MARINE INVESTIGATION REPORT
M97L0076

OVERTURNING

PILOT BOAT "NAVIMAR V"
PORT OF QUÉBEC, QUEBEC
07 AUGUST 1997

Transportation Safety Board of Canada

Bureau de la scurit des transports du 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.

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Synopsis

In order to relieve the pilot who had been on duty from Les Escoumins, Quebec, aboard the “NAVIOS MINERVA”, the pilot boat “NAVIMAR V” came alongside the bulk carrier while passing the pilot station at Québec, Quebec, shortly before 0100. Two pilots from the Québec / Trois-Rivières sector climbed onto the accommodation ladder, but before they could reach the vessel’s deck, the pilot boat plunged into the sea and resurfaced upside down.

The master of the pilot boat was trapped in a compartment and the deckhand was thrown overboard. The Canadian Coast Guard Ship “STERNE”, which was dispatched to the scene, recovered the deck-hand, who had climbed onto the overturned hull, and the master, who had swum to the surface. The “STERNE” took the survivors to the Canadian Coast Guard base, where an ambulance was waiting to take them to hospital. Both crew members were suffering from hypothermia and nervous shock, but they were released from hospital a few hours later. The “NAVIMAR V” drifted in the St. Lawrence River before sinking off the mouth of the Saint-Charles River, in about 30 metres of water. The pollution caused by the pilot boat was deemed minor.

The Board determined that the pilot boat “NAVIMAR V” overturned because when she came alongside the “NAVIOS MINERVA”, she overtook a wave generated by the ship, pitched onto the wave crest then surged down into the trough of the next wave before plunging into the sea. The submerged bow slowed down the pilot boat but, due to her momentum, she continued to pitch until the vessel turned over. The decision to use the accommodation ladder instead of the vessel’s pilot ladder contributed to the sequence of events.

Ce rapport est également disponible en français.

1.0 Factual Information

1.1 Particulars of the Vessel

	"NAVIMAR V"
Official Number	320195
Port of Registry	Québec, Quebec
Flag	Canada
Type	Pilot boat
Gross tonnage[1]	12
Length	9.9 m
Draught	Forward: 0.64 m Aft: 1.04 m
Cargo	None
Crew	2 persons
Passengers	2 pilots
Built	1963, North Vancouver, B.C.[2]
Propulsion	2 diesel engines developing 313 kW
Owners	Les Croisières Navimar Inc.

1.1.1 Description of the "NAVIMAR V"

The pilot boat, built entirely of aluminium, has a hard-chine hull and a spray deflector on each side of the bow. There are two compartments under the after deck, each accessible through a hatch. Aft are fuel tanks and the steering gear which controls two rudders; midships are two engines driving the two screws. On the after embarkation deck, two guardrails have been installed on each side of the centre line, about 70 cm apart, so that pilots can hold the handrail during transfer manoeuvres. The superstructure extends forward from amidships to the chain locker bulkhead. A glazed double door and a companionway aft of the passenger compartment provide access to the after deck.

1 Units of measurement in this report conform to International Maritime Organization (IMO) standards or, where there is no such standard, are expressed in the International System (SI) of units.

2 See Glossary at Appendix C for all abbreviations and acronyms.

1.1.2 Description of the "NAVIOS MINERVA"

The "NAVIOS MINERVA" is a Panamanian-registered bulk carrier built in Japan in 1997, which is 225 m long and has a deadweight of 68 775 tonnes. The bridge, accommodation and engine-room are aft of the seven cargo holds. On each side of the accommodation there is an accommodation ladder that lowers forward. The vessel is also equipped with a dedicated facility for pilot transfers, on each side of the vessel, near hatches Nos. 5 and 6.

1.2 History of the Voyage

On 06 August 1997, the "NAVIOS MINERVA", carrying 22 crew members and a cargo of 50 968 tonnes of alumina from Cape Town, South Africa, was upbound in the St. Lawrence River en route to the port of Trois-Rivières, Quebec.

At 1414 eastern daylight time (EDT)[3], at calling-in point 4A, the Marine Communications and Traffic Services (MCTS) traffic regulating officer at Les Escoumins instructed the "NAVIOS MINERVA" to prepare the starboard accommodation ladder for the pilot to embark. At 1508 at calling-in point 5A, the MCTS traffic regulating officer asked the "NAVIOS MINERVA" to approach within half a nautical mile of the Les Escoumins pilot station, and he reminded navigating personnel to use the starboard accommodation ladder. At 1534, a pilot from the Les Escoumins/Québec sector boarded the vessel using the accommodation ladder, and the vessel proceeded to the port of Québec without incident.

At 2355 off Sainte-Pétronille, Quebec, the pilot reported to the Québec MCTS, and the vessel approached the Québec pilot station. On 07 August 1997 at 0005, main engine speed was reduced to "full manoeuvring speed ahead", and two minutes later to "half speed ahead". In the meantime in Louise Basin, two relief pilots from the Québec/Trois-Rivières sector boarded the "NAVIMAR V" and sat down in the passenger compartment. The pilot boat left the pilot station, entered the St. Lawrence River, travelled along the wharves to the mouth of the Saint-Charles River, then made a half-turn offshore to meet the "NAVIOS MINERVA".

Off Louise Basin, the pilot boat overtook the bulk carrier on her starboard side. Using both engines and a searchlight, the master manoeuvred the pilot boat so as to come alongside the vessel at a point about 15 m forward of the accommodation ladder. The Doppler log of the "NAVIOS MINERVA" indicated a speed over the ground of eight knots. The master of the pilot boat rested the port shoulder of his boat against the bulk carrier's side. The deck-hand on the pilot boat instructed the vessel's crew to lower the accommodation ladder. By reducing the speed of the port engine, the master of the "NAVIMAR V" allowed the vessel to catch up to the pilot boat until the accommodation ladder was over the after deck of the pilot boat. He noted that the guardrails in the middle of the after deck were in the way, and ordered the deck-hand to ask that the accommodation ladder not be lowered any further. The master moved the stern of the pilot boat away from the bulk carrier's side, and then the accommodation ladder was lowered to within 30 cm of the after deck. The two relief pilots immediately began climbing the accommodation ladder.

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[3] All times are EDT (coordinated universal time (UTC) minus four hours) unless otherwise stated.

A few moments later, the stern of the pilot boat raised suddenly and a slight list developed to starboard as the bow plunged into a wave trough. On the after deck, the deck-hand noticed that the bottom platform of the accommodation ladder was slowly moving toward the superstructure of the pilot boat. The master immediately ordered the deck-hand to have the accommodation ladder raised and the bulk carrier's crew did so at once. On turning forward, the master noted that the bow had plunged deeply into the water. The water level was now up to the top of the forward wheel-house windows. He moved the controls for both engines to the neutral position and tried to exit the accommodation but the after door was now above his head. When the bottom platform of the accommodation ladder struck the port ventilation trunk, the deck-hand toppled overboard. The pilot boat continued her forward pitching motion and, at about 0010, resurfaced upside down.

In the water, the master was disoriented in the darkness under the completely overturned hull. He saw light which he thought was coming from the surface and swam in that direction, but found himself in the engine compartment. In the meantime the deck-hand, who was wearing a flotation device, surfaced near the hull. One of the two relief pilots hurried to the bulk carrier's bridge to inform the bridge team of the situation. At 0012, he reported the accident to the Québec MCTS centre. The speed of the bulk carrier's main engine was reduced to "slow ahead", and at 0013, the engine was stopped. The MCTS relayed the information to the Québec Search and Rescue (SAR) Sub-Centre, and at 0014, the CCGS "STERNE" was dispatched to the scene of the accident, off berth No. 25. The MCTS also contacted the local tug firm, which mobilized the tug "DONALD P.". In the meantime, the deck-hand climbed onto the overturned hull and made verbal contact with the master, who was trapped in the engine compartment.

Using searchlights, the crew of the "STERNE" located the hull of the "NAVIMAR V" at about 0023, and recovered the deck-hand. When the "DONALD P." reached the scene at about 0030, a davit was prepared to attempt to right the pilot boat. Twice the master tried to swim to the surface, but since he was disoriented in the darkness, he returned to the engine compartment instead. At about 0042, air bubbles were seen coming from the openings of the pilot boat, which began to right herself. The master took advantage of the situation to swim to the surface, where he was recovered by the crew of the "STERNE". The SAR unit returned to the Canadian Coast Guard (CCG) base, where an ambulance was waiting for the survivors. Both crew members were suffering from hypothermia and nervous shock, but were released from hospital a few hours later. At 0050, the “DONALD P.”, which had remained at the scene, reported to the Québec MCTS that the pilot boat was sinking in 30 m of water off the mouth of the Saint-Charles River. She was refloated on 16 September 1997.

1.3 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	-	-	-	-
Missing	-	-	-	-
Serious	1	-	-	1
Minor/None	1	2	-	3
Total	2	2	-	4

1.4 Damage

1.4.1 Damage to the Pilot Boat

The windows in the superstructure were shattered; water destroyed the navigation instruments and the electrical and electronic installations as well as the insulation. Damage included deformation of the rudder stocks, detachment from the hull of a section of the spray deflector, and abrasion damage to the port side ventilation trunk. However, it was possible to restart both engines when the boat was refloated.

1.4.2 Damage to the Vessel

Damage was limited to the bottom platform of the starboard accommodation ladder of the “NAVIOS MINERVA”, which was deformed when it struck the port side ventilation trunk of the “NAVIMAR V”.

1.4.3 Damage to the Environment

It was reported that very little oil leaked from the pilot boat. The diesel fuel remained in the fuel tanks.

1.5 Certification

1.5.1 Pilot Boat and Vessel

The “NAVIMAR V” and the “NAVIOS MINERVA” were crewed, certified, and equipped in accordance with existing regulations.

1.5.2 Personnel

The master of the "NAVIMAR V" is certificated for the command of a vessel used in pilotage services in Minor Waters, Class II.

The master and watch officers of the "NAVIOS MINERVA" are certificated for the class of their vessel and for the type of voyage.

1.5.3 Pilot

The pilot aboard the "NAVIOS MINERVA" holds a pilot licence valid for the tonnage of the vessel he was piloting and for the sector of the St. Lawrence River in which he was working.

1.6 Personnel History

1.6.1 Master of the Pilot Boat

The master of the pilot boat had 46 years' navigating experience and had been the master of the "NAVIMAR V" since 1989. Since that time he had carried out over 4000 pilot transfer assignments. The evening before the occurrence he had gone to bed at about 1900 and had risen at about 0700 on 07 August 1997. He had consumed one alcoholic beverage at mid-day, and then he had reported for work at the pilot station at about 1815.

1.6.2 Master of the Vessel

The master had been navigating for 18 years and had served as master of the "NAVIOS MINERVA" since 30 March 1997.

1.6.3 Pilot

The pilot had 43 years' navigating experience and had been serving as a pilot since 1966. As the bulk carrier was a new vessel, this was the pilot's first assignment on the "NAVIOS MINERVA".

1.7 Weather Conditions and Current Information

1.7.1 Weather Forecasts

In the port of Québec on 07 August 1997, the weather was clear, the winds light, and the sea calm.

1.7.2 Tide Forecasts

The accident occurred at about 0010 on 07 August 1997, or about 2 hours and 40 minutes after the forecast high tide; therefore, both vessels were in an ebb current at the time of the transfer.

1.7.3 Current Forecasts

According to the Fisheries and Oceans Canada publication *Atlas of Tidal Currents*, two to three hours after high tide at Québec, the current vector off Louise Basin indicates a speed of three to four knots and a direction of approximately 060°T. Those parameters are based on average weather conditions.

1.8 Navigation

1.8.1 Navigation Instruments

The navigation instruments of both vessels were in good working order.

1.8.2 Pilotage

Since visibility was good, conduct of both the vessel and the pilot boat was carried out by visual observation during the approach of the two vessels and the transfer of the pilots.

1.9 Communications

1.9.1 Communications Between the Vessel and the MCTS Centre

On 06 August 1997 at 1414, the "NAVIOS MINERVA" reported at the calling-in point off Pointe-à-Michel, Quebec. The Les Escoumins MCTS centre then instructed the crew to prepare the starboard accommodation ladder for the pilot. At 1508, when the navigating personnel reported at the next calling-in point, off Pointe-au-Boisvert, Quebec, the MCTS traffic regulating officer asked for confirmation that the starboard accommodation ladder was ready, and asked the vessel to proceed to the Les Escoumins pilot station, five cables from shore.
The bulk carrier subsequently proceeded up the St. Lawrence River to the port of Québec with no communication problems. Following the accident at 0012:12, one of the relief pilots from the Québec/Trois-Rivières sector reported the occurrence to the Québec MCTS Centre while the "NAVIOS MINERVA" was proceeding at reduced speed in the port of Québec.

1.9.2 Communications Between the Vessel and the Pilot Boat

A replay of the very high frequency (VHF) radio communication tapes from 0000:01 on 07 August 1997 confirmed that there had been no communication between the "NAVIMAR V" and the "NAVIOS MINERVA". Since neither the master of the pilot boat nor the pilot on board the bulk carrier was expecting any problems with the transfer manoeuvre, they did not see any point in making contact by radiotelephone to determine when the pilot boat should come alongside and transfer the pilots, nor were they required to do so by regulations.

1.9.3 Communications Between the Pilot and the Navigating Personnel

There was no misinterpretation of the helm or speed orders for the manoeuvres on board the "NAVIOS MINERVA".

1.10 Pilot Boat "NAVIMAR V"

1.10.1 Modification History

The pilot boat was purchased in 1988 to be used in pilotage services in the port of Québec. Previously this vessel had been used as a service boat in the Vancouver area. During the winter of 1993, the superstructure was shortened in order to enlarge the after deck and the exhaust system of the main engines was converted to a wet system. In 1996 further modifications were made to improve transverse stability and to correct a bow-trimming condition. At that time, the hull was widened from 3.05 to 3.76 m, and the original engine was replaced with two 210 hp units mounted lower and farther aft. The fuel tanks were moved aft. The volume of the bow was increased and a spray deflector added.

An incident occurred in the spring of 1997, when a strong easterly wind stirred up a moderate sea off Sainte-Pétronille. While the pilot boat was proceeding to an upbound vessel for a pilot transfer, she suddenly plunged her bow into the sea. The master reduced the engines' speed and the forward end of the pilot boat resurfaced. A second approach was then made without incident. Following that incident, the owner had approximately 800 kg of concrete ballast added to the stern of the boat, near the steering gear. It was reported that adding the ballast improved but did not completely eliminate the boat's unsatisfactory dynamic trimming behaviour. The addition of solid ballast was not reported to Transport Canada as required.

1.10.2 Pilot Boat Selection Criteria

Every five years, the Laurentian Pilotage Authority (LPA) issues a call for tenders for pilot boat services in the ports of Québec and Trois-Rivières. Bidders must comply with specifications set by the LPA. The selection criteria include construction materials, length and breadth of the hull, type of propulsion and speed, power-generating system, navigation instruments and passenger-carrying capacity. The LPA's requirements are based on the *Standards for Pilot Vessels*, TP 10531, issued by Transport Canada in 1989, which deal only superficially with the ergonomics of the wheel-house and the location and number of embarkation/disembarkation decks. References concerning the field of view from the steering station and the stability requirements are brief.

1.10.3 Regulatory Inspection Requirements

Since most pilot boats are also passenger vessels that carry few passengers and are of small tonnage, the regulations governing the tonnage and class of voyage for these vessels are those that apply to passenger vessels that carry 12 passengers or less, and are not specific to pilotage services per se. These small boats tend to plane at full speed, but the regulatory requirements of STAB 6 of the *Stability, Subdivision and Load Line Standards*, TP 7301, do not address characteristics that could affect longitudinal dynamic behaviour.

The "NAVIMAR V" was not required to have a stability booklet. Transport Canada called for initial statical stability data for the vessel after the 1996 modifications and waived the requirement for an inclining experiment for certification purposes. Since the vessel was considered a pilot boat and a passenger vessel, she was issued an inspection certificate limited to Minor Waters Class II voyages as a pilot boat.

1.10.4 Crew

This pilot boat is operated on a 24-hour basis by four crews, each comprising a master and a deck-hand. Among them, these crews account for some 3500 transfers per year.

1.10.5 Visibility from the Steering Station

The after deck serves as the embarkation/disembarkation deck and the wheel-house is at the forward end of the superstructure. At the time of the occurrence, the master's view aft from the steering station was partly obstructed by the passenger compartment. In the moments before the occurrence, the master's attention was focussed on transferring the two pilots to the bulk carrier, and according to the crew, there was no fore-warning of the impending accident.

1.11 Vessel "NAVIOS MINERVA"

1.11.1 Accommodation Ladder

On each of the vessel's quarters, there is a 12.1 m-long accommodation ladder. Each ladder is fastened to a pivoting platform approximately halfway between the transom and the forward end of the accommodation. At that point, the vessel's side is curved. The accommodation ladder on each side of the vessel lowers forward and the ladder's bottom platform does not rest against the vessel's side, but juts out more than a metre from the shell plating.

1.11.2 Pilot Ladder

In compliance with international regulations, the vessel is also equipped with a dedicated facility for pilot transfers, on each side of the vessel near hatches Nos. 5 and 6. Because the vessel may have a high freeboard when in light condition, the facility consists of a combination accommodation-type ladder and pilot ladder. This combination of ladders enables the pilot to climb three to nine metres up a rope ladder above the pilot boat before switching ladders and climbing the steps of the second ladder.

1.11.3 Visibility from the Bridge

Although a pilot boat manoeuvring alongside cannot be seen by a person from the centre window of the bridge, it is possible to get a good view of the pilot boat from the bridge wing.

1.11.4 Manoeuvring Speeds

Bridge orders are relayed to the engine-room via an engine telegraph. When the vessel is loaded, the manoeuvring speeds correspond to the following speeds:

Manoeuvring Speed	Speed
Full ahead (manoeuvre)	10.2 knots
Half ahead	7.1 knots
Slow ahead	6.3 knots
Dead slow ahead	5.4 knots

Depending on the amount of cargo being carried, the navigating personnel estimate "full speed ahead" (sea) to be approximately 12.5 knots.

1.11.5 Main Engine Data Recorder

A check of the timer for the main engine data recorder showed that the time recorded was the exact local time and that the time zone was the one in effect. The recorded data indicated the following changes of speed:

Speed	Date	Time
Full ahead (sea)	06 August 1997	23:02.5
Full ahead (manoeuvre)	07 August 1997	00:05.0
Half ahead	07 August 1997	00:07.5
Slow ahead	07 August 1997	00:12.0
Stop	07 August 1997	00:13.0

1.12 Pilotage Services

1.12.1 Use of the Pilot Ladder

The *Regulations Respecting Pilot Ladders and Mechanical Pilot Hoists on Ships* made pursuant to the *Canada Shipping Act* did not apply to the Panamanian-registered "NAVIOS MINERVA" because the Canadian regulations only apply to Canadian vessels. The Administration responsible for the vessel, Panama, is a signatory to the *1974 International Convention for the Safety of Life at Sea* (SOLAS). Chapter 5, Rule 17 of the SOLAS Convention stipulates that pilot ladders must be used for pilotage service. The International Maritime Pilots Association also advocates the use of pilot ladders. The same is true of the annual edition of *Notices to Mariners,* which is published by Fisheries and Oceans Canada and which is required to be carried on all ships in waters of Canadian jurisdiction. This document contains a notice to foreign mariners calling on them to comply with the requirements of the SOLAS Convention.

The "NAVIOS MINERVA" had a draught of 10.85 m and and a freeboard of about 7.45 m. Since the bulk carrier's freeboard was less than 9 m, pilots could readily climb on board using the pilot ladder facility rather than using an accommodation ladder.

1.12.2 Use of the Accommodation Ladder

In the compulsory pilotage areas on the St. Lawrence River, most pilots use the accommodation ladder for access to vessels. This pilot transfer arrangement practice dates back a number of decades, to a time when most vessels were designed with the accommodation amidships. Thus the pilots requested that the MCTS centre inform foreign crews of this particular practice when they report at the two calling-in points downstream of the Les Escoumins pilot station.
In this instance, the combination of ladders intended for pilot transfer located amidships was not used because

the MCTS centre had instructed the bulk carrier's crew to prepare the starboard accommodation ladder. The navigating personnel did not inform the MCTS centre that the vessel was also equipped with a pilot embarkation/disembarkation facility amidships.

1.12.3 Speed of the Vessels During the Transfer

The movements of the "NAVIMAR V" and the "NAVIOS MINERVA" in the port of Québec were recorded on a radar video plotter at the Québec MCTS centre. It was therefore possible to determine the approximate speed of both vessels during the approach manoeuvre and the transfer of the two pilots. Between 0006:08 and 0010:56, the "NAVIOS MINERVA" moved approximately 0.64 nautical mile, indicating a speed over the ground of eight knots. The video plotter's automatic radar plotting aid (ARPA) system helped determine the drift of the tug "DONALD P." alongside the "NAVIMAR V" after the accident; it indicates a movement in the direction 031°T at a speed of 1.9 knots. Thus in an ebb tide, the pilot transfer was made at a speed through the water of about 9.9 knots.

Speed and heading have a greater effect on the behaviour of a small vessel than a large ship in similar seas. A small vessel running before the sea does not progress at a uniform rate, but is subject to some acceleration and deceleration when on the crest or in the trough of the waves. Should the small vessel lose synchronization with the waves, its smaller mass, and inertia can cause significant changes of its speed between wave crests. Consequently, the forward rate of progress of a small vessel fluctuates much more than a larger vessel, in similar conditions and at similar speeds.

1.12.4 Safety Management System

Although the owner of the pilot boat was not required to comply with the *International Safety Management Code* adopted by the International Maritime Organization (IMO), he had introduced a safety management system on board his pilot boats. The company's code of practice for pilot transfers is based on the code prepared by the British Ports Federation.

Article 3.1 of the company code stipulates that the master of the pilot boat must choose where the transfer is to be made, in conjunction with the pilot of the vessel to the extent possible. Chapter 4 of the code lists the steps to be followed during the approach, including making contact with the vessel by VHF radiotelephone to exchange the information required for a safe transfer. Canadian regulations contain no standards or code of practice for pilot transfer arrangements.

2.0 Analysis

2.1 The Transfer Operation

The pilot boat came alongside the bulk carrier without making arrangements with the pilot who had the conduct of the vessel. Unlike the master of the pilot boat, the pilot on board the large vessel has a better perspective and is therefore in a better position to decide when the transfer should be made. The pilot can take the surrounding traffic into account when controlling the vessel's speed and heading. The master of the pilot boat is not in such a position.

The pilot transfer was made at an approximate speed of 9.9 knots through the water, which was greater than usual. There is no regulatory speed range for approach manoeuvres and pilot transfers. Because there are no standards for these operations, the pilots and the crews on the pilot boats must use good seamanship principles and bear in mind the particular operational characteristics of the pilot boat.

2.2 Choice of Ladder for the Transfer

MCTS traffic regulating officers instruct the crews of foreign vessels to use the accommodation ladder, but this is not in accordance with international and Canadian regulations. The custom on the St. Lawrence River for a number of decades has been for pilots to use the accommodation ladder rather than the pilot ladder, unless exceptional conditions require a departure from that practice.

Although it is easier to climb up an accommodation ladder than a pilot ladder, the former has some drawbacks particularly when it is located on the vessel's quarter. Since the 1970s, most accommodation ladders are installed in way of the accommodation on the vessel's quarter and generally lead forward. This means that the pilot boat cannot rest parallel to the vessel's side during the transfer. This makes it difficult to keep the pilot boat's transfer deck in position below the bottom platform of the accommodation ladder. It is more dangerous for the pilot to climb onto or off the bottom platform when it is away from the vessel's side and swinging during the transfer.

A pilot ladder meeting Canadian and international standards is usually deployed vertically on the parallel part of the vessel's side where the pilot boat can come alongside in a safe and stable manner. However, there are some drawbacks to using a rope pilot ladder. It is steep to climb and requires greater physical effort from the pilots, especially when the freeboard is high. The physical condition of some pilots and/or the fact that they may be wearing cumbersome clothing in winter are factors that can hamper a pilot using a pilot ladder. Finally, when the embarkation facility consists of a combination accommodation-type ladder and pilot ladder, pilots must transfer their weight from one ladder to the other. Sometimes the bottom platform of the accommodation ladder is not properly supported, which may also compromise the safety of the pilot.

Although the "NAVIOS MINERVA" was equipped with a pilot ladder facility amidships, the crew did not deploy it because the MCTS centre at Les Escoumins had instructed them to prepare the accommodation ladder. In this instance, it would probably have been safer to use the combination of ladders for the pilot transfer.

2.3 Regulatory Requirements for Construction and Stability

The functions of Transport Canada include, but are not limited to the review and approval of construction plans, stability data, and the subsequent inspection of proposed or existing vessels, to ensure compliance with applicable regulatory requirements. Such approval is based on the suitability of the submitted design parameters. The accuracy of the data presented is the responsibility of the owner and/or his naval architect. Consequently, regulatory approval is not specifically related to the operational efficiency or performance of the completed vessel.

Compliance with established minimum regulatory stability criteria ensures that small vessels attain what are generally recognized as adequate intact traverse stability characteristics throughout a range of operational loading conditions related to their routine service.

The regulatory criteria are such that the magnitude of the intact stability they provide generally ensures that the vessel also has adequate margins of reserve intact stability to withstand and recover from the dynamic effects of severe weather, or other detrimental external influences to be expected in normal operations. However, current criteria are primarily focused on transverse stability and do not address the longitudinal dynamic stability and trimming characteristics which may be of concern to small vessels that routinely operate at relatively high speeds in close proximity to larger vessels.

2.4 Operational Requirements

The operational parameters of the "NAVIMAR V" require that a relatively high hull speed be achieved to ensure short transit times between the pilot boat station and the transfer location with large vessels. The pilot transfer operation also requires that the pilot boat be capable of overtaking the vessel with ease, maintaining a steady speed and stable platform while alongside and pulling away from the vessel once the transfer is complete. These operational parameters largely dictate the hull form, weight and powering characteristics necessary for the vessel to be able to make the speed transition through the displacement and semi-displacement modes to top speed when a full-planing condition is achieved.

The dynamic trimming characteristics applicable to all small vessels as they accelerate and make the transition from slow speed up to full planing speed are such that maximum wave making resistance and trim by the stern occur before sufficient hydrodynamic force has been developed to "lift" the hull into the full-planing condition.

The length, hull form, displacement and powering of the "NAVIMAR V" were such that the maximum after trim occurred at about 10 knots, which coincided with the speed through the water at the time of the occurrence. Consequently, at this speed, the pilot boat was in a highly vulnerable condition while maintaining station alongside and riding near the crest of one of the waves produced by the larger vessel. Any slight variation in the relative speeds of the two vessels would cause her to overtake the wave crest, surge down its face and bury her bow when she reached the trough. This sudden resistance to forward progress could cause the boat to slow down and plunge further into the sea as the wave pattern of the larger vessel continued at the original transfer speed of 10 knots.

Although the trend is toward pilot transfers being carried out at higher speeds, a lower speed would reduce the height of the wave pattern generated by the larger vessels and would also markedly reduce the detrimental effects of excessive dynamic trim as the pilot boats would then be operating at a lower transition speed range.

2.5 Pilot Boat Design

It is difficult to see how a pilot boat could be completely immune to capsizing or plunging, but pilot boat design criteria must meet the needs of the industry and pilotage authorities. By enacting regulatory standards that are better suited to pilotage operations, Transport Canada could minimize the potential risk of accidents in dangerous situations. Although Transport Canada has standards for pilot boats, the stability criteria in those standards do not comprehensively address the dynamic characteristics for small vessels such as the "NAVIMAR V". In its *Devis pour la fourniture d'un service de transbordement de pilotes dans le port de Québec* [charter agreement], the LPA describes the minimum requirements for pilot boat construction. Article 5.10 states that all vessels must be equipped according to the Transport Canada *Standards for Pilot Vessels*, TP 10531, or must be capable of operating in a manner which is no less safe and efficient than if they were so equipped. This occurrence shows that the standards do not sufficiently address current pilot boat operational requirements. More recent pilot boats generally have a larger embarkation area forward of the wheel-house than aft of it, which makes it easier for the master to observe the transfer manoeuvre. Moreover, today's pilot boats operate at higher speeds during pilot transfers. Consequently, specific attention must be paid to their dynamic longitudinal trimming characteristics in the design stage, to ensure a safe operation throughout the vessel's displacement, transition, and full-planing modes.

Aside from the TP 10531 standards, there are few reference documents for the design and operation of pilot boats in Canada. Transport Canada and LPA requirements for stability data and hull characteristics are minimal. After examining the proportions of a pilot boat, Transport Canada may waive the requirement for the owner to provide stability data.

The design modification of the "NAVIMAR V" seems to have been an exercise in trial and error. The series of modifications carried out in 1993, 1996, and in the spring of 1997, prior to this occurrence, were collectively unsuccessful in eliminating the perceived shortcomings in the vessel's dynamic trimming characteristics. Further modifications, after refloating the vessel in 1998, were made to reduce once again the detrimental after trimming characteristics.

It is up to pilotage authorities which set operational and performance parameters for pilot boats to ensure that the vessels meet the needs for foreseeable operating conditions. With a broad counter stern, hard-chine hull, and relatively flat bottom, the "NAVIMAR V" was likely to have sensitive dynamic trimming characteristics when operating at semi-planing speeds when in overtaking or following seas.

In terms of general arrangement, the current trend in pilot boat design is for the steering station to be located in the middle of the transfer deck. There was nothing to suggest that the after deck of the "NAVIMAR V" could not provide a stable and safe working platform for the pilots. However, the ergonomics of the "NAVIMAR V" were not conducive to a full assessment of the situation, because the master had to divide his attention between the approach manoeuvre ahead and the transfer of the pilots behind him. In other words, he had to look forward to rest the bow on the vessel's side, to make sure it did not plunge into the sea, and also look aft to keep the after deck lined up under the accommodation ladder. TP 10531 does not address all these factors.

2.6 Manoeuvrability of the Pilot Boat

The level of care and skill required of a crew manoeuvring a pilot boat are significant factors in this occurrence. Even the most experienced master may suffer a moment's inattention. An emergency manoeuvre to correct the vessel's behaviour may be as harmful as poor vessel design. The human factor is also part of the operating system. There is every indication that the crew were well rested and highly experienced; however, the relatively high speed at which the transfer was made and the waves generated by the "NAVIOS MINERVA" affected the pilot boat's dynamic behaviour when the "NAVIMAR V" was in a vulnerable position against the vessel's side.

The bulk carrier's speed was reduced to "half ahead" some three minutes before the pilot boat came alongside, but that was not sufficient time to take enough way off the vessel for the transfer. The pilot on duty overestimated the vessel's deceleration. Because the bulk carrier was moving at a speed through the water of about 10 knots, the waves she generated were probably unusually large. During the transfer, the pilot boat was manoeuvred onto the crest of one of those waves which was just forward of the accommodation ladder platform. Because the speed of the wave was less than the speed of the pilot boat, the "NAVIMAR V" accelerated into the trough towards the next wave.

Because the accommodation ladder was on the vessel's quarter, the bottom platform was not resting onto the vessel's side and the pilot boat's bow had to be rested on the vessel's side to line up the after deck under the accommodation ladder. When the pilot boat pitched forward on the wave crest, the boat surged down the wave's leading face, the fore deck became submerged, and caused the pilot boat to slow down in relation to the bulk carrier. The bottom platform of the accommodation ladder then caught up to the pilot boat and came in contact with the port side ventilation trunk. As the bow continued to plunge into the sea, it acted like a sea anchor, taking more way off the pilot boat. The momentum of the pilot boat caused it to continue its forward pitching motion until the vessel turned over.

3.0 Conclusions

3.1 Findings

1. The Les Escoumins Marine Communications and Traffic Services (MCTS) centre instructed the "NAVIOS MINERVA" to prepare the starboard accommodation ladder to embark the pilot.

2. Under international regulations, the vessel was required to use a pilot ladder to transfer pilots.

3. Instructing MCTS traffic regulating officers to tell foreign crews to use the accommodation ladder is a request made by the pilots but is contrary to international regulations.

4. The Canadian *Pilot Ladder Regulations* do not apply to foreign vessels.

5. The vessel is equipped with a pilot embarkation/disembarkation facility amidships, but the crew prepared the accommodation ladder on the vessel's quarter.

6. Because of the location of the accommodation ladder on the vessel's quarter, the ladder's bottom platform juts out more than a metre from the shell plating.

7. The same accommodation ladder was used at the Québec pilot station, and neither the pilots nor the master of the pilot boat objected to that practice.

8. Most St. Lawrence River pilots use the accommodation ladder to board vessels.

9. The pilot aboard the bulk carrier and the master of the pilot boat did not come to an agreement by radio communication on the time and position for the transfer.

10. In Canada, there is no standard or code of practice for pilot transfer arrangements and pilotage duties.

11. The ship "NAVIOS MINERVA" was making way at a speed through the water of about 10 knots at the time of the transfer. That speed is greater than usual. The pilot overestimated the vessel's deceleration.

12. Because of the guardrails on the after deck of the pilot boat, she had to be moved farther away from the bulk carrier's side.

13. The pilot boat was manoeuvred onto the crest of a wave generated by the bulk carrier.

14. The speed of the waves generated by the vessel was less than the speed of the pilot boat.

15. While trying to keep the after deck of the pilot boat lined up under the accommodation ladder and at the same time maintaining an angle with respect to the vessel, the pilot boat descended into the trough of the next wave and the bow plunged into the sea.

16. The addition of concrete ballast did not completely eliminate shortcomings in the pilot boat's dynamic trimming characteristics.

17. There is little reference material on pilot boat design and operation in Canada. Their development seems to result from operating experience and trial and error.

18. The regulations prescribing the criteria for assessing pilot boat stability do not address the dynamic trimming characteristics of small vessels throughout the displacement, transitional and planing speed ranges encountered in normal operation.

19. Transport Canada regulatory requirements and inspection criteria do not fully meet current pilot boat operational parameters.

3.2 Causes

The pilot boat "NAVIMAR V" overturned because when she came alongside the "NAVIOS MINERVA", she overtook a wave generated by the ship, pitched onto the wave crest then surged down into the trough of the next wave before plunging into the sea. The submerged bow slowed down the pilot boat but, due to her momentum, she continued to pitch until the vessel turned over. The decision to use the accommodation ladder instead of the vessel's pilot ladder contributed to the sequence of events.

4.0 Safety Action

4.1 Action Taken

4.1.1 Safety Advisory

In March 1998, Marine Safety Advisory (MSA No. 05/98) was sent to the Laurentian Pilotage Authority Canada (LPA) concerning the shortcomings noted in the pilot embarkation practice on the St. Lawrence River.

4.1.2 New Criteria for Awarding Contracts

In preparation for renewing the contract for pilot boat services in the port of Québec, the LPA revised its technical specifications and issued a call for tenders using stricter stability criteria for pilot boats. Bidders must now provide the plans of the proposed vessels. Besides speed criteria, the pilot boat must now meet the stability requirements of level STAB 6 of the *Stability, Subdivision and Load Line Standards.*

4.1.3 Technical Improvements to the Pilot Boat

During the winter of 1997-1998, the owner of the "NAVIMAR V" completely modified the pilot boat. A section of the vessel, from the bow to the forward bulkhead of the engine compartment, was removed and replaced by a new section. A new keel, one and a half times longer than the previous one, was added, making it possible to extend the forward part of the boat by 2.7 m. The new section contains two watertight compartments instead of one, and provides for greater forward buoyancy, that is additional upward thrust on the part of the boat that is forward of the longitudinal centre of gravity. Because of the larger forward deck, pilot transfers can be made forward. The forward deck and the after deck are both equipped with two guardrails in the centre to provide a handhold. The wheel-house and the passenger compartment were completely refitted. One of the two after doors was replaced with a wider window providing better horizontal visibility. The pilot boat is now powered by two Cummins turbo diesel engines developing 210 hp each. The twin-screw propulsion and power-assisted controls combined with larger rudders make for improved manoeuvrability.

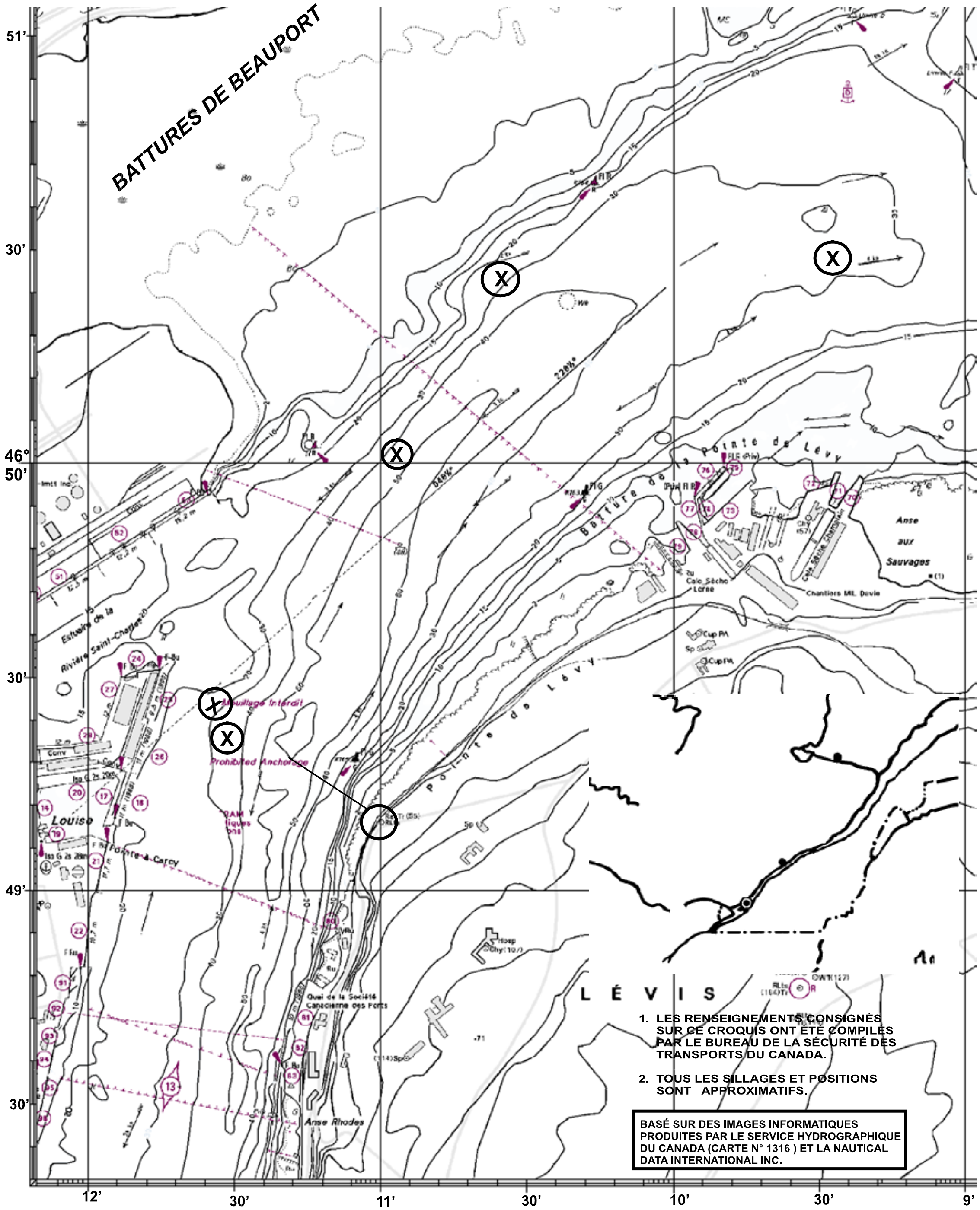
4.1.4 Pilot Transfer Arrangement Discussion

Further to a meeting held on 12 June 1998 between Transport Canada , the Corporation des pilotes du Saint-Laurent central, the Corporation des pilotes du Bas Saint-Laurent and the Laurentian Pilotage Authority Canada, Transport Canada issued a report and subsequently a letter indicating the following two recommendations: a) that transfer operations be cancelled where the accommodation ladder leads forward - unless a pilot ladder is used to climb the first 1.5 m; and b) that the master on board the pilot boat refuse to carry out the transfer operation if he deems the conditions for the transfer to be unsatisfactory. It was agreed that Transport Canada would issue a Ship Safety Bulletin if the parties came to a consensus, but such consensus was not reached.

On 2 March 1999, the Corporation des pilotes du Bas Saint-Laurent indicated to MCTS, Quebec Region, that its pilots preferred the Canadian *Pilot Ladder Regulations* to international regulations and that it wanted them implemented even though they do not apply to foreign vessels.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 04 April 2001.

Appendix A - Sketch of the Occurrence Area



Appendix B - Photographs

Appendix C - Glossary

ARPA	automatic radar plotting aid
B.C.	British Columbia
CCG	Canadian Coast Guard
CCGS	Canadian Coast Guard Ship
cm	centimetre
hp	horsepower
IMO	International Maritime Organization
kg	kilogram
kW	kilowatt
LPA	Laurentian Pilotage Authority
m	metre
MCTS	Marine Communications and Traffic Services
MSA	Marine Safety Advisory
SAR	Search and Rescue
SI	International System (of units)
SOLAS	*1974 International Convention for the Safety of Life at Sea*
T	true (degrees)
TSB	Transportation Safety Board of Canada
VHF	very high frequency
°	degree