THE CONTRIBUTION OF AIR CUSHIONED VEHICLES IN OIL SPILL RESPONSE[1]

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ABSTRACT: *On July 22, 1991, the* Tuo Hai, *a 46,500 ton Chinese grain carrier, collided with the* Tenyo Maru, *a 4,800 ton Japanese fish processing ship, off the coast of Washington State. The* Tenyo Maru *sank, creating an oil spill that cost upwards of $4 million (U.S.) to clean up. The incident initiated a joint response from the U.S. and Canadian governments. As part of this response, the Canadian Coast Guard mobilized an SRN-6 hovercraft. This air cushioned vehicle (ACV) provided logistical support to responders on both sides of the international boundary.*

The response operation along the Pacific Coast was extensive. Dense fog and the remote location of the impacted area provided formidable challenges to the cleanup effort. It was the mission scenario of the Canadian SRN-6 hovercraft to provide logistical support—as an experiment in ACV utility—to the organizations responding to this incident. Based on this experience, it can be argued that the hovercraft offers great potential value in responding to marine oil spills. Appropriate application of ACV technology can enhance oil spill response work, spill waste management, and incident surveillance.

This paper discusses the contribution of the SRN-6 hovercraft to the Tenyo Maru *response, briefly examines the use of another, very different hovercraft, during a response in the Gulf of St. Lawrence, and reviews a new hovercraft design and discusses its potential contributions.*

The approach to the entrance of the Straits of Juan de Fuca is a busy shipping lane. Deep-draft vessels from the world over converge here on their voyages to U.S. ports in the Puget Sound region and to Canadian ports in the Straits of Georgia region. A sizable foreign-flag factory trawler fleet operates offshore, in addition to many smaller Canadian and U.S. fishing vessels.

Dense fog blanketed the Pacific Coast on the morning of July 22, 1991. A halibut fishing season opening drew a large number of small vessels to the ocean, cluttering radar displays with many targets. At 6:49 a.m., the 610 foot Chinese grain carrier, *Tuo Hai*, struck the *Tenyo Maru* almost amidships. In fewer than 10 minutes, the *Tenyo Maru* sank in international waters. Fuel from the sunken vessel began escaping immediately.

The *Tenyo Maru*, a 365 foot Japanese fish-factory ship, carried over 364,000 gallons of fuel. Of that amount, approximately 273,000 gallons was No. 6 intermediate fuel oil and the balance was No. 2 diesel oil. As the ship sank to a depth of 510 feet, many of its fuel tanks were imploded by the pressure. Estimates of the spill ranged from 60,000 to 100,000 gallons. Large patches of oil migrated from the source, 22.5 nautical miles offshore, to as far south as the Columbia River. After assessing the environmental risk to the area, the Canadian Coast Guard invoked the Canadian-U.S. Joint Marine Pollution Contingency Plan to organize a joint response. Offshore skimming operations were launched within two days of the sinking. Seasonal southerly ocean currents and northwesterly winds spared the Canadian shoreline from impact but, instead, directed the slick to the American side. Seven days after the collision, oil washed ashore on Washington beaches.

Geography of the impacted area and the response effort

Few areas of the world remain as unspoiled as the coast of Washington. A large percentage of this remote territory is protected under the United States' Wilderness Act. The principle trustees of the land are the National Park Service and various Native American tribes. Only a small portion of the shoreline is visible from public access roads. Indeed, those wishing to experience the coast must hike Olympic National Park or tribal beaches. Motor vehicles and aircraft landings are normally prohibited on Park Service beaches.

This area of the Pacific coast is biologically rich. Summer months represent the height of the reproductive cycle. Fish, sea birds, and sea mammals converge on these fertile waters to raise their young as they have done for centuries. Species such as bald eagles, rhino auklets, common murres, tufted puffins, sea otters, whales, and spawning salmon congregate here. Any source of pollution contacting this area is bound to affect a wide spectrum of natural resources.

A number of organizations were charged with managing the *Tenyo Maru* incident. With the *Tenyo Maru* sinking in the Canadian Economic Zone, the Joint Contingency Plan required the operation on-scene coordinator (OSC) designate be a Canadian Coast Guard officer. The deputy OSC was provided by the U.S. Coast Guard. Acting as trustees for the impacted U.S. lands were the National Park Service and the Makah Indian tribe. Interfacing with this structure were a number of state, provincial, and federal agencies, environmental groups, and remediation contractors. The potentially responsible par-

1. The opinions expressed here are the views of the authors and not the official views of Global Environmental, Inc., or the Canadian Coast Guard.

ties, each from a different nation, were legally represented by private attorneys.

Response efforts can be divided into three arenas: offshore skimming activities, beach cleanup, and salvage lightering. The local oil spill cooperatives of Clean Sound (U.S.) and Burrard Clean (Canadian) were contracted to provide equipment to conduct and support offshore skimming operations. Under the supervision of the U.S. Coast Guard, private contractors were hired to engage in beach cleanup. Finally, the Canadian Coast Guard undertook the task of pumping oil from the wreck and removing that oil from the scene. The majority of response activities took place from July 22, 1991, through August 31, 1991.

Mission of the SRN-6 hovercraft

The Canadian Coast Guard Environmental Response branch assembled an incident control team to manage a large group of personnel and resources to contribute to the containment, recovery, and cleanup of the oil associated with the *Tenyo Maru* casualty. As part of the Canadian Coast Guard team, an SRN-6 hovercraft was assigned to a broad, multitask mission.

Hovercraft are high speed, amphibious vehicles that utilize a fan-generated cushion of air to reduce surface friction. They are capable of operating over water, ice, and land. This SRN-6 hovercraft was built by the British Hovercraft Corporation. The craft is 48 feet long and 25 feet wide. It is capable of operating at full power for up to 10 hours while carrying an 8,800 pound payload. Normal cruising speed is between 30 and 40 knots, but the machine can operate at a top speed of 60 knots during favorable weather conditions.

On July 29, 1991, the CCG Base-Sea Island deployed their standby ACV to make a 150-mile trip to the Ucluelet, British Columbia Command Center. Hovercraft *086* arrived there in 5 hours, with a cargo of pollution control equipment.

On the morning of July 30, 1991, the Canadian on-scene commander (OSC) held a briefing for the ACV group at the Ucluelet Command Center (UCC). At this briefing, the OSC assigned the following objectives to the ACV crew:

- Pollution surveillance—from Port Renfrew to Estevan Point (Figure 1)
- Transportation—move personnel and equipment as required
- Investigation—check all beaches and shorelines in subject area for oil and wildlife impact
- Reporting—regularly advise UCC of results and be prepared to receive new orders hourly
- Community relations—visits to involved communities, and liaison with contract workers
- International liaison—provide transportation of personnel and equipment to U.S. Coast Guard Group/Neah Bay, and assist their objectives in the Cape Flattery area as required by UCC
- Wreck site contact—provide an available method of moving goods and key personnel to the collision site at all times
- Zero visibility operations—throughout periods of reduced visibility and dark hours, the hovercraft is to deliver all of the above tasked objectives
- Search and rescue—provide increased search and rescue (SAR) coverage to the affected area, and SAR protection to personnel and equipment within the spill cleanup operation
- Interdepartmental liaison and assistance—assist personnel from various agencies during the course of coastal surveillance sorties

Some 110 nautical miles separate Estevan Point and Port Renfrew on the west coast of Vancouver Island. Between these two areas are fully 600 nautical miles of shoreline and beaches: all of it within potential reach of oil from the *Tenyo Maru*. Through the two week assignment, the hovercraft patrol led the full range of coastline, covering 2,145 nautical miles—with emphasis on the environmentally sensitive beaches of the Broken Island group, West Coast Trail, Carmanah, Hesquiat, and Flores Island.

The results of the OSC's specific objectives are outlined in the following summary.

- Surveillance, investigation, and reporting: Daily patrolling of the coastal areas between Port Renfrew and Estevan Point was conducted. Numerous landings on remote and otherwise inaccessible beaches were completed. Spill response personnel were able to inspect the shoreline first hand for signs of oil and habitat impact. Reports of oil sightings from aircraft were routinely checked; from higher altitudes sea weed was sometimes identified as a slick; these reports were quickly checked, cancelled, or confirmed.
- Transportation and interdepartmental liaison: Throughout the 15-day operation, the hovercraft transported 48 different passengers representing a dozen organizations working on the *Tenyo Maru* incident. A variety of equipment was transferred to Canadian Coast Guard ships due, in part, to restricted visibility and space constraints aboard helicopters.
- Wreck-site contact and zero-visibility operations: Routine trips to the wreck site (25 nautical miles WNW of Cape Flattery) were made throughout the assignment. When extensive fog prohibited helicopters from flying, a number of transfers to ships were made by hovercraft. The average transit time from the Ucluelet Command Center to the wreck site was 1.1 hours (distance of 35 nautical miles). Hovercraft operations were not hampered by poor visibility, though crusing speeds were reduced to 30 knots in areas of less than quarter-mile visiblity.
- International and community liaison: In conjunction with OSC daily tasking, ACV crews provided static displays and demonstrations to the public. Much public support for CCG operations seemed to be gained through this effort. On the international front, two working trips were made to the U.S. Command Center at Neah Bay, Washington. U.S. Coast Guard personnel and cleanup crews were transferred to a number of beaches and bird rookeries in the Tatoosh Island area.
- Search and rescue: The hovercraft responded to seven distress calls during its two week deployment. The incidents ranged from medical evacuations to a fishing vessel lost in the fog in heavy weather on the rocks off Ucluelet. The hovercraft was also used to assist CCG ships with the transport of sick and injured where fog made evacuation by helicopter impossible.

Analysis of beach cleanup operations

The governing factor in conducting beach cleanup operations on this spill was the extreme inaccessibility of the sites. Oil from the *Tenyo Maru* made landfalls at dozens of isolated locations along a 50-mile stretch. Beaches composed of rock, sand, and cobble were separated from one another by rugged headlands. As the spill evolved, shoreline impacts varied from tide cycle to tide cycle. Crews maintained a constant shuttle following oil to newly impacted beaches.

Approximately 70 workers were dedicated to beach operations. Beach access by road to National Park lands simply did not exist. Very limited road access was available to some tribal-land beaches. Access to beaches from the water (through landing craft or small boats) was impractical due to reefs and breaking surf. Support of beach cleanup operations was therefore achieved through the use of seven helicopters. Overhanging trees, small beach frontages, and narrow openings in "pocket" beaches made the Hughes 500 and the Bell 206 the aircraft of choice.

The objective of the beach cleanup operation was to minimize environmental impact by quickly removing oil from the beach. Contaminated soils were collected in one-man-managable plastic spill bags. Snare booms were used to protect unimpacted areas from contamination as well as to passively scrub oiled cobbles clean. Disposal was initiated by shuttling segregated materials to interim collection points, then later airlifting those items to off-site collection grounds. Wildlife rescue sorties were conducted twice daily.

These incident objectives were, for the most part, accomplished through the use of helicopters. The helicopters used a common, highway-accessible landing zone along the Waatch River. This landing zone served as a staging area for personnel and equipment—but not as an off-site disposal area.

Though proven in past incidents, and certainly successful in this one, the helicopters possessed limiting factors. Dense fog habitually dogged the *Tenyo Maru* beach cleanup operation. Safety restrictions, brought about by this reduced visibility, often limited the number of airborne helicopters. Logistical efficiency was severely hampered when periods of reduced visibility would coincide with periods of peak activity. An example would be crew dispatch on foggy mornings. Safe air operations dictated the use of only two helicopters. At the beginning of the

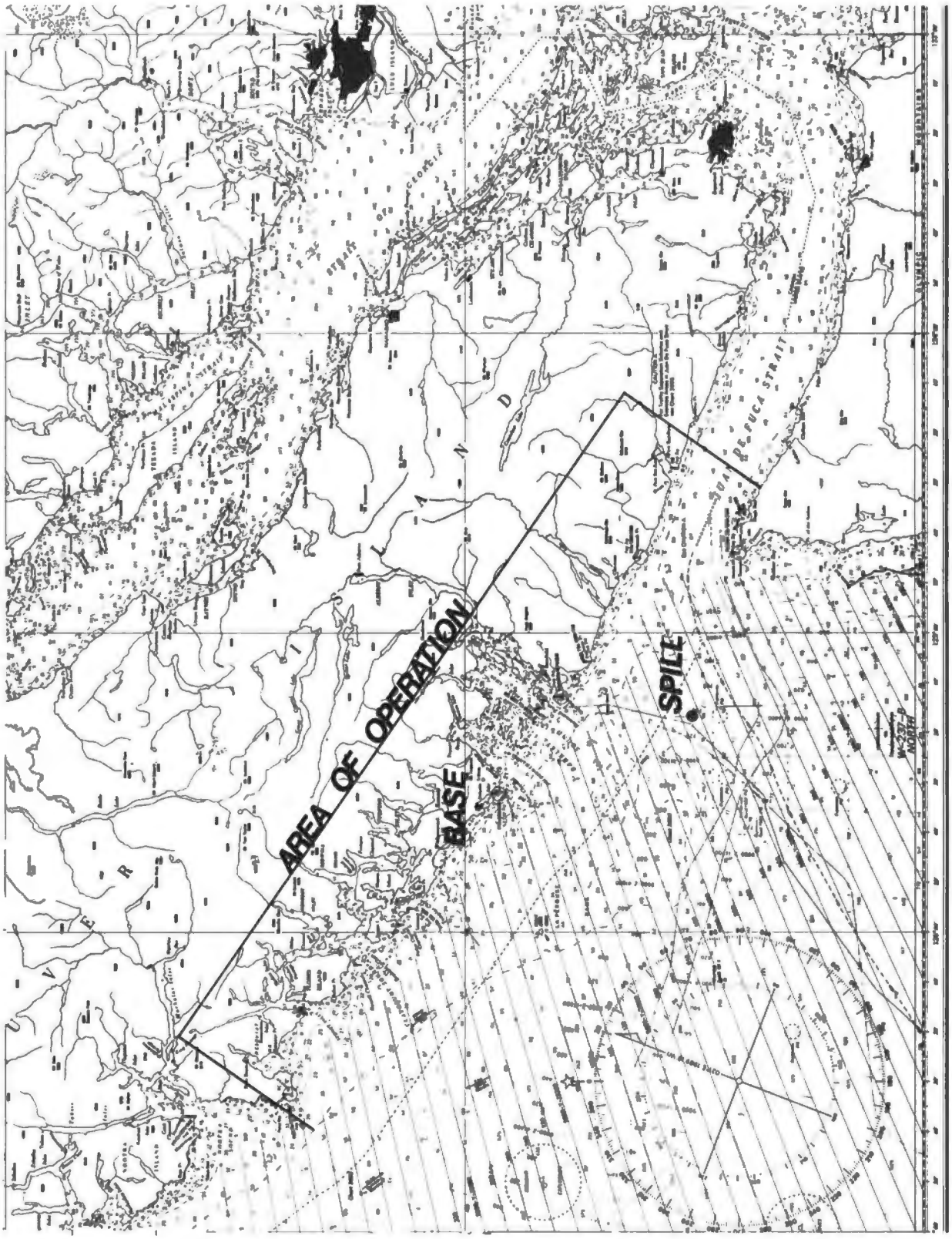

Figure 1. This chart shows the area of operation of Hovercraft *086* during the *Tenyo Maru* incident. The vessel patroled 650 nautical miles of Canadian coastline, and supported American cleanup crews in the Cape Flattery area.

workday, as many as 70 people would be airlifted a distance of up to 30 miles, three or four individuals at a time. Under these circumstances, dependency on air logistics reduced the efficiency of the cleanup operation.

Two air-logistic items bear additional examination here. Those items are payload and the distance flown between job sites. The Hughes 500 and Bell 206 have an upper payload range of 1,300 pounds. Thus, many sorties were needed to accomplish the tasks outlined for beach cleanup. In disposal operations alone, the *Tenyo Maru* incident generated 1,004,000 pounds of contaminated soils, 180 cubic yards of spent sorbent materials, and 4,500 wildlife carcasses. All of these materials were removed from the beach by small-payload helicopters. In an effort to improve the efficiency of the air logistics, it became critical to reduce the distances flown. Suitable hub landing zones—ones that were central to the spill site yet accessible to supply lines—had to be chosen. Logic dictates that the farther the helicopter flys to a job site, the more fuel it consumes and the faster the ship approaches its mandatory maintenance down time. The more fuel and hours a small-payload vehicle like the helicopter burns between landing points, the more inefficient it becomes as a source of logistical support.

Operational performance of the SRN-6 hovercraft

During the period that the SRN-6 hovercraft was assigned to the *Tenyo Maru* incident, two working trips were made to the U.S. cleanup sites. The purpose of these trips was to evaluate the potential air cushioned vehicles offer in supporting an oil spill response. Though configured primarily for search and rescue missions, the SRN-6 provided valuable lessons in the utility of ACVs over other modes of logistical support in coastal oil spill response operations.

Departing from the U.S. Command Center at Neah Bay, Washington, the SRN-6 conducted surveillance on beaches, kelp beds, rookeries, and tidal pocket beaches. Landfalls, for inspection purposes, were made at Tatoosh Island and Titacoclos Falls Beach. The craft was dynamically held on station while observers departed to inspect the marine mammal rookery islands in the Tatoosh Island vicinity (Figure 2). Breaking surf usually makes these small islands inaccessible by boat. Pocket beaches, such as Hole-In-The-Wall Beach on the Pacific Ocean side, were visually inspected from the hovercraft. These tiny beaches, surrounded on three sides by sheer rock bluffs, are also rarely accessible by boat and represent a high-risk mission for a helicopter.

Two response crews, working on the Straits of Juan de Fuca, were supported from the SRN-6. One crew was harvesting oil contaminated kelp from small skiffs. The other crew was conducting traditional beach cleanup operations on First Beach of the Makah Tribal Lands. The SRN-6 successfully maneuvered bow on to the beam of the skiffs and dynamically held position while personnel and supplies were transferred. At this point, the craft actively demonstrated that it could safely support vessels ranging in size from the 272-foot CCG buoy tender *Martha L. Black*, working offshore at the wreck site, to a tiny 14-foot inflatable skiff working in shallow water, just off the beach. The beach cleanup crews were supported by making a landfall on First Beach to transport personnel and supplies (Figure 3).

To U.S. cleanup crews operating on the ocean beaches during the *Tenyo Maru* incident, use of the SRN-6 was only an experiment. Yet one cannot help but superimpose the positive results of that experiment on the traditional air logistic means of supporting oil spill cleanup operations on sensitive beaches, shores, and tidal flats. In a 30-day period, 485 air hours were logged in multiple helicopters transporting personnel three or four at a time. During that same time period, 101 helicopter air hours were logged in external-load waste disposal operations. It should be noted for future spills, that access to a high payload, all weather capable ACV can significantly improve logistical efficiency over the current standard.

Figure 2. Hovercraft *086* holds position while scientists inspect the marine mammal rookeries off Tatoosh Island during the *Tenyo Maru* spill.

Figure 3. Cleanup crews working on First Beach during the *Tenyo Maru* spill are supported here by Hovercraft *086*.

Responders on land, sea, and air were all challenged here by the same weather patterns. Predominant weather conditions were thick fog, moderate seas with swells to 7 feet, and westerly winds to 20 knots. As near-zero visibility conditions terminated air operations, the SRN-6 hovercraft was able to make an average speed of 34 knots without being adversely affected by the ground swell. Surf conditions, to a maximum of eight feet, were negotiated by the hovercraft. It should be noted that the steepness and width of the exposed beach beyond the surfline is a key factor in the degree of difficulty of the landing. Sufficient room has to exist to allow the craft to decelerate and land. In numerous areas, breaking seas were tempered by shoals and kelp beds, affording easier landing zones behind these natural breakwaters. On departure into surf, the wave impact was avoided by timing the departure and leaving at a 45° angle.

In terms of sea-keeping and weather limits, the hovercraft performed beyond the requirements of the pollution operations group. Beach cleanup operations are effectively unsafe for shore workers at about the same point where ACV access to those beaches becomes unacceptable. The zero visibility capability of the ACV allowed it to shuttle people and equipment to and from beaches and ships on several days when air operations were not possible.

In adverse weather conditions, such as strong winds and poor visibility, which limit the use of helicopters, the hovercraft successfully completed the safe transport of personnel and equipment, and conducted surveillance. In reasonable weather conditions, relatively large numbers of personnel and quantities of pollution countermeasures equipment were transported at three to four times the speed of conventional surface craft. This extra speed and cargo carrying capacity considerably enhanced cleanup operations on vast, rugged shorelines that were largely accessible only by helicopters.

Looking at another ACV-assisted spill response

As beach responders during the *Tenyo Maru* incident, we learned from the SRN-6 experiment that the hovercraft is the only amphibious vehicle capable of hauling tremendous loads at high speeds in zero visibility conditions. Its amphibious nature enables the hovercraft to make complete use of its radar by eliminating concern over water depth. The gas turbine driven SRN-6 can deliver a payload of 8,000 pounds for an operating cost of $479 (U.S.) per full power hour. In placing that payload on the beach, the hovercraft will only make an imprint of 26 pounds per square foot, less than the impression a person makes.

The Canadian Coast Guard has experienced similar positive results with hovercraft technology in other oil pollution control assignments.

Figure 4. The hydraulic crane and well deck design of the *Waban Aki* enable the craft to support a broad range of response activities.

Figure 5. The *Waban Aki* loads contaminated soil at a remote location during the *Rio Orinoco* incident in the Gulf of St. Lawrence.

An ACV of a different design was used during their response to the *Rio Orinoco* incident in the Gulf of St. Lawrence. In late October of 1990, the *Rio Orinoco*, an asphalt-carrying tanker, was driven aground on Anticosti Island after mechanical problems shut down her main engine. Though the cargo tanks remained intact, the grounding punctured the ship's fuel tanks. Spilled bunker fuel contaminated 20 miles of beaches on the island.

Striking similarities exist between geography encountered in the *Tenyo Maru* cleanup and that encountered in the *Rio Orinoco* incident. Like the Washington Coast, Anticosti Island lies in the path of busy shipping lanes. The island itself is a remote, sparsely populated, 120 mile long wilderness area owned by the provincial government. Strong winds, high energy seas, and shoal waters make this a treacherous area to support a beach cleanup operation conventionally.

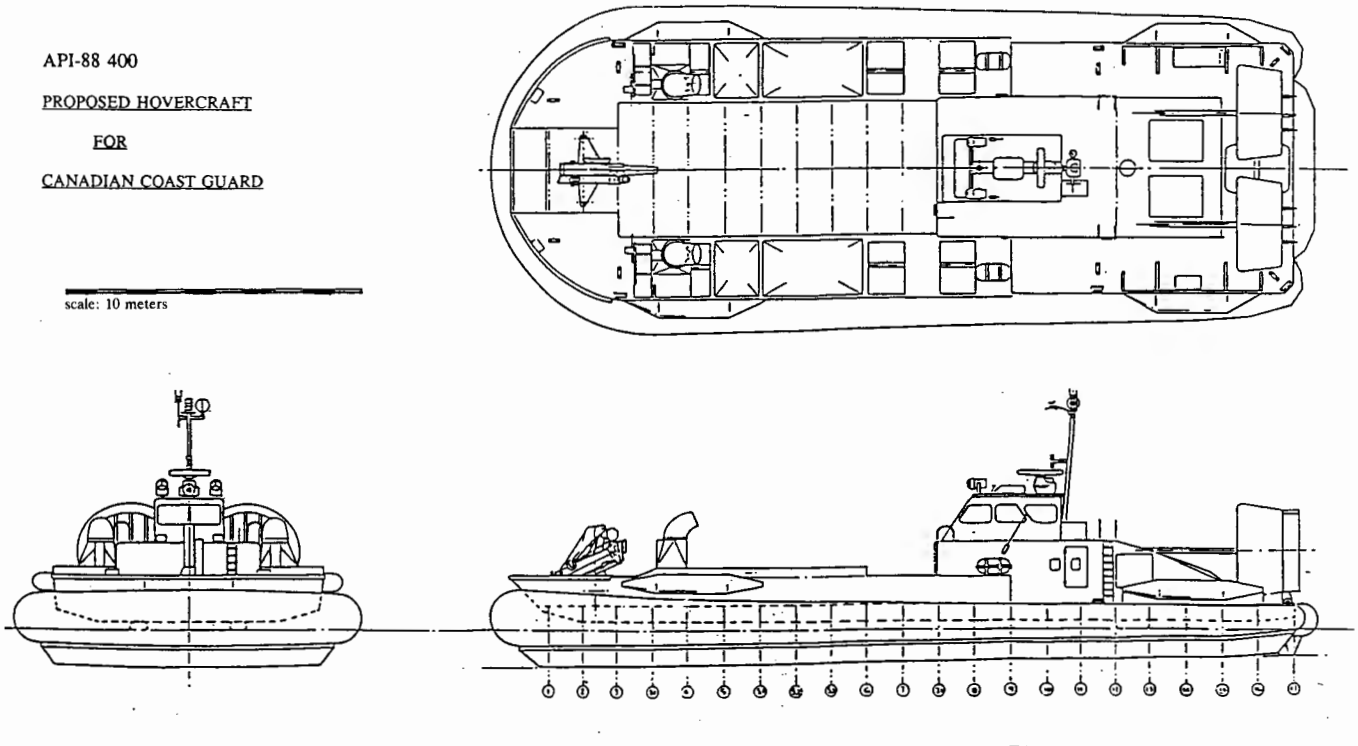

Figure 6. This line drawing depicts the proposed AP 1-88.400 hovercraft of which the *Waban Aki* was the prototype.

Speedy logistic support was needed to increase efficiency in the *Rio Orinoco* response before snow and seasonally progressively shorter days terminated the cleanup operation.

To assist the oil spill and salvage response, the Canadian Coast Guard deployed their hovercraft, *Waban Aki*. The *Waban Aki* is a modified British Hovercraft Corporation AP 1-88.250 hovercraft. It is 80 feet long with a 36 foot beam. Unlike the SRN-6 hovercraft, the *Waban Aki* is of well deck design with a bow ramp and a detachable hydraulic crane (Figure 4). The size and the well deck design enable the vehicle to carry a 22,000 pound payload at an average cruising speed of 35 knots.

Prior to the arrival of the *Waban Aki*, cleanup crew deployment with boats, helicopters, and all-terrain vehicles had taken up to four hours. Replacing these conventional methods of logistical support with the hovercraft enabled the Canadian Coast Guard to transport, in a single trip, all 87 *Rio Orinoco* responders. Transit time, including stops at four different work sites, was under one hour. The hovercraft utilized its amphibious capabilities on days when sea conditions were extremely rough by shifting its operations to cruising over tidal flats. In addition to transporting beach personnel, the *Waban Aki* deployed containment boom, removed 764,000 pounds of contaminated soils from the beach, and ferried personnel and equipment to the grounded ship (Figure 5). These tasks were accomplished regardless of visibility conditions.

Conclusion

As of this writing, the Canadian Coast Guard is in the design phase of a newly modified British Hovercraft Corporation AP 1-88 of which the *Waban Aki* was the prototype. Unlike the SRN-6, which was configured for search and rescue, the new craft, designated AP 1-88.400, will be of well deck construction for maximum cargo handling capability (Figure 6). With a proposed length of 95 feet and a width of 38 feet, the new generation hovercraft will be able to carry a payload of 40,000 pounds at a cruising speed of 50 knots. Diesel, instead of gas turbine, power will significantly lower operating costs to $300 (U.S.) per full power hour.

The well deck design of the new vehicle offers maximum utility as a response platform. It would provide responders with a high-speed means of delivering 20,000 feet of containment boom, or associated equipment to a casualty. In remote location cleanups, such as the *Tenyo Maru* or the *Rio Orinoco* incidents, it would allow for the cost-effective removal of contaminated material in bulk from the most inaccessible of locations. These features, combined with the hovercraft's inherent all-weather operating capabilities, offer incident managers one of the most versatile resources in coastal and inland response operations today.