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EPA **Project Summary**

Evaluation of a Containment Barrier for Hazardous Material Spills in Watercourses

Thomas N. Blockwick

This project was undertaken to design, develop, and evaluate a physical barrier system to contain accidental concentrated spills of insoluble hazardous materials in water. The system was to be effective in flowing water, lightweight, easily transportable, and capable of being deployed by a minimum number of trained personnel.

A prototype barrier designed to meet the above criteria was constructed of a flexible, fiber-reinforced plastic curtain with air-inflatable flotation. To prevent escape of polluting materials from the contained mass of water, the bottom of the barrier is sealed against the bottom of the watercourse with a liquid-filled bladder held in place with several anchors. The ends of the curtain are laced together to give a cylindrical shape.

Full-scale field testing of the barrier system was initially conducted in 1971 and 1972 to evaluate deployment techniques, to determine the amount of leakage from the barrier by using dye as a simulated hazardous material, and to measure the loads imposed on the barrier by currents. Testing was again conducted in 1976 with an improved barrier system incorporating changes based on the earlier tests.

As a result of the field tests, it was concluded that a properly designed barrier system could contain spills and leaks that were not rapidly dispersed into the water environment. Such spills would include releases of concentrated insoluble hazardous substances that pool on or near the bottom. But the studies also demonstrated that the hazardous material barrier (HMB) had serious shortcomings, the greatest being its sensitivity to currents, the time required for deployment, and weight-related handling difficulties. Rapid technological advancements in plastics and their fabrication, coupled with the experiences gained from this study, may now make it possible to construct a barrier that can be deployed more rapidly and with less difficulty.

Though this report is being issued several years after project completion, information on the study was presented at the 1972 National Conference on Control of Hazardous Materials Spills, and technical advice has been provided on this topic to EPA Regions making inquiries. We hope that the release of the report will stimulate those in the user community that may want to further the development of this concept.

This material was originally published by the U.S. Environmental Protection Agency as EPA-600/S2-83-112.

This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

System Description

The barrier is constructed of a highly flexible, fiber-reinforced plastic material that can be deployed around a spill source such as a sunken barge, rail car, or tanker truck containing concentrated insoluble hazardous materials that pool on or near the bottom of the waterbody. Incorporated into the barrier are an air-inflated flotation collar that supports the barrier and a liquid-filled bladder that seals the bottom of the barrier to the bottom of the waterway in which the barrier is deployed. The ends of the barrier are laced together before deployment to give the cylindrical shape needed for the confinement of a spill. Figure 1 shows the barrier fully inflated on the water surface.

Five explosive embedment anchors are used by divers to moor the barrier in place. These anchors were selected because of their very high holding power-to-weight ratio and the speed with which they can be installed relative to alternative anchoring systems. Each anchor assembly weighs approximately 100 lb in the ready-to-fire configuration.

Equipment used in deployment includes special devices for pulling the barrier to the bottom and mooring it to the anchor pendants, equipment for inflating the air bladder and filling the water bladder, vessel(s) for deploying the barrier, and marker buoys and anchors for temporarily mooring the barrier until it can be permanently anchored.

A small boat with at least a 1000-lb capacity is required for installation of the system. The boat should be equipped with at least a 5-hp outboard motor if it is used to deploy the barrier. If the barrier is to be deployed in a watercourse where there is a current, then a larger, more powerful motor is required for towing of the barrier.

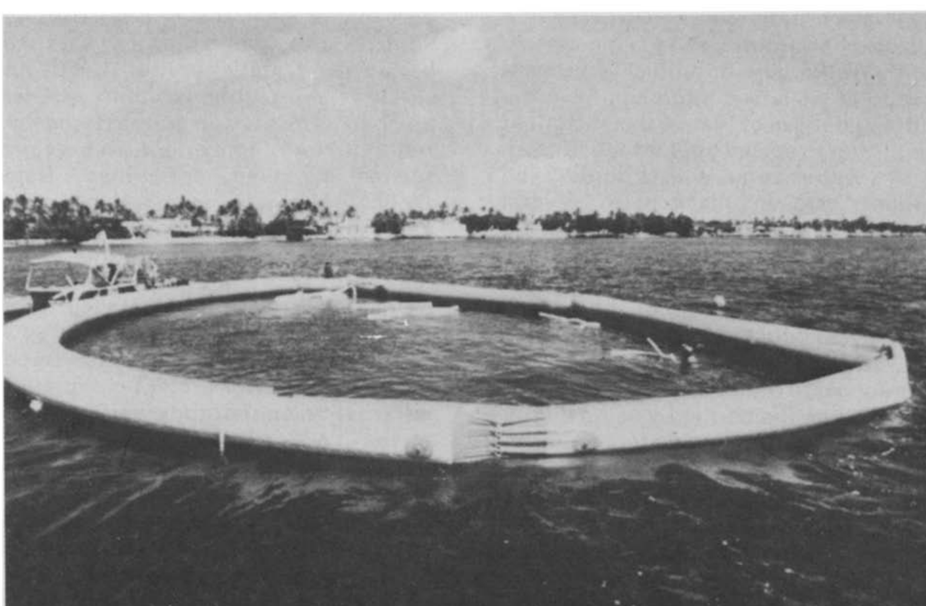

Figure 1. *Fully-inflated barrier.*

Prototype Field Tests

Three field tests were conducted with the prototype barrier between October 1, 1971, and April 30, 1972. The first test was conducted in Sugar Grove, West Virginia, to evaluate the barrier and deployment techniques under still water conditions. Deployment, mooring, and anchoring of the barrier were no problem under the still water conditions of the lake. Some mechanical problems were encountered in opening the tapes holding the barrier bundle together, and some minor leaks were observed in the flotation bladder. Dye tests with Rhodamine-B as a simulated spill demonstrated that no dye leaked from the barrier over a 24-hour period.

The second test was conducted on the lower Potomac River, southeast of Colonial Beach, Virginia. This site afforded the depth, currents, and bottom conditions required to subject the barrier and deployment procedures to more severe conditions. Positioning and mooring the barrier at the test site did prove more difficult in the river current (1 knot). Unfortunately, wind, waves, and adverse weather conditions caused the barrier to unfurl prematurely and forced cancellation of this trial before any testing could be carried out.

The site of the third trial was near Lake Worth Inlet, Palm Beach, Florida. This location was considered ideal since there were tidal currents of 1 to 2 knots and underwater visibility was excellent. The purpose of this test was to observe certain stages of deployment and aspects of the in-place barrier. Although mooring and anchoring were completed rapidly, the currents at this site, and perhaps undiscovered damage during the earlier tests, caused the barrier to tear quite extensively and ultimately to feather in the current. The suspected pattern of failure is described in the full report.

Following the 1972 field tests, recommendations were made to construct a new, strengthened barrier, and in 1976, field testing and evaluation were conducted at the formerly used site in Palm Beach, Florida, to benefit from the experience of that previous test.

Current velocities were measured during the field testing to determine the effects of the tidal currents on the configuration and integrity of the improved barrier. A fluorescent dye tracer study was attempted to evaluate the ability of the barrier to contain a simulated spill. But this procedure could not be completed because the current flow caused the barrier to collapse into itself on the surface, while the bottom bladder failed to maintain a seal with the bottom. Lead weights were subsequently used to keep the bottom seal in place, but the flotation collar continued to collapse in the current.

Recovery of the barrier for reuse, a necessity if it is to be cost-effective, proved in all tests to be a time-consuming and tedious operation, even when using heavy equipment.

Conclusions and Recommendations

The hazardous material barrier system can be a viable countermeasure against spilled hazardous materials. Field tests indicate that deployment of the barrier in currents faster than 1 knot is not recommended, since the design configuration cannot be maintained effectively and reliably. With currents above 1 knot, the barrier loses its shape and tends to close in on itself.

The self-embedment anchoring system used to moor the barrier is extremely effective. The pull-down system used for deployment of the barrier worked well, but a more efficient mechanical handling system is needed for launching and recovering the barrier. Deployment of the barrier can be accomplished in time to contain spills that are not rapidly dispersed or where a significant amount of the pollutant remains at the source 8 to 12 hr after the barrier system arrives at the scene of the accident.

Recommended system changes include: (1) the use of a stronger or multiply material at critical points of the barrier; (2) the use of non-kinking hoses for inflation of the flotation collar and for filling of the liquid bladder; (3) the design of a procedure and a system for draining the bottom seal bladder; and (4) consideration of mechanical aids that will eliminate or reduce the need for divers.

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Thomas N. Blockwick was with Samson Ocean Systems, Inc., Boston, MA 02110.
***Ira Wilder** is the EPA Project Officer (see below).*
The complete report, entitled "Evaluation of a Containment Barrier for Hazardous Material Spills in Watercourses," (Order No. PB 84-123 942; Cost: $10.00, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Oil and Hazardous Materials Spills Branch
Municipal Environmental Research Laboratory—Cincinnati
U.S. Environmental Protection Agency
Edison, NJ 08837