ICSOT KOREA 2015: ABSTRACTS

1. DESIGN OF ULTRA DEEP WATER RIGID & FLEXIBLE PIPELAY/ HEAVY LIFT/ DP3 / CONSTRUCTION VESSEL

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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.

Apart from this, this vessel has two under deck carousels for flex pipe as the vessel can lay flex pipes also using same MLS tower.

Two ROVs and a central moonpool equip this vessel for deep sea operations. 40MW power is supplied via 12 gensets and seakeeping abilities to match DP3 requirements are ensured by 6 azimuth thrusters. State of the art anti-roll / anti-heel tanks and flume tank on vessel's superstructure ensure stability and good sea keeping during heavy lift operations. Our paper will take the audience through the design process, limiting parameters and obstacles overcame during the design process to present this nex-gen ULTRA DEEP WATER RIGID & FLEXIBLE PIPELAY/ HEAVY LIFT/ DP3 / CONSTRUCTION VESSEL.

2. PREDICTIVE STUDY ON WELDING DEFORMATION IN FABRICATION OF CANTILEVER BEAM COMPONENT OF JACK-UP RIG WITH ELASTIC FE COMPUTATION

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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. In detail, a series of computations with TEP FE analysis are carried out to examine all typical welded joint in the considered welded structure of cantilever beam component beforehand, where fast computation is implemented with ISM (Iterative Substructure Method), and the computed plastic strain is used to estimate the corresponding inherent deformation for each examined typical welded joint. Then, those inherent deformations are applied into the shell elements model as load to instead of the mechanical effect caused by welding, and elastic FE analysis is conducted to indirectly predict welding deformation. Also, the assembled sequence will essentially influence the product quality and manufacturing cost, interface element with different material properties is presented to closely examine the fitting and welding procedures. Two potential assembled processes are finally investigated to assess those welding deformations as an application of elastic FE computation using inherent deformation and interface elements.

3. CRITICAL REFLECTIONS ON MARITIME DESIGN IN PRACTICE

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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.

4. PHYSIOLOGICAL COMPUTING FOR MARITIME ERGONOMICS APPLICATIONS

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In safety-critical systems such as marine engine power-plant operation, we always hope that the operator could

persistently monitor system parameters (e.g. engine revolution) and adapt to unforeseen changes (e.g. lubrication oil pressure low) and avoid any misses or incidents (e.g. engine shut down), in other words, to perform their jobs perfectly. With the improvement of hardware reliability, it is the abnormal psychophysiological state of the operator that more likely lead to performance degradation of the system. Thus it is necessary to address how to maintain the optimal operator functional state (OFS) in the context of human-machine systems, where the risk of accident is closely related to human component. Physiological computing is to correlate an operator's physiological changes and their functional states based on simple selected features or complex algorithms such as support vector machine and fuzzy modeling. The physiological evaluation indices mainly include heart rate variability (HRV) recorded from electrocardiogram (ECG), blood pressure, respiration, eye blinks and pupil diameter, skin potential, hemodynamic indices and cerebral cortex indices such as electroencephalogram (EEG) and event-related potentials (ERPs). 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.

5. WINTERIZATION DESIGN OF ALUMINUM HELIDECK IN ARTIC ENVIRONMENT

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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. In order to cope with the rising demand for operating in the Arctic region, existing and new Arctic vessels with a Polar Class designation are lacking to cover for adequate winterization design with HSE philosophy. Existing ships and offshore platform was not designed based on reliable data based on numerical and experiment studies. There are only designed as a performance and functional purposes. Hence, current industrial practices can be difficult to cover a wide range design purposes due to geometric/material changes, and cost saving purposes etc. with a serious risk for worker and operator. It is very important to obtain of reliable data and provide of design guidance of the anti-icing structures by taking the effects of low temperature into consideration. Therefore, the main objective of this paper reconsiders anti-icing design of aluminium helideck using the heating cable. To evaluate of reliable data and recommend of anti-icing design method, various types of analysis and methods can be applied in general. In the present study, finite element method carried out the thermal analysis with cold chamber testing for performance and capacity of heating cables. According to the results and methods can be used to inform and offer as a standardized regulation and design guidance for winterization design of equipment of ships and offshore platforms, thereby providing a more systematic, comprehensive guidance for winterization design than previously available.

6. INVESTIGATION INTO POSITIVE AND NEGATIVE EFFECTS OF REDUNDANCY REQUIREMENTS FOR VESSELS

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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.

7. CONDITION ASSESSMENT OF DOUBLE HULL OIL TANKERS IN COLLISIONS

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Collision accident is one of the most serious accidents that might lead to such severe consequences, as well as total loss of the ship in some cases, particularly when large tankers and/or gas carriers are involved in collisions. In this study, focusing are given to the residual ultimate longitudinal strength of damaged ships after collision to predict the potential risk of hull collapse. A set of damaged scenarios which represent the entire range of possible collision damages is selected using a sampling technique based on probability density distributions of influencing parameters. The residual strength performance of damaged ships are calculated using ALPS/HULL Intelligent Supersize Finite Element Method (ISFEM) and then, a diagram relating the residual strength performance to the damage index (abbreviated as the R-D diagram) can be established. This diagram will be very useful for a first-cut assessment of a ship's safety against side damage's accidental or in-service damage for four types of double-hull oil tankers - VLCC, Suezmax, Aframax, and Panamax.

8. PRESCREENING OF OCEAN ENVIRONMENT FOR THE PREDICTION OF EXTREME TENSION LOADS ON OFFSHORE STRUCTURES

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For the estimation of the dynamic behaviours of an offshore structure and extreme loads on mooring lines, a tremendous number of simulation cases should be considered to deal with all the environmental and operational conditions which the structure may encounter during its lifetime. Since a sophisticated time-domain coupled analysis cannot handle this massive computational load, an efficient preliminary process to downsize the simulation cases will be very useful.

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.

9. 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

If you would like to offer a paper for the conference, please paste your 250 word abstract here: 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. The efforts are also intended to support the IMO E-navigation initiative where guidelines for software quality assurance and human centred design are developed. The addition will make it possible to meet the ISDS and additional requirements related to Human Factors (e.g. ISO 11064, NORSOK S-002, IMO e-Navigation, etc.) by applying one defined DNV GL process.

10. ULTIMATE STRENGTH PERFORMANCE OF COMMERCIAL SHIPS ON ARCTIC OCEAN

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Generally, global strength analysis (longitudinal strength analysis or hull girder strength analysis) and the local buckling analysis (stiffened panel strength analysis) are performed to identify the structural capacity and safety of ships in the early design stage. The ultimate strength performances of commercial ships on the Arctic Ocean considering the low temperature environment are dealt in this paper. Three types of ship, i.e., oil tanker, bulk carrier and container ship with four different sizes (totally 12 ships) are considered in four low Arctic temperatures and room temperature. ALPS/HULL and ALPS/ULSAP are used for the global strength analysis of hull girders and stiffened panels. The obtained results are summarized in terms of temperature, vessel type, vessel size, loading type and other effects. The important insights and outcomes are documented.

11. IMPLEMENTATION OF RISK AND WORKING ENVIRONMENT ANALYSES FOR OFFSHORE INSTALLATIONS ON THE NORWEGIAN CONTINENTAL SHELF

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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). Due to strict requirements for the risk and WE in NORSOK standards referred to in the PSA regulations and lack of experience of users, there have been many challenges on implementing the risk and WE analyses and utilizing results from the analyses for design, construction and operation of offshore installations. 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.

12. PRESSURE-IMPULSE DIAGRAM FOR PREDICTION OF STRUCTURAL DAMAGE TO THE LNG FPSO TANKS UNDER SLOSHING IMPACT LOADS

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Pressure-impulse (P-I) diagrams are commonly used in the preliminary design or assessment of structural integrity to establish safe response limits for given loading. Sloshing impact loads can cause structural damage of the LNG tank in LNG FPSOs. The research studies that have attempted to resolve the impact pressure issue can be classified into hydrodynamics-related studies and structural-mechanics related studies. The latter aims to calculate the dynamic structural response, including damage, caused by the applied impact pressure actions. The present study is a sequel to the author's previous paper [Paik, J.K. et al., 2015. Nonlinear impact response analysis of LNG FPSO cargo tank structures under sloshing loads]. In contrast to the previous paper, 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

13. REDUCING PROJECT RISKS AND DELAYS IN INTERNATIONAL OFFSHORE EPC PROJECTS

Petter Ellingsen, DNV GL, Korea

DNV GL is preparing a "Project Risk Joint Industry Project (JIP)" in close dialogue with the industry and key stake holders involved in ongoing projects with the objective to reduce delays and cost overruns in international offshore EPC projects. A separate and more

recent "Standardization JIP" initiative will address challenges related to large variations in owner's technical requirements for components and equipment for offshore projects.

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.

14. 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. To achieve this end, many companies are exploring how methodologies and technologies from other industries can help ensure safe and reliable drilling operations. One example of this type of initiative is the application of Integrated Barrier Analysis (IBA) methodologies in both the design and operation of offshore drilling platforms. Based on survivability modeling and simulation technologies originally developed to assess naval combatant mission capability in a damaged state; IBA's offer a "One Model and One Tool" approach which allows for through-time integrated failure effect and consequence classification analyses across all technical, operational, and procedural barriers. Within this paper, the authors review the 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.

15. DETERMINATION OF DESIGN ACCIDENTAL FIRE LOAD FOR OFFSHORE INSTALLATIONS WITH TREATMENT OF PARAMETRIC UNCERTAINTY

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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. There are many parameters to be used for the frequency and consequence analysis. Selecting initial leak size was one of the most critical part and inconsistent approaches to selecting those values resulted in different risks about an identical system. Frequency analysis of past investigations also thoroughly overlooked the inaccuracy and unsuitability of statistical data despite its severity. The main sources of uncertainty in QRA were discussed in this study. Parameter uncertainty can be expressed by probability distributions and treated by Latin Hypercube Sampling (LHS) technique. Different exceedance plots from parametric uncertainty were obtained and theses plots indicated the inaccuracy and discredit of previous DAL procedure, which had used only one fire exceedance plot. Fire exceedance plots involved information about uncertainty of the defined DAL fire.

16. SUBSEA PIPELINE ROUTE DETERMINATION BY GEOCOST MAPPING AND RISK ASSESSMENT

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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. Although the initial task for subsea pipeline installation is subsea pipeline route determination, extensive research and development are carried out on subsea pipeline structural problem while less attention is paid to subsea pipeline route determination. The wrongly selected pipeline route leads to loss of expenses and installation delays when unexpected seabed conditions or other human activities are encountered. Furthermore, untried subsea pipeline laying work experience may create many unexpected problems and serious hazards afterward. This paper explained how to approach a sound and practical process of each hazard factor for subsea pipeline route determination. Finally, this research provides a guidance of the subsea pipeline route determination for managers and technical professionals in the maritime and offshore oil and gas industries.

17. SENSITIVITY ANALYSIS OF WTIV LEG DESIGN CONSIDERING SOIL CHARACTERISTICS FOR KOREAN WEST-SOUTH OFFSHORE WIND ZONE

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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.

18. ALUMINIUM HELIDECK DESIGN FOR EUROCODE9 WITH DEFORMATION BASED DESIGN

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Aluminium alloys are gaining increasing usage in the construction industry, offering high strength-to-weight ratios, good durability and ease of fabrication. The aluminium helideck structure should satisfy requirements in accordance with some offshore regulations and rule notations such as the Australian/New Zealand Standard and EUROCODE 9. The width-to-thickness ratio and the yield stress are recognized as the governing design parameters in the design of cross sections in these specifications. The aluminium helideck structures are composed of several structural units such as aluminium part and steel part. The aluminium part is composed of pancake, girder, safety net and so on.

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.

19. MECHANICAL PROPERTIES OF MILD AND HIGH-TENSILE STEEL UNDER IMPACT LOADS IN AN ARCTIC ENVIRONMENT

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Mild and high-tensile steel is a primary material to build ships and offshore structures. Because of the need to operate in the Arctic sea, ships and offshore structures are exposed to a low temperature. They are also likely to subject to impact loads arising from collisions with iceberg or other objects. The aim of the present study is to characterise the mechanical properties of mild and high-tensile steel under impacts loads at low temperature equivalent to an Arctic environment and also a cryogenic condition, the latter being associated with an environment due to leak of liquefied natural gas from FLNG or LNG carrier's cargo tanks. In the present study, tensile testing on material is undertaken with varying the temperature and also loading speed. The coefficients of the Cowper-Symonds equation are suggested based on the test database.

20. DETERMINING OF FIRE ACCIDENTAL LOADS FOR ALUMINIUM SAFETY HELIDECK

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Helicopters are essential in supporting offshore oil and gas activities around the world. The helideck structure must satisfy the safety requirements associated with various environmental and accidental loads. Recent decades have seen a number of fire accidents on offshore due to helicopter collision (take-off and/or landing). For those accidents, a substantial amount of effort has been directed towards the management of fire in offshore helideck's safety design. 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.

21. A STUDY OF STRESS DISTRIBUTION ON BENDING ANGLE OF ELBOW UNDER ULTRA HIGH EXTERNAL PRESSURE

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Elbows are one of popular components in pipeline structures. Stress distribution of elbow is different from straight pipe because of its geometrical characteristics. Stress distribution of elbow also changes according to type of operation load. In the other word, elbows under internal high pressure show different stress distribution from those under external high pressure. There are several researches and literatures about stress distribution of elbows and pipelines under internal pressure and few methods were developed to assess stress distribution of elbow under internal pressure such as Lorenz Factor. However, there are very few researches about behaviour of elbow under external operation pressure which represents subsea environment. Established pipeline systems in subsea environment require frequent detection and risk assessment due to harsh environment conditions to prevent structural failure after damages occur. The main purpose of present study is to find the pattern of stress distribution of elbow under external pressure to develop an assessment method.

22. STUDY ON WORKLOAD MEASUREMENTS AT THE MARINE ENGINEERING EDUCATION UNDER THE MARINE ENGINE SIMULATOR ENVIRONMENT

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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 the classroom, teacher can use the skill quiz or technical reports for improvement of the student's knowledge level, and he can if necessary add the supplementary materials to the main curriculum, and he can change the lesson speed dealing with students' response. On the other hand, simulator training will be extremely different against to classroom lesson because simulator training includes various non-technical skill training. If lecture leads a gap between its level and student's ability, the lecture is difficult to get the satisfied goal. When the task workload is remarkably varying at each student, then some of the student is expected to be difficult to understand the lesson contents. It will be difficult to pick up the modification points and modification level from training scenario, to modify the training program.

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.

Keyword: biological reaction, task workload, engine room simulator, marine engineering education, marine engineer

23. SIGNIFICANCE OF SAFETY INSTRUMENTED FUNCTIONS (SIF) IN INSURING INTEGRITY OF THE OFFSHORE ENERGY FACILITIES

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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. An industry standard, IEC 61511, which describes about safety instrumented system (SIS), requires that safety integrity levels (SIL) be established for safety instrumented functions (SIF). Throughout facility life span, including design stage and operation, we all agree an importance of SIF meeting the expected performance. However, in the real world, few aspects are quite challenging: (1) with the areal constraint given, having sufficient redundancy may not be easy, (2) lack of confidence on important data such as failure frequency as well as common cause failure (CCF) under the rigorous offshore environment (3) adequacy of full (and partial) stroke tests between production cycles (or during production duration, if required).
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.

24. 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.

The speaker is a voluntary ambassador for the reporting schemes.

25. A METHOD TO CALCULATE LEVEL ICE LOADS ON MULTI LEGGED CONICAL STRUCTURES

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Multi Legged structures are often used in arctic environments to withstand strong ice loads. Usually, these types of offshore structures have cones around their legs for the benefit of inducing level ice bending failure and thus reducing global ice loading. The present work introduces a method to predict global ice loads on Multi Conical Legged Structures due to interaction with level ice by combining the Croasdale Method and the Formula of Mellor. The first one allows estimating forces of unbroken ice on front legs whilst the second one is applied to calculate broken ice forces on back legs. Formation of ice radial cracks around the legs becomes an important assumption and it plays an important role in the calculations. Results are compared with available published data for a Downward Breaking Multi Conical Legged Structure; nevertheless, further validation is suggested to prove applicability of this proposed method.

26. ULTIMATE STRENGTH OF FLEXIBLE PIPE SUBJECTED TO INTERNAL PRESSURE

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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. And the simulation of pressure armor layer has been studied comprehensively with different methods. In the mathematical analysis the material nonlinearity and geometric nonlinearity of the structural layers are both considered. Based on the principle of virtual work, an exact solution for stresses and deformations of the pipe under short-term internal pressure has been studied and

the obtained ultimate pressure has been compared with the results from the simple prediction method. The finite element analysis method is used to simulate the pipe under increasing internal pressure using ABAQUS. The model is established with the C3D8R elements. And the material nonlinearity is also considered in the model. The results from mathematical and FE simulation agree with each other for ultimate pressure of the flexible pipe and are compared with the burst pressure of experimental research by others. The ultimate strength equations and FEA models can be useful for the burst prediction and design of flexible pipe.

27. DEVELOPMENT OF AUTOMATIC FINE MESH GENERATION FOR FE MODELING OF SHIP STRUCTURES

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IACS CSR-H(Harmonized Common Structural Rule) for Tankers and Bulk Carriers has been effective on July 1 2015. CSR-H requires much more engineering efforts and time especially than their predecessors, making the user-friendly software be needed for shipbuilders and classification societies. Using CSR-H software, ship designers are able to design ship structure efficiently and accurately.

28. TEST FACILITIES FOR SAFETY STUDIES OF SHIPS AND OFFSHORE STRUCTURES ASSOCIATED WITH EXTREME AND ACCIDENTAL CONDITIONS

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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

29. NEW METHODOLOGY OF FMEA FOR PROCESS SAFETY

Jin Hyung PARK, *Yokogawa Electric Korea*

FMEA is one of the most representative hazard analysis methodology especially. Failure Modes and Effect Analysis (FMEA) is a systematic procedure for the analysis of a system to identify the potential failure modes, their causes and effects on system performance (performance of the immediate assembly and the entire system or process). FMEA for turret safety system was done for each part like UPS unit & Power Distribution, HIS, Engineering Workstation, Network, Controller, Marshalling Cabinet, Extension Alarm Panel. This FMEA methodology was slightly quantitative by adopting the likelihood and the severity. The criticality is decided by the criticality matrix configured with likelihood and severity. The detection was also included in this FMEA methodology to evaluate if the failure in each component can result in a system-level failure. The methodology of FMEA can vary in different industry types, but the methodology of FMEA in this research project was developed and optimized for process industry as far as possible.

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.

31. KEYNOTE: 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.

Composites are the alternatives of steel, metal and wood in many applications. Having advantages over conventional materials in weight, strength, stiffness, corrosion resistance, they are becoming more and more attractive for structural and non-structural applications in the oil and gas industry. The areas within the offshore industry, where the composites are used include rigid pipework, coiled tubing, rigid and flexible risers, structural repairs and others. However, in spite of their undoubted advantages, the main of which may be the ability to be tailored for specific purpose, their introduction in the offshore industry is a very slow process. Lack of appropriate performance information, regulatory requirements, efficient design procedures and reparability issues are the main obstacles.

One practical application of long fibre reinforced composite pipes is considered in detail as a case study. Stress and failure analysis was performed for thin and thick-walled fibre reinforced filament-wound pipes with different lay-ups subjected to outer pressure of various magnitudes. For this purpose, a robust analytical tool was developed. The presented results show how the thickness of pipes and lay-ups affect the stress distribution under different types of loading.

32. PREDICTIONS OF ICE SCOUR LOADS AND RATE EFFECT EVALUATION FROM SMALL SCALE 1G TESTS

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Ice scouring (or ice gouging) of the seabed is a common feature of most of the coastal regions of northern countries. It is a phenomenon which occurs when ice moves while in contact with the seabed. The scour may take the form of a long linear trench following a relatively straight line and it may cover only a few tens of meters or kilometers. Ice scours can be caused by ice ridges or icebergs.

The design of subsea pipelines in arctic and sub-arctic regions must consider the potential hazards of ice features such as icebergs and ice ridges.

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.