

14th Offshore Symposium – LNG: From Source to Market November 10th, 2004

Author's Reception

On November 9th the Texas Section hosted a reception for the authors and presenters at the 14th Offshore Symposium. The presenters, session co-chairs and SNAME Texas executives enjoyed a pleasant evening at the Houston Maritime Museum. Regional Vice-President, Peter Noble, presented a model of the Polar Endeavour to museum director, Jim Manzolillo. The Polar Endeavour class of vessels is state-of-the-art crude-oil carriers for the Alaskan waters. The model should fit in nicely along the numerous models and naval artifacts on display at the museum.

Opening Session

The next day more than 170 attendees showed up at the Westchase Marriott for the 14th Offshore Symposium. This year's topic was Liquefied Natural Gas, or LNG. Presenters came from far away to educate the attendees about the marine aspects of this increasingly important sector of our industry. After enjoying coffee and breakfast, Texas Section Vice-Chair, Lars Ronning of ConocoPhillips Marine, welcomed the attendees and introduced the first speaker, Capt. Jonathan Cook from Excelerate Energy. Capt. Cook gave an overview of the global LNG market and explained why imports of LNG are necessary to keep up with the domestic energy demands. The second half of his presentation was dedicated to a discussion of Excelerate Energy's EnergyBridge LNG import terminal. This LNG import solution uses modified LNG carriers equipped with equipment to regassify the LNG directly into a Submerged Turret Loading buoy, from where it is piped into the gas grid for further distribution.

The second presenter was introduced by session co-chair and SNAME member, Dr. Johan Wichers from Marin USA. Bill Glenn, Jr. (SNAME member) from Royston, Rayzor, Vickery & Williams discussed the differences between traditional ocean-going transportation and LNG transportation. Mr. Glenn started with an outline of who holds authority over which parts of the ocean. He then touched on the Deepwater Ports Act and its implications for offshore LNG re-gas facilities. Mr. Glenn also discussed the roles of flag states and port states in LNG shipping and concluded his presentation with a discussion on security concerns regarding LNG shipping, particularly in light of the ISPS code and the Marine Transportation Security Act of 2002.

Session A - Ship Design and Operation

There were four excellent presentations in this session.

The first one was "Next Generation LNG Containment System and LNG Carrier Designs" by Kjell Faafeng, who is a senior manager and partner in Inocean, a naval design company in Oslo, Norway. This presentation addressed the novel LNG containment system developed by Ocean LNG Inc. The tank system utilizes cylindrical

tanks with shaped ends and is designed according to IMO IGC Independent Tank Type B. It is unique in the way it maximizes the void spaces in the ship's hull with full access around the tank for inspections from the outside of both insulation and tank structures. Compared to the well-known spherical LNG tank containment system, the Ocean LNG tank system can carry about 25 percent more cargo

The second presentation was entitled "The Terrorist Threat to LNG" presented by Anthony Bingham, who is the global LNG business manager for the Lloyd's Register Group based in Houston. This presentation highlighted the perceived terrorist threat to LNG, particularly to LNG carriers, and discussed how the LNG industry has received such a bad reputation in the public arena. First, Mr. Bingham outlined the excellent safety record of the LNG industry. He went on to debunk several common misperceptions about the dangers of LNG and examined the attack on the M/V Limburg in light of some of these misperceptions.

The third presentation was entitled "Global and Local Loads in Design of LNG Ships" by Rong Zhao, who is a senior principal researcher at Marintek. This presentation discussed one of the key issues for the design of membrane-type Liquid Natural Gas (LNG) ships, which is to predict sloshing induced local loads for insulation systems, especially when a design concept or type of operation deviates significantly from present experience. Examples are a large increase in ship size or operation in unrestricted partially filled conditions, which have not been previously envisaged. Mr Zhao described the extensive experimental and theoretical studies that have been carried out by MARINTEK and Lloyd's Register to investigate sloshing impact loads inside prismatic membrane tanks.

"Sloshing Impact Load and Strength of Membrane-type LNG Containment System in Large LNG Carriers" was the title of the last presentation by Yung Shin and Hoseong Lee. Yung Shin is a technical advisor in Research and Product Development at the American Bureau of Shipping in Houston, and Hoseong Lee is a staff consultant with ABS Technology. Dr. Shin and Dr. Lee described a numerical and experimental scheme to evaluate full-scale sloshing loads and impact strength of the containment system. The scheme consists of seakeeping and sloshing analyses to identify the critical wave conditions for the sloshing model test to measure the sloshing impact loads on rigid tank walls, evaluation of full-scale impact loads by the 'composite' scale law and a hydro-viscoelastic-fracture analysis of the containment system with consideration of fluid-structure interaction during the vibratory motion of the containment system. The newly introduced composite scale law revealed that the existing ad-hoc scale law is still applicable to the existing operational condition at high filling level but not applicable to the partial filling conditions. Fluid-structure interaction between LNG and containment system is considered during the dynamic structural analysis of containment system with the LNG modeled as an acoustic media.

Bill Kinney (SNAME member) and Harry Ren (Section Arrangements Chair) from Diamond Offshore co-chaired this session.

Session B – Terminal Design and Operation

The participants who attended Session B were treated to four excellent presentations on Liquefied Natural Gas (LNG) Terminal Design and Operation. Audience participation was quite high as the presentations elicited a number of interesting and thoughtful questions.

Dajiu Jiang, a Principal Engineer with Aker Kvaerner in Houston, began the session with a presentation on concrete gravity-based offshore LNG terminals. To set the stage for his presentation, Mr. Jiang discussed the projection for market demands for LNG in the world's two largest energy-importing countries, the United States and China. Industry forecasts show that up to 20 offshore LNG terminals could be built in US waters within the next ten years. Seven LNG terminals are planned for Chinese waters by 2010. Mr. Jiang then continued his presentation with a discussion of the design of a concrete gravity-based structure (GBS). He presented information on GBS installation, materials and workmanship, numerous design aspects, and applicable design codes and classification requirements.

Max Krekel (SNAME member), a Senior Naval Architect with Bluewater Offshore Production Systems (USA) in Houston, continued the session with his presentation on a shallow water single point mooring (SPM) system for ship-to-shore LNG transfer. Mr. Krekel discussed several options for offshore LNG terminal layouts, most of which have evolved from onshore terminals. In particular, he described the advantages of weathervaning moorings and transfer systems for LNG carriers. Mr. Krekel presented information on the design and model testing of the "Big Sweep" concept, a system consisting of a monopod structure with a swivel deck, a rigid truss arm with mooring outrigger and end buoyancy element, and an LNG transfer system. This terminal is designed to handle "cargos of opportunity." Model tests showed concept feasibility, including operability and hurricane survival.

Raymond Fales (SNAME member), Vice-President of Technology with ABB Floating Production Systems in Houston, then presented his paper on an innovative floating LNG vessel. In deepwater remote offshore oil fields, it is uneconomical to get the associated gas to market because of the lack of infrastructure and the high entry-level production rates for onshore LNG facilities. Mr. Fales discussed the design and application of a floating LNG facility that can be moored next to a deepwater oil production facility. Produced gas transferred from the primary oil production vessel to an LNG FPSO is converted to LNG through the patented NicheLNG process, a system which uses no intermediate cooling liquids and has a very low equipment count. Mr. Fales presented a number of different field development concepts based on the deployment LNG, LPG and LNG/LPG FPSOs. These FPSOs can be designed to work with any number of "standard" offshore terminals. In addition, they can be serially redeployed.

Jaap de Wilde, a Senior Project Manager with MARIN in Wageningen, The Netherlands, presented the final paper of the session. He discussed the recent development and applicability of several numerical simulation tools for evaluating the hydrodynamic performance of offshore LNG production, offloading, and import concepts. Mr. de Wilde

presented a number of videos from model test programs that showed the complex motions between adjacent offshore structures, such as those that would comprise a terminal (fixed or floating) and a shuttle tanker. He discussed the development of numerical models for offloading operations for several configurations: stern-to-bow, side-by-side vessels, tanker-to-GBS, and tanker-to-jetty. As an added bonus, Mr. de Wilde discussed recent model tests and numerical simulations of tug boat operations and performance, including both pushing tugs and towing tugs, for maneuvering large tankers.

Barbara Stone (Section Paper Chair) of Sea Engineering and Bob Randall (SNAME member) of Texas A&M University co-chaired this very interesting session.

Lunch

Regional Vice-President of SNAME, Peter Noble, gave a brief report of SNAME activities, including the SMTC&E/SPS, which will be held in Houston in 2005. Mr. Noble solicited help in organizing and executing this event. Those interested could contact him or Section Chair, Henry Reeve, for more information.

Mr. Reeve then introduced the luncheon speaker, James MacHardy, who is the General Manager of the Society of International Gas Tanker and Terminal Operators (SIGTTO). Capt. MacHardy discussed the increase in the LNG tanker fleet and the associated requirement for crews for these vessels. MacHardy highlighted the impending shortage of trained people to crew these specialized ships. SIGTTO has joined forces with the International Association of Maritime Universities and the Nautical Institute in addressing this shortfall through training. Despite these efforts, Capt. MacHardy admitted that there might not be enough qualified crews by the time many of the new vessels are delivered. In his presentation he also highlighted the problem the LNG industry faces with public perception of the risks involved and NIMBY (Not In My BackYard) attitudes among residents in areas of proposed LNG import terminals. He concluded that the industry must do a better job on communicating the excellent safety record of the LNG industry to the public.

Session C – Ship Powering

All the papers in this session were prepared and presented by international authors from the UK, Finland, Denmark and Norway. The session was well attended and with excellently prepared and presented papers and lively audience participation during the discussion periods

Traditionally LNG ships have been steam powered, but much development work is underway and many of the new generation of larger LNG ships are being designed with different propulsion plant.

Ole Greone from Denmark presented a paper entitled “LNG C S S D P” in which he discussed a variety of slow speed applications including traditional heavy fuel engines

and also developments for gas fueled engines. Roger Tooke from the UK authored a paper “ENOMICAL RELIABLE – GAS TURBINE POWER FOR LNG CARRIERS” which described the use of gas fuelled gas-turbine electric solutions for LNG carriers. Innovative arrangements were described where the main turbines were placed on the main deck aft and this may allow for more cargo capacity since less of the hull is required for engine room space.

A paper entitled “GAZ DE FRANCE E – T FIRST LNG CARRIER OF A NEW GENERATION” was presented by Barend Thijessen from Finland. This paper described a new LNG ship being built in France which has a propulsion system based on dual fuel medium speed diesel engines with electric transmission. This ship will be delivered soon and another larger ship with the same system is already under construction.

The session was rounded out with a paper by Hans Anders Smogeli from Norway. This paper was titled “VIBRATION E FROM SLOW SPEED LARGE BORE DIESEL ENGINES IN LNG CARRIERS, CONSEQUENCES FOR CONTAINMENT SYSTEMS”. This paper covered the important analysis of engine induced structural vibration on both Moss spherical and GTT membrane type LNG containment systems and reached the conclusion that there is little chance of major problems with the use of slow speed diesels in well designed ships.

The LNG Ship Powering Session was co-chaired by Paul Griffin (Section Executive Committee) of ChevronTexaco and Peter Noble (SNAME Fellow) of ConocoPhillips Marine.

Session D – Risk, Safety and Security

Four papers were presented in this session.

The first paper was “Operational Framework and Safety Studies for LNG Operations”, presented by Johan de Jong of MARIN. This paper described operational and safety assessment methodologies used to evaluate ship operations in port situations. The presenter gave an overview of the project and briefly discussed the maneuvering simulation techniques used in the project. The author then presented a case study for a proposed LNG terminal, explaining the application of fast-time and real-time simulations, the Quantitative Risk Assessment approach developed for the project, and findings of the study. The audience raised several questions regarding applications to the offshore industry.

The second paper was entitled “Enabling Technologies for Mooring, Unloading, Regasification and Storage for Offshore LNG Receiving Terminals”, by James Davis, P.E. of Paragon Engineering Services. The author presented an overview of offshore loading systems and identified enabling technologies in the areas of mooring, transfer, vaporization and storage that are needed to make offshore unloading of LNG carriers technically and economically feasible. The author then reviewed currently available

systems and providers and offered indicative costs for various types of systems. The audience contributed a number of questions to this presentation.

The third paper was entitled “Practical Design Considerations and Risk Assessment Methods for LNG Systems”, by Libang Zhang (SNAME member) of ABB Lummus Global. The author discussed various methods used for risk assessment of LNG handling, and gave examples of Fault Tree Analysis (FTA) method and Event Tree Analysis (ETA) commonly used in the industry. The author presented several historical examples of LPG and LNG carrier incidents and explained the consequences and solutions taken to mitigate the incidents. The author then answered a number of questions from the audience.

The final paper in the session was “Response of an Offshore Platform Leg to Terrorist Attack”, presented by Jim Wesevich of Baker Engineering and Risk Consultants. The author gave an overview of several notable ship blast-loading cases and presented a numerical analysis methodology developed to predict the structural response of various offshore structures under explosive forces. The author concluded that the use of FEA methods and blast loading codes can be used to determine accurately the sensitivity of ship and platform structures to various explosive charge sizes and stand off distances, and then to develop required security measures or design sufficient redundancy into the structures.

Following the last paper, the audience raised several questions regarding the behavior of LNG. Mr. Davis then presented a brief summary of the known characteristics and myths of LNG. The session was co-chaired by Michael Praught (SNAME member) of MODEC International and Donald Burris (Section Secretary/Treasurer) of Atlantia Offshore.

Closing Session

The final session of the day saw all of the conference attendees reunited for a general session featuring two papers of broad impact.

The first paper, by Melissa Hertel (Jensen Maritime Consultants) and Kevin Kinports (Seven Seas Consulting) described the use of a time domain simulation program to model the entire LNG supply chain from storage at loading port, to loading rate, to ship, to offloading, to storage, to re-gasification. The simulation program allows the user to determine where the bottlenecks in the supply chain are, and how they may best be avoided, while meeting delivery targets. The program is able to account for external factors such as vessel maintenance and weather delays.

The final paper of the day was presented by Bill Sember, Vice President of Energy Development at ABS. His paper discussed in broad terms how the challenges to industry presented by the sudden, rapid growth of the LNG sector are being addressed by industry as a whole, and ABS in particular. On the technology side, Mr. Sember displayed the results of some of the research work that has been done by ABS to address the issue of sloshing in partially loaded tanks. On the operations side, he discussed how ABS is

looking ahead to position surveyors experienced in LNG vessels at ports most likely to be host to the vessels during scheduled surveys.

The Closing Session was co-chaired by Mr. James McHardy, General Manager of SIGTTO and Mr. Henry Reeve (Texas Section Chair) of Alan C. McClure Associates. After the final presentation, Mr. Reeve adjourned the 14th Offshore Symposium.

Thanks to our generous sponsors, attendees and presenters who contributed to making this a success. Thanks also to the organizing committee who made it all come together: Henry Reeve, Donald Burris, Harry Ren, Barbara Stone, Johan Wichers, Peter Noble, Paul Griffin and Lars Ronning.