UNITED STATES ENVIRONMENTAL PROTECTION AGENCY'S TEST FACILITY OHMSETT: THE FIRST SIX MONTHS

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ABSTRACT

The U.S. Environmental Protection Agency completed the basic construction of its Oil and Hazardous Materials Simulated Environmental Test Tank (OHMSETT) in the summer of 1974. Spill cleanup methods and equipment will be safely evaluated and improved at this facility without endangering the environment. The Leonardo, New Jersey, facility is designed to simulate conditions in rivers and estuaries.

The core of the facility is a 667-ft long by 65-ft wide concrete, above-ground, outdoor tank, 11 ft deep. It is filled to a depth of 8 ft with estuarine water. Regular waves up to 30 in high and 100 ft long can be generated, or a severe interference chop condition can be made by reflecting regular waves off an angled end wall. The tank is spanned by a 40-ton bridge designed for towing floating test equipment at speeds up to 6 knots. The bridge also contains apparatus for laying thin oil slicks onto the water surface immediately ahead of equipment being tested. A 2,000-gpm, pressure-leaf, diatomaceous earth filter maintains sufficient water clarity to permit the use of underwater video recording and photography. A 7,000-square-foot support building houses offices, a laboratory, mechanical and electronic shops, and an equipment preparation area.

A description of experiences during the first 6 months of operation and a discussion of the facility's potential for serving public and private users will be presented.

INTRODUCTION

The U.S. Environmental Protection Agency's Edison, New Jersey, Industrial Waste Treatment Research Laboratory (NERC) has begun full-time operation of its Oil & Hazardous Materials Simulated Environmental Test Tank (OHMSETT). This test facility, located in Leonardo, New Jersey, is the only one of its kind in the world today. The U.S. Environmental Protection Agency designed, constructed, and is operating OHMSETT for the purpose of helping to solve a major environmental problem: the safe, effective cleanup of oil and hazardous materials spills.

Background

On March 18, 1967, the supertanker *Torrey Canyon* drove into Pollard Rock off southwestern England. Over 30,000 metric tons of crude oil were released, much of which ended up on the coasts of Great Britain and France. The news media broadcasted to the world not only the inadequacy of available cleanup methods and technology, but also some of the consequences of a major oil spill. Almost exactly a year later on March 3, 1968, the tanker *Ocean Eagle* went aground and broke in half in the approaches to San Juan, Puerto Rico, spilling large quantities of oil. Nine months after that on January 28, 1969, a major discharge began near Platform A in the Santa Barbara channel; within a month an estimated 4,500 metric tons of oil had reached land along 90 km of the adjacent California coast while still more floated offshore. The sheer visual impact of hundreds of acres of blackness relentlessly moving onto the shore, of many oily bird carcasses, and of miles of sticky beaches created a strong public demand for rapid and effective cleanup techniques and equipment.

Additionally, many thoughtful persons began to wonder whether the suffocation of wildlife and their habitats by these massive oil spills was truly the most critical problem. Perhaps over the long run, the more subtle effects of much lower oil concentrations on juvenile populations, for example, might result in far greater environmental impact. America has been recording roughly 11,000 oil spills per year recently, and almost a million gallons have been reported spilled in the first quarter of 1974 alone.

Obvious actions to be taken included measures to prevent additional oil spills through analysis of recorded spills and the correction of shortcomings identified. Appropriate legislation was enacted in 1970. The resulting analysis revealed a high percentage of human error; this can be countered to a large degree by proper training. In addition, occasional equipment failures will also ensure that oil spills can never be completely eliminated. Therefore, the need for methods and equipment for cleaning up oil spills will always exist.

The major spill disasters cited earlier amply demonstrated the inadequacy of the state-of-the art of cleanup technology in the late 1960s. The federal government then moved to increase the sophistication and effectiveness of methods and equipment through a series of research and development contracts. Many of these contracts involved testing with oil, and almost without exception, oil escaped to the environment during each test. This situation was clearly unacceptable.

Another problem with testing in the natural environment was the lack of control over test conditions. Test conditions were not reproducible, making comparisons very difficult. Waves could be too high or too short, or currents would be too large, or the wind would render handling of test oils impossible. Examples of multiship task forces waiting in vain for conditions even remotely resembling those desired for testing (at costs of up to a quarter of a million dollars at a time) were all too common.

Of the existing artificial test facilities, some were too short to provide adequate test duration, or did not make acceptable waves, or would not permit the use of oil and hazardous materials, or took inordinately long to clean up between tests.

In order to circumvent the shortcomings of both the real world and the man-made facilities then in existence, the U.S. Environmental Protection Agency decided to construct a unique test facility specifically designed for the purpose of improving spill cleanup

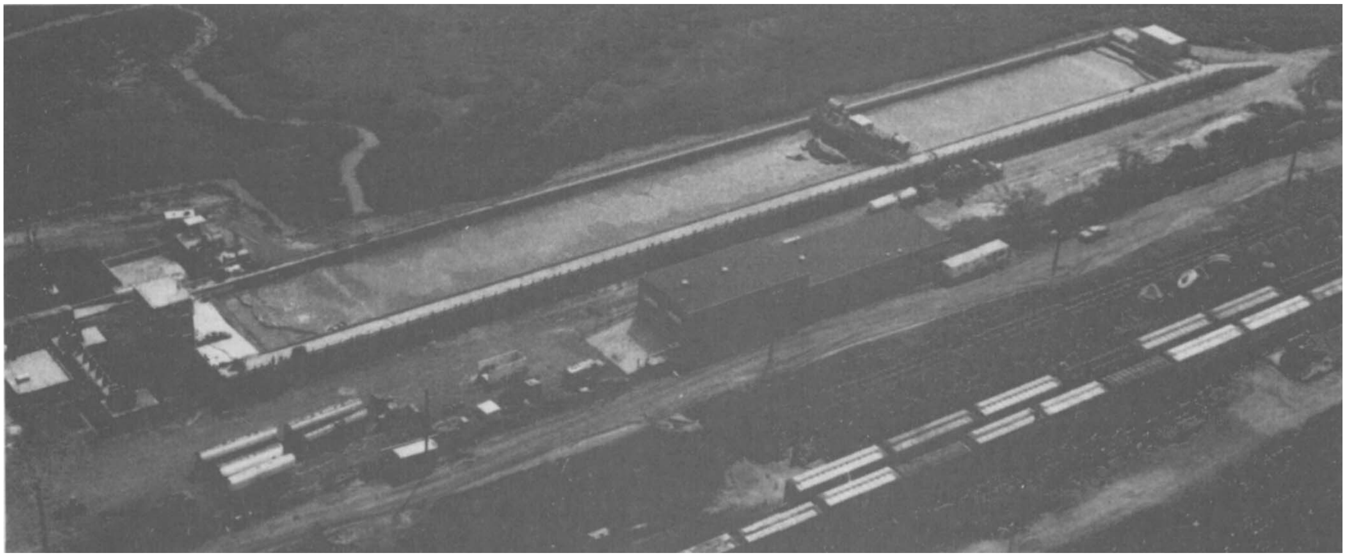

Figure 1. Aerial view of OHMSETT

methods and equipment in an environmentally safe manner and at an acceptable degree of efficiency. The statutory authority was contained in the Federal Water Pollution Control Act, as amended (1970), 33 U.S.C. 433 et seq.

Facility description

Because the majority of spills occur in inland, estuarine and near-shore waters (and because the construction costs of simulating full-scale offshore conditions are orders-of-magnitude greater), the minimum facility design goals were the production of wave heights up to 2 ft, wave lengths up to 15 ft, and relative water currents up to 6 knots in a facility capable of testing full-size equipment.

The basic facility consists of an above-ground, pile-supported, rectangular, concrete tank 667 ft long, 65 ft wide and 11 ft deep. 2.6 million gallons of water are required to fill it to the normal operating depth of 8 ft. Estuarine water from adjacent Sandy Hook Bay is normally used, but a system for filling with fresh water is also provided.

Wave characteristics depend upon both the wave generator and the wave absorbing or reflecting properties of the basin. The wave generator consists of two rectangular flaps, aligned end to end and hinged along their bottom edges. The flaps may be rocked back and forth in phase or 180 degrees out of phase. Power is derived from two 125 HP electric motors which are connected by a hydrostatic drive system to a large flywheel and mechanical linkages. This system permits generating waves with periods from 2 to 7 seconds and lengths from 15 to more than 100 ft in a series of discrete wave heights up to 30 in. The shape of the longer waves is distorted because of the tank's shallow depth.

The wave energy can be absorbed at the far end of the tank by a beach built of wood slats and plastic netting. The beach can also be lowered to the tank bottom so that waves may be reflected off the tank's vertical end wall. This wall is V-shaped, which causes reflected wave trains to intersect. If the original waves are generated with the flaps in their out-of-phase position, the interfering wave trains cause a very confused sea of the sort found in a tidal inlet with heavy boat traffic.

Water currents are equivalent to relative motion between the water and test object. Either the object can be held fixed relative to the earth and the water pumped past it, or the water can lay still while the test object is towed through it. The latter approach is far less expensive in this case because of the large quantity of water involved. Thus, a movable bridge resting on rails spans the tank width and can tow a floating test object with a 36,000-pound drag at speeds up to 10 feet per second. The bridge is powered by two 500 HP-winches and a cable system.

Besides providing a work platform, the bridge also carries an oil distribution system designed to lay down carefully controlled volumes of oil at rates up to 50 gallons per minute at known, discrete widths immediately ahead of the test object. This system permits the test tank to be operated in winds up to 20 mph, a feature which greatly increases facility usability. The system is self-calibrating, temperature controlled, and provided with a means of rapidly changing test oils without cross contamination.

Oil is controlled on the tank surfaces by a bubbler system which helps keep the oil away from the walls, beach, and wave flaps and which keeps spent test oil stored on the water surface. The system consists of a blower supplying air to perforated plastic pipe fixed to the tank bottom. The escaping, rising air bubbles entrain water and generate a surface water current flowing toward the center of the tank. This current overcomes oil spreading forces and oil movements due to winds.

At the end of each test run, spent test oil is moved by a skimming bar (which can be lowered from the bridge) into an area ringed by bubbles and held there during successive tests. When the test series is completed, the oil is guided to a weir by surface currents generated by the bubbler system and water streams from hand-held fire hoses. The weir leads to settling and separation tanks. After a suitable period, the oil is pumped off and reused for further tests. The water is passed through the main filter, which removes any remaining oil, and is then returned to the tank.

The water treatment system is critical to the operation of the test facility. When the test tank is filled with Sandy Hook Bay estuarine water, the incoming water is filtered to remove the majority of living organisms (such as barnacle larvae) and the large quantity of suspended sediments. Cleaning oil off smooth tank walls is laborious enough, but removing it from barnacle-covered walls would be worse. Water clarity is essential when using underwater photographic and video-type equipment. The pressure-leaf type, diatomaceous earth filter system operates semiautomatically and has no side streams; the sole products are filtered water which is returned to the test tank and spent filter aid which is removed to a state-approved landfill. When the main tank has to be emptied back into Sandy Hook Bay for the winter maintenance period, the entire tank contents are recirculated through the filter until all applicable discharge standards are met. System efficiency is such that oil-in-water content can be reduced to about half a part per million with no difficulty. During normal operations, tank water is also recirculated through the system to help maintain clarity. A hypochlorite generator adds chlorine to the filtered water which keeps algae and bacteria under control while leaving no long-lived, toxic residue in the water.

A control building at one end of the tank houses bridge and wave generator controls, video monitoring and control equipment, and electrical power and control equipment. A 7,000-square-foot support building contains offices for the ten-man full-time operating crew and for any visiting test personnel, a quality control laboratory, a small wood, metal, and plastics shop, a small electronic shop, and a high-bay equipment preparation and assembly area.

Brief history

OHMSETT construction began in April 1972. Owing first to modifications and improvements initiated after that date, and then to strikes by truckers and suppliers, acceptance testing of the major systems was not completed until early August 1974, about a year later than first projected. Originally, 90 days was to have been scheduled for shakedown, but the first outside user, the U.S. Coast Guard, was already on site in July and anxious to test during good weather. A further startup complication resulted from the Coast Guard's need to deploy test oil at a rate of about 2,000 gpm which is 40 times the design flow of the bridge oil distribution system. A suitable, high-volume system was designed, fabricated, and used before the original one was even tested with oil and prior to the completion of construction of the facility. Needless to say, during those weeks when acceptance tests, startup, facility construction, facility modification, and actual testing were carried out concurrently, OHMSETT was a busy place. In general, all problems were solved and the first series of tests were completed satisfactorily and on time through the devotion, technical know-how and long hours of hard work by the several groups involved.

The U.S. Coast Guard left OHMSETT by the end of September. Since then, systems startup and shakedown have proceeded, construction is reaching completion, and preparations for the U.S. Environmental Protection Agency evaluation of certain classes of commercially available equipment for inland spill cleanup is proceeding.

Major findings

Major findings of the first six months of operation include the following:

a. wave generator: exceeds design specifications; simulates (full-scale) rough harbor, estuarine, and up to mild oceanic conditions
b. wave absorbing beach: after being modified by the addition of 10 vertical, parallel layers of polyethylene netting extending to the tank bottom, absorbs satisfactorily almost all wave lengths up to 80 ft
c. high-volume oil distribution and recovery system: fabricated and used successfully in wind speeds up to 20 mph; system is supported by 2 tank trucks running on the roadway paralleling the tank (synchronization of the trucks with the bridge can be successfully accomplished); extends test oil volume flow (both discharge and recovery) to include the range from 175 to 2,000 gpm; intermediate system, 50 to 200 gpm, is being fabricated
d. polyethylene tank liner: used successfully to prevent oiling of tank walls prior to startup of bubbler system (despite some occasional rips)
e. bubbler system: successfully keeps spent test oil away from walls, beach, and wave generator; reduces cleanup time by 80% (to 2 hr/day); can hold spent test oil trapped in a bubble-generated convergence zone in winds up to 20 mph and in most waves that can be made in the tank
f. filter system: reduces oil in water to about 0.5 ppm; clarifies water so that naked eye can clearly see over 65 feet underwater
g. #2 fuel oil: mixes down into tank water and triggers bacterial growth, which drastically reduces visibility (filter can clarify water again in time); various bactericides are being investigated for suitability
h. hypochlorite generator: generates chlorine from tank water (and eliminates need to handle and store this substance which has come into short supply); chlorine greatly reduces tank fouling and algae water-clarity and wall-coating problems; chlorine flashes off to air in a short time (leaving no long-term toxic residual to cause problems if tank should have to be drained on an emergency basis)
i. fluid quality: constantly monitored by on-site laboratory (on a grab sample basis)
j. oil and water are treated and recycled, oil is sent out for dehydration
k. OHMSETT facility is eminently usable even in these very early stages; design and construction are a success.

Outlook for future

A definite desire to use the OHMSETT facility for testing and evaluating oil spill cleanup equipment has been demonstrated by the U.S. Coast Guard and the U.S. Navy, not to mention the U.S. Environmental Protection Agency. Such usage may be expected to continue at a high level by these and others. Additionally hazardous materials spill cleanup equipment will soon be tested and will probably dominate the OHMSETT schedule after a few years. The design of OHMSETT took this expected trend into account, and plans are underway to refine the capabilities of the facility to help advance hazardous material spills cleanup technology.

Summary

The U.S. Environmental Protection Agency designed and built OHMSETT in Leonardo, New Jersey, to fulfill a specific need. The facility gives every evidence of continuing to be able to meet that need for the foreseeable future. OHMSETT does indeed provide an environmentally safe place to evaluate and improve methods and full-scale equipment for cleaning up spills of oils and hazardous materials in inland, estuarine and calm offshore waters.