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Boom Vane™ Field Tests

Interim Report
January 2000

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N O T I C E

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16. Abstract (MAXIMUM 200 WORDS)

This report describes the evaluation of a new piece of oil pollution equipment called the Boom Vane™ in Martha's Vineyard and New York harbor. The equipment is designed to hold boom out in fast currents to recover oil without the use of heavy anchoring equipment. It was shown to be effective in a previous test on the Columbia River. This was the first attempt at using the Boom Vane™ in tidal estuaries. It was also deployed from two vessels as a possible replacement for the outriggers needed to hold boom away from the side of the vessel in Vessel of Opportunity Skimming Systems (VOSS).

The Boom Vane™ does not appear to be useful in tidal estuaries when currents are not steady and uniform. The equipment can be used for parts of a tidal cycle but eddies and interrupted flow caused by changing tides prevent the equipment from being effective throughout the cycle. It still could be used on vessels larger than 50 feet, although a small outrigger boom may still be needed to control the system when a vessel turns. Recommendations are provided for use of this equipment on vessels or in areas with non-uniform current flow.

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All of the participants contributed to the success of these tests. Special thanks to Mr. John Joe Dec of the First Coast Guard District who arranged and helped to organize the exercises. Also thanks to the Coast Guard participants who supplied personnel and assistance including the Marine Safety Field Office, Cape Cod, Activities New York, and the Atlantic Strike Team. Special thanks to Aids to Navigation Team Woods Hole for personnel and a utility boat. Finally, thank you to Mr. Ralph Packer of Vineyard Haven and Mr. Dennis McCarthy of Clean Harbors Cooperative for providing vessels, equipment and personnel.

EXECUTIVE SUMMARY

Even though 70 percent of the oil transported on U.S. waterways is in currents that routinely exceed one knot, very little research and product development has been conducted on new technologies and strategies to respond to oil spills in currents from one to five knots. Oil spills in fast-moving water above one knot are difficult to control and recover due to the ease at which oil mixes with water and entrains under booms and skimmers. Fast currents also make deploying equipment and maneuvering on the water very difficult and dangerous due to the high forces exerted on boats and recovery equipment. A lack of effective fast-water containment and recovery systems, and limited training and experience in these difficult and dangerous response conditions, have hampered response efforts in rivers and coastal areas.

The goal of the U.S. Coast Guard (USCG) Research & Development Center (RDC) Project, "Innovative Response Techniques (Fast-Water Containment)," is to improve the fast-water containment and recovery capabilities for both the Coast Guard and commercial response firms. The first part of this project reviewed existing technology that is documented in the report, "Control of Oil Spills in Fast Water Currents, A Technology Assessment," (Coe, Gurr, 1999). Recommendations included the evaluation of several systems in field demonstrations. The first field tests occurred in March 1999, on the Columbia River that defines the border between Oregon and Washington, and included the Boom Vane™ (Patent Pending) manufactured by ORC of Sweden. This report documents the field tests of the Boom Vane™ that continued in Martha's Vineyard, Massachusetts, and in New York Harbor to evaluate its use in tidal conditions. The Boom Vane™ design is based on the trawl doors used by fishermen. It uses the hydrodynamic force of the passing current to pull the boom away from the shore and out into the middle of a waterway. The Boom Vane™ is designed to replace the heavy anchoring equipment that is now used to hold booms out in the current and can be used in two modes. The recovery mode deflects oil into the shore for cleanup, and the deflection mode moves the oil out into the current and away from sensitive areas.

In Martha's Vineyard, the equipment was deployed during the evaluation of a contingency plan exercise to protect a local pond. About 150 feet of boom was successfully deployed on the flood tide using the Boom Vane™. There were three deployments in New York. The first evaluated the Boom Vane™ as a replacement for outrigger booms that are used for Vessel of Opportunity Skimming Systems (VOSS). The system appears to work on vessels larger than about 50 feet, but a small outrigger may still be needed to control the system during vessel maneuvers. The deployment of the equipment in a deflection mode was not successful due to the lack of sufficient current. The deployment in the East River was in the recovery mode with about three knots of current. After some initial deployment problems, the Boom Vane™ was used to hold 350 feet of boom in a "J" configuration.

The Boom Vane™ can be used in tidal estuaries when the currents are strong (greater than one knot) and consistent. Recommendations are provided for the use of the Boom Vane™ in tidal conditions in the future.

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1.0 INTRODUCTION

1.1 Background

Oil spills in fast moving water above one knot are difficult to control and recover due to the ease at which oil mixes with water and entrains under booms and skimmers. Fast currents also make deploying equipment and maneuvering on the water very difficult and dangerous due to the high forces exerted on boats and recovery equipment. A lack of effective fast water containment and recovery systems, mooring problems, and limited training and experience in these difficult and dangerous response conditions have hampered response efforts in currents on rivers and coastal areas. Even though 70 percent of the oil transported on U.S. waterways are in currents that routinely exceed one knot, very little research and product development has been conducted on new technologies and strategies to respond to oil spills in currents from one to six knots.

The Coast Guard (CG) Research & Development Center (RDC) is performing the project Innovative Response Techniques (Fast-Water Containment). The goal of this effort is to improve the fast-water containment and recovery capabilities for both the Coast Guard and commercial response firms. The first part of the project was a review of existing technology that is documented in the report, Control of Oil Spills in Fast Water Currents, A Technology Assessment, (Coe, Gurr, 1999). Recommendations included the evaluation of several systems in field demonstrations and at the Minerals Management Service's OHMSETT Facility. The first field demonstration occurred on the Columbia River in March 1999, and is documented in a separate report (Hansen, 1999). Participants at the field demonstration were very enthusiastic about the potential for the use of the Boom Vane™ to replace conventional anchoring techniques. This report describes demonstrations of the Boom Vane™ at two locations in the Northeast, Martha's Vineyard and New York Harbor.

1.2 Objectives

The objective of this test was to evaluate the performance of the Boom Vane™ in tidal estuaries. This equipment is manufactured by ORC of Sweden and has only been used in fast flowing rivers. Performance parameters generally include usability, survivability and compatibility with other systems.

1.3 Participating Organizations

The groups that participated in the tests are:

- **USCG Research and Development Center:** provided the Boom Vane and documentation for the tests.
- **Coast Guard District One:** Mr. J.J. Dec (m) sponsored the exercises by contacting CG offices. He also attended the exercise to observe and provide input to deployment plans.

- **USCG Marine Safety Field Office (MSFO) Cape Cod**: provided personnel to direct and help with boom handling.
- **Packer Fuel Oil:** Provided 1200 feet of boom and personnel to launch and recover it. Also arranged for meeting space for debriefing meeting.
- **Activities New York:** Arranged for Clean Harbors to provide personnel and vessels for New York exercise and observed the exercise.
- **Atlantic Strike team**: Participated at New York exercise and provided documentation support
- **Aids to Navigation Team (ANT) Woods Hole**: Provided a 21-foot utility boat to transport the equipment and handle the booms in Vineyard Haven.
- **Clean Harbors Cooperative:** Provided boom, vessels and personnel for the New York exercise.
- **Other Participants/Observers:** Various state, commercial and government observers listed in Appendix A.

1.4 General Description of Activities

There were several general objectives for these exercises. The major objective for the Martha's Vineyard exercise was to evaluate the current contingency plan for the opening to Lagoon Pond. This pond is a sensitive area that contains a lobster hatchery and is a prime scallop bed. The main oil receiving and storage facility for the island is located about one-half mile southwest of this opening. Winds and tidal currents would push any oil that escapes from the facility into the pond. The movement of the oil could be by wind or currents so conditions must be continuously monitored. The second objective was to evaluate the Boom Vane™. The equipment was deployed in a diversion configuration to collect any oil that may leak past the primary boom. For the New York exercises, the Boom Vane was tested in a recovery mode, a deflection mode and from a small boat and medium sized vessel in a Vessel of Opportunity (VOSS) mode.

1.5 Available Equipment

- **USCG MSFO Cape Cod:** Provided chest waders for personnel.

- **The R&D Center:** Supplied a video camera and digital camera for documenting the tests. A current meter on a 15-foot pole was available for the test in New York.

- **CG District one:** Supplied a digital camera and rice hulls. The rice hulls were used to simulate oil and were deployed from the small boat in the areas where oil would be expected to move. Details concerning their deployment are contained in a Guide that is shown in Appendix B.

- **Packer Fuel Oil:** Provided oil boom that is stored in a trailer at Tisbury dock in Vineyard Haven. The boom was a fence type and was 18 inches high. Equipment also included a small boat and beach anchoring equipment.

- **Activities New York**: Supplied survival suits.

1.5.6 Clean Harbors: Several response vessels with personnel and harbor boom.

2.0 BOOM VANE DESCRIPTION

A current rudder has been developed in Sweden based on the trawl doors that fishermen use. It uses the hydrodynamic forces of the passing current to pull a boom away from shore and out into the current. The current rudder is positioned in the water so that the paravanes are parallel to the current or angled into the shore. The downstream end of the boom is moored to shore or to an inline skimmer as desired. Only a few degrees of angle toward the opposite bank are required to move the boom across the river. When vessel traffic needs to pass or large debris floats downstream, the boom can be quickly retrieved to shore by one person by changing the paravane angle of attack to point toward the near shore. After vessel passage, the boom can be easily deployed back out into the channel.

The rudder concept was refined and further developed by ORC of Sweden and the patent approval is pending. This newer system (see Figures 1 and 2) was evaluated during tests on the Columbia River and is called the Boom Vane™. It weighs about 25 pounds and is about 4.5 feet long. Note that multiple curved vanes are used to increase the area that is impacted by the current. There is a stabilizing fin that can be seen in the rear view. This model has a simpler control system having either a deployed or a stalled mode. To bring the system into the shore, only one control line is needed to pull on the tail and reorient the vanes to a neutral angle that does not permit the individual vanes to exert a force. The vane can then easily be pulled in. It can be deployed in deflection or recovery modes (see Figure 3). The control line is always attached to the vane but is not shown in the Figure.

Figure 1. Front view of Boom Vane.

Figure 2. Rear View of Boom Vane.

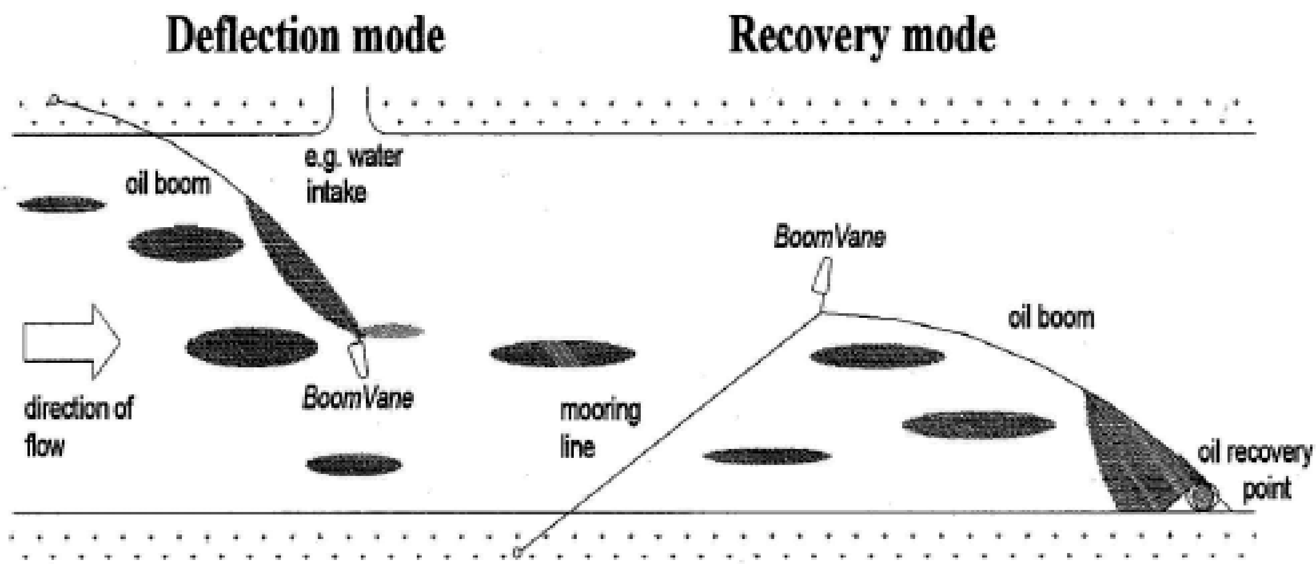

Figure 3. Boom Vane Deployment Modes

The standard method of launching is to deploy from the shore. First, the entire system including the boom and mooring line is laid out along the shore. One end of the boom is attached to the vane and its trailing edge fastened to something on the shore. The boom vane is pushed out into the current. Once out into the current, the vane will easily pull the remaining boom off the beach. The mooring line length can be adjusted to obtain a good shape of the boom.

3.0 MARTHA'S VINEYARD EXERCISES

Lagoon Pond is a very sensitive area that is crucial to Martha's Vineyard. It has a large scallop population that is worth about $1 million per year, and a lobster hatchery. Any introduction of oil into the pond will have serious consequences for the island's economy.

3.1 Schedule of Events

October 5, PM: Boom Vane™ was checked out at Group Woods Hole
October 6: 0530 Participants took ferry from Woods Hole to Vineyard Haven. ATON Vessel departs Group Woods Hole to transport Boom Vane™
0800: Begin Deployment of Equipment.
1100: Recovered equipment
1300: Debriefing meeting in Vineyard Haven
1500: Return to Woods Hole

3.2 Vineyard Haven Harbor

Lagoon Pond connects through a narrow opening about 100-125' wide to Vineyard Haven Harbor. A wooden drawbridge spans the opening (see Figure 4). Wooden dolphins are connected between the pilings to prevent vessels from leaving the channel. The oil storage/transfer facility is located about 1/2 mile down Beach Road and can be seen on the right side of Figure 5. The predominant wind is usually out of the Southwest, which will push oil originating from the main harbor into the pond. An ebb tide may also increase the flow of oil along the shore, parallel to Beach Road towards the inlet.

Figure 4. Beach Road Bridge.

Figure 5. View to Southeast along Beach.

Any oil that is deflected past the entrance could end up on the beach or breakwater north of the opening. Oil could be reintroduced to the inlet on the next flood tide if the currents move it off the breakwater or beach.

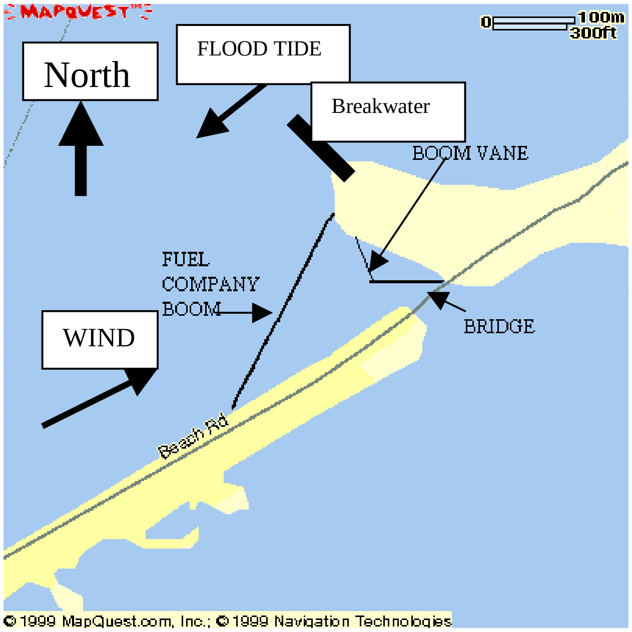

Figure 6. Entrance to Lagoon Pond.

The current contingency plan for this inlet consists of laying boom across the pilings of the bridge. Booms cannot contain oil in the expected 2 knots of current in the channel during a flood tide. An alternative is to place a longer boom (see Figure 6) that spans a larger portion of the opening. The objective is to have the boom encounter the oil further out; an arrangement that is more tangential to the prevailing winds and currents. This exercise tested this new approach.

3.3 Tidal Cycles

The high and low tides for this area on October 6 are shown below.

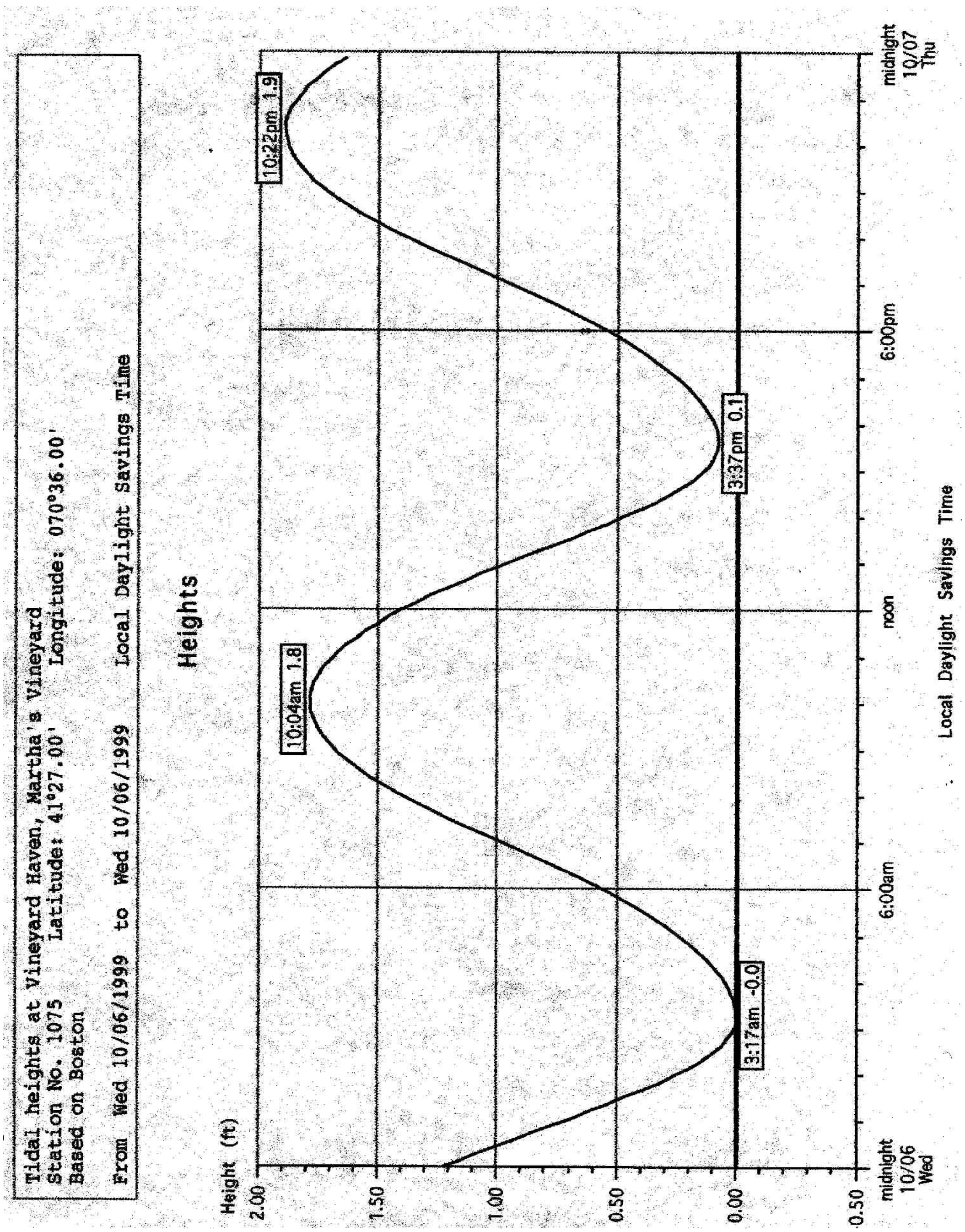

Figure 7. Tidal Schedule for Vineyard Haven.

3.4 Equipment Evaluation

Evaluation of the equipment began with the delivery of the Boom Vane™ by the 21-foot utility boat manned by the Aids to Navigation team (ANT) Woods Hole (Figure 8). The vane was set up on the beach along with 200 feet of boom. The initial deployment consisted of 1000 feet of boom connecting the two beaches on either side of the opening. Deployment of the boom was directly off the trailer (see Figure 9). The Boom Vane™ was deployed on the north side of the channel to utilize the force of the current and was positioned to catch oil that might migrate along the north side of the opening. Some problems were encountered in getting the Boom Vane™ deployed. Right at the shoreline, the current was estimated to be less than 1/4 knot so the Vane could not generate sufficient force to pull the boom out. The shallow water required that personnel wade out and push it into the current. Currents about 50 feet from shore were estimated at about one knot.

Figure 8. Boom Vane™ being delivered by 21-foot utility boat.

It was noted that the wind was out of the Northeast, opposite the normal direction. The main boom was tightened to obtain the correct angle with respect to the wind and current. The shape can be seen in Figure 10. Rice hulls were thrown into the water and the boom generally kept them out of the channel. The boom was moved on several occasions so that local fisherman could pass through. Some of the rice hulls were blown to the beach due to the opening of the channel for these boats. No rice hulls reached the boom that was connected to the Boom Vane™. The final shape of this boom is shown in Figure 11. About 150 feet of boom was in the water. Note the shallow angle that has the capability of deflecting oil.

Figure 9. Setup of equipment on shore.

Figure 10. View of main boom.

Figure 11. Final configuration of boom and Boom Vane™.

4.0 NEW YORK HARBOR

Locations were chosen around the harbor so that several response options could be evaluated. The Pralls Island site was chosen to evaluate the use of the Vane in a deflection mode. The East River site was chosen to evaluate the containment/recovery configuration. Both of these sites have oil storage or transfer facilities located nearby.

4.1 Schedule of Activities

October 25, PM: checked out Boom Vane™ pierside at Clean Harbors Headquarters

October 26:
- 0800 Participants meet at Staten Island Marina to board vessels
- 0900: Began deployment of equipment from 33-foot response vessel
- 1100: Deploy equipment from MV Samantha Miller oil response vessel (65 foot)
- 1300: Debriefing meeting at Marina

October 27:
- 0800 Participants meet at Staten Island Marina to board vessels for Pralls Island
- 0900: Begin Deployment of Equipment
- 1400: Recover equipment
- 1500: Debriefing meeting in at Marina

October 28:
- 0800 Participants meet at Staten Island Marina to board vessels for Roosevelt Island in the East River
- 0900: Began Deployment of Equipment
- 1000: Change equipment setting to adjust for ebb tide
- 1500: Recover equipment
- 1600: Debriefing meeting in at Marina

4.2 Vessel of Opportunity Evaluation

Evaluation of the Boom Vane™ for use by vessels of opportunity was the first task. This gave Clean Harbors Cooperative (CHC) personnel the opportunity to become familiar with the equipment before deploying in more complex configurations. The system was taken aboard a 34-foot LORI skimmer (see Figure 12). This skimmer has an open deck and doors at the waterline on the portside that opened to a rope mop skimmer. It also had a bow ramp and a small davit for handling equipment over the side. The normal configuration includes an outrigger with a short section (20 feet) of boom that diverts the oil to the rope mop. The objective of this test was to see if the Boom Vane™ can replace the outrigger. The resulting configuration can be seen in figures 13 and 14.

It was difficult for the operator to maintain a steady course and speed with the system deployed. The current was moving about 1.5 knots and a brisk wind was blowing across the waterway. For each course change, the Boom Vane™ moved with respect to the vessel, either closing or opening the pocket. After multiple attempts at maintaining

Figure 12**.** LORI Skimming Vessel.

Figure 13. Boom configuration viewed from the bow.

Figure 14. Boom configuration viewed from the stern.

course and speed the boat was tied to the pier on the port side with the system deployed out in the current. This stabilized the system. A representative of Millar's Launch offered the 65-foot M/V Samantha Miller. The Boom Vane was transferred and the system was deployed using 50 feet of boom with the vessel initially tied to the dock. This configuration (see Figure 15) worked better, especially when the towline was moved to an opening in the bow. This permitted the vane to ride further out from the vessel and towards the bow. The vessel then got underway to evaluate the system. The larger boat was able to maintain a steady course and speed with no noticeable impact on the maneuvering capabilities. Vessel speed was approximately 1.5 knots with the system exposed to 2.5 knots in turns.

Figure 15. System deployed from the 65-foot Samantha Miller.

4.3 Site 2: Pralls Island

This site is a sensitive area with a marsh and a side stream (see Figures 16 and 17). Permanently moored buoys have been placed at this location. The Boom Vane™ was evaluated in the deflection mode as a replacement for the buoys.

Figure 16. Pralls Island Opening.

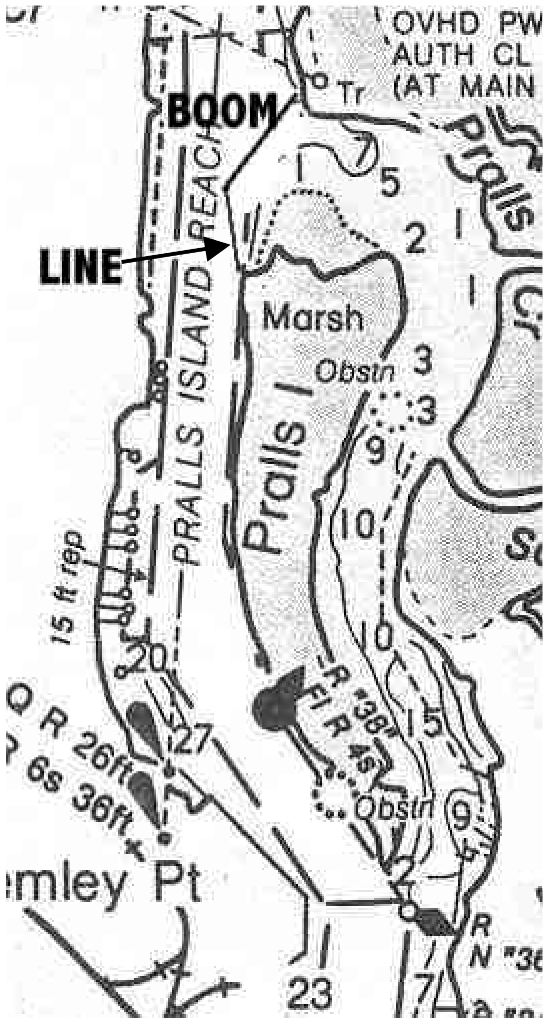

Figure 17. Chart of Pralls Island Reach.

4.3.1 Equipment Evaluation

The vessels arrived on the site and began deployment of the boom. Four hundred feet of 36-inch boom was deployed and one end was tied to a tree. The Boom Vane was launched from the bow of the vessel. After waiting for the boom to be pulled out, it was determined that the time was too close to slack tide so the current was too weak. After a wait of about one-hour, several attempts failed to pull the vane out into the current. Current speeds close to shore were not more that 1/2 knot. With the weaker currents, the Boom Vane was able to hold 200 feet of boom about 50 feet off shore (see Figure 18).

When reviewing the chart (see Figure 17), the main channel is almost on the other side of the reach. This is where the highest currents would normally be located but the vane could not be pulled over that far. The current is also reduced because the river widens at this point. The vane does not appear to be useful in this situation.

Figure 18. Boom Vane™ deployed off Pralls Island.

4.4 Roosevelt Island

The site is at Ravenswood, across the East River from Manhatten and Roosevelt Island, a city park with easy access to the river (see Figures 19 and 20). A containment/recovery arrangement was placed at this location for the flood tide that moves towards the upper right-hand corner of Figure 19.

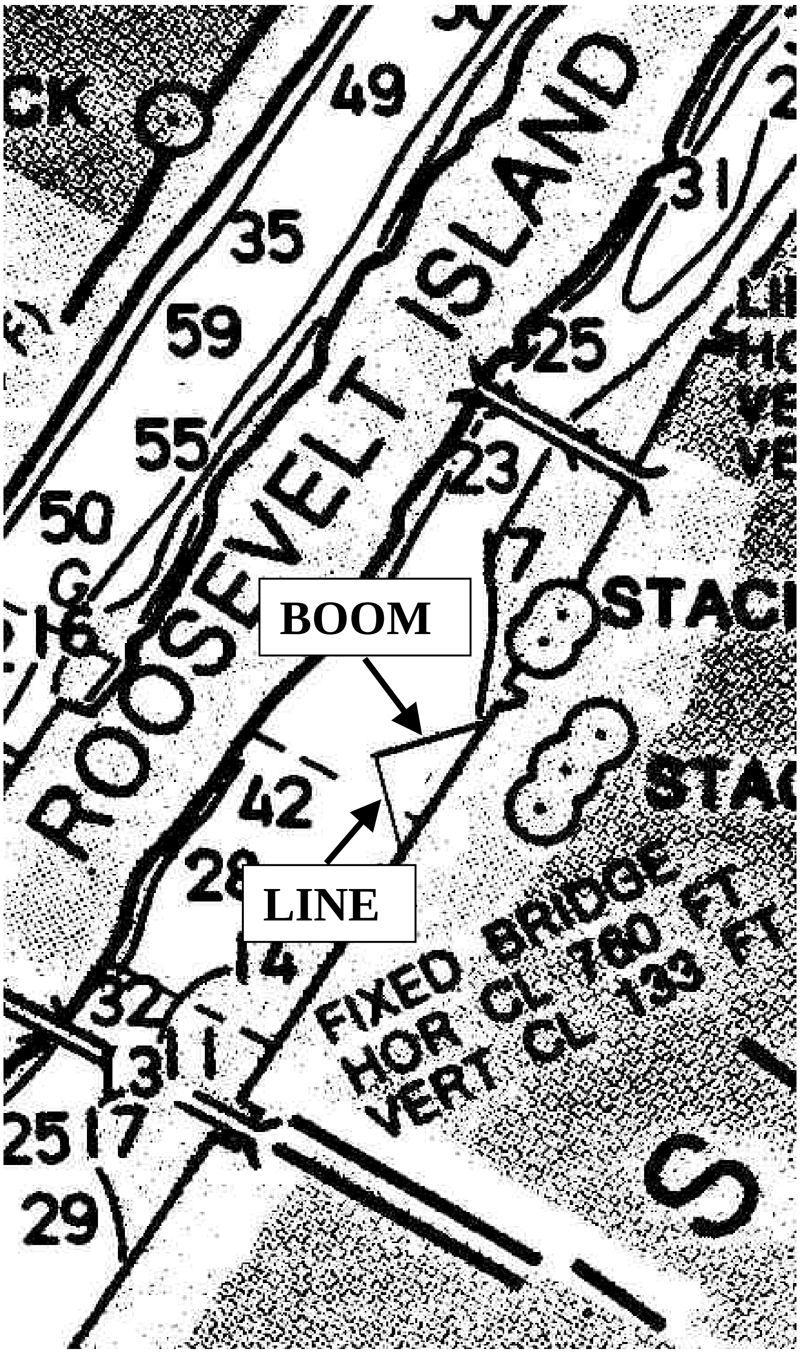

Figure 19. Roosevelt Island.

Figure 20. Roosevelt Island Deployment Site.

4.4.1 Equipment Evaluation

The deployment consisted of 350 feet of 36-inch boom arranged in a containment configuration to capture oil on a flood tide. Currents were estimated to be running about 3 knots in the middle of the channel. This is a deeper boom that wasn't recommended for this system in these conditions. Problems were encountered when deploying the Boom Vane™ from the vessel. In an attempt to stay clear of the oil boom itself, the vane was deployed on the shore side of the boat. As a result the vane hit the vessel as the current forced the vane out towards the center of the river. Other problems arose when the mooring line detached on the first deployment. The configuration was then set with the oil boom in a "J" configuration, not the recommended method of using the Boom Vane™. This arrangement increases the load on the Boom Vane™. Additional oil boom was added to form a collection pocket. (see Figure 21). The collection pocket was formed to protect the shoreline from the oil that was being diverted. This is not the recommended method of deployment. A pocket is not shown in Figure 2 because the Boom Vane ™ is not designed to handle the extra drag that a pocketed boom creates. In addition, the apex of the pocketed boom was pulled away from the shore by the current. This does not permit skimmers to operate from the shore. A better arrangement would have been to use a completely separate section of boom along the shore. The final arrangement is seen in Figure 22.

Figure 21. Boom Deployed in East River.

Figure 22. Final Deployment of Boom Vane™.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Evaluation of the Boom Vane™ has provided a large amount of information concerning its operation from vessels and in tidal estuaries. Additional training is needed before the equipment is deployed in the field.

5.1 Use on Vessels

The design of the vane causes it to maintain a specific angle of the towline with respect to the current. In these tests the angle averaged about 35 degrees.

> **Recommendation**: Consideration must be given to ensure that a sufficient lead length is available that places the vane in the correct position. For example, on the 65-foot vessel, the towline was tied off about 50 feet forward of the desired vane position.

Smaller vessels may have difficulty in maintaining a steady pocket.

> **Recommendation:** Vessels larger than 50 feet or smaller ones with sufficient steering capability (such as twin screws) should be used. A lightweight outrigger could be integrated into a system to stabilize the system during maneuvering.

Handling the Boom Vane™ with the towline and boom attached can be difficult and dangerous.

> **Recommendation**: Use of a crane, winch or lifting davit is recommended for vessels with a freeboard more than a couple of feet. The lifting hardware should be strengthened to handle rougher conditions that are usually encountered during an actual spill.

5.2 Use in Tidal Estuaries

The Boom Vane™ was designed for steady and consistent river flow. Estuaries provide a dynamic condition that changes frequently and may not be consistent with each tidal cycle. Many of the recommendations provide some measures to counteract these inconsistencies.

> **Recommendation**: Local conditions must be analyzed before any deployment. Use of tables for maximum current should only be used when the exact location of that maximum with respect to the shore is known. Whenever possible, the actual current should be measured. Planning should also include an analysis of the conditions and duration of slack water. About 20-30 minutes should be allowed to change the configuration of a system. This time may be reduced if two complete sets of booms and towlines are available and placed in advance so that only the vane needs to be transferred.

The performance of a system is dependent upon the amount and draft of the boom being used.

> **Recommendation**: The length of boom should be the minimum amount need to perform the required function. In addition, a boom with a six-inch draft should be used to minimize the forces exerted. This will permit the vane to perform better in lower currents.

In areas where the current near the shore is low, additional methods may be needed to get the vane into a stronger current.

> **Recommendation**: Personnel with waders may be needed in shallow areas. A small work boat can be used to tow the system further out into the current. In addition, the distance between the Boom Vane™ and boom can be increased to expose the vane to the stronger currents by adding line between them. One problem this may cause is that in some locations the oil follows the faster current. By placing the vane on an extra line, and in the middle of the river, the actual position of the boom would be too close to the shore to stop the oil. One alternative is to deflect the oil out into the fast current and use another system on the opposite shore to recover the oil. This arrangement might be useful at a site like Pralls Island.

Deployment of the system from the shore is preferred but vessels can be used.

> **Recommendation**: The deployment should occur as follows:
> A) Locate the up current anchoring location
> B) Continue up current and place the boom into the water.
> C) Secure the boom end, transfer control lines ashore making sure they are under positive control.
> D) Deploy the remainder of the equipment including the vane.
> E) Once the system is afloat, use the anchor and control lines to set the proper configuration.
> F) The deploying vessel should be careful in not getting trapped between the vane and the current. For a vessel with a bow ramp, the best deployment method is to back the boat into the current when launching the vane from the bow. This reduces the chance of the boat getting tangled in the rigging or mooring line.

The configuration of the system is crucial to the success of recovery or deflection.

> **Recommendation**: Use of the vane in specific locations should be tested in the field. This ensures that the correct amount of towline and boom is available. Tie points and recovery locations should also be identified in advance.

Additional Recommendations:

> A) Care should be taken with the control line. In high currents, the booms move quickly so the operator must have the line free in order to react.

B) Set the end of the boom in the recovery mode at a location that is accessible to a skimmer. Floating skimmers can be placed in the pocket. Anchoring the pocket will permit access by tanks or vacuum trucks on shore.
C) The hardware for lifting needs to be strengthened.

Overall, the Boom Vane™ did not have impressive performance over the several days of evaluation. It was the consensus of the participants that it would not make a useful addition to the NSF or MSO response equipment inventory at this time. The D1 DRAT intends to conduct further tests as time permits in narrow waterways with higher currents.

6.0 REFERENCES

Coe, T., Gurr, B. (1999, May). Control of Oil Spills in Fast Water Currents, A Technology Assessment, Report (CG -D-18-99).

Hansen, K. (1999, September). Columbia River Fast Water Tests.

Appendix A: Participants

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Appendix B: Rice Hull Deployment Procedures

1. One hundred ponds of rice hulls will be used during this testing. Not all of the rice hulls need to be used. If it looks like 50 lbs. is enough to simulate an oil slick then more will not be added.
2. They will be deployed form a nearby boat or onshore. Because the rice hulls are very light and can be blown around by a very light breeze they should be deployed near the water surface by hand.
3. A small amount should be deployed (approximately one bucket) to determine whether they will move in to the boomed off area before going into Lagoon Pond. If the wind will not cooperate or there is negligible current the decision therefore should be made not to use the rice hulls. If however, the wind and current does move the rice hulls to the boomed area the rice hulls will be used.
4. The rice hulls should be deployed in a manner that will allow them to spread out over the water surface. This means one should not dump the entire bag at once but broadcast by hand over several minutes. Remember we are trying to simulate oil.
5. Pool skimmers, garbage bags, and garbage cans can be used to aid in the recovery of the rice hulls when they have collected in boom or in natural collection areas.
6. After testing all recovered rice hulls will be taken offshore and slowly broadcasted