OTC 19272

Protection and Risk Mitigation Strategies for Subsea Infrastructure in Ice Environments

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This paper was prepared for presentation at the 2008 Offshore Technology Conference held in Houston, Texas, U.S.A., 5–8 May 2008.

Abstract

A review of the current capability within the industry is given for assessing the iceberg environment and iceberg keel / seabed structure interaction, with emphasis on operations relevant to the east coast of Canada. Consideration of calculating contact frequency and ice loads for iceberg keel impact is discussed, for both freely floating and gouging icebergs. Available environmental data for the Labrador Shelf and Grand Banks of Newfoundland are summarized. An overview of the operational experience of placing subsea production facilities in glory holes to provide protection from iceberg keels is provided, along with a review of studies related to the development of alternative solutions. Studies have been performed to investigate the feasibility of design and construction of cased (or silo) glory holes, external protection structures such as rock berms and steel or concrete structures, and the effects of direct impact scenarios such as the use of caisson wellhead systems.

Ongoing efforts to improve the knowledge base, analytical capability and engineering solutions to predict the effect of iceberg keel loading on subsea oil and gas facilities are described. Obstacles to safe and economic development are identified, along with a discussion of methods that can be used to overcome these and provide practical solutions for future development.

Background

Over 25% of the world's petroleum reserves are believed to be in arctic regions and other offshore, ice frequented environments. As world energy demand increases, development of oil and gas resources in harsh ice environments is being increasingly considered by industry. The advancement of safe, cost-effective and reliable engineering solutions for subsea infrastructure in ice environments is a key requirement for sanctioning stand alone and marginal field developments. Subsea infrastructure requiring protection from ice keel contact includes components such as wellheads, production trees, manifolds, umbilicals, flowlines and pipelines.

This paper describes an ongoing joint industry project that was initiated to address uncertainties and develop approaches to mitigate the risks associated with oil and gas development in ice-prone regions. The project comprises two components that address differences in approach for issues related to pipelines in Arctic regions, and subsea production facilities in sub-Arctic regions. It is funded by a combination of the Atlantic Canada Opportunities Agency through its Atlantic Innovation Fund and a number of large oil and gas operators. Project collaborators include private companies, government agencies and academic organizations.