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**STUDY TITLE**: Forecasting the Explosive Removal of Offshore Structures

**REPORT TITLE**: Modeling Structure Removal Processes in the Gulf of Mexico

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**BACKGROUND:** The Outer Continental Shelf (OCS) of the U.S. Gulf of Mexico (GOM) is one of the most highly developed and mature basins in the world. Over the last 50 years, the oil and gas industry has installed over 6,000 structures and 33,000 miles of interconnecting pipelines in the gulf waters. Today, there are about 4,000 active structures installed in federal water ranging from less than 10 feet to over 7,000 feet.

Structures need to be constructed, delivered, installed, and equipped prior to production, operated and serviced during production, and then eventually decommissioned and removed after production. Each of these activities has both a direct and indirect impact on the communities in which the service facilities and manufacturing operations are located, and hence induce a “spill-over” effect on the economic growth of regions which serve the development. An entire industry has been built in the GOM around installing production equipment and structures, servicing those structures (maintenance, repairs, supply), and then removing the structures when production ceases.

Operators wishing to remove an OCS platform or facility are required to submit a structure removal permit application to MMS for technical review and the preparation of an environmental assessment (EA) under National Environmental Policy Act (NEPA) guidelines. Prior to mobilization, additional permits are required for well abandonment (temporary or permanent) and/or pipeline decommissioning to ensure that all of the infrastructure components to and from the structure are secured. Removal operations proposing explosive severance are currently subject to the terms and conditions of a programmatic Biological Opinion (BO)/ Incidental Take Statement (ITS) issued by the National Oceanographic and Atmospheric Administration's Fisheries Service (NOAA Fisheries) under an Endangered Species Act (ESA) Consultation with MMS. If an operator proposes any activities that fall outside of the BO/ITS severance criteria, a site-specific ESA Consultation and new BO/ITS will be required.

**OBJECTIVES**: The purpose of this report is to examine the operational aspects of removal processes in the GOM; to quantify the application, use, and regulatory structure of explosive methods of severance; and to develop a production-based model to forecast the removal of offshore structures.

**DESCRIPTION:** Offshore structures combine capital, labor, materials and fuel to produce hydrocarbons, and operate under the physical laws and engineering specification of the system, economic principles which determine the design and commerciality of production, and man-made rules governing operation and decommissioning activities. Significant interrelationships exist between the physical laws by which a system operates and the commercial rules and regulations established for the system.

Structures are installed to produce and process hydrocarbons, and when the time arrives that the cost to operate a structure – or more commonly, a group of structures – exceeds the income from the hydrocarbons under production, the structure(s) exists as a liability instead of an asset and becomes a candidate for divestiture or decommissioning. Over 2,200 structures have been removed from the GOM over the last half-century, and over the past decade, 125 structures on average have been removed annually. Within one year of lease termination, the Minerals Management Service (MMS) requires that the lessees remove all structures to a depth of 15 feet below the mudline and that the site be returned to prelease conditions. Although multiple techniques may be used to sever the structural components, they are generally categorized as either explosive or nonexplosive methods.

**SIGNIFICANT CONCLUSIONS**: Predictive models of the use of explosives are severely constrained by the number of factors involved in decision-making, and while a formal method has been developed to forecast structure removals, many uncertainties influence the model results.

**STUDY RESULTS**: A statistical description of the explosive removal of offshore structures is developed, and the influence of factors such as water depth, planning area, configuration type, and structure age upon the application of explosive removal methods

is investigated. Estimates for the number of structures that are expected to be removed from the GOM over a 25-year time horizon are forecast using a heuristic life expectancy and probabilistic removal model.

The factors involved in the decision to use a specific severance technique are described, and the probability that a structure will be removed with explosive technology is quantified. A predictive model of the decision to use explosive methods is also developed. An empirical analysis of oil and gas structures removed in the GOM between 1986-2001 provide the historic data required to compute the probability of an explosive removal and to estimate binary choice models for severance selection. Binomial logit and probit models of severance selection are constructed to establish the relationship between structure attributes and the probability that a particular severance technique will be employed.

Four models of abandonment timing decisions are developed, ranging from a resource-based forecast to a sophisticated, risked, net present value approach. Meta-modeling simulation is employed to construct functionals that describe how the age of the structure upon abandonment is related to the system parameters. The sensitivity of the results to differences in the model assumptions, and the practical matter of whether refined methods are, in fact, more accurate than simple forecasting techniques, is discussed. A generic field development scenario is used to illustrate the decommissioning timing models.

The economic limit of offshore structures is estimated using historic data from GOM structures removed over the past two decades. This is the first time that threshold limits of production near abandonment have been investigated and quantified.

A production-based model to forecast removal rates and costs of offshore structures is presented. A stochastic decline model is used to forecast production, and in conjunction with estimates of the economic limit, is used to determine the time that a structure is abandoned. The expected time a structure is removed is based on federal regulatory requirements which determine the latest possible removal scenario. A description of the modeling framework and results are presented, along with a discussion of the limitations of analysis.

**STUDY PRODUCTS**: Kaiser, M.J., D.V. Mesyanzhinov, and A.G. Pulsipher. 2005. Modeling Structure Removal Processes in the Gulf of Mexico. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, La. OCS Study MMS 2005-029. 133 pp.