G+ Safe by design

Workshop report: Davit cranes

G+ Global Offshore Wind
Health & Safety
Organisation

In partnership with

energy institute

G+ SAFE BY DESIGN WORKSHOP REPORT: DAVIT CRANES

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1 EXECUTIVE SUMMARY

This G+ Safe by Design workshop was focused on the design and operation of offshore wind turbine generator (WTG) transition piece (TP) mounted davit cranes. A series of workshops were held in Edinburgh on 22 March 2017 to explore davit crane operations and technologies with a focus on Safe by Design principles.

Across the workshops a number of common and interrelated issues and associated recommendations were identified.

1.1 FINDINGS AND ANALYSIS

- To date, the offshore wind industry has lots of operational experience with davit cranes and their role in minor offshore lifting operations. Looking forward, davit cranes are likely to remain an important part of minor lifting operations offshore.
- The issues encountered with the design and operation of davit cranes are generally typical of a technology which has been selected for an application which is similar to, but not the same as, that for which it was designed.
- It is now appropriate to develop guidance, standards and training which address the design and operation of davit cranes as employed in offshore wind, rather than relying on extrapolation of good practice from other sectors and generic sources.

1.2 RECOMMENDATIONS

- A new part three of the EN 13852 *Cranes. Offshore Cranes* suite of standards is being drafted which would be directly applicable to davit cranes used in offshore wind. It is recommended the G+ takes part in the consultation exercise to help shape this standard to ensure the requirements of the whole industry are addressed.
- In addition to formal standards, the G+ should consider developing some supplementary guidance to support the specification and procurement of davit cranes in offshore wind.
- Issues associated with the operation of davit cranes should be captured from across the industry to support the development of future standards and supplementary guidance.
- The G+ should consider developing guidance to support the operation of davit cranes. The scope of this guidance should be the entire component journey (from warehouse to turbine) rather than just the lifting operation itself.

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 who have come together 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 of its activities in the offshore wind industry. The G+ has partnered with the Energy Institute (EI) to develop materials including good practice guidelines for the offshore wind industry in order 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.

By bringing the Safe by Design workshops into the G+ work programme, the G+ aims to explore industry operations and technologies with a focus on Safe by Design principles. The G+ workshops examine the current design controls relating to a particular 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 four workshops have been held under the auspices of the G+ covering: marine transfer/access solutions, escape from a nacelle in the event of a fire, lifting operations, and WTG service lifts. The outputs from three of these workshops have also been made available in reports which can be downloaded from the G+ website to be used as a reference by the industry.

2.2 INTRODUCTION

In September 2015 a Safe by Design workshop on lifting operations was held. Whilst successful in its objectives, it highlighted that lifting operations was a large subject to cover in its entirety and that it would be beneficial to focus on more specific areas. Therefore, under the direction of the G+ Focal Group, a Safe by Design workshop on davit cranes was held on 22 March 2017 in Edinburgh, UK.

The outputs from this workshop are documented in this report.

3 METHOD/AGENDA/ATTENDANCE

3.1 METHOD

Following the format utilised in previous Safe by Design workshops, a one-day workshop was held on 22 March 2017 in Edinburgh, bringing together stakeholders from across the industry to consider the use of davit cranes in the offshore environment. After opening remarks from Frank Monaghan, Health and Safety Director, ScottishPower Renewables, the workshop started with two presentations:

DONG Energy – Overview of issues incidents whilst using davit cranes, by Christian Seeberg Braun.

Three recent incidents were highlighted including a wire snap, an incorrect slinging and an incident where an equipment bag slipped on a hook and dropped onto the vessel. This led to developing three continuous improvement areas aimed at preventing dropped objects, further controlling the exposure of personnel, preventing escalation and more severe damage to vessels. Additionally design considerations were explored including the effect of wind on a load. The presentation concluded with plans for additional functionality and reach of davit cranes for new projects.

Reflex Marine – Safe and efficient cargo handling for offshore wind, by Philip Strong.

The presentation started by providing an overview of the challenges of handling cargo on open water and the integrated approach needed to achieve successful cargo operations. Following this, Reflex Marine's products were presented, including the StormPro range aimed at cargo handling in harsh weather and their cargo landing system initiative, utilising laser technology.

Following the presentation sessions, attendees were briefed on the approach for the workshop discussion breakout groups in the afternoon.

Three workshops topics were facilitated by personnel from the ORE Catapult. The topics for the workshops were as follows;

– Davit crane specification and design.
– Offshore windfarm operation and maintenance (O&M): safe operation of davit cranes.
– Alternative technologies and innovation in cargo transfer.

Each attendee participated in two out of three workshops.

At the end of the breakout sessions, each group presented their main findings and conclusions to all of the attendees in a plenary session, allowing further discussion before concluding the workshop.

3.2 AGENDA

Workshop opening remarks

Frank Monaghan, Health and Safety Director, ScottishPower Renewables

Presentation 1 – DONG Energy: Overview of issues/incidents whilst using davit cranes

Christian Seeberg Braun, Team Lead HSE Risk and Improvement, DONG Energy Wind Power

Presentation 2 – Reflex Marine: Safe and efficient cargo handling for offshore wind

Philip Strong, CEO and Technical Director, Reflex Marine Ltd

Exercise – workshop breakout sessions managed by facilitators

Group 1 – Davit crane specification and design (Facilitators: *Paul Taylor* and *Gordon Stewart*, ORE Catapult)

Group 2 – Offshore windfarm O&M: safe operation of davit cranes (Facilitators: *Conaill Soraghan and Lynsey Duguid*, ORE Catapult)

Group 3 – Alternative technologies and innovation in cargo transfer (Facilitators: *Ralph Torr* and *Owen Murphy*, ORE Catapult)

Plenary session – Presentation on key findings/outputs from breakout group discussions

Closing remarks

Frank Monaghan, Health and Safety Director, ScottishPower Renewables

3.3 ATTENDANCE

Graham Hacon	3Sun Group
Jody Potter	3Sun Group
Christian Seeberg Braun	DONG Energy
Jakob Wedel-Heinen	DONG Energy
Daniel Allen-Baines	E.ON
David White	E.ON
Marcus Peters	E.ON
Garry Bradford	EDF
Kevin Tyrens	EDF
John Yorston	EDPR
Andrew Sykes	Energy Institute
Michael Joos	Energy Institute
John Krogh	Fanø Kran-Service
Kate Harvey	G+
Beth Rawson	HSE
Steve Lewis	HSE
Mark Ford	IMCA
Roy Dickson	Innogy
Andy Lewin	ORE Catapult
Conaill Soraghan	ORE Catapult
Gordon Stewart	ORE Catapult
Lynsey Duguid	ORE Catapult
Owen Murphy	ORE Catapult
Paul Taylor	ORE Catapult
Ralph Torr	ORE Catapult
David Armour	Red Rock Power
Andrew Grimes	Reflex Marine
Philip Strong	Reflex Marine
Alice MacLeod	ScottishPower Renewables
Frank Monaghan	ScottishPower Renewables
Gavin Gibson	ScottishPower Renewables
Michael Crawford	ScottishPower Renewables
Paul Barton	ScottishPower Renewables
Jimmy Staal Damsgaard	Seasight Davit Cranes
Birger Elgaard Andersen	Siemens
Danny Travis	Siemens
Ralf Schuettendiebel	Siemens
Victoria Buelow	Siemens

Dan McKinley	SSE
Kenny Beardsell	SSE
Thomas Eriksen	Statkraft
Matthew Bramwell	Statoil

4 WORKSHOP SUMMARIES

4.1 WORKSHOP 1 – DAVIT CRANE SPECIFICATION AND DESIGN

The workshop initially identified the current standards and sources of guidance available to the offshore wind industry for davit cranes. This was followed by an evaluation of the consistency with which these standards are applied across the industry and if the standards currently being applied are fit for purpose. The most commonly cited and used standard was EN 13852-2 *Cranes. Offshore cranes. Floating cranes*. However, it was concluded that this was not consistently applied across the industry and not wholly fit for purpose.

Recommendations:

– A standardised guidance document/checklist to aid crane selection by G+ members, including all the health and safety considerations, should be developed. Development of such should be a collaborative and coordinated industry endeavour to ensure that the widest range of experience and lessons learned are captured. It is also recommended that a steering group be established to provide oversight of this. Additionally this team should be multidisciplinary and include those operating and maintaining the cranes.

– A new part of the EN 13852 suite of standards is being drafted which would be more applicable to the davit cranes used in offshore wind. This is currently referred to as EN 13852-3 *Cranes. Offshore cranes. Low capacity offshore cranes* and is being drafted by CEN/TC 147. It is recommended the G+ takes part in the consultation on this standard to ensure the relevant safety considerations of the whole industry are addressed.

– An opportunity exists to optimise and drive continual improvement by sharing lessons learned between industry stakeholders. The collective industry experience is significant but this knowledge is rarely shared effectively and consequently improvements made are often isolated and have less effect/benefit. The G+ could explore this opportunity to share lessons learned further. Similarly, lessons can be learned from other industries, particularly oil and gas.

– There are many years' worth of data on davit crane operations available to the industry. The G+ should explore if further meaningful data can be gathered through their incident data reporting system. Additionally the G+ should carry out a retrospective review of annual data already gathered since 2013.

4.2 WORKSHOP 2 – OFFSHORE WINDFARM O&M: SAFE OPERATION OF DAVIT CRANES

The purpose of this workshop was to identify the main issues and challenges concerning how davit cranes are operated and maintained in the offshore wind industry, and suggest recommendations and outcomes that will help address these challenges.

The number one issue identified by all stakeholders in the offshore wind industry, including owners, operators, equipment manufacturers and service providers, was the lack of a common approach to training and demonstration of competency.

The other sources of many issues at site are a lack of appropriate process and behaviours regularly deviating from the plan.

Recommendations:

- The G+ should consider creating a template end to end cargo lift plan format that starts from the warehouse and spans the entire component journey, with a view to publishing the template as guidance to the industry.
- The G+ should follow up and collect examples of existing pre-use checklists from workshop attendees in order to identify commonality and then issue a basic pre-use checklist as industry good practice.
- The G+ should request that the Global Wind Organisation (GWO) develops an offshore wind minor lift course that GWO Training Providers could deliver.
- The G+ should revisit the lifting operations workstream initiated in 2013 and explore how materials resulting from this could be refocused to address any gaps there are in the existing guidance relevant to minor lifting operations.

4.3 WORKSHOP 3 – ALTERNATIVE TECHNOLOGIES AND INNOVATION IN CARGO TRANSFER

This workshop explored the potential for innovation in current davit crane design and possible alternatives. The workshop sessions discussed near term, incremental improvements to davit crane design and operation and longer term, more radical design changes or alternatives.

The workshop found that significant operational experience with davit cranes already exists. The use cases for davit cranes are generally well understood and reasonably consistent across projects.

Process innovation could offer some easy improvements and is available to existing projects as well as those in development. For example pre-slinging loads and conducting load packing and slinging in a workshop environment takes decision making and risk out by removing the opportunity for human error in a high pressure crew transfer vessel (CTV) unloading environment.

The requirement for davit cranes similar to those currently deployed is likely to be an enduring feature in offshore wind.

Recommendations:

- It is recommended that the G+ considers a project to record the usage of, and issues with, davit cranes across a number of sites, with the results pooled and shared with participants to inform future davit crane functional specification and operations and maintenance activity. This should include dedicated data collection and review of existing incident reports and work orders.
- It is recommended that the G+ reviews onshore experience from other industries where lifting is routine and perhaps more tightly controlled than in offshore wind, for example conventional construction. To support this, current davit crane usage risk assessments could be shared amongst projects.

ANNEX A
DETAILED WORKSHOP NOTES

A.1 WORKSHOP 1 – DAVIT CRANE SPECIFICATION AND DESIGN

Purpose of the workshop

This workshop aimed to identify the current international/European standards and sources of guidance available to the offshore wind industry for davit cranes and to evaluate the consistency with which these standards are applied across the Industry. Furthermore, it was to determine if the standards currently being applied are fit for purpose.

Identifying standards and guidance for a davit crane in the offshore environment

Evidence

– Several international/European standards and sources of guidance were identified as being used, or that could be of use to the offshore wind industry; these are shown in Table A.1.

Table A.1: List of identified standards/guidance documents

EN 13852-2 *Cranes. Offshore cranes. Floating cranes*
EN 13852-3 *Cranes. Offshore cranes. Low capacity offshore cranes* (Status: under drafting)
API Recommended Practice 2D – *Operation and Maintenance of offshore cranes*
HSG 221 *Technical guidance on the safe use of lifting equipment offshore*
DNV GL-ST-0378 *Standard for offshore and platform lifting appliances*
IMCA M 171 *Crane specification document*
Machinery Directive 2006/42/EC

Analysis and findings

– By far the most commonly referenced standard is EN 13852-2. *Cranes. Offshore cranes. Floating cranes.*
– It was identified that a new part of the EN 13852 *Cranes. Offshore cranes* suite of standards is being drafted which would be more applicable to the davit cranes being used in offshore wind. This is currently referred to as EN 13852-3 *Cranes. Offshore cranes. Low capacity offshore cranes*. This was not common knowledge amongst the workshop groups.
– Knowledge, awareness and use of the other standards/documents identified (Table A.1) is limited.

Recommendations and outputs

– EN 13852-3 is currently being drafted by European Committee for Standardization (CEN) Technical Committee 147. The UK input is as part of the European working group. This working group is mirrored by a BSI working group which provides

comments and feedback. The International Marine Contractors Association (IMCA) is represented on this group, but there are no offshore wind developers. Therefore, it is recommended the G+ takes part in the consultation exercise to help shape this standard to ensure the requirements of the whole industry are addressed.

Usefulness of standards/guidance and consistency of application

Evidence

- A crane manufacturer identified that EN 13852-2 in its entirety was currently unworkable for the offshore wind industry although parts of it were useable and useful. The Machinery Directive 2006/42/EC is being used as the main guidance document for some crane manufacturers.
- One developer had to hire consultants to try and understand the requirements of EN 13852-2 and found they could only apply parts of it due to its complexity and incompatibility with the low capacity davit cranes used in offshore wind.

Analysis and findings

- EN 13852-2 is not wholly workable or applied consistently across the industry and the proposed new standard EN 13852-3 is some years away from being published.
- Developers are not applying a common standard and in some cases the specification requirements are primarily determined by looking at the last project.
- In summary, the current standards and guidance are neither fully fit for purpose nor applied consistently across the industry (see Figure A.1).

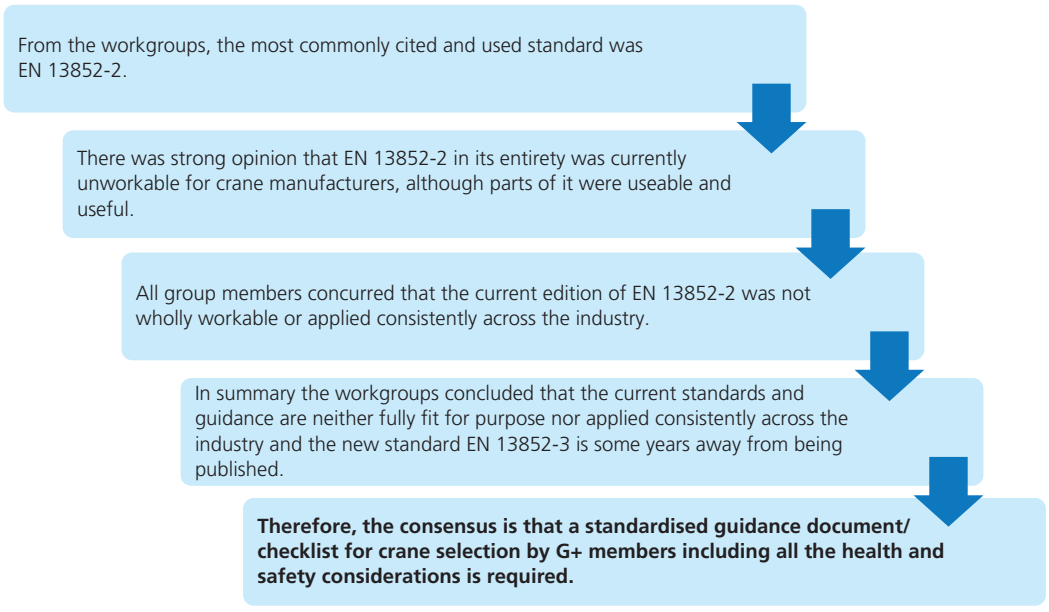


Figure A.1: Standard evaluation summary

Recommendations and outputs

– A standardised guidance document/checklist to aid crane selection by G+ members, including all the health and safety considerations, should be developed. This should be a collaborative and coordinated industry endeavour to ensure that the widest range of experience and lessons learned is captured. It should include all the stakeholders, including developers, crane and turbine manufacturers, and marine representatives working together. Additionally this team should be multidisciplinary and include those operating and maintaining the cranes. It is also recommended that a steering group be established to provide oversight.

Risk identification and utilisation of information

Evidence

– Routinely, risk assessments including hazard identification/hazard and operability (HAZID/HAZOP) studies are conducted to identify and mitigate risks from the design phase, through to the construction and O&M phase. Often a cross-functional team including engineers, manufacturing/operations personnel and safety professionals is involved in this.
– Some developers have put obtaining the design risk information from the supply chain into their contracts.
– This risk information is not routinely seen by the personnel who operate and maintain the cranes.
– Through operating experience, developers have identified risks that were not initially considered during the design phase. For example, one developer highlighted that birds nesting/perching on the cranes and the associated guano resulted in all the windfarm's crane's wires having to be replaced and steps taken to prevent birds nesting/perching on the cranes.

Analysis and findings

– There was a willingness and positive attitude towards sharing risk information; however this was being negated by concerns about intellectual property and that this can cause issues when wanting to share risk information. Therefore it would be useful to consistently build the requirement for providing/obtaining the necessary risk information from the appropriate parties into contracts.
– The main considerations involved in determining the specification of crane were identified as the weight that is to be lifted and the sea state/significant wave height. However, it was highlighted that there were a number of other factors that should be routinely considered such as: load profiles and lifting frequencies, effects of wind on loads, vessel capabilities, and integration with the transition piece infrastructure.
– CAD modelling was used to check interfaces by some developers to ensure successful crane integration with the transition piece infrastructure. However, this was not always successful, as at an early stage the crane manufacturer to be used was unknown. Consequently conflicts were identified at a very late stage and fixes would have to be implemented at a cost, e.g. having to move the crane winch handles to the opposite side.

Recommendations and outputs

– An observation was made that although challenging, early involvement in the wind farm design stage by crane manufacturers would help mitigate risk and ensure the correct crane for the turbine and the application. This should be considered within the previous recommendation of G+ taking part in the consultation on EN 13852-3.

Development of crane specification and procurement

Evidence

- There is a varied approach as to who is involved and how the crane specification is derived as well as the procurement routes, which may be dependent on the contract in place.
- Often developers would provide a general specification to the turbine manufacturer who would add to this before providing it to the crane manufacturer and subsequently the davit crane would be supplied with the turbine.
- Some developers prepare and provide the full specification themselves but noted this is a lengthy process and any changes can be costly and time-consuming.
- Alternatively, some other developers use a competent and trusted third party to develop the specification. However, ensuring competency of the supplier and developing trust takes time and resources. The developer signs the final acceptance of the specification in these cases.
- It was also found that often there is strong pressure from commercial teams to strip out cost, which can influence decision making on the crane specification and selection.
- In terms of procuring cranes, developers ensured they used a competent supplier, verified by quality assurance techniques such as initial qualification, audit and performance review. They also conducted visits for witness testing and factory acceptance testing (FAT).
- After procurement and receipt of the first crane, some developers will do a site trial (mock-up) to check fit, form and function, and compatibility with the transition piece infrastructure. This also serves a dual purpose in that it is utilised for user training and training the trainers.

Analysis and findings

- Development of the crane specification and procurement routes varies from developer to developer.
- Not all developers involve the personnel operating and maintaining the cranes and surrounding infrastructure in the specification development. Including them should be more widely considered.
- Any issues identified at the site trial (mock-up) stage can be problematic and considered as an opportunity missed for identification at an earlier stage. Changes can be difficult to make especially if it's the 'steel' and can be time-consuming (often several months) and costly to implement.
- One developer confirmed that changes made at this late stage are fed back into the developers HAZOP and risk information; however, it was not clear if this was standard practice across all the developers.
- In other situations, decisions not to implement changes have occurred and this has resulted in the operations teams having to use cranes that are not fully fit for purpose.
- The biggest challenge for crane manufacturers has been reliability. Cranes need to last in a hostile environment and are required to function for a few hours a year when needed. The way cranes appear currently (more closed structures) is in order to ensure their durability and reliability.
- Additionally, a crane manufacturer's view was that customers are constantly pushing the boundaries and asking for cranes to operate in high significant wave heights. These cranes can be developed and manufactured but there was a concern that in doing this, it would be more difficult to maintain safe operations.

- Developers agreed that specifications are changing frequently, driven by operational needs and that the primary enabler was improved vessel capability in more challenging sea states so that safe operations are not compromised.
- Initially in the industry there was little experience of cranes but there have been significant lessons learned over the years and although there are still improvements to be made, it was important to recognise that significant improvements have been made already.

Recommendations and outputs

- An observation was made that involving the personnel operating and maintaining the cranes and surrounding infrastructure in the specification development, utilising their operational knowledge and experience, is considered highly desirable and should be promoted in any guidance developed. This observation should also be considered alongside the recommendation of the G+ taking part in the consultation on EN 13852-3.

Feasibility, content and approach

Evidence

- From the earlier discussions within the workshop groups, it was concluded that a standardised guidance document/checklist for crane selection including all the health and safety considerations should be developed. The following examines how feasible this would be to create and the most effective way to gather the information, including learning from other sectors.
- A number of ideas, thoughts and suggestions were identified:
  - It should be a simple guidance document without all the references seen in standards to make it easier to understand and wholly useable.
  - Identify and align the parts of the current standards/guidance (creating a 'menu' of standards) that the stakeholders want to use at the various life-cycle stages as the main part of the guidance.
  - Include maintenance and certification requirements, and schedules.
  - Consideration of the vessels used.
  - Consideration/assessment of crane placement/transition piece infrastructure.
  - Include the level of traceability required for the crane components and materials including welding and fastenings.
  - Gather, review and include relevant lessons learned.
  - Include a standard interpretation of the Machinery Directive 2006/42/EC.
  - Share crane inspection data more widely (typically crane inspectors will record onto their own paperwork) to help inform the content.

Analysis and findings

- It is clear that a guidance document is needed and would be welcomed by the industry; however, the method and approach to developing this is critical to its content, value and successful adoption by the G+. Therefore, this should be a collaborative and coordinated industry endeavour. As recommended previously, it should include all the stakeholders, including developers, crane and turbine manufacturers, and marine representatives, working together with a common goal for mutual benefit.

– It should be multidisciplinary and include those operating and maintaining the cranes. A steering group should also be set up to drive and oversee this to a successful conclusion.

Figure A.2: Davit crane selection guidance document preparation outline

Recommendations and outputs

– No further recommendations.

Good practice and other sectors

Evidence

– This section is aimed at further identifying what should be included in the recommended guidance document based on current good practice from within the industry and also from other sectors, including oil and gas.
– Further proposals to shape the guidance document's content include:
  – An assessment of the weights and frequencies of lifts i.e. create a lift weight profile at the various windfarm life-cycle stages e.g. construction and O&M, to help inform crane specification requirements.
  – Although lessons learned are being used by G+ members to help inform specifications in isolation, if this information was more effectively shared it could drive further improvements in performance and safety across all the industry.

– An interrogation of reporting systems to identify davit crane issues and subsequent analysis of data to help inform specifications. A suggestion was made that all the crane-related incident data could be provided to the G+ or an appropriate third party to collate, analyse and identify opportunities for improvement.

Analysis and findings

– In terms of learnings and best practice from other industries, it was concluded that industries such as heavy haulage/transport or construction would not offer significant useful learnings for offshore wind and that resources should be utilised elsewhere.
– Marine davit cranes, such as those for launching life rafts were also considered as a possible learning opportunity; however, after discussion it was concluded that these are too simple and not worth considering further. However, it was identified by a crane manufacturer that learnings had already been gained from the marine industry including the protecting of some components from salt water corrosion and also design improvements to prevent bird nesting/fouling.
– It was found that cranes could be over-specified based on those used in the oil and gas industry and also that on platforms there are dedicated crane operators, which is not the case on offshore wind turbines.

Recommendations and outputs

– An opportunity exists to optimise and drive continual improvement by sharing lessons learned between the industry's stakeholders. There are a lot of lessons being learned within the industry but these are rarely shared effectively and as a result the improvements made are often isolated and have less effect. A more collaborative and coordinated approach could be very beneficial across the entire industry. It is recommended the G+ organisation explores this opportunity further.
– Similarly, and linked to this, lessons can be learned from other industries, particularly oil and gas. This is happening in silos but it is recommended a planned and coordinated approach be developed by the G+, leveraging the contacts and experience that former oil and gas employees now in offshore wind will have.
– There are many years' worth of data on davit crane operations available to the industry. The G+ should explore if further meaningful data can be gathered through their incident data reporting system. Additionally the G+ should carry out a retrospective review of annual data already gathered since 2013.

WORKSHOP 2 OFFSHORE WINDFARM O&M: SAFE OPERATION OF DAVIT CRANES

Purpose of the workshop

The purpose of this workshop was to identify the main issues and challenges concerning how davit cranes are operated and maintained in the offshore wind industry, and suggest recommendations and outcomes that will help address these challenges.

The workshop opened with a general discussion about how davit cranes are used in the offshore wind industry today. Then the groups explored how they are inspected, serviced and maintained. Finally the groups scrutinised the training and competency requirements and gaps associated with operation and maintenance of davit cranes.

Establishing the use-cases of davit cranes

Evidence

– The main use cases of davit cranes on an offshore windfarm are presented in Figure A.3.

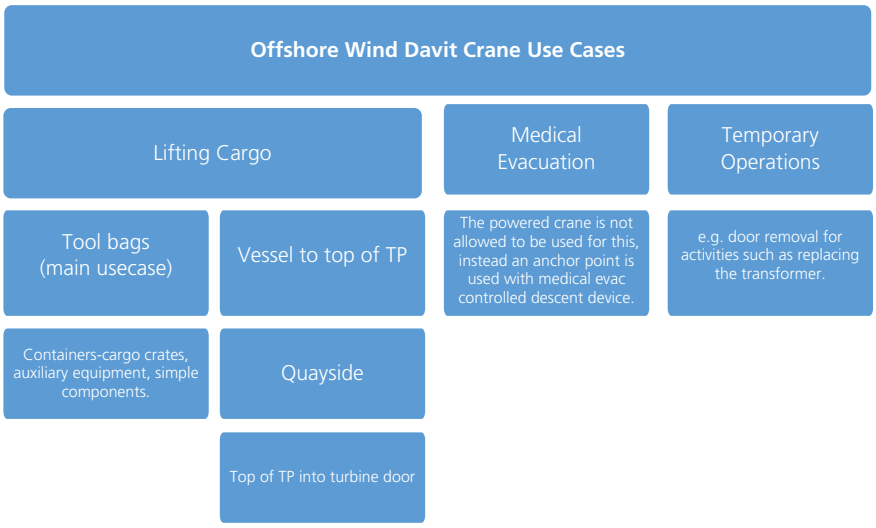


Figure A.3: Davit crane use cases

– When used, the loads lifted tend to be much lighter than their load capacity. Typical examples are lifting tool bags. As an example, a wind turbine service may require four lifts of tool bags in one day.
– The limitations of using a davit crane (such as wind speed, sea state, visibility and precipitation) are typically based on the manufacturer's operation manual. Also one developer noted that there are different views of what these limits are within staff on the same site. The question was asked if it would be possible to challenge these assumptions and safely push out the envelope. It was noted that none of the attendees was aware of this being done to date at sites.
– Pre-use checks are in use but each organisation has created its own due to a lack of industry guidance. The common elements include:
  – Visual (corrosion, hook, wire, bolts, safety catch).
  – Controls (electrical/hydraulic/manual).
  – Test lift and brakes.
  – Weather (wind speed and sea state).

  - Accessories (slings, shackles, pad eyes).
- Lift plans are written but deviations from plans cause a significant proportion of the incidents. A lot of the time generic lift plans are used for smaller lifts which are not always fit for purpose.
- The common issues with using davit cranes appear to be:
  - Overfilling bags – could be addressed with process innovation.
  - Slinging – could be addressed with better training and competency.
  - Overcrowding hooks – could be addressed by a combination of process innovation, training and more suitable lifting accessories. The culture of urgency has to be addressed.

Analysis and findings

- Most of the challenges and issues around using davit cranes stem from a lack of training and insufficient competency.
- All marine lifting operations require risk assessment and method statements (RAMS) but the general consensus is that generic plans are used for minor lifts and certain aspects of the operation such as slinging are not included in the plan at all. Without comprehensive plans, a culture of complacency and urgency has emerged causing the davit cranes to sometimes be used in an unsafe manner.
- Lift plans are limited by the lack of involvement of the deck crew and the slinging. It is not clear who is responsible for that aspect of the lift. There should be some accountability in the same way that a named individual is the lift supervisor (crane operations).
- Deviations from plan are primarily driven by a culture of urgency. For example individuals want to get the job done quickly to complete a shift or there is programme pressure to finish quickly.
- There is a need for much better end to end processes and plans, starting with preparing tools and materials in the warehouse and following the complete component journey. At each point responsibility should be clear. An example process map is demonstrated in Figure A.4.
- Attendees of the workshop were willing to share their pre-use checklists to explore the commonality across the industry.

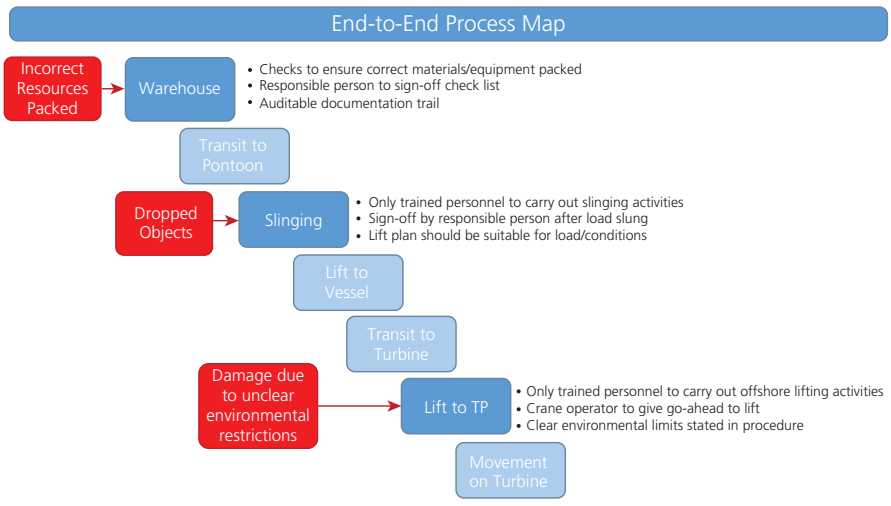


Figure A.4: Example process map

Recommendations and outputs

- The G+ should create a template end to end cargo lift plan format that starts from the warehouse and spans the entire component journey. Also the G+ should publish the template as guidance to the industry.
- The G+ should collect examples of existing pre-use check lists from attendees in order to identify commonality and then issue a basic checklist as good practice.

Inspection, service and maintenance of davit cranes

Evidence

- The inspection, service and maintenance of the davit cranes offshore is each governed differently:
  - Inspections – written scheme. This is statutory and they receive an annual inspection.
  - Service – O&M manual.
  - Maintenance – based on owner operator maintenance strategy. Could be either reactive or preventive. A common driver is reacting to safety alerts and industry shared knowledge.
- Service, inspection and maintenance of davit cranes is done predominantly by third party contractors.
- The common issues that require maintenance on davit cranes are:
  - Corrosion – brake system, welds, casting, hoses.
  - Over-maintenance – too much grease.
  - Wrong type of grease – could be wrong plan or storeman following plan incorrectly.
  - Wire not spooling – misalignment. This happens when loads are dropped in an uncontrolled manner.
  - Hooks in the body – jamming the mechanism.
  - Guano.
  - Power control module malfunction.
  - Electric controls prone to failure.

Analysis and findings

- The scope of service and inspection is driven by crane manufacturer's manuals. However, these are often difficult to comply with due to the approval required by the responsible person at various stages of the process, i.e. it may state that a technician carrying out a specific task shall be approved by a specific company to do this task, with the approval requirements differing for each work task.
- It should be noted that manufacturers are beginning to address some of the maintenance issues.
- Crane manufacturers often cannot follow up the sale of their product with necessary training or spare parts. A challenge exists that given this fact, the crane manufacturer is supposed to be involved when there are changes such as maintenance on the crane, wire, hooks etc. Workarounds are evident here. A similar workaround occurs when a service provider cannot get the crane manufacturer to train them, so the service provider must get the turbine OEM to request it.

Recommendations and outputs

– No further recommendations.

Training and competency

Evidence

– Operators, OEMs and service providers agree there is not one specific training course fit for the needs of the offshore wind context. Therefore there is no common approach to training and building competency.
– Currently organisations are combining various aspects of the following courses:
  – Construction Plant Competence Scheme (CPCS).
  – Lifting Equipment Engineers Association (LEEA) – it was acknowledged that this may be considered best in class but it is still not wholly applicable to the offshore wind industry.
  – Construction Industry Training Board (CITB).
– Current davit crane training does not include the slinging, and slinging can be much more challenging than the operation of a crane.
– Lack of understanding of the scope of the certification of the equipment has led to incidents. It is not always clear what the certification really covers and how long the cover lasts.
– Existing sources of guidance for lifting practice identified include:
  – IMCA are providing guidance around lifts classified as routine, non-routine and engineered lifts. This is expected to be available in July 2017.
  – ISO.
  – CEN and National Standards Bodies.
  – DNV-GL.
  – RenewableUK.

Analysis and findings

– Operators, OEMs and service providers agree that there is a strong need for a specific training course focused on minor lifts for the offshore wind industry. As is their duty, these organisations have combined aspects of various existing generic lifting courses and this has led to an inefficient variation in competency across the sector.
– For any potential training course development, it is important to involve all stakeholders involved at site, including crane manufacturers, turbine OEMs, developers, deck crew and service providers, in the development process. Suggestions for industry requirements of an offshore wind davit crane minor lifts training course are presented in Table A.2.

Table A.2: Offshore wind minor lifts training course

Content	Notes
Bespoke scope	Potential separation out of a slinging course and a crane operation course.
	Need for two tiers, a detailed service and inspection course and a crane user's course.
Impacts of poor operation	Root cause analysis of common incidents resulting from poor/inadequate maintenance.
	Explanation of the risks resulting from bad use of the davit crane (to address the urgency culture).
Scenario-based training	How to respond to changes and deviations from a lift plan e.g. a service provider arrives at site with a new type of tool bag.
Training centres	Overview of representative equipment found at training centres.
Include all stakeholders	Try to involve all stakeholders involved at site including crane manufacturers, turbine OEM, developer, deck crew, service providers.
Equipment familiarisation	Reinforce the additional need for equipment specific familiarisation at site.

– To support the training, development of competency and process improvement recommended by this Safe by Design workshop, there is a need for guidance documents readily accessible to all stakeholders. G+ has previously collected a body of knowledge in this area through workgroup and workshop activities. Other organisations also have relevant guidance in development and it is important to avoid producing guidance which is not needed.

Recommendations and outputs

– The G+ should request that the GWO develop an offshore wind minor lift course that any GWO Training Provider could deliver.
– The G+ should revisit the lifting operations workstream initiated in 2013 and explore how materials resulting from this could be refocused to address any gaps there are in the existing guidance relevant to minor lifting operations.

WORKSHOP 3 – ALTERNATIVE TECHNOLOGIES AND INNOVATION IN CARGO TRANSFER

Purpose of the workshop

These workshop sessions explored the potential for innovation in current davit crane design and possible alternatives. To guide these discussions the session began by establishing a baseline of davit crane 'use cases' (i.e. what davit cranes are used for, by whom, when and how often) and 'component journeys' (i.e. what is the broader journey the davit crane load is on, where does it start, where does it finish, how is the load handled and packaged as it moves along this?). This was followed by a brief discussion on the broader trends in offshore wind which may have direct or direct implications for davit crane use cases and hence design. With these established the core of the workshop sessions discussed near term, incremental improvements to davit crane design and operation and longer term, more radical design changes or alternatives.

Use cases and component journey

Evidence

– The vast majority of use for davit cranes is for small loads (<200 kg) being lifted frequently (almost every time a technician visits the turbine). Specific use cases as noted are provided in Figure A.5.

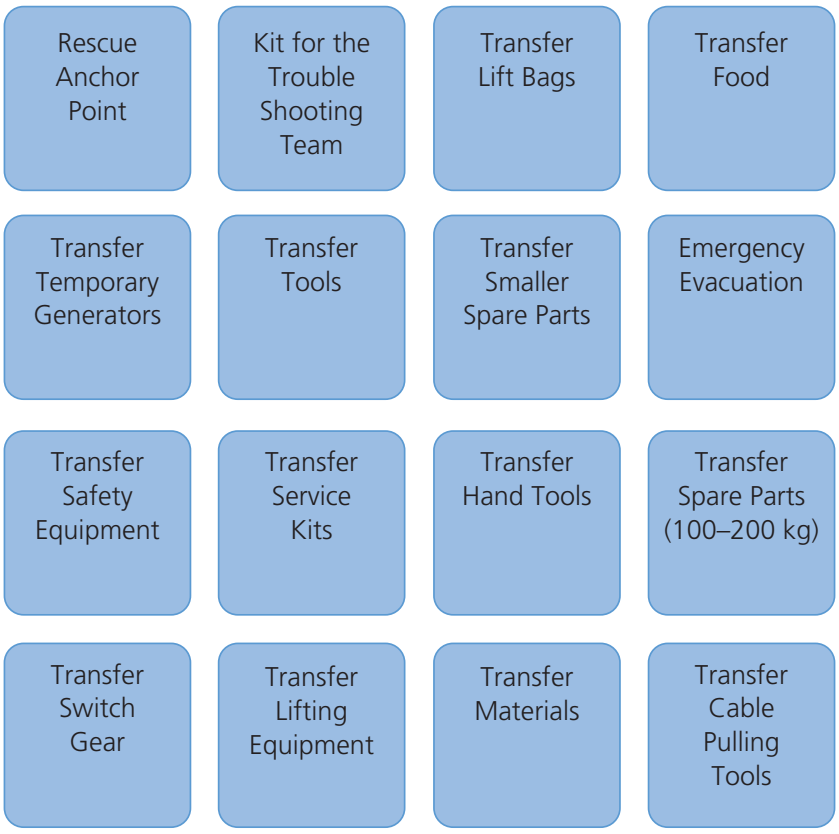


Figure A.5: Typical use cases

- The vast majority of use cases relate to lifting materials and tools. These are generally lifted in lifting bags but various other forms of lifting containment were referenced.
- No evidence of any planned use for personnel transfer other than for emergency evacuation was identified. However, davit cranes are generally a critical link in the emergency evacuation chain.
- The functional specification of davit cranes is primarily driven by a turbine OEM- supplied list of components which may need to be transferred during the O&M period. Whilst the vast majority of these are small, there are a number of large item weights and dimensions. Despite the fact that these components (e.g. switchgear) are likely to be transferred to/from the turbine infrequently, if at all, they drive the requirement for a crane which can lift a few tonnes rather than a few hundred kilograms. This is generally not resisted by those procuring the cranes as davit crane price is relatively insensitive to lifting capacity over this range of capacities.
- Whilst it appears the use cases for davit cranes, and hence a large part of the functional specification, are known at the specification stage, it can be challenging to incorporate requirements which relate to the TP platform and davit crane interfaces in davit crane specification and TP platform specification.
- When TP platform specifications are developed, the location and specification of the davit crane is typically a compromise, as it will not be possible to achieve all of the requirements for the davit crane and TP platform.
- It was clear that during lifting activities there is often a significant sense of urgency around the operation, as with crew transfer operations. This sense of urgency means that generally those involved in the lifting activities seek to complete the lifting activity as quickly as possible to allow the CTV to transit to the next location and maximise productivity.
- Approximately 50 % of loads lifted by a davit crane continue from the TP to nacelle by nacelle crane, and approximately 50 % are either broken down or moved in one piece inside the tower at TP level.
- Some evidence suggested that load organisation/packing were sometimes not well planned and that, particularly in reactive maintenance teams, there may be adjustment or revision of load organisation/packing several times between the original organisation/packing in the onshore warehouse and the moment before the load is lifted from CTV to TP.

Analysis and findings

- Significant operational experience with davit cranes already exists.
- The use cases for davit cranes are generally well understood and reasonably consistent across projects.
- There does not appear to have been any formal cross-industry assessment of how davit cranes are used and what common issues are encountered with them. Most project owners only track what they are required to under health and safety procedures and hence don't have this more general usage information formally recorded.

Recommendations

- It is recommended that the G+ considers a project to record the usage of, and issues with, davit cranes across a number of sites, with the results pooled and shared with participants to inform future davit crane functional specification and operations and maintenance activity. This should include dedicated data collection and review of existing incident reports and work orders.

Future trends and their impact on davit cranes

Evidence

- The functional specification of davit cranes is primarily driven by a turbine OEM- supplied list of components which may need to be transferred during the O&M period. There was no evidence to suggest that these will change fundamentally in the future, although there was a suggestion that some load dimensions and lifting heights are increasing, driving larger davit crane capacities and lifting height requirements.
- Foundation concept designs and davit crane integrations have to date tended to be gradual evolutions of what has gone before i.e. evolution not revolution.
- There is a strong drive for cost reduction in the procurement process.
- There may be a trend of increasingly integrated design through the way turbine supply and foundation supply contracts are structured.
- There is an anticipated increase in size of turbines and transition pieces, with an expectation that jacket foundations will become more likely.
- There is an anticipation that the integration of the davit crane with Supervisory Control And Data Acquisition (SCADA) systems is likely in future.
- For future sites, further from shore, it is anticipated that there will be an increasing role for service operation vessels (SOVs) in operations and maintenance logistics. The use of SOVs is thought most likely for planned service activities. For reasons of speed of repositioning, it is expected that troubleshooting or reactive teams will continue to be deployed by CTV due to the speed with which CTV and davit transfers can be made.
- Operational day-to-day decision making around davit cranes, vessel specifications and improvements are heavily influenced by lowest price, a trend which was expected to continue.
- The size, capability and complexity of davit cranes are expected to increase in response to an increasing size of foundation or transition piece. For example, greater reach may be required for jacket foundations, and having a longer boom is expected to drive a move to electric/hydraulic power rather than manual actuation.
- As davit cranes grow in size a move from manual to electric and hydraulic power has been noted. However, hydraulic cranes used infrequently can quickly suffer corrosion in the hydraulic componentry as a result of under-use and hence careful consideration is required when selecting new designs of davit cranes.
- Radical departure away from davit cranes to a cargo transfer solution looks unlikely in the short and medium term.
- It is anticipated that finding a suitable compromise between cost, space and functional specifications for davit cranes will become more challenging.
- If more work is completed from SOVs then it is likely that davit cranes will be used less frequently in the future, as SOVs will likely include a heave-compensated crane and/or a walk to work gangway. This is particularly true for activities involving heavier/larger loads. As a result davit crane capacities may reduce if projects plan from the design phase to rely on SOVs for routine servicing and unplanned lifting of heavier/larger components.
- Service teams feel that they will be able to transfer loads faster using davit cranes/CTVs rather than gangway/SOVs.

Analysis and findings

- There may be a shift to turbine OEMs offering a more complete Engineering, Procurement, Construction and Installation (EPCI) style contract scope, including foundations. In such a case it could be anticipated that the specification and procurement of a davit crane would be conducted by a single organisation, potentially removing some of the existing barriers and allowing design interfaces to be optimised.
- It is conceivable that SOVs will displace a number of the uses of davit cranes and result in them being used less frequently than at present (particularly the heavier/ larger lifting activities).

Recommendations

- An observation could be that the G+ considers a project to review the main functional elements of a davit crane to identify how different functional designs have fared in the offshore environment. This would provide an evidence base to inform design specification and procurement of davit cranes for future projects and could link into the previous recommendation made under the 'use cases and component journey section'.

Innovation

Evidence

- There was a suggestion that conservatism in cargo transfer solutions may continue, as concepts and designs tend to be driven by a core of experienced personnel who generally take their knowledge from one project to the next.
- The functional requirements for davit cranes may not be fully collated at an appropriate stage of the foundation and TP design, despite being known. However, successful integration of functional requirements is crucial to ensure effective operation of a davit crane.
- There were suggestions that a number of simple improvements in current davit crane design and operation could be made. For example, mandating the use of standard, pre-slung load carrying containers (bags, boxes, etc.), avoiding the ability to tamper with loads once packed to encourage better planning onshore.
- There may be some commercial innovation available by considering how various parties are incentivised. For example, improved installation and commissioning being incentivised to ensure high quality and better whole lifetime performance without significantly increasing cost. Similarly, users of davit cranes could be incentivised to suggest improvements, submit observations and report more near misses.
- Specifically designing cargo containers to minimise the chances of operator error or improvisation under pressure.
- Linking davit cranes into the SCADA system and fitting them with enhanced monitoring and remote operation capabilities. Functional tests could be done remotely on a more regular basis. Faults in the cranes could be identified in advance and planned operations adjusted accordingly.
- Unmanned aerial vehicles (UAVs) could be used to transfer small loads rapidly without the need for a crane at all.

Analysis and findings

- Process innovation could offer some easy improvements and is available to existing projects as well as those in development. For example pre-slinging loads and

conducting load packing and slinging in a workshop environment takes decision making and risk out by removing the opportunity for human error in a high pressure CTV unloading environment.

- Simplifying lifts by colour coding slings, shackles and lifting points also offers the opportunity to remove human error.
- Simplifying lifts by consolidating available lifting equipment to reduce human error. For example, making only a single rating of sling available across site, perhaps consistent with the safe working load of the davit.
- A simple standardised training course (e.g. through GWO) could increase consistency in slinging and lifting behaviours.
- The requirement for davit cranes similar to those currently deployed are likely to be an enduring feature in offshore wind.

Recommendations

- An observation could be that as part of developing guidance and best practice recommendations the G+ coordinates a review of the process of organising, packing, slinging and lifting equipment for scheduled service tasks to suggest how this can be standardised within projects. Projects should seek to utilise a single type of lifting container and rigging arrangement. Projects should prohibit the ability to tamper with loads once they leave the workshop.
- A further observation is that a standard service lifting container could be developed which includes space for standard spares and tools, in addition to capacity for task-specific equipment and tools. This could be used across multiple projects.
- It is recommended that the G+ reviews onshore experience from other industries where lifting is routine and perhaps more tightly controlled than in offshore wind, for example construction. To support this current davit crane usage risk assessments could be shared amongst projects.

ANNEX B
PRESENTATION SUMMARIES

PRESENTATION 1 – DONG ENERGY – OVERVIEW OF INCIDENTS WHILST USING DAVIT CRANES

Executive summary

DONG Energy is focused on the standardisation of wind farms and products through design optimisation. The aim of this work is to make the Wind Energy business more cost-effective, improve safety through design at the same time, and look into minimising the service intervals by improving quality. Through an interrogation of DONG Energy's incident data base (Synergie) the Davit crane was identified as a piece of equipment where improvements could be made.

As part of the presentation on this topic and the work DONG Energy is doing currently to improve safety performance when operating davit cranes, an overview of 3 recent incidents were given. These incidents involved:

– A crane wire snapping.
– Incorrect slinging of spare parts.
– A bag slipping from the crane hook and dropping onto a vessel.

Additional details pertaining to the three incidents was presented which included the work done to establish the root cause and lessons learned. The presentation then shifted focus onto tracks for continuous improvement, with a number of fishbone diagrams (developed within DONG Energy) highlighting major and root causes for dropped objects, exposure of personnel to risk and severe damage to a vessel. The final part of the presentation covered detailed design improvements to mitigate a number of the causes identified, which included:

– Calculations to predict the impact of drift and stability of loads in wind.
– A new type of supply chain which can be utilised with larger vessels.
– Modifications to improve davit crane functionality.

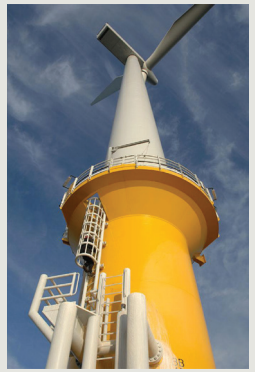
OVERVIEW OF INCIDENTS WHILST USING DAVIT CRANES

G+ Safe by Design Workshop – Davit Cranes, Edinburgh, 22-03-2017

Christian Seeberg Braun &
Jakob Wedel-Heinen

DONG energy

1. Three recent incidents
   - Wire snap
   - Incorrect slinging
   - Bag slips on hook and drops on vessel
2. Tracks for continuous improvement
   - Prevent dropped objects
   - Control exposure of personnel
   - Prevent escalation and severe damage to vessel
3. Detailed design issues
   - Drift and instability of objects in wind
   - Davit Crane with longer reach
   - Davit Crane functionality



DONG energy

Three recent incidents

DONG energy

Wire snap

Event
- When lifting equipment from vessel to TP, the davit crane wire snaps approx. 4 meters below TP. All equipment falls into the water. Most equipment could not be salvaged.
- Crew vessel is at the time moving away from the boat landing (approx. 50 meter away) but manages among others to pick up the oil can.
- No persons were harmed and no oil was released.

Immediate actions:
- Ensure all yearly service to be ended for the farm.
- Temporary preventive reduction in maximum lifting weight of crane, reduced to 250 kg. Reduction effective until cause has been established.
- Make sure everybody using cranes during this temporary period MUST do extra inspection of wire and hook area.
- Inform all on site. Emphasize to all the importance of lifting over water for as long as possible.

Longer term actions:
- Strength of subject wire tested after accident with no deviation from spec.

DE Synergi 123977

DONG energy

Incorrect Slinging

Near Miss Event:
- Vessel crew sent spare parts up without slinging them correctly

Immediate action:
- More elaborate instructions to vessel crew

Longer term actions
- Clear processes for standard lifts.
- Instruction/training of deck hand
- More preparation onshore

DE Synergi 125617

5

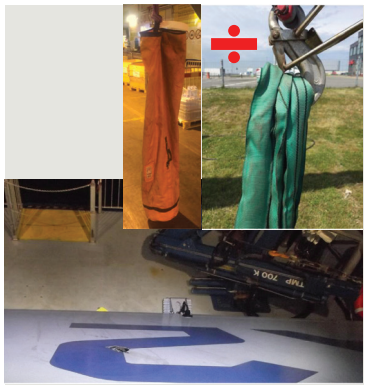
DONG energy

Bag slips on hook and drops on vessel

Event:
- Team on WTG was called down due to weather worsening
- While vessel pushing on to WTG foundation the team on the WTG platform hooked on two big bags and one sausage bag containing steel bars
- The sausage bag slipped from the davit crane hook during the lift
- The sausage bag fell on to the front of the wheel house, causing a damage (hole) of about 5 to 6 cm2.
- No personal harm occurred

Actions:
- Root Cause analysis suggested that the load was not properly secured
- Toolbox talk to make technicians aware of the requirement to check that the load is suitable secured

DE Synergi 116671



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Tracks for continuous improvement

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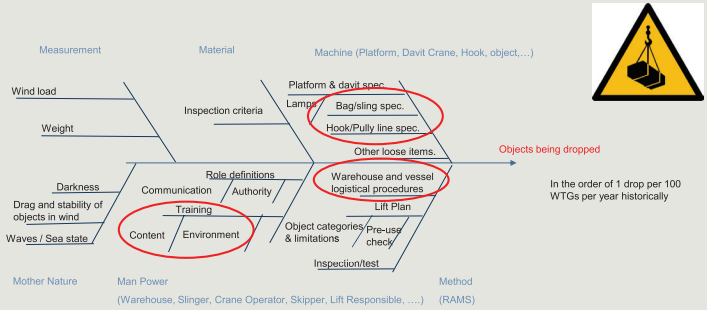
Prevent dropped objects



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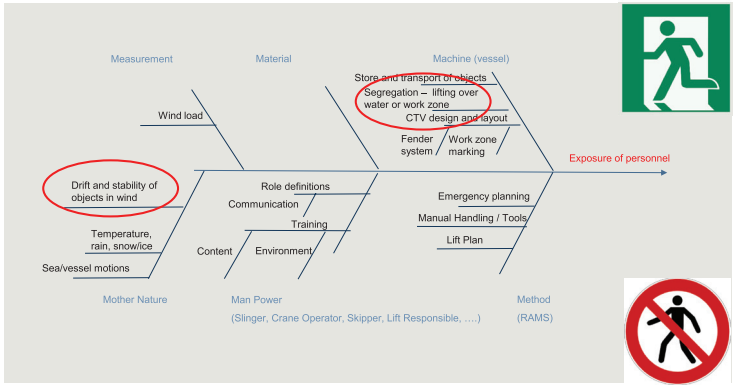
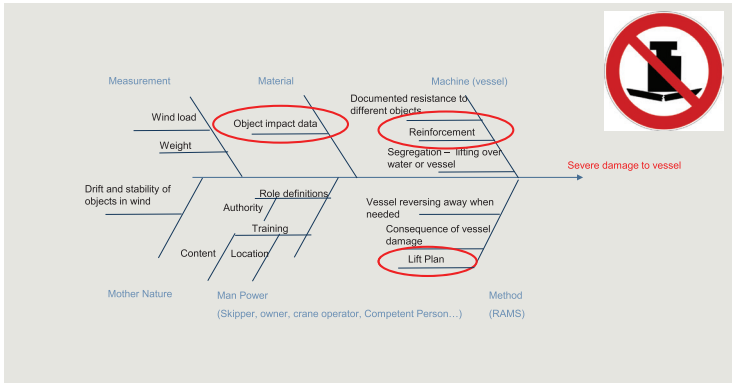
Control exposure of personnel

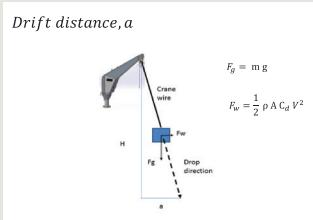


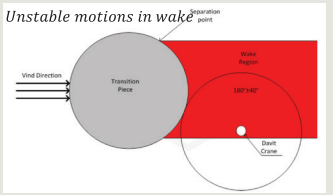
Prevent escalation and severe damage to vessel

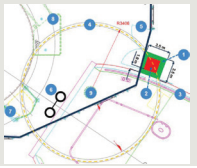


Detailed design issues

Drift of objects and instability in wind



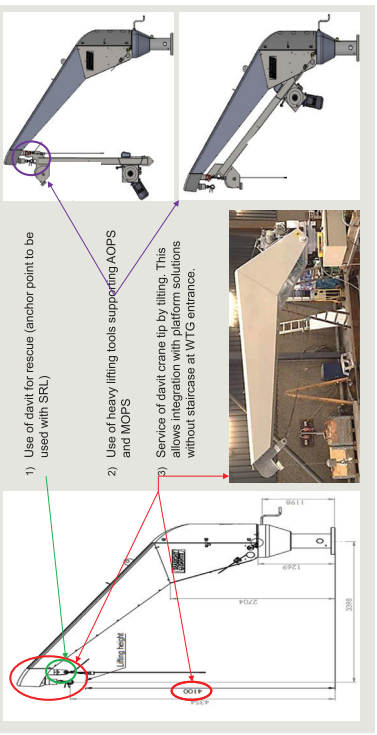




Typical drift distances, a:

Mass	50 kg	100 kg	200 kg	500 kg	1000 kg
Cylinder	4,3 m	2,1 m	1,1 m	0,4 m	0,2 m
Square box	7,1 m	3,6 m	1,8 m	0,7 m	0,4 m

Davit crane functionality



DONG energy

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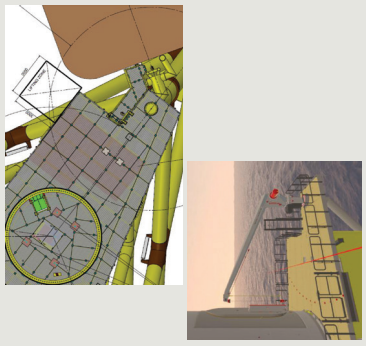
Davit Crane with longer reach – "Supply Crane"

DONG Energy in the process of launching "Supply Crane" for some of the new projects

- Allows lifting over water for jackets
- Serves wider vessels
- Electrical yawing with UPS



DONG energy

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Questions?

DONG energy

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PRESENTATION 2 – REFLEX MARINE – SAFE AND EFFICIENT CARGO HANDLING FOR OFFSHORE WIND

Executive summary

This presentation was provided at the request of the G+ in order to demonstrate safe and efficient cargo handling for offshore wind and identify potential design improvements in cargo transfer to WTGs.

Reflex Marine has consulted widely with operators, marine and lifting specialists in the offshore wind sector about the challenges of handling cargo for O&M activities. There is a broad consensus about the constraints and hazards of cargo handling on small vessels with pronounced vessel motions. Operational limitations imposed by such operations also directly impact offshore wind farm economics. Improvements can be made by:

– Providing highly resilient and protective storage and shipping solutions.
– Reducing container weights and dissipating impact energy (smarter design and materials).
– Reducing the risks and consequences of impacts and dropped objects.
– Creating more efficient cargo handling procedures (with appropriately designed equipment).
– Removing crews from the hazardous zones.

Reflex Marine has applied experience over 20 years in the marine sector, moving around one million personnel each year, often in harsh weather regions. It has developed a new approach to cargo handling, focusing on container design and deck handling systems that allow the relative motions to be controlled without putting crews in harm's way. Reflex also believe that real improvement will be made, not through incremental steps, but by bringing together operators, marine and lifting specialists in order to develop holistic risk based solutions.

reflexmarine
WIND TURBINE ACCESS

Storm-Pro

Safe and efficient cargo solutions for offshore wind energy

G+ Technical Meeting – 22nd March 2017

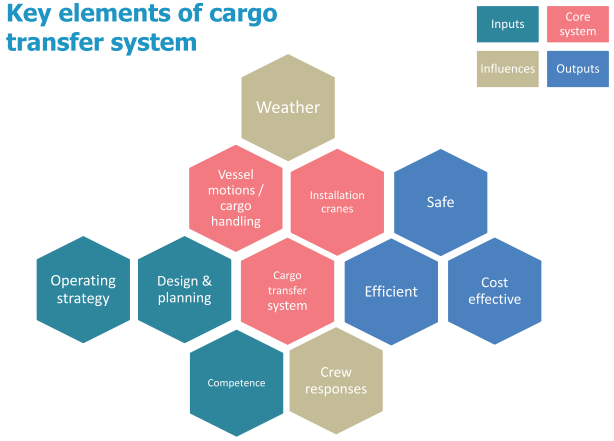
Philip Strong
CEO & Technical Director

Contents

- Integrated approach to cargo operations
- Current challenges
- Introducing Storm-Pro
- Conclusions

An integrated approach

Key elements of cargo transfer system



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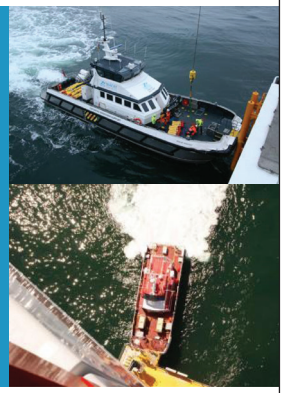
Challenges of Cargo Handling in Open Water

Key challenges

- Stability of small vessels
- Limited deck area
- Controlling mass in motion
- Safety of deck crews
- Restricted safe operating weather window



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Lift types vary

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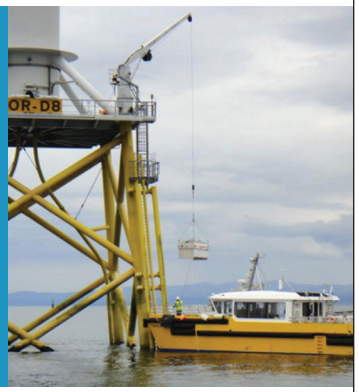
A question of mass

- Standard containers are heavy
- Poor ratio *pay load : net load*
- Economic impacts of weight:
  - Decreased vessel performance
  - Limited crane capacity
  - Limited deck capacity
- Safety impacts:
  - Mass in motion can be dangerous and destructive



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A question of safety

- High vessel motions in harsh weather
- Heavy loads hard to control
- Aggressive profiles can cause considerable damage
- Restricted deck space puts crews in harms way
- Cargo spills and breakages present further hazards

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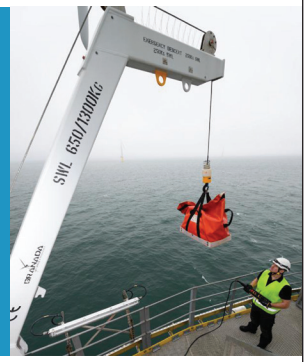
A question of performance
Operating envelope

- Delays due to restricted safe operating envelopes
- Limits on cranes (due to high 'non-paying' load)
- Damage to assets is a major risk
- Spillages and incidents impact performance



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Images used following creative commons (non-commercial) rules

Introducing Storm-Pro

StormPro
Harsh weather cargo handling

- Effective impact protection
- Light weight and robust
- Safe harsh weather operations
- Protects cargos and assets
- Stretches your work envelope

***Soft power* that puts you in control**

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Key elements

- Light weight – greater payload
- Dissipated impact energy
- Highly protective shell
- Ergonomic work interface
- Floating & self-righting options
- Flexible (customizable) to cargo

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Images used following creative commons (non-commercial) rules

Robust structure

- Safe load path
- Easy inspection and maintenance

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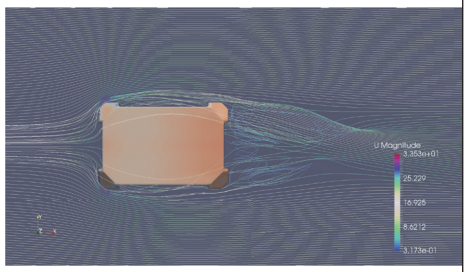
Images used following creative commons (non-commercial) rules

Low wind resistance

- Stable in high winds
- STORMpro Cx=0.49 vs BOX Cx=0.97



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Flexible handling on deck

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Adaptable
More that just a container

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Images used following creative commons (non-commercial) rules

Versatile
Customisable to cargo

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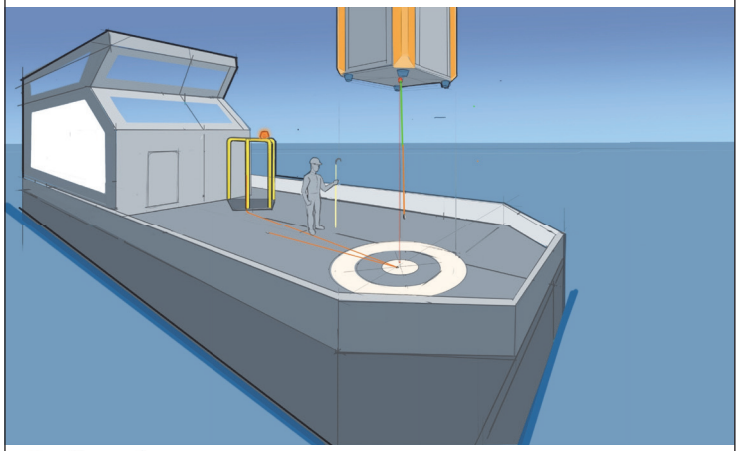
Cargo Landing System



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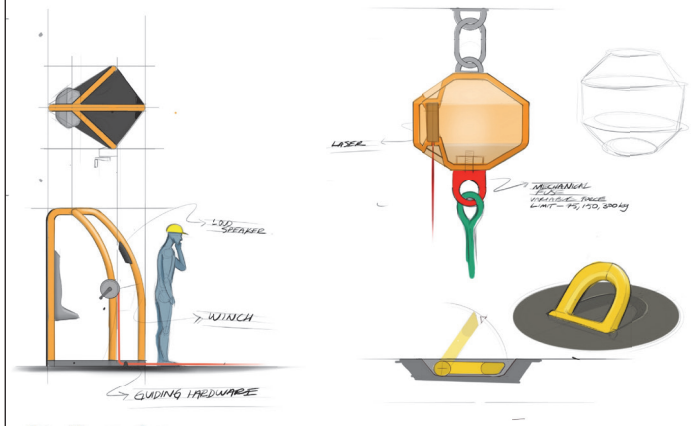

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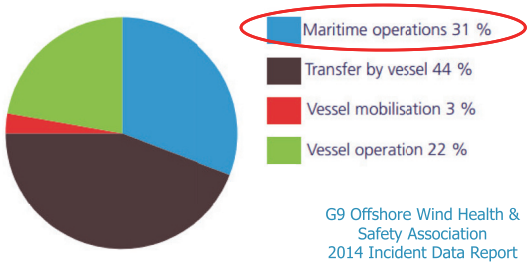
Optimising performance & safety

Safety: Cargo handling is a primary risk

Incidents by activity in offshore wind



G9 Offshore Wind Health & Safety Association
2014 Incident Data Report

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Cargo handling KPIs

- Safety
  - Incidents & LTIs
  - Per 10,000 visits
- Crew experience
  - Comfort and confidence
- Cost per visit
- Operational uptime
  - % monthly / annually

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Supporting best practice

Supporting best practice

Raising the standard of Crane transfer

Towards parity with 'aviation standards'

- User and I&M training
- Supporting media
- Client technical support
- Partner network
- Collecting incident data
- Implement learning

'Risk-based approach'

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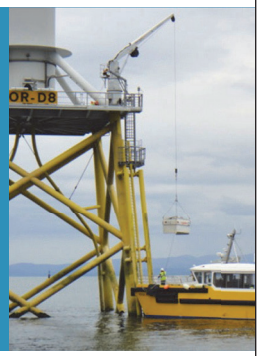
Some conclusions

- Cargo handling in open water is challenging
  - Safety and economic issues
  - Risks of harm to crews and damage to assets
  - Operational downtime / restrictions
  - Reduced vessel performance
- Storm-Pro solution:
  - Light weight and robust
  - Dispersed impact energy
  - Safe harsh weather operations
  - Protects cargos and assets
  - Stretches your work envelope



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Storm-Pro
Harsh weather cargo handling

Puts you in control

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WIND TURBINE ACCESS

Thank You

ANNEX C
ABBREVIATIONS AND ACRONYMS

API	American Petroleum Institute
BS EN	British Standards / European Standards
CEN	European Committee for Standardization
CITB	Construction Industry Training Board
CPCS	Construction Plant Competence Scheme
CTV	crew transfer vessel
DNV-GL	Det Norske Veritas – Germanischer Lloyd
EI	Energy Institute
EPCI	engineering, procurement, construction and installation
FAT	factory acceptance test
G+	G+ Global Offshore Wind Health and Safety Organisation
GWO	Global Wind Organisation
HAZID	Hazard identification study
HAZOP	Hazard and operability study
HSE	Health and Safety Executive
HSG	Health and Safety Guidance
IMCA	International Marine Contractors Association
ISO	International Organization for Standardization
LEEA	Lifting Equipment Engineers Association
OEM	original equipment manufacturer
O&M	operation and maintenance
RAMS	risk assessment and method statement
SCADA	supervisory control and data acquisition
SOV	service operation vessel
TP	transition piece
UAV	unmanned aerial vehicle
WTG	wind turbine generator

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