

OFFSHORE WIND





TEMPORARY WORKS DESIGN

TWD is an engineering company specialized in creating custom-designed tools and structures that allow you to perform transport & installation projects safely and on time. You can regard TWD as your problem solver. The reliable partner that creates functional and creative solutions, no matter what the time frame is, or the complexity of the challenge. Our goal is to reinforce your project team's capabilities and complement them where required, so we can together achieve a successful project execution.

-  FLEXIBLE
-  PRACTICAL
-  CREATIVE






... are the driving forces behind each of our designs

Our thorough knowledge of structural and mechanical engineering, hydro-dynamics, finite element methods and design for offshore conditions, enables us to develop the optimal solutions that meet the wide variety of your demands.

Besides the development of practical installation methods and the design of the required tools, TWD engineers can assist during the procurement, fabrication and mobilization phase. This approach allows us to shorten the required lead times, properly integrate the contributions of different subcontractors and assure that our constructions will function as intended.

This document provides an overview of our track record of safe and robust designs used for Offshore Wind installations. The document provides a selection of projects. References and additional examples can be provided upon request.

MARKETS

-  OFFSHORE WIND
-  OFFSHORE OIL & GAS
-  HEAVY CIVILS
-  SALVAGE
-  DECOMMISSIONING

SERVICES

-  DESIGN
-  FABRICATION SERVICES
-  NAVAL ENGINEERING
-  SPECIAL DISCIPLINES

OFFSHORE WIND



TWD is well established in the growing market of Offshore Wind. Our designs, developed in close cooperation with a wide variety of offshore installation contractors, contributed to the successful erection of many offshore wind farms.

Offshore Wind installation projects have a highly repetitive character, which makes their success largely depending on the chosen installation methods. Due to our experience, we understand the critical aspects in the transport & installation cycle. With logical deck lay-outs, innovative and practical handling tools and well thought-out installation procedures, we can contribute to a significant reduction of the offshore cycle time.

Whether the challenge is simple or complex, a seafastening or a pile gripper, our functional design method leads to logical and cost effective solutions. Our track record, from which examples are included in following sections, illustrates how we could contribute to your future Offshore Wind installation project.

WE CAN ASSIST IN FOLLOWING STAGES OF OFFSHORE WIND INSTALLATION



FOUNDATION TRANSPORT & INSTALLATION



TURBINE TRANSPORT & INSTALLATION



SUBSTATION TRANSPORT & INSTALLATION



CABLE INSTALLATION



SECONDARY STEEL INSTALLATION

Take a look at our website!

TWD.NL
TWD-UK.COM



SVANNEN GRIPPER
VAN OORD

Currently the biggest monopile gripper frame for diameters up to 11m



OFFSHORE WIND



TWD DESIGNS INVOLVED IN THE INSTALLATION OF THE FOLLOWING OFFSHORE WIND FARMS

- | | | | | | |
|-----------------|------------------------|-------------------|---------------------------|--------------|------------------------|
| ■ ABERDEEN BAY | ■ BLIGH BANK 2 | ■ DEUTSCHE BUCHT | ■ HORNS REV 3 | ■ NORTHWIND | ■ THORNTON BANK |
| ■ ALBATROS | ■ BLYTH | ■ DUDGEON | ■ HORNSEA 1 | ■ ORMONDE | ■ TRIANEL |
| ■ ANHOLT | ■ BORKUM RIFFGRUND 1 | ■ EAST ANGLIA ONE | ■ KENTISH FLATS EXTENSION | ■ RACE BANK | ■ VEJA MATE |
| ■ ARKONA | ■ BORKUM RIFFGRUND 2 | ■ GALLOPER | ■ KRIEGERS FLAK | ■ RAMPION | ■ WALNEY EXTENSION |
| ■ BALTIC 2 | ■ BORKUM WEST 2 | ■ GEMINI | ■ LUCHTERDUINEN | ■ RENTEL | ■ WESTERMEERWIND |
| ■ BARD OFFSHORE | ■ BORSELLE 3 & 4 | ■ GLOBAL TECH I | ■ MERKUR | ■ RHYL FLATS | ■ WESTERMOST ROUGH |
| ■ BELWIND | ■ BURBO BANK EXTENSION | ■ GODE WIND | ■ NORDERGRÜNDE | ■ ROBIN RIGG | ■ WEST OF DUDDON SANDS |
| ■ BEATRICE | ■ BUTENDIEK | ■ GWYNT Y MÔR | ■ NORDSEE ONE | ■ SANDBANK | ■ WIKINGER |
| ■ BINHAI H2 | ■ DANTYSK | ■ HOHE SEE | ■ NORTHER | ■ TAHKOLUOTO | |



GALLOPER
GEOSEA
 Stacked MP seafastening and bull rail on Innovation

SEAFASTENING MONOPILES - GALLOPER

As offshore wind turbines and their foundations become ever larger, contractors across the industry face growing challenges with their vessels' limited capacities. To stay efficient and competitive with their current fleets, they require innovative installation concepts and daring engineering solutions. One example is the 'upgrade' of GeoSea's heavy lift jack-up vessel Innovation. To prepare for handling the large foundations of the Galloper wind farm, TWD designed the first ever skidding monopile seafastening on an installation vessel. To make the skidding possible, and to efficiently spread the loads of these heavy monopiles, we designed two bull rails for the Innovation. Besides, TWD also designed modular seafastening frames for the transition pieces and the hammer, as well as a tower for stacking four anode cages.

SIMILAR SCOPE PERFORMED ON:

- | | | | |
|----------------------|---------------|---------------------------|------------------------|
| ■ ALBATROS | ■ GEMINI | ■ KENTISH FLATS EXTENSION | ■ RENTEL |
| ■ BLIGH BANK | ■ GALLOPER | ■ NORDSEE ONE | ■ ROBIN RIGG |
| ■ BORKUM RIFFGRUND 1 | ■ GODE WIND | ■ NORTHER | ■ SANDBANK |
| ■ BORKUM RIFFGRUND 2 | ■ HORNS REV 3 | ■ NORTHWIND | ■ WESTERMOST ROUGH |
| ■ DEUTSCHE BUCHT | ■ HORNSEA 1 | ■ RACE BANK | ■ WEST OF DUDDON SANDS |



VEJA MATE
OFFSHORE WIND FORCE
 Seafastening and inspection tool.



SANDBANK BILFINGER

Monopile upending hinge
and stacked seafastening
construction on Pacific Orca

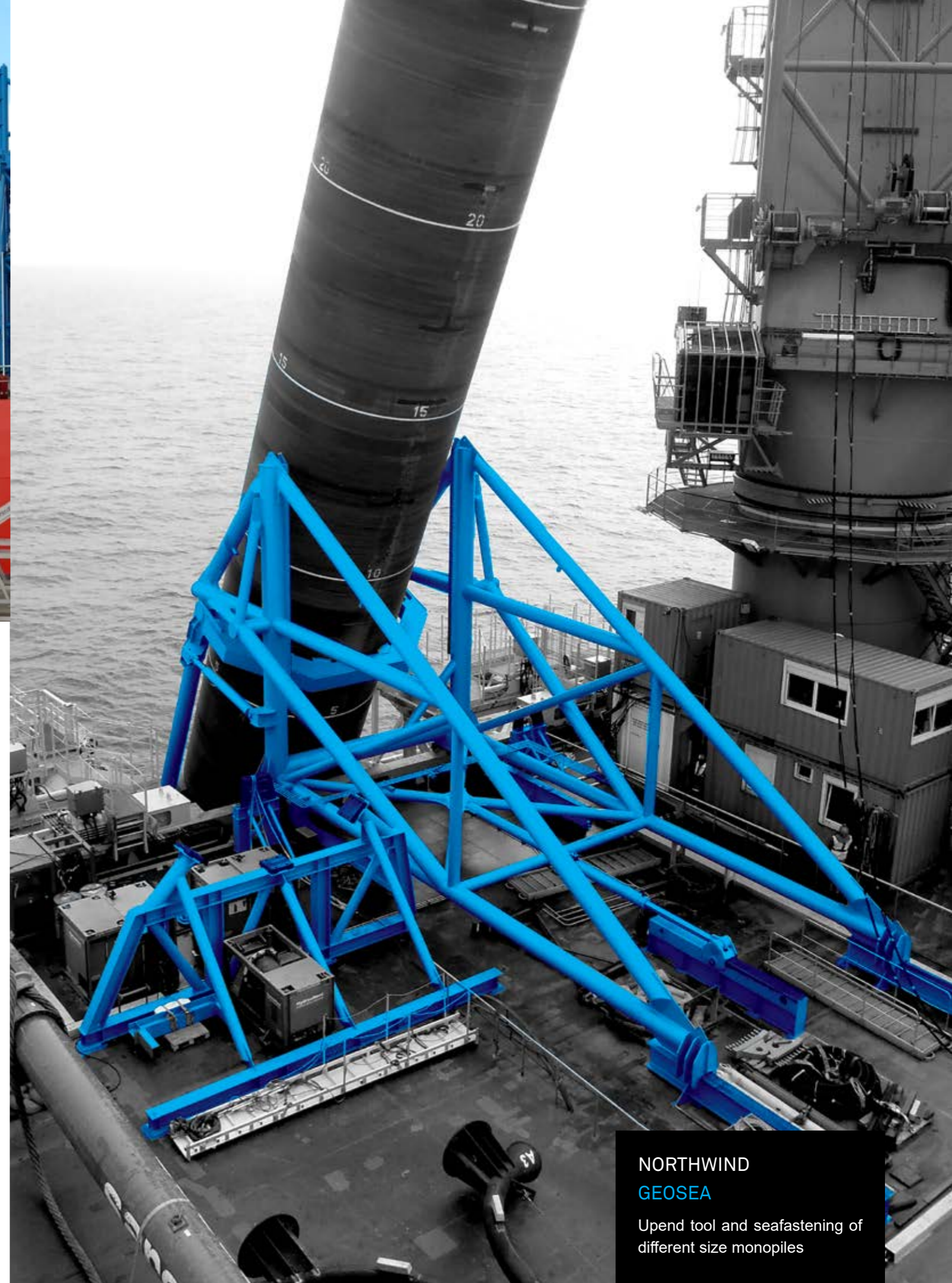
UPENDING MONOPILES - SANDBANK

Serving as an oversized swing, the upending hinge was designed to support the 900 t monopiles during upending. The crane lifts one end of the pile, manipulating the pile quickly and safely from horizontal to vertical. Due to the lean design, the hinge not only operated efficiently, but was easy to manufacture and required minimal vessel modifications.

Besides the design of seafastening, upend tool, pile gripper and HSD-deployment frame, TWD engineers were actively involved in the fabrication, mobilization and commissioning of the different handling tools. Such an integral approach results in a very efficient project, optimal functioning of the equipment and a satisfied customer.

SIMILAR SCOPE PERFORMED ON:

- | | | | |
|----------------------|------------------|---------------|---------------------------|
| ■ ALBATROS | ■ DEUTSCHE BUCHT | ■ NORDSEE ONE | ■ WESTERMOST ROUGH |
| ■ BLIGH BANK | ■ GODE WIND | ■ NORTHER | ■ WEST OF DUDDON SANDS |
| ■ BORKUM RIFFGRUND 1 | ■ GALLOPER | ■ NORTHWIND | ■ KENTISH FLATS EXTENSION |
| ■ BORKUM RIFFGRUND 2 | ■ HORNS REV 3 | ■ RENTEL | ■ RACE BANK |
| ■ BORSELLE 3 & 4 | ■ HORNSEA 1 | ■ ROBIN RIGG | |



NORTHWIND GEOSEA

Upend tool and seafastening of
different size monopiles



LUCHTERDUINEN
VAN OORD
Monopile gripper frame during mobilization on Aeolus

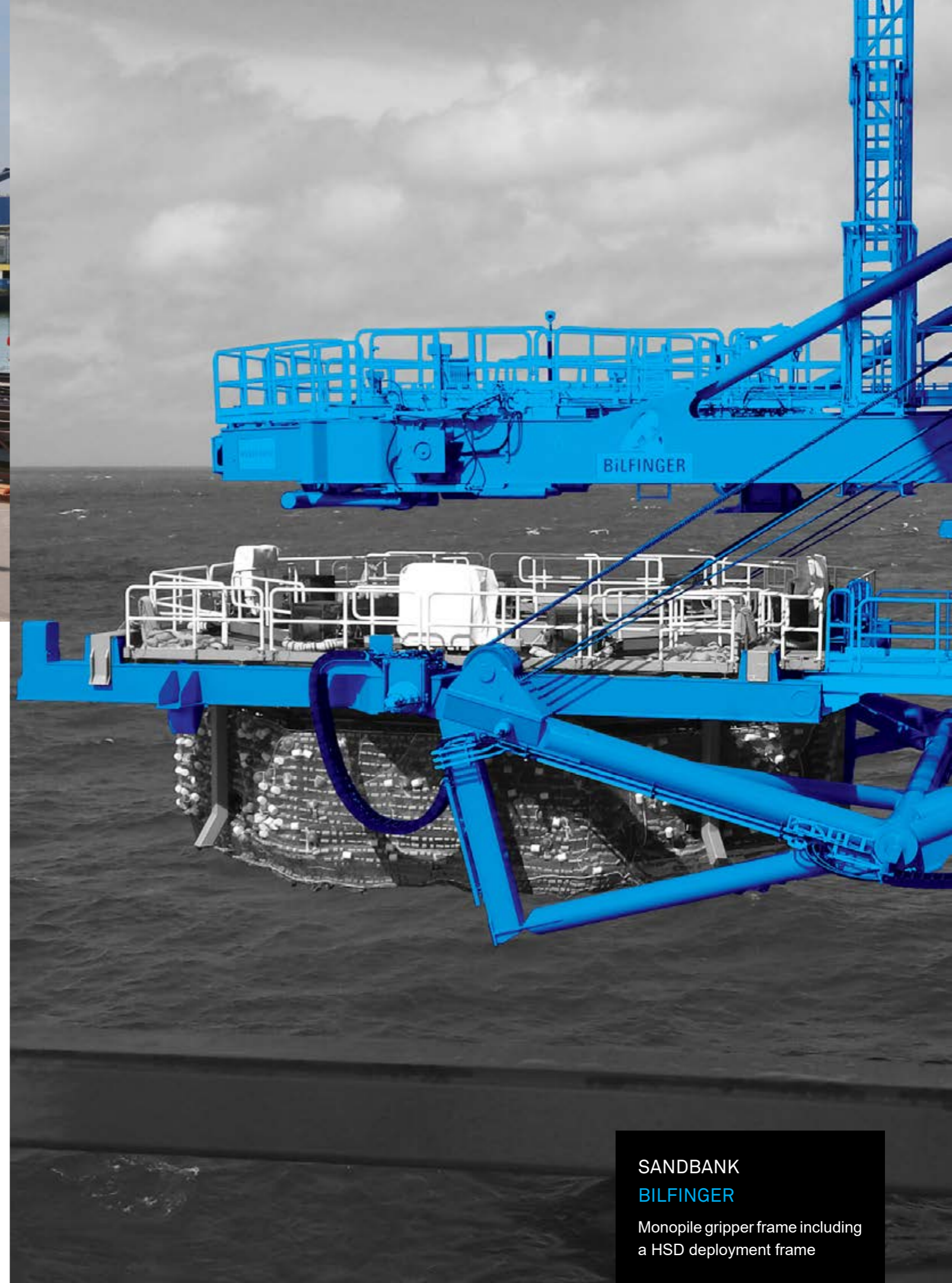
MONOPILE GRIPPER - LUCHTERDUINEN

After a successful monopile installation campaign on the Luchterduinen wind farm, Van Oord ordered a second monopile gripper to be used on the Pacific Osprey. The Pacific Osprey joined the Aeolus, both equipped with similar pile grippers, for the installation of the 150 foundations of Gemini wind farm. Both the foundation installations of Luchterduinen and Gemini were completed far ahead of planning.

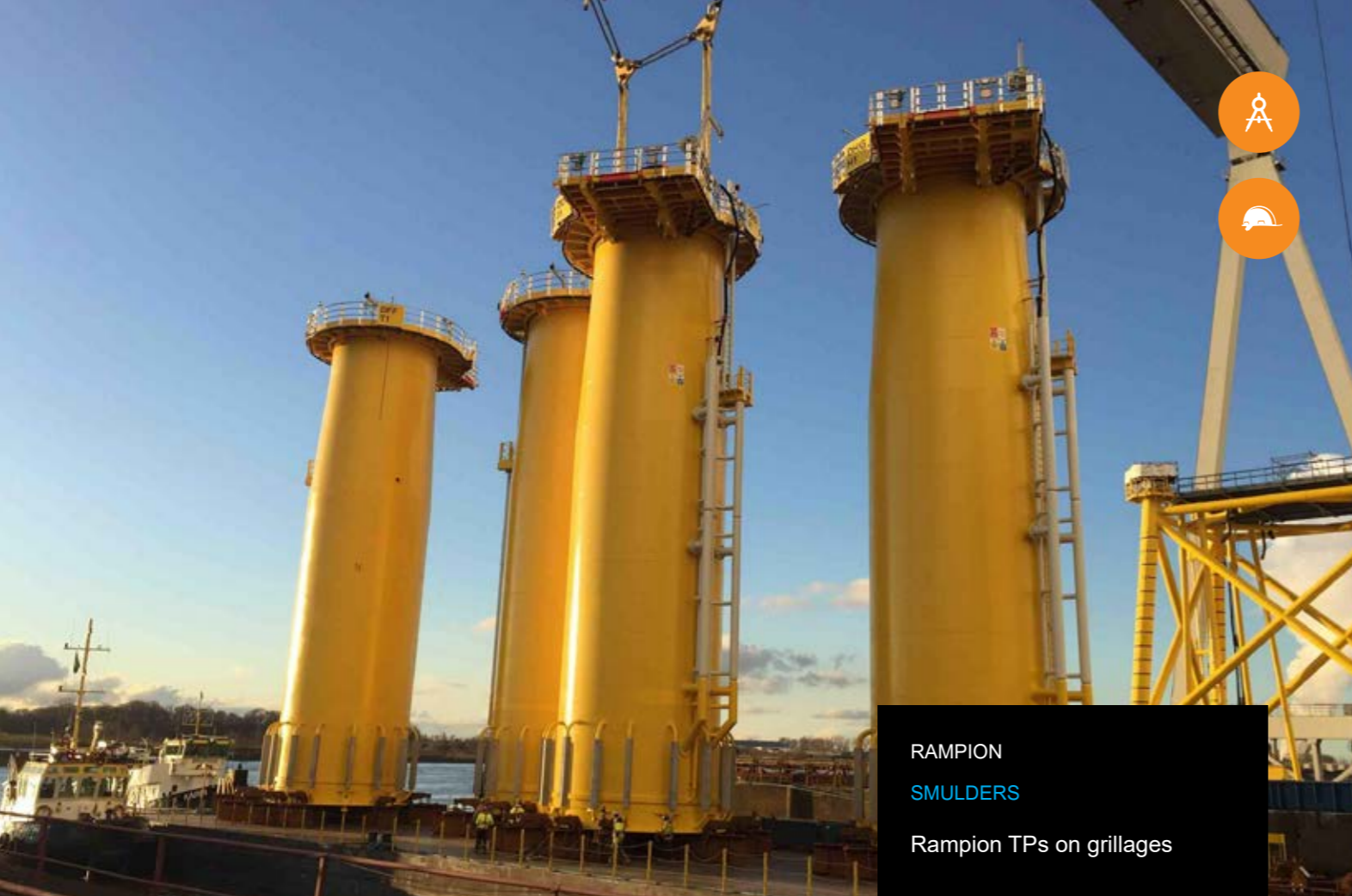
The gripper is designed to handle a range of monopile sizes, and is able to rotate them and correct their position within a 3 by 3m working envelope. The system can work at deck and keel level to guide piles as close to the water level as possible. Walkways and railings all around the gripper allow it to be used as a working platform, also at intermediate levels. For transit, the frame is folded by a winch and skidded inboard. The multi-step jacking and skidding processes are fully automated using integrated position sensors.

SIMILAR SCOPE PERFORMED ON:

- ARKONA
- GEMINI
- SANDBANK
- DEUTSCHE BUCHT
- NORTHER
- WALNEY EXTENSION



SANDBANK
BILFINGER
Monopile gripper frame including a HSD deployment frame



RAMPION
SMULDERS
Rampion TPs on grillages

TRANSITION PIECE SEAFASTENING - RAMPION

Smulders is the world's biggest manufacturer of TPs. With multiple projects running at the same time this results in a logistical challenge: how to transport different diameter TPs on multiple barges with the same seafastening?

TWD designed a robust, cheap and smart seafastening that Smulders has been using on all their TP projects since Rampion. TP diameters that can be accommodated are between 5 and 8 meters. The modular parts were designed so they could easily be changed and mobilized on a different barge. Also the clamp arrangement can be rearranged such that any TP can be fitted on the grillages. Extra attention was paid to the clamp design. Riggers on site can easily secure the TP without the need of expensive and complicated tools. Besides the grillage design, TWD assist Smulders with all required naval analyses and integrity checks for the transports.

SIMILAR SCOPE PERFORMED ON:

- | | | | |
|----------------------|-----------------|---------------|------------------------|
| ■ BLIGH BANK | ■ GEMINI | ■ MERKUR | ■ RENTEL |
| ■ BORKUM RIFFGRUND 1 | ■ GODE WIND | ■ NORDSEE ONE | ■ SANDBANK |
| ■ BURBOBANK | ■ HOHE SEE | ■ NORTHER | ■ TIANEL |
| ■ DUDGEON | ■ HORNSEA 1 | ■ RACE BANK | ■ WESTERMOST ROUGH |
| ■ GALLOPER | ■ KRIEGERS FLAK | ■ RAMPION | ■ WEST OF DUDDON SANDS |



GODE WIND
GEOSEA
Monopile, Transition piece and
Anode cage seafastening on
barges



BORKUM RIFFGRUND

GEOSEA

Smart quick-coupling clamps to support suction bucket jacket on the Innovation

JACKET SEAFASTENING - BORKUM RIFFGRUND

For the test suction bucket jacket of Borkum Riffgrund I, Ørsted (Dong) and GeoSea required a seafastening that would serve as example to future suction bucket jacket seafastening. TWD designed an innovative and operation-friendly structure that clamps the suction buckets on deck. The relatively thin buckets were clamped by utilizing pretensioned threaded bars, in order to avoid welding or difficultly accessible lashings. To prevent the bucket of getting damaged, the clamps were outfitted with a wooden interface.

This successful project demonstrated a seafastening solution which becomes even more interesting for repetitive suction bucket jacket installations, where a reduced offshore cycle time directly results in reduced installation costs.

SIMILAR SCOPE PERFORMED ON:

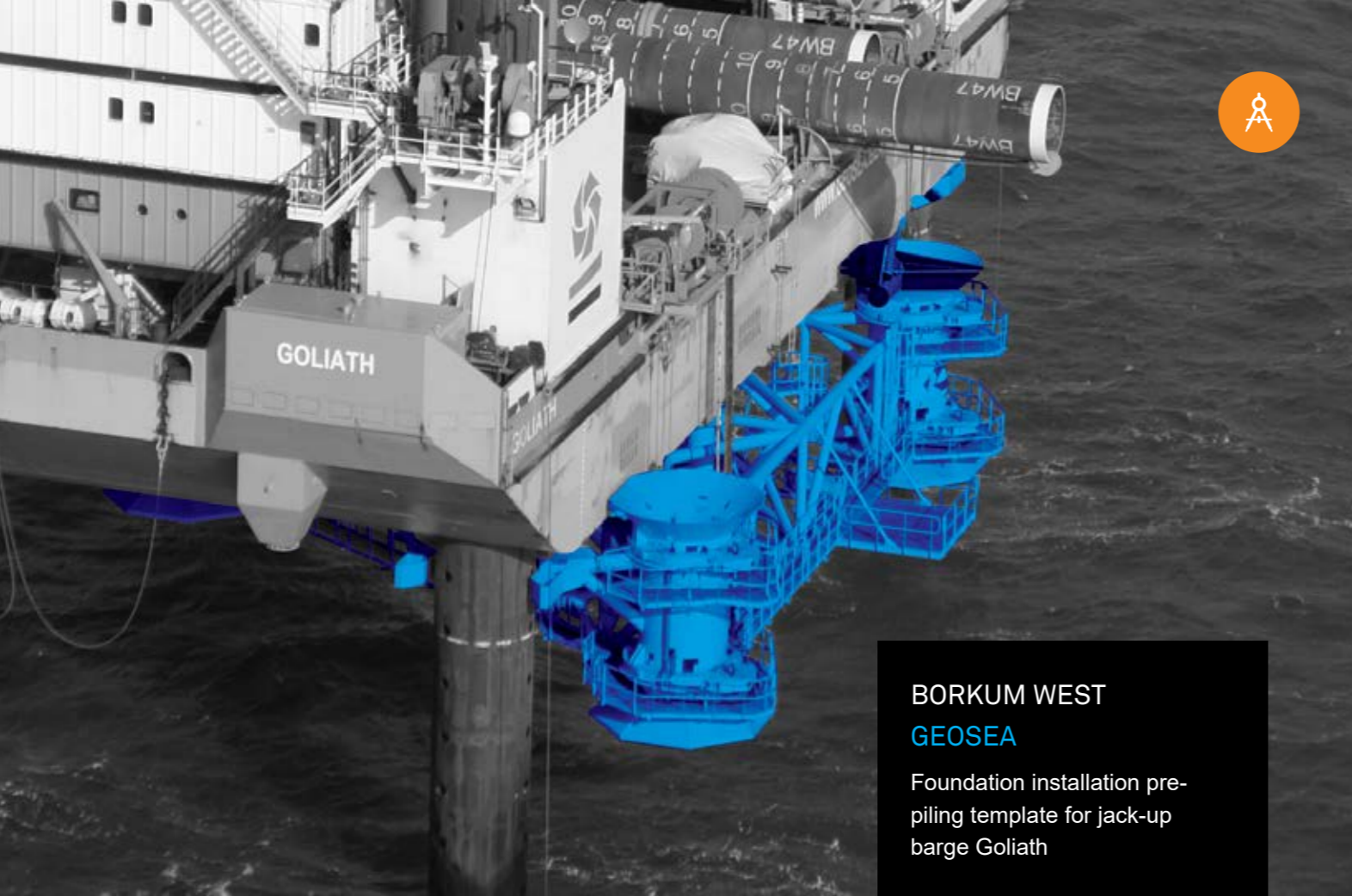
- ABERDEEN BAY
- BEATRICE
- TAHKOLUOTO
- BALTIC 2
- BORKUM RIFFGRUND 2
- WIKINGER



BALTIC 2

BOSKALIS

Seafastening of 800t jackets on NB90 barge



BORKUM WEST
GEOSEA
 Foundation installation pre-piling template for jack-up barge Goliath

PRE-PIILING TEMPLATE - BORKUM WEST II

TWD designed a piling template for GeoSea’s jack-up barge, Goliath. Suspended by winches, the template can be lowered to the seabed and levelled during pile driving. After driving the piles into the seabed, the template can be loosened from the piles with a simple and robust hydraulic loosening mechanism. It is then lifted against the hull so that the barge can sail to the next location.

The robust template assures accurate positioning of the piles throughout the entire piling campaign. Due to a smart and effective mechanical design, the template never gets stuck, works fast and accurately and is, due to its simplicity, cost-effective to fabricate.

SIMILAR SCOPE PERFORMED ON:

- BELWIND
- ORMONDE
- BALTIC 2
- THORNTON BANK

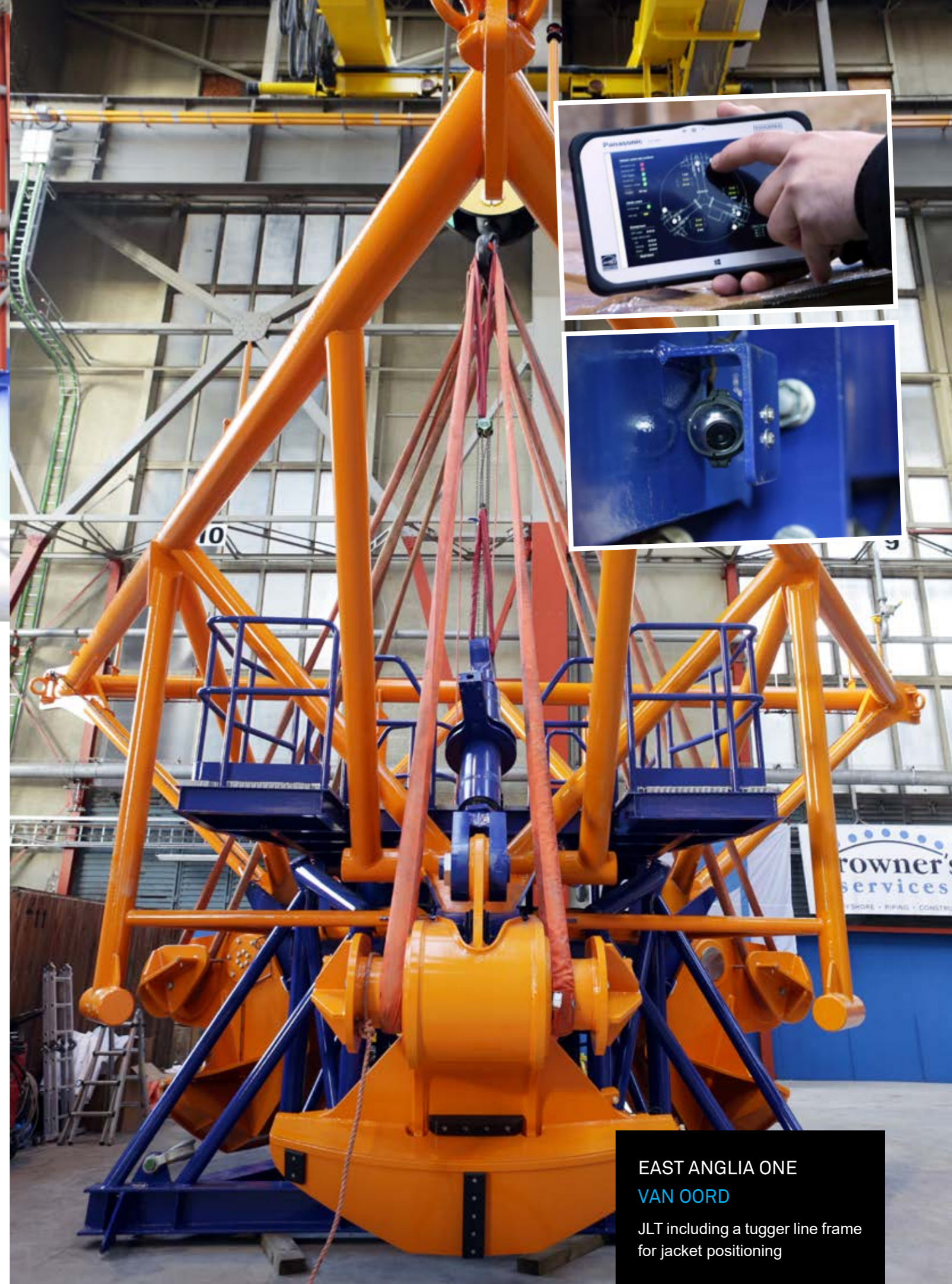


ORMONDE
GEOSEA
 Pre-piling template suspended below jack-up barge Buzzard



JACKET LIFTING TOOL TWD INNOVATIONS

Saves significant installation
and operation time



LIFTING TOOL INNOVATIONS

TWD developed a Jacket Lifting Tool that enables you to install the next generation wind turbine jackets. The Jacket Lifting Tool is light weight and currently available with a SWL up to 1500 tonne. The design of the tool can be scaled up and tailored to your maximum crane capacity in case an increased SWL is required.

Being fully remote controlled, it ensures a safe and easy installation, without the need of crew accessing the top of the jacket. The Jacket Lifting Tool is designed with operational safety, speed and redundancy as main objectives. TWD has a large track record in the design of offshore lifting tools and we incorporated this experience in the design of the light-weight Jacket Lifting Tool.

We also designed monopile and TP lifting tools for variable SWLs and diameters.

ADVANTAGES:

- Light weight
- SWL 500-1.500+ tonne
- Fully remote, no wiring or access required
- Adaptable for different diameters and multiple projects
- Full tool delivery or only design
- Delivered in your company colors

EAST ANGLIA ONE
VAN OORD
JLT including a tugger line frame
for jacket positioning



BLADE EXCHANGE TOOL TWD INNOVATIONS

An innovative floating removal and installation method that significantly saves costs and time

FLOATING INNOVATIONS

BLADE EXCHANGE TOOL

The demand for expected and unexpected maintenance work on blades increases with every newly installed offshore wind turbine, and with a potential of 5.000 sub-5MW blades which need to be exchanged in the coming years; a cost-effective solution is required. By replacing the jack-up vessel with a floating solution with similar workability, significant costs and time can be saved. With the design of a dedicated turbine maintenance system, TWD has come up with an innovative floating removal and installation method, using a barge, PSV or dedicated vessel.

MOTION COMPENSATED PILE GRIPPER

Currently the majority of foundations are installed by jack-up barges. However, most existing jack-up barges do not have sufficient jacking and crane capacities to efficiently install the XL-monopiles of future wind farms. Floating installation vessels allow higher pay-loads and crane capacities than jack-up barges. Being able to install XL monopiles with a floating vessel, without giving in on workability, reduces the cost of monopile installations up to 40%. The Motion Compensated Pile Gripper, as developed by TWD and Barge Master, opens the door to these significant savings and further secures the promising future of offshore wind.

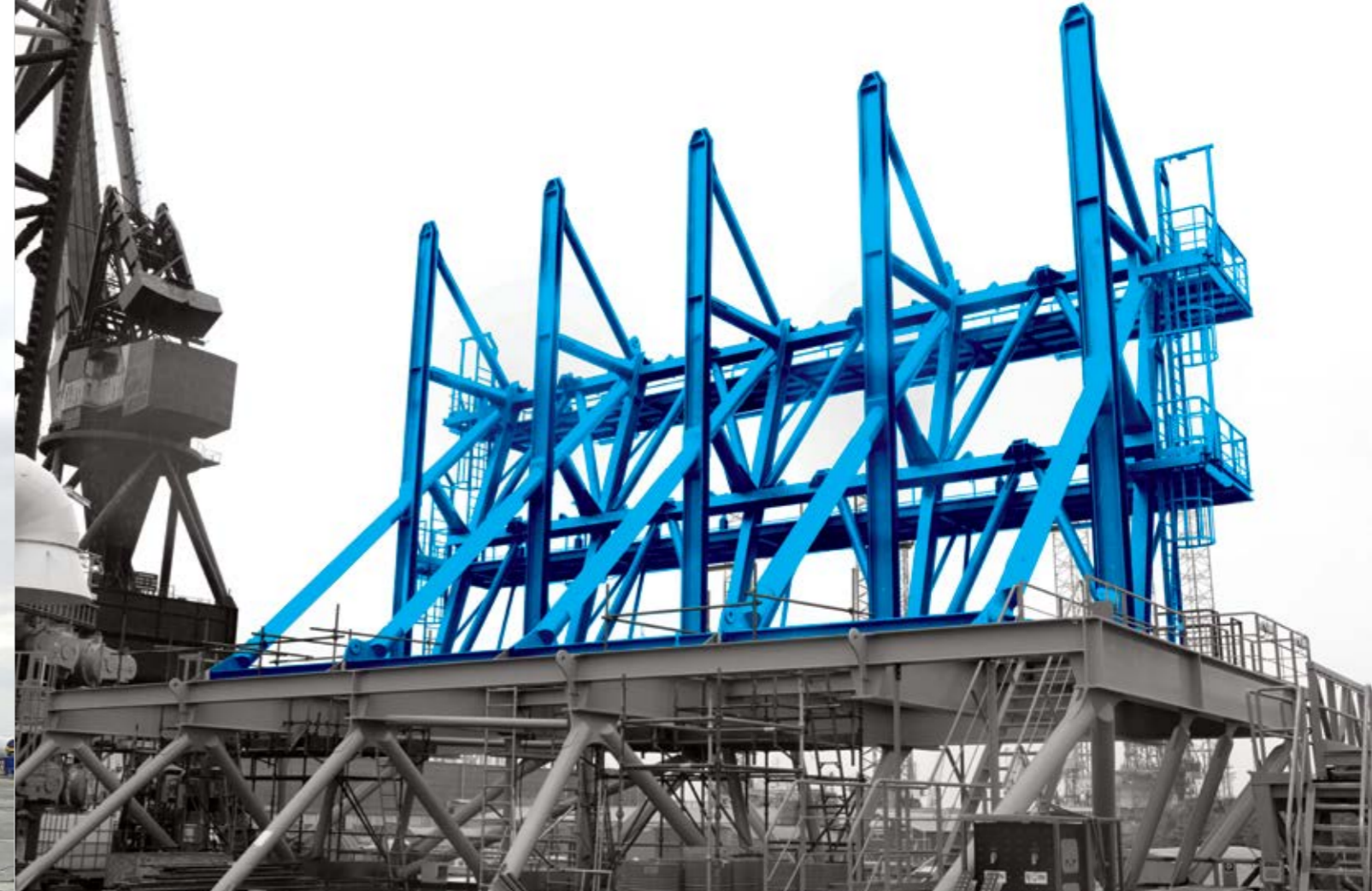


MOTION COMPENSATED PILE GRIPPER TWD INNOVATIONS

Tailor made, integral solution for pile upending, lowering and piling



VESTAS V164
VAN OORD / BOSKALIS
WTG components on Pacific Orca



TURBINE SEAFASTENING - VESTAS V164

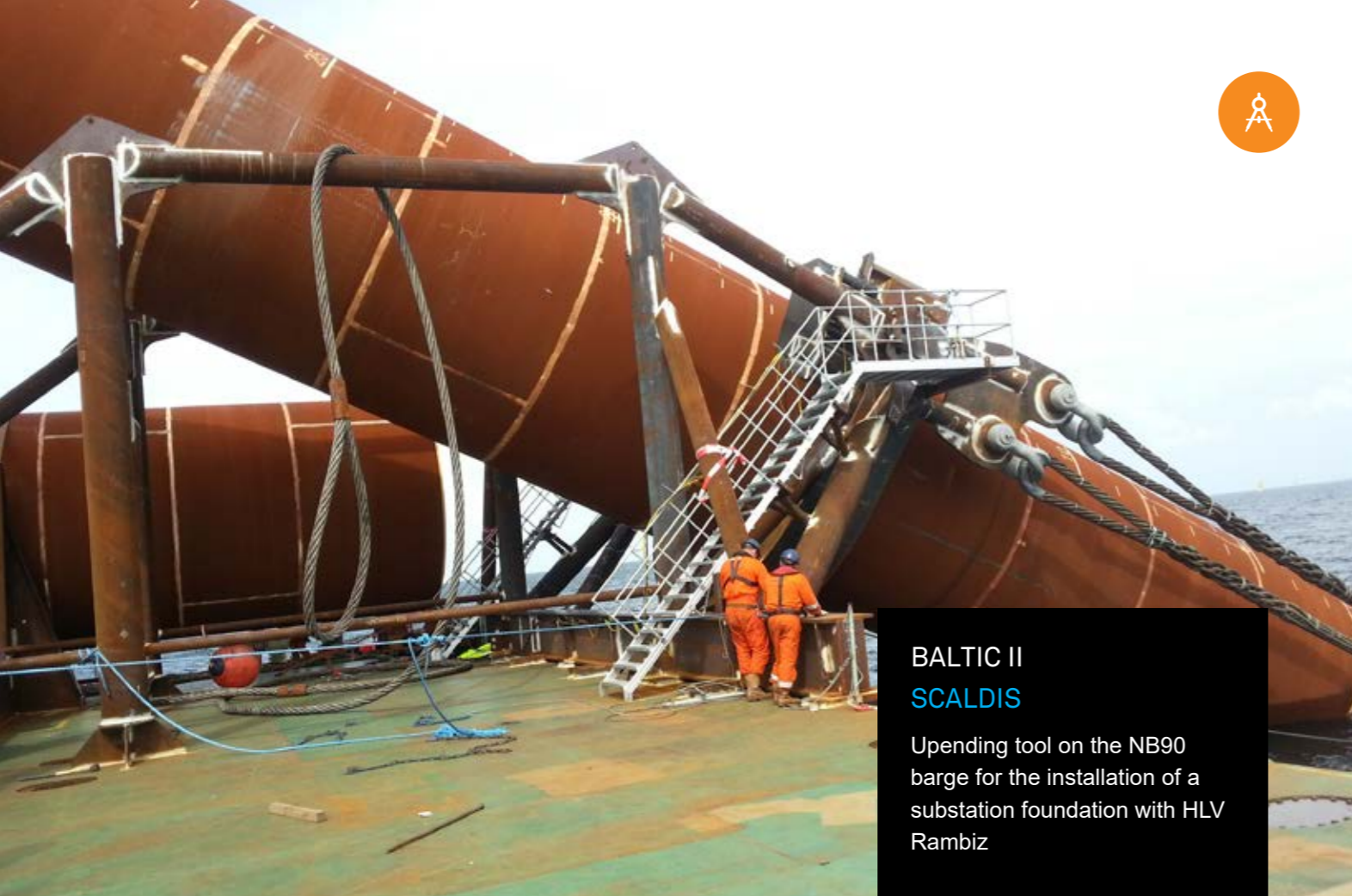
The Vestas V164 is one of the most powerful turbines in the world, with only a few vessels being capable to transport and install the WTG components. Boskalis and Van Oord both needed to install these turbines on different wind farms: Aberdeen Bay, Norther, Deutsche Bucht and Borselle 3&4. Boskalis planned to use the Pacific Orca, while Van Oord used their jackup vessel Aeolus. To reduce the costs of installation and fabrication time TWD made a first concept and took the challenge to design seafastening that would fit both vessels. Because the grillages would be mobilized multiple times, smart and easy connections to the deck were required. With the high center of gravity of the towers extra attention was paid to fatigue and Vortex-Induced-Vibration studies. Besides the towers TWD designed the nacelle grillages and the cantilevered blade support structure.

SIMILAR SCOPE PERFORMED ON:

- | | | | |
|-------------------|---------------------------|------------------|-------------|
| ■ ABERDEEN BAY | ■ GLOBAL TECH I | ■ NORTHWIND | ■ TRIANEL |
| ■ BLIGH BANK | ■ KENTISH FLATS EXTENSION | ■ DEUTSCHE BUCHT | ■ BINHAI H2 |
| ■ BORKUM WEST 2 | ■ MERKUR | ■ TAHKOLUOTO | ■ RENTEL |
| ■ BORSSELLE 3 & 4 | ■ NORTHER | ■ THORNTON BANK | |



MERKUR
GE RENEWABLE
Blade rack to support Haliade150 blades on Seafox 5



BALTIC II
SCALDIS
Upending tool on the NB90 barge for the installation of a substation foundation with HLV Rambiz

SUBSTATION INSTALLATION - BALTIC II

For the Baltic II substation 4 piles of 80 meters and 700 tonnes needed to be driven. Scaldis and Weserwind contacted TWD to solve the operational challenge how to handle and upend these piles. The limited hook height of the Rambiz resulted in a large stick out and upending from a floating barge with a floating crane meant limits were pushed.

TWD designed a robust upending frame with cables to support the bottom of the pile. A tensioning system was designed to keep the cables on tension and no sudden sliding of the pile could occur. This way a safe upending procedure was achieved. Four months prior to offshore installation, engineering works started and within 3 weeks the primary steel design was delivered to the client. Besides the design, TWD assisted also in the certification, procurement, fabrication and mobilization of the tool. TWD engineers were present offshore to operate the hydraulic system.

TWD WAS ALSO INVOLVED IN THE SUBSTATION INSTALLATION OF:

- ALBATROS ■ BLIGH BANK ■ KRIEGERS FLAK ■ RENTEL
- AMRUMBANK WEST ■ GEMINI ■ NORDSEE ONE
- ARKONA ■ HOHE SEE ■ RAMPION



AMRUMBANK
SCALDIS
Rambiz installing the topside. TWD performed barge stability and bollard pull calculations



STEMAT 82
VBMS
 Loading tower, gooseneck structure and cable carousel on Stemat 82

CABLE INSTALLATION EQUIPMENT - STEMAT

TWD re-designed the existing cable lay carousels on several Stemat vessels. For example, the reel type carousel on the Stemat 82 was transformed into a bucket type. The conversion included the re-design of a new outer ring and the modification of the inner ring. The inner ring was modified to hold 1625 t (maximum) of cable while the outer ring was designed to hold 2000 t.

Furthermore, TWD designed a cable goose neck for on and off loading the carousel. The design included both the loading tower and the goose neck structure, where the goose neck is used to nicely guide the cables into the bucket.

TWD WAS ALSO INVOLVED IN THE CABLE INSTALLATION OF:

- | | | | |
|-------------|-----------------|----------------|------------------|
| ■ ANHOLT | ■ GWYNT Y MÔR | ■ NORDERGRUNDE | ■ THORNTON BANK |
| ■ BALTIC 2 | ■ HOHE SEE | ■ ORMONDE | ■ WESTERMEERWIND |
| ■ BUTENDIEK | ■ HORNSEA 1 | ■ RAMPION | |
| ■ DANTYSK | ■ LONDON ARRAY | ■ RENTEL | |
| ■ DUDGEON | ■ LUCHTERDUINEN | ■ SANDBANK | |



STEMAT SPIRIT
VBMS
 Twin deck design and seafastening of cable installation equipment on Stemat Spirit



CAGE INSTALLATION AID – KENTISH FLATS

The Kentish Flats Extension OWF consisted of TP-less foundations. Consequently, the secondary steel cage had to be mounted directly on the monopile flange. The precise fit of these cages would be a challenging and time consuming offshore operation, hence TWD was requested to design a custom made lifting tool allowing to quickly and safely install the cages.

The lifting tool, which could be easily positioned on the MP flange because of its guides and bumpers, consisted of an orientation and lowering mechanism to slide the secondary steel cage perfectly in position. During transit, the cage functioned as a seafastening construction.

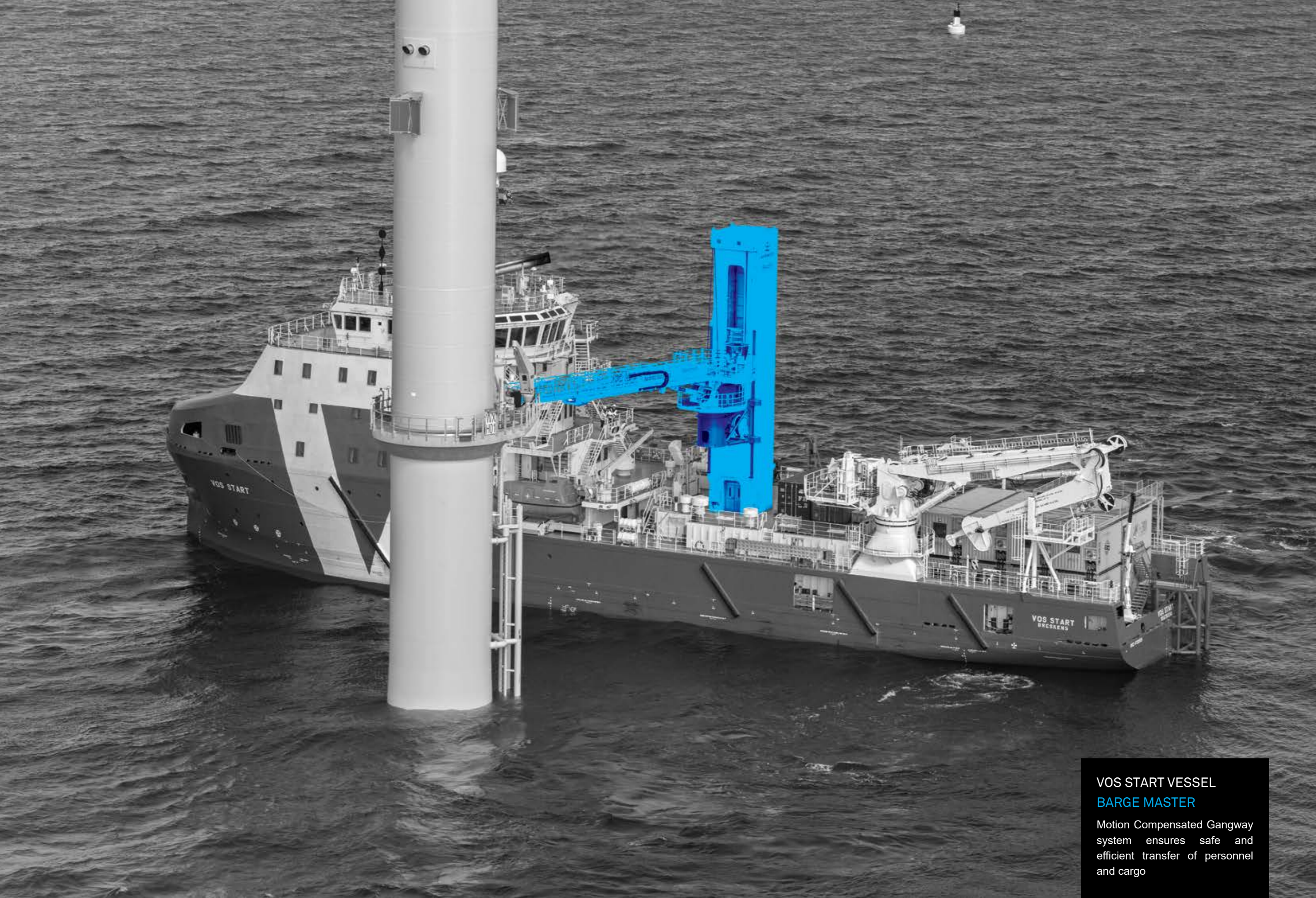
SIMILAR SCOPE PERFORMED ON:

- NORDSEE ONE – BOAT LANDING INSTALLATION AID
- NORTHWIND – J-TUBE INSTALLATION AID

Watch the
installation movie
on our website



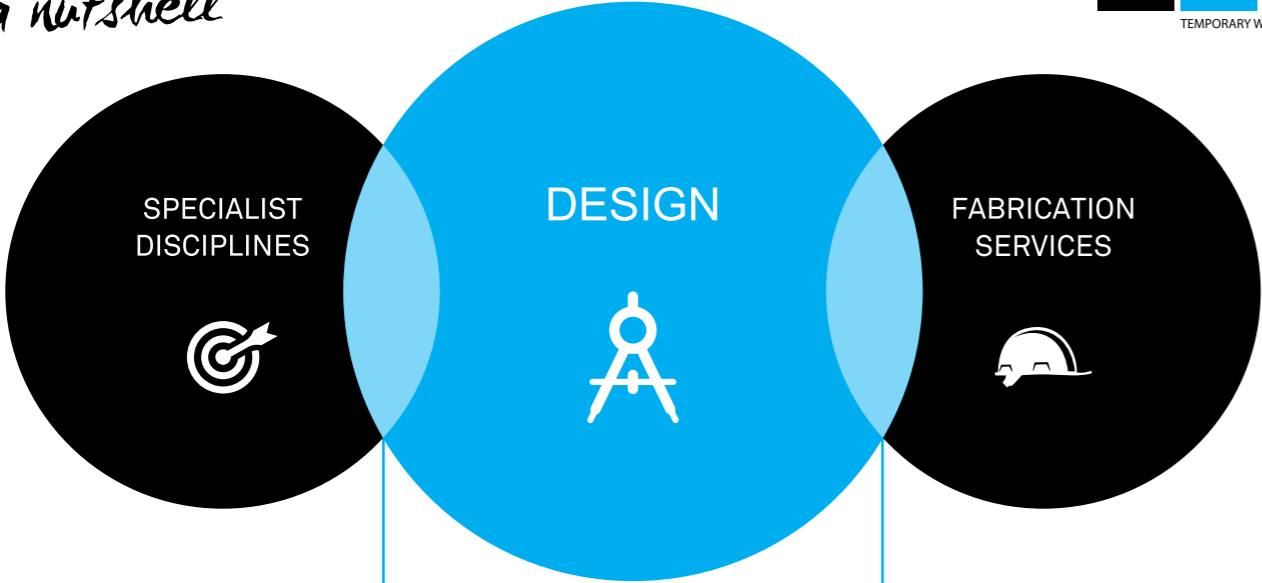
NORTHWIND
GEOSEA
J-tube installation aid ready to be positioned on the MP flange



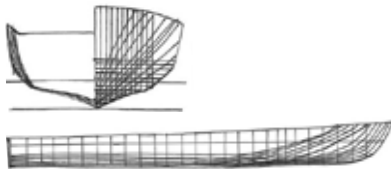
VOS START VESSEL
BARGE MASTER

Motion Compensated Gangway system ensures safe and efficient transfer of personnel and cargo

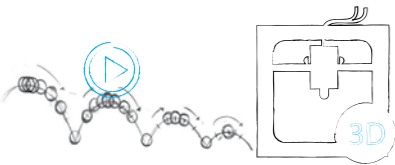
TEMPORARY WORKS DESIGN
In a nutshell



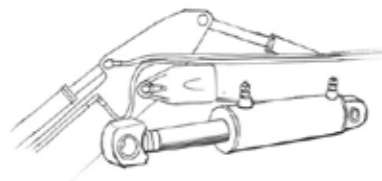
NAVAL ENGINEERING



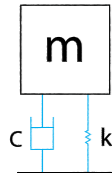
3D VISUALIZATIONS



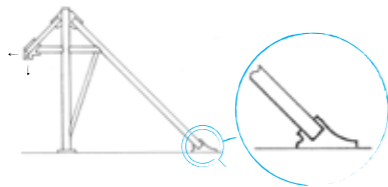
HYDRAULIC ENGINEERING



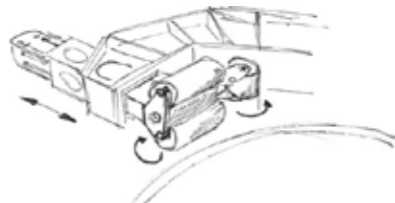
DYNAMIC ANALYSIS



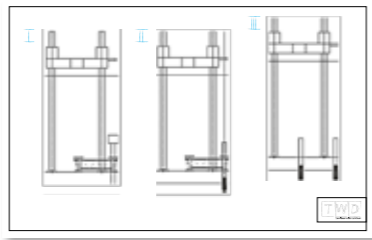
STRUCTURAL ENGINEERING



MECHANICAL ENGINEERING



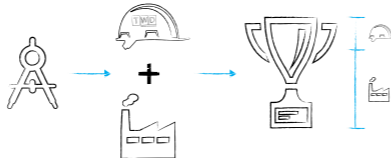
INSTALLATION ENGINEERING



PROCUREMENT ASSISTANCE



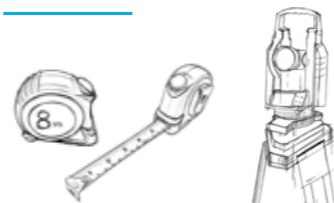
FABRICATION ASSISTANCE



FIELD ENGINEERING



MEASUREMENT SERVICES



TAKE A LOOK AT THE
FABRICATION SERVICES PAGE
ON OUR WEBSITE



Engineered to function



GET IN TOUCH

TEMPORARY WORKS DESIGN

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TRACK RECORD OFFSHORE WIND