Pacific Northwest
NATIONAL LABORATORY

PNNL-39139

Towards Commercialization of Hydrophone Flow Shields to Improve Passive Acoustic Data Quality (CRADA 678) Final Report

March 2026

1 Emma Cotter (Pacific Northwest National Laboratory)
2 Ian Brownstein (XFlow Energy)
3 Ben Strom (XFlow Energy)

U.S. DEPARTMENT of ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Pacific Northwest National Laboratory
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Responsible Technical Contact at DOE Lab (PNNL):

Emma Cotter

Provide a list of publications, conference papers, or other public releases of results, developed under this CRADA:

This project produced a report describing the results of flow shield testing for public distribution.

Provide a detailed list of all subject inventions, to include patent applications, copyrights, and trademarks:

No subject inventions were developed under this CRADA, but the work relates to a prior patent application: US Patent App. 18/900,269

Executive Summary of CRADA Work

This project performed testing, market research, and manufacturing refinement to ready patent-pending hydrophone flow shields developed at PNNL for commercialization. The flow shields reduce the impact of flow noise on underwater sound recordings in areas of strong flow, like tidal channels or rivers. Flow noise is a challenge in many applications where it is necessary to measure underwater sound, including measuring the sound produced by marine energy converters and monitoring marine mammals. This project addressed several key questions about flow shield performance that are high-priority for potential customers and refined existing manufacturing processes to be scalable for market-level production. Specifically, this project conducted calibrations and field evaluations of the flow shields to comprehensively evaluate their performance. Overall, the results indicate that the flow shields reduce flow noise by over 20 dB at frequencies below 50 Hz at flow speeds greater than 0.5 m/s and are proven to survive deployments more than 6 months long.

Summary of Research Results

Flow noise, or low frequency pseudo-sound caused by turbulent flow past a hydrophone, is a persistent challenge for passive acoustic measurements in locations with currents (tidal channels, rivers, ocean currents), in shallow water where wave orbital velocities can induce flow noise, and when hydrophones are mounted to mobile platforms (e.g., vessels). Flow shields can reduce the effects of flow noise, but there have been few quantitative evaluations of their performance. To address this gap, in 2024, Pacific Northwest National Laboratory (PNNL) conducted a side-by-side test of three flow shield designs and found that an oil filled, urethane enclosure manufactured by XFlow reduced flow noise by over 30 dB at frequencies below 40 Hz in a tidal channel with 1.3 m/s peak velocities and, unlike thin fabric flow shields, was likely sufficiently robust for long-term deployments (Cotter et al. 2024). While Cotter et al. (2024) demonstrated the potential of the oil-filled flow shield to improve acoustic measurements in dynamic environments, analysis was limited to frequencies below 20 kHz, and only one oil-filled flow shield was tested for a limited period of one week.

Therefore, PNNL and XFlow partnered to refine the design of the oil-filled flow shield and conduct further testing of its performance. This study addressed three key topics:

- High-frequency performance
- Additional field testing and evaluation
- Ease of assembly

Overall, the results indicate that the flow shields:

- Attenuate propagating sound by no more than 2 dB at frequencies below 30 kHz
- Reduce flow noise by over 20 dB below 50 Hz at flow speeds greater than 0.5 m/s
- Are proven to survive deployments more than 6 months long[1]
- Are easy to assemble

[1] Note that failure was not observed at 6 months, rather this was the maximum test duration possible during the project period.

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