# Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of contents</td>
<td>1</td>
</tr>
<tr>
<td>Company</td>
<td>2</td>
</tr>
<tr>
<td>Overview of offshore wind design services</td>
<td>3</td>
</tr>
<tr>
<td>2.1 Naval architecture: motion, stability and mooring analyses</td>
<td>3</td>
</tr>
<tr>
<td>2.2 Seafastening equipment</td>
<td>4</td>
</tr>
<tr>
<td>2.3 Upending tools</td>
<td>4</td>
</tr>
<tr>
<td>2.4 Pre-piling templates</td>
<td>5</td>
</tr>
<tr>
<td>2.5 Monopile gripper frame</td>
<td>5</td>
</tr>
<tr>
<td>2.6 Cable lay equipment</td>
<td>6</td>
</tr>
<tr>
<td>2.7 Specials: mobilization assistance, lifting tools, J-tube Installation Aid</td>
<td>6</td>
</tr>
<tr>
<td>Organisation</td>
<td>7</td>
</tr>
<tr>
<td>3.1 Design team</td>
<td>7</td>
</tr>
<tr>
<td>3.2 Project documentation</td>
<td>7</td>
</tr>
<tr>
<td>Quality system</td>
<td>8</td>
</tr>
<tr>
<td>4.1 Document control and quality checks</td>
<td>8</td>
</tr>
<tr>
<td>4.2 Quality accreditation</td>
<td>8</td>
</tr>
<tr>
<td>Services overview</td>
<td>10</td>
</tr>
<tr>
<td>Software</td>
<td>11</td>
</tr>
<tr>
<td>Example of general arrangements of upending frame</td>
<td>12</td>
</tr>
</tbody>
</table>
1 Company

TWD is a dynamic engineering firm specialized in the design of temporary works, structures which facilitate the construction of permanent works. Our thorough knowledge of structural and mechanical engineering, finite element methods, and design for offshore conditions, enables us to develop creative solutions to meet the wide variety of client demands.

Projects range from the design of a piling template used to drive foundation piles for offshore wind turbines, a motion study for an offshore lifting operation, to a parbuckle tool for a salvage project. Flexibility, practicality, and creativity are the driving forces behind each of our designs and our enterprising work ethic.

We offer cost-efficient solutions for the heavy civil, offshore, and salvage industries, specializing in the custom design of:

- Pile handling tools
- Lifting tools
- Seafastening
- Cable handling equipment
- Support structures
- Vessel motion analyses

We are able to assist in each stage of a project’s execution, whether it be drafting, engineering, commissioning, or fabrication management. Our talented, international team of mechanical, civil, and maritime engineers is available for your requests.

For more information please visit our website: http://www.twd.nl

Jack-up barge with TWD designed pre-piling template for installation of wind turbine foundations
2 Overview of offshore wind design services

TWD is well established in the growing market of offshore wind. Our designs have served clients like Van Oord, Boskalis, Tideway, VSMC, Hochtief and GeoSea, for their projects in Offshore Wind Farms including Ormonde, Baltic II, Borkum West, Borkum Riffgrund, West of Duddon Sands, Westermost Rough and Thorntonbank. TWD provides designs for every stage of the installation phase of offshore wind turbines, including:

- Naval Architecture; motion, stability and mooring analyses
- Seafastening equipment
- Upending tools
- Prepiling tools
- Monopile gripper
- Cable lay equipment
- Specials; mobilization assistance, lifting tools, J-tube Installation Aid

In the sub-paragraphs below, the abovementioned products are described in more detail with a corresponding project example. References can be provided upon request.

2.1 Naval architecture: motion, stability and mooring analyses

TWD offers specialized naval architecture services related to marine operations and installation engineering, for example for the transportation of transition pieces from Antwerp to Vlissingen, where TWD performed a motion analysis to determine the maximum accelerations during transport, and a stability analysis and ballasting plan for the transportation and offloading of the barge.

Deck layout of TP seafastening on a transport barge
2.2 **Seafastening equipment**

TWD has designed many seafastening frames and installation tools for various barges, including the jack-up barge Neptune. The components on the Neptune were used for the installation of 72 Wind Turbine Generators and an Offshore High Voltage Station at the Northwind Offshore Wind Farm. The TWD designed grillages were used to transport monopiles (500mT), transition pieces (350mT), and a hydrohammer (250mT).

![Aerial of JUB Neptune with seafastening aids and upending system](image1)

2.3 **Upending tools**

TWD executed designs for numerous upending frames, for example the upending frame onboard of GeoSea’s Pacific Orca. This light weighted upending frame is used for lifting piles into vertical position, which, due to a smartly chosen rotation point, keeps piles very stable during the lifting process.

![Upending frame for lifting piles into vertical position](image2)
2.4 Pre-piling templates

TWD designed a piling template for GeoSea’s jack-up barge, Goliath. Suspended by winches, the template can be lowered to the seabed or docked underneath the jack-up barge. After driving the piles into the seabed, the template can be loosened from the piles with a specially designed hydraulic loosening system. It is then lifted against the hull so that the barge can sail to the next location.

Helicopter view of piling template and jack-up barge Goliath

2.5 Monopile gripper frame

TWD provided the complete design of a pile gripper frame for Van Oord’s new heavy lift jack-up vessel, Aeolus. The gripper frame can be lowered below the hull, allowing piles of all lengths to be driven. It is also fully retractable for transit, greatly reducing the drag and footprint of the vessel. The hydraulically operated gripper arms with rollers ensure that the monopiles of different sizes of can be safely caught in the gripper and kept the monopile in the correct position during hammering. This makes the design suitable for a large range of projects. The comprehensive design addressed all related parts, including designs of the interfaces for the hydraulics and bearing systems.

Monopile gripper frame onboard of the Aeolus
2.6  **Cable lay equipment**

TWD designed a cable guiding loading tower for the Stemat 82. Design adjustments were also made to the carousel itself; the reel type carousel was transformed into a bucket type, including the re-design of a new outer ring and the modification of the inner ring. The inner ring was modified to hold 1625 mT (maximum) of cable while the outer ring was designed to hold 2000 mT.

![Part of the loading tower with cable carousel on the Stemat 82](image1.jpg)

2.7  **Specials: mobilization assistance, lifting tools, J-tube Installation Aid**

TWD provides specialized designs, for example the J-tube Installation Aid (JIA), which was used to assist the subsea installation of the J-tubes on the monopiles. The JIA is a fully hydraulically operated system placed on top of the monopile that ensures correct installation of the J-tubes on the monopiles without assistance from divers. TWD also provides designs for multiple lifting tools and we are able to assist during mobilization.

![The J-tube Installation Aid during lifting](image2.jpg)
3 Organisation

3.1 Design team
The project engineer (PE) in the TWD project organisation plays the central role and is the primary point of contact for the client. The PE focuses on one single project and guides the complete process from kick-off to detailed design. In this role, the PE translates client wishes into practical, safe, and economical designs. The PE is responsible for budget and planning and supervises the design team of engineers and draftsmen.

The lead engineer (LE) supervises the project team and plays an active role in the design process. The LE oversees the design process, suggests concepts, and performs quality checks on every deliverable. (see chapter Quality system).

The senior draftsman (SD) is responsible for timely delivery of drawings, revision status, work distribution and planning of the draftsmen. The SD is in charge of the master model and analyzes the sub-assemblies provided by the draftsmen regarding overall function, clashes, and consistency.

3.2 Project documentation
The design team members work in close cooperation and constant communication with each other. For cases in which the basis of design report (BoD) is not sufficient or specific enough, a so called ‘mini-BoD’ will be created stating all requirements, functions, loads, and points of attention for a sub-design.

Decisions made throughout the design process are tracked by the design decision sheet, a to-the-point BoD, easy to update and maintain.

All deliverables (drawings, calculations, and reports) are listed in a document list, including revision and status, and will run through the quality system (see chapter Quality system).

The project planning is made in Microsoft Project, depicting an overview of deadlines, relations between processes, and capacity planning.
Project hours are electronically registered and can be split per project part. The weekly hour sheet will give a detailed overview of the hours spent per topic, providing a clear detailed overview of the budget status. The project parts to be monitored can be agreed upon.

4  Quality system

TWD is dedicated to achieve client satisfaction by delivering high quality designs that are practical, safe, and economical. We do this by using a quality management system that provides a framework for our complete design and engineering process.

4.1  Document control and quality checks

Most of TWD’s clients are involved in projects where delay and/or failure is very expensive. Consequently, TWD has developed and implemented thorough quality control systems for calculations, reports, and drawings. Clear file and revision names are used and registered in document lists to avoid errors. Check sheets are used to register the checks performed for every revision of a document. An example flow diagram of the report quality check process used by TWD is shown on page 9.

4.2  Quality accreditation

TWD’s designs are routinely reviewed, approved and certified by certifiers including DNV-GL, London Offshore Consultants (LOC), Lloyds Register, Bureau Veritas and ABS.
Quality Check process (report)

Deliverable
- Report (R-01, R-02, R-XX)
- Memo (M-01, M-02, M-XX)

Quality Check
1. Intermediate check (IC)
   - Responsible for delivery (PE)
   - By LE
   - No checks required
2. Methodical Check (MC)
   - Responsible for delivery (PE)
   - By LE
   - Use methodical check sheet
3. Numerical Check (NC)
   - LE decides the checker
   - By PE (unbiased)
   - Use numerical check sheet
4. Approval (AP)
   - By TM
   - Use approval check sheet

Administration
- Registration
  - Copy of check sheets to QM
  - Check and update QM (QMI)
  - Check project binder (QMI)
  - Check project binder on server for unchecked deliverables (QMI)
- Verification
  - Check sheets copies in QCI binder (QMI)
  - Check and update PMI (PMI)
  - Add report to Project Register (PE)

Client
Also send to involved LE, engineer

TWD quality check process diagram

Quality check process (drawing + MTO)

Deliverable
- Drawing
- MTO

Quality Check
1. Intermediate check (IC)
   - Sc IQ
2. Final Check (FC)
   - By PE
3. Approval (AP)
   - By LE or TM
   - LE/PM signs on drawing

Administration
- Registration
  - Deliverables in project binder (PE)
  - Update document list (PE)

Client
Also send to involved LE, engineer and draftsman

TWD quality check process diagram
5 Services overview

The overview below shows the different services that are offered by TWD. Allowing TWD to manage the entire design process, from drafting to commissioning, will result in short communication lines, a solid project overview, and savings in time and costs.
6 Software

TWD has developed several calculation tools for reliable and efficient calculation of pad- and lashing eyes, kicker plates, current and wave loading, loading capacity of deck constructions, and forces acting on cargo due to vessel motion. Furthermore, the following several widely recognized software packages are used:

- **Amarcon Octopus**
  Accurately determining vessel motions based on strip theory. By calculating vessel and cargo motions, the resulting seafastening loads can be accurately determined.

- **Autodesk AutoCAD**
  Industry standard 2D- and 3D drafting software

- **Autodesk Inventor**
  Intelligent digital prototyping software developed for mechanical engineering design

- **Delftship**
  Software which allows for fast and accurate hull modelling and hydrostatic analysis

- **Dlubal Rfem**
  Finite element method structural analysis software with 1D, 2D, and 3D analysis capabilities

- **Global Maritime GMOOR**
  Analyzes the performance of mooring systems by simulating the station keeping behavior and line tensions for catenary moored vessels

- **Mathworks MatLab**
  Mathematics / programming software with numerous tools for analysis of complex problems and processing of large amounts of data

- **Nemetschek SCIA Engineer**
  Finite element method structural analysis software for 1D and 2D elements. Capabilities include buckling and non-linear calculations. The extensive profile library ensures rapid calculation

- **OrcaFlex**
  Marine multibody dynamics program for static and dynamic analysis of a wide range of offshore systems, including all types of marine risers (rigid and flexible), moorings, offshore installations and towed systems

*Example of 2D FEM analysis of barge construction (left) and of detailed motion analysis (right)*
7 Example of general arrangements of upending frame

[Diagram of general arrangements of upending frame]