

Thorough **model testing** required to make cruising in tough environments sustainable

The exploration cruise sector is an expanding market with tough requirements. Modern exploration cruise vessels are designed with the user experience in mind, with the option to disembark people and take them ashore via kayaks and RIBs. Of course, the environmental impact and safety at sea are also paramount, and vessels need to be designed to cope with extremely rough weather conditions and harsh environments. A state-of-the-art vessel of this type is Ulstein's new exploration cruise vessel design. SSPA was chosen as the hydrodynamic testing partner, which included traditional calm-water towing tank tests and tests in our seakeeping basin, both under way and at zero speed. Extensive Computational Fluid Dynamics (CFD) simulations were performed. An important part of testing was to correlate these calculations with the model tests. Together, we developed a testing programme to assess the behaviour of the vessel in the most typical operating conditions. During testing, both the pod design and testing parameters were changed. Our experts supported the Ulstein design team, so they could deliver the best solution for their customer, shipowner Lindblad Expeditions Holdings Inc.

Purpose-built

The exploration cruise sector currently runs on an ageing fleet of converted vessels. Traditionally, these vessels have been existing passenger ships adapted to cope with tough polar environments. However, the new generation of vessels is purpose-built, raising operators' and final customers' expectations of the design's performance.

The environmental impact, safety at sea and not least the user experiences are all very much the focus when designing such a vessel. Modern exploration cruise vessels typically need to be able to cope with extremely tough weather conditions, while having good virtual anchoring capacity and the option to disembark people and take them ashore. This means ships are often equipped with stabilising fins effective not only at speed but also during dynamic positioning, as well as large open embarkation platforms. As the vessel could be surrounded by ice at any time, the ship still needs to perform well even with its

fins folded and allow for the operation of kayaks and RIBs from the large aft and side platforms. This adds to the challenges faced by the designers when developing a cruise vessel for these harsh environments.

Access to land is (fortunately) limited, which places a number of demands on the design of such a vessel. Only a limited number of visitors, fewer than 100, can be on land at the same time including the crew, forcing the owners to limit the size of the vessel. This in turn limits the number of operators, as ships need to wait for their turn to disembark their passengers and crew.

This leads to vessels that are very specific in size and capacity:

- Minimising the environmental impact is important. Specific fuel oil consumption (SFOC) and silent propulsion are two typical key focuses.
- Vessels are relatively small compared to other cruise ships.
- The hull needs to be reinforced against ice.
- The vessel must have good seakeeping ability to withstand tough weather conditions.
- For passengers, the experience ashore is as important as the experience onboard.
- There is no quay to disembark people and these operations must be able to be comfortably performed in environments that preclude the use of fin stabilisers, e.g. the presence of ice. Furthermore, these operations are performed with virtual anchoring (dynamic positioning capacity), using large platforms at the aft and on the side of the vessel for launching RIBs and kayaks.

Facilitating our customers' journey to success

Nicolas Bathfield, Manager of Hydrodynamics and Stability at Ulstein Design & Solutions, oversaw hydrodynamic development with his design team. Together with SSPA, a test programme was developed to assess the behaviour of the vessel in the most typical operating conditions and with the aim of trying to conduct tests at the most critical resonance wave periods. During testing, both the pod design and testing parameters were changed.

We asked Nicolas Bathfield about this project and how he thinks SSPA can best support designers and shipowners.

The pod design was altered late in the testing phase due the Polar Class approval process and additional tests were carried out. Were you able to use the results from the first round?

"This is why we need flexible partners. We work to time constraints that are tough to meet and a lot of work has to be done in parallel, instead of the sequential design spiral we are normally used to", says Nicolas Bathfield. He continues, "Ulstein Design & Solutions is working hard to establish an agile design process that allows for adapting the design to new requirements or for solving unforeseen challenges that may arise in any project. This in turn requires our partners to be able adapt to these changes and help us continually improve our designs over the course of the project. The first round of testing was definitely not wasted: it was a benchmarking test

"The ocean model basin was crucial for this type of project, and the delivery time too. Flexibility was also an important factor in our decision."



National Geographic Endurance

The vessel is designed for polar expeditions, with a high ice class and polar vessel features with Ulstein's signature X-BOW.

Total length: 124 metres

Beam: 21 metres

Displacement:
Approximately 8,000 tonnes

Lindblad Expeditions Holdings Inc. is an expedition travel company that works in partnership with National Geographic to inspire people to explore and care about the planet.

Ulstein Group has 600 employees and is headquartered in Ulsteinvik, Norway. In total, Ulstein Verft has built more than 300 vessels, and more than 100 vessels designed with the X-BOW have been delivered.



Matz Brown

Project Manager

Matz graduated with an MSc from Chalmers University of Technology in 1979 before working at Götaverken Arendal. He has also worked at Uddevallavarvet and was a teacher for several years. Matz has been at SSPA since 1997 and specialises in hull design and model testing for sailing yachts and fast vessels.

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Martin Kjellberg

Specialist, Seakeeping & Manoeuvring

Martin graduated from Chalmers University of Technology with an MSc in 2007 and a PhD in 2013. Since then he has been at SSPA, specialising in seakeeping and manoeuvring model testing, as well as numerical seakeeping analysis methods.

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Ulstein Design & Solutions tested two vessels, one of which was the National Geographic Endurance. Illustration: Courtesy of Lindblad Expeditions.

that gave us even more confidence in our CFD models, as our prediction was borne out in the test results with very good agreement!"

What was the most important goal to achieve with the tests?

"Together with SSPA, we designed a testing procedure aimed at testing the ship under all critical conditions. We wanted to capture the behaviour of the vessel during natural roll and pitch periods to make sure we got a good understanding of the maximum accelerations and motions that passengers would experience onboard under a certain set of conditions. Model tests are expensive, so we have to limit the scope. The rest can be simulated."

Is X-BOW an important feature of the design?

"Yes, this helps to dampen movements significantly in head seas. We wanted to run extensive model testing in an ocean model basin to look at the behaviour of the X-BOW in terms of slamming, but also in combination with the aft platform. It was important to verify that in stern-quartering seas, the X-BOW's volume

above waterline (it is not really a flare) helped dampen the combined roll and pitch motions induced by the wave meeting the extremely flat aft buttock lines that are typical of this type of vessel", says Nicolas.

"I also believe that the shipowners, who assisted with the tests, were very pleased with what they saw during wave model testing."

You are a former SSPA employee, did this have anything to do with the choice of model testing facility?

"We chose the basin based on the model test programme we wanted to run – the ocean model basin proved to be a crucial element for this project and we had strict time constraints when we ordered the tests that SSPA were able to meet. We cannot allow our past experiences influence our choices. If anything, me being a former employee was a challenge for both sides, as I had strong opinions on how I wanted the test programme to be run", says Nicolas.

"I particularly appreciated the support during the tender phase, when SSPA's experts helped us define the best possible model testing programme

for our project. It was of utmost importance for us to make sure we gathered enough information during the limited time available for testing and avoided having to run any extra rounds of testing, which would have been costly. I think that together we succeeded in getting the most out of the tests while at the same time allowing the shipowner to be present during testing with their own film crew."

"I know through experience that this can be really demanding, as safety, confidentiality and time constraints are hard to balance when there are lots of visitors on site during a testing round, especially if a film crew is present. I am grateful to SSPA for arranging this so my customer also had a great experience during the test sessions", Nicolas concludes.

How can SSPA support designers and shipowners?

- Calm-water performance
- Seakeeping and comfort analysis
- Cavitation and noise measurement
- Propeller noise analysis with Computational Fluid Dynamics (CFD) simulations