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16. Abstract

A second series of fire tests utilizing the American Standard for Testing Materials (ASTM) F-20 draft, Standard Guide for In-Situ Burning of Oil Spills on Water: Fire-Resistant Containment Boom, as a guideline were conducted in a wave tank at the U.S. Coast Guard Fire and Safety Test Detachment in Mobile, Alabama, during August-September 1998. The test series used six different fire-resistant oil spill containment booms, including two water-cooled designs. Three of the booms used in the evaluation were modified designs of booms used in the first series conducted in 1997. A 15-meter section of each boom was formed in a circle and subjected to a diesel fuel fire, for up to three hours, while waves were produced. Testing issues, such as the boom constraint system, the location of the heat flux gauges and thermocouples, and special procedures for water-cooled booms, were addressed. The results of the second test series are presented, and the strengths and weaknesses of the protocol are discussed, along with areas for possible improvement.

17. Key Words
diesel fuel, fire-resistant boom, oil spill, in-situ burning, pool fires

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Executive Summary

Most response plans for in-situ burning of oil at sea call for the use of a fire-resistant boom to contain the oil during a burn. Presently, there is no standard method for the user of fire-resistant boom to evaluate the anticipated performance of different booms. The American Standard for Testing Materials (ASTM) F-20 Committee has developed a draft standard, Standard Guide for In-Situ Burning of Oil Spills on Water: Fire-Resistant Containment Boom; however, the draft provides only general guidelines and does not specify the details of the test procedure. Utilizing the guidelines in the draft standard, a second series of experiments was conducted to evaluate a protocol for testing the ability of fire-resistant booms to withstand both fire and waves.

For the first phase tests, a wave tank capable of assessing the capabilities of a section of boom by subjecting it to a fire and waves was designed and constructed at the U.S. Coast Guard Fire and Safety Test Detachment in Alabama. A hydraulically powered paddle at one end of the tank was used to generate waves, and a sloped beach at the opposite end was used to dissipate the wave energy. The boom tested was formed into a circle, floated on water in the center of the tank, and held in position during the tests with water-cooled vertical stanchions located inside the boom circle. Number 2 diesel fuel was pumped into the center of the boom circle to provide fuel for the tests. The test cycle consisted of three one-hour burning periods with two one-hour cool-down periods between the burning periods. The test cycle was terminated early if degradation of the boom resulted in substantial fuel loss. Five booms were subjected to the test procedure based on the draft standard in the first phase.

Although the first phase tests were largely successful, several issues were identified for further study. Three of those issues, 1) method of boom constraint, 2) protocol for testing water-cooled booms, and 3) measurement of heat flux and temperature near the boom, were specifically addressed in the second phase tests. In the second phase, six booms were subjected to the test procedure based on the draft standard. Two of the booms were of fabric-based construction, two were water-cooled fabric and two were stainless steel. The degradation to the booms during the tests ranged from minimal to substantial, and the test for one of the fabric booms and one of the water-cooled booms was terminated before the complete test cycle due to fire damage to the booms.

An improved method of boom constraint was successfully used in the second phase tests. The vertical stanchions inside the boom circle in contact with the boom were replaced with vertical stanchions outside the boom circle. The boom was connected to the external stanchions with cable beneath the water that held the boom in a circular pattern, while allowing the boom to freely move up and down with the waves. During the first test of a water-cooled boom, the fire became less intense as the fire progressed, and the fire continued to burn for more than two hours. This burning pattern was also observed in the first phase tests. Using short duration burns, a revised fuel delivery rate for the water-cooled booms was calculated and used successfully to obtain the desired one-hour full intensity burn.

Based on the experience gained in the first phase testing, the heat flux and temperature measurement devices were relocated from inside the boom circle in the first phase tests, to just outside the boom circle near the top of the boom in the second phase tests. This resulted in improved heat flux and temperature measurements. Although the maximum heat flux and temperature were not determined in all of the tests due to wind direction, adequate data were collected to characterize the maximum thermal exposure to the boom.

The improvements to the test protocol in the second phase testing were a success. The test appears to provide a realistic simulation of the thermal loading expected during the use of fire-resistant oil spill containment boom. Several issues identified in first phase testing remain. In general, these issues are related to the test philosophy and cannot be readily resolved by further testing. These issues are: 1) adequacy of thermal and wave exposure, 2) the impact of varying natural wind on the test conditions, and 3) selection of an evaluation criteria.