# Numerical Investigation of Ventilation Risk for a Large Diameter Propeller

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## ABSTRACT

Numerical and experimental investigations carried out in STREAMLINE [1] revealed a significant potential to improve a vessel propulsive efficiency by transforming its conventional-sized propeller to a Large Diameter Propeller (LDP) with an integrated aft design. This concept is further developed in LeanShips [2] for a general cargo vessel incorporating a LDP in a traditional position but with much reduced propeller/hull clearance and a 'tunnel' shaped aft design. One possible drawback of using such a large propeller is a greater risk of propeller ventilation which may affect the vessel propulsive efficiency.

Air suction from free-surface and limited submergence due to ship motions are the dominating factors in the inception of the propeller ventilation (Faltinsen et al. (1981) and Kozlowska et al. (2017)). The vertical ship motions and the corresponding instantaneous propeller submergence is more crucial for the LDP vessel since the tunnel-shaped aft design configuration significantly reduces the air suction into the propeller. Although the importance of vessel motions in the occurrence of propeller ventilation is somehow pinpointed in these investigations, the risk assessment for propeller ventilation is not fully understood based on the actual position of the water surface due to ship motion responses.

In an earlier study the authors of the current paper have carried out a comprehensive investigation on the seakeeping performance of the model-scale LDP vessel bare hull in regular head waves using SHIPFLOW Motions (fully non-linear unsteady potential flow code). Consequently, a critical wave condition is identified with regards to the risk of propeller ventilation. The objective of this paper is to investigate the performance of a higher fidelity viscous flow solver, STAR-CCM+, in seakeeping performance assessment of the LDP vessel using an Unsteady Reynolds-Averaged Navier-Stokes (URANS) approach. The propeller is not modeled in the simulations and its interaction with free-surface is assumed to be insignificant in comparison to the contribution from the propeller distance from free-surface governed by the ship motions. The relative distance between the free-surface and the conceptual propeller is studied based on monitoring the ship motions and the pressure at the propeller tip clearance, see Figure 1. Zero pressure in this figure represents atmospheric pressure (higher ventilation risk). Despite the comparable ship motions computed from the inviscid and the viscous solvers, free-surface analysis reveals a lower ventilation risk in the viscous solver.

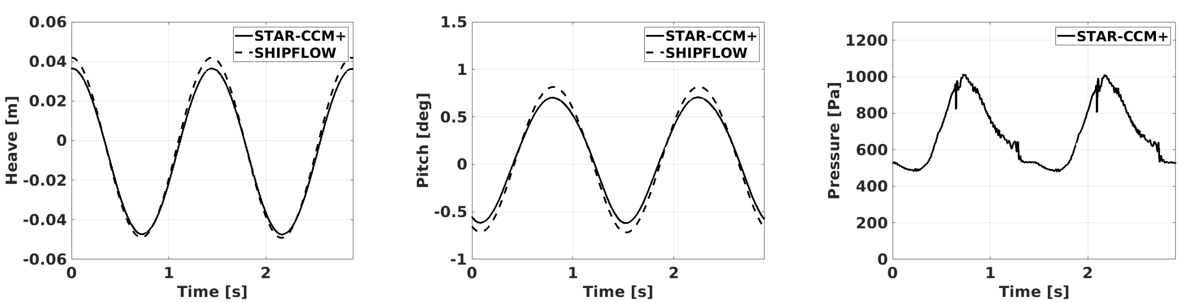


**Figure 1**: Computed heave (left), pitch (middle) and pressure (right) from different methods

## REFERENCES

[1] STREAMLINE (STrategic REsearch for innovAtive Marine propuLsioN concEpts), EU-funded project, 2010-2014.

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