NCE JOB MEMO

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DATE:	December 6, 2024
SUBJECT:	Addendum to NCE Report 2024-079 on Thrust Force vs. Overall Vessel-Generated Underwater Radiated Noise

Noise Control Engineering, LLC (NCE) recently completed a study[1] for the Maritime Administration (MARAD) to measure, assess, and understand the underwater radiated noise from three tugs owned and operated by Crowley. As part of this study, underwater noise of the *eWOLF*, *Tioga*, and *Leader* was measured during Simulated Tug Assist (STA) conditions and compared on the basis of the engine power percentage relative to full power. Details of the measurements, STA operating conditions, and data processing are provided in the original report.

The percentage of total installed power was used in the study for STA comparison purposes as this is a convenient and pertinent metric; see Section 3.1 of the report. This led to the conclusion that the *eWOLF* generally produced similar underwater levels to the *Tioga* at similar STA power levels, and that noise improvements of the *eWOLF*'s battery-electric system are limited to transit conditions.

Following the finalization of the report, estimated thrust forces were provided by Crowley for each vessel at each STA condition. The bollard pull (100% power) thrust has been previously measured by Crowley at each vessel's sea trials. The estimated thrusts at lower STA powers are scaled by the percentage of engine power. Note that measurements of thrust were planned during testing for this project, but could not be performed for technical reasons. The scaling approach used here assumes the ratio of propulsion efficiencies between 100% and lower power conditions are similar across the three vessels.

An alternative STA underwater noise comparison using the estimated thrust force is presented in Figure 1. Under this approach, the overall noise of the *eWOLF* is at least 5 dB lower than those of the *Tioga* and *Leader* at thrusts greater than 25 short tons.

Comparisons of noise at the same thrust is a better approach than comparisons at the same percentage power. Thrust, which can also be thought of as the force the tug applies to another

[1] Z. Weiss, J. Spence, B. Bonnice, "Vessel-Generated Underwater Radiated Noise Comparison Study (Tugs): *eWOLF*, *Tioga*, and *Leader*," NCE Report 2024-079, Revision 0, November 15, 2024

vessel during assist operations, is more relevant to a tug's effectiveness at performing those operations. For example, if it takes a certain amount of force to move a vessel, then that force needs to be applied regardless of the available power of the installed engines. Therefore, the comparison of underwater noise vs. STA thrust indicates the *eWOLF* has reduced underwater noise than the other vessels when doing the same work.

As discussed in the report, the *Tioga* underwater noise is a combination of engine noise and propeller cavitation, where the *eWOLF* noise is primarily due to propeller cavitation. It is worth noting that the *eWOLF* propeller is larger and turns at a slower rate than the *Tioga.* These design features can lead to reduced noise from cavitation.

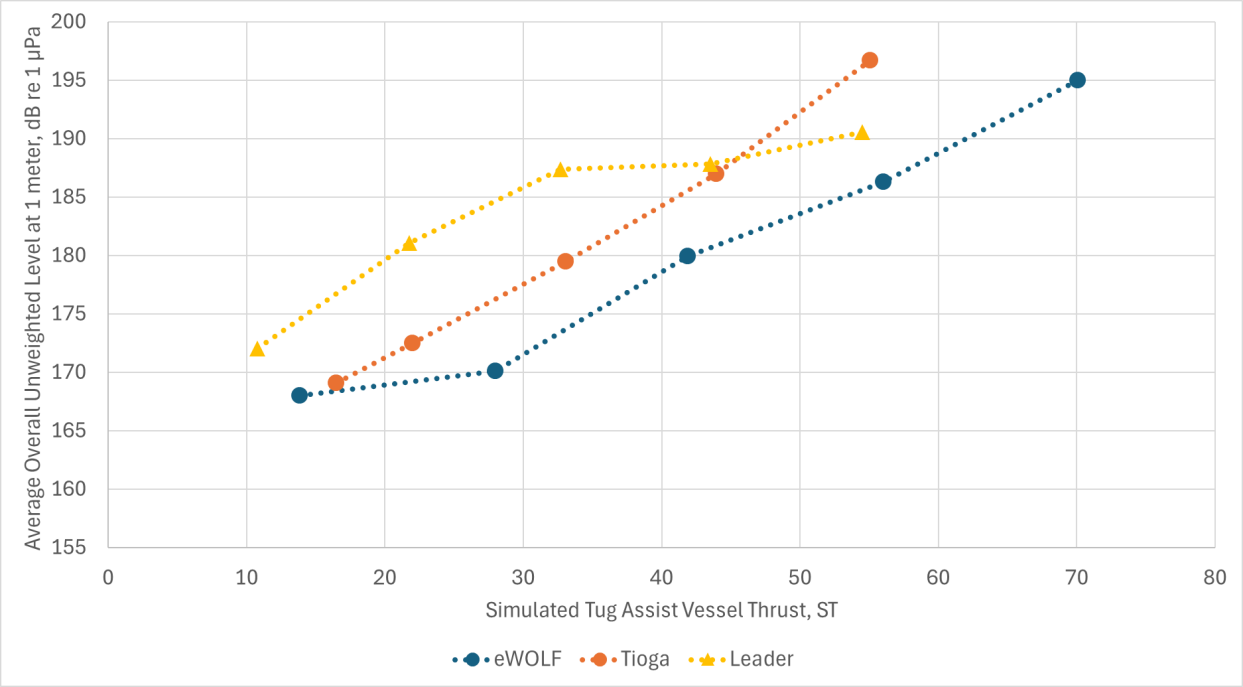

Figure 1: Underwater Noise at STA Condition, Average Overall Noise Levels at 1-meter vs. Estimated Thrust in Short Tons