OWL-010

3D Motion Compensation

Maintenance of large offshore wind turbine generators

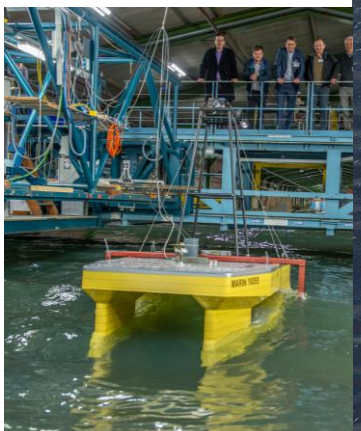
Offshore Wind Logistics

&

Huisman Equipment

Utrecht
13th of February 2020

Offshore Wind Logistics B.V.



Project driver

The Energy Transition has triggered a growing demand for clean energy. This has, amongst others, resulted in **growth opportunities in** the offshore wind market, and therefore in the **offshore wind installation- and maintenance market.** We identify the following trends:

- **Pressure on cost.** The need for competitively priced clean energy from offshore wind has resulted in a strong focus on **reducing LCOE.** This is being achieved (1) through economies of scale by designing and building ever larger turbines, and (2) by putting continuous pressure on margins throughout the value chain.

- **Limited availability of shallow water locations for field development.** New wind parks are being planned and developed in **deeper water**, as locations in shallow water are getting full.

Both trends are causing difficulties for the existing installation- and maintenance equipment in the market (jack-up vessels) due to limitations in crane height and/or leg size.

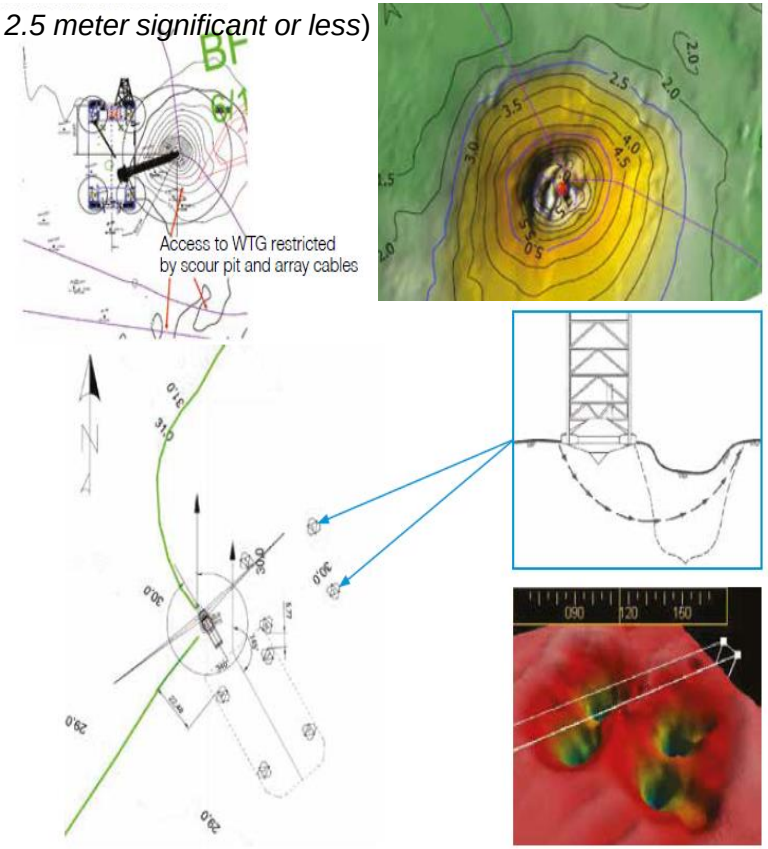
Initial approach

Offshore Wind Logistics B.V. (OWL) started in 2016 after an offshore wind park operator consulted the OWL management with regards to component change-out issues in one of their offshore wind parks, specifically in improving operation efficiency.

Initially OWL approached offshore wind turbine maintenance from jack-up platform size reduction.

Jack-up vessels have severe limitations, with the following as example:

- When used for lifting only, lots of time is spent on ‘jacking time’
- Wave height during jacking procedure (*jacking only with Hs between 1 and 2.5 meter significant or less*)
- Soil conditions of sea bottom
- Elephant marks on sea bottom
- Tidal stream
- Vessel control at departure work site
- Transit speeds of self sailing units are low
- Problems increase when reducing unit size
- Expensive and sensitive



Project origination

As OWL had hands-on experience in operating floating cranes, OWL soon recognized it could economize the operations by using a floating Platform. With prime examples operating in the industry this development started.

Key performance indicators of a floating Platform:

- Based on proven & existing technology
- Floating during lift operation
- Zero to none movement when operating in waves up to a given standard
- Proven capability for precise operations (such as lifting, drilling, diving / ROV ops, etc.)
- Self-propelled & DP2 or better without interference with seabed
- Ability to withstand (severe) weather while operational (offshore)
- Reducing overall LCOE

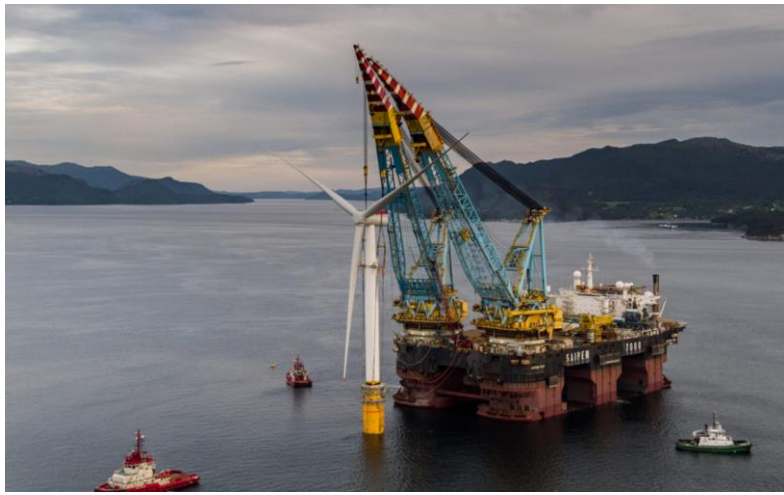


Image: Ørjan Richardsen / Equinor.

OWL-010
VESSEL and 3D COMPENSATED CRANE

VESSEL

Design:	Naval Dynamics DeltaCat (NDDC) WTSU OWL1
Type:	Wind Turbine Service Unit
Class notation:	DnV GL +1A1 COLUMN STABILIZED UNIT OFFSHORE ACCOMODATION UNIT CRANE EO DYNPOS AUTRO HELDK-SH
Main characteristics:	2,500 m^2 free deck space One (1) Huisman 3D Motion Compensated crane One (1) Huisman full electric Pedestal Mounted Crane 36 mt @ 43 m One (1) SMST Telescopic Access Bridge 25-30 m DP Class III station keeping

Length o.a.	**89.25 m**
Length w.l.	**85.00 m**
Beam o.a.	**55.00 m**
Draft @ operation	**16.00 m**
Draft @ transit	**9.60 m**
Draft @ survival	**9.60 /15.00 m**
Installed power	**22.6 MW**
Transit speed	**12.0 kts**

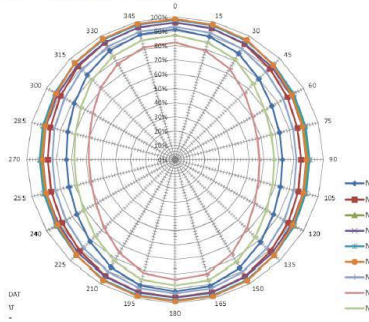
CRANE

Crane Developed together with **HUISMAN Equipment**

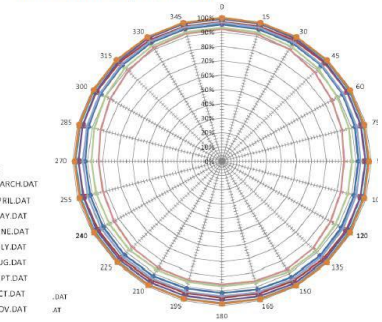
- 145m hook height above sea level while at work draught (16 meters);
- Lift capacity of 240t SWL , 3D motion compensated to a 5cm accuracy at significant wave heights Hs < 4 m
- 600t main hoist with fly-jib rigged, not compensated single hook
- 800t main hoist with fly-jib derigged, not compensated single hook

Benchmark workability analysis

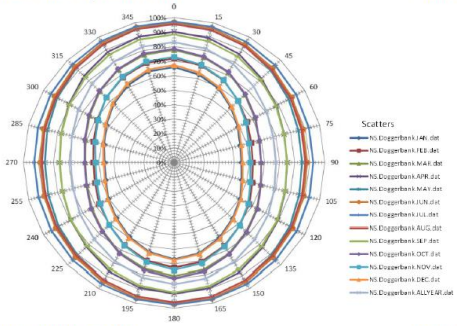
German Bight
Stern 240 ton compensated lift



German Bight
Side 240 ton compensated lift



Dogger Banks
Stern 240 ton compensated lift



Dogger Banks
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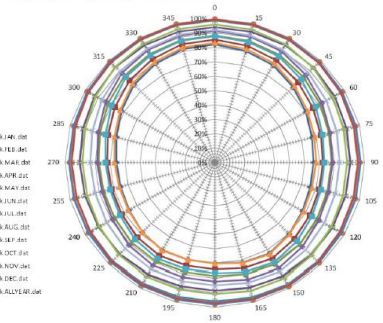
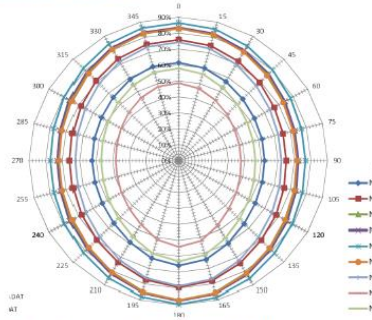
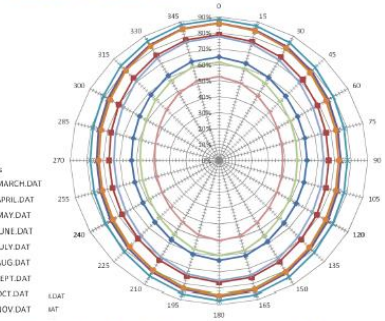


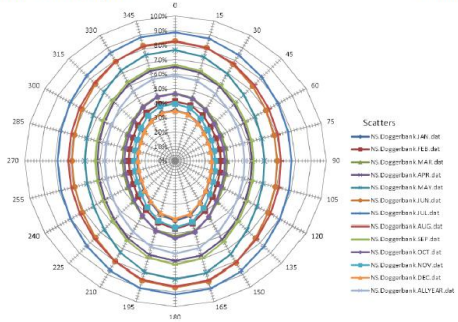
Stern 600 ton Heavy lift



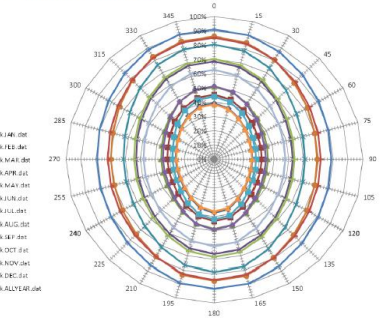
Side 600 ton Heavy lift



Stern 600 ton Heavy lift



Side 600 ton Heavy lift



The Polar diagrams show the workability percentage along the radius plotted per environmental direction.
The outer ring equals 100% workability.
Each graph has months indicated in different colors

OWL-010 Marin tests

Hull form & Numerical Model

Response Amplitude Operators (Vessel Motions RAO)

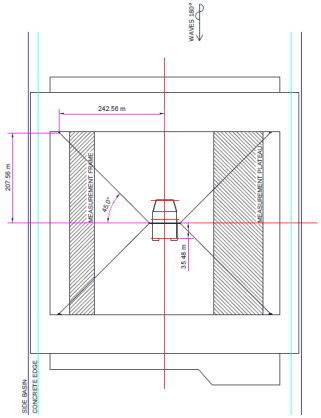
Based on computer simulations (program 'MOSES' for hull & OrcaFlex for crane)

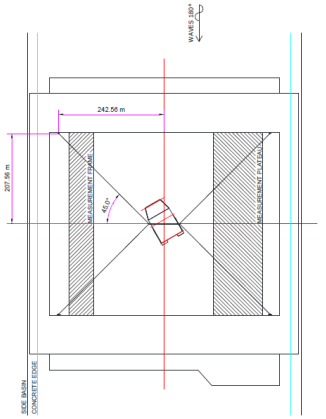
- **Hydrostatic analysis** - Floatation analysis
- **Operability Analysis -** Determine limiting environmental conditions based on motion criteria.
- **Workability analysis, incl. Performance of main crane**

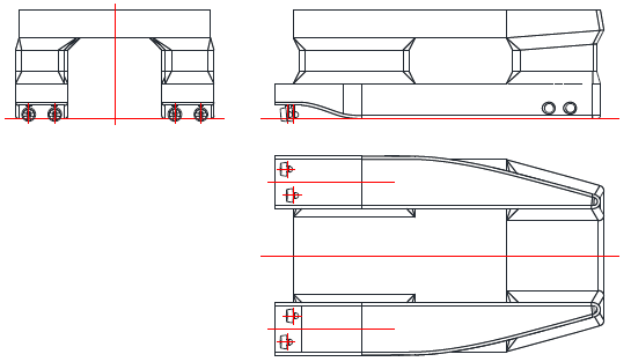
Model Tests MARIN

Use ship model 1:40, with exact weight balance as in real ship

- Will provide Time Trace Vessel Motion under various sea state conditions (separate presentation);
- Will update computer simulations both (Moses & OrcaFlex) with measured data;







Marin tests

Proposed Seastate

ID	Name	Hs	Tp	Spectrum	Gamma	Remarks
		(m)	(s)	(-)	(-)	
1	SURV-02	9.0	11.9	Jonswap	3.3	Survival seastate
2	OPE-03	4.0	7.9	Jonswap	3.3	
3	OPE-03	4.0	12.5	Jonswap	1.0	
4	OPE-04	2.5	6.2	Jonswap	3.3	
5	OPE-04	2.5	9.9	Jonswap	1.0	

Marin test results

The motions of the WTSU have been measured for difference wave conditions, and the RAOs have been analysed.

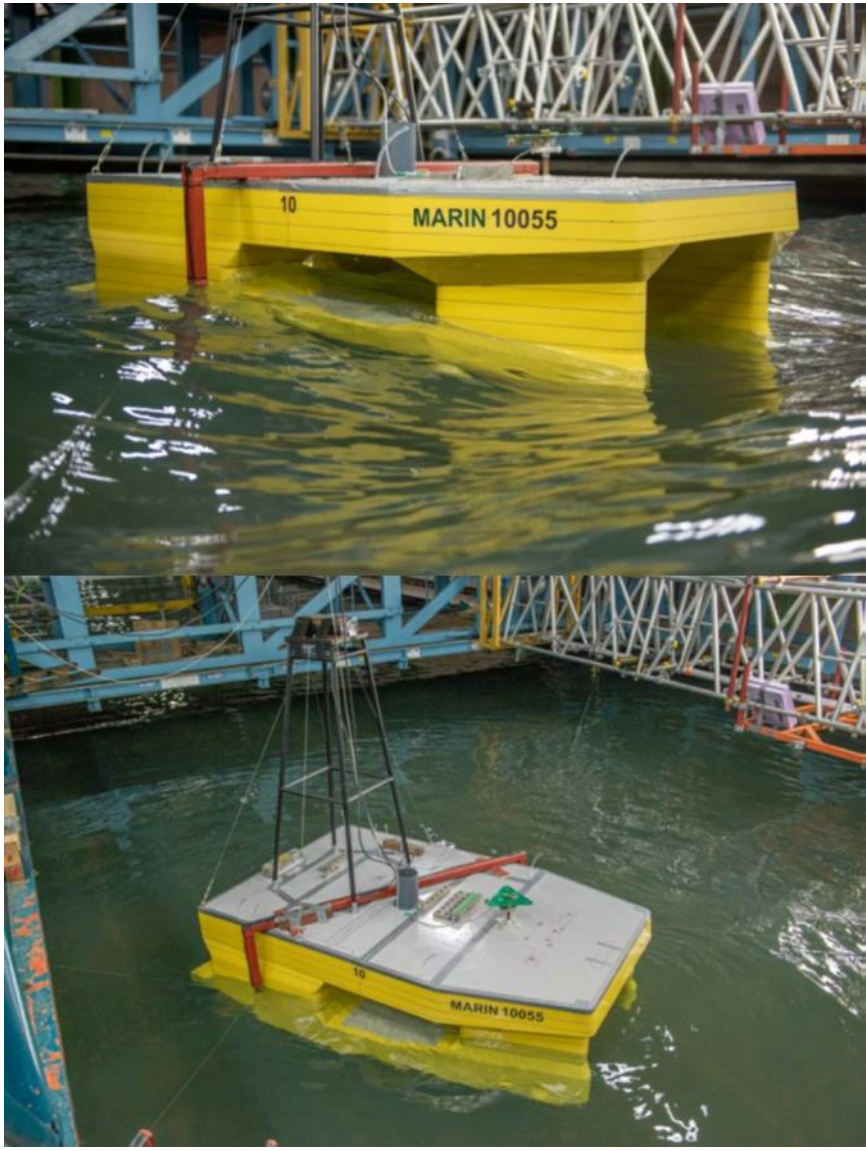
In general, the motion RAO obtained in different sea states agree well for all modes.

Motion response for the tested head seas has produced valuable data to further fine-tune motion response of the computer models.

Especially with regards to viscous damping, which was the main uncertainty that existed.

All motion and accelerations are lower or equal than predicted earlier

No unexpected surprises have been observed



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Both trends are causing difficulties for the existing installation- and maintenance equipment in the market (jack-up vessels) due to limitations in crane height and/or leg size.

Offshore Wind Logistics B.V. (OWL) has developed a solution to meet both challenges simultaneously by designing and building a semi-submersible crane ship (“OWL-010”), with a motion compensated crane that can exchange heavy components with hook heights of 145 meters, sufficient to reach the latest generation wind turbines.

The vessel has been designed in close cooperation between **OWL** and **Huisman Equipment**.

Based on proven technology, the main advantages of OWL’s new Crane Vessel compared to existing solutions are: higher reach, faster turnaround times, longer working seasons, 50% lower day rate, increased fuel efficiency.

The vessel has been ordered and has an expected delivery in 2nd half 2022.
OWL is currently negotiating Time Charter contracts within the offshore wind industry.

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