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ONRT Free-Running CFD and System Based Simulations for Transient Maneuvers: Four Quadrant and Accelerating Turn[1]

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ABSTRACT

Free-running CFDShip-Iowa V&V have progressed from course keeping including added power, heavy weather, and capsize to turning circles in calm water and waves and zigzag maneuvering to high-speed planing hulls including dynamic instabilities[2]. These studies have provided significant physical insights and contributed as test cases to NATO AVT Working groups and CFD and Maneuvering Workshops all which well-position the community of interest to tackle the grand challenge of transient maneuvers, which is currently under investigation under the auspices of AVT-399 "Assessment of Experiments and Prediction Methods for Naval Ship Transient Maneuvers in Calm Water and Waves." This paper will provide the CFD conditions, setups, validation variables, and results for transient maneuvers, including four-quadrant (steady self-propulsion, to stopping, to steady-state backing, to ahead, and return to steady state self-propulsion) and accelerating turn. The results will be analyzed regarding the physics of unsteady 3D vortex onset, progression and hull/propeller/rudder interactions and ship motions; and with reference to the NATO Specialist Team for Seaway Mobility (ST/SM), which has developed a standard agreement (STANAG) for naval ships. Comparisons will be made with commonly used system-based methods. Discussions will be provided on future research including zigzag and other transient maneuvers, and conclusions will be drawn on the applicability of the prediction tools for the assessment of the transient manoeuvres related to specific criteria.

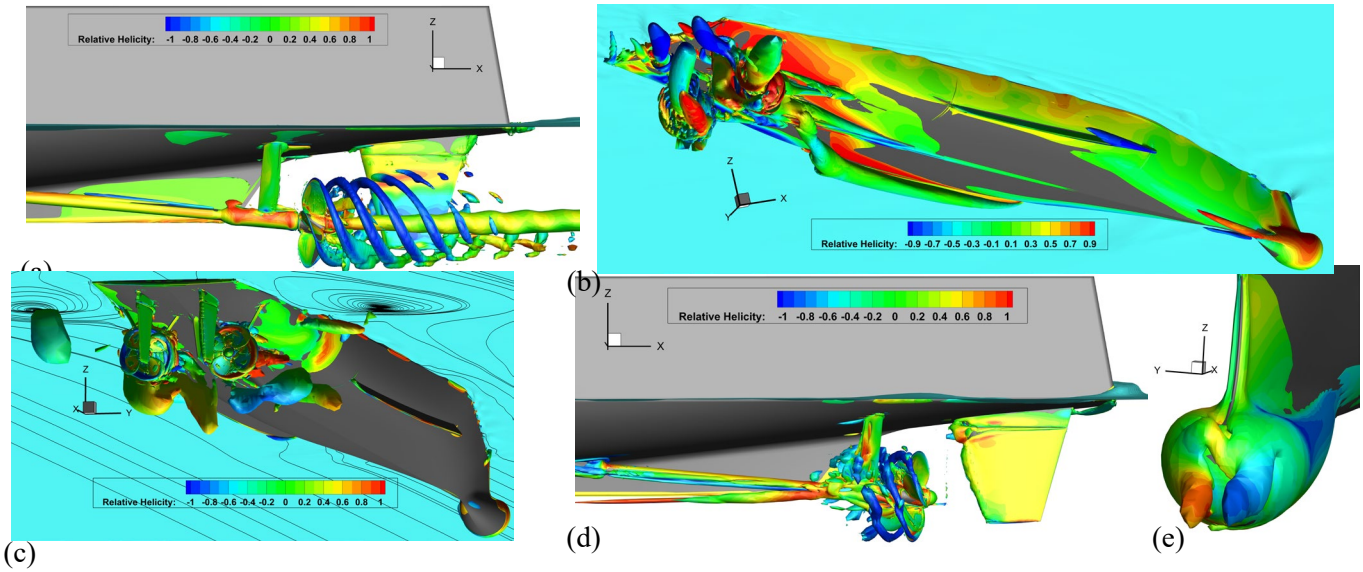

Figure 1. Free-running ONRT simulation results, iso-surface of Q-criterion ($Q = 200$) colored by relative helicity: (a) self-propulsion, (b) accelerated turning, (c) stopping, (d) backing, and (e) close-up view of bow for backing.

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[2] References available on request and to be included in full paper.