KNUD E. HANSEN
SHIP DESIGN SINCE 1937

OFFSHORE WIND VESSELS

INNOVATIVE DESIGN TO ACCELERATE WINDFARM CONSTRUCTION

OUR EXPERIENCE

Power production from offshore wind farms has become one of the foremost means of reducing CO2 and other Greenhouse Gas (GHG) emissions on a global scale.

As the world transitions to a future powered by clean energy, there is a rapidly growing demand for vessels to support the offshore wind industry.

KNUD E. HANSEN has the expertise and experience to be a valuable partner for designing installation vessels, heavy lift- and support vessels from Concept to Class approval of an offshore wind project.

For more than 20 years, we have been instrumental in developing this growing sector with our culture of forward thinking and innovation. From vessel design to engineering services to construct and operate offshore wind farms, KNUD E. HANSEN continues to exceed today's industry standards to create the ships of tomorrow.

PROVEN DESIGNS

- Wind Turbine Installation Vessels
- Foundation Installation Vessels
- Maintenance Vessels
- Walk-to-Work & Hotel Vessels
- Mono-pile upending Trolleys
- Cable Layers
- Offshore Survey Vessels
- Floating Powerplants


IMO 9601326

OFFSHORE CONSTRUCTION
Jack-up Installation Vessels

KNUD E. HANSEN has been leading the world in the development of the offshore wind construction vessels. The company designed the world's first purpose built wind turbine installation vessel TIV Resolution back in 2001, when the offshore wind industry was just starting and it has now been operating successfully for over 20 years.

▲ World's first wind turbine installation vessel – TIV Resolution

Ten years later in 2010, KNUD E. HANSEN was the first to develop the current generation of wind turbine installation vessels, able to install 5-8 megawatt turbines in water depths of over 50 meters. These vessels, Pacific Orca and Pacific Osprey, were designed for crane and legs upgrades to meet future demands. They remain in high demand and are able to meet the challenges of installing future 12-15 megawatt turbines even when newer vessels in the market have reached their limits.

Today, KNUD E. HANSEN is again designing the future with the next generation of wind turbine installation vessels. With the growth and development of the offshore wind sector, the installation vessels are becoming more specialized to be more commercially competitive. Tomorrow's vessels, for example, may specialize just in transport and installation of the foundation, while a different vessel transports and assembles the wind turbine.

The ATLAS vessel designs are intended as a platform for further customization according to your objectives. Cranes, thrusters, generators and jacking systems can all be modified and selected from various suppliers and the vessel arrangement tailored to suit the individual needs of each client. This approach provides competitive advantages over other less flexible, off-the-shelf designs. ►►

First of the giants – Pacific Orca ▼ ►


PACIFIC ORCA

ATLAS A-Class, KNUD E. HANSEN´S WTIV platform ▲

ATLAS A-CLASS
Wind turbines transport & Assembly

The ATLAS A-CLASS vessel is specifically dimensioned for transportation and assembly of wind turbines onto pre-installed foundations. As a result of not needing to carry heavy foundations that can weight many thousands of tons, the Atlas A-Class is optimized with a smaller 1600-2500 tons crane and lighter hull. Therefore, the leg structure and jacking equipment can also be minimized resulting in a vessel that has the lowest capital cost and operating expenses.

ATLAS C-CLASS
Foundation & Wind turbines installation

With a jacking deadweight of 18,000 tonnes, 6,800 square metres of cargo deck area and a 3,000 tonne crane, the ATLAS C-Class is capable of carrying six new generation 15-20 megawatt wind turbines. The vessel is able to carry and install four of the extra-large monopile foundations and transition piece bases for these new generation turbines.

The impressive size and scale of these ground-breaking ATLAS vessels are enhanced by KNUD E. HANSEN engineering expertise and experience with jack-up vessels. Legs are designed to withstand daily jacking cycles over the vessel's lifetime and spudcans have features to ensure jacking operations are trouble-free. A smart power system with variable speed generators and energy recovery from jack downs provide for fuel-efficient operations.

Customized C-Class installation vessel for Van Oord

The ATLAS C-Class has been customized to meet the needs of Van Oord. The 175-metre vessel will reduce the cost per megawatt of constructing offshore wind farms and make wind energy more competitive as an energy source.

The jack-up vessel can operate on methanol and install turbines up to 20 MW size at sea with a very low CO2 footprint.

Energy efficiency is improved by the large battery system that enables peak-load shaving, reduced generator running and energy recovery in jack-down operations.

The main crane can lift more than 3,000 tonnes and the four giant legs, each measuring 126 meters in length allow the vessel to be jacked up high above from waves in up to 70 meters water depth. The vessel is under construction and expected to enter the market in 2024.

▼ 175m WTIV for Van Oord, based on the Atlas C-Class

WALK TO WORK
Hotel & Access Vessels

Offshore wind farms continue to get bigger and move further from ashore. With the construction requiring hundreds of persons over many years, on-site accommodation and easy access to each wind turbine is crucial.

Many days are required to properly set-to-work and commission a wind turbine. Service Operations Vessels (SOVs) enable more expensive assets like jack-up vessels to just do the heavy lifting while they do the more time-consuming tasks like commissioning.

SOVs are equipped with a motion-compensating gangway, which makes it possible to walk directly from the vessel to the wind turbine together with tools and equipment.

They can be designed to serve as an accommodation platform and remain alongside a wind turbine for an extended period of time or more as an in-field connector taking crews and equipment between accommodation vessels and the wind turbines.

▲ 180 metre Accommodation Vessel Aquarius II

CREW TRANSFER
Vessels

Typically, these fast vessels are conventional monohulls or catamarans, however monohulls are not particularly fast or efficient, and catamarans tend to exhibit high accelerations and motions in heavy seas, causing increased nausea and fatigue.

The KNUD E. HANSEN developed TRIWIND concept is a trimaran with a long and slender fore body with accommodation astern in order to provide the best combination of passenger comfort, improved seakeeping and high-speed capability. The 24 meter vessel can accommodate 12 persons with a service speed of 25 knots. Optional ride control fins can be fitted for enhanced seakeeping performance.

TRIWIND 24 m crew transport vessel ▲

CABLE LAYING
Vessels

As wind farms are often located far from shore in areas that experience severe wind and waves, the need for economical and robust cable laying vessels becomes increasingly important. Included in our portfolio of wind farm support vessels are designs for infield cable layers.

The 117 metre vessel features a large working deck, three holds for 20 meter diameter cable reels, a A-frame crane and a heave compensated knuckle-boom offshore rate crane, each with a 25 tonne capacity at maximum outreach.

▲ 90 metre SOV Bibby Wavemaster

SPECIALIZED
Design & Engineering

The success of any offshore wind-related project requires in-depth knowledge of the demanding environmental conditions that it will encounter, and a detailed understanding of the various construction stages that it must be executed. Every KNUD E. HANSEN project is based on decades of know-how, visionary ideas and comprehensive engineering studies.

Special Equipment

KNUD E. HANSEN has designed specialized equipment for the offshore wind industry. For the installation of a mono-pile foundations using a floating crane, we designed a heave-compensating, mono-pile upending trolley.

Engineering Support

KNUD E. HANSEN has the experience and capability to perform a wide range of in-service engineering support tasks for the offshore windfarm sector.

- Stability calculations
- Seakeeping calculations
- FEM structural calculations
- CFD analysis of hydrodynamics & airflow
- Design of sea-fastening equipment & supporting structures
- Techno-economic studies to optimize design & operations
- Transport studies for heavy & oversized turbine components
- DP assessments.

Survey & Refit

KNUD E. HANSEN has completed over 400 refit and modernization projects for vessels of all types around the world, operating in every environment.

- Dry dock support
- Technical inspections & Condition surveys
- Lightweight surveys, Inclining experiments & stability book updates
- Updating of statutory drawings for plan approval
- Calculations & drawings for structural & system modifications
- LNG & Hydrogen/Green fuel conversion
- EEXI, Energy audit & Energy recovery.

Stability & sea-fastening design for transition pieces ▼

KNUD E. HANSEN
Design Process

Typically, a design project starts with preliminary discussions with the client to gain a broad understanding of their needs, the intended purpose, size and capacity of the vessel, as well as its operating profile and environmental conditions.

Our vast portfolio of reference designs and vessels in operation today often serve as a basis for these discussions and help identify opportunities and possible solutions for the client.

Sometimes feasibility studies are performed to better evaluate principal particulars, capacities, and limitations within a given set of vessel or operational constraints.

Concept Design

The first stage is the development of a Concept Design for the intended vessel. This phase is an opportunity to explore various options for the vessel while keeping the scope of work relatively small. For a Wind Turbine Installation Vessel, a Concept Design would typically include:

- Outline General Arrangement
- Data sheet / Vessel Description
- Preliminary Weight Estimate
- Initial Hull Form Development
- Empirical Speed & Power Calculation
- Preliminary Dynamic Positioning Calculation
- Preliminary Intact & Damage Stability Calculation
- Preliminary Load Calculation
- Initial Sketches (ie. legs and jacking system)

In addition, we often develop a simple 3D model to enable the client to visualize the exterior of the vessel (ie. how the turbine parts are stowed on deck). The Concept Design would then serve as the springboard for more detailed client discussions and evolution to the next phase of design.

Tender Design

Once the Concept Design has been approved by the client, the next phase is to develop a Tender Design which can be used to obtain indicative build pricing from shipyards.

This phase involves further developing the Concept Design and expanding to the scope of work to include the following deliverables:

- 3D Visualization of the vessel's exterior
- Tender Specification
- Maker's List
- Updated Loading Conditions
- Deck Loading Plan
- Tank- and capacity plan
- Preliminary Midship Section
- Longitudinal Strength Calculation
- Preliminary Design of the legs and spud cans, the leg well, the leg guides and the jack-houses
- Preliminary global Finite Element Analysis (FEA) of vessel structure
- Preliminary Design of the main crane pedestal
- Preliminary Engine Room Arrangement
- Initial Calculation of Machinery Systems
  Electrical Load Balance
- Electrical Single Line Diagram.

Contract Design

While potential building yards are calculating their prices, KNUD E. HANSEN may develop a Contract Design, which could be the basis for the contract negotiations. The main difference between a Contract Design and the Tender Design would be a much more comprehensive Contract Specification describing the vessel in detail.

Basic Design

The Basic Design phase includes all drawings that are necessary for approval by the Classification Society and Flag State Authorities. It also includes drawings that are necessary to form the basis of construction drawings can be further developed during the Detailed Engineering phase. The scope of work in this phase varies somewhat based on specifics of the vessel and requirements of the Class.

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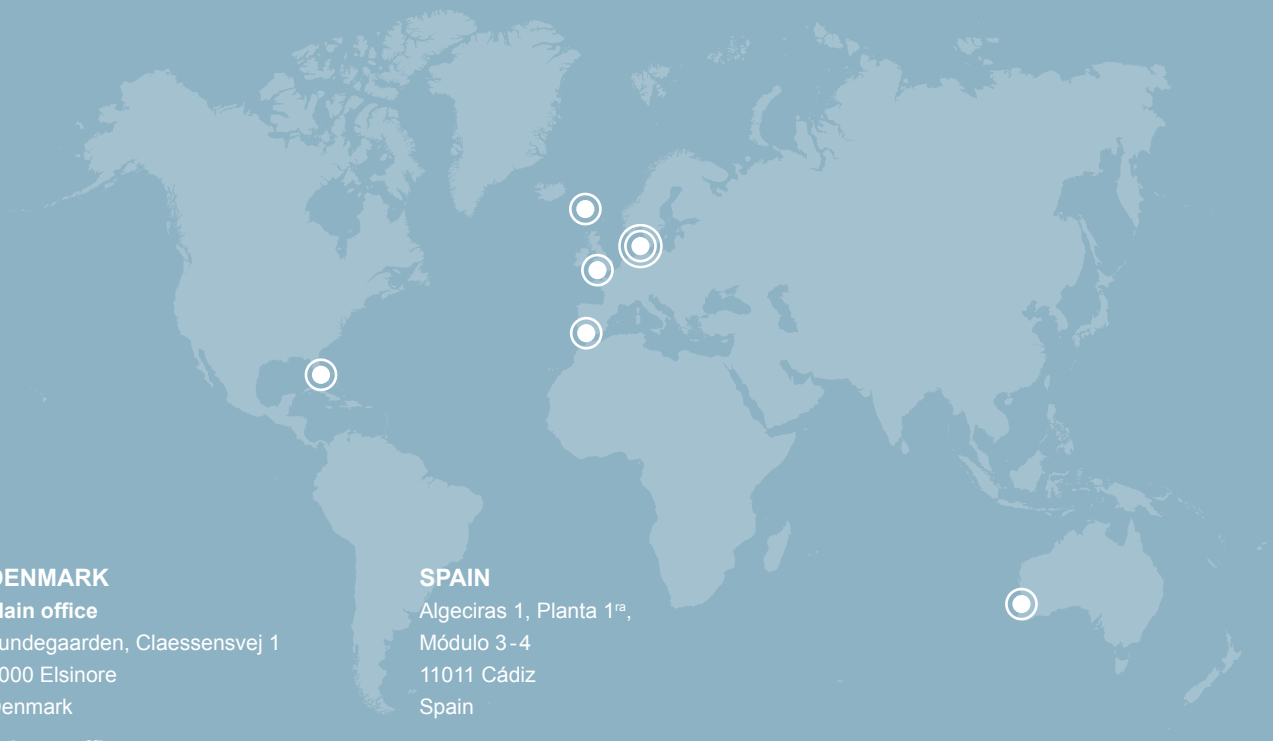

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