

OSRR Project # 1137: Oil Spill Containment Boom Computational Fluid Dynamics and Physical Modeling Study Written Abstract

Evaluating oil containment in towed boom is important for spill planning but cannot be assessed in field trials with oil in US waters. The Ohmsett facility provides a relevant test environment, but the size of the tank limits the speed and scale of system that can be tested. BSEE project 1134 investigated how accurately computational fluid dynamics (CFD) modeling and physical scaled model testing results may predict full-scale performance of towed oil containment boom systems. This project follows the work of BSEE project 1089 which conducted a literature review of oil containment boom technology. The project identified that assumptions of the reliability of scaled boom models had not been adequately tested and identified CFD as a potential means of assessing oil boom's containment ability. Three oil containment boom systems (Elastec Foam, Abasco, Elastec Airmax) were selected for this project. First, the three boom systems were tested at 100%, 50%, and 25% scale with oil in the Ohmsett tank to determine the tow speed that led to oil loss. The Ohmsett tank results were compared to CFD model results performed using ANSYS Fluent software.

Physical scale testing and CFD model first oil loss speeds were comparable at the 100% scale. However, CFD modeling at smaller scales provided noticeably different results compared to physical testing. At the 50% and 25% scale, modeling results showed oil failure over the boom, which was not observed in the physical tests. This failure was suspected to be the result of an unrealistic acceleration in the model resulting in a disturbance. Attempts to model the smaller boom scales with smaller acceleration jumps resulted in the same failure over the boom. Longer model run times with more gradual acceleration and increased equilibration times is suspected to yield results more representative of physical scale models. However, the computational requirements need for longer model run times should be considered for future work. Conducting a sensitivity study for the existing models is recommended to find a balance between model complexity and necessary computing time. Less sensitive models could provide similar boom failure results with decreased model run time.

Based on the CFD modeling and physical results, recommended revisions have been proposed for American Society for Testing and Materials (ASTM) F2084 test standards. The first recommendation is to increase the time spent at each tow speed during physical tests, allowing the system to reach equilibrium and increase the likelihood of detecting oil loss. This increased time at speed is dependent on the restrictions of the test facility. The second recommendation is to eliminate preload testing in favor for a single preload volume equivalent to 50% fill of the catenary boom with 1 inch depth of oil. This modification to the standard is intended to decrease the necessary number of trials and save experimental time. Beyond ASTM recommendations, it is recommended that future work investigate means of decreasing drag from the boom skirt, particularly at the apex. A semiporous material at the boom apex could decrease drag by allowing water to flow through the skirt, while containing oil.