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# INVESTIGATION OF TURBULENCE MODELS AND BLOCKAGE EFFECTS ON NUMERICAL HYDRO-ACOUSTICS STUDIES

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## ABSTRACT

The design of high-performance propellers for marine applications involves a comprehensive evaluation of thrust, torque, cavitation, and hydroacoustic characteristics. Hydroacoustic studies are pivotal for enhancing passenger comfort in commercial systems, ensuring the longevity of machinery, and enabling effective detection and identification of military vehicles. This study investigates the hydroacoustic performance of propellers using numerical methods to address challenges associated with experimental techniques, such as background noise and blockage effects in cavitation tunnels.

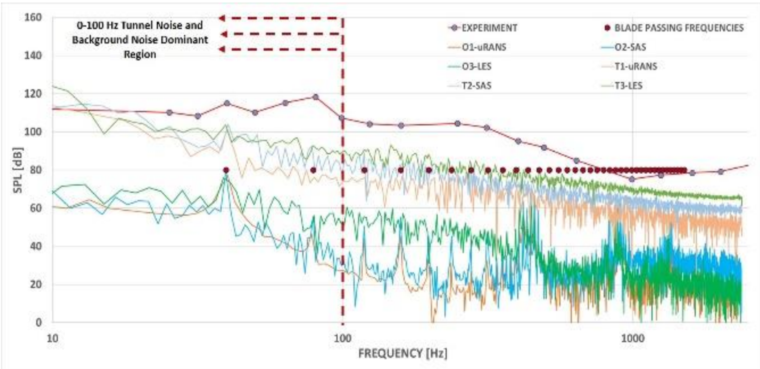

Figure 1 : Analysis Set Frequency-Based Noise Levels of DTMB4119 with Experimental Data

The numerical approach employs the Ffowcs Williams-Hawkings (FW-H) analogy to calculate noise generated by monopole, dipole, and quadrupole sound sources. The study focuses on the DTMB4119 propeller geometry, leveraging its extensive experimental data. Three turbulence models—uRANS, SAS, and LES—were applied to both open-water and cavitation tunnel configurations. The mesh structure comprised poly-hexcore grids with 18.1 million cells for open-water analyses and 19.3 million cells for tunnel configurations.

The results, given in *Figure 1* (Ebrahimi et al., 2019), reveal that the LES model provides the most accurate noise predictions in open-water scenarios, closely aligning with experimental data. Conversely, the cavitation tunnel configuration exhibits significant noise amplification (~40 dB) due to blockage effects, boundary layer interactions, and equipment-induced noise. Notably, the LES model also outperforms other models in the tunnel configuration, capturing critical acoustic phenomena that are absent in uRANS and partially resolved by SAS.

Future work will explore the influence of mesh density on LES results and quantify the acoustic impact of varying blockage ratios in cavitation tunnel tests.

## References

Ebrahimi, A., Seif, M. S. and Nouri-Borujerdi, A. “Hydro-Acoustic and Hydrodynamic Optimization of a Marine Propeller Using Genetic Algorithm, Boundary Element Method, and FW-H Equations”, J. Mar. Sci. Eng., Vol. 7, pp. 321, (2019).