leanwind

Logistic Efficiencies And Naval architecture for Wind Installations with Novel Developments

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List of Abbreviations

Acronym	Description
ABS	American Bureau of Shipping
APRM	Applied Policy Research Methodology
CEC	Clean Energy Council
CTV	Crew Transportation Vessel
CWIF	Caithness Windfarm Information Forum
DMA	Danish Maritime Authority
DNV-GL	Det Norske Veritas – Germanischer Lloyd
DP	Dynamic Positioning
EWEA	European Wind Energy Association
FMECA	Failure Mode, Effects, and Criticality Analysis
FSA	Formal Safety Assessment
GWO	Global Wind Organisation
HAV	Hand-Arm Vibration
HAZID	Hazard Identification
HAZOP	Hazard and Operability
HLV	Heavy Lift Vessel
HSE	Health and Safety Executive
IFC	International Finance Corporation
IJUBOA	International Jack-Up Barge Operators Association
IMO	International Maritime Organization
ISM	International Safety Management Code
JUV	Jack-Up Vessel
LOLER	Lifting Operations and Lifting Equipment Regulations
MAIB	Marine Accident Investigation Branch
MSC	Maritime Safety Committee
O&M	Operation and Maintenance
OAV	Offshore Access Vessel
OIM	Offshore Installation Managers
OSVDPA	Offshore Service Vessel Dynamic Positioning Authority
RCO	Risk Control Option
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations
ROV	Remote Operating Vehicle
RRR	Rapid Risk Ranking
SAR	Search and Rescue
SIMOPS	SIMultaneous OPerationS
SOLAS	Safety Of Life At Sea Convention
STCW	Standards of Training, Certification, and Watchkeeping
WBV	Whole Body Vibration
WTG	Wind Turbine Generator
WP	Work Package

Executive Summary

The work presented in this deliverable report documents the findings and results from Task 6.3 "Health and Safety Issues" of the LEANWIND Project. It is a comprehensive analysis of the existing situation regarding health and safety issues in the offshore wind industry, in terms of regulatory framework and relevant guidelines from key players of the industry, availability of health and safety specific accident databases, and the risk levels of critical accident scenarios. The main focus of the work presented in this report is to assess selected innovation categories that have been examined in the framework of the LEANWIND Project, in terms of their effect on health and safety issues. The report deals with innovations for worker access systems, lifting arrangements, and novel vessel concepts. Furthermore, the report presents an overview of existing regulations and requirements regarding training competencies of personnel involved in the O&M of Offshore Wind Farms. The report identifies gaps that need to be filled in order to cover the actual competencies required in the wind industry and proposes training requirement guidelines that will help in improving the overall level of safety for workers in Offshore Wind Farms. The report is structured in the following four sections: state of the art, health and safety related accidents, health and safety risk assessment and training requirements.

The **state of the art** section includes the analysis of the existing framework of regulations and guidelines relating to occupational health and safety in the offshore wind industry and the identification of gaps through a structured regulatory gap analysis. In addition, a brief overview of risk assessment applications in the offshore wind industry is presented. The state of the art is concluded with a review of the existing databases for occupational accidents in Offshore Wind Farms that have been identified in the context of Task 6.3. The identified data sources include the data stored by the Caithness Windfarm Information Forum, the summary statistics on injuries and fatalities provided by the G+ Offshore Wind Health and Safety Association (formerly named G9 Offshore Wind Health and Safety Association) and the reports provided by UK's HSE.

The following section presents two characteristic case studies of actual **accidents** that have occurred in Offshore Wind Farms and relate to health and safety issues. The selected accidents involved the collapse of a crane during an offshore lifting operation and the collision of a CTV with the tower of a WTG.

The section on **health and safety risk assessment** outlines the methodology that was employed for achieving the goals of Task 6.3. The methodology follows the general guidelines set by the IMO for Formal Safety Assessments (FSAs) and comprises the following steps: 1) hazard identification, 2) risk modelling, 3) qualitative analysis, and 4) semi-quantitative analysis. The identification of hazards was based on an extensive survey of the relevant literature and distinguishes between common industrial hazards and particular hazards that are present in an Offshore Wind Farm. Risk modelling involved the construction of bow-tie models for critical accident scenarios that were selected based on existing statistics for occupational accidents. The constructed bow-tie models combine a fault tree with an event tree analysis, which means that each selected critical scenario is examined from its root causes up to the consequences that follow the accident. The qualitative analysis aimed to determine the most important events in the development of each examined accident scenario and was coupled with a high-level barrier analysis that aims to assess the effectiveness of specific existing RCOs. The semi-quantitative analysis was used for assessing the effect of selected innovation categories on the current level of

health and safety risk. The approach that was followed combined frequency and severity indices into a risk index, by employing custom risk ranking matrices. Frequency and severity were also assigned specific numerical values, based on expert judgement and logical inference, in order to calculate the relative probability of occurrence for each top event and the relative probability of each accident scenario outcome. The selected innovations were assessed by comparing the calculated likelihood of equivalent fatalities, for each accident that was examined, of a base case (current state of the art) with the one calculated for each innovation category. The calculated likelihood of equivalent fatalities for each accident scenario that was examined was also benchmarked against annual frequencies of related incidents from data provided by the G+ Offshore Wind Health and Safety Association.

The final section of the report focuses on reviewing the current state of the art regarding **training requirements and certifications** for marine crew and industrial personnel involved in the O&M of an Offshore Wind Farm. Based on the identified gaps, the report proposes specific actions that should be taken in order for training requirements and specifications to cover the actual competencies that are necessary for the personnel working at an Offshore Wind Farm.

The report concludes with interesting findings and insights based on the analysis that was presented. The most important conclusions are the following:

- The existing regulatory framework, regarding health and safety issues, needs to become more wind industry specific to cover the special set of hazards present at an Offshore Wind Farm.
- More details on health and safety related accidents and corresponding data should be made available, in order to support quantitative risk assessment studies that aim to improve the health and safety level for Offshore Wind Farms.
- The majority of innovation categories do not have an adverse effect on the level of health and safety risk, compared to the current state of the art, and therefore no specific novel RCOs are proposed in the context of this report.
- Training requirements and certifications should be made more wind industry specific to cover the actual competencies required for working at an Offshore Wind Farm, and safe behaviour courses should be combined with courses on technical skills.