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HYDRODYNAMIC ISSUES OF FLNG SYSTEMS

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ABSTRACT

Advanced hydrodynamic analyses of floating LNG terminals are presented in the paper. They consist of the complex interaction of multiple bodies and the coupling effect of seakeeping (wave diffraction and radiation around bodies) and sloshing (liquid motions in tanks). Based on the recent development to introduce the dissipation in potential flows and new formulations of boundary element method, the seakeeping analysis is enhanced to be able to make accurate predictions of gap resonances and major dynamic effect of liquid motion in tanks.

INTRODUCTION

Nowadays, the offshore LNG terminals have become a reality, and the initial feasibility studies evolved to the actual project achievements. Two kinds of LNG terminals exist. On one hand, FLNG (Floating Liquefied Natural Gas) or LNG-FPSO are at the beginning of the LNG chain as production units. On the other hand, FSRU (Floating Storage and Regasification Unit) or LNGRV (Liquefied Natural Gas Regasification Vessel) are at the end of the LNG chain as they vaporize the LNG into the gas network for the end user.

Among the issues to be addressed for the development of such LNG terminals, the following three focus operations must be examined and result in a series of advanced studies in Bureau Veritas. One is the liquefaction process with regards to limited deck space and floating unit motions and accelerations (only for FLNG and not for FSRU). One other is the containment system with regards to offshore conditions for continuous operation. And third one concerns LNG offloading from the FLNG to LNGC or from LNGC to FSRU.

Regarding the containment system, one of major issues to be addressed is the operation at all filling levels on the contrary to standard LNGC which can navigate only at low (below 10% of the height) and high filling levels (above 70% of the height) and not at partial fillings (between 10% and 70% of the height). Using BV experience with LNGRV that can operate at all filling levels for some given locations, BV has issued new guidelines ([NI554], [NI564]) for sloshing assessment for LNG terminals in May 2011. First, ([NI554]) describes the seakeeping analysis, CFD calculations and sloshing model tests which allow to determine the design sloshing loads to be applied on the cargo containment system, the inner hull structure and the pump mast (and its supporting structure). Second, ([NI564]) describes the two levels of strength assessment (a rule-based approach and a more refined approach using non-linear and dynamic finite element analyses) for the cargo containment system, the inner hull structure and the pump mast (and its supporting structure) under the design sloshing loads determined in ([NI554]).

The LNG offloading operability and reliability from the FLNG to the LNGC (or from the LNGC to the FSRU) is one