Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

MARINE INVESTIGATION REPORT
M99W0116

STRIKING

CANADIAN COAST GUARD HOVERCRAFT "SIYAY"
STEVESTON JETTY, SOUTH ARM OF THE FRASER RIVER, BRITISH COLUMBIA
15 JULY 1999

Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Marine Investigation Report

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Summary

While on a search and rescue mission on the south arm of the Fraser River, the Canadian Coast Guard hovercraft "SIYAY" struck a rock breakwater on the west side of a gap in the jetty. There were no serious injuries as a result of this occurrence, but the craft sustained significant damage.

Ce rapport est également disponible en français.

Other Factual Information

	"SIYAY"
Official Number	AP1-88/402
Port of Registry	Ottawa, Ontario
Flag	Canada
Type	Hovercraft AP1-88/400
Registered Tonnage	70 000 kg
Length	28.5 m
Draught	1.4-m cushion
Built	1998, GKN Westland Aerospace
Propulsion	Four Caterpillar 3412 TTA turbo-charged engines: two engines rated at 671 kW provide lift and two engines rated at 738 kW provide propulsion. Two 2.7-m diameter four-blade Hoffman variable-pitch propellers operating in ducts. 3779 horsepower (2818 kW)
Crew Members	4
Passengers	None
Registered Owner	Fisheries and Oceans Canada, Canadian Coast Guard

Description of the Craft

The “SIYAY” was built in 1998 by GKN Westland Aerospace (sub-contracted to Hike Metal Products Limited, Wheatley, Ontario) for the Canadian Coast Guard (CCG).

The AP1-88/400 is a hovercraft, which travels on a fan-generated cushion of air, with propulsion provided by two variable-pitch propellers. The hovercraft is equipped with a removable crane (not on board at the time of the occurrence) and has a payload of up to 25 000 kg, allowing for great flexibility for transporting a combination of freight and passengers. Vehicles can be loaded directly on deck through a bow ramp. These features, as well as being fully amphibious, make the AP1-88/400 particularly useful in oil pollution clean-up operations and other applications, including search and rescue (SAR) and aids to navigation maintenance and construction.

The control cabin of the “SIYAY”, similar in design to that of an aircraft, is near the after end of the craft (see Figure 1). The design allows for an excellent view forward, with the exception of

Figure 1. The “SIYAY”.

the bow thruster vents to port and starboard at the forward end of the craft, which cause blind sectors. Operationally these blind sectors are overcome by the craft captain and port seat occupant exchanging information as targets move from one sector to the other.

The control cabin consists of four seats, two forward and two aft. Manoeuvring- and navigation-related instrumentation is arrayed across the fore part of the control cabin, below the windows (see Figure 2). Dual control levers for the propulsion system are in a centre console between the two forward seats. Dual controls for the bow thrusters are immediately in front of each forward seat. The very high frequency radios are on the centre console, and communication is via headsets. Navigation instrumentation consists of a radar, gyro, global positioning system, and depth finder. An additional radar is in the after part of the control cabin in a position accessible to the port side seat occupant.

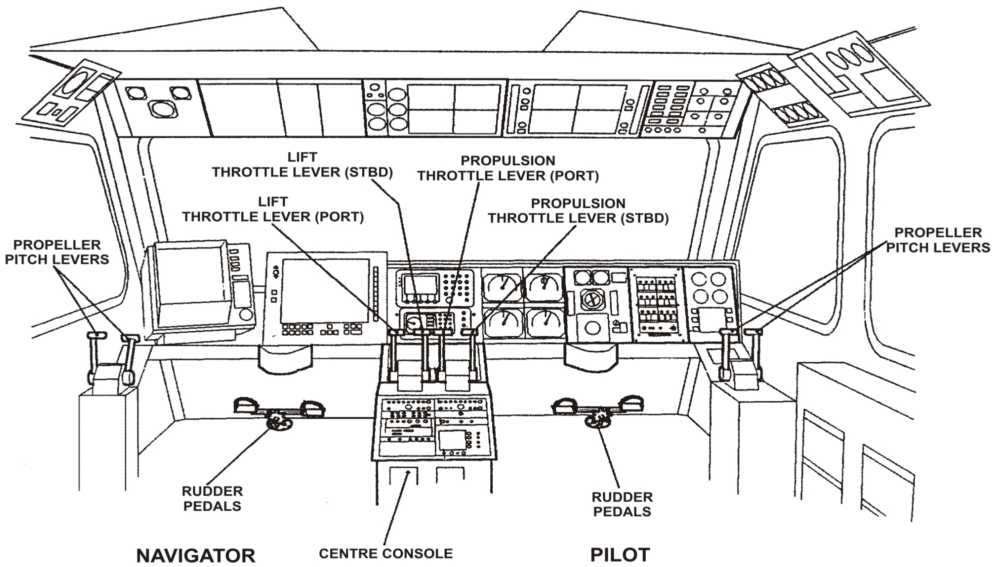

Figure 2. Instrumentation in the fore part of the AI1-88/400 control cabin.

The craft captain normally occupies the starboard forward seat, the navigator the port side forward seat during daylight operations; the two additional crew members occupy the after seats. During night-time operations, the navigator occupies the port after seat.

The distance from the fore part of the control cabin to the bow is 13.1 m and to the stern 15.4 m.

The CCG Sea Island Base in Richmond, British Columbia, had been operating two SRN-6 hovercrafts in continuous SAR service since August 1968 (see Figure 3). In 1993, the CCG identified the need for a hovercraft replacement program for the two SRN-6s at Sea Island Base and recommended the AP1-88, in part because of its multi-mission capabilities.

In 1987, the CCG Laurentian region received an AP1-88/200 series hovercraft (“WABAN AKI”), which has since been in continuous service performing duties in SAR, ice-breaking, oil spills, and servicing and recovering large navigational buoys along the St. Lawrence. The expanded operational capabilities of the AP1-88 units, particularly the servicing and recovering of large navigational buoys is a task normally associated with conventional workboats and CCG ships. The CCG was very satisfied with the performance of the “WABAN AKI”, and the decision to order the larger AP1-88/400 series hovercraft was based largely on the opportunity to enhance operational capability, particularly the ability to carry more and larger buoys. In April 1998, the Laurentian region received the AP1-88/400 “SIPU MUIN”, followed by delivery of the sistership “SIYAY” to the Western Region in November 1998.

Figure 3. The Canadian Coast Guard's SRN-6 hovercraft.

History of the Voyage

The "SIYAY" departed Sea Island Base on the evening of 14 July 1999, for patrol and training exercises. The crew configuration consisted of the craft captain seated at the controls on the starboard side and the lookout occupying the forward port seat position in the control cabin. The first officer (navigator) and a SAR specialist were seated on the port and starboard after seats, respectively. At 2330 Pacific daylight time, the crew received a call from the Victoria Rescue Co-ordination Centre (RCC), just as they had completed night-time beach landing exercises on Shingles Point, Valdes Island, which is on the west side of the Strait of Georgia, some 16 miles from the entrance of the Fraser River at Sand Heads (see Appendix A).

The crew was instructed by the RCC to search for a pleasure craft reported to be aground 0.25 miles southwest (downstream) of Steveston, on the south arm of the Fraser River. The "SIYAY" entered the Fraser River via Sand Heads at 2400, on the south side of the Steveston Jetty. Heading towards Steveston, they searched the area along the jetty using their searchlight. They were later informed by RCC that the craft was on the north side of the jetty, whereupon the craft captain turned the craft around, heading westward along the jetty wall. The jetty wall contained a number of gaps, and the craft captain decided to attempt passing through one of these gaps located between beacons nos. 7 and 7A, to reach the north side as quickly as possible. An alternative was to navigate around Sand Heads, which would have taken several extra minutes.

The crew located a gap in the jetty using radar, lined up the craft with the aid of light buoy No. S6, and then proceeded toward the gap on a visual approach. The pilot was operating the starboard searchlight, maintaining focus on the east end of the gap, while the lookout used the port searchlight to maintain reference to the west side of the gap. As the craft captain approached the gap, he lost visual reference to the east side, and consequently became concerned about where the craft was in relation to the gap. The craft captain attempted to rotate his searchlight to illuminate the west side of the gap, but in doing so, the searchlight lit up the bow thruster vents, making visual reference even more difficult. At this point,, the craft captain reduced speed and attempted to steer using the compass. The reduced speed resulted in greater spray, which created a large amount of visual clutter because it was illuminated by the searchlight. The poor visibility made attempts at reestablishing visual contact with the gap even more difficult. The crew reported feeling the craft move sideways as the bow passed through the gap, immediately followed by the port side of the craft contacting the west side of the jetty. Time of contact was estimated to be 0019, on 15 July 1999. The craft returned to base unassisted.

Injuries to Persons

No one was seriously injured.

Damage

Approximately 6.5 m^2 of hull plating and internal framing (between frames 7.1 and 12) sustained damage on the port side of the craft. Damage to the starboard side consisted of a crack at the T-section of extrusion at frame 11. The aft landing pad debris guard on both sides of the craft was damaged. Extensive damage was sustained by the cushion skirt on the port side of the craft. There was no pollution as a result of the occurrence.

Personnel Certification and Experience

There were four crew members on board the “SIYAY”. The craft captain held a CCG Watch Keeping Mates (WKM) Certificate of competency. He joined the CCG hovercraft unit in 1980, serving as first officer until 1983 after which he served as pilot.[1] He has operated SRN-5 and SRN-6 hovercrafts during this period; training on the AP1-88/400 beginning in 1999. The pilot had successfully performed a practical examination in the operation of the craft in the presence of Transport Canada, Marine Safety (TCMS). He had not taken bridge resource management training, which is not mandatory.

The first officer/navigator held a WKM certificate and had one year of experience on hovercrafts. One SAR specialist had six months’ experience on hovercrafts, and the other SAR specialist/lookout had one month’s experience.

Craft Certification

The craft was inspected in accordance with Transport Canada (TC) requirements. It operated with an Air Cushion Vehicle Safety Certificate - Special, issued by TCMS, in Vancouver on 15 February 1999.

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[1] The term “pilot” is used in CCG hovercraft operations to refer to the individual controlling the craft. In practice, it is usually the craft captain or first officer.

Environmental Considerations

Visibility was good, with winds from the east at 12 knots. The river current was estimated at 3 to 5 knots in a west-southwesterly direction. The tide was ebbing, with a high water at Steveston predicted to be 4.0 m (13.1 ft.) at 2045, July 14, to a low of 3.1 m (8.5 ft.) at 0120, July 15. The craft struck the jetty approximately one hour before low water.

The 16th edition of *Sailing Directions, British Columbia, South Coast,* has a cautionary note, which reads as follows:

> Steveston Jetty has several gaps in it through which a cross current flows and on ebb tides extremely turbulent water exists in the vicinity of the rock groyne at Steveston Bend.

The gap through which the "SIYAY" attempted to navigate was some three cables west of Steveston Bend.

Duty Times

The Sea Island Hovercraft Unit operated 24 hours a day, 365 days a year. Crews worked on a four-days-on, four-days-off cycle. Days one and two are from 0800 until 1800, and days three and four from 1800 until 0800.

AP1-88 Service Entry Plan

The Sea Island Hovercraft Unit developed a service entry plan for the AP1-88. The last update to the plan prior to the occurrence was in April 1999, to bring the craft into service by 17 May 1999. The plan consisted of five phases, including acceptance of the craft, structural changes required to the craft, regulatory endorsement of type rating, and a wide variety of training requirements to ensure that the AP1-88 service requirement would be met.

The demands on personnel operating high speed craft are well documented by the CCG and the Sea Island Hovercraft Unit. Therefore, a service entry plan for the new generation AP1-88 was developed to phase in the transition period. The last update to the plan prior to the occurrence was in April 1999, to bring the craft into service by 17 May 1999.

The five part plan considered all aspects of operating a large displacement (*all up weight*) hovercraft under the *High Speed Craft Code*, including factors such as craft familiarization, crew fatigue, environmental hazards, craft limitations, and crew complement.

The monitoring program included a feedback mechanism to inform CCG management if the goals and corresponding time lines proved ambitious, or resources became exhausted.

Recommendations from the service entry plan included a communications exchange database for operations personnel receiving training; instrument controls familiarization; customizing manufacturer's operating and machinery manuals; crew recruitment; development of a detailed trials program (program specific); and performance measurement matrix development.

The service plan also identified the need to develop a future task analysis program for enhanced roles within CCG for the AP1-88. However, this activity would not be entertained until the level of service with the AP1-88 (craft and crew performance) met the existing SRN-6 standard.

Ergonomics of the AP1-88/400

During the design stage of the "SIPU MUIN" and "SIYAY", personnel of the CCG Ship Safety Branch (now TCMS) and SAR hovercraft pilots monitored the work, while GKN Westland Aerospace staff acted as project advisors. There were no CCG ergonomic or human factor advisors or programs in place during the acquisition, design, and testing stages.

During the investigation, a number of ergonomic design problems were identified, particularly for SAR night-time operation, including:

- obstructed field of view from the control cabin, caused by the bow thruster vents;
- side windows were not inclined and therefore reflections were problematic at night;
- searchlights were designed for two-handed operation by someone other than the pilot (one hand is required to stabilize the unsecured control unit, while the other hand is needed to operate the joystick);
- some navigation equipment did not allow for individual control of illumination and lighting;
- night-time operation required relocation of navigator from fore to aft of the bridge, because the light from the radar reflected on the control cabin windows affecting the ability to see out of the windows and the crew's night vision;
- light from search beams reflected off the water spray from the bow of the craft,[2] thereby obscuring forward visibility from the bridge at night.

Hovercraft Pilot Training

The pilot is in charge of the craft controls. Prior to acquiring the AP1-88/400, Sea Island Base chartered an AP1-88/300 craft to allow a day of classroom training followed by five hours of practical training, for each captain. Formal training of pilots to operate the AP1-88/400 consisted of a two-week classroom systems course, provided by the manufacturer (Westland) in April 1998. The rest of the training was provided in-house. The west coast hovercraft pilots spent one

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[2] When a hovercraft is under full power and underway, spray is left behind in the wake. However, when a hovercraft stops, spray will be generated if the lift engines are left at high power settings because the cushion air will be forced to escape round the periphery of the skirt. To avoid spray, usually cushion air or lift is reduced when the hovercraft stops. The reduction of lift will allow the skirt to settle on the surface and eliminate spray by creating a seal with the surface.

to two weeks on the "SIPU MUIN" in the Laurentian region. Night operational training on this type of hovercraft was not included in the Laurentian training program, as they do not have personnel highly experienced in night-time hovercraft operations. For training in general hovercraft night operations, the Laurentian region had gone to the west coast region for training (performed on the SRN-6).

The in-house training program for the craft captains learning to operate the AP1-88/400 was relatively unstructured. A training profile had been constructed for each of the craft captains, but adherence to and monitoring of the profile was not consistent. After returning from the one to two weeks of training in the Laurentian region, a Pilot Standards Officer (a pilot from the Laurentian region with experience on the AP1-88/400) was on base to guide training exercises and to provide a "check out" to pilots wishing to attain solo status; however, this was not a dedicated training position. In essence, the west coast craft captains continued to learn how to operate the "SIYAY" on a self-taught, on-the-job-training basis.

No formal assessment of pilot proficiency was conducted on the "SIYAY" for SAR operations.

No periods of time were specifically dedicated to training. Training time was taken on a "time permitting" basis between operational activities.

Concomitant with the west coast pilots learning to operate the AP1-88/400, they were trying to develop a training program for future pilots.

Hovercraft Crew Training

There was no formal training for work on hovercrafts for the rest of the complement of the four-member crew. Training took place on the job and was at the discretion of the craft captain piloting the craft.

The Effect of Staffing Levels on Training

The unit at Sea Island experienced a severe decrease in the number of experienced hovercraft pilots in the three years prior to acquiring the "SIYAY". According to CCG policy, Sea Island should have had 11 pilots and an officer in charge. At the time of the accident, Sea Island was four officers short.

Typically, three years are required to train an officer for the command position of the SRN-6 hovercraft and approximately six to eight months on the SRN-6 for a mate to become first officer.

Minimum new entry requirements for pilots is WKM Certificate of Competency.

A limited number of hovercraft pilots are qualified by the CCG each year. Seven pilots were qualified in 1998, but these pilots were placed on ships rather than the hovercraft unit at Sea Island.

Temporary staffing of hovercraft pilots is rarely possible because of the unique skills required in operating a hovercraft.

Policy Regarding SAR Mission in the AP1-88/400

CCG policy states that if a vessel is operational, it can be tasked by RCC for a SAR mission, although the pilot retains the final decision on whether or not to respond. No formal operational standard was used to determine when a particular crew was deemed "operational". The informal base policy was that craft captains use their own discretion to decide whether to use the AP1-88/400 or the SRN-6 on a SAR mission.

Procedures

An AP1-88/400 procedures manual had not been developed. The AP1-88/400 Hovercraft Type Operating Manual was prepared and issued by GKN Westland Aerospace for training purposes only.

During both training and operations at Sea Island Base, many aspects of operation were left to the discretion of craft captains on duty. Crew members reported observing wide variation among craft captains in the operation of the SRN-6 and the AP1-88/400, and in their teaching of procedures.

Fitness to Work

CCG policy requires that all individuals on medical stress leave comply with a manager's request for a "fitness to work assessment" prior to returning to duties. During the course of the investigation, it was established that one of the crew members had been on stress leave seven months prior to the occurrence, but that the assessment process had not been applied uniformly.

In a TSB investigation of a collision involving a CCG vessel (Report No. M91C2004), the Board identified the lack of a formal mechanism within the CCG to identify and monitor persons who are not medically fit for duty and who occupy safety-sensitive positions, such as ships' officers and pilots. As a result of that investigation, the Board recommended that:

> The Department of Transport, in cooperation with Health Canada and the Canadian Coast Guard, define policies and procedures to ensure that personnel returning to safety-sensitive duties following any medical treatment are fit for those duties.

(M95-05)

As a result, the CCG uses the services of Health Canada's Occupational Health and Safety Agency (OHSA) to assist in setting the criteria for evaluating the health of CCG employees, including fitness to work criteria. The assessments are performed by physicians and occupational health nurses. The purpose of any type of OHSA health assessment is to provide a manager with a means for determining whether an employee is healthy enough to perform optimally and safely, given the demands and risks of the job.

Analysis

The mission of the CCG SAR program is to save and protect lives in the marine environment, and one of the CCG's objectives is to "maintain the highest professional standards". CCG management's goal is to ensure that the SAR program operates at maximum efficiency by adjusting SAR coverage requirements as needs change, and by deploying specialized primary SAR units as required. SAR program management cooperates with other program managers in the deployment of multi-tasked resources in an effort to further enhance response capabilities.

This analysis focuses on the conditions of the occurrence, as well as the decisions and actions made by CCG management and the crew of the craft that resulted in this crew responding to a SAR mission request in the "SIYAY".

Acquisition Process

Replacing the SRN-6 hovercrafts with the multi-mission AP1-88/400s was a strategic decision made to meet the SAR program goals. However, the acquisition process did not fully address mission requirements and expected operational conditions of the primary SAR role at Sea Island Base, namely night-time SAR. The CCG did not consider or require ergonomic principles in the design of the craft, which resulted in significant design limitations.

A fully ergonomically designed ship requires systematic integration of human factors into system design processes. Such an approach requires a specific plan for involving representative personnel responsible for operation and maintenance of the system at the design, development, testing, and commissioning stages working with ergonomic specialists. This type of plan, a Human Engineering Program Plan, serves as a road map for ergonomic design efforts.[3] Such a comprehensive plan contains the following elements (see Appendix A for details):

- Management commitment to the ergonomic function.
- Systems and task analyses to identify and analyze functions to which ergonomic principles are to be applied.
- Ergonomic support of vendors and sub-contractors.
- Ship plan review for ergonomic consideration.
- Document and manual review for ergonomic consideration.
- Documentation of all ergonomic design principles incorporated into the ship's design.

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[3] American Bureau of Shipping, *Guidance Notes on the Application of Ergonomics to Marine Systems*, 1998.

- Ship check during construction to ensure ergonomic recommendations are appropriate.
- Test program to ensure systems were built to ergonomic standards.

Ergonomic Design

The ergonomic design issues identified with respect to SAR operations in the AP1-88/400 are of particular concern given the safety-critical nature of SAR tasks. A number of factors influence the degree of visibility required from the helm:

- task requirements;
- operating speed (e.g. faster speeds require greater visibility for a timely response); and
- location of the lookout (e.g. bridge wing lookouts decrease bridge visibility requirements).

With regard to the AP1-88/400, the task requirements include being able to operate at high speeds and pulling alongside people or boats in the water and on potentially crowded shores, day or night, and in poor visibility. Visibility from the control cabin is therefore a critical factor. The illumination of water spray by the searchlights reportedly caused the pilot to lose visual reference to the shore. Water spray is particularly problematic when the vessel is operating at low speed. Given the existing control cabin configuration of the "SIYAY", operational procedures become an important method of compensating for the visibility limitations created by the design. These policies and procedures were not developed at the time of the occurrence.

Training Program for the AP1-88/400

The differences in size, configuration, and handling characteristics between the SRN-6 and the AP1-88/400 are significant. Thus, the transition from the smaller to the larger craft requires a full training program, developed specifically for the unique operating environment of west coast SAR.

A training program, whether it is initial training, familiarization training, or refresher training, should result in the trainee being able to perform the required tasks to a predetermined, measurable, and demonstrable level of competence. A formal training program did not exist at the CCG, nor were resources dedicated entirely to developing and implementing a training program for the introduction of the AP1-88/400 to Sea Island Base. Training developed for the operational environment of the Laurentian region was being adapted on a trial-and-error basis to address west coast SAR operations. Training design is a critical element of any training program as the training content must be appropriately structured and presented for optimum learning. While the training plan at Sea Island Base demonstrated some aspects of a training program, such as content, methods and strategies to achieve and assess the required level of competence were not in place.

The risk of mishaps was increased by the CCG's decision to train personnel on the AP1-88/400 without the following:

- dedicated resources (e.g. human and time);
- a clearly developed philosophy of operation;
- well-documented and understood policies; and
- standard operating procedures.

Staffing Levels

CCG management recognized the shortage of qualified pilots trained to operate hovercraft. The decrease in the number of such experienced pilots at Sea Island Base during the three years prior to introducing the AP1-88/400 created difficulties in ensuring adequate human resources for maintaining service standards. Unique training requirements of individuals occupying a hovercraft position, as opposed to positions in the general fleet, eliminated the possibility of short-term relief and was compounded by training requirements on the new craft, where workload for staff increased considerably.

While questions were raised about a crew member's fitness for duty seven months before the incident, management was aware of a work assessment, but chose not to undertake it partly as a result of staff workload and an inability to acquire short-term relief.

Tasking craft captains to develop a AP1-88/400 training program and perform normal duties, coupled with chronic under-staffing of qualified pilots at Sea Island Base, represents a risk to the safe operation of the vessel.

Policy on the Use of the AP1-88/400

The AP1-88/400 was being used for training and operational purposes by personnel at various stages of training. Given that there was no formal operational standard for determining when a crew was adequately trained to respond to an operational SAR tasking, the decision rested with the craft pilot, who could not provide an independent assessment of his/her own performance. The absence of a formal operational standard posed a higher risk to persons, equipment, and the environment during SAR operations, as the CCG could not ensure a minimum level of competence of AP1-88/400 crews.

Procedures for the AP1-88/400

In most high-risk operations, procedures are support tools used to ensure safe and predictable operations. The nature of SAR operations requires relying on the knowledge and capabilities of the crews on scene; operations cannot be left up to the whim of the individual. Procedures can be designed to assist the crew by specifying sub-tasks and actions that ensure the primary task at hand will be carried out in an efficient, logical, and error-resistant manner. Standard operating procedures also promote coordination among crews and provide a common ground for crews unfamiliar with others' experience and technical capabilities. In this manner, standard operating procedures set the framework for good bridge resource management; determining individual roles enhances collective knowledge.

The SRN-6 searchlight was designed to be used by the pilot. In contrast, the design of the AP1-88/400 searchlight calls for operation by someone other than the pilot. Standard procedures for operating searchlights had not been implemented, and the craft captain of the "SIYAY" was attempting to operate the starboard searchlight and pilot the craft in demanding conditions.

The craft captain reduced speed and lift when he lost visual reference with the breakwater. However, these actions resulted in greater spray and increased the risk of striking an object underneath the craft. There were no procedures to guide the craft captain in deciding which actions would achieve the desired outcome. This situation illustrates that relying on skills and procedures developed on one type of craft might not be appropriate on another type of craft.

Findings as to Causes and Contributing Factors

1. While attempting to navigate through a gap in the Steveston Jetty, the "SIYAY" contacted the breakwater because the craft captain lost visual reference to the sides of the gap.

2. The pilot's forward visibility was obscured by the bow thrusters and the reflection of the searchlight on the water spray.

Findings as to Risk

1. Ergonomic principles were not fully integrated into the design and acquisition process of the AP1-88/400 craft, resulting in blind spots created by the bow thruster vents which also affected use of the searchlights; high night-time illumination levels in the fore section of the control cabin; and night-time window reflections, which compromise the safe operation of the vessel.

2. Resources devoted to developing and implementing a training program for the AP1-88/400 were insufficient to ensure that trainees would be able to perform the required tasks to a predetermined, measurable, and demonstrable level of competence.

3. The informal policy of allowing individual craft captains to decide on when and where to use the "SIYAY" for operational SAR missions, rather than a formal operational standard to determine when a particular crew was operationally ready, increased the risk that crews would not be at an adequate level of training for the mission at hand. The wind and current conditions at the gap in the breakwater required a high level of piloting skills.

4. The crew on board the "SIYAY" was operating without the assistance of standard operating procedures designed specifically for that craft, resulting in poor bridge resource management (e.g. pilot operating a searchlight that required the use of both hands and should therefore have been delegated to another crew member), and inappropriate piloting decisions (e.g. the decision to enter the gap and the decision to reduce power and thrust upon losing visual reference of the gap entrance).

5. Chronic staffing shortage for qualified hovercraft pilots at Sea Island Base compromised the 24-hours-a-day, 365-days-a-year operational readiness status at Sea Island Base.

6. Procedures for requesting a fitness-to-work assessment of a staff member returning from stress leave were not pursued by management.

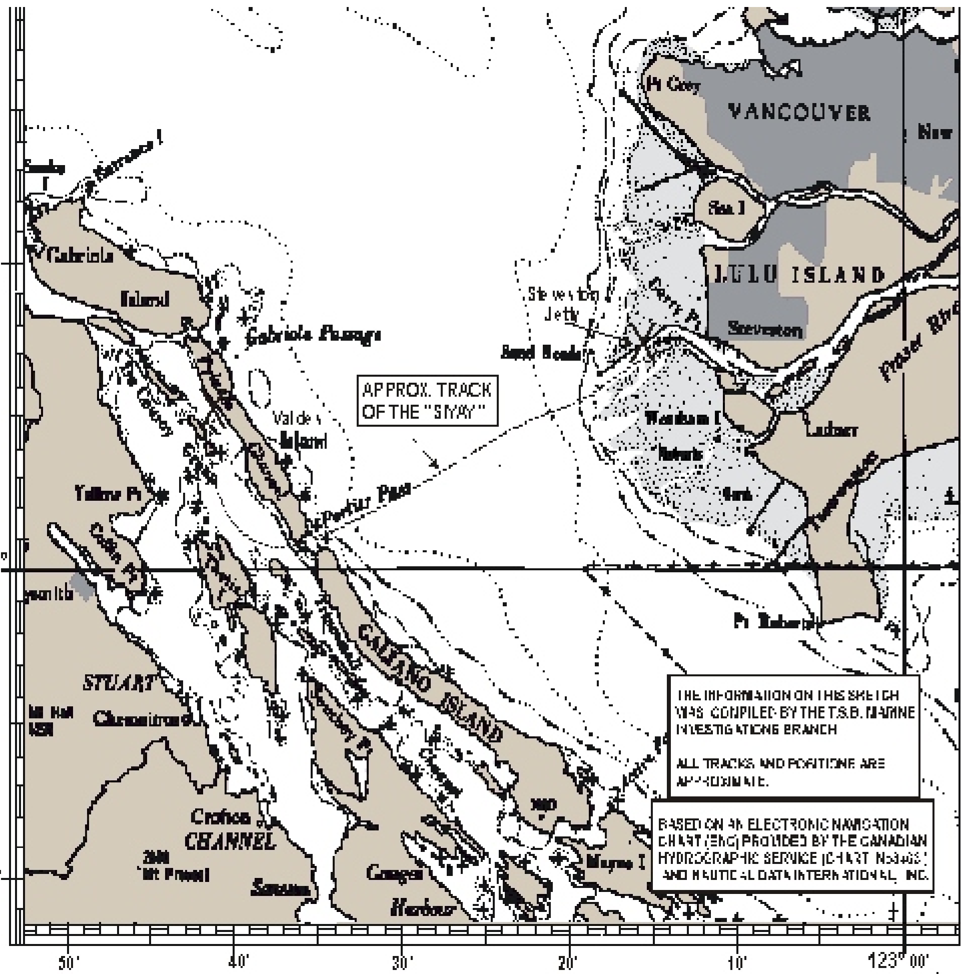
Safety Action

The following actions have been taken since the occurrence:

1. control cabin windows have been reconfigured to reduce glare;
2. searchlight controls have been relocated;
3. bow thruster vents and the forward ramp have been painted black to reduce glare;
4. bow thruster controls have been relocated;
5. an additional searchlight has been installed on the bow to account for blind spots caused by thruster vents and to reduce glare;
6. the spray reduction skirt has been modified to enhance effectiveness;
7. the Service Entry Plan for training has been formalized and is strictly adhered to;
8. increased staffing has resulted in a sufficient complement of trained pilots and first officers to operate the "SIYAY"; and
9. the duty pilot will decide which hovercraft should be used for particular SAR missions.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 10 January 2002.

Appendix A - Sketch of the Occurrence Area



Appendix B - Outline of a Human Engineering Program Plan

A comprehensive Human Engineering Program Plan contains the following elements:[4]

1. Management: to set up and define the position of the ergonomic specialist team in the organization and its functions. This will establish a position of the responsibility and authority for the human engineering function to effectively implement ergonomic principles in the design.

2. Systems and task analyses: To identify and analyze functions to which ergonomic principles are to be applied. This includes the identification and analyses of tasks required for each of these functions. This will serves as a basis for ergonomic considerations for the design and arrangement of work stations, control stations, etc.

3. Ergonomic support of vendors and sub-contractors: To provide support for the required ergonomic principles to the vendors and sub-contractors. This is to ensure the principles are incorporated into the design of components and sub-systems that are purchased outside of the organization.

4. Ship plan review for ergonomic consideration: To review the design and construction plans for compliance with required ergonomic principles. This includes providing recommendations for incorporating ergonomics into the design, conducting meetings to explain the recommendations and documenting and tracking implementation to ensure they are incorporated into the design.

5. Document and manual review for ergonomic consideration: To review documents and manuals such as equipment maintenance manuals, stability manuals and damage control manuals to ensure they meet the ergonomic principles required for the design. This includes providing ergonomic recommendations, documenting and tracking the recommendations to ensure they are incorporated into documents and manuals.

6. Documentation of ergonomic compliance: To document all ergonomic design principles incorporated into the ship's design. The documentation should include a description of the as-built equipment or system on the ship and is intended to demonstrate that the completed design meets the human performance requirements and ergonomic criteria for successful operation or maintenance. Where tradeoffs are made in the ergonomic design, the details should be documented.

7. Ship check during construction: To check that the ergonomic recommendations are practical, realistic and effective and are implemented during construction.

8. Test program: To test that the as-built equipment and systems perform to the established ergonomics standards.

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4 American Bureau of Shipping, *Guidance Notes on the Application of Ergonomics to Marine Systems*, 1998.