



OTC 18981

Offshore LNG Storage in Concrete Gravity Caissons: Project Development and Procurement

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This paper was prepared for presentation at the 2007 Offshore Technology Conference held in Houston, Texas, U.S.A., 30 April–3 May 2007.

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Abstract

Numerous offshore LNG projects have been proposed over recent years and many have included concrete gravity based caisson solutions to meet functional requirements such as breakwater protection, secondary containment structures for LNG storage and topside liquefaction or regasification facilities support. Those functional requirements are examined and caisson arrangements and solutions that meet all, or only some of the requirements, are reviewed as are the LNG storage technologies appropriate to offshore gravity based LNG storage. It is shown that project developers can elect to reduce the caisson functional requirements with a corresponding reduction in material quantities but also simplify project execution plan by separating disparate construction demands. It is concluded that the simplest caisson and storage arrangement in terms of construction cost and execution is the cylindrical form of substructure and tankage. Such an arrangement can be implemented using existing contracting partnerships and allows topside fabrication to be undertaken at specialist offshore fabrication facilities.

Introduction

The last five years has seen a number of offshore concrete liquefied natural gas (LNG) import terminals proposed for development yet only one has moved to construction in the current round of projects expected to be completed by 2010. No doubt the delay is in a large part due to the relative scarcity of LNG in the Atlantic Basin in particular and less than expected increases in the price of natural gas in North America. Significantly, US onshore developments have been shown to be easier to site and permit and less costly than their offshore alternatives. This, perhaps, should not be that surprising given the relatively undeveloped Gulf of Mexico coastline and the difficulties that arose during offshore

permitting. The next round of LNG terminals could well be more difficult to site so the focus could shift back offshore. In that event the offshore LNG industry needs to be clearer on its approach to the development of offshore LNG projects to make them cost and schedule effective.

Concrete caissons have long been associated with offshore LNG projects.

The LNG development phase in the 1970's included at least one scheme for a short piled surface piercing caisson supporting a cylindrical LNG storage tank. The most recent offshore LNG development work has included cylindrical and rectangular caissons with one of four different storage technologies. The design requirements for offshore caissons have ranged from a minimalist storage requirement to the requirement for both topside facilities support and breakwater action. With such differing design demands, the solution must and should be quite different and perhaps the concept development and procurement approach should also differ.

This paper will review a wide range of possible concrete gravity substructure solutions for a number of project criteria. The paper will quantitatively describe best practice solutions for LNG storage using 9% Nickel, membrane, prismatic and concrete storage. Ranges of application for each scheme will be prepared as will outline execution plans and cost estimates.

Project Drivers for Gravity Caisson Schemes

Offshore LNG projects are being considered for a number of reasons such as proximity to gas supplies, isolation from third parties for security related reasons, for ease of permitting, proximity to shipping channels, remoteness from population centers and to avoid high civil and marine construction related costs at onshore sites.

Project drivers for gravity based caisson type solutions include:

- Siting in relatively shallow water close to the coast, minimum 15m and maximum 30m water depth
- Large storage volumes
- Possible requirement for a large and stable deck area for layout of facilities
- Possible caisson length and orientation criteria to provide an appropriate degree of berth protection to ensure high berth availability