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Design, Construction and Operation of LNG/LPG Vessels

International Conference

Design, Construction and Operation of LNG/LPG Vessels

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09.30-09.25 COFFEE AND REGISTRATION

09.25-09.30 WELCOME ADDRESS

09.30-10.05 SHIP DESIGN REVISITED – A MODERN APPROACH FOR A MODERN ERA, *D. Scott, C. Tuzcu, Q. Gao, C. Pilia, P. McMullen and G. Mermiris, Tritec Marine Ltd, UK*

It could be argued that cargo ship design has matured substantially over the past three decades. This could be attributed to continuous development of underlying rules and regulations, concerted industry efforts to reduce accidents and improve safety, and focused R&D activities on the most complex phenomena and processes that govern the operation of ocean going vessels. A new ship may be designed to comply with all rules and regulations but its performance from a financial point of view is meaningful only during a fraction of its operational life. So, what makes a design successful these days? Can the compliance to safety and environmental rules, and the deadweight and speed requirements guarantee sustained financial success? Perhaps it is time to challenge the overall approach as to what constitutes a good design in a top-down manner, rather than continue to focus on piecemeal bottom-up technological solutions. In response to these arguments, the way to translate a concise set of design requirements into tangible engineering solutions that will permeate and define all phases of the life-cycle of a commercial cargo ship will be presented, followed by a concept design of a 38,000 m^3 LNG carrier.

10.05-10.40 NEW GENERATION OF MULTIPURPOSE GAS CARRIERS, *Carlos Guerrero, Bureau Veritas, France*

Ethylene and Ethane has been usually transported in relatively small ships below 20,000 m^3 with semi-refrigerated type C tanks. However, new technical developments and the evolution of the regulations are now making possible the utilization of larger ships with innovative containment systems such as bi-lobular type C, independent prismatic and membrane. Exports of ethane from the USA shale gas industry to North Europe and potentially to South America and other places in the Far East are expected to increase significantly. In addition ethane is considered as an environmental friendly solution also for power generation as NOx, SOx and particulate matters are reduced significantly to similar levels than using methane as fuel. Thus ethane transportation is expected to grow and the use of ethane as fuel not only in power generation on shore but also as a clean transportation fuel for ships. Classification societies are involved in the approval of cargo containment systems used for large scale transportation of liquefied ethane. They also assess main engines technologies such as dual fuel engines able to burn new fuels like ethane on board of ships. Some innovative designs of multipurpose gas carriers have been also developed following the evolution of the liquefied gas industry. These LNG/LEG/LPG carriers are multi product ships and specific issues will have to be considered in the approval. This paper presents a number of such innovative solutions for the containment of any kind of liquefied gas on board of multipurpose gas carriers and some specific case studies in relation with containment systems and marine ethane fuel engines.

10.40-11.10 COFFEE

11.10-11.45 LNG BUNKERING SHIPS, *Carlos Guerrero, Bureau Veritas, France*

LNG as a marine fuel has taken a position as one of the more interesting solutions to comply with stringent environmental regulations for ships. Global sulfur cap will drive shipowners to consider clean fuels instead of cleaning systems eventually for bigger ships involved in world trade. Bureau Veritas was originally involved in the approval of ships specifically designed for LNG bunkering back in 2011 and has now become a leader in the certification of this type of ships. Some of these first LNG bunkering ships have recently entered into service. Specific issues have to be considered during the assessment of LNG bunker ships. Among others, the transfer system and the issues in relation with the boil off gas management are the most important. In addition, the ship to ship operations between a small scale LNG carrier and the gas fuelled ship may involve additional risks. Recovery of the boil off gas generated during the transfer process and supply of inert gas to the lines seems to be, if not essential, at least recommended. Other interesting services to be performed by the bunkering ship are gas freeing operations and recovery of LNG from the gas fuelled ship in case of emergency. Bureau Veritas developed in 2015 specific regulations for the assessment of LNG bunker ships. The regulation NR.620 covers safety issues and is the instrument to grant the service notation LNG bunkering ship.

11.45-12.20 SOME CHARACTERISTICS AND FEATURES OF PURPOSE DESIGNED LNG BUNKERING VESSELS, *Woo-Jeong Choi, Lloyd's Register Asia, Jose Navarro and Rob Tustin Lloyd's Register EMEA, UK*

Utilization of gas as a fuel, stored in liquefied natural gas (LNG) state, for commercial shipping has emerged as an alternative to liquid heavy fuel oil (HFO) bunkers with implementation of stricter regulation of air pollutants such as nitrogen oxide and sulphur dioxide. For ocean going ships where operational endurance, and range, requires large capacity bunker fuel tanks the adoption of gas a fuel has established a need for a new type of dedicated LNG bunkering vessel: a combination of a small scale LNG carrier with specialist LNG systems for handling the ship to ship bunkering of LNG. In 2017 three early examples of purpose designed, and built, LNG bunkering vessels have been put into service to support LNG bunkering operations in European Ports. Comparing LNG bunkering vessels in service and under construction, and also drawing on Lloyd's Register knowledge from involvement in two of these early project examples, the paper will offer an overview of characteristics and features of these purpose designed vessels and outline some considerations for specification, design and operation of a dedicated LNG bunkering vessel including (1) Options for cargo tank and propulsion system specification (2) Provision and arrangement of bunkering operation hardware such as transfer arms and mooring fenders (3) Consideration of operations, including Boil Off Gas (BOG) management, cargo handling and emergency shutdown procedures during LNG bunkering operations.

12.20-13.20 LUNCH

13.20-13.55 TRANSHIPMENT, DISTRIBUTION AND UTILISATION OF LNG, *Keith Hutchinson and David Dobson, Babcock International, UK*

The continued growth in the application of natural gas for electrical power generation, industrial and domestic consumption combined with its increasing transhipment in its cooled transitory form of Liquefied Natural Gas (LNG) , primarily via sea, is generating a significant and rising demand for small LNG Carriers (LNGC) small-scale floating LNG reception, storage, regasification and generating facilities. Small-scale floating LNG assets can inherently provide a supply of natural gas to locations where larger floating assets or traditional (fixed) land-based infrastructures are either uneconomic, prohibited by geographical or geological issues, or where demand is only temporary or seasonal. Additionally, the speed with which small-scale LNG assets can be brought into commercial operation favours applications where there is a short mobilisation / execution schedule. Locations particularly suitable for small-scale floating LNG include the small emerging markets of island and coastal states, communities / facilities not connected to an existing 'national grid' of gas pipelines and also isolated industrial or power-generating plants (for instance, gas-fuelled power stations). Hence, small-scale LNG is a particularly cost-effective vehicle for providing natural gas to market and facilitates solutions that are low-risk, flexible and inherently able to readily adapt to changing market conditions. Design and technology selection aspects for small-scale floating LNG supply and utilisation chain options will be covered, include types and configuration of LNGCs, GSVs (Gas Supply Vessels), FSRUs, etc. including the many often conflicting and diverse design and operational criteria which must be addressed coherently within the design process in order to generate robust and safe solutions for floating assets and ships. The paper shall also address the possible areas of operation / deployment for small-scale floating LNG assets, including the future of LNG as a fuel, both in the marine sector and on land, together it's processing and distribution.

13.55-14.30 INNOVATIVE TANK FOR SMALL SCALE LNG BUNKER VESSELS, COASTAL VESSELS, FUEL TANKS AND CONVERSIONS, *Thomas Lamb, University of Michigan,Regu Ramoo, ALTAIR Engineering, Inc., USA, B W Eng, Altair Taiwan, Inc. and S Egambaram, M N Nadzri, Altair Malaysia Sdn. Bhd.*

Small Scale LNG has become inclusive of all aspects of LNG storage and transport in recent years. The increasing use of LNG as a ship propulsion fuel requires small LNG vessels to bunker the LNG fueled ships. Many ship owners are getting into the LNG bunker vessel market. To date they have all used cylindrical or bi-lobe tanks. Designs have also been prepared using a 2bar variant of the membrane system and a recent order using the Korean KC-1 membrane system. One of the authors converted offshore supply vessel into crab fishing vessels for the Alaskan Crab industry. He agrees that cost effective LNG bunker vessels could be quickly obtained by converting OSVs based on the cost and design simplicity of the conversion. The paper presents an approach to satisfying the complete logistical needs, excluding from gas field to initial storage which would be the same for all options, utilizing the CDTS and semi-CDTS for storage on land, on barge and in the LNG Bunker Vessels. The paper will describe how a new tank design provides a superior alternative to the cylinder and bi-lobe design, and shows its flexibility to fit new and converted bunker and small coastal vessels as well as fuel tanks in all types of ships even up to cruise ships. A description of the development of the new tanks including its structural analysis will be presented.

14.30-15.00 COFFEE

15.00-15.35 LNG POWERED DRY BULK CARRIER?, *A Trakakis, Arista Shipping, Greece and D Antonopoulos, Marine Solutions, Greece*

LNG is one of the potential alternative fuel solutions to meet the specified IMO fuel sulfur content limits since it does not contain any sulfur. Furthermore, gas and DF engines utilizing the Otto combustion process can produce NOx emissions below the IMO Tier III limits. On a calorific value basis, LNG prices are lower than traditional marine fuel prices. However, there are still challenges for the application of LNG as a fuel, notably fuel containment, fuel preparation systems, additional CAPEX and the LNG bunkering infrastructure. This paper discusses the challenges involved and how these were met, when considering LNG as fuel in an ocean-going dry bulk carrier and focuses on the main engine technologies and machinery space arrangement. The study was conducted by Arista Shipping, the American Bureau of Shipping (ABS) and Wärtsilä, based on a representative bulk carrier design, an 82,000 dwt Kamsarmax vessel. The study concentrated on the selection criteria and available technologies for the main engine and the respective machinery space arrangements, whilst taking into account the applicable Classification requirements, relevant statutory safety regulations (IGF code) and the shipowners operational requirements. The selected propulsion arrangement included advanced W31 two-stage turbocharged 4-stroke medium speed DF engines from Wärtsilä driving a CPP through a reduction gearbox.

15.35-16.10 GTT MARS NEW TECHNOLOGY FOR LPG CONTAINMENT SYSTEM, *Mélodie Noris, GTT, France*

GTT is a leading engineering company in containment systems for the shipping and storage in cryogenic conditions of LNG, ethane and recently, LPG. Currently, Type A technology, a prismatic steel tank, with a full secondary barrier, is used in 100% of the fleet of Very large Gas Carriers (VLGC). The objective of GTT is to design a dedicated technology tailored to the LPG market for gas carriers, which adds more value to the transportation of LPG than the Type A technology. GTT's MARS LPG technology is a light and compact solution, which enables the design of a more efficient vessel with reduced dimensions, lower fuel consumption, or the optimization of the cargo capacity. This extra cargo could be either monetized: +26% of revenue in the current low freight rate environment (based on a $30/t Baltic Index) for a voyage from Arabian Gulf to India, with two discharges in the East and West coast ; or used for the propulsion of the ship for instance. This will afford more flexibility to switch to LPG when needed, and comply with the new environmental regulation on fuel emissions imposed by the IMO. Besides, the flexibility is increased by the reduction of cooling down time to only 3 hours, which prevents from keeping a heel that can also be monetized. Then, GTT MARS does not suffer any thermal shock. Finally, full scale tests demonstrate the high resistance of the membrane in the event of a collision at sea.

16.10- GENERAL DISCUSSION

09.00-09.30 COFFEE AND REGISTRATION

09.30-10.05 THE USE OF WASTE HEAT RECOVERY TO IMPROVE THE EFFICIENCY OF DUAL FUEL DIESEL ELECTRIC LNG CARRIERS, *Effiong Ekanem Attah, Nigeria LNG Limited, Nigeria and Richard Bucknall, University College London, UK*
The Dual Fuel Diesel Electric (DFDE) Technology has become the dominant propulsion of choice for modern Liquefied Natural Gas (LNG) Tankers, gradually replacing the previous choice- Steam Turbine Propulsion in current and future designs. This change is due to the higher thermal efficiency of the DFDE technology resulting in financial savings in operating expenditure of the vessel (OPEX) over the vessel life cycle when compared to the steam turbine propulsion system. However, Greenhouse Gas Emissions (GHG) reduction regulations such as the Energy Efficiency Design Index (EEDI) on CO_2 reduction and new competing LNG propulsion technologies such as gas injection slow-speed two-stroke engines have highlighted the need to seek improvements to the current DFDE Technologies. This need has led to the development of the waste heat recovery system (WHRS) as an option to improve the efficiency of LNG DFDE vessels. This paper presents a WHRS as a method of improving the efficiency of DFDE LNG carriers. This paper will cover three major aspects: 1) The WHRS designed concept to be employed, 2) Trial Run of the WHRS in actual sea going operations. 3) Discussion of results and implications for future designs.

10.05-10.40 DRIVING RELIABILITY, EFFICIENCY AND SAFETY ON LNG/LPG VESSELS THROUGH AUTOMATION, *B O Berntsen and K Høglund, Høglund Marine Automation AS, Norway*
As the popularity of LNG as a marine fuel grows, the LNG carrier segment continues to expand, while a new generation of vessels is emerging to meet the growing demand for LNG bunkering services. Høglund is pioneering the automation of these vessels, and has fitted 15 LNG-powered ships with its automation solutions, which represent 12% of the global LNG-powered fleet. While automation system interfaces and design have evolved to fit big scale LNG carriers over the last four decades, medium and small-scale LNG carriers/bunker vessels is a new market, which is still not optimized. This opens up the opportunity for new ideas and fresh thinking to ensure success in the automation of these new vessel types. But as always with new technologies, reliability, efficiency, and safety must be prioritized to make sure systems are working as intended, while still reducing CAPEX and OPEX.

10.40-11.10 COFFEE

11.10-11.45 LPGREEN: LPG CARRIER OF TOMORROW CONCEPT DESIGN, *George G. Dimopoulos, DNVGL, Greece*
LPGreen was a joint development project between Greek shipowner Consolidated Marine Management, South Korean shipyard Hyundai Heavy Industries), Finnish cargo handling specialists Wartsila Oil & Gas and classification society DNV GL. The project aimed to develop a more energy efficient, environmentally friendly, and safer LPG carrier. In the project, the latest advances in ship design, machinery technology, cargo handling systems and operational experience, within the bounds of existing shipbuilding methods, were utilised with a clear target: to arrive at an LPG carrier concept that can be ordered and been built immediately. The resulting concept achieves improved performance on several fronts. Compared to the reference vessel, there is an improvement of 6–9% in energy efficiency, depending on machinery configuration and fuel used. Loading duration has been decreased by 30%, by the proposed cargo handling system resulting also in a 5% reduction in energy demand. Most importantly, LPGreen has demonstrated the technical feasibility of a LPG fuelled propulsion concept, which, depending on fuel prices and the development of a commercial framework, could result in a cut of up to 30% in fuel expenses. To realise these gains, advanced computer tools were used. Hydrodynamic CFD hull form optimisation both in calm water and waves was conducted, while the overall concept integrated machinery system evaluation and optimisation was conducted using DNV GL's COSSMOS modelling framework. The LPGreen concept demonstrates that the close collaboration of industry leaders coupled with advanced analysis methodologies and computer tools can lead to efficiency improvements and innovation in practice.

11.45-12.20 JETTYLESS SHIP TO SHORE TRANSFER AND BUNKERING OF LNG, *Jonathan Strachan, Houlder Ltd, UK.*
The demand for LNG to be used to power small scale clean burn onshore power stations is developing in a number of regions throughout the world. The extensive infrastructure required for a traditional LNG receiving jetty, combined with mooring dolphins is likely to have a significant environmental impact coupled with high capital expenditure. In response, Houlder has collaborated with floating hose supplier Trelleborg to support small to mid-scale LNG operations where fixed jetties are impracticable, too costly or environmentally damaging. The Floating Transfer Terminal is based on a compact floating barge that connects to the LNG carrier by means of Houlder & KLAW LNG's transfer system and to the shore by Trelleborg's Cryoline cryogenic floating hoses. The paper presents the design of the FTT and its components, considerations for the mooring of a typical LNG carrier and the FTT, along with the results of a seakeeping study.

12.20-13.20 LUNCH

13.20-13.55 SLOSHING AND SWIRLING IN MEMBRANE LNG TANKS AND THEIR COUPLING EFFECTS WITH SHIP MOTION, *Makoto Arai and Gustavo Massaki Karuka, Yokohama National University, Japan and Hideyuki Ando, Monohakobi Technology Institute, Japan*
Experimental and numerical studies of sloshing in membrane tanks of LNG carriers were carried out. By using partially filled membrane tank models, a series of model experiment was carried out with a motion bed facility. Pressure and total hydrodynamic forces to the tank were measured under regular and irregular excitation. A 3D finite-difference method was used for the numerical simulation of the liquid in the tank and the results were compared with measured ones. In the prismatic shaped membrane tanks with partially filled condition, a violent two-dimensional sloshing in the transverse direction of the tanks can occur when the tanks are excited at near resonance frequencies. However, in the case if the tank-length-to-tank-breadth ratio is closer to unity, rotational motion of the free surface in the tank, i.e., swirling, is easily generated. In this study, the finite-difference sloshing simulation explained above was coupled with ship motion simulation in the time-domain to take into account the ship-tank coupling effect. The numerical results were compared with the data obtained by a model experiment in a model basin to further confirm the above mentioned sloshing and swirling phenomena in the actual waves. The conditions that induce the swirling in the prismatic membrane tanks were studied and the tank-length-to-tank-breadth ratio which causes the swirling motion was identified.

13.55-14.30 THE PRACTICAL IMPACT OF THE 2016 IGC CODE MODIFICATIONS ON A VLGC HULL DESIGN, *Lucian Viorel Anghel, Ionel Hristache and Marcel Negraia, Icepronav Engineering SRL, Romania*
This paper describes a programme of work to quantify signature performance during the design process and develop new tools to support decision making. This new capability enables flow generated noise performance to be progressively assured against requirements and the performance to be balanced against programme, cost and risk considerations. A range of tools and techniques are now available, which are applicable across the design process. This comprises scoping calculations for application during concept design where the quality and availability of information is low and there is a need to rapidly explore the design space. During the preliminary or FEED stage, more sophisticated techniques are employed to make use of the greater quality of information. At this stage analytical methods are fused with empirical relationships to provide a hybrid approach which is sensitive to design changes, but still rapid enough to enable design exploration and sensitivity studies. During detailed design, high fidelity numerical methods are used to capture design details and produce high resolution predictions. New flow noise mitigation strategies are also discussed, including avoidance of cavitation and the application of silencing devices for fluid systems.

14.30-15.05 CONVERSION TO LNG BUNKER VESSEL, *Aniruddha Sen, NTSPL, India*
The objective of the paper is to present cost-efficient alternatives for converting existing OSV/PSVs to LNG Bunker Vessels. Considering the present and immediate future of oil economy being weak and inconsistent, OSV/PSV fleet owners need to exercise their discretion is choosing between "keeping the fleet locked at port" or "exploring alternate means to utilize the capability of the vessels by converting them into LNG Bunker vessels". Case studies and examples of how this can be achieved will be presented alongwith relevant data to support the conversions.

15.05- GENERAL DISCUSSION

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