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STUDY TITLE: Evaluation of Potential Environmental Impacts from Subsea Processing

REPORT TITLE: Effects of Subsea Processing on Deepwater Environments in the Gulf of Mexico

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KEY WORDS: Subsea processing; pressure boosting; subsea separation; environmental regulations; deep sea; Gulf of Mexico

BACKGROUND: The Gulf of Mexico provides 93% of the United States' total offshore petroleum production. As demand for increased domestic oil supply increases, and new technologies for accessing deep sea petroleum reserves are developed, oil and gas exploration and production activities are expanding into the deeper portions of the Gulf. The current record is 10,011 ft (3,051 m) in ChevronTexaco's Toledo prospect. The extreme pressures, low temperatures, and lack of accessibility present significant technological challenges. Furthermore, little information is readily available on the potential environmental effects. This report represents the compilation and synthesis of existing published and unpublished literature on the environmental effects of subsea processing operations on the deepwater environment.

OBJECTIVES: (1) Synthesize information on subsea processing technologies including future trends of development; (2) Review and synthesize all studies conducted on the potential environmental impacts of subsea processing; (3) Evaluate potential environmental impacts of subsea processing technologies; (4) Identify data gaps and information needs; and (5) Evaluate existing regulations relative to applicability to subsea processing.

DESCRIPTION: Literature searches were conducted using web-based search engines and key words including: subsea production, subsea processing, deep sea, oil and gas, Gulf of Mexico, and pressure boosting. Online abstracts and summaries were reviewed prior to obtaining copies of relevant articles. The Minerals Management Service (MMS), Gulf of Mexico, web site was also searched to identify relevant reports on the marine environment and oil and gas production in the Gulf of Mexico. The literature search regularly identified reports published in the Offshore Technology Conference proceedings. The project team obtained and reviewed over 1,120 papers in the conference proceedings for the years 2002 to 2005 to identify relevant documents. Additional references were identified by the technical experts on the project team. Relevant information was identified from 71 literature publications, 12 MMS reports, and numerous web sites. In November 2006, MMS sponsored a one-day technical workshop for representatives from MMS, the U.S. Environmental Protection Agency, and the oil and gas industry. The purpose of the meeting was to advance MMS's goal of being ready to make permitting decisions when industry is ready to request permits for installation and operation of subsea processing facilities. During this meeting a dialogue was established between MMS, U.S. EPA, and the oil and gas industry to identify issues and concerns regarding implementation of subsea processing technologies and the development of future regulations by MMS.

SIGNIFICANT CONCLUSIONS: Technologies that are currently being implemented in deep water include multiphase pumps (Type 1) and partial separation with pumping (Type 2). Multiphase pumping systems are proven technologies, whereas Type 2 systems have seen limited use. Technologies currently being developed for future application include combinations of separators, scrubbers, and pumps that allow complete separation of production stream at the seabed (Type 3). The most advanced systems (Type 4) are likely to include multistage separation and fluid treatment with the production of export quality oil and gas.

The potential impacts and major environmental concerns associated with subsea operations are similar to those observed with existing surface technologies. The primary difference between surface and deep sea technologies is the restricted ability to detect and respond to releases at or near the seabed. Additionally, the major potential impacts and environmental effects could be different in deep water because the potentially affected biological communities are not as well characterized in terms of species composition, ecological significance, and the rates of community recovery from physical or chemical interventions. Other potential environmental hazards associated with the operation of subsea processing systems include exposure to large thermal gradients, induced electromagnetic fields, and low-level noise. Existing statutes, regulations, and technical guidance for oil and gas exploration and production were reviewed and were found to be adequate for assessing potential risks. Additional efforts and the development of new tools to characterize the potential impacts on biological communities in the vicinity of subsea operations are recommended.

STUDY RESULTS: Two main factors limit petroleum production in deep waters, pressure and temperature. The pressures required to lift the product to the surface are substantially greater in deep water than in shallow waters. Installation of long

multiphase flowlines from wells to surface processing platforms, while reducing costs, increase backpressure on the wells, thereby reducing flow rates and recoveries. Significant differences in temperature between the seawater and petroleum product may cause partial separation of the oil, gas, and water components (slugging) and the formation of hydrates and waxes in the pipeline risers which may significantly impede flow. The potential impacts and major environmental concerns associated with subsea operations are similar to those observed with surface technologies. These include the release of drilling fluids and untreated drill cuttings during exploration and production, release of large volumes of hydrocarbons or utility fluids due to failures in piping, seals and connections, and the release of untreated produced water and sands. A key technological and environmental issue involved in the implementation of subsea separation is the handling and disposal of the produced waters and sands. Options include transport to the surface, reinjection into depleted formations, or discharge to the ambient environment.

The advent of subsea technologies also introduces new environmental issues. These include the existence of large temperature differences between operating equipment and ambient conditions, the use of new treatment chemicals, the creation of electromagnetic fields associated with the operation of pumps and other equipment on the seafloor, and noise. The potential toxic effects of new or significantly modified products for treating the production and processing flow streams on benthic and free-swimming organisms should be determined. The deeper water habitats also exhibit unique features that should be considered in regulating subsea processing.

STUDY PRODUCTS: Tetra Tech. 2008. Effects of subsea processing on deepwater environments in the Gulf of Mexico. U.S. Dept. of the Interior, Minerals Management Service. Gulf of Mexico OCS, New Orleans, LA. OCS Study MMS 2008-022. 73 pp.

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