOU that outlined responsibilities associated with facilities located on the Outer Continental Shelf (OCS). The purpose was to minimize duplication, and to promote consistent regulation of these facilities. The use of floating facilities and responsibilities assigned by OPA created a need to update the MOU. Therefore, on January 5, 1998, MMS and USCG published an update of the 1989 MOU (63 FR 256) for public comment. We analyzed those comments and we revised the MOU as shown in Appendix A. We appreciate the excellent comments and suggestions that we received.

We are now implementing the MOU. The following is a sample list of actions that we will be considering in the process:

- Review the standards of both agencies for consistency;
- Determine the need for legislative changes to improve efficiency and clarify the jurisdiction for floating facilities;
- Determine how to make a smooth transition of duties;
- Determine how the certified verification agent program will function;
- Focus on our inspection programs to eliminate duplication;
- Work on safety management including accident investigations to promote safe practices;
- Implement the civil penalties process set out in the MOU;
- Continue to work on single point reporting;
- Communicate electronically;
- Improve the process of reporting and collecting incident data;
- Share incident data to prevent accidents, particularly fatalities;
- In the rare cases when both agencies are conducting a review (i.e., Design, fabrication, installation of non-ship-shape floating facilities), determine how the process will work; and
- Coordinate more research efforts for safety and oil spill prevention and response.

We will be forming many teams with participants from MMS, USCG, and industry to ensure that implementation of the MOU is provides the most efficient and effective means to manage offshore oil and gas development. We also plan to have meetings/workshops during the MOU implementation process. The current requirements for each agency will remain in effect until new regulations implementing the MOU are promulgated.

Dated: January 8, 1999.

Carolita Kallaur,

Associate Director for Offshore Minerals Management.

Appendix A—Memorandum of Understanding Between Minerals Management Service, U.S. Department of the Interior and United States Coast Guard, U.S. Department of Transportation

Ia. Purpose

This Memorandum of Understanding (MOU) defines the responsibilities of the Minerals Management Service (MMS) and the United States Coast Guard (USCG) relating to managing the activities of MODU's, fixed, and floating systems. It is designed to minimize duplication and promote consistent regulation of facilities under the jurisdiction of both agencies. This MOU does not apply to deepwater ports as licensed by the Secretary of Transportation under the Deepwater Port Act of 1974, as amended.

Ib. Scope

This MOU covers oil and gas activities located in the Outer Continental Shelf (OCS). However, oil-spill preparedness is for facilities located seaward of the coast line, unless noted otherwise. Certificates of financial responsibility are for certain facilities located in the OCS and the State waters included in the definition of Covered Offshore Facility found at 30 CFR 253.3. An MOU, dated February 3, 1994, among the Departments of Transportation and the Interior and the Environmental Protection Agency established jurisdictional responsibilities for facilities located both seaward and landward of the coast line.

II. Definitions

For purposes of this MOU, the following definitions apply:

Act—The OCS Lands Act (OCSLA)—43 U.S.C. 1331 *et seq.*

Coast Line—The line of ordinary low water along that portion of the coast that is in direct contact with the open sea and the line marking the seaward limit of inland waters, as defined by the Submerged Lands Act (43 U.S.C. 1301 (c)).

Outer Continental Shelf—The submerged lands that are subject to the Act.

OCS Activity—Any activity in the OCS associated with exploration, development, production, transporting, or processing of OCS mineral resources including but not limited to oil and gas.

OCS Facility—Any artificial island, installation, pipeline, or other device permanently or temporarily attached to the seabed, erected for the purpose of exploring for, developing, producing, and transporting resources from the OCS. This term does not include ships or vessels for transporting produced hydrocarbons. The following are types of OCS facilities:

1. *Fixed OCS Facility*—A bottom-founded OCS facility permanently attached to the seabed or subsoil of the OCS, including platforms, guyed towers, articulated gravity platforms, and other structures. This definition also includes gravel and ice islands and caisson-retained islands engaged in OCS activities used for drilling, production, or both.

2. *Floating OCS Facility*—A buoyant OCS facility securely and substantially moored so that it cannot be moved without a special effort. This term includes tension leg platforms, spars, semisubmersibles and shipshape hulls.

3. *Mobile Offshore Drilling Units* (MODU's)—Vessels capable of engaging in drilling operations for exploring or exploiting subsea oil, gas, or mineral resources.

OPA—The Oil Pollution Act of 1990 (Pub. L. 101-380).

Regional Director (RD)—The MMS officer delegated the responsibility and authority for a region within MMS. The USCG referrals for violations occurring in a particular MMS Region would be made to that MMS Region's RD.

Regional Supervisor (RS)—The MMS officer (or the authorized representative) in charge of operations within a Region.

Vessel—Every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on the water. This term does not include atmospheric or pressure vessels used for containing liquids or gases.

Violation—Failure to comply with the OCSLA, any regulations, or the terms or provisions of leases, licenses, permits, or rights-of-way issued under the OCSLA.

III. Responsibilities

The following table lists the lead agency for system responsibilities associated with MODU's and fixed and floating OCS facilities. Other agency roles are identified where applicable. The lead agency is responsible for coordinating with the other agency as appropriate. The attachments to the table list the typical equipment that is included in the system.

The MMS and USCG will work together to develop the standards necessary to implement this MOU. Where the agencies have overlapping responsibilities, they will work together to minimize duplication.

Item	System	Sub-system	Lead agency			Other agency role/comments
			MODU	Fixed	Floating	
1	Design & Operating Overview/Plan.					
1.a	....	Deepwater Operating Plan.	N/A	MMS	MMS	Where required.
1.b	....	Design Basis Document.	USCG	N/A	USCG	
1.c	....	Design, fabrication, and installation verification plans.	N/A	MMS	MMS	Section applies to MMS's Certified Verification Agent (CVA) Program.
2	Structural Integrity.					
2.a	....	Structural integrity, modifications for construction and repair requirements.	USCG	MMS	MMS & USCG	USCG responsibilities for fabrication, installation, and inspection of floating units are found in 33 CFR Subchapter N. MMS responsibilities are found in 30 CFR Subpart I. USCG and MMS will each review the design of the turret and turret/hull interface structure for ship-shape floating facilities. All other aspects of the design and fabrication of all ship-shape floating facilities will receive only USCG review. All design, fabrication, and installation activities of all non-ship-shape floating facilities will be reviewed by both agencies.

Item	System	Sub-system	Lead agency			Other agency role/comments
			MODU	Fixed	Floating	
2.b		Design environmental conditions.	USCG	MMS	MMS	Establishes in-place design environmental criteria.
					USCG	Establishes design environmental criteria for intact and damage stability.
2.c		Risers (drilling, production, and pipeline).	MMS	MMS	MMS	Some pipeline risers may be subject to the Research and Special Programs Administration's (RSPA) jurisdiction.
3	Floating Stability.		USCG	N/A	USCG	USCG reviews and approves stability and sends copies to MMS.
4	Station Keeping.					
4.a		Foundations	USCG	MMS	MMS	
4.b		Mooring and tethering systems.	USCG	MMS	USCG & MMS	USCG is not responsible for site specific mooring analyses.
4.c		Dynamic positioning.	USCG	N/A	USCG	
5	Drilling, Completion, Well Servicing & Workover.		MMS	MMS	MMS	See Attachment A for description of Drilling, Completion, Well Servicing & Workover Systems.
6	Production		MMS*	MMS	MMS	See Attachment B for description of Production Systems. *Production equipment is not normally installed on a MODU. However, such equipment may be installed for a finite time and designed for removal. In such cases, MMS is the lead agency.
7	Pipeline Operations and Components.		MMS	MMS	MMS	Note: Certain pipelines are subject to MMS MOU(s) with RSPA.
8	Lightering Equipment & Procedures.		USCG	USCG	USCG	
9	Utility Systems					
9.a		Boilers, pressure vessels, waste heat recovery (from any engine exhaust), water heaters and other piping or machinery.	USCG	MMS	USCG	Listed equipment/systems not supporting drilling or production.
					MMS	Listed equipment/systems supporting drilling or production.
9.b		High pressure (H.P.) washdown.	USCG	MMS	USCG	Listed system components and piping not supporting drilling or production.
					MMS	Listed system components and piping supporting drilling or production.
9.c		Seawater supply.	USCG	MMS	USCG	
9.d		Compressed air.	USCG	MMS	USCG	Listed system components and piping not supporting drilling or production.
					MMS	Listed system components and piping supporting drilling or production.
9.e		Potable wash and sanitary water.	USCG	USCG	USCG	
9.f		Sewage unit & piping.	USCG	USCG	USCG	
9.g		Diesel fuel	USCG	MMS	USCG	
9.h		Bilge & ballast, including pumps and related control systems.	USCG	N/A	USCG	
9.i		Fuel gas from well.	MMS	MMS	MMS	For MODU's and floating facilities, when powering drilling and production systems.
			USCG		USCG	For MODU's and floating facilities, when powering emergency and ship-service systems.

Item	System	Sub-system	Lead agency MODU	Lead agency Fixed	Lead agency Floating	Other agency role/comments
10	Elevators for Personnel.		USCG	USCG	USCG	
11	Aircraft Landing and Refueling.	Decks, fuel handling, and storage.	USCG	MMS	USCG	
12	Fire Protection					
12.a		Fire protection, detection, and extinguishing.	USCG	USCG	USCG	See Attachment C for description of Fire Protection, Detection, and Extinguishing. Excludes MMS-regulated safety systems.
2.b		Structural fire protection for accommodations.	USCG	USCG	USCG	
13	Safety Systems					Includes interfaces between fire protection systems and MMS regulated safety systems.
13.a		Emergency shut-down systems.	MMS	MMS	MMS	For MMS required systems. Excludes "remote stopping devices" required for USCG-regulated systems.
13.b		Gas detection	MMS	MMS	MMS	
13.c		Drilling, production, well-control safety, and shut-down systems.	MMS	MMS	MMS	
13.d		General alarm	USCG	USCG	USCG	Includes public address system when integrated with general alarm system.
14	Electrical Design & Equipment.					
14.a		Production	MMS*	MMS	MMS	See Attachment B for definition of Production Systems. *Same comment as item #6.
14.b		Drilling systems.	USCG	MMS	USCG	See Attachment A for definition of Drilling Systems.
					MMS *	*MMS is the lead agency for drilling equipment installed for a finite time and designed for removal.
14.c		Emergency lighting power generation and distribution.	USCG	USCG	USCG	
14.d		Hazardous areas classification.	USCG	MMS	MMS and USCG	MMS and USCG will work on common, logical standards to minimize duplication of effort for industry.
15	Aids to Navigation.		USCG	USCG	USCG	
16	Communications		USCG	USCG	USCG	
17	Pollution Prevention.					
17.a		Pollution not associated with vessel transfers.	USCG	USCG	USCG	Garbage and plastics per the International Convention for the Prevention of Pollution from Ships MARPOL 73/78.
			MMS	MMS	MMS	Other Pollution.
17.b		Petroleum and other product transfers to and from a vessel (includes lightering of produced hydrocarbons).	USCG	USCG	USCG	
18	Cranes and Material Handling Equipment.					

Item	System	Sub-system	Lead agency			Other agency role/comments
			MODU	Fixed	Floating	
18.a		Crane design, certification, and operations.	USCG	MMS	USCG	
18.b		Other Material Handling Equip.	USCG	MMS	USCG	
19	Ventilation					
19.a		Accommodations and machinery spaces.	USCG	USCG	USCG	
19.b		Areas other than accommodations or machinery spaces.	USCG	MMS	MMS	
20	Life Saving Equipment.		USCG	USCG	USCG	
21	Workplace Safety and Health.					
21.a		Personnel protection equipment.	USCG	USCG	USCG	
21.b		Hazardous material storage & handling (other than produced hydrocarbons).	USCG	USCG	USCG	
22	Living Quarters and Accommodation Spaces.		USCG	USCG	USCG	Includes permanent and temporary units design & arrangement.
23	General Arrangements.					
23.a		Access/egress & means of escape.	USCG	USCG	USCG	
23.b		Safety plan, fire control or fire equipment, and lifesaving equipment plans.	USCG	USCG	USCG	
24	Miscellaneous Systems and Operational Requirements.					Supplements list of above mentioned systems.
24.a		Structural inspection requirements.	USCG	MMS	USCG	USCG will copy MMS on approvals and compliance records. MMS recommends that USCG at least meet the requirements of the American Petroleum Institute's Recommended Practice 2A (API-RP2A)—Planning, Designing, and Constructing Fixed Offshore Platforms Working Stress Design.
24.b		Personnel requirements for marine and lifesaving operations.	USCG	USCG	USCG	
24.c		Emergency evacuation plans.	USCG	USCG	USCG	
24.d		Drills—fire, abandon, and lifeboat.	USCG	USCG	USCG	

Item	System	Sub-system	Lead agency			Other agency role/comments
			MODU	Fixed	Floating	
24.e		Inspection and testing of all production and drilling equipment.	MMS	MMS	MMS	Includes hydrogen sulfide gas (H2S).
24.f		Inspection and testing of marine and lifesaving equipment.	USCG	USCG	USCG	
24.g		Well-head & platform removal (decommissioning).	MMS	MMS	MMS	
24.h		Safe welding, burning and hot tapping.	MMS	MMS	MMS	
24.i		Diving operations & equipment.	USCG	USCG	USCG	
24.j		H2S contingency plan (including equipment, control, and detection systems).	MMS	MMS	MMS	Includes H2S personnel protection equipment.
25	Investigation—Lead Responsibility:					Agencies to consolidate/standardize and eliminate duplication in reporting and data-collection requirements (see section VIII of this MOU).
25.a		Oil Pollution reportable under the Outer Continental Shelf Lands Act (OSCLA).	MMS	MMS	MMS	Addresses oil pollution reportable under OSCLA.
25.b		Oil Pollution under the Clean Water Act (CWA impact).	USCG	USCG	USCG	Conduct preliminary assessments and follow-on actions in accordance with the National Contingency Plan and investigation into violation of CWA.
25.c		Incidents involving systems under USCG jurisdiction.	USCG	USCG	USCG	
25.d		Incidents involving systems under MMS's jurisdiction.	MMS	MMS	MMS	
26	Administer Shutdown or Resumption of Operation of a Facility.		MMS	MMS	MMS	See Section V, Para C.2 of this MOU for the Federal On Scene Coordinator (FOSC) responsibility for spill response.
27	Safety Analysis	Safety analysis of industrial systems.	USCG	MMS	MMS	For MODU's see the requirements of 46 CFR 58.60–11 and 58.60–13.

Attachment A—Drilling, Completion, Well Servicing and Workover Systems

System requirements for operating the following equipment and systems:

—Drilling, production, and workover risers
—Blowout prevention equipment and control systems
—Drilling system and related relief valves, vent system, pressure vessels and piping, pumps, water systems, safety systems, cementing systems, and circulating systems
—Riser and guideline tensioning systems
—Motion compensation systems
—Instruments and controls
—Atmospheric vessels and piping
—Fitness of the Drilling Unit
—Lifting and hoisting equipment associated with the derrick
—Cementing systems
—Circulating systems, including:
pipes and pumps for mud;
shale shakers; desanders;

degassers.
—Structures including derrick and sub-structure
—Bulk material storage and handling systems
—Other pressurized systems designed for industrial operations

Attachment B—Production Systems

Includes but not limited to the following equipment:
—Hydraulic systems
—Connections between production and workover (industrial) systems
—Production safety systems including subsurface and surface well control
—Relief valves, relief headers, vent and flare systems
—Production wells and wellhead
—Well-handling equipment (contract drilling rig)
—Instrumentation, controls, and measurement (including oil and gas)s
—Gas compression
—Process system and related pumps
—Odorization for gas piped into enclosures
—Process system and related pressure vessels and piping
—Process system and related heat exchangers, including waste heat recovery units
—Chemical injection and treatment systems

Attachment C—Fire Protection, Detection and Extinguishing

Includes the following equipment:
—Deluge systems in the wellbay area
—Firewater pumps, piping, hose reel and monitor equipment
—Foam extinguishing equipment
—Fixed gaseous extinguishing equipment [carbon dioxide(CO2) and halon alternatives]
—Fixed watermist extinguishing equipment
—Portable and semi-portable extinguishers
—Fire and smoke detection (excludes interfaces to MMS regulated safety systems)

IV. Civil Penalties

The USCG reports violations of OCSLA statutes or regulations that may result in civil penalty action to MMS. The USCG will investigate and document OCSLA based violation cases according to the procedures in 33 CFR 140.40 with the following clarification:

1. The cognizant Officer-in-Charge, Marine Inspection (OCMI) makes the determination whether a violation "constitutes or constituted a threat of serious, irreparable, or immediate harm." If the OCMI determines:

a. That it does, then the OCMI will refer the case to MMS and recommend that a civil penalty be assessed.

b. That it does not, then the OCMI will establish a reasonable time for the violator to fix the problem. The OCMI may do this in consultation with MMS, particularly on matters in which MMS has expertise or knowledge of industry practice. If the violator does not correct the problem, or does not file an appeal with the appropriate USCG official in the allotted time, the OCMI will refer the case to MMS, pursuant to 43 U.S.C. 1348(a).

When referring a case to MMS, the OCMI will forward the following information:

i. The case file, which consists of a summary of the investigation and a USCG determination of the regulations violated.

ii. A description of the seriousness of violation and any incidents actually associated with the violation.

iii. If requested, additional information concerning the merits of a civil penalty action. All physical evidence remains with the USCG, but available to MMS upon request.

2. If the violator files an appeal of a USCG's enforcement action the USCG will not forward the case to MMS until the appeal has been resolved.

3. Upon receipt of the violation report, the MMS Regional Civil Penalty Coordinator will appoint a Reviewing Officer (RO) who will process the report in accordance with the MMS OCS Criminal/Civil Penalties Program Guidebook.

4. Notification of the MMS RO's decision regarding the civil penalty assessment, collection, compromise, or dismissal shall be provided to the OCMI originating the violation report.

V. Oil Pollution Responsibilities

A. Certificates of Financial Responsibility (COFR)

1. The MMS issues certifications of oil-spill financial responsibility for certain facilities located in the OCS and State waters included in the definition of Covered Offshore Facility found at 30 CFR 253.3. The COFR ensures that responsible parties can pay for cleanup and damages from facility oil spills.

2. The MMS will provide COFR-related information to the USCG upon request. Upon request from the USCG, MMS will provide available information for any covered OCS facility (COF) in certain OCS and the State waters included in the definition of Covered Offshore Facility found at 30 CFR 253.3 that are involved in an oil pollution incident including:

(1) Copies of the lease, permit, or right of use and easement for the area in which the COF is located;
(2) Contacts for claims;
(3) Agents for service of process;
(4) Amounts guaranteed; and
(5) List of all responsible parties.

3. The USCG issues COFR for vessels and floating OCS facilities which store oil. This COFR is in addition to the MMS COFR and addresses the operator's financial responsibility for the clean up and damages from oil discharges resulting from non-well-related sources and produced oil stored onboard the floating OCS facility.

B. Oil Spill Preparedness and Response Planning

1. The MMS, for all facilities seaward of the coast line, requires that responsible parties maintain approved Oil Spill Response Plans (OSRP) consistent with the area contingency plan; ensures that response personnel receive training; and that response equipment is inspected. The MMS will require unannounced oil-spill response drills. The MMS RS will advise the Federal On Scene Coordinator (FOSC) of drills to coordinate participation, and avoid conflict or duplication.

2. The USCG Captain of the Port serves as the pre-designated FOSC in accordance with the National Contingency Plan. The appropriate FOSC will also jointly approve OSRPs for floating facilities which store oil. Participation in MMS drills will be at the discretion of the FOSC. The FOSC will advise the MMS RS of spill-response drills and activities, such as exercise and response activities, occurring on facilities seaward of the coast line.

C. Spill Response

1. All spills are required to be reported to the National Response Center (NRC). The NRC provides notification to the appropriate agencies and State offices. Additionally, OCS facility owners or operators are required to report spills of one barrel or more to the MMS RS.

2. The FOSC will direct and monitor Federal, State, and private actions, consult with responsible parties, and determine the removal action. The MMS RS will direct measures to abate sources of pollution from an OCS facility. However, if a discharge poses a serious threat to public health, welfare, or the environment, in accordance with Public Law 101-380 (OPA) Sec. 4201, the FOSC may mitigate or prevent the substantial threat of a discharge and notify the MMS RS as soon as possible. The MMS will authorize the return of an OCS facility to operation in coordination with the FOSC.

VI. Exchanging Services and Personnel

To the extent its own operations and resources permit, each agency will provide the other agency with assistance, technical advice, and support, including transportation, if requested in accordance with 43 U.S.C. 1348. Exchange of services and personnel is non-reimbursable (except for pollution removal funding authorizations for incident specific fund access). The assistance may extend to areas beyond the OCS where one Agency's expertise will benefit the other agency in applying and enforcing its safety regulations.

VII. Other Cooperative Functions

1. Both agencies will exchange data and study results, participate in research and development projects, and exchange early drafts of rulemaking notices to avoid duplicative or conflicting requirements.

2. Both agencies will review current standards, regulations, and directives and will propose revisions to them as necessary in keeping with the provisions of this MOU.

3. Both agencies will review reporting and data collection requirements imposed on operators of OCS facilities and, where feasible, eliminate or minimize duplicate reporting and data collection requirements.

4. Each agency will conduct scheduled and unannounced inspections to ensure compliance with its own requirements. If the inspector notices deficiencies that fall within the responsibility of the other agency, the deficiency will be reported to the other agency for action. However, if the deficiency may cause serious or irreparable harm to persons, property, or the environment, the inspector may take the necessary preventative action. The preventative action will then be reported to the other agency.

VIII. Accident Investigations

The MMS or the USCG is responsible for conducting investigations and preparing a public report for each major fire, oil spillage, serious injury, and fatality associated with OCS activities. To avoid duplication of effort and to simplify administration, the responsibility for investigating and preparing a public report for these incidents rests with the agency that is listed in Section III as being responsible for the system associated with the incident. In addition, the MMS investigates blowouts and the USCG investigates collisions.

For those incidents for which both agencies have an investigative interest in the system associated with the incident, one agency will assume lead investigative responsibility with supporting participation by the other agency. The lead agency in a joint investigative effort shall investigate and prepare, approve, and release the report in accordance with the normal procedures of that agency, subject to the following terms and conditions:

1. The lead agency shall be determined through mutual agreement. If mutual agreement is not reached, each agency may decide to conduct its own investigation.

2. The specific details of a supporting agency's participation in a joint investigation shall be determined on a case-by-case basis through mutual agreement.

3. Prior to the public release of a joint agency report, the supporting agency will be afforded an opportunity to comment on the report. If the supporting agency's conclusions and/or recommendations differ with those of the lead agency, either both conclusions and/or recommendations will be included in the lead agency's report in a mutually acceptable manner, or a joint report will not be issued, and each agency may issue separate reports.

IX. Implementing this MOU

1. Each agency will review its internal procedures and, where appropriate, will revise them to accommodate the provisions of this MOU. Each agency will also designate in writing one senior official who will be responsible for coordinating and implementing the provisions of this MOU.

2. Each agency will designate regional officials to be responsible for coordinating and implementing the provisions of this MOU in their respective regions.

3. The USCG—MMS MOU concerning regulation of activities and facilities in the OCS, dated August 29, 1989 is canceled on the effective date of this agreement.

4. If new technology (or new uses of current technology) require a change to this MOU, the MMS regional office and appropriate USCG district will work together to reach an agreement. The MMS regional office and the USCG district will notify their respective Headquarters office of any change. If the MMS regional office and the USCG district office can't reach an agreement, it will be elevated to MMS and USCG Headquarters. The new policy will become part of a revised MOU the next time the MOU is revised.

X. Savings Provision

Nothing in this MOU alters, amends, or affects in any way the statutory authority of MMS or the USCG.

XI. Effective Date

This MOU is effective upon signature.

XII. Termination

Both parties may amend this MOU by mutual agreement and either agency may terminate it with a 30-day written notice.

Signed at Washington, DC, December 16, 1998.

James M. Loy,

Commandant, U.S. Coast Guard, Department of Transportation.

Cynthia Quarterman,

Director, Minerals Management Service, Department of Interior.

[FR Doc. 99-817 Filed 1-14-99; 8:45 am]

BILLING CODE 4310-MR-P

DEPARTMENT OF THE INTERIOR

National Park Service

Acadia National Park, Bar Harbor, Maine, Acadia National Park Advisory Commission; Notice of Meeting

Notice is hereby given in accordance with the Federal Advisory Committee Act (Pub. L. 92-463, 86 Stat. 770, 5 U.S.C. App. 1, Sec. 10), that the Acadia National Park Advisory Commission will hold a meeting on Monday, February 8, 1999.

The Commission was established pursuant to Public Law 99-420, Sec. 103. The purpose of the commission is to consult with the Secretary of the Interior, or his designee, on matters relating to the management and development of the park, including but not limited to the acquisition of lands and interests in lands (including conservation easements on islands) and termination of rights of use and occupancy.

The meeting will convene at park Headquarters, McFarland Hill, Bar Harbor, Maine, at 1:30 p.m. to consider the following agenda:

1. Review and approval of minutes from the meeting held September 28, 1998
2. Committee reports
   - Land Conservation
   - Education
   - Park Use
   - Science
   - Nomination—nomination of officers
3. Old business
4. Superintendent's report
5. Public comments
6. Proposed agenda and date of next Commission meeting

The meeting is open to the public. Interested persons may make oral/written presentations to the Commission or file written statements. Such requests should be made to the Superintendent at least seven days prior to the meeting.

Further information concerning this meeting may be obtained from the Superintendent, Acadia National Park, P.O. Box 177, Bar Harbor, Maine 04609, tel: (207) 288-3338.

Dated: January 7, 1999.

Len Bobinchock,

Acting Superintendent, Acadia National Park.

[FR Doc. 99-929 Filed 1-14-99; 8:45 am]

BILLING CODE 4310-70-P

DEPARTMENT OF THE INTERIOR

National Park Service

Joshua Tree National Park Advisory Commission; Notice of Meeting

Notice is hereby given in accordance with the Federal Advisory Committee Act that a meeting of the Joshua Tree National Park Advisory Commission (Commission) will be held from 9:00 am (PDT) until 3:00 pm on Saturday, March 6, 1999, at the Helen Gray Center, on Whitefeather Drive in the village of Joshua Tree, California. The Commission will hear presentations about issues related to the Backcountry and Wilderness Management Plan, which serves as an amendment to the General Management Plan for Joshua Tree National Park, a comprehensive assessment regarding placement of wireless telecommunication facilities (WTF), and an environmental assessment to relocate segments of a military training route over the park.

The Commission was established by Public Law 103-433, section 107 to advise the Secretary concerning the development and implementation of a new or revised comprehensive management plan for Joshua Tree National Park.

Members of the Commission include:

Mr. Chuck Bell: Planner
Ms. Diane Benson: Town of Yucca Valley
Ms. Cyndie Bransford: Recreational Climbing
Mr. Gary Daigneault: Property Owner
Hon. Kathy Davis: County of San Bernadino
Mr. Brian Huse: Conservation
Mr. Michael McCormack: Property Owner
Mr. Julian McIntyre: Conservation
Mr. Roger Melanson: Homeowner
Mr. Ramon Mendoza: Native American Interest
Ms. Leslie Mouriquand: Planner
Mr. Richard Russell: All Wheel Drive Vehicle Interest

B

United States Coast Guard Correspondence Regarding the EIS

U.S. Department of Transportation

United States Coast Guard

Commander
8th Coast Guard District
Hale Boggs Federal Building

501 Magazine Street
New Orleans, La. 70130-3396
Staff Symbol: D8(mvs)
Phone: (504) 589-6193
FAX: (504) 589-4999

16700
December 18, 2000

Mr. J. Hammond Eve
Regional Supervisor, Leasing and Environment
Minerals Management Service
Gulf of Mexico Region
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

Dear Mr. Eve:

This responds to your letter of November 16, 2000. Thank you for the opportunity to allow us to provide comments on your agency's draft Environmental Impact Statement (EIS) on Floating Production Storage and Offloading Systems (FPSOs).

On December 7, 2000 Rear Admiral Robert C. North, the Coast Guard's Assistant Commandant for Marine Safety and Environmental Protection, met at Coast Guard Headquarters with Ms. Carolita Kallaur, the Minerals Management Service's Associate Director for Offshore Minerals Management. The regulation of FPSOs was one of the primary topics of discussion. During this meeting, Rear Admiral North and Associate Director Kallaur agreed that our agencies would work cooperatively to develop an appropriate regulatory scheme for FPSOs. The Coast Guard has now formed a project team at Coast Guard Headquarters to address specific Coast Guard regulatory issues associated with FPSOs and to interface with your agency. The goal of this project team is to clarify current Coast Guard regulations applicable to FPSOs and develop necessary additional regulations should they be needed. Thus, many of the issues contained in the public comment letters you forwarded will be addressed as this project team conducts its work. I have however, taken this opportunity to provide some general comments on major topics addressed in the public comment letters that fall under Coast Guard jurisdiction.

Articulated Tug/Barges (ATBs)

Several comment letters expressed concern regarding the possible use of articulated tug/barges (ATBs) as a shuttle vessel for crude oil from FPSOs. Some comments questioned whether appropriate standards were in place for a large 500,000 barrel ATB. In addition, some individuals were concerned about the maneuverability and required manning for ATBs. Coast Guard Navigation and Vessel Inspection Circular (NVIC) 2-81 (Change 1) describes current Coast Guard policies regarding integrated tug barges (ITBs). The Coast Guard considers an ATB to be a specialized type of ITB. Thus, we will likely use NVIC 2-81 (Change 1) as the starting point for regulating these units. In addition, the Coast Guard's FPSO project team described above will be considering whether current ITB requirements satisfactorily address the safety and environmental issues surrounding the design, construction and operation of large ATBs. Adjustments to the requirements in NVIC 2-81 (Change 1) are possible as our evaluation of these large shuttle vessels moves forward. Some of the provisions of NVIC 2-81 (Change 1) regarding vessel manning may need to be modified after considering the statutory changes in work hour limitations imposed by the Oil Pollution Act of 1990.

Pilotage

Several public comment letters describe concerns regarding the use of federally licensed pilots on board United States flag vessels shuttling crude oil from FPSOs in the Gulf of Mexico. Overall, the comments reflected a position that state licensed pilots were preferable to federally licensed pilots for navigating shuttle vessels in designated pilotage waters. Title 46 U.S. Code, Chapter 85 provides the statutory basis for federal pilotage. The Coast Guard has published comprehensive regulations regarding professional requirements for pilots' licenses at 46 CFR Subchapter B, Part 10, Subpart G (46 CFR 10.701-713). These regulations specify the minimum requirements an individual must meet to obtain a federal first-class pilot license.

46 CFR 15.812 describes the specific manning requirements for various types and sizes of vessels while underway in the navigable waters of the United States. A U.S. flag shuttle tanker calling on a U.S. port from an FPSO located on the U.S. Outer Continental Shelf (OCS) would not require a state pilot. The vessel would be considered to be on a "coastwise" voyage (as opposed to a "register" or foreign voyage). As a U.S. flag vessel over 1,600 gross tons, not sailing on register, the vessel must be under the direction of a federal first-class pilot whenever operating in designated pilotage waters (see 46 CFR 15.81). Likewise, a federal first-class pilot would be required aboard a vessel towing or pushing a U.S. flag tank barge over 10,000 gross tons not sailing on register, whenever the vessel was within designated pilotage waters. Other pilotage requirements apply to specific types and sizes of vessels operating on particular waters (see 46 CFR 15.812).

Oil Spill Response

The possibility of an oil spill from an FPSO must be comprehensively evaluated, including developing appropriate pollution response strategies and tools. Your agency's draft EIS addressed a concern with the availability and quantity of dispersants needed to mitigate a major oil spill from an FPSO. I share these same concerns. There is no Coast Guard regulatory requirement that mandates the use of dispersants. However, dispersants are often the best and most logical tool to respond to a large oil spill in an offshore environment. The supply and availability of dispersants needed for a major oil spill from an FPSO should not deplete the regional supply, but supplement current supplies. Minimum requirements should be addressed through Regional Response Team IV. The Co-Chairpersons for the region are Mr. Charles Gazda (EPA) and CDR Michael D. Drieu (USCG). Mr. Gazda can be reached at (214) 665-2270, and CDR Drieu can be reached at (504) 589-3656.

16700
December 18, 2000

Rear Admiral North, the Coast Guard Assistant Commandant for Marine Safety and Environmental Protection, sent a letter dated November 16, 1998 to MMS Associate Director Kallaur stating that FPSOs are classified as tank vessels. Since FPSOs are considered tank vessels, they must comply with Oil Pollution Act (OPA) of 1990 requirements, including double hull construction and response plans.

I note that your draft EIS considers the use of an attendant vessel at the FPSO to enhance safety and pollution response. Current Coast Guard regulations do not require an attendant vessel for offshore lightering operations. We are aware that the Louisiana Offshore Oil Port (LOOP) has voluntarily provided an attendant vessel to enhance safety and pollution response at their offshore oil terminal on the Louisiana Gulf Coast. The Coast Guard FPSO project team will carefully consider the issue of attendant vessel use at FPSOs as they conduct their review.

Vessel Traffic Management

Several letters express a concern regarding the increased risk to vessel traffic due to the anticipated increase in the number of shuttle tankers or ATBs calling on Gulf Coast ports. Both the Houston Channel and the lower Mississippi River have regulated vessel traffic schemes managed through Coast Guard Vessel Traffic Systems. However, port authorities, vessel operators, state agencies and the Coast Guard need to work together to plan and coordinate these activities. Both areas have navigation safety advisory committees that assist the Coast Guard in managing vessel traffic safety. One of my staff members, Mr. Monty Ledet, can assist you with addressing vessel traffic concerns. He can be reached at (504) 589-4686.

As stated previously, the Coast Guard Headquarters FPSO Project Team will be providing more specific guidance concerning FPSO operational, construction and response requirements that may modify comments provided in this letter. Since this project team first convened on December 7, 2000, I have no further details at this time. I encourage you to contact Lieutenant Commander Russell Proctor at (202) 267-0499 or Lieutenant Commander Linda Fagan at (202) 267-0972 for further information on the work of our FPSO Project Team.

Sincerely,

G. D. MARSH
Captain, U.S. Coast Guard
Chief, Marine Safety Division
By direction of the Commander,
Eighth Coast Guard District

Copy: Commandant (G-MO), (G-MOC), (G-MSO), G-MSE, G-MOR
Marine Safety Center

C

MMS Notice of Intent to Prepare EIS; Letters Received During Public Scoping for EIS; and Fact Sheet

the drilling of new wells, re-drilling or re-completion of wells, construction of collection systems, and plugging and abandonment). Development of oil and gas resources in this area has been carefully managed over the years to mitigate potential impacts to cultural resources and other values. Effective mitigation of such potential impacts would continue to be emphasized during the temporary segregation period and under the proposed withdrawal.

The proposal, if finalized, would withdraw the following described Federal lands and minerals, subject to valid existing rights, from settlement, sale, location, and entry under the general land laws, including the mining and mineral material sales laws, but not the mineral leasing laws. The proposal includes withdrawing the reserved Federal mineral interest underlying private surface within the ACEC, but would not affect surface rights of those private lands. The allowance of any temporary land use permits, rights-of-way or cooperative agreements would be authorized only when necessary to accommodate valid existing rights and previously authorized actions.

New Mexico Principal Meridian

T. 35 N., R. 16 W.,
Sec. 6.
T. 35 N., R. 17 W.,
Secs. 1, 12, and 13.
T. 35 N., R. 19 W.,
Secs. 3 to 10, inclusive, secs.15 to 22, inclusive, and secs. 28 to 30, inclusive.
T. 35 N., R. 20 W.,
Secs. 1 to 3, inclusive, secs.10 to 15, inclusive, secs. 22 to 27, inclusive, secs. 34 and 35.
T. 36 N., R. 16 W.,
Secs. 18 to 20, inclusive, and secs. 29 to 32, inclusive.
T. 36 N., R. 17 W.,
Secs. 4, secs. 8 to11, inclusive, secs. 13 to 30, inclusive, and sec. 36.
T. 36 N., R. 18 W.,
Secs. 1 to 32, inclusive; sec. 36, N½.
T. 36 N., R. 19 W.,
Secs. 1 to 34, inclusive, and sec. 36.
T. 36 N., R. 20 W.,
Secs. 1 to 3, inclusive, secs. 10 to 15, inclusive, secs. 22 to 27, inclusive, and secs. 34 to 36, inclusive.
T. 37 N., R. 17 W.,
Secs. 3, 4, secs. 8 to 10, inclusive, secs. 16 to 20, inclusive, and secs. 30 and 31.
T. 37 N., R. 18 W.,
Secs. 1 to 36, inclusive.
T. 37 N., R. 19 W.,
Secs. 1 to 36, inclusive.
T. 37 N., R. 20 W.,
Secs. 1 to 3, inclusive, secs. 10 to 15, inclusive, secs. 22 to 27, inclusive, and secs. 34 to 36, inclusive.
T. 38 N., R. 17 W.,
Secs. 33 and 34.
T. 38 N., R. 18 W.,
Secs. 13 to 15, inclusive, and secs.17 to 35, inclusive.
T. 38 N., R. 19 W.,
Secs. 2 to 36, inclusive.
T. 38 N., R. 20 W.,
Secs. 1 to 3, inclusive, secs.10 to 15, inclusive, secs. 22 to 27, inclusive, and secs. 34 to 36, inclusive.
T. 39 N., R. 18 W.,
Secs. 6, 7, secs. 17 to 20, inclusive, and secs. 29 and 30.
T. 39 N., R. 19 W.,
Secs. 1 to 3, inclusive, secs. 5, 7, 8, secs. 10 to 15, inclusive, secs. 18, 19, and secs. 21 to 28, inclusive, sec. 30, and secs. 32 to 34, inclusive.
T. 39 N., R. 20 W.,
Secs. 13, 14, secs. 23 to 27, inclusive, and secs. 34 to 36, inclusive.

The areas described aggregate approximately 165,000 acres of Federal lands and 6,400 acres of reserved Federal mineral estate underlying privately held surface in Montezuma and Dolores Counties.

For a period of 2 years from the date of publication of this notice in the **Federal Register**, the Federal lands and minerals will be segregated from settlement, sale, location, and entry under the general land laws, including the mining and mineral material sales law, subject to valid existing rights, unless the proposal is canceled or unless the withdrawal is finalized prior to the end of the segregation. Further, the segregation does not preclude issuance of land use permits, rights-of-way or other authorizations that are needed to accommodate valid existing rights and previously authorized actions under the Mineral Leasing Act and other public land laws. All previously authorized activities and permitted uses of the segregated lands may be continued in accordance with the terms of the authorization.

Dated: June 8, 1999.

Ray Brady,

Manager, Lands and Realty Group.

[FR Doc. 99-14917 Filed 6-9-99; 8:45 am]

BILLING CODE 4310-JB-P

DEPARTMENT OF THE INTERIOR

Minerals Management Service

Prepation of a Draft Environmental Impact Statement on Floating Production, Storage, and Offloading Systems on the Gulf of Mexico Outer Continental Shelf

AGENCY: Minerals Management Service, Interior.

ACTION: Notice of Intent (NOI) to prepare a Draft Environmental Impact Statement (DEIS).

SUMMARY: The Minerals Management Service (MMS) will prepare an Environmental Impact Statement (EIS) on floating production, storage, and offloading (FPSO) systems on the Gulf of Mexico (GOM) Outer Continental Shelf (OCS). The MMS has awarded a contract to Ecology and Environment, Inc. (E&E) to prepare the EIS to examine the use of FPSO systems in the deepwater areas (water depths greater than 200 meters or 656 feet) in the Central and Western Planning Areas of the GOM OCS. The contract was awarded in April 1999; it is anticipated that completion of the EIS will take 18 months. Based upon the analysis in the EIS, the MMS will decide whether FPSO systems will be an acceptable option for consideration for use on the GOM OCS; the decision will not constitute approval for the use of any particular FPSO at any specific site. Individual plans proposing use of an FPSO will be subject to MMS's established project-specific and site-specific evaluation and decision process.

1. *Authority.* Pursuant to the regulations implementing the procedural provisions of the National Environmental Policy Act (NEPA), the MMS is announcing its intent to prepare an EIS on FPSO systems on the GOM OCS. This NOI also serves to announce the scoping process for this DEIS. Throughout the scoping process, Federal and State agencies, local governments, and other interested parties will have the opportunity to aid the MMS in determining the scope of the DEIS, significant issues that should be addressed, and alternatives to be considered.

2. *Proposed Action.* FPSO's may be used as production facilities to develop marginally economic or remote oil fields in the deepwater areas of the GOM OCS. This DEIS will consider scenarios that represent the potential range of FPSO activities that could occur if the proposed action were implemented. The "base case" of the proposed action to be evaluated is a permanently moored, double-hulled, shipshaped FPSO with up to 1 million barrels of crude oil storage capability. The seafloor well equipment and on-board production equipment will be the same types as those used with other deepwater production facilities. Produced oil will be offloaded to nondynamically positioned, 500,000-barrel-capacity shuttle tankers for transport to ports in Texas or Louisiana or to the Louisiana Offshore Oil Port (LOOP). Associated or produced gas will be transferred to shore via a gas pipeline.

The range of the proposed action will include technical variations such as the use of disconnectable moorings, single hull or single bottom design variations, non-shipshaped FPSO systems, increased crude oil storage up to 2.3 million barrels, dynamically positioned shuttle tankers, reinjection of natural gas for later recovery, and gas-to-liquids conversion.

3. *Alternatives.* One of the alternatives to be considered in the DEIS is the exclusion of FPSO systems from the "lightering prohibited area" established by the U.S. Coast Guard at 33 CFR part 156 subpart C. Other alternatives may be identified during the scoping process.

4. *Scoping.* Scoping is an open and early process for determining the scope of the DEIS and for identifying significant issues related to a proposed action. Scoping also provides an opportunity for interested parties to help identify alternatives to the proposed action. For this DEIS, public scoping meetings will be held from 7 p.m. to 10 p.m. on June 21, 1999, at the Natural Resources Center—Room 1003, Texas A&M University in Corpus Christi, Texas; on June 22, 1999, at the Radisson Hotel and Conference Center, 9100 Gulf Freeway, Houston, Texas; on June 23, 1999, at the Beaumont Hilton in Beaumont, Texas; on June 24, 1999, at the Players Island Hotel in Lake Charles, Louisiana; and on June 28, 1999, at the Radisson Inn Airport in Kenner (New Orleans), Louisiana. Additional information on the scoping meetings will be distributed to interested parties. Details on the times and locations for the public scoping meetings will also be advertised in local media and are available on the MMS website at http://www.mms.gov or through the MMS Public Information Office at 1-800-200-GULF or GulfPublicInfo@mms.gov.

5. *Comments on the NOI.* In addition to participation at the scoping meetings, Federal and State agencies, local governments, and other interested parties are invited to send their written comments on the scope of the DEIS, significant issues to be addressed, and alternatives that should be considered in the DEIS to the contact person at the address listed below. Comments should be enclosed in an envelope labeled "Comments on the NOI to Prepare a DEIS on FPSO's" and should be submitted no later than 45 days after publication of this NOI in the **Federal Register**.

6. *Decisions.* The MMS will make several decisions based on the analysis in the EIS; (a) whether FPSO systems will be permitted in the Central and Western Planning Areas of the GOM OCS; (b) the range of acceptable FPSO operations; and (c) the potential exclusion of FPSO systems in certain geographic areas of the Central and Western Planning Areas of the GOM OCS; or (d) a decision for no action. The no action alternative will mean that FPSO systems will not be permitted in the Central and Western Planning Areas of the GOM OCS.

FOR FURTHER INFORMATION: Questions concerning the NEPA process and the DEIS should be directed to Minerals Management Service, Gulf of Mexico OCS Region, Attention: Ms. Deborah Cranswick (MS 5410), 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123-2394, telephone (504) 736-2744.

Dated: June 4, 1999.

Chris C. Oynes,

Regional Director, Gulf of Mexico, OCS Region.

[FR Doc. 99-14704 Filed 6-9-99; 8:45 am]

BILLING CODE 4310-MR-M

INTERNATIONAL TRADE COMMISSION

Sunshine Act Meeting

AGENCY HOLDING THE MEETING: United States International Trade Commission.

TIME AND DATE: June 18, 1999 at 11:00 a.m.

PLACE: Room 101, 500 E Street S.W., Washington, DC 20436, Telephone: (202) 205-2000.

STATUS: Open to the public.

MATTERS TO BE CONSIDERED:

1. Agenda for future meeting: none.
2. Minutes.
3. Ratification List.
4. Inv. No. AA1921-111 (Review) (Roller Chain from Japan)—briefing and vote. (The Commission will transmit its determination to the Secretary of Commerce on July 1, 1999.)
5. Outstanding action jackets:

(1) Document No. EC-99-011: Approval of study objectives, annotated study outline, final staffing plan, and final work schedule in Inv. No. 332-406 (Overview and Analysis of the Economic Impact of U.S. Sanctions with Respect to India and Pakistan).

(2) Document No. GC-99-047; Inv. Nos. 751-TA-17-20 (Titanium Sponge from Japan, Russia, Kazakhstan, and Ukraine).

In accordance with Commission policy, subject matter listed above, not disposed of at the scheduled meeting, may be carried over to the agenda of the following meeting.

Issued: June 8, 1999.

By order of the Commission.

Donna R. Koehnke,

Secretary.

[FR Doc. 99-14891 Filed 6-8-99; 2:57 pm]

BILLING CODE 7020-02-M

DEPARTMENT OF JUSTICE

Drug Enforcement Administration

[Docket No. 98-11]

Alfred Khalily, Inc. d.b.a. Alfa Chemical; Grant of Restricted Registration

On January 8, 1998, the Deputy Assistant Administrator, Office of Diversion Control, Drug Enforcement Administration (DEA) issued on Order to Show Cause to Alfred Khalily, Inc., d.b.a. Alfa Chemical (Respondent) of New York, notifying it of an opportunity to show cause as to why DEA should not deny its applications for registration as an importer and as a distributor of List I chemicals, for reason that such registration would be inconsistent with the public interest as determined pursuant to 21 U.S.C. 823(h).

Respondent, through counsel, filed a request for a hearing on the issues raised by the Order to Show Cause. Following prehearing procedures, a hearing was held in Uniondale, New York on May 19 and 20, 1998, before Administrative Law Judge Gail A. Randall. At the hearing, both parties called witnesses to testify and introduced documentary evidence. After the hearing, both parties filed proposed findings of fact, conclusions of law and argument. On October 30, 1998, Judge Randall issued her Opinion and Recommended Ruling, recommending that Respondent's applications be granted subject to two conditions. On November 23, 1998, the Government filed exceptions to the Administrative Law Judge's Opinion and Recommended Ruling and on December 15, 1998, Respondent filed its reply to the Government's exceptions. Thereafter, on December 16, 1998, Judge Randall transmitted the record of these proceedings to the Deputy Administrator.

The Deputy Administrator has considered the record in its entirety, and pursuant to 21 CFR 1316.67, hereby issues his final order based upon findings of fact and conclusions of law as hereinafter set forth. The Deputy Administrator adopts, in full, the Opinion and Recommended Ruling of the Administrative Law Judge, and his adoption is in no manner diminished by any recitation of facts, issues and conclusions herein, or of any failure to mention a matter of fact or law.

Alfred Khalily started Respondent in 1990, and is Respondent's president, only officer, and only employee. In 1991, Respondent merged with another company named American Roland pursuant to a two-year contract. This company was involved in the

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Division of Ecological Services
17629 El Camino Real, Suite #211
Houston, Texas 77058-3051
281/286-8282 / (FAX) 281/488-5882

July 6, 1999

received DHC
JUL 14 1999

MEMORANDUM

To: Ms. Deborah Cranswick (MS 5410), FPSO System Coordinator, Gulf of Mexico OCS Region, 1201 Elmwood Park Boulevard, New Orleans, LA 70123

From: Chief, Regulatory Activities, Clear Lake ES Field Office, Houston, Texas

Subject: Scoping comments For the Draft EIS on the FPSO System in the Gulf of Mexico OCS

The scoping meeting on June 22, 1999 was quite informative and I believe you will be developing a comprehensive and informative EIS.

Large spills have always been the only spills of concern for the OCS because of the low likelihood for smaller spills to reach land. There will be a lot of oil sitting in one of those stationary tankers offshore, and each should have its own specific, pre-approved contingency plan/action plan for a major spill. This means weather-worthy equipment at the site at all times unless the operation can be designed to unload the oil reserve under certain specified hazard conditions, such as an imminent hurricane in the Gulf.

The EIS should explore thoroughly the extent to which shuttle-tankering will emerge and generate the need for new or expanded handling facilities as well as the increase in spill risk as a result of many shuttle tankers coming to port.

We look forward to reviewing the draft EIS when it becomes available.

cc:
Regional Director, FWS, Region 2, Albuquerque, NM
Ben Kropoc, Coastal Management Division, DNR, Baton Rouge, La

GREATER LAFOURCHE PORT COMMISSION

PORT FOURCHON

"LOUISIANA'S MULTI-USE PORT"

OFFICE: 16819 EAST MAIN
GALLIANO, LOUISIANA

TED M. FALGOUT
EXECUTIVE DIRECTOR

June 30, 1999

RECEIVED
JUL 6 - 1999
LEASING & ENVIRONMENTAL
MS 5400

MMS, Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Attn.: Ms. Deborah Cranswick (MS5410)

Dear Ms. Cranswick:

I have the following comments on the scope of the DEIS being prepared by MMS on the potential use of FPSO systems in the deepwater areas of the OCS.

As you are probably aware, Port Fourchon is the major focal point for intermodal transfer of the support services for deepwater oil and gas activity in the Central Gulf. It is also the support base for LOOP, the Louisiana Offshore Oil Port, this nation's only offshore oil terminal.

It only seems natural, that the system that has worked so well to handle foreign oil (LOOP), which is also now handling domestic deepwater oil with the same unmatched efficiency and safety, will handle FPSOs as well.

Assuming this is the case, Port Fourchon and Lafourche Parish will even become more significant to this country's energy supply and even more impacted by the development of the Federal OCS.

This Commission has long felt that OCS impacts, especially to focal point areas like Port Fourchon and Lafourche Parish have not been properly documented by MMS (except the most recent EIS on the Central Gulf in which we had significant input) and very little if anything has been done to mitigate these impacts.

When this Commission and most other agencies conduct a project that has identifiable impacts, we are required to mitigate these impacts before we can proceed with the project. This seems not to be the case with the MMS/EIS - Federal OCS.

GREATER LAFOURCHE PORT COMMISSION • P.O. DRAWER 490 • GALLIANO, LOUISIANA 70354 • (504) 632-6701 • FAX (504) 632-6703

A specific example is the recognition by MMS in the FEIS of the Gulf of Mexico OCS Oil and Gas Lease Sales 169, 172, 175, 178, and 182 of the impacts of the proposed and existing OCS activity on LA Highway 1. The impacts of OCS development are clearly identified and nothing has been done to mitigate these impacts. This inconsistency must be corrected and identified impacts properly mitigated.

Again, we are in the process of planning what seems to be a reasonable procedure to help provide this nation's energy in an efficient and safe manner, but this procedure will impact landside support areas and especially focal point areas like Port Fourchon.

The scope for the DEIS must include proper identification of the landside impacts of the proposed project and address ways to properly mitigate these impacts.

If we fail to properly address this issue, then we fail to provide "Environmental Justice" by every sense of the term.

Yours very truly,

Ted M. Falgout
Executive Director

TMF:sli

Shell Offshore Inc.

One Shell Square
PO Box 61933
New Orleans LA 70161-1933
(504) 728-6161

July 14, 1999

Regional Supervisor
Office of Field Operations
Minerals Management Service
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Attn: Ms. Deborah Cranswick (MS 5410)

SUBJECT: Preparation of a Draft Environmental Impact Statement for the Proposed Use of FPSO Systems in the Deepwater Areas of the Gulf of Mexico Federal Register Document 99-14704, June 10, 1999 (Volume 64, Number 111)

This is in response to the Federal Register notice on June 10, 1999 which addressed the preparation of an Environmental Impact Statement (EIS) for the use of Floating Production, Storage and Offloading (FPSO) type facilities on the Gulf of Mexico Outer Continental Shelf. Shell supports the forethought of MMS and industry in reviewing these issues in advance of specific projects of this type. Shell also acknowledges the other EIS efforts of MMS in assessment of deepwater issues, as well as the USCG study on lightering. The current EIS will complement and expand the data already available and will serve to advance responsible development of domestic oil and gas reserves . We would like to confirm and elaborate on several points that were mentioned during the scoping meeting held in New Orleans on June 28, 1999.

Oil Spill Record

The record of oil spills, measured as a percentage of the total oil handled by FPSO facilities already in operation throughout the world, is negligible and is several orders of magnitude better than the record of tanker operations in general. What is particularly noteworthy is that the record of shuttle tanker operations, which include the transfer operation at the FPSO, transit to shoreside or offshore terminal, and the transfer at the terminal also represent considerable improvement over the record of the existing worldwide tanker trade. Thus it can be reasoned that decreasing our dependence on foreign oil through the use of FPSOs in the Gulf of Mexico would result in a decreased amount of oil released into the marine environment both worldwide and on our own OCS.

Regulatory Regimes

During the scoping meeting the current regulatory structure was briefly mentioned as it applies to FPSOs, drawing on FPSO's long record of successful operations in other parts of the world. What was not noted, but bears emphasis, is that the current regulatory structure in the United States is already in place to manage FPSOs. This is evident in the recent Memorandum of Understanding signed between the USCG and MMS on December 16, 1998. The twenty plus years of FPSO experience worldwide have established precedents with Classification Societies and other regulators which bear little difference from the regime under which U.S. flag tankships currently operate. The regulatory infrastructure for the shuttle tanker fleet is also fully defined and requires no changes related to the support of FPSO operations.

Lightering Prohibited Areas

One potential issue to resolve concerns the permitting of FPSOs within lightering prohibited areas of the Gulf of Mexico. While the USCG Commandant's interpretive letter of November 16, 1998 held that FPSO offloading was "lightering" from a regulatory perspective, Shell believes that stationary operations should be considered for regional or case-by-case exemption from exclusion (that is, they should be permitted) in the "lightering prohibited" areas. The objective of these areas is to provide an area for environmental or navigational reasons that is free from vessels engaging in traditional lightering, which is typically accomplished with both the tanker and shuttle tanker underway. Vessels so engaged cannot readily maneuver to avoid other vessels, shoals or environmentally sensitive areas. Unlike tanker lightering, the FPSO and its attending shuttle tanker will always be on a known, fixed location. Consequently, they do not pose the same risk that the lightering prohibited areas are intended to mitigate. Since some areas within designated lightering prohibited areas may be more environmentally sensitive, Shell would find it acceptable to include a provision to request the exemption on a case-by-case basis determined by the specific location of the FPSO.

Socioeconomic Impact

The Gulf Coast in the Central and Western Planning areas is highly influenced by the offshore oil industry. Some areas have suffered as a result of oil prices or the overall decline in production from older depleted near-shore or "shelf" developments. The acceptance of FPSOs will permit continued development of the many existing businesses that are a dominant force in these local economies. FPSOs will not require significant changes to the current support infrastructure. People, food, fuel, and necessary consumable products will continue to move as they do now. The shuttle tanker operations will merge seamlessly with the current volumes transferred from large foreign super tankers and processed by the existing refineries along the Gulf Coast. Perhaps the most significant infrastructure impact will be to the shuttle tanker fleet itself. Under current laws tankers that transfer oil originating on the U.S. OCS will have to be built by U.S. shipyards, be U.S. flagged and operated by U.S. citizens. The current shuttle tanker resources are predominantly foreign flagged and operated by foreign crews. The Gulf Coast has available shipbuilding and ship repairing capacity and has the labor base to support and operate such vessels.

In summary, Shell supports the completion of the Environmental Impact Statement as an appropriate and proactive step that will, by leading to the acceptance of FPSOs, increase the number of options available to operators involved in Deepwater development. MMS' prior EIS efforts have served to increase the body of knowledge available to industry and the regulators alike and it is our expectation and hope that this effort will emulate your past performance.

We appreciate the opportunity to attend and participate at the scoping meeting. If you need any further information, please contact me at (504) 728-6982, or Mr. Rick Meyer at (504) 728-6393.

Very Truly Yours,

Peter Velez

Peter K. Velez
Manager Regulatory and Public Affairs

State of Louisiana

es H. Jenkins, Jr.
Secretary

Department of Wildlife & Fisheries
Post Office Box 98000
Baton Rouge, LA 70898-9000
(225) 765-2800

M.J. "Mike" Foster, Jr.
Governor

July 20, 1999

Ms. Deborah Cranswick (MS5410)
U.S. Minerals Management Service
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Dear Ms. Cranswick:

I am hereby providing scoping comments from the Louisiana Department of Wildlife and Fisheries regarding the programmatic Draft Environmental Impact Statement for the potential use of floating production, storage, and offloading (FPSO) systems in the deepwater areas of the Central and Western Planning Areas of the Gulf of Mexico Outer Continental Shelf.

During the scoping meeting it was stated that these activities will take place in deep water up to 200 miles offshore. The project maps showed that the areas proposed for use were, indeed, well offshore from Texas, but much nearer to the Louisiana coast. Given the potential proximity of this activity to Louisiana's fragile coastal marshes, efforts to minimize the potential for their injury is essential, and both offshore and inshore sensitive habitat areas need to be identified and impacts to such addressed.

The secondary impacts of FPSO development should also be addressed. These include the impacts that will result from transporting oil in shuttle tankers; the additional shoreline development, support, or infrastructure that will be required to service this fleet; and the environmental hazards and the additional risk to Louisiana's coastal areas associated with this shuttle tanker traffic. What will be the impacts on the ports - will there be need for extra channel maintenance or other activities that will result in additional adverse environmental impacts? The increase in the number and size of shuttle tankers in existing navigation channel should not be used to increase current channel size. The increase number of trips by shuttle tankers can increase the erosion along these channels resulting in lost of adjacent habitat and increase maintenance dredging. There are sensitive inshore habitats and special areas that can be negatively impacted by these shuttle tankers.

According to the Notice of Intent, FPSOs will be used as production facilities to develop marginally economic or remote fields in the deepwater OCS. The "base case" has the FPSO producing gas and oil; the gas is transported to shore via pipeline, while oil is stored aboard the FPSO and subsequently transported via shuttle tanker. This seems to be internally inconsistent if the purpose of using FPSOs is for marginal fields where pipelines aren't feasible. On the one hand, pipelines are not feasible for these areas, but in the "base case" gas pipelines are feasible. Are pipelines feasible, or not? If gas pipelines are feasible, why are oil pipelines not feasible?

During the presentation, the safety record of lightering operations was cited. Given the very small spill volume reported from 1993 to 1997, I suspect that the statistics were generated from reported spills only. The Coast Guard through the National Response Center receives reports of hundreds of mystery spills off Louisiana each year. In addition, first reports of spills are notoriously unreliable in that the volume spilled is consistently underestimated. If the risk analysis for shuttling oil from FPSOs is to have any veracity, then an effort to get a more realistic estimate of spills from lightering should be made. The risk analysis should include the possibility of a catastrophic failure of one or more FPSO systems, and/or loss of shuttle tankers, including loss of full cargo/storage.

The range of alternatives includes single hull or single bottom designs, and storage up to 2.3 million barrels. Are single hulls/bottoms consistent with OPA 90? What additional risk to Louisiana's sensitive coastal marshes will be incurred by these alternatives?

The safety of FPSO systems during storms also was discussed. It was stated that the systems must be built to withstand a 100-year storm event. This was never defined, however. Performance of FPSO systems during storms in other parts of the world was discussed, however the descriptions were either in terms of a 100-year event at that location or in Beaufort Scale. In order to be locally relevant, this should be discussed in terms of a Gulf of Mexico 100-year event and Saffir-Simpson Scale.

I would like to suggest a possible means of mitigating FPSO development in the Gulf. Since traditional mitigation in the form of habitat creation or set-aside is not feasible in the deepwater areas where this activity will occur, perhaps information or data gathering could be used as mitigation, instead. Implementing a monitoring program to provide information on the deepwater GOM including physical, chemical, and biological oceanography would greatly assist resource management agencies in protecting public trust resources should there be an accident related to FPSO development. Such a program should include real-time wind and current measurements from stations across the inner and outer shelf, similar to the Texas Automated Buoy System (TABS) that MMS helps to sponsor.

Thank you for the opportunity to participate in the scoping process. If you need additional assistance, contact Jim Hanifen at this address.

Sincerely,

John E. Roussel,
Assistant Secretary
Office of Fisheries

LA 1 COALITION

Roy P. Francis
Executive Director

July 14, 1999

Ms. Deborah Cranswick (MS5410)
Minerals Management Services
Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Dear Ms. Cranswick:

I have the pleasure of representing a non-profit organization that is working for road improvement from Port Fourchon to U. S. 90 in Raceland, Louisiana. With the increase in activity in the deep waters of the Gulf of Mexico, community leaders felt the need to organize an effort to improve the infrastructure to Port Fourchon.

For over fifty years this region has been proudly leading the way to help this nation meet its energy needs through both the boom and the bust cycles. As I am sure you are aware, just a few years back the Gulf of Mexico was labeled the "Dead Sea", but now is considered America's "New Frontier." But with that prosperity there is a price, and one of the most significant impacts to the landside infrastructure that is facilitating this offshore industry is Louisiana Highway One (LA1). LA 1 is a two-lane highway that was never intended to lead to the focal point of deepwater drilling in America.

As your agency is studying the potential use of FPSO systems, it is likely that Port Fourchon will be a considered a strategic location for the same reasons that Louisiana Offshore Oil Port is supported from Port Fourchon and the Central Gulf Outer Continental Shelf activities dominate Port Fourchon.

Although this community is willing to service the oil and gas industry, they also recognize the need for MMS to properly identify and mitigate the impacts associated with this level of activity. In the EIS of Lease Sales 169, 172, 175, 178 and 182 the impacts to LA 1 were recognized; however, I am unaware of any attempts to mitigate the impacts.

P.O. Box 2048-NSU • Thibodaux, Louisiana 70310 • Phone: (504) 448-4485 • Fax: (504) 448-4486
Email: slec-rpf@nich-nsunet.nich.edu

For seven years I have been involved in coastal issues which include; permitting, restoration, and management. To my knowledge, when an EIS is conducted and impacts are identified, the project will proceed only when there are mitigation provisions. Is the same not true for MMS?

Geographically and environmental Port Fourchon is an ideal location to service the Central Gulf of Mexico, and the community readily accepts this role. However, this planning process for FPSO's and other offshore activities must take into account the impacts to the overburdened infrastructure.

I appreciate this opportunity to comment. If you have any questions or comments please do not hesitate to contact me at (504) 448-4485.

Sincerely,

Roy P. Francis

Roy P. Francis
Executive Director

July 26, 1999

Todd J. Marse
2220 Kathleen Dr.
Marrero, LA 70072

MMS, Gulf of Mexico OCS Region
Attn: Ms. Deborah Cranswick (MS 5410)
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

MMS Public Scoping Comments:

Environmental Impact Statement for the Proposed Use of FPSO Systems in Deepwater Areas of the Gulf of Mexico

Perhaps I should begin by apologizing for the casual tone of these comments; however, the nature of my ideas readily lend themselves to such treatment and, therefore, can be more effectively communicated in this manner.

First of all, I believe that the importance of a complete and comprehensive EIS cannot be overemphasized, since it will, in effect, be setting precedent for future assessments of proposed applications of technological advancements in the area of oil and gas exploration and development. Secondly, I recommend a healthy awareness of certain deficiencies of statistical analysis when depended upon for environmental risk assessments. For instance, it is pointless to speak of "average annual accidental releases" when over 90% of this "average" is a result of a single event. A more realistic and effective approach is to employ a "worst case scenario" approach to predict and assess the effects of a proposed action, both under multiple circumstances and with varying degrees of hazard. An example would be the occurrence of a major collision involving a shuttle tanker and a full FPSO, while a category four hurricane (with the capacity to transport any released materials into coastal zones) rapidly approaches the collision site. While this scenario might be considered unlikely, the pseudo-laws of uncertainty will not let us completely dismiss this and similar possibilities.

Of course, many other considerations must be addressed in this EIS, some of which were voiced at the June Public Scoping Meetings. Included as those aspects of greater priority, I would suggest analysis of the cumulative effects of rapidly altered transport traffic patterns, the effects of introduced structures and associated emissions and noise levels, the affected migratory movements and life cycles of organisms present and, most importantly, the possible effects of unforeseen events and circumstances.

In conclusion, I wish to remind all concerned with the development of this and other EISs and EAs that, "What we don't know is of greater quantity than what we do," and that no one is exempt from the hazards of arrogance.

Sincerely,

Todd J. Marse

Todd J. Marse

United States Department of the Interior
Minerals Management Service

FACT SHEET

PUBLIC SCOPING MEETING ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED USE OF FPSO SYSTEMS IN DEEPWATER AREAS OF THE GULF OF MEXICO

MEETING AGENDA

Introduction

Presentation

Break

- View displays
- Sign up to speak
- Develop comments/ questions

Public Comment

- Anyone who registered to speak will be called to the podium to offer comments.
- A court reporter will record comments to ensure that the comments will be considered in the EIS.
- Written questions/ comments will be read.

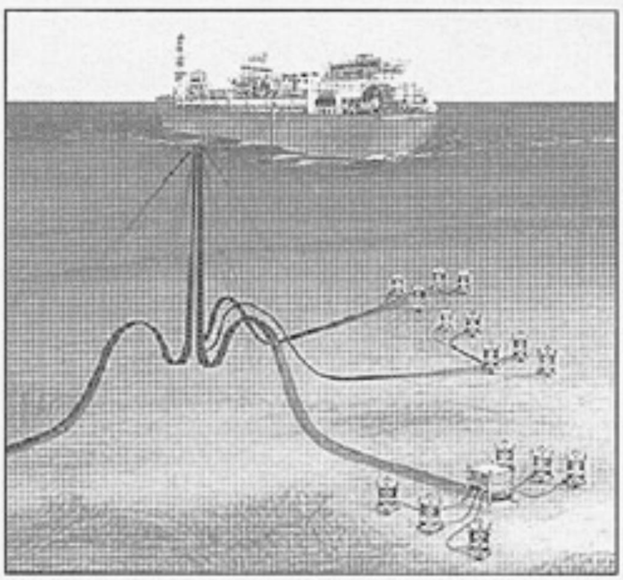
INTRODUCTION

The Minerals Management Service (MMS) is preparing an Environmental Impact Statement (EIS) that will address the potential environmental impacts of the use of floating production, storage, and offloading (FPSO) systems in the deepwater areas in the Central and Western Planning areas of the Gulf of Mexico (GOM) Outer Continental Shelf (OCS). In compliance with the National Environmental Policy Act (NEPA), this programmatic EIS will be used by MMS in its decision-making process. The NEPA process ensures that environmental information is available to public officials and citizens before decisions are made and actions are taken.

WHAT IS A PROGRAMMATIC EIS?

The Council on Environmental Quality encourages the use of programmatic EISs to address the environmental effects of a wide-ranging or long-term program. In this case, the programmatic EIS will discuss FPSOs in general and assess the effects of these systems on the GOM OCS. MMS will evaluate whether FPSO systems would be acceptable for use on the GOM OCS; the decision will not constitute approval for the use of any particular FPSO at any specific location. If FPSOs are considered acceptable by MMS, plans for the proposed use of an FPSO at a specific location will still be subject to MMS' NEPA requirements and established decision-making process.

PROPOSED PROJECT



FPSOs may be used as production platforms to develop oil fields in the deepwater areas of the GOM OCS. For this EIS, deepwater is defined as water depths greater than 200 meters, or 656 feet. The base case scenario for this EIS is a permanently moored, double-hulled, ship-shaped FPSO with up to 1 million barrels of crude oil storage capacity. The seafloor well equipment and on-board production equipment will be the same type as those used with other deepwater production facilities. Produced oil will be offloaded to non-dynamically positioned shuttle tankers for transport to ports in Texas or Louisiana or to the Louisiana Offshore Oil Port (LOOP). Associated or produced gas will be transferred to shore via a gas pipeline.

Technical options will also be evaluated in the EIS. These options include disconnectable mooring, single-hull or single-bottom design variations, non-ship shapes, increased crude oil storage up to 2.3 million barrels, dynamically positioned shuttle tankers, reinjection of natural gas for later recovery, and gas-to-liquids conversion.

ALTERNATIVES

Alternatives will include exclusion of FPSO systems from the lightering prohibited area established by the U.S. Coast Guard and others identified during the scoping process.

THE EIS PROCESS AND PUBLIC PARTICIPATION

NEPA provides for opportunities for public involvement in the EIS process. At the scoping meetings, the public is requested to provide input into the "scope" of issues to be addressed in the EIS. Issues of concern to citizens should be stated during the public comment period, either at the scoping meeting or in writing. Comments should clearly describe specific issues or topics that you believe should be addressed in the EIS.

An EIS will be prepared and made available to the public and other government agencies for review and comment. Several public hearings will be scheduled during this review period to give individuals the opportunity to present their comments on the draft EIS. In addition, written comments can be mailed to the MMS. Public and agency comments will be addressed in the final version of the EIS.

SCOPING COMMENTS

Questions concerning NEPA and/or comments on the scope of the DEIS should be directed to the following address:

MMS, Gulf of Mexico OCS Region
Attn: Ms. Deborah Cranswick (MS 5410)
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

All scoping comments must be received by July 26, 1999, to be considered in the DEIS.

EIS PROCESS FOR PROJECT REVIEW

D

MMS Consultation with the National Marine Fisheries Service and United States Fish and Wildlife Service

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Washington, DC 20240

NOV 30 2000

Memorandum

To: Assistant Director for Endangered Species
U.S. Fish and Wildlife Service

From: Carolita U. Kallaur Thomas A. Readinger
for Associate Director for Offshore Minerals Management

Subject: Endangered Species Act Section 7 Consultation for Floating Production, Storage, and Offloading (FPSO) Systems in the Central and Western Gulf of Mexico Lease Sale Areas

The Minerals Management Service released a draft Environmental Impact Statement (EIS) in August 2000, that examines the potential effects of the use of FPSOs in the deepwater areas of the Central and Western Gulf of Mexico Outer Continental Shelf. The draft EIS is a programmatic document that considers a generic FPSO system and operation, as well as a range of technical variations. Based upon the analysis in the final EIS, the MMS will decide whether FPSO systems are an acceptable option to consider for use on the GOM OCS. This decision will not grant approval for the use of any particular FPSO at any specific site. Specific FPSO proposals will undergo additional review by the MMS and other Federal and State agencies.

Under Section 7(a)(2) of the ESA, the MMS requests that the FWS uphold the biological opinions prepared for the Central (December 24, 1997) and Western (March 9, 1998) multi-sale leasing programs as valid for the consideration of FPSOs. The FPSO EIS analyses found no impacts of a nature or degree not previously considered under the MMS multi-sale EISs and the current biological opinion.

The "base case" evaluated in the draft EIS is a permanently moored, double-hulled, ship-shaped FPSO with up to 1-million barrels of crude oil storage capability. The seafloor well equipment and on-board production equipment will be the same types as those used with any other deepwater production facilities. Produced oil will be offloaded to 500,000-barrel-capacity shuttle tankers for transport to ports in Texas or Louisiana or to the Louisiana Offshore Oil Port. The produced natural gas will be transferred to shore via a gas pipeline.

The alternatives considered in the draft EIS are: (1) no FPSOs in the "lightering prohibited area" established by the U.S. Coast Guard; (2) no FPSOs in the Corpus Christi and Port Isabel leasing areas; (3) no FPSOs in the Viosca Knoll and Mississippi Canyon leasing area; and (4) requirement for an attendant vessel during offloading operations. A "No Action" alternative is also evaluated in the draft EIS.

The findings of the draft EIS were that the potential environmental effects from the use of FPSOs are essentially the same as impacts associated with other deepwater development and production systems used in the GOM as addressed in the MMS Environmental Assessment on deepwater activities and multi-sale EISs, except that emissions associated with shuttle tankers laying idle during offloading could cause air quality exceedances in the Breton Class I Area.

We request that the FWS issue an opinion by mid-January 2001 to allow the MMS to include it in the Record of Decision. If you consider recommending measures to minimize impacts to threatened and endangered species or determine a jeopardy opinion may exist for all or any part of the proposed action, we ask that you notify us as early as possible, according to 50 CFR 402.14(g)(5), to allow the MMS and FWS staff time to jointly discuss the findings. We believe that such discussions will facilitate the consultation and ensure effective protection of listed species. We understand that when the FWS issues an opinion for the proposed action, it does not relinquish the opportunity to reconsider and modify that opinion.

We are enclosing a copy of the draft EIS and we will be glad to provide any additional information that you may find necessary for your deliberations. To facilitate a timely beginning and completion of this consultation, we are sending a copy of this letter and enclosure to the FWS Southeastern Regional Office in Atlanta, Georgia, the FWS Southwestern Regional Office in Albuquerque, New Mexico, and the FWS Ecological Services Field Offices in Panama City, Florida, and Houston, Texas.

If you have any questions on this consultation, please address them to Ms. Judy Wilson, Minerals Management Service, Mail Stop 4042, 381 Elden Street Herndon, Virginia 20170-4817 (commercial and FTS telephone: (703) 787-1075), or Mr. Dennis Chew, Minerals Management Service, Gulf of Mexico Region, Mail Stop 5412, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123-2394 (commercial and FTS telephone: (504) 736-2794).

Attachment

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

In Reply Refer To: MS 5430

DEC 19 2000

Mr. Andreas Mager, Jr.
Habitat Conservation Division
National Marine Fisheries Service
9721 Executive Center Drive N.
St. Petersburg, Florida 33702

Dear Mr. Mager:

Thank you for reviewing the Draft Environmental Impact Statement (DEIS), Proposed Use of Floating Production, Storage, and Offloading Systems (FPSO) on the Gulf of Mexico Outer Continental Shelf. With this letter, Minerals Management Service (MMS) is responding to the Essential Fish Habitat (EFH) Conservation Recommendations as contained in your letter of October 10, 1999; however, this response does not constitute a consultation.

As you noted in your letter, MMS considers this DEIS a programmatic document for potential future activities. The MMS does not believe we are in a position to request an EFH consultation at this stage of the National Environmental Policy Act (NEPA) process. Our responses below to the EFH Conservation Recommendations reflect this position. We will provide a copy of your recommendations to the appropriate MMS personnel for consideration.

National Marine Fisheries Service (NMFS) Recommendation 1: The standard conservation measures required as a part of the authorizations granted by MMS, and Alternative B and General Restrictions or Conditions B1, B2, B3, and B4 should be incorporated in any future authorizations.

MMS Response: The MMS agrees that standard conservation measures should be incorporated into future FPSO authorizations. While MMS will designate a Preferred Alternative in the final Environmental Impact Statement (EIS), the FEIS is an information document, not a decision document. The MMS must complete the NEPA process before the decisionmaker can decide upon an alternative. The decision to adopt one of the Alternatives (at a programmatic level) will be made, in accordance with Departmental policy, at the time of the Record of Decision, a minimum of 30 days after the FEIS is filed. Specific actions will be evaluated in separate Environmental Assessments (EA) for any proposed FPSO action.

NMFS Recommendation 2: Any future site-specific FPSO proposals should be coordinated with the NMFS pursuant to the requirements of the Magnuson-Stevens Fishery Conservation and Management Act.

MMS Response: The MMS will request an EFH consultation with NMFS when we prepare an EA for the first proposed FPSO action. At that time, EFH assessment materials judged as adequate in the FPSO DEIS will be incorporated by reference. The manner in which this first consultation is performed will determine the need for future coordination with NMFS regarding other site-specific proposals. We believe that a programmatic consultation for FPSO use in the Gulf of Mexico would be the most efficient mechanism for both our agencies. In any event, MMS concurs with the recommendation and will coordinate with NMFS on future FPSO proposals as determined by the initial consultation.

Thank you again for the review of the FPSO DEIS. If you have any questions or wish to discuss these issues, please contact Mr. Gregory Boland at (504) 736-2740 or via e-mail at gregory.boland@mms.gov.

Sincerely,

Chris C. Oynes

Chris C. Oynes
Regional Director

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Washington, DC 20240

U.S. Department of the Interior
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NOV 30 2000

Mr. Donald Knowles
Director, Office of Protected Resources
National Marine Fisheries Service
1335 East-West Highway, Room 13821
Silver Spring, Maryland 20910

Dear Mr. Knowles:

The Minerals Management Service released a draft Environmental Impact Statement (EIS) in August 2000, that examines the potential effects of the use of floating production, storage, and offloading (FPSO) systems in the deepwater areas of the Central and Western Gulf of Mexico Outer Continental Shelf. The draft EIS is a programmatic document that considers a generic FPSO system and operation, as well as a range of technical variations. Based upon the analysis in the final EIS, the MMS will decide whether FPSO systems are an acceptable option to consider for use on the GOM OCS. This decision will not grant approval for the use of any particular FPSO at any specific site. Specific FPSO proposals will undergo additional review by the MMS and other Federal and State agencies.

Under Section 7(a)(2) of the Endangered Species Act, the MMS requests that the National Marine Fisheries Service uphold the January 6, 1998, biological opinion prepared for the Central and Western multi-sale leasing programs as valid for the consideration of FPSOs. The FPSO EIS analyses found no impacts of a nature or degree not previously considered under the MMS multi-sale EISs and the current biological opinion.

The "base case" evaluated in the draft EIS is a permanently moored, double-hulled, ship-shaped FPSO with up to 1-million barrels of crude oil storage capability. The seafloor well equipment and on-board production equipment will be the same types as those used with any other deepwater production facilities. Produced oil will be offloaded to 500,000-barrel-capacity shuttle tankers for transport to ports in Texas or Louisiana or to the Louisiana Offshore Oil Port. The produced natural gas will be transferred to shore via a gas pipeline.

The alternatives considered in the draft EIS are: (1) no FPSOs in the "lightering prohibited area" established by the U.S. Coast Guard; (2) no FPSOs in the Corpus Christi and Port Isabel leasing areas; (3) no FPSOs in the Viosca Knoll and Mississippi Canyon leasing area; and (4) requirement for an attendant vessel during offloading operations. A "No Action" alternative is also evaluated in the draft EIS.

The findings of the draft EIS were that the potential environmental effects from the use of FPSOs are essentially the same as impacts associated with other deepwater development and production systems used in the GOM as addressed in the MMS Environmental Assessment on deepwater activities and multi-sale EISs, except that emissions associated with shuttle tankers laying idle during offloading could cause air quality exceedances in the Breton Class I Area.

We request that the NMFS issue an opinion by mid-January 2001 to allow the MMS to include it in the Record of Decision. If you consider recommending measures to minimize impacts to threatened and endangered species or determine a jeopardy opinion may exist for all or any part of the proposed action, we ask that you notify us as early as possible, according to 50 CFR 402.14(g)(5), to allow the MMS and NMFS staff time to jointly discuss the findings. We believe that such discussions will facilitate the consultation and ensure effective protection of listed species. We understand that when the NMFS issues an opinion for the proposed action, it does not relinquish the opportunity to reconsider and modify that opinion.

We are enclosing a copy of the draft EIS and we will be glad to provide any additional information that you may find necessary for your deliberations. To facilitate a timely beginning and completion of this consultation, we are sending a copy of this letter and enclosure to the NMFS Southeastern Regional Office in St. Petersburg, Florida.

If you have any questions on this consultation, please address them to Ms. Judy Wilson, Minerals Management Service, Mail Stop 4042, 381 Elden Street Herndon, Virginia 20170-4817 (commercial and FTS telephone: (703) 787-1075), or Mr. Dennis Chew, Minerals Management Service, Gulf of Mexico Region, Mail Stop 5412, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123-2394 (commercial and FTS telephone: (504) 736-2794).

Sincerely,

Thomas A. Readinger

for Carolita U. Kallaur
Associate Director for
Offshore Minerals Management

Enclosure

cc: Mr. Charles Oravetz
Regional Administrator
Southeastern Regional Office
National Marine Fisheries Service
9721 Executive Center Drive
St. Petersburg, Florida 33702

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
9721 Executive Center Drive North
St. Petersburg, FL 33702
(727) 570-5312; FAX 570-5517

DEC 27 2000

F/SER3:BH

Ms. Carolita U. Kallaur
U.S. Department of the Interior
Minerals Management Service
Washington, DC 20240

Dear Ms. Kallaur:

This is in reference to your November 30, 2000 letter and attached environmental impact statement (EIS) regarding the use of floating production, storage, and offloading systems (FPSO) in deep water areas of the Central and Western Gulf of Mexico Outer Continental Shelf. The FPSO type analyzed in the EIS is a permanently moored, double-hulled, ship-shaped facility with up to one million barrels of crude oil storage capacity. The seafloor well equipment and on-board production equipment will be the same types as those used with any other deep water production facilities. The National Marine Fisheries Service (NMFS) consultation number is I/SER/2000/01385. If you have any questions about this consultation, please refer to this number.

Lease sales and the subsequent development and production for oil and natural gas in the Central and Western Gulf of Mexico Outer Continental Shelf Planning Areas were analyzed during a formal Endangered Species Act (ESA) section 7 consultation. This consultation was concluded when the NMFS issued its Biological Opinion (Opinion) dated January 6, 1998. The Opinion concluded that the lease sales and the subsequent development and production of oil and natural gas were not likely to jeopardize the continued existence of species protected by the ESA under NMFS purview.

As long as the Minerals Management Service (MMS) follows the reasonable and prudent measures and their implementing terms and conditions, detailed in the Incidental Take Statement issued with the January 6, 1998 Opinion, NMFS does not believe that the use of FPSOs will change the conclusions of that Opinion. Therefore, this concludes your consultation responsibilities under section 7 of the ESA for the proposed action for species under NMFS purview. Consultation should be reinitiated if new information reveals impacts of the identified activity that may affect listed species or their critical habitat, a new species is listed, the identified activity is subsequently modified or critical habitat determined that may be affected by the proposed activity.

Incidental takes of marine mammals (listed or non listed) are not authorized through the ESA section 7 process. If such takes may occur, an incidental take authorization under Marine Mammal Protection Act (MMPA) Section 101 (a)(5) is necessary. NMFS suggests that MMS contact Ken Hollingshead of our headquarters Protected Resources staff at (301) 713-2323 regarding application procedures for an incidental small take authorization under Section 101(a)(5) of the MMPA.

If you have any questions, please contact Bob Hoffman, Fishery Biologist, at the number listed above.

Sincerely yours,

Charles A. Oravetz

for Joseph E. Powers, Ph.D.
Acting Regional Administrator

cc: F/PR3
F/SER4 (Dale)
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