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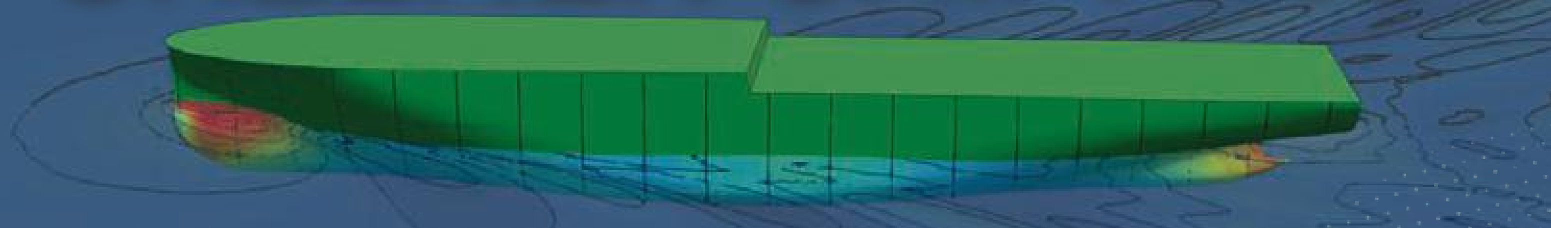
The Hamburg Ship Model Basin Newsletter

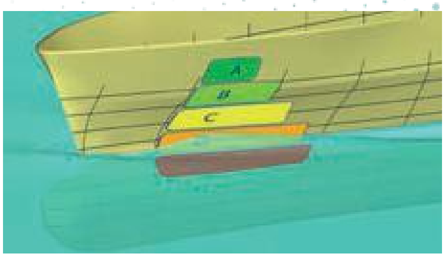
GREENER SHIPPING



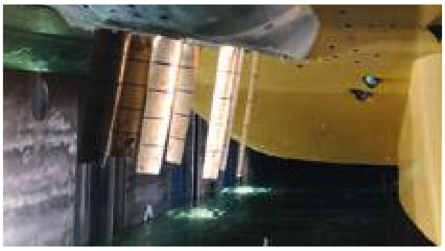
Performance Optimization for the Maritime Transition

Flotte Hamburg
Ensuring Safe Waterways

EEXI / CII
Solutions for Greener Shipping



Cycloid Propulsion
A new Scale Correction Method



editorial

Dear reader,

It's that time again: SMM is upon us, and our industry is ready to showcase the latest developments, technologies, and trends in view of the maritime transition. This fair is not just a highlight on the calendar; it is a central gathering place for experts, innovators, and visionaries from around the world. It offers us the opportunity to network, exchange ideas, and shape the future together.

For our company, participating in this fair is a special event. It allows us to present our newest products and solutions, which are the result of hard work and innovative thinking. It is the perfect venue to demonstrate how we are shaping the market and supporting our customers with our technologies and services a selection of which is presented in this issue of HSVA's NewsWave.

SMM is more than just an exhibition; it is a platform for dialogue and collaboration. In recent years, we have witnessed how important partnerships and collaborations have originated from this event. Special testing methods, numerical simulations and hydrodynamic optimization as described in this issue are key aspects for a successful path to green shipping.

In addition to that, we are celebrating two important milestones in the technical development of HSVA's services: 40 years ago, our ice tank opened its gates for model testing, and five years later the brand-new HYKAT followed. Both testing facilities belong to the world's most rare, unique and specialized model test facilities for the maritime market. At the same time, we are celebrating 111 years of HSVA!

In a time when technological innovations are advancing at an ever-faster pace, the SMM provides indispensable guidance. It inspires us to look beyond the horizon, gain new impulses, and continuously evolve. We warmly invite you to visit our stand, engage with our experts, and discover our latest innovations. Let us set the course for driving excellence for the maritime future.

Best regards,

Janou Hennig

Prof. Dr. Janou Hennig

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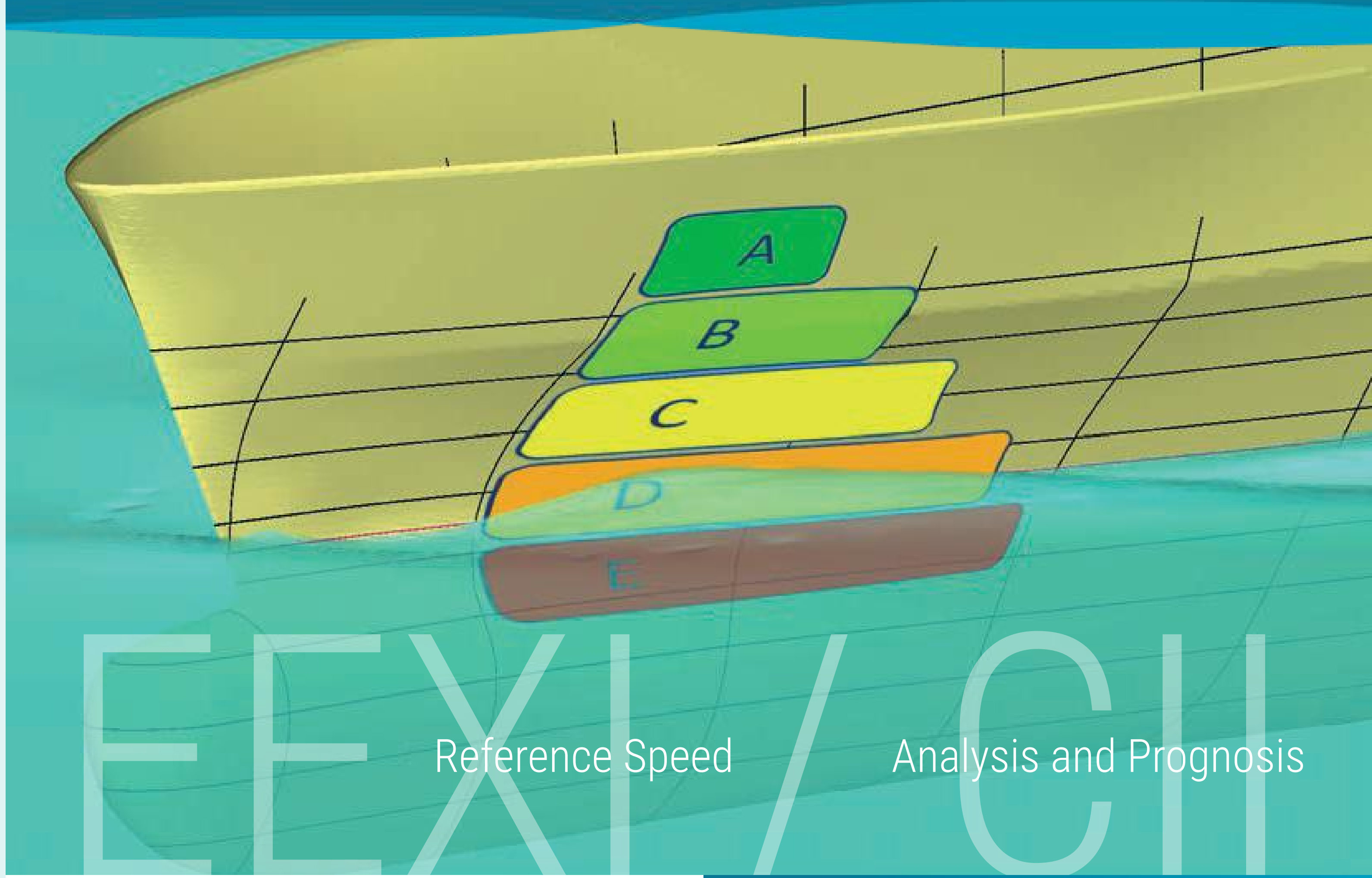

EEXI: Energy Efficiency Index for Existing ships
CII: Carbon Intensity Indicator

HSVA's Numerical Solution for a Greener Shipping in Light of EEXI and CII

by Peter Horn and Jonas Wagner

The IMO has set with its Greenhouse Gas Strategy the target to significantly reduce greenhouse gas emission by the sailing fleet of merchant vessels. As first instrument for emission control of ships the EEDI (Energy Efficiency Design Index for new built ships) was introduced in 2013 followed by the EEXI in 2021 and the CII in 2023.

IMO's Path for Greener Shipping

In June 2021, IMO introduced the EEXI, the Energy Efficiency Index for Existing Ships, which went into force on 1st January 2023. Since then, the IMO resolutions MEPC.350(78) and MEPC.351(78) consider numerical calculations as an acceptable way to derive the reference speed in the EEXI regulation framework. In addition to the EEXI, the Carbon Intensity Indicator (CII) came into effect in 2023, which delivers a yearly assessment of the energy efficiency of ships in operation. ▶

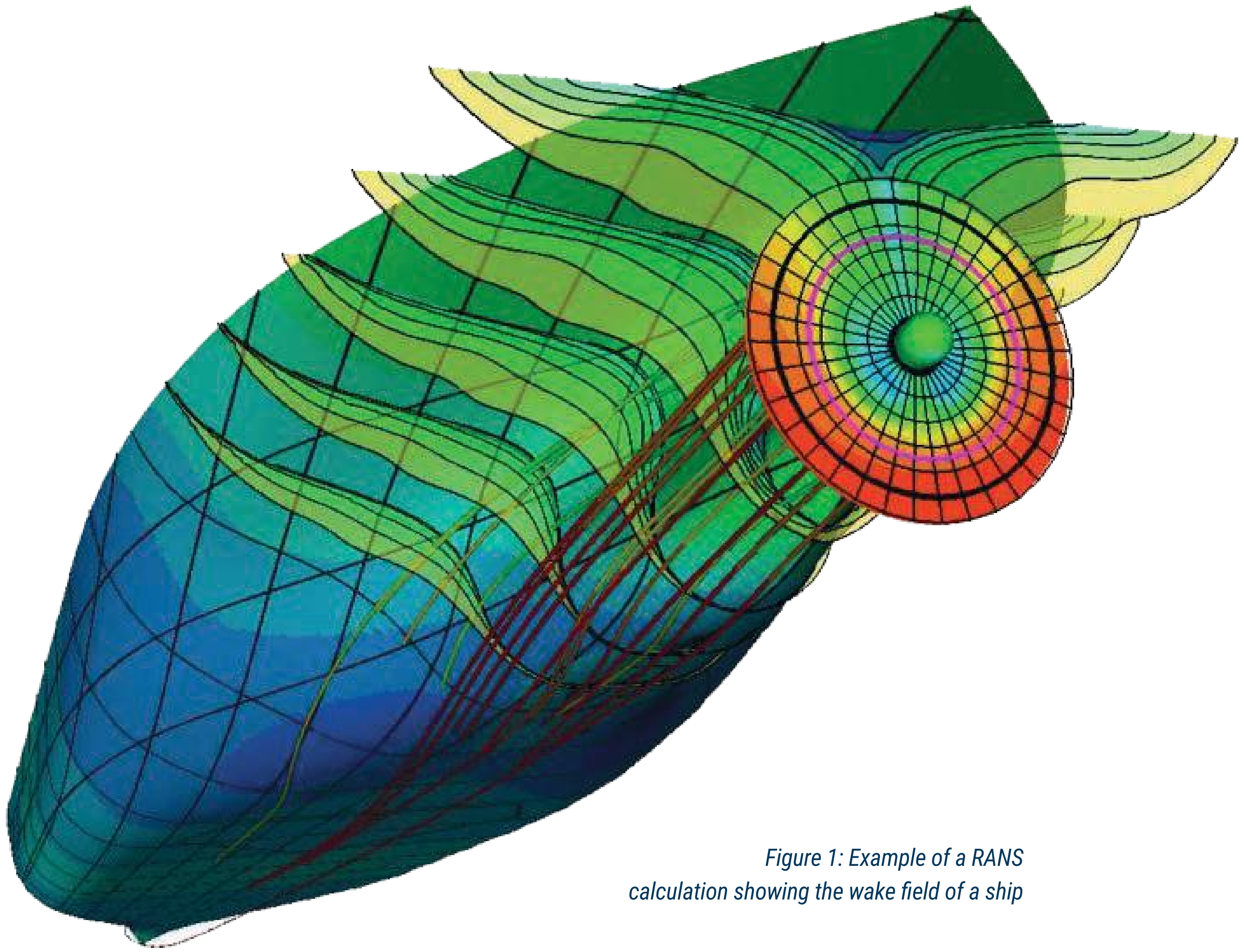

Figure 1: Example of a RANS calculation showing the wake field of a ship

HSVA's CFD Solution to Determine the EEXI Reference Speed

As a reliable partner, HSVA has a long-term experience in resistance and propulsion predictions via numerical methods. We have been pioneering CFD technology, including the development of own CFD codes and demonstrate our qualification according to IACS Recommendation No. 173. (2022) as well as the ITTC procedure "Quality Assurance in Ship CFD Application" (7.5-03-01-02, 2021).

The broad experience in CFD application has consistently been included in our in-house "Best Practice Guidelines for RANS calculations" where settings for the mesh structure, refinement regions, turbulence models, wall functions and convergence criteria have been defined to perfectly suit our jointly developed RANS Code ***FreSCo+*** (developed in cooperation with the Hamburg University of Technology (TUHH)). The application of these guidelines within HSVA assure the quality by uncertainty assessment and the overall demonstration of confidence in CFD calculations.

Benefits of HSVA's Vast Database and Experience

For an individual EEXI calculation, a case specific proof of qualification is performed. A calibration factor can be derived from the comparison to a model test or sea trial of a parent hull form (original hull form), a comparison to model test result from a similar vessel or a comparison to a set of CFD calculations from a "set of comparable ships". At HSVA, we derive individual calibration factors from genuine numerical propulsion simulations. Regularly the guidelines are over-complied with regard to the requirements by employing a RANS-BEM approach (the propeller is modelled according to Boundary Element Methods). The calibration factor is then applied to the result of the EEXI relevant propulsion simulation for the vessel in question. Thanks to HSVA's extensive database of model test results, the availability of a suitable calibration factors is almost always ensured. By performing numerical investigations on a daily basis, HSVA is constantly growing its database of available CFD results serving as basis for the category „set of comparable ships" according to the IACS Guidelines.

Beyond Design Indices: The Carbon Intensity Indicator

The operational value CII evaluates the CO_2 emissions per year as reported via the IMO Data Collection System (DCS) in relation to the transport work performed. Based on this evaluation, all ships are to be classified into efficiency categories A to E while ships in categories D and E need to take actions for improvement (MEPC.339(76)). The CII reference lines for these categories will be reduced every year, leading to an increasing demand for the implementation of further GHG-reduction measures.

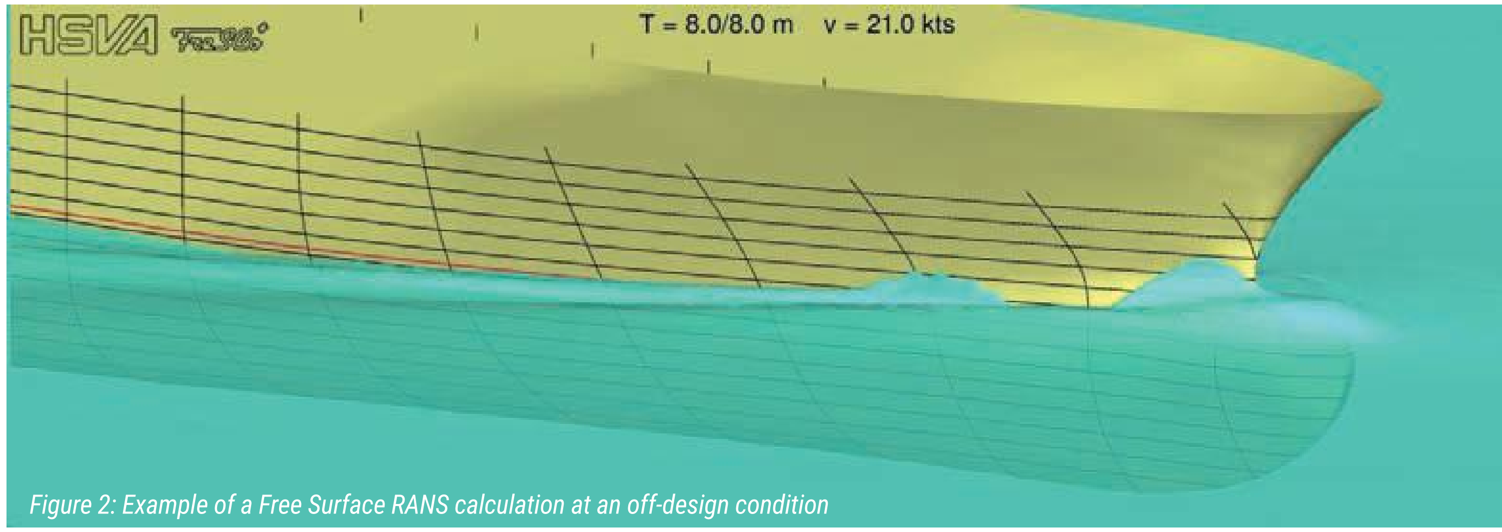

Figure 2: Example of a Free Surface RANS calculation at an off-design condition

HSVA's Services regarding Prediction and Verification of CII

Since the prior knowledge regarding a vessel's CII performance becomes increasingly important, sophisticated and reliable performance prediction methods are needed that take both the vessel's operational profile as well as its expected environmental conditions into account. In order to fulfil this requirement, HSVA participated in research regarding the development of digital twins for cargo ships. Such models provide deep insight into most hydrodynamic and operational aspects of the vessels and can be used both in ship design as well as the operational phase. During design phase, such tools can be used to predict a vessel's fuel oil consumption or CII along a dedicated route by combining advanced CFD calculations with enhanced statistical analysis and prediction models. Possible use cases for the operational phase exist in coupling the digital twin to a decision-support system including weather routing. Examples of such use cases have recently been published within the research Project MariData (https://maridata.org/).

HSVA can also support you in analysing your vessel's CII performance and propose improvements for example by means of Energy Saving Devices (ESD) or operational recommendations. At the same time, we offer services for (full scale) performance verification of ESDs and related measures on the basis of on-board monitoring data. Thanks to our years of experience and our data analytics capabilities, these analyses go far beyond the standards specified by ISO and ITTC for full scale performance analysis, allowing for detailed insights into your vessels performance.

Ask for a White Paper on EEXI reference speed prediction and our free webinar on our services related to EEXI / CII

Please feel free to ask our experts for detailed information. A comprehensive **White Paper on EEXI reference speed prediction** is available. Also, a **free webinar on our services related to EEXI / CII** will be held in September (details to be found at hsva.de).

HSVA is covering the relevant questions that arise in connection with EEDI/EEXI/CII. Our services comprise i.e.:

- Determination of EEXI Reference Speed
- Evaluation of Energy Efficiency Measures (including wind propulsion)
- Energy Saving Technologies' Performance Assessment and Documentation
- CII Analysis and Prognosis

HSVA is happy to team up with you – either for the next EEXI reference speed, or CII performance prediction and analysis of your vessel.

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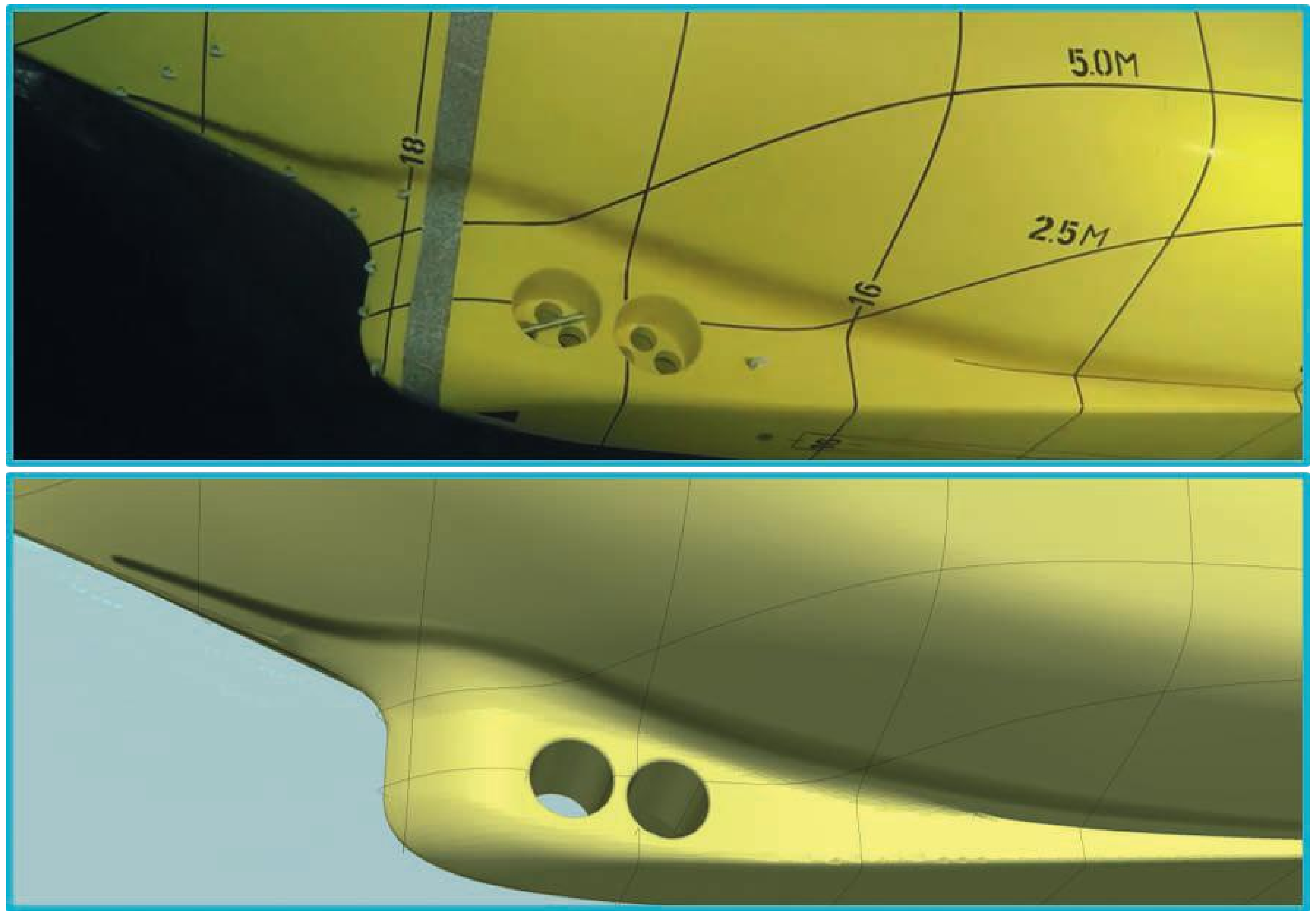


Figure 1: Experimental observation (above) vs. numerical simulation (below)

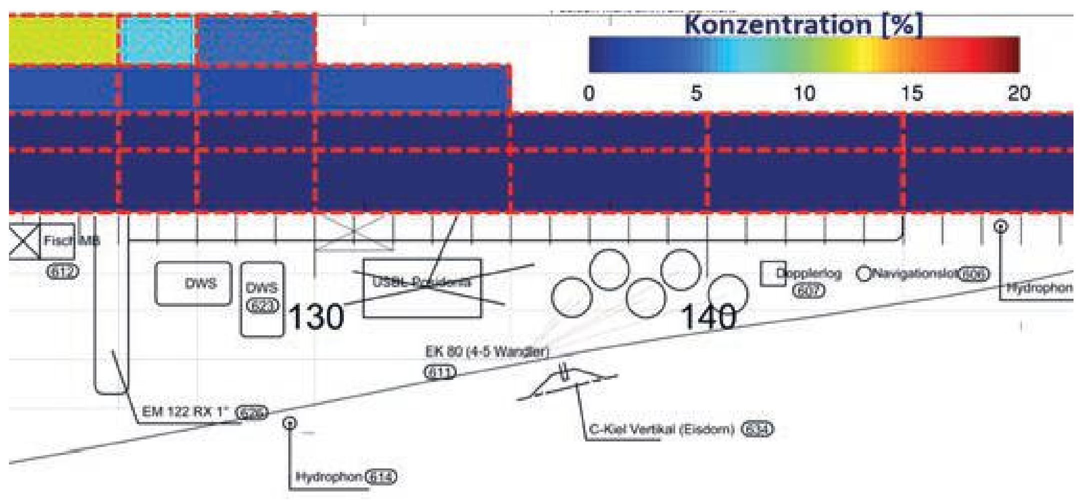
Bubble Sweep Down Investigation

In the vast and often unexplored marine environment, research vessels equipped with sonar technology play an indispensable role in enhancing our understanding of the ocean's depths.

by Yan Xing-Kaeding, Christian Schröder and Peter Horn

These vessels, pivotal for a wide range of scientific endeavors, depend critically on the clarity and accuracy of sonar data to conduct oceanographic studies, environmental monitoring, and underwater archaeological explorations. However, the integrity of this data can be significantly compromised by the phenomenon of bubble sweep down. This occurs when air bubbles travel near to the hull of the ship or directly to the sonar equipment, distorting the acoustic signals essential for precise measurements and imaging. HSVA has accumulated extensive expertise in conducting both computational analyses and tank tests to evaluate air bubble flow in both calm water and seaway conditions for various vessel types.

Figure 2: One example of computed maximum air bubble concentration beneath a sonar system under seaway condition (view from bottom, the lower part representing the sonar layout on the ship bottom and the upper part revealing the heat map of maximum air bubble concentration seen by the sonar system)



Simplified BSD Method

During the design and hull form optimization phases, a simplified method is employed to evaluate the likelihood of bubbles sweeping under the sonar transducer position or other critical components. In the simplified approach, the visualization of water particle paths is accomplished through streamlines derived from calm water viscous flow simulations (see Figure 1). These streamlines represent a purely post-processing step of a Computational Fluid Dynamics (CFD) calculation and are integrated with basic calm water resistance calculations. The origin of each streamline is strategically selected in the bow wave area, a critical zone where air bubbles are likely to form and be carried beneath the hull. Employing identical streamline configurations across all evaluated hull designs simplifies the comparison process during hull form optimization. By examining the trajectory of these streamlines, designers can effectively assess and compare how different hull variants manage the flow of water and entrained air bubbles, ensuring that the most efficient and effective design is selected.

Enhanced Dynamic Trace Method

To further enhance the visualization of air bubble flow under seaway or unsteady conditions, a more sophisticated method involving tracers representing the air bubble is utilized. The computations are carried out using HSVA's in-house RANS-solver, which incorporates a passive transport equation (tracer) to simulate and visualize the path of the air bubbles. Based on HSVA's extensive experience, the tracer-based analysis provides a reliable indicator for evaluating the risk of bubble sweep-down. This conclusion is supported by comparative studies of bubble sweep-down characteristics across various modern hull designs tested at the HSVA's large towing tank, alongside correlations between computed tracer concentrations (see Figure 2) and full-scale observations from operational vessels.

An assessment of the risk of bubble sweep-down in the sonar area can be made by analyzing results from simulations in both calm water and head wave scenarios taking into account the ship's heave and pitch motion. Should the findings indicate a need for improvements in hull designs to better manage bubble sweep-down characteristics, HSVA will propose an optimized hull design and conduct further in-depth investigations as required. This iterative process ensures that each proposed design not only meets but exceeds operational expectations for effectively reducing the risk of bubble sweep down.

Model Test Capabilities

Lastly, HSVA offers the distinct capability to conduct model test verification studies in the final stage, with the opportunity to coordinate and optimize these approaches synergistically. The model test capabilities include:

- Verification of bubble sweep down behavior as predicted in the numerical studies. (see Figure 1 as an example).
- Facilities equipped for visualizing streamlines.
- Capability to conduct tests at various speeds, in both calm water and wave conditions.

This integrated approach allows HSVA to thoroughly validate and refine models, ensuring robust and reliable results in the study of bubble sweep down effects.

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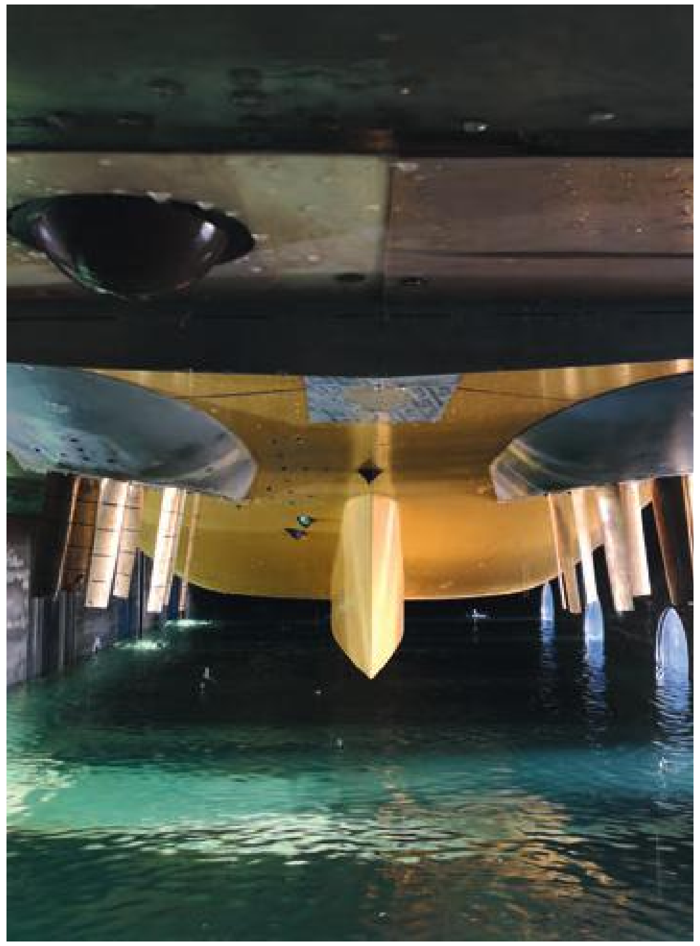
Development of a New Scale Correction Method for Cycloidal Propellers



Cycloidal propulsors, like Voith Schneider propellers or ABB Dynafin, differ a lot from common screw propellers not only visually but especially in their hydrodynamic characteristics. To get better insights into these special propulsors and their hydrodynamic characteristics, HSVA has recently developed new force balances, which are able to measure the propeller forces in addition to the torque (see NewsWave 2023).

by Tom Lücke

Being already in development "fever" and using the momentum created so far, this progress in measuring methods shall be followed by the next required step to develop a scale correction method especially tailored for this kind of propellers.

As you might know our scaling of screw propeller open water and propulsion prognoses are based on our HSVA Strip Method acc. to Streckwall.

Now we are developing a new surface strip method especially for the scale correction of cycloidal propellers. Similar to our existing method we account for the propeller's geometry and its hydrodynamic characteristics (local Reynolds-Numbers and flow situation) by means of surface stripes and drag- as well as lift coefficients (cd, cl). Here the very instantaneous behavior of each propeller blade and its mutual interaction with the other blades is the challenge for describing their behavior for Reynolds-Numbers of interest.

Besides feed-back from full scale sea trial data and propulsion tests, recently performed propeller open water tests at different Reynolds-Numbers and also investigations by means of our in-house viscous flow solver ***FreSCo+*** serve as the basis to develop this method.

We are still in the developing phase. As the method is soon ready, we are looking forward for its application.

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Twin Skeg LNG Carriers

from the Database Point of View

Since more than two decades HSVA has collected vast experience with performing model tests for LNG Carriers with two propellers behind skegs. In total more than 500 configurations have been investigated in the 300 m long towing tank. And more than 25 design variants finally have been investigated in the large cavitation tunnel HYKAT.

by Hilmar Klug

The length of the ships ranges from just above 60 m to 360 m (Figure 1).

In far most cases the length/breadth ratio is in the range of 5…7 (Figure 2).

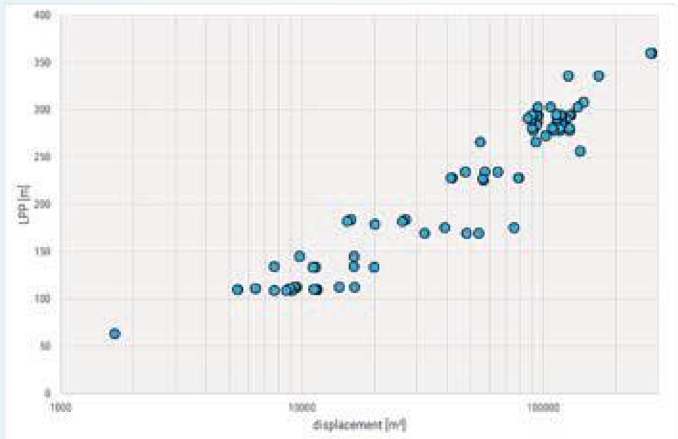

Figure 1: Length as function of the displacement volume

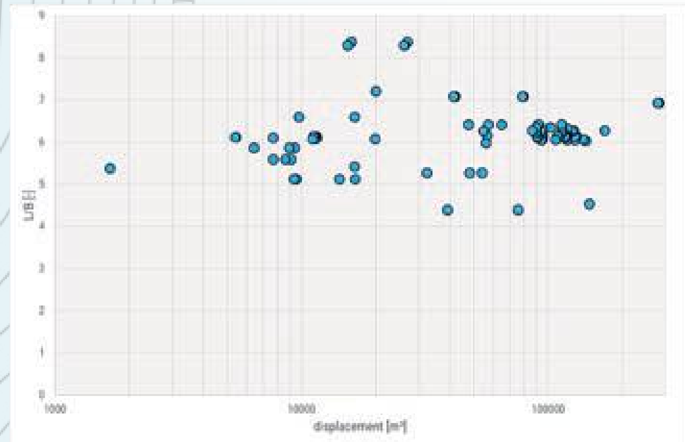

Figure 2: Length-breadth-ratio as function of the displacement volume

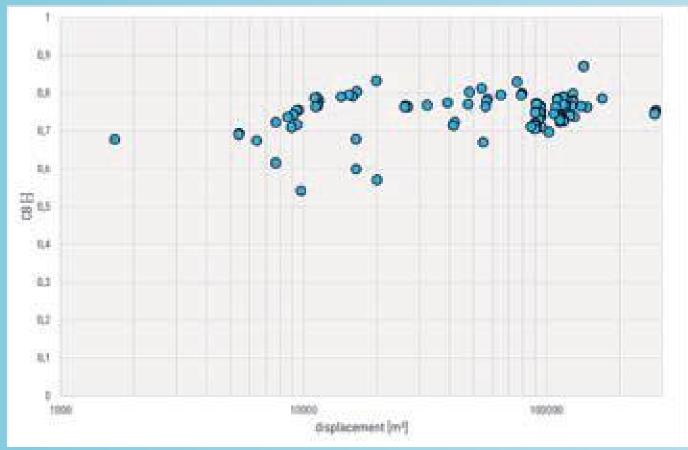

Figure 3: Block coefficient as function of the displacement volume

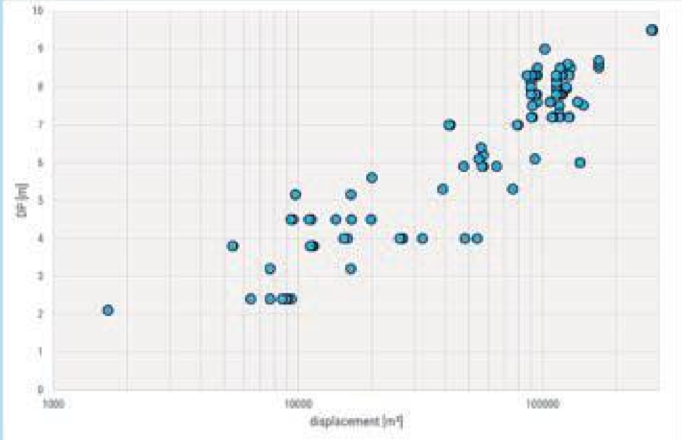

Figure 4: Propeller diameter as function of the displacement volume

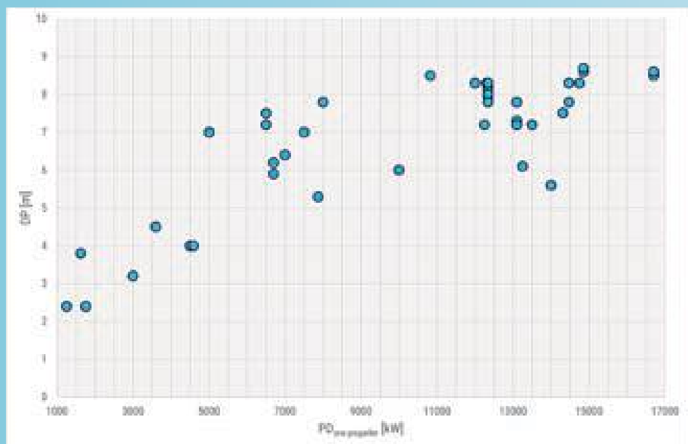

Figure 5: Propeller diameter as function of the main engine power

The block coefficient mostly is in the range of 0.7…0.8 (Figure 3).

The propeller diameter usually increases with the displacement volume (Figure 4) and the main engine power (Figure 5) with an upper limit defined by the ballast draught.

The hull shapes of the vessels vary quite significantly although they are of the same ship size (all ships with similar cargo volume; bow shapes: Figure 6; aft bodies: Figure 7).

The most challenging hull design aspects for this ship type are the performance of the fore body at ballast draught and loaded draught, and the diffusor formed by the two skegs, which in some conditions decelerates the flow unfavourably, resulting in flow separation, vortices and increased resistance.

Ships of similar size show a rather wide range of the first harmonic pressure pulses (Figure 8).

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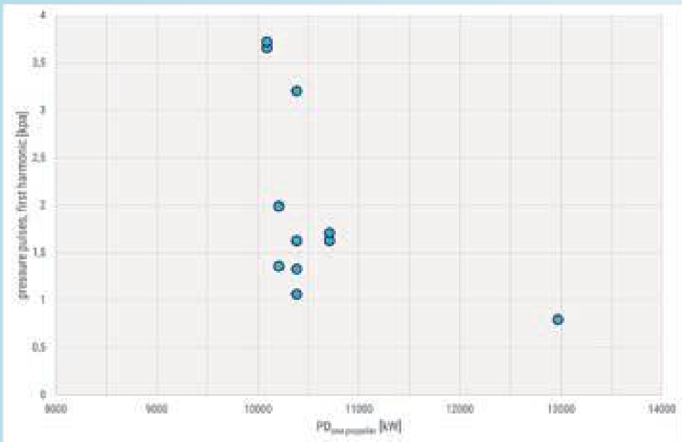
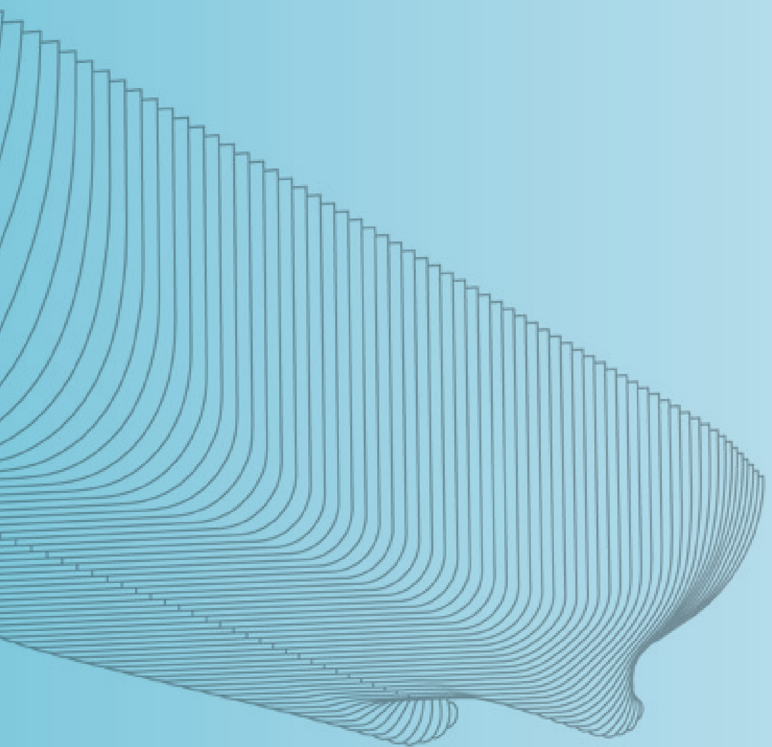


Figure 8: First harmonic pressure pulses of selected twin skeg LNG carriers



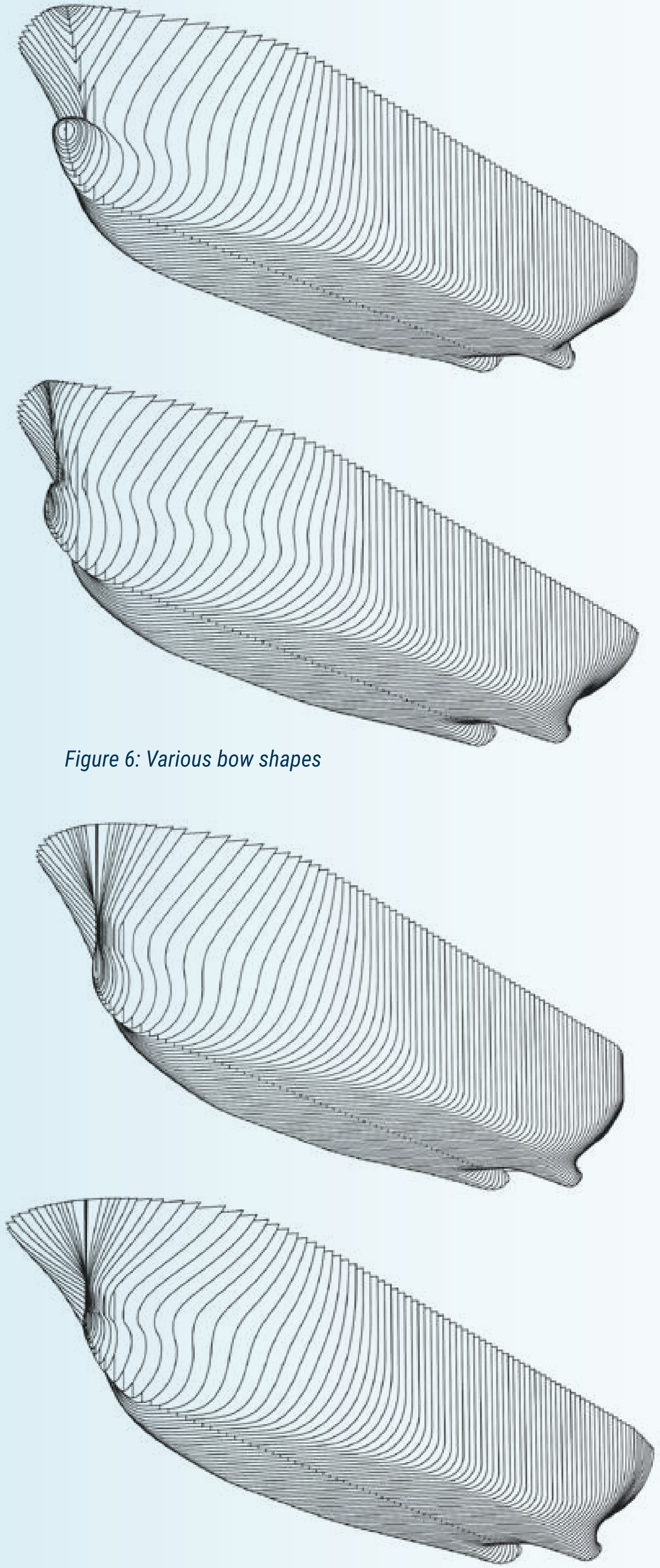


Figure 6: Various bow shapes

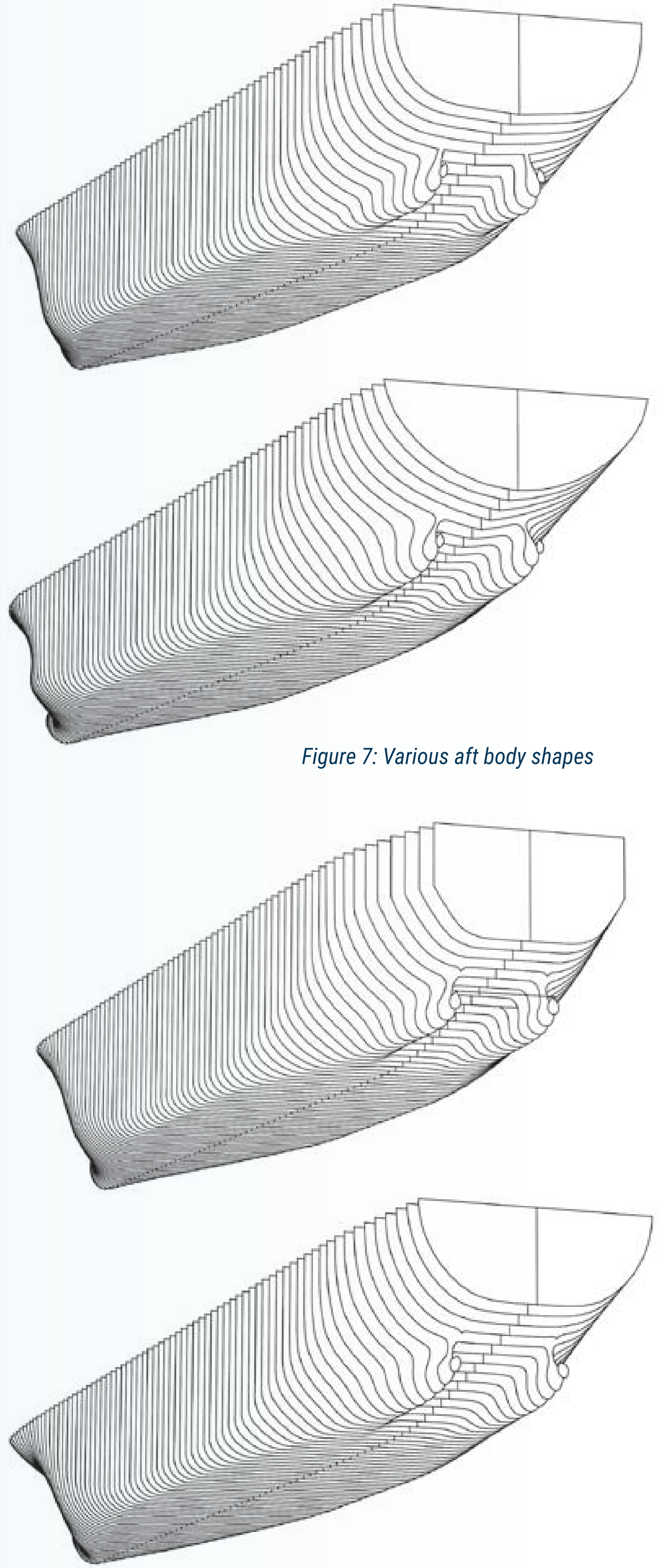
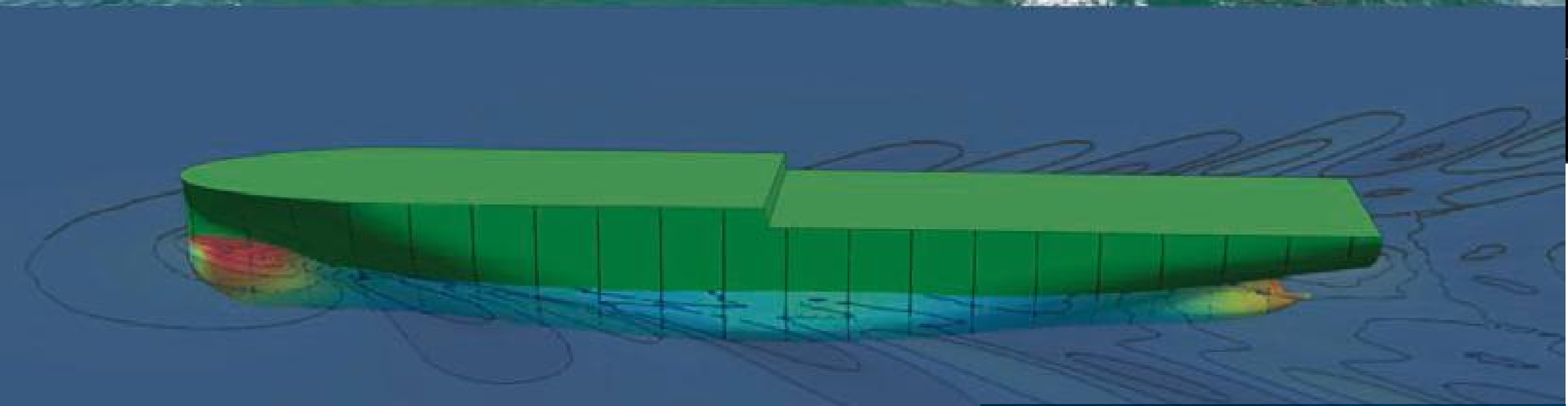


Figure 7: Various aft body shapes



Main Particulars

Length over all	99.98 m
Width	18.00 m
Design Draught	5.30 m
Installed Rower	3000 kW
Design / Top Speed	13.0 kn / 16 kn

Newcastle Bay

a HSVA Design for Northern Australia

The cargo vessel Newcastle Bay has entered service for Sea Swift, Northern Australia's largest shipping company. This purpose-build vessel will play a vital role in ensuring essential deliveries to the remote coastal regions in far North Queensland and the islands of the Torres Strait.

by Henning Grashorn

The Hamburg Ship Model Basin (HSVA), as a subcontractor of Cairns based naval architects G.A. Glanville & Co. Pty Ltd, was responsible for the hull form development and hydrodynamic performance of the vessel.

A thorough design campaign was performed to ensure an economic and cost-effective operation of the vessel. The design emphasized versatility, with hull lines optimised for a wide range of draughts and speeds, e.g. by implementing a moderate, but functional, bulbous bow.

After successful sea trials the vessel is now in operation for Sea Swift.

HSVA proudly contributed to the development of this vessel and hopes that it will serve Sea Swift successfully in the future.

„Smooth seas and safe travels, Newcastle Bay!"

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HSVA is pleased to be part of the procurement of two new ships for the water police of Hamburg, ordered by Flotte Hamburg. The three vessel built by Estonian shipyard Baltic Workboats will be on duty in the port of Hamburg, the river Elbe and the North Sea.

Ensuring Safe Waterways in the Port of Hamburg and Beyond

by Lars Johnsen

The ships are intended to replace four older vessels build in the 1990s and are equipped with a hybrid propulsion system allowing for zero-emission propulsion for a limited time. In late 2022 and early 2023, an extensive test campaign with the two type-vessels of abt. 24 m and 29 m in length was conducted at HSVA, including high speed resistance and propulsion tests with the twin screw semi-planning vessels.

To ensure not only efficient but also a safe and ergonomic working environment in the rough waters of the North Sea, the campaign was completed by broad seakeeping investigations bringing Baltic Workboats signature wave-piercing hull design to the test! A numerical assessment was complemented by physical model tests in dead ship condition, as well as head, following and quartering waves at high speeds. This was done to ensure the highly non-linear behaviour of the planning vessels in the short, steep waves than can occur at the mouth of the river Elbe was properly captured. The ultra-lightweight models of abt. 2-3 m length, running at up to 4 m/s were completely free-running during the seakeeping tests, allowing the assessment of various conditions, such as emergency stops or going astern. Throughout the tests, both ships showed convincing performances in calm water, as well as in waves! After the successful test campaign, HSVA wishes Baltic Workboats and Flotte Hamburg a successful commissioning in 2025.

contact: johnsen@hsva.de

Main Particulars

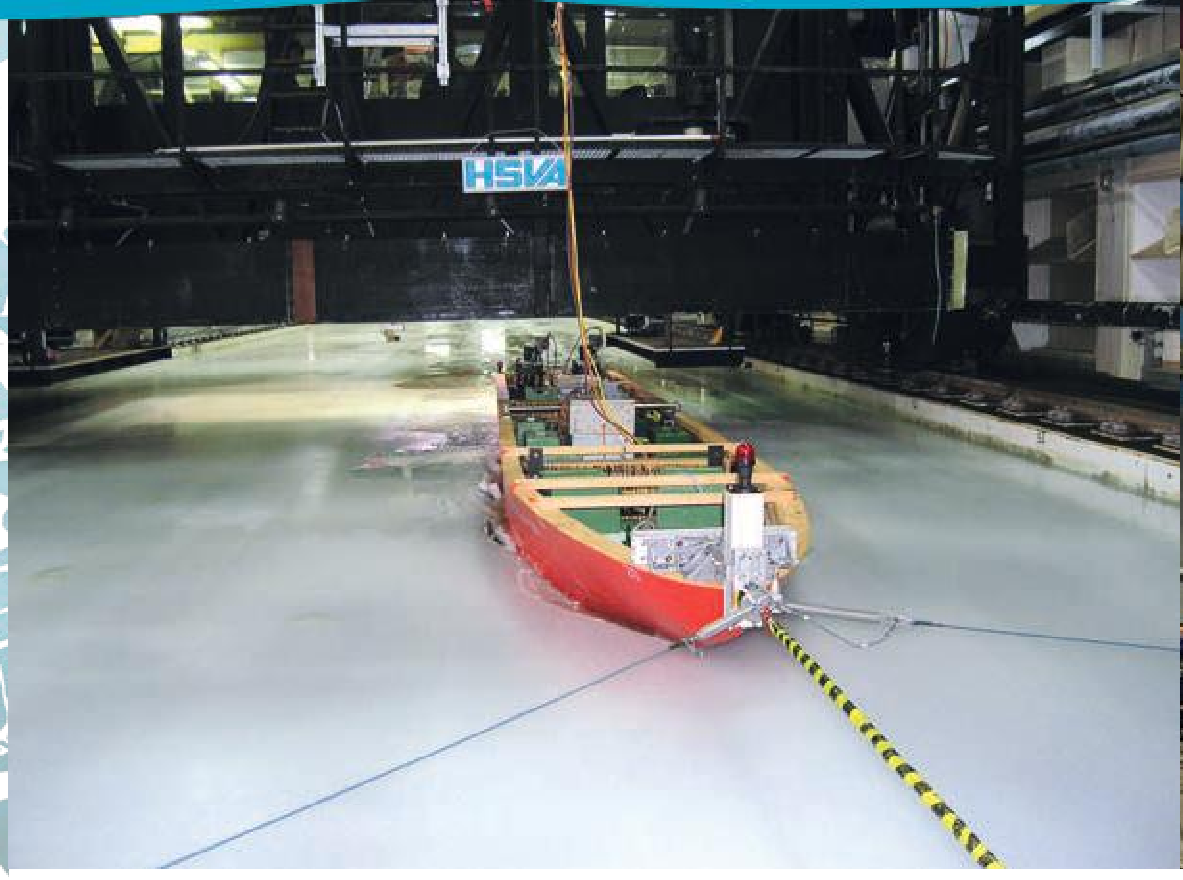
Length over all	23.97 m / 28.97 m
Crew	4 pers. / 5 pers.
Top Speed	25 kn / 25 kn
Pure electric mode	2h@7 kn

40th Anniversary of HSVA's Ice Model Basin and 35th Anniversary of HYKAT

by Nils Reimer, Lars Koopmann, Tom Lücke and Björn Carstensen

This year we celebrate the 40th Anniversary of our Large Ice Model Basin at HSVA.

The development of ice model testing started in the 50s of the last century. First steps were made in small test basins and focused on the preparation procedure of model ice with acceptable mechanical properties in relation to sea ice. In a next step ship testing in ice was established and a first ice basin sized 30 x 6 x 1.2 m was commissioned in the 70s. Though this basin was providing good conditions for resistance tests it was still limited regarding its size (smaller models, higher scaling influence), the towing capacity of the carriage. In the early 1980s Germany developed a new polar research vessel (Polarstern) which was a milestone for the polar research and also for the application of ice technology. The development was still carried out in the then existing ice basin at HSVA but was one of the driving factors that lead to the construction of a new larger model basin, in order to enhance the capabilities of HSVAs ice testing facilities. ▶



After commissioning of the large ice model basin first projects included the development of the famous Thyssen-Waas Bow for icebreaking and many other principle studies on icebreaking resistance and ice floe distribution along the hull. The larger width of the new basin also allowed manoeuvring tests to certain extent. The exploration of oil fields in the high North required suitable methods for risk evaluation. Therefore first tests for load determination on offshore structures like JZ 20 in Bohai Bay were carried out in the 1980 and followed by several tests with different type of platforms (e.g. jacket, caisson).

Research activities included the development of dynamic positioning systems for ice, complex failure modes and ice induced vibrations. Again the high flexibility of the ice basin which was thought ahead by the designers of the facility turned out to be a great advantage. In 2014 the large ice model basin was equipped with a wave generator system which allows principle investigations of wave-ice interaction and to create ice fields by means of more realistic conditions.

Today the Arctic and Antarctic Oceans gain more and more importance. Exploration of highly demanded mineral resources and new shipping routes as well as tourism and fishery are some key factors of interest. The past showed that in the polar regions, both environmental conditions and industrial activities are continuously changing. Recent years have shown an increased pace of change. Ice model testing will need to reflect this and be ready for future challenges. HSVA will address new trends such as summer ice conditions, green polar shipping in ice and safety of novel ship operations like wind farm supply in icy waters.

This year we celebrate the 35th Anniversary of our HYKAT at HSVA.

Another successful test facility of HSVA has this year its 35th anniversary: the hydro-acoustic and cavitation tunnel – in short the HYKAT. From the beginning, it was planned and built as a very silent cavitation tunnel. In its design, the focus was laid on the capability to carry out cavitation- and hydro-acoustic investigations for very silent vessels. Since then, the HYKAT has proven and extended its role and importance.

Nowadays, in HYKAT a colorful mixture of tests are carried out and all types of vessels and their propellers and rudders are investigated. The flexibility in usage offers the possibility to carry out special tests, as for example the investigation of full scale Air Lubrication Outlets and the evaluation of frictional resistance for special surface textures at large Reynolds numbers. In no time after these special tests, the tunnel ready again for its main purpose: cavitation observations and pressure pulse measurements. The possibility to investigate the cavitation behavior of the propeller and appendages in the wake field of the full model is used for all types of ships. The special advantage of the HYKAT is, that these investigations are performed at about 3-4 times the Reynolds-Numbers than those attainable in the towing tank.

While the focus of tests and investigations for commercial shipping was initially only on evaluating the risk for cavitation erosion and cavitation induced vibrations, it shifts more and more to the field of hydro-acoustic measurements. This field was formerly only of interest for research and navy vessels, but with a growing need for protection of marine animals, the topic gains importance in commercial shipping as well. With a worldwide known unique facility as the HYKAT and with passionate colleagues we are well prepared for the future.

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Energy-Efficient Refurbishment at HSVA

Due to rising energy prices and the responsibility to help shape the energy transition, HSVA decided to improve the company's energy efficiency.

by Axel Schult

At the end of 2022, HSVA carried out an energy audit in accordance with DIN EN 16247 with the engineering firm ENHH GmbH - Energieberatung Hamburg. The aim of the audit was to identify energy-saving measures of which some were already successfully implemented in 2023 and 2024.

Saving Thermal Energy

Improvements include the core insulation of the air layer (approx. 10 cm) of all external walls of the large towing tank, a total of 1,373 m². This has significantly reduced the heat requirement. In addition, the quality of the experiments in the towing tank improved due to a more stable internal temperature in winter and summer.

Another important measure was the installation of measurement technology that enables the continuous recording and visualization of system statuses in the central heating system. This includes in particular the system temperatures, i.e. the temperature of the heating water in the flow and return of the various heating circuits. Continuous monitoring and analysis of the heating data is a decisive step towards improving energy efficiency. It makes it possible to adjust the heating curve and quickly rectify malfunctions in the control system.

Hydraulic balancing of the 400 radiators in the local heating network on the factory premises also leads to increased efficiency. By calculating the room-by-room heating load and subsequently optimizing the heat supply, the energy efficiency of the central heating system was improved. After balancing, the heat flows according to the actual demand on the factory premises and in the buildings, individual rooms could be prevented from being either overheated or undercooled. This not only leads to a more pleasant room temperature, but also to considerable energy savings.

The conversion of the heating concept with a heat exchanger in the HYKAT also had a major effect. In addition to the potential savings of 30 tons of CO_2 per year, this change to the existing system leads to more uniform tunnel water temperatures and therefore greater measurement accuracy.

The increase in energy efficiency was very quickly visible at HSVA. In 2023, the heat requirement was already reduced by well over 40%.

Producing Renewable Energy

Electricity is the most versatile and therefore the most valuable form of energy. With our towing tank roof, we have a 6,000 square meter potential area in the city. HSVA has a very high energy demand. The new photovoltaic plant will achieve an output of 1,000 kWp with approx. 2,600 modules. HSVA will operate the plant and can thus sustainably produce a large proportion of the own consumed electricity.

With the described measures, HSVA is positioning itself for the future. We are reducing our dependency by purchasing significantly less energy and lowering our costs for electricity and gas. The measures implemented at HSVA relieve the strain on the power grids by reducing peak loads.

HSVA's goal is to be CO_2 neutral by 2030.

contact: schult@hsva.de

Lars Koopmann

Lars Koopmann joined the HSVA as project manager and researcher in June 2023 and enhances the team at our HYKAT. Lars is responsible for cavitation and special projects and is involved in the further development of the facility and procedures. He can draw on many years of experience in research and project work. In the past, Lars has worked intensively on both numerical simulations and experimental investigations. The practical relevance is always important to him and he enjoys working in a great team.

His family is very important to Lars and he loves being out on the water, in the mountains or on his bike.