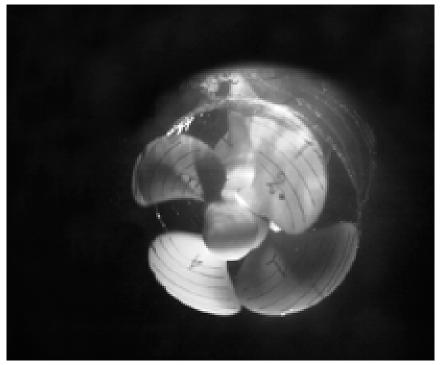
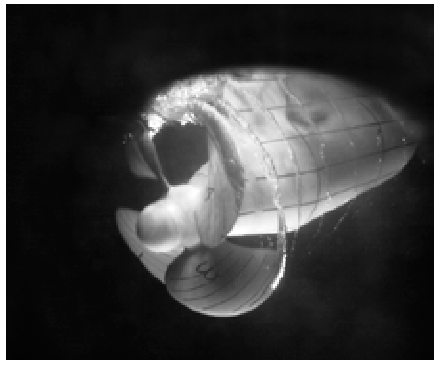
First images of cavitation and ventilation in waves

History was made on May 22 when the first-ever cavitating and ventilating images appeared on the monitors at MARIN's new Depressurised Wave Basin.



Tip vortex and leading edge cavitation during a wave trough, with ventilation vortex crossing the tip vortex cavitation downstream.



Ventilation and cavitation during a wave trough. A double vortex system is originating from blade 3. Ventilation around the tip combined with cavitation on blade 4. Cavitation inception on blade 1.

At that moment, a 10 m cruise vessel model was sailing in waves under a very low atmospheric pressure. Meanwhile, in the control room of the basin, five MARIN employees were staring at the monitors and then there was much excitement as the first images of slowly arising and dissipating cavitating and ventilating vortices appeared.

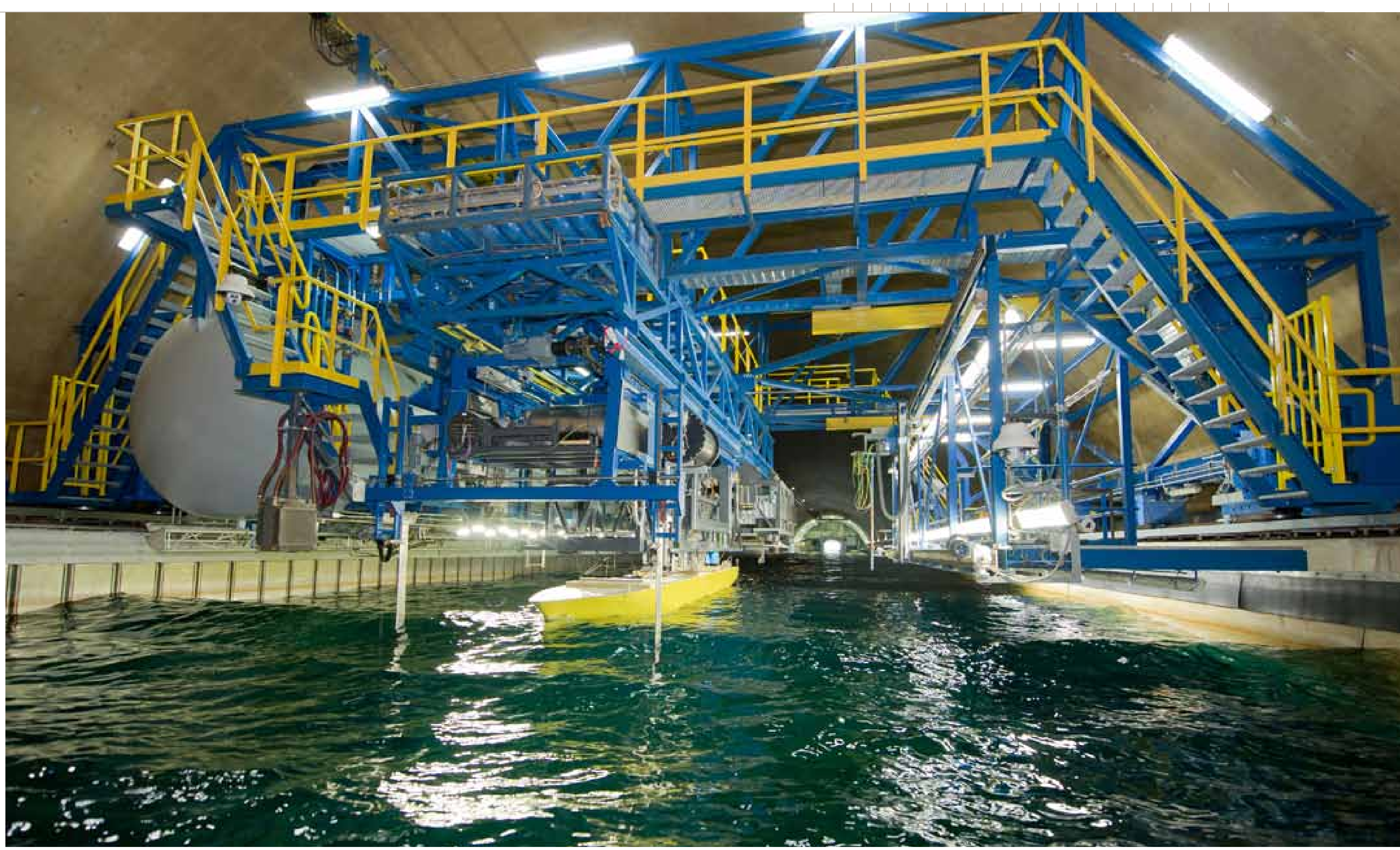
This was the first time the new DWB, which was inaugurated in March (see Report Nr. 105), was given the chance to prove its capabilities and highlight its capacity to provide breakthrough research. The DWB is a unique facility worldwide, representing a combination of a depressurised towing tank with a wave maker.

The air pressure in the entire basin was lowered to 50 mbar to give the correct conditions for propeller cavitation, while at the same time the wave makers were operated to simulate a 5 m wave height for the ship model. With this combination, cavitation and the ventilation of propellers in operational conditions can be investigated, a capability that is not present anywhere else in the world.

These innovative tests were carried out for the EU-funded STREAMLINE research programme, which focuses on fuel efficiency and is driven by increasing environmental concerns and soaring oil prices.

Gerco Hagesteijn &
Joris Brouwer
g.hagesteijn@marin.nl

136832



New propulsion concepts STREAMLINE is a response to the demand for more advanced vessels and for radically new propulsion concepts, which deliver a step-change in efficiency. The STREAMLINE consortium, led by Rolls-Royce, comprises 22 partners from eight countries, providing world leading expertise from the European Union's marine Industry.

Over a four-year time period, the research programme will address several issues. One key objective is to demonstrate that radically new propulsion concepts can deliver an increase in efficiency of at least 15% over current state-of-the-art systems. STREAMLINE will also investigate methods to fully optimise current systems such as conventional screw propeller systems, pods and water-jets.
MARIN is involved in various ways, from fundamental CFD development for ducts, the design of biomechanical propulsion, to groundbreaking model tests to provide benchmark cases for CFD.

Ventilation of pods For pods, an in-depth study is being carried out regarding the possibilities of placing the pod unit at a position optimised for total vessel efficiency. Risk of ventilation, especially in open sea conditions, is at this moment the limiting factor. Only cavitation behaviour in calm water conditions is assessed during the propulsion system design under current practice, although it is known that shaft and bearing loads in operational conditions impose important constraints on the design. Ventilation can sometimes occur on pods, a phenomenon which affects blade forces and moments, and consequently the shaft loading as well. MARIN carried out a unique series of tests in the DWB where these phenomena are simulated to fully understand the ventilation effects, therefore allowing more freedom in the positioning of the pod.
For this purpose a cruise liner model was selected and fitted with podded propulsors. The forces and moments of the propeller were measured on both pods in all directions. The portside pod was instrumented to measure the entire propeller, while the starboard pod had only one of the four blades instrumented in order to measure the blade root loading in detail. The test setup and instrumentation were similar to the setup used for the CRS ProPolar project (see Report No. 104). Seven different cameras were used to record the tests, including two high-speed video cameras.
The light loading condition of the vessel was used in combination with a series of wave periods with the highest chance of ventilation. Using high-speed video recordings with 2000 fps, both cavitation and ventilation events were captured in great detail together with synchronised force and moment measurements on the instrumented blade. The fluctuations of the blade root loading showed significant fluctuations during a cavitation or ventilation event.

These first results show that already from the first project on, the DWB is making an important contribution to knowledge development and it is certain to play a vital role in improving the safety and efficiency of propulsion systems in operational conditions.

The research leading to these results has received funding from the *European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n°233896.*