G+ Safe by Design workshop:

Floating Offshore Wind - Transfers, access and egress, and materials handling

G+ Global Offshore Wind
Health & Safety
Organisation

In partnership with
energy institute

G+ IN PARTNERSHIP WITH ENERGY INSTITUTE

SAFE BY DESIGN WORKSHOP

FLOATING OFFSHORE WIND

Published by
Energy Institute, London
The Energy Institute is a professional membership body incorporated by Royal Charter 2003
Registered charity number 1097899

The Energy Institute (EI) is the chartered professional membership body for the energy industry, supporting over 23 000 individuals working in or studying energy and 200 energy companies worldwide. The EI provides learning and networking opportunities to support professional development, as well as professional recognition and technical and scientific knowledge resources on energy in all its forms and applications.

The EI's purpose is to develop and disseminate knowledge, skills and good practice towards a safe, secure and sustainable energy system. In fulfilling this mission, the EI addresses the depth and breadth of the energy sector, from fuels and fuels distribution to health and safety, sustainability and the environment. It also informs policy by providing a platform for debate and scientifically-sound information on energy issues.

The EI is licensed by:

- the Engineering Council to award Chartered, Incorporated and Engineering Technician status, and
- the Society for the Environment to award Chartered Environmentalist status.

It also offers its own Chartered Energy Engineer, Chartered Petroleum Engineer, and Chartered Energy Manager titles.

A registered charity, the EI serves society with independence, professionalism and a wealth of expertise in all energy matters.

This publication has been produced as a result of work carried out within the Technical Team of the EI, funded by the EI's Technical Partners. The EI's Technical Work Programme provides industry with cost-effective, value-adding knowledge on key current and future issues affecting those operating in the energy sector, both in the UK and internationally.

For further information, please visit **http://www.energyinst.org**

The EI gratefully acknowledges the financial contributions towards the scientific and technical programme from the following companies:

Corio Generation
EDF
Equinor
Ocean Winds
Ørsted
RWE
Scottish Power Renewables
Siemens Gamesa
SSE
Vattenfall

However, it should be noted that the above organisations have not all been directly involved in the development of this publication, nor do they necessarily endorse its content.

ISBN 978 1 78725 XXX X

Published by the Energy Institute

Hard copy and electronic access to EI and IP publications is available via our website, **https://publishing.energyinst.org**.
Documents can be purchased online as downloadable pdfs or on an annual subscription for single users and companies.
For more information, contact the EI Publications Team.
e: **pubs@energyinst.org**

CONTENTS

LIST OF FIGURES

Page

Figures

DISCLAIMER

This report has been prepared on behalf of and for the exclusive use of G+ In Partnership with Energy Institute, and is subject to and issued in accordance with the agreement between G+ In Partnership with Energy Institute and Worley Europe Limited. Worley Europe Limited accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party.

1 EXECUTIVE SUMMARY

On 30 November 2022 G+ held a Safe by Design Workshop which brought together industry experts to assess health and safety risks relating to floating offshore wind. The purpose of the workshop was specifically to identify the steps the industry could take to effectively reduce health and safety risks that are unique to floating offshore wind.

The workshop focused on three themes: 1) access to the structure from a vessel; 2) moving around the structure including emergency egress, and 3) materials handling.

1.1 RECOMMENDATIONS

A range of topics was discussed during the workshop which has led to the following key recommendations for the industry:

1. Research into motion of floating offshore wind assets and its short-and long-term impact on the human body should be undertaken.
2. Guidance covering vessel and foundation interfaces should be developed.
3. A Safe by Design Good Practice Guide should be produced that embeds the Safe by Design philosophy in development and design process.
4. Research and guidance should be completed on lifting operations on floating offshore wind assets.
5. Guidance on training requirements should be updated to cover floating offshore wind.
6. Research into the characteristics of different foundation concepts should be carried out to help selection and operations and maintenance (O&M) modelling.
7. A framework for better sharing of technical information for foundation motions, human factors and health issues across the industry should be implemented.
8. Guidance on the requirement for multiple access points for access and egress on the foundation and enclosed areas in the foundation should be developed.
9. Guidance on managing towing operations and the need to access structure should be developed.
10. A research programme to test the rail system and lifts in more dynamic environments should be carried out.

These recommendations represent initiatives that provide tangible steps that the industry can take to reduce risks related to floating offshore wind. A number of other recommendations were identified for consideration for developers and asset operators when developing projects and managing assets.

2 BACKGROUND AND INTRODUCTION

2.1 BACKGROUND

The G+ Global Offshore Wind Health and Safety Organisation (G+), comprises the world's largest offshore wind developers and wind turbine generator (WTG) original equipment manufacturers (OEMs), established to form a group that places health and safety at the forefront of all offshore wind activity and development. The primary aim of the G+ is to create and deliver world class health and safety performance across all its activities in the offshore wind industry. The G+ has partnered with the Energy Institute (EI) to develop materials, including good practice guidelines to improve health and safety performance. Through sharing and analysis of incident data provided by G+ member companies, an evidence-based understanding of the risks encountered during the development, construction and operational phases of a wind farm project has been developed. This information has been used to identify the health and safety risk profile for the offshore wind industry.

In 2014, the Crown Estate asked the G+ to take over the running and delivery of their Safe by Design workshops. The Crown Estate had run a number of these previously, covering topics such as diving operations, lifting operations, wind turbine design and installation and the safe optimisation of marine operations.

The G+ aims to explore industry operations and technologies with a focus on Safe by Design principles. The workshops examine the current design controls relating to a topic, discuss where current design has potentially failed, identify opportunities for improvement and then seek to demonstrate the potential risk reduction to be gained from these new ways of thinking and operating.

To date, nine workshops have been held under the auspices of the G+ covering: Marine transfer/access systems; Escape from a nacelle in the event of a fire; WTG service lifts and follow up; Davit cranes; WTG access and egress; WTG access to the transition piece below airtight deck; Hydraulic torquing and tensioning systems, and Blades. The outputs from all of these workshops have been made available in reports which can be downloaded from the G+ website, to be used as a reference by the industry.

Details of the workshops can be found at the following link: https://www.gplusoffshorewind.com/work-programme/workshop.

2.2 INTRODUCTION

G+ selections of topics for Safe by Design workshops have generally been led by a review of historical safety statistics. A Safe by Design workshop covering floating offshore wind was, however, considered necessary due to the expected rapid increase in installed and operating assets using floating technology, along with its lack of maturity and lack of others undertaking work on the health and safety element. Floating offshore wind was selected for this workshop due to a recognition that future risks and the control measures for fixed bottom may not apply, or may need to be modified, and there was limited operational experience. G+ specifically identified the need to consider the safe transfer of personnel to and around offshore floating foundations and WTGs and O&M activities.

2.2.1 Floating offshore wind context

Floating offshore wind is on the cusp of rapid acceleration in terms of size and scale of the number of assets operating, yet it is fundamentally a nascent technology. Any immature technology contains inherent risks and the design feedback loop provides a mechanism for issues to be identified and resolved during the following iteration of the technology as shown in Figure 1.

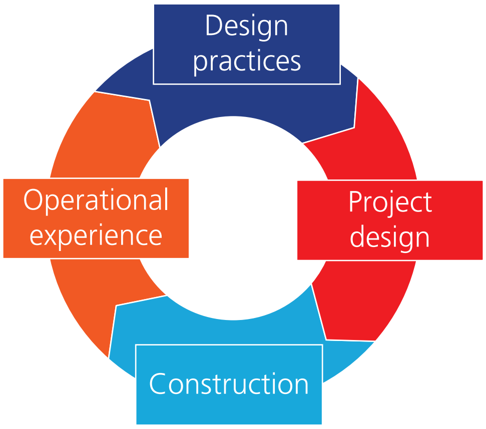

Figure 1: Typical design feedback loop

In offshore wind, the pace of the industry combined with the relatively long project development durations, exposes the industry to the potential for significant numbers of assets entering operation with risks before they are identified and can be managed.

Another feature of offshore wind is number of assets with the same design; a design feature will therefore impact several hundred assets across a site and industry. There will also be a significant number of offshore transfers so the frequency of exposure to any given hazard represents a substantial aggregated risk. Effective risk management at the design stage will therefore yield significant benefits for the industry.

An additional feature of offshore wind is the diversity of concepts being developed. The workshop focuses on the current four main concepts but there are a number of variations of these and many other unique concepts all with their own specific set of hazards.

3 METHOD, AGENDA AND ATTENDANCE

3.1 METHOD

A one-day workshop was held on 30 November 2022 at The Village hotel in Aberdeen, which was attended by over 70 industry professionals from the offshore wind industry including: developers; operators; HSE professionals; OEMs; vessel operators; universities; training providers, and risk management consultants. The workshop focused specifically on floating offshore wind and safe transfers, across three key themes:

– access and egress onto the structure;
– access and egress on and around the structure, and
– materials handling and work execution.

There are a number of different floating concepts being developed, with little convergence and each having fundamentally different risk profiles. During the planning phase it was considered necessary to consider the four current mainstream concepts: namely barge; spare; tension leg, and semi-submersible, as shown in Figure 2:

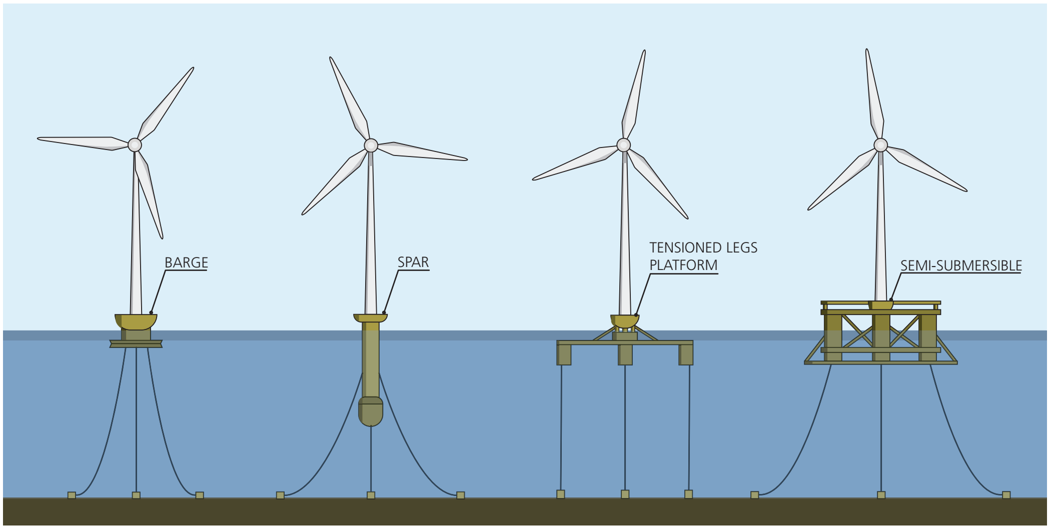

Figure 2: Floating concepts in the scope of the workshop

The event began with an opening remark from Marcus Peters, Global Head of Offshore HSE (Development. Construction, new Markets and Technologies), RWE Offshore, and then followed by a presentation from Steve Hillier, Director of Asset Management, Worley. This presentation outlined the objectives for the day and the purpose, additionally exploring the importance of managing risk at the design stage in a floating offshore wind context.

After the opening attendees separated into breakout rooms, each exploring one of the three themes of the day. See annex A for a list of companies in attendance.

There were two breakout sessions during the day: the aim of the first session was to identify hazards associated with the theme, and the second session explored the solutions to the identified hazards. After each session, all groups returned to the main discussion area to communicate key points and topics discussed in their group. The agenda for the workshop can be found in Annex B.

After the workshop, the records of the discussions across the three groups were reviewed to identify common topics and key insights to enable the development of main recommendations. Some of the recorded findings were considered to be new risks to floating offshore wind, some were considered to be risks that could be higher than fixed bottom and some were considered to be the same as fixed bottom. There were also some findings that clearly represented a risk, while others related to concerns due to the lack of operational experience or research. These factors were used to assess the findings and convert them into the key relevant recommendations.

4 BREAKOUT GROUP DISCUSSION

This section of the report explores the key Safe by Design topics raised during the discussions in breakout sessions and covers the risks that are unique to floating offshore wind or potentially increased compared to fixed bottom.

4.1 MOTION SICKNESS AND INCLINATION

Motion sickness featured in most discussion groups and is a clear concern for the participants of the workshop. Floating offshore wind will inevitably create a more dynamic workplace for offshore technicians due to the increased movement of the structure compared to fixed bottom installations. Any motion or inclination of the structure will be enhanced at the nacelle level due to its height.

Several possible implications of this were identified:
1) Motion sickness resulting in people feeling unwell.
2) Requirement to enact an emergency rescue in extreme cases.
3) Increased fatigue which has a secondary impact of increasing risks associated with other activities.
4) Long-term impact on the human body.

It was clear in the workshop that this specific risk was mainly raised due to the participants, perception of the risks and the feeling that it is an area that is not fully understood, and there was a recognition that the severity of this risk is likely to vary significantly for the different concepts.

Possible mitigations raised were:
1) Implementation of shorter or different shift patterns for the technicians.
2) Introduction of a process to determine if individuals are particularly susceptible during training.
3) Continuous monitoring of the structure and the individual while on the structure, combined with modelling, including motion and wave frequency, to assist in identifying the specific conditions that increase motion sickness.

Mitigations such as different shift-patterns have a significant impact on staffing requirement and operations. It is therefore recommended that a research programme is commenced to improve the industry's understanding of this potential risk. The research should assess motion of different floating concepts at different areas of the structure and the WTG alongside the short-and long-term impact on the human body. It is recommended that this programme combines the technical, asset operations and health communities to ensure a holistic research programme is delivered.

4.2 MANUAL HANDLING

There were concerns in relation to manual handling due to 1) the increased motion, and displacements of the structure compared to fixed bottom, and 2) the need to move material and/or, equipment along horizontal members of the semi-submersible concept.

The workshop discussion raised concerns regarding possible injuries when manually handling large loads, dragging bags around the turbine from one point to another, climbing ladders with materials and repetitive lifting causing excess strain on the person. The impact of dynamic amplification can impose further stresses onto the technician due to the increased motion of the structure hindering balance and stability of individuals. Therefore, there was a common understanding that manual handling risks will be higher for floating compared to fixed bottom concepts. At concept design phase, it is important to consider logistics holistically, including hatch and crane placements to reduce strain when manually handling, reducing dragging and repetitive lifting.

There were also a number of micro-level mitigations suggested such as trolleys, designing lifting equipment to account for the motion of the structure and appropriate hook-on points; however given the diversity of concepts in the industry it isn't considered practical to implement this through technical specifications. A macro-level recommendation is for projects to develop a holistic logistics plan at the concept stage, and for this to be constantly refined during the design, and for it to be used to guide optimising design decisions.

4.3 ACCESS AND EGRESS

Access and egress issues were raised in all discussion groups in a variety of contexts.

4.3.1 Access and egress onto the structure

Concerns were raised regarding the transfer onto the structure from a crew transfer vessel (CTV). Specifically, the relative movement between the CTV and structure that is increased, compared to fixed bottom increasing the risks of incidents during transfers, such as trips due to loss of balance. It was suggested that vessels could use a clamp-on mechanism to create stability and reduce hazard likelihood. The possibility of a CTV losing power/control and getting stuck under the semi-submersible was also identified as a risk specific to floating wind. Additional risks were identified relating to the risk of vessels interacting with the mooring systems.

It was recognised that many sites will adopt a walk-to-work (W2W) system which would mitigate the risk of the transfer from a CTV; however, providing a stable system, given the vessel and floating structure will be moving relative to each other, presents different issues.

The key observation was the lack of integrated design processes to combine the foundation design with the vessel design. Currently, they are generally carried out in isolation which inevitably leads to sub-optimal operational solutions.

There are two recommendations:

1) The industry should explore the potential for standards that define the interfaces between the structure and the vessel. These should be produced in collaboration between foundation designers, asset developers and operators, vessel designers and vessel operators. This should also be used to guide joint technology advancements and foster a more integrated approach to the management of this important

interface.

2) The project-specific logistics plan described in the previous section should also cover the interface between the vessels and the foundation to ensure an integrated approach is considered throughout the project development.

Lifts and fall-arrest systems are used extensively throughout the industry and, given the safety-critical nature of this equipment, are part of specific inspection and maintenance regimes. For fixed bottom this is considered to be effective; however, there are concerns that the increased dynamics of floating wind will increase wear rates of guide wires and other components and the movements may also take the components outside current specified inclination limits. It is recommended that a research programme is carried out to assess the implications of the dynamics associated with offshore wind on existing lift and fall-arrest system technology and identify any requirements for design changes.

4.3.2 Access into enclosed spaces

Floating structures will be equipped with ballast systems that will require inspection and maintenance. Traditionally, fixed bottom foundations are designed with single hatches to enter levels below the WTG within the foundation. Although these areas are not expected to be entered frequently, experience from the workshop attendees has shown that they are accessed far more than originally envisaged for inspections or non-routine O&M activities. The single access hatch is subsequently required for normal access, emergency escape, logistics and sometimes to provide a route for ventilation equipment. For floating structures, the need to access for routine O&M will increase so it is recommended that the management of enclosed spaces should be considered during design and multiple access and egress routes included, for example two hatches rather than one.

4.3.3 Access around the structure

Risks associated with slips, trips, and falls were considered to be higher compared to fixed bottom structures due to the additional movement which could compromise balance. It was suggested that expected movements at different parts of the structure should be assessed during the design stage and this should be used to develop the O&M procedures.

The structures are expected to suffer from guano accumulation and there will be larger areas to keep clean. There are also concerns about using traditional pressure washing to remove guano on concrete structures and possible long-term material damage. It was considered important to, as far as practicable, include features to prevent resting points and include anti-fouling deterrents and ensure this risk is properly considered at the concept stage when bird surveys are being carried out. Additionally, for concrete structures, the long-term impact of pressure washing and guano on the material and reinforcement should be investigated to determine if it is a feasible control measure.

Ice was also raised as a concern due to the larger external walkways, particularly for semi-submersible concepts. It was considered necessary to control this risk through access procedures; however, it was acknowledged that this may result in significant inaccessible periods for some sites.

A key suggestion was to ensure that lighting is properly considered at the design stage, with specific studies carried out to ensure the level of lighting and also the location was appropriate for all activities.

4.3.4 Emergency evacuation and emergency rescue

Emergency evacuation was considered to represent a significant challenge compared to fixed bottom concepts. The structures will generally be more complicated, with less straightforward evacuation routes which will increase the time to evacuate or recover a casualty. Some concepts were considered to be more challenging. For example, a semi-submersible concept may have the boat landing some distance from the WTG so a casualty may have to be moved horizontally across the structure. Another issue identified was the possibility that an evacuation from the top of the nacelle may result in someone descending between the members of the semi-submersible structure, preventing a CTV from recovering the individual. This, again, demonstrated the need for holistic thinking that commences at the concept stage to ensure that the various interfaces are managed. This should consider the rescue and evacuation routes and include all stakeholders.

4.4 INFORMATION SHARING AND MATURITY DEVELOPMENT

Many discussions in the workshop touched on sharing of information within the industry. Although the sharing of safety statistics was considered to be valuable, the need to share other information was considered necessary to enable the industry to effectively and rapidly transition into floating concepts at scale. As mentioned in 2.2.1 a particular challenge for offshore wind is the ability to feedback operational experience into the design phase to ensure any early issues are resolved in subsequent projects. Although the expected pace of the industry will make this difficult, a systematic structure for sharing of non-confidential information is considered important. This should include technical items such as measured displacements and motion, human factors and health statistics.

4.5 TURBINE RELIABILITY

The workshop discussions were generally based on an expectation that the turbine reliability levels will be lower for floating compared to fixed bottom installations. The natural consequence of this is an increase in reactive and preventative maintenance and more visits to the assets. Ultimately, this will lead to greater exposure to any hazards that are present and more frequent complex non-routine maintenance activities. The industry has invested heavily in remote monitoring technology and the use of drones to minimise the need for technicians to undertake maintenance and this is expected to continue. The participants, however, considered it necessary for the industry to further explore opportunities to reduce maintenance requirements and improve asset reliability.

4.6 BALLAST SYSTEMS

Ballast systems will be a feature of floating wind and will require inspection and maintenance in enclosed spaces, increasing the overall maintenance requirements compared to fixed bottom. As described in 4.3, it was considered necessary to design the access and egress arrangements to avoid single points of entry.

There were also considered to be requirements to:

1. Develop guidance on the different ballast materials that could be utilised.
2. Exploring the options to extend the ballast system longevity will result in less maintenance required.
3. Develop guidance for regular monitoring with sensors for early detection of issues.
4. Where data are collected, it is recommended these findings are shared industry-wide which will assist in the investigation and trialing of different ballast materials.
5. Reduce requirements for physical intervention as much as possible.

4.7 RISKS DURING TOWING

Risks associated with towing offshore foundations were identified as on area which the industry needed to understand further and manage effectively. For example, prior to final installation of floating structures there may be a requirement to access the structure, so there were concerns about power and adequate lighting to move around the structure. The risk observed in relation to tugging highlighted the limited use of this activity in the industry to date and there is a lack of adequate technical standards and guidance. There were also concerns about the complexities controlling the position of the floating structures using tugs and the potential for damage to the structure.

Given the frequency of towing operations during construction and operational phases, and the industry's lack of experience, it is recommended that there is a specific industry initiative to: develop operational guidance; define training; competency; design, and operational requirements to ensure towing is effectively managed and the structure is optimised for towing operations.

4.8 COMPLEX LIFTING

Lifting operations were identified as potentially presenting additional complexity and risks in comparison to fixed bottom. Lifting operations will be between two floating structures with possible relative movement, which will complicate the ability to control the lift but also introduce the risk of snatch loading on the lifting equipment. Main component lifts were also identified as a critical operation which, as well as having complexities minimising relative movements, will also change the centre of gravity on the floater.

It is recommended that a research project is carried out to assess the limitations of routine and non-routine lifting operations in floating wind to assess the suitability of existing equipment and the restrictions. As highlighted throughout the report, consideration also must be given during the design phase to consider lifting requirements and crane placement.

5 RECOMMENDED INDUSTRY ACTIONS

The workshop highlighted a range of potential risks and possible mitigation opportunities. Where appropriate, these have been brought together as 10 key recommendations for the industry which are set out here.

Recommendation 1 – Research into motion and its short- and long-term impact on the human body

The industry should commence a research programme to improve its understanding of potential risks associated with the motion of the structure and develop any specific mitigation required.

The research should assess motion of different floating concepts at different areas of the structure and the WTG alongside the short-and long-term impact on the human body. It is recommended that this programme combines the technical, asset operations and health communities to ensure a holistic research programme is delivered.

Recommendation 2 – Development of guidance covering vessel and foundation interfaces

The risks associated with transfer of personnel, whether from a CTV or a W2W system, are considered to be higher compared to fixed bottom installations. It was observed that the interface between the vessel and the structure is a key factor that influences this risk, yet there is no integrated design process to optimise it. It is not considered feasible or appropriate for the industry to develop perspective standards given the make-up of the industry; however, it is recommended that the industry should explore the potential for standards that define the interfaces between the structure and the vessel. These should be produced in collaboration between foundation designers, asset developers and operators, vessel designers and vessel operators. This should also be used to guide joint technology advancements and foster a more integrated approach to the management of this key interface. This initiative could also lead to a technology roadmap from OEMs, foundations designers/fabricators, vessel providers and other relevant industry members to assist in the proactive management of interfaces as the industry develops.

Recommendation 3 – Safe by Design Good Practice Guide

There are a number of areas where risks can be managed through early consideration and adoption of ‘systems thinking’. For example, developing a holistic logistics plan at the concept stage and further developing and refining it as the design progresses will increase the likelihood that interfaces will be effectively managed. It is not feasible to develop this for floating offshore wind industry as a whole, as it will need to be tailored to the specific site; it is therefore recommended that a Safe by Design Good Practice Guide is developed that sets out how the principles can be integrated into a project design process.

Recommendation 4 – Research into lifting operations

It is recommended that a research project is carried out to assess the limitation of routine and non-routine lifting operations in floating wind to assess the suitability of existing equipment and the limitations.

Recommendation 5 – Updated guidance on training requirements

There were a number of areas identified where the existing training may not be sufficient. A review of the requirements for offshore floating should be carried out and compared with existing training scopes. It was noted that current practices focus on the proper use of the equipmentz, but not necessarily the best way to use it to avoid fatigue. An example is the techniques for climbing which have a significant impact on fatigue and, given there are concerns that the motion on the floating structures could increase fatigue levels, it is important to have a broad review.

Recommendation 6 – Research into the characteristics of different foundation concepts to help selection and O&M modelling

As outlined in Recommendation 1, it is necessary to improve the industry's understanding of the motion of the different concepts and the associated limitations for access and operation. It is considered necessary to research the characteristics of the different structures to enable effective selection and O&M modelling. Although this is principally a commercial risk, the impact of assets entering operation with unachievable limits or impracticable maintenance windows could result in a number of issues.

Recommendation 7 – A framework for better sharing of technical information for foundation motions, human factors and health issues across the industry should be implemented

The industry needs a strong and consistent feedback loop to maximise the opportunity for sites in development to take advantage of lessons from operating assets. This should include technical items such as measured displacements and motion, human factors and health statistics.

Recommendation 8 – Multiple access points for access and egress on the foundation and enclosed areas in the foundation

Ballast systems introduce systems that will need inspection and maintenance in enclosed environments. Multiple routes of access should be part of the design (e.g. two hatches) to enable effective management and execution of any activities within the enclosed spaces.

Recommendation 9 – Guidance on managing towing operations and need to access structure

There were several risks associated with towing operations and accessing the structure in transit. It is therefore recommended that the industry commences a collaborative project to assess all aspects of towing operations, with the objective of developing guidance and standards for design and operations.

Recommendation 10 – Research programme to test rail system and lifts in more dynamic environments

There are concerns that the increased dynamics of floating wind will increase wear rates of guide wires and other components and also take the components outside current inclination specifications. It is recommended that a research programme is carried out to assess the implications of the dynamics associated with offshore wind on existing lift and fall-arrest system technology and identify any requirements for design changes.

6 PROJECT CONSIDERATIONS

In addition to the key industry themes described in Section 5, the workshop identified a number of items that should be considered by project developers and designers. These are listed as follows:

Item	Considerations
1	Use technology to reduce offshore inspection frequencies, such as by the use of drones and fixed internal cameras, therefore reducing the time exposed to hazards.
2	Include multiple access points on the floating structures to accommodate different situations, including rescue.
3	Assess benefit of alternative self-rescue mechanisms within the tower such as a viking chute to avoid the need for external intervention and reduce time to evacuate.
4	Ensure vessels can accommodate stretchers.
5	Design gangways to handle movements on both ends. Design substructures to be compatible with multiple gangways and not be limited to one design, or standardise the W2W systems.
6	Utilise hoist systems for access and engage with CTV suppliers and designers to improve design for all body types,
7	Early engagement with vessel providers to ensure interfaces are considered prior to design, to ensure details are optimised for all parties.
8	Compete design risk reviews at an early stage with fabricator/transporation & installation(T&I)/operations and decommissioning; this improves industry collaboration and a degree of standardisation.
9	Investigate different types of floating systems and whether their heights are variable; the data can be used to understand vessel positioning.
10	Design vessel to provide 360 line of sight.
11	Use 3D modelling to check operational method and interfaces.
12	Assess the impact of different platform heights and the potential requirement to climb higher; this will provide informed decisions on training requirements and likelihood of fatigue.
13	Adapt DP2/DP3 systems to reference the structure (using prisms/markers) rather than being geo-located.
14	Include anti-fouling deterrents to minimise guano, and give consideration to continuous monitoring to understand risk areas.
15	Minimise design resting points to reduce guano, to reduce the risk of slips, trips, and falls.
16	Determine which areas need to be routinely cleaned if guano is present.
17	Consider colours of potential slip hazards to make them more visible, and include posters at access points as a reminder.
18	Suspend WTG operation before personnel are on board, to minimse motions.

Item	Considerations
19	Monitor weather and nacelle position for service operations vessel (SOV)/ helicopter operations and the assess the impact on actual inclination and movement.
20	Monitor motions for the nacelle and floater.
21	Look at storage for tools in the correct location to minimise movement and excessive load for lifting, reducing strain.
22	Assess ramps versus steps to ease movement and reduce trips and falls.
23	Assess lumens requirement and compare with regulations.
24	Develop simple attachments and connections, to reduce the impact of a trip and motion of the floating structure.
25	Include specific attachment points for tools, and ensure there is a sufficient number of them.
26	Increase focus on working procedures on tool tethering.
27	Ensure no lone working, reduce risk of multiple hazards due to an increased level of awareness.
28	Provide protection of middle section where applicable.
29	Implement a solution for fall into middle, for example netting/ladders; note anodes may be in place.
30	Incorporate anchor points for safe extraction in the design.
31	Design with inclination in mind, i.e. Floating means the angle moves.
32	Shorter job duration and place a higher consideration on different shift patterns. Challenge traditional working patterns; floating offshore wind is an emerging industry, so new approaches may be required.
33	Maximise possibilities for access with SOV, helicopters and CTV options and include several boat landing options; this will contribute to a best-informed decision and safe transfer.
34	Assess vessel grip around boat landings to reduce the impact of movement.
35	Reduce people's exposure time.
36	Include railings in design rather than wires, to reduce the hazard of personal protection equipment (PPE) or equipment becoming caught.
37	Avoid active ballast systems as much as possible, as this requires increased subsea work.
38	Assess different ballast options but avoid regular physical inspection as much as possible; can different materials be explored that may reduce the requirement for subsea inspection.
39	Implement cross-learnings from oil & gas (O&G) for mooring lines.
40	Include a trolley-based design on the platform, reduce the manual drag.
41	Introduce a climb assist for all body types to reduce the weight of load; this will also offer additional support.
42	Reduce the weight of PPE; heavy PPE increases load on a person when climbing, increasing fatigue.
43	Involve technicians in the development of these new technologies and ensure standards are developed to set a baseline for designs.

7 CONCLUSION

This report has discussed the findings from the Safe by Design workshop for floating offshore wind transfers and outlined actionable recommendations.

The workshop is considered to have been a valuable activity and it has delivered some tangible outcomes. This reinforces the need for the workshop and the level of participation demonstrates the interest the industry has in effective management of the risks associated with floating offshore wind.

It is recommended that the industry progresses the activities proposed in Section 5 within appropriate industry forums that have the ability to deliver a collaborative project, and include relevant knowledge from other sectors, and with the appropriate mandate.

ANNEX A
WORKSHOP ATTENDEES

The following list outlines companies that had presence at the workshop:

1. BP
2. Cairn Risk Consulting
3. CGA
4. Copenhagen Offshore Partners
5. Corio Generation
6. EQUINOR
7. ex-Orsted
8. Floating Energy Allyance
9. Flotation Energy
10. G+
11. GE Vernova
12. Generating Better
13. HMCG
14. HSE
15. IMCA
16. KOOKA Technology Corporation
17. Mainstream Renewables
18. Ocean Winds
19. ORE Catapult
20. Ørsted
21. Osbit Limited
22. Principle Power
23. Renewable Safety
24. RWE
25. RWE Offshore Wind
26. RWE Renewables
27. Scottish Power
28. Scottish Power Renewables/IBRO
29. Shell
30. SiemensGamesa
31. SSE
32. Subsea7
33. The Carbon Trust
34. TotalEnergies
35. University of Portsmouth
36. University of Strathclyde
37. Vattenfall
38. Windcat Workboats
39. Worley

APPENDIX B
ABBREVIATIONS

CTV	Crew Transfer Vessel
EI	Energy Institute
O&G	Oil & Gas
O&M	Operations & Maintenance
OEM	Original Equipment Manufacturer(s)
PPE	Personal Protective Equipment
SOV	Service Opertaions Vessel
T&I	Transportation and Installation
WTG	Wind Turbine Generator
W2W	Walk to Work

ANNEX C
AGENDA

The followng table below outlines the agenda of the event:

Context Setting
Welcome from G+ – *Marcus Peters,* Global Head of Offshore HSE (Development. Construction, new Markets and Technologies)*, RWE Offshore* Context and Scene Setting – *Steve Hillier, Worley, Director of Asset Management*
Group Session 1 – Defining the Design Problem
Theme 1 Group – Access and Egress onto the structure (*facilitator: Howarth Greenoak, Worley)* Theme 2 Group – Access and Egress on and around the structure (*facilitator: Matt Skidmore, Worley)* Theme 3 Group – Materials Handling and Work Execution (*facilitator: Chris Cowland, Worley)*
Break
Plenary – Defining the Design Problem
Group discussion *(facilitator: Steve Hillier, Worley)*
Group Session 2 – Exploring Design Solutions
Theme 1 Group – Access and Egress onto the structure (*facilitator: Howarth Greenoak, Worley)* Theme 2 Group – Access and Egress on and around the structure (*facilitator: Matt Skidmore, Worley)* Theme 3 Group – Materials Handling and Work Execution (*facilitator: Chris Cowland, Worley)*
Plenary – Exploring Design Solutions
Group discussion *(facilitator: Steve Hillier, Worley)*
Conclusion
Closing Remarks
Marcus Peters, Global Head of Offshore HSE (Development. Construction, new Markets and Technologies)*, RWE Offshore*

Energy Institute
61 New Cavendish Street
London W1G 7AR, UK

t: +44 (0) 20 7467 7100
f: +44 (0) 20 7255 1472
e: pubs@energyinst.org
www.energyinst.org

9781787253629

ISBN 978 1 78725 362 9
Registered Charity Number: 1097899