The Royal Institution of Naval Architects

Design & Operation of

Wind Farm Support Vessels

International Conference on the
Design & Operation of Wind Farm Support Vessels

28-29 January 2015, London, UK

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Design & Operation of Wi

28-29 January 20

DAY 1 PAPERS:

08.30-09.00 **COFFEE & REGISTRATION**

09.05-09.40 **HUMAN FACTORS ASPECTS OF OFFSHORE WIND FARM CREW TRANSFER,** *Christopher Anderberg & Henrik Pahlm, Chalmers University of Technology, Sweden*

Rapid advances in offshore wind farm technology, vessel design and regulations are moving turbine maintenance operations further from land and into increasingly unpredictable and challenging environments. Thus the importance of understanding the task of transferring wind farm technicians from shore to turbine. Only by considering the requirements of the humans conducting the operation and that which allows them to fulfil this role, can one begin to design for safe and efficient operations. This study is based on observations on board wind farm support vessels taking place during crew transfer operations along the south coast of England in September 2014. The transfer process will be observed from the perspectives of both the seafaring crew and wind farm technicians. Follow-up interviews/focus groups will then be conducted. From this a task analysis will be created highlighting the critical moments in the crew transfer process and thereby the preconditions for a safe and efficient transfer. This study is being conducted as part of the EBDIG Wind Farm Support Vessels project within the EU's Leonardo da Vinci Lifelong Learning Programme.

09.40-10.15 **A MARINE DESIGN APPROACH TO WFSV BRIDGE LAYOUT DEVELOPMENT AND CREW TRANSFER,** *S McCartan, C Diels and T Thompson, EBDIG-IRC, Coventry University, UK. C Anderberg, H Pahlm and F Forsman, Division of Maritime Operations, Chalmers University Of Technology, Sweden. T Dobbins, ST-Research Ltd, UK. H-J Wirsching, Human Solutions GmbH, Germany*

The aim of Marine Design is to improve the human factors, functionality and aesthetics of a vessel or system, and its' marketability. Based on the principles of Industrial Design, the objective of which is to study both function and form, and the connection between product (vessel or system), the user and the environment. User Centred Design (UCD) is a process in which the needs, requirements, and capabilities of crew members as end users of a vessel or system, are given extensive consideration at each phase of the design process. UCD answers questions about users, their tasks and goals, then uses the findings to inform the design process with specific user scenarios. This paper reports on an ethnographic analysis carried out onboard a WFSV to evaluate current navigational practices and other command and control activities specific to WFSV, including technician transfer to the turbine. The ethnographic analysis informed an ergonomic analysis carried out using the Digital Human Modelling (DHM) software RAMSIS, which allowed the bridge displays to be evaluated in the virtual design space.

10.15-10.50 **CREW TRANSFER VESSEL PERFORMANCE EVALUATION,** *S.Phillips, IB.Shin, C.Armstrong and I.Hudman, Seaspeed Marine Consulting Ltd, UK*

This paper summarises recent experience gained by Seaspeed in the evaluation of performance of Crew Transfer Vessels through extensive programmes of sea trials and model tests. This has been extended to the development of performance plots for specific vessels along with the predicted operational availability of such craft on specific wind farms. Sea trials have been undertaken on a range of Crew Transfer Vessels and the results compared with theoretically predicted performance in order to evaluate the level of agreement and to highlight where further analysis and understanding is required. Model tests have been used to enhance these predictions and to provide an improved physical understanding of specific issues such as propulsor ventilation and wave breaking effects when pushing onto a wind turbine tower. This paper builds on the methodology presented in the Seaspeed paper presented in the same conference in 2014.

10.50-11.20 **COFFEE**

11.20-11.55 **THE UK OFFSHORE WIND FARM JOB CREATION CAPACITY, O&M COSTS AND CONTENT ANALYSIS,** *Paul Igwe, University of Plymouth Graduate School of Management, UK*

Cost reduction is a central theme in the development and growth of the offshore wind industry. As the UK offshore wind cost reduction task force has identified, a strong supply chain is essential for cost reduction in the offshore wind industry. The UK Government long-term target is to use the offshore wind to provide sufficient generating capacity to meet its 15% of its renewable energy targets by 2020. An effective and efficient supply chain is required to maximise the potentials and OWF projects has the potential to generate activity for hundreds of industries leading to significant job creation capacity. The O&M potential market opportunities have been encouraging firms to make major investments. This emerging market presents opportunities to small and medium enterprises (SMEs), as they can capitalise on their local knowledge, commercial and technical or innovative solutions to benefit from the growth that this industry offer.

11.55-12.30 **THE INFLUENCE OF MULTIPLE WORKING SHIFTS FOR OFFSHORE WIND FARM O&M ACTIVITIES - STRATHOW-OM TOOL,** *Yalcin Dalgic, Iain Dinwoodie, Iraklis Lazakis, David McMillan, Matthew Revie, Jayanta Majumder, University of Strathclyde, UK*

Offshore wind projects are moving towards deeper waters and more distinct locations in order to capture stronger winds and eventually increase power productivity. However, challenging climate conditions limit the operability and accessibility of the maintenance vessels significantly; therefore, the turbine downtimes due to vessel inaccessibility become dominant. Moreover, offshore wind farm operators in the UK only perform maintenance activities if there is enough daylight at the offshore wind farm in order to prevent potential accidents. These major difficulties influence the power production undesirably and increase the financial risks of the operating offshore wind farms. In this context, the focus of this research is the investigation of operational and financial benefits that multiple working shifts can bring to the operating offshore farms and the influence of the offshore wind farm location on the operational decisions. The operational simulations are performed by the offshore wind operational expenditure and logistics optimisation tool StrathOW-OM, which is developed by the University of Strathclyde and commercial partner organisations within Technology Innovation Centre (TIC) project.

12.30-13.30 **LUNCH**

13.30-14.05 **WFSV - 12 PASSENGERS?** *Andy Page, Thomas Partington, Alicat, UK*

Windfarm Support Vessels (WFSV's) are currently restricted to a maximum of 12 passengers; this restriction is in place according to the requirements as listed in all European Flag State codes in circulation. With the increase in activity in offshore stations considered as "round 3" there is an increased desire from industry for vessels to carry more the 12 passengers. According to the European flag state codes a vessel carrying more the 12 passengers must be designed in accordance with the IMO HSC 2000 Code. The question is: is there a benefit to the economy, environment and the social working environment if the vessels could carry more than 12 passengers and if so how that could be addressed? Can the classification of the technician on-board be changed from passenger to something else so long as they hold a minimum level of training? Or perhaps it could be proved otherwise; that given the inherent transverse stability of the catamaran the vessel is capable so long as the relevant fire and safety protection is installed.

14.05-14.40 **MAN OVER BOARD RESCUE CAPABILITIES IN OFFSHORE WIND PROJECTS,** *Daniel Olsson, Dacon AS, Norway*

Wind farms today are constructed further and further offshore. This alters the parameters involved in man over board rescue operations. Today the challenges are very similar to those found in offshore Oil & Gas. However, regulations and industry practice are largely based on small, low-freeboard work boats and with a proximity to shore based resources in mind. Could some of the practices from offshore Oil & Gas be used in offshore wind or are the equipment and practices of today sufficient to meet the challenges of more remote wind parks? This paper is an overview of the most common practices in offshore Oil & Gas as well as Offshore Wind. It explains the similarities between man over board rescue in the two as well as proposes suggestions for how the industry can move forward to improve industry practice

14.40-15.15 **NAVIGATIONAL & SAFETY ASSESSMENT OF WIND FARM SUPPORT VESSELS,** *S.GOPINATH ,R.MUTHUKUMARASAMY, AMET University Chennai, India*

The service durability and safety of a vessel can be assessed to its peak only in harsh conditions. Usage of eLORAN (Enhanced LOng RAnge Navigation) as a backup and support for navigation system in place of GPS, which tends to fail in harsh conditions is suggested. The paper evaluates the navigation and safety system of wind farm support vessels with accordance to modern classification rules and projects the usage of new rules for a robust service in all sea conditions.

15.15-15.45 **COFFEE**

15.45-16.20 **AN INVESTIGATION STUDY FOR A GREEN INNOVATIVE WIND FARM SERVICE VESSEL DESIGN,** *Egemen Celik, Osman Ender Kalender, Damen Shelde Naval Shipbuilding,*

In the last years, a worldwide search is going on for green energy production. An answer to the question is wind energy so; the wind farms are created. This study aims to create an elegant and innovative wind farm service vessel especially standing out with its green technology used for performance. A 20 m length vessel is to be designed according to the utmost expectations; with hull form and structural optimizations, using FEA, to reduce the installed power. Seakeeping analysis is to be made to ensure the comfort of passengers and crew. After completing a full design driven by a diesel engine, two alternative fuels are chosen to be compared. Two alternative machinery systems will be used for the same design; one is to be powered by a hybrid/electrical system, the other is by a LNG system. The entire designs diesel, hybrid/electrical and LNG will be investigated in terms of fuel consumption, power established for same service speed, cost and emissions.

16.20-16.55 **PLANNING FOR IMO TIER 3 ENGINE ROOM DESIGN,** *Matthew Lis, MAN Engines & Components, UK*

From January 1st 2016 new vessels built to operate in the waters of North America and the Caribbean will have to meet IMO Tier 3 NOx emissions standards. These standards will be rolled out across many other parts of the world in 2021 including many areas populated by planned and existing wind farms.Using experience gained from our work in the on-road and shipping sectors MAN is developing the technology to reach these NOx standards for high-speed marine engines with minimal impact on engine room design but changes will have to be made as Selective Catalytic Reduction equipment is integrated into vessels. We will present our modular SCR system which has been developed in conjunction with our class-leading Euro-6 truck engines to help for vessel arrangement planning in the coming years. Alternative ways of reducing emissions are also under development and we will present some details of MAN's marine LNG engines that are under development which offer other solutions or part-solutions for customers seeking other propulsion solutions.

16.55- **GENERAL DISCUSSION & DRINKS RECEPTION**

ind Farm Support Vessels

015, London, UK

DAY 2 PAPERS:

08.30-09.00 **COFFEE & REGISTRATION**

09.05-10.15 **A NOVEL DESIGN FOR AN OFFSHORE WIND FARM VESSEL: APPLICATION OF THE AERODYNAMICALLY ALLEVIATED MARINE VEHICLE (AAMV),** *D. James, PE1, M. Collu, MRINA, Cranfield University, UK*

With the recent third round of site allocations for offshore wind farms in extended UK waters, new challenges for efficient operation and maintenance require new solutions to be provided for technician and equipment transfer out to 200 nm from shore. Based on the ongoing work at Cranfield University, a representative methodology for the design of an innovative Aerodynamically Alleviated Marine Vehicle (AAMV) is demonstrated. This process builds upon previous work including theoretical2 and experimental models, culminating with the summary of a preliminary design for a vessel of similar capability. Utilising aerodynamic efficiencies of wing-in-ground effect (WIG) craft, it is shown how a vessel can be equipped with lifting surfaces in order to alleviate the weight of the vehicle, leading to a lower effective displacement, drag and required power. The design spiral of conventional marine craft is modified to include the relevant considerations to equilibrate the aerodynamic forces and moments. Some areas of current and future work are discussed, with experimental results presented.

09.40-10.15 **SEA-PEM – THE NEW WIND FARM MULTIPURPOSE-FAST SUPPORT VESSEL FOR THE NEW CHALLENGES AT THE OFFSHORE WIND INDUSTRY,** *Alfonso Jurado Fuentes, Project Manager, GHENOVA, Spain*

The offshore wind industry has undergone a huge growth in recent years and wind farms are being built further offshore. This new scenario brings new needs and they have to be overcome keeping in mind costs reduction and safety improvement. SEA-PEM Project, offshore wind farm multipurpose-fast support vessel for O&M in offshore wind farms, is a Semi-SWATH of 30 meters length with high autonomy and versatility intended for the new generation of offshore wind farms. Hull design of this walk-to-work vessel is focused to improve the seakeeping and safety making possible to carry out O&M in rough weather. To verify the design, two models were fabricated for carrying out resistance and seakeeping tests.

10.15-10.50 **THE STATISTICAL ANALYSIS OF PRINCIPAL PARTICULARS OF WIND FARM SUPPORT VESSELS,** *Aleksander V. Bondarenko, National University of Shipbuilding, Ukraine*

The data considering wind farm support vessels (WFSV) has been collected. The basic tasks executable by these vessels as well as the key factors taken into account at their design, are distinguished. The diagrams of distribution of vessels on hull material, speed, number of technicians, type of propulsion are built. The basic structural features of vessels are considered. Such basic hull forms of WFSV as monohull, catamarans, SWATH, trimarans and their different varieties are studied. The dependences are got for determination of principal particulars of vessels on the initial stages design for the catamarans. The trends of development of WFSV are shown.

10.50-11.20 **COFFEE**

11.20-11.55 **EXPERIMENTAL ASSESSMENT OF IMPACT LOADS ON CATAMARAN STRUCTURES,** *A.Nazarov, P.Suebyiw, A.Piamalung, Albatross Marine Design, Thailand*

Catamaran platform provides certain benefits for wind farm support vessels and it was widely applied for large number of such craft. Wind farm support vessels are often operated in harsh environments associated with considerable loads on their structures, which require proper structural design approaches. This paper presents the method and results of experimental assessment of structural loads on catamarans during sea trials. Using pressure gauges, slamming pressures were recorded on different parts of catamaran structures. These measurements were synchronized with accelerometer data logging and can be used to advance the design methods and establishment justified design loads. The results of measurements are compared with existing structural engineering methods from rules of classification societies; conclusions are made on possible improvements. Practical structural design issues are reviewed with special interest in composite structures.

11.55-12.30 **THE APPLICATION OF SANDWICH PLATE SYSTEM FOR THE STRENGTHENING OF SPUD CANS ON OFFSHORE JACK-UP VESSELS,** *Martin Brooking, Director, SPS Shipbuilding, UK*

This paper describes the application of the innovative 'Sandwich Plate System' technology (SPS) to the strengthening of spud can feet on offshore wind support vessels. Effective operation of wind support vessels is greatly dependent on their ability to move quickly and safely between locations with a minimum of site preparation. For vessels operating in the North and Baltic Seas, a risk to safe operation is the existence of boulders on the sea bed, deposited as the glacier retreated during the last ice age. Without removal, large boulders will cause high concentrated loads and major structural damage to unprotected spud can feet – leading to unexpected repairs and costly down-time. In January 2014 SPS Overlay was used on the spud can feet of "MPI Resolution", to provide significant strengthening and resistance to the high concentrated loads caused by the presence of boulders. The application of SPS on this vessel has enabled operations to proceed safely and efficiently with minimised site preparation. The paper describes the technical work carried out to design, achieve DNV class approval and implement the upgrades within a tight docking schedule.

12.30-13.30 **LUNCH**

13.30-14.05 **MARINE DESIGN OF A WFSV MODULAR INTERIOR,** *S McCartan and T Thompson, EBDIG-IRC, Coventry University, UK. B Verheijden, Academy Minerva, Groningen, Netherlands. J Morgan, KPM-Marine, UK.*

The aim of Marine Design is to improve the aesthetics, human factors and functionality of a vessel or system, and its' marketability. Although the process of design may be considered 'creative', many analytical processes also take place. Some of the processes that are commonly used are user research, benchmarking, sketching, human factors evaluation and CAD visualisation. Marine Design has a focus on technical concepts, products and processes, as the understanding of product life cycle is fundamental to the design for manufacture (DFM) of vessels or any other product in order for it to become a market leader. Marine Design encompasses the engineering of objects, usefulness as well as usability, market placement, and other concerns such as seduction, psychology, desire, and the emotional attachment of the user to the object. This paper reports on a Marine Design approach to the development of a Wind Farm Support Vessel interior using a modular construction system. The modular system was specifically developed to be fitted in hours, whereas, conventional fitting approaches currently take days. This design innovation facilitates adaptability, whereby the interior of a vessel can be changed to another use within a day, giving the operator vessel flexibility and extended operating life.

14.05-14.40 **INADEQUATE SUPPLY OF VESSELS WITH RIGHT LIFTING CAPACITIES FOR ~28 % OF THE 6000 TURBINES TO BE INSTALLED BY 2020, WILL NECESSITATE ALTERNATIVE FOUNDATION DESIGNS,** *Rashi Jindal, MEC Intelligence, India*

We compare lifting capacity of vessels in the European market against the anticipated demand based on configurations of upcoming windfarms. With increasing project depths, turbine sizes; future foundations are going to be heavier. There would be a major shortage of vessels with right lifting capacities (heavy lift vessels / jack up vessels / cranes) due to large number of upcoming projects. This would necessitate deployment of bigger vessels leading to a non-optimum demand supply situation - Over 1130 turbines - 4 MW, 6 MW at 20m, 30m depth won't find vessels with right lifting capacities (800-1200 tonnes) during 2017-2020. These would depend on vessels with bigger lifting capacities (>1200 tonnes), atleast 30-60 % costlier. Over 300 turbines - 6 MW at 40m, 50m depth, and 8 MW at 30m, 40m depth won't find vessels with right lifting capacities (1200 tonne-1600 tonnes) during 2019-2020 and would need to depend on vessels with bigger lifting capacities (>1600 tonne), atleast 30 % costlier. Turbines of size 8 MW (>40 m depth), 10 MW (at>20 m depth) won't find vessels with adequate lifting capacities (>1600 tonnes) during 2019-2020, as over 200 turbines would not get any vessels.

14.40-15.15 **DESIGN-DRIVEN INNOVATION: AN OSV PLATFORM WFSV MOTHERSHIP FOR NORTH SEA OPERATIONS**

S McCartan and T Thompson, EBDIG-IRC, Coventry University, UK. B Verheijden, Academy Minerva, Groningen, Netherlands. C Anderberg and H Pahlm, Division of Maritime Operations, Chalmers University Of Technology, Sweden.D Boote and T Colaianni, DITEN, Genoa University, IT. Research has indicated that current wind farm support vessels will not be appropriate for accessing the UK Round 3 far shore wind farms of the North Sea. This paper presents a mothership concept design proposal, that challenges perceptions of the working and living environment on commercial vessels through the implementation of Design-Driven Innovation. The interaction between innovation of design meaning and technology innovation can transform the market within an industry and even create new market sectors. An analysis of the offshore wind market identified the challenges of vessel financing compared to the oil & gas sector, as a unique opportunity for a common platform technology vessel. The concept presented has an innovative WFSV launch/recovery system enabling a conventional OSV platform to be adapted into a mothership role. Resulting in a more cost effective solution in terms of design and construction that the benchmarked specialist vessels.

15.15-15.45 **COFFEE**

15.45-16.20 **MULTIPLE POD UNITS FOR EFFICIENT VESSEL HANDLING IN WIND FARM OPERATIONS,** *G Torneman ,AB Volvo Penta. Sweden*

Volvo Penta IPS propulsion systems with forward facing contra rotating propellers have proven themself to be very successful in WFSV Wind Farm Support Vessels in the 16-19 m range. With Volvo Penta Quadruple IPS installation all the features of the IPS system, including active manoeuvring in high seas, no risk of losing grip in water in bollard push against the wind farm pylon and reduced fuel consumption compared with fixed pitch propellers and waterjets, are available for the 24-30 m range of WFSV. The paper will show the calculations of speed and thrust for different vessels type as well as different lay-outs of the IPS system in a multiple engine application. Experience from WFSV operation with Volvo Pentas engines and prop system will also be presented with load factors and experience from real duties.

16.20-16.55 **EFFECTS OF CHANGES IN HULL GEOMETRY ON SEA KEEPING BEHAVIOUR OF MONO-HULL VESSELS,** *Ahmad Sohrabi, Pasargad, Iran*

Dynamics of a vessel in wave is dependent to its geometry characteristics, speed, dimensions and also wave characteristics. In this field, Hull form optimization from a hydrodynamic performance point of view is an important aspect of ship design. The present work is devoted to see what the effects of changes in vessel's main dimension are on RAOs of heaving, pitching and rolling motions of the vessel. By changing main dimensions of a mono-hull in different forms and using strip theory as a calculation method, it demonstrated that increasing length of vessel and its slenderness, causes decreasing in amplitudes of mono-hull vessel's motions. Validation of results with experimental works also shows the amount of accuracy in the present work.

16.55- **GENERAL DISCUSSION**

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