

The Royal Institution of Naval Architects



# ICSOT Korea: Safety of Offshore and Subsea Structures in Extreme and Accidental Conditions



International Conference

**ICSOT Korea:**  
Safety of Offshore and Subsea Structures in  
Extreme and Accidental Conditions

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- 08.30-08.55**      **COFFEE & REGISTRATION**
- 09.00-09.30**      **NOVEL MATERIALS FOR OFFSHORE AND SUBSEA STRUCTURES: SAFETY IMPLICATIONS**, *Professor Igor A. Guz, Head of School of Engineering, University of Aberdeen*  
The paper reviews practical applications of novel materials in the oil and gas industry. It focusses on possible future opportunities of utilising various composite and functionally graded materials in offshore and subsea structures and the subsequent safety implications drawing from the experience of the aerospace industry which had been facing similar challenges 40 years ago.
- 09.30-10.00**      **REDUCING PROJECT RISKS AND DELAYS IN INTERNATIONAL OFFSHORE EPC PROJECTS**, *Petter Ellingsen, DNV GL, Korea*  
This paper presents the main idea behind the "Project Risk JIP". International EPC projects are subject to many different types of causes for delays. Some of the typical challenges are related to vendor pre-qualification, application of requirements and standards, using the results from safety studies in design and complex interfaces. A framework to address those challenges will be presented including specific risk mitigating steps to avoid rework and delays. In addition, the current status of the "Project Risk JIP" including scope, approach and deliverables will be presented.
- 10.00-10.30**      **THE TRANSITION OF ADVANCED RISK AND SAFETY CAPABILITY TO THE OFFSHORE INDUSTRY**  
*William Cowardin, alion offshore, USA*  
The challenges facing the offshore industry in the 21st century include operations in more difficult and sensitive regions as well as the application of ever increasing levels of technology. The challenges facing the industry are analogous to those facing world navies during the second half of the 20th century. It is imperative that exploration and production proceed in the safest and most reliable manner possible. Within this paper, the authors review the Integrated Barrier Analysis (IBA) process, discuss the benefits and applicability of IBAs within the offshore industry, and review a number of "lessons learned" related to transitioning this technology from the naval industry. The paper will review the similarities and dissimilarities between the IBA as applied for offshore and traditional naval survivability and will discuss how these advanced analyses methodologies can be used to demonstrate that offshore operations are conducted with as low as reasonably practical risk.
- 10.30-11.00**      **TEST FACILITIES FOR SAFETY STUDIES OF SHIPS AND OFFSHORE STRUCTURES ASSOCIATED WITH EXTREME AND ACCIDENTAL CONDITIONS**, *Jeom Kee Paik, KOSORI, Korea*  
Ships and offshore structures can face extreme and accidental events that can result in catastrophic consequences in association with casualties, property damages and pollution. Because the mechanism and its responses of structures in extreme and accidental events are highly nonlinear, it is essential to take advantage of experimental approaches as well as computational approaches in terms of identifying such nonlinear responses. Relevant test facilities are then required to meet the needs where full scale or at least large scale models should be dealt with. The objective of this article is to introduce test facilities recently built in the Korea Ship and Offshore Research Institute (KOSORI) at Pusan National University in Korea in terms of specifications and capabilities of various test facilities. Those facilities include test infrastructures in association with ultra-high subsea pressure, fires, explosions, structural failure and dropped object as well as high speed material test.
- 11.00-11.30**      **COFFEE**
- 11.30-12.00**      **THE CHIRP AND MARS CONFIDENTIAL REPORTING SCHEMES**  
*Alan Loynd, Branscombe Marine Consultants Ltd., Hong Kong*  
The CHIRP and MARS confidential reporting schemes offer a means for people in the maritime industries to report accidents and near-miss events so that lessons may be learned. This paper describes the schemes and discusses the benefits. It describes how confidentiality is maintained and stresses the need for more industry participation.
- 12.00-12.30**      **CRITICAL REFLECTIONS ON MARITIME DESIGN IN PRACTICE**  
*Yushan Pan, Sisse Finken, University of Oslo, Norway, Sashidharan Komandur, Maritime Human Factors Laboratory, Norway*  
This paper reports on observations and discussions conducted through a fieldwork at a platform supply vessel for investigating technology in use. The intention with the fieldwork was to get a better understanding of the knowledge and relations maritime operators, living in an after ship bridge system, have with modern digital technologies. The findings are presented in the form of twofold and analysed through the lens of actor-network theory. The analysis shows how the use of technology is immersed in a net of socio-material relations. It also shows that these relations contribute to dynamically change safety effects onboard in a variety of ways. The contribution of this work is to give critical reflections on how socio-material structures affect the character of safety operations, and the implications this has for the design of marine technology.
- 12.30-13.00**      **PHYSIOLOGICAL COMPUTING FOR MARITIME ERGONOMICS APPLICATIONS**, *Yanbin Wu, Takashi Miwa, Makoto Uchida, Graduate School of Maritime Sciences, Kobe University, Japan*  
This paper aims to review the psychophysiological indices that are widely used to predict human cognitive states in both cognitive psychology research and applied industries. Possible applications of physiological computing in maritime human factors are suggested. A marine engine power-plant simulator operation study is done to evaluate operators' mental workload based on chosen psychophysiological indices and physiological computing methods.
- 13.00-14.00**      **LUNCH**
- 14.00-14.30**      **THE INTEGRATION OF HUMAN FACTORS PRINCIPLES WITH THE DEVELOPMENT AND QUALITY ASSURANCE PROCESS OF INTEGRATED SOFTWARE DEPENDENT SYSTEMS**  
*Saara Keränen, DNV GL, Republic of Korea*  
Best practices for addressing Human Factors are not used to their full potential in the design of control systems in the Oil and Gas industry. ISO 11064 and activities defined herein are applied, at least to some extent, but there is often a lack of integration of these principles with overall engineering. At the same time the control of offshore units is becoming increasingly dependent on complex software-based controls and automation. The quality of the Human Machine Interface of these systems is essential for safe operations. It is the main information source used by the operators to build their situation awareness (SA). Lacking or inadequate SA is one of the primary factors in accidents attributed to human error. The DNVGL class notation OS D-203 sets requirements to the development and quality assurance process of Integrated Software Dependent Systems. DNV GL is in the process of initiating a Joint Industry Project (JIP) to develop a guideline on how to integrate Human Factors Principles with the ISDS standard.
- 14.30-15.00**      **IMPLEMENTATION OF RISK AND WORKING ENVIRONMENT ANALYSES FOR OFFSHORE INSTALLATIONS ON THE NORWEGIAN CONTINENTAL SHELF**, *Kyung Won Yang, DNV GL Oil & Gas, Republic of Korea*  
According to the Petroleum Safety Authority Norway (PSA) regulations, risk and working environment (WE) analyses shall be carried out to manage major accidents, environmental and other risk, to ensure a sound working environment and to provide support for decisions related to the design, construction and operation of offshore installations operated on the Norwegian Continental Shelf (NCS). This presentation will provide an introduction to how risk and WE analyses can be properly and efficiently implemented and applied to offshore installations on the NCS based on PSA regulations, NORSOK Z-013, NORSOK S-002 and experience from projects which DNV GL Oil & Gas have carried out for owners and ship yards.
- 15.00-15.30**      **STUDY ON WORKLOAD MEASUREMENTS AT THE MARINE ENGINEERING EDUCATION UNDER THE MARINE ENGINE SIMULATOR ENVIRONMENT**, *Takashi MIWA, Makoto UCHIDA, Kaoru SHIMAMOTO, Yanbin WU, Kobe University, Japan, Masumi NAKAMURA, Yuge National College of Maritime Technology, Japan*  
For the safety navigation of the ship, engineers have to keep the safety operation and management of the engine with good teamwork appropriately. Therefore, every engineer must exert full their own ability, and they are required to realize the minimum basic skills for the engine operation before they commence to be onboard. Then, at the maritime educational institutions, the requirement knowledge and skills as ship engineer are given to students by lectures and exercises. In this study, in order to carry out the properly education training, we pay attention to understand the mental state of the student. Then we tried to measure the workload of student who operates the engine system under marine engine simulator environment.
- 15.30-16.00**      **COFFEE**
- 16.00-16.30**      **INVESTIGATION INTO POSITIVE AND NEGATIVE EFFECTS OF REDUNDANCY REQUIREMENTS FOR VESSELS**, *KIM Hyungju, HAUGEN Stein, UTNE Ingrid Bouwer, Norwegian University of Science and Technology, Norway*  
The International Maritime Organization (IMO) and Classification Societies have issued several redundancy requirements for vessels to increase mechanical reliability of marine systems: Dynamic Positioning (DP) notations for offshore vessels, Redundant Propulsion (RP) notations for merchant vessels, and Safe Return to Port (SRtP) regulation for passenger vessels. These redundancy regulations have one requirement in common; physical separation of redundant systems. Physical separation can protect redundant systems against simultaneous failure due to a single fire or flooding, and consequently, mechanical reliability increases. At the same time, this physical separation can cause additional positive and negative effects for human reliability, maintainability, environmental performance, etc. This paper conducts a complete qualitative comparison of all positive and negative effects of physical separation, and emphasizes the necessity of integrated assessment models and regulations which include all kinds of perspectives.
- 16.30-17.00**      **PREDICTIONS OF ICE SCOUR LOADS AND RATE EFFECT EVALUATION FROM SMALL SCALE 1G TESTS**, *S. Arnau & A. Ivanović, University of Aberdeen, UK*  
An analytical model to predict scouring loads generated by an iceberg keel scouring a cohesionless seabed. currently available in literature and adjusted for this study was validated using the physical model set up constructed in the laboratory. Scale issues that arise from testing under 1g conditions with small scale models such as using the same particle size as the prototype, soil response at low stress levels, 3D effects of the soil failure mode and the rate effect in sands are discussed.
- 17.00-17.30**      **SUBSEA PIPELINE ROUTE DETERMINATION BY GEOCOST MAPPING AND RISK ASSESSMENT**, *Jihyun Jung, American Bureau of Shipping, Korea*  
The primary objective of this research is to provide a design guideline for subsea pipeline route determination. Furthermore, suggesting the risk assessment methodology considering a variety of hazardous factors for minimizing the life and property and the natural environment hazards on subsea pipeline installation. The quantitative method of subsea pipeline route determination recommended in this paper uses least-cost mapping techniques to determine the optimal route across a composite cost surface.
- 17.30-**            **GENERAL DISCUSSION & EVENING DRINKS RECEPTION**

08.30-09.00 COFFEE & REGISTRATION

09.00-09.30 DETERMINING OF FIRE ACCIDENTAL LOADS FOR ALUMINIUM SAFETY HELIDECK, J.K. Seo, S.J. Kim, B.J. Kim and J.K. Paik, *The Korea Ship and Offshore Research Institute (The Lloyd's Register Foundation Research centre of Excellence), Pusan National University, Korea, W.H. Shin, Research Institute Team, N.K Co., Ltd., Korea, J.S. Park, Central Research Institute, Samsung Heavy Industries Co., Ltd., Korea.*

The present study reports results, focussing on defining fire design loads due to helicopter accident in offshore helideck. A framework for the quantitative risk assessment of fires requires the definition of both the frequency and consequences of the accidental events. The proposed procedures of determining fire design loads, can be efficiently applied in offshore helideck development projects, and the application includes the assessment of design fire loads as well as the quantification of effects of risk control options such as optimization of helideck pancake profile, location and number of water deluge systems etc.

09.30-10.00 WINTERIZATION DESIGN OF ALUMINUM HELIDECK IN ARTIC ENVIRONMENT, S.Y. Bae, G.H. Kang, *Korea Marine Equipment Research Institute, J.S. Park, Samsung Heavy Industries Co., Ltd, W.H. Shin, N.K Co., Ltd., J.K. Seo, Pusan National University, Korea*

In recent years, the demand for ships and offshore platforms that can navigate and operate through the Arctic Ocean has been rapidly increasing due to global warming and large reservoirs of oil and natural gas in the area. Winterization design is one of the key issues to consider in the robust structural safety design and building of ships that operate in the Arctic and Sub-Arctic regions. However, international regulations for winterization design in Arctic condition regulated that only those ships and offshore platforms with a Polar Class designation and/or an alternative standard.

10.00-10.30 ALUMINIUM HELIDECK DESIGN FOR EUROCODE9 WITH DEFORMATION BASED DESIGN, J.S. Park, Y.S. Ha, C.W. Lee, K.B. Jang, *Samsung Heavy Industries Co., Ltd., Korea*

In the present paper, the aluminium helideck design with relevant EUROCODE 9 is done based on the strength calculation. It could be possible to reduce calculation time and thus provide reasonable solution in view of practical design. Static and nonlinear collapse behavior of developed structure is investigated in this study. The main purposes are to provide a reasonable solution that can improve the product quality by checking both strength and deformation criteria. The effect of deflection during the fabrication stage is considered in the structural design based on newly proposed EUROCODE 9. Lastly a comparison between the present results and the results by FE-Analysis is presented.

10.30-11.00 DETERMINATION OF DESIGN ACCIDENTAL FIRE LOAD FOR OFFSHORE INSTALLATIONS WITH TREATMENT OF PARAMETRIC UNCERTAINTY, Bongsik Choo and Daejun Chang, *Korea Advanced Institute of Science and Technology, Republic of Korea*

Offshore installations, which are operated in extreme marine environment, are essentially threatened by the various hazards to cause harms. Specially, the topsides of the offshore platform, which treats combustible oil and gas, are always exposed hydrocarbon fire hazards bring out a high consequence disaster. In this situation, a concept of 'Design Accidental Loads (DAL)' based on Quantitative Risk Assessment (QRA) is introduced to ensure safety of offshore. Fire exceedance plot as main output of the QRA is established by combining consequence and frequency analysis results. Even though the QRA has made much advance in recent decades, most types of them have overlooked inherent uncertainty.

11.00-11.30 COFFEE

11.30-12.00 DESIGN OF ULTRA DEEP WATER RIGID & FLEXIBLE PIPELAY/ HEAVY LIFT/ DP3 / CONSTRUCTION VESSEL, Aniruddha Sen, *Navnautik, India*

We would like to present our latest design of ULTRA DEEP WATER RIGID & FLEXIBLE PIPELAY/ HEAVY LIFT/ DP3 / CONSTRUCTION VESSEL. This vessel has already been constructed and handed over to owners for operational purpose. This flagship vessel is the latest addition to the deep sea pipe laying industry and is equipped with 3000 ton heavy lift crane, MLS tower for 1200 mt pipe laying capacity and 4 reels equipped with steel pipes.

12.00-12.30 PREDICTIVE STUDY ON WELDING DEFORMATION IN FABRICATION OF CANTILEVER BEAM COMPONENT OF JACK-UP RIG WITH ELASTIC FE COMPUTATION, Jiangchao

*Wang, Huazhong University of Science and Technology, China, Hongquan Zhao, Junlin Zhu, Jiasheng Zou, Jiangsu University of Science and Technology, China, Zhengfeng Wu, Shizhong Du, Zhenhua Heavy Industries Company, China*  
How to eliminate the welding deformation in fabrication of large marine structures, is always an important engineering problem. Meanwhile, welding deformation can be known in practice with experimental measurement or numerical simulation. In this paper, in order to predict the possible welding deformation in fabrication of cantilever beam component of jack-up rig, an elastic FE computation is employed, in which the whole considered welded structure is meshed by coarse shell elements; welding inherent deformation is evaluated with TEP FE analysis, and will be applied to the existed welding line as load; interface element is used to represent the entire assembled process with considering the fitting procedure before welding.

12.30-13.00 ULTIMATE STRENGTH OF FLEXIBLE PIPE SUBJECTED TO INTERNAL PRESSURE, Yong Bai, Shuai Yuan, Peng Cheng, *Zhejiang University, China*

The increasing use of flexible pipes in subsea with high pressure/high temperature brings about much more challenges. Although there is a simple prediction method for burst pressure, a precise calculation of the ultimate strength of flexible pipe subject to internal pressure is essential for the safe use of flexible pipe under harsh

environments. In this paper, the mathematical analysis and finite element analysis are employed to study the properties of pipe under the internal pressure.

13.00-14.00 LUNCH

14.00-14.30 PRESCREENING OF OCEAN ENVIRONMENT FOR THE PREDICTION OF EXTREME TENSION LOADS ON OFFSHORE STRUCTURES, Dong-Hyun Lim, Yonghwan Kim, *Seoul National University, Korea, Taeyoung Kim, Samsung Heavy Industries, Korea*

In this study, a pre-screening procedure to reduce the number of environmental conditions for dynamic analyses of offshore structures is suggested. For the efficiency of the procedure, the frequency-domain theories are adopted in the estimation of the platform offset, using quasi-static analyses in the prediction of line tension. The results are validated by comparing with the time-domain solution of coupled platform-mooring line analysis, and fair agreement is found. Also, the characteristics of environmental conditions classified as extreme cases are investigated through application of the pre-screening procedure to actual numerous environmental conditions.

14.30-15.00 PRESSURE-IMPULSE DIAGRAM FOR PREDICTION OF STRUCTURAL DAMAGE TO THE LNG FPSO TANKS UNDER SLOSHING IMPACT LOADS, Sang Eui Lee, Bong Ju Kim, Jung

*Kwan Seo, Yeon Chul Ha, Pusan National University, Korea, Jeom Kee Paika, Pusan National University, Korea, University College London, UK, Toshiyuki Matsumoto ClassNK, Japan, Su Hwan Byeon, STX Offshore and Shipbuilding Co., Ltd, Korea*  
The aim of this paper is to numerically examine the dynamic structural response characteristics of a LNG tank in LNG FPSOs at an initial design stage using a direct analysis method and to derive pressure-impulse diagram. The analyses of nonlinear structural responses are performed using the LS-DYNA code. Numerical simulations are carried out for a tank of LNG FPSOs under design sloshing loads. Parametric studies are carried out to derive the pressure-impulse diagram. The knowledge obtained from a series of nonlinear finite element method computations are documented. The insights developed from the present work will be useful for damage-tolerant design of LNG tanks. Keywords: Pressure-impulse diagram, Sloshing load; Nonlinear finite element method; SPB type; LNG FPSOs

15.00-15.30 SENSITIVITY ANALYSIS OF WTIV LEG DESIGN CONSIDERING SOIL CHARACTERISTICS FOR KOREAN WEST-SOUTH OFFSHORE WIND ZONE, Tae-Min Cho, Joo-Shin Park, Yeong-

*Su Ha, Jun-Hwan Jeon, Ki-Bok Jang, Central Research Institute, Samsung Heavy Industries Co., Ltd., Korea*

In this study, sensitivity analysis of WTIV (Wind Turbine Installation Vessel) leg for Korean west-south offshore wind zone is performed considering soil characteristics. Firstly, environmental conditions and seabed characteristics of Korean west-south offshore wind zone is collected and investigated. Based on these data, design specifications are established and the overall basic design is performed. The sensitivity analysis of WTIV leg design for Korean west-south offshore wind zone due to changes of soil characteristics is performed. It is observed that the WTIV leg design is very sensitive to soil characteristics. The structural integrity of the WTIV leg is verified through the code check and the adequate safety margin is observed. The results of this study can be expected as practical and useful data for the design of the WTIV for Korean west-south offshore wind zone.

15.30-16.00 COFFEE

16.00-16.30 THE BETTER DESIGN OF HIPPS

*Jin Hyung PARK, Yokogawa Electric Korea*

HIPPS is the abbreviation of High Integrity Pressure Protection System. The gas out of the gas/oil well is compressed to really high pressure and the design pressure of equipment in main process for gas treatment is much lower than the gas pressure compressed by compressor. So the mistake of pressure operation results in very serious consequence in main process. HIPPS is installed to protect the main process from high pressure by compressor after well head. Considering this importance of HIPPS, the technology of HIPPS needs to be diversified and separated from other safety system and be more reliable. The better design with diverse technology of HIPPS and the reason of better design of HIPPS will be described in this paper.

16.30-17.00 SIGNIFICANCE OF SAFETY INSTRUMENTED FUNCTIONS (SIF) IN INSURING INTEGRITY OF THE OFFSHORE ENERGY FACILITIES, Hee-Cheon Cho, Ka-Ryung Yea, Heung-Sik Kwak,

*Younjong Kim, United Pacific PLG, Korea*  
The biggest limitation given to offshore facilities comes from areal and spatial constraint. With that considered, immediate and reliable isolation of the systems must be insured to protect the properties as well personnel having a minimum window for evacuation, if not none. In this paper, couple examples are brought in to look at what difficulties are there, and to share how they can be attacked to find reasonable solutions. Also, a brief introduction on the approaches determining SIL as well as quick review on the quantitative verification methods, all suggested by IEC Codes, would be presented. Together with conventional safety assessment methodologies for the process unit integrity (such as Hazard and Operability, Consequence Analysis), an evaluation on SIF reliability is an important issue in many corners of the energy industries.

17.00-17.30 ASSET INTEGRITY MANAGEMENT FOR SUBSEA SYSTEMS USING RISK BASED APPROACH, Y. Bai, Z. Shang, *Zhejiang University, China*

17.30- GENERAL DISCUSSION