Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

MARINE INVESTIGATION REPORT
M04W0034

CAPSIZING AND LOSS OF LIFE

SMALL FISHING VESSEL *HOPE BAY*
QUEEN CHARLOTTE SOUND, BRITISH COLUMBIA
26 FEBRUARY 2004

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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Report Number M04W0034

Summary

Shortly after midnight on 26 February 2004, while transiting Queen Charlotte Sound, British Columbia, the commercial fishing vessel *Hope Bay* listed suddenly to starboard and capsized. The four persons on board abandoned the vessel by jumping into the sea. Search and rescue personnel initially rescued one person and recovered the bodies of two others. The body of the fourth person was recovered later the same day. The vessel remained afloat for about 12 hours before sinking.

Ce rapport est également disponible en français.

Other Factual Information

Particulars of the Vessel

Name	***Hope Bay (ex Leroy and Barry)***
Official Number	323661
Port of Registry	Victoria, B.C.
Flag	Canada
Type	Bottom trawl commercial fishing vessel
Gross Tonnage[1]	126
Length[2]	22.13 m
Built	1967, Saint John, N.B.
Propulsion	One 380 kW Caterpillar diesel engine, single propeller
Cargo	50 802 kg of turbot and 5443 kg of dover sole
Crew	3
Fishery Observer	1
Owner	Private Owner, Victoria, B.C.

Photo 1. *Hope Bay* making way off the west coast of Vancouver Island, circa 2000.

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 of units.

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

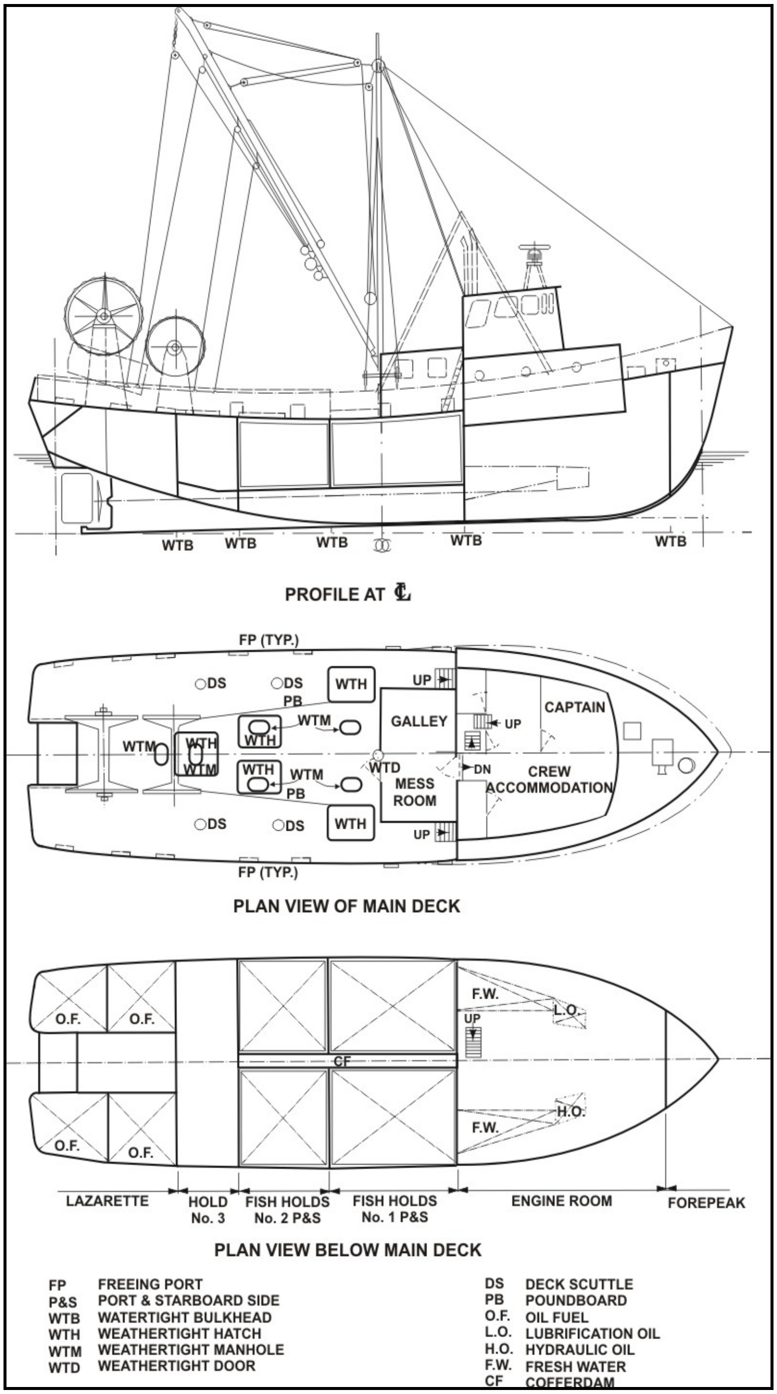

Figure 1. Outline General Arrangement

Vessel Description

The *Hope Bay* was a small fishing vessel of closed construction, having an all-welded steel double-chine hull with a partly raised forecastle deck, a stern ramp and a skeg. The hull below the main deck was subdivided by five transverse watertight bulkheads, separating (from forward): the forepeak; engine room; two forward (No. 1 port and starboard) and two after (No. 2 port and starboard) insulated fish holds divided by a centre line cofferdam; a third hold (No. 3 hold) designated as a void space; and the lazarette, which housed the steering gear. Four diesel oil tanks were arranged on the port and starboard sides outboard of the lazarette. Fresh water storage tanks were located on the port and starboard sides of the engine room (see Figure1).

A deckhouse located forward of amidships enclosed the wheelhouse, crew accommodation, and engine room access. A weathertight dutch door giving access to the working deck was fitted on the starboard side of the aft transverse bulkhead of the deckhouse. Doors on the port and starboard sides of the aft bulkhead of the wheelhouse provided access down to the working deck. The vessel was rigged for stern trawling operations and was equipped with two net drums installed on the working deck.

The working deck was covered with a wooden grating. To facilitate loading of fish, two pound boards[3], 91 cm (3 ft) high, were located longitudinally on top of the grating. Aft of the accommodation, access to the below-deck compartments was provided by hatch covers, and additionally by manholes fitted either in the hatch cover or the working deck (See Figure 1.) Fish-loading deck scuttles were also fitted into the deck plating outboard of the hatchways in way of the No. 2 fish holds and No. 3 hold. Freeing ports were located in the bulwarks.

History of the Voyage

On 17 February 2004, the trawler *Hope Bay* was refuelled in Port Hardy, B.C. Five days later, on February 22, 16 tons of ice were loaded into the fish holds and, at around midnight, the vessel departed for fishing grounds in Queen Charlotte Sound. Fuel and fresh water tanks were nearly full, and there were four persons on board: the skipper, the mate, the engineer, and one fishery observer contracted by the Department of Fisheries and Oceans.

The vessel arrived at the fishing grounds at about 1600[4] on 23 February 2004 and began fishing at approximately 1830. Fishing continued for some 25 hours until around 1930 on February 24 , when Nos. 1 and 2 fish holds were nearly full with a combination of fish, salt water, and ice. No. 3 hold remained empty. By the time the fish were stowed, the weather had deteriorated and the *Hope Bay* sought refuge from impending southeasterly gales. The vessel had a starboard list as it steamed westward for two hours to Heater Harbour on Kunghit Island, Queen Charlotte Islands, B.C., where it anchored at about 2130. (See Figure 2.)

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[3] Planks that form the sides of a box on deck to facilitate fish-sorting/loading operations.

[4] All times are Pacific standard time (Coordinated Universal Time minus eight hours) unless otherwise noted.

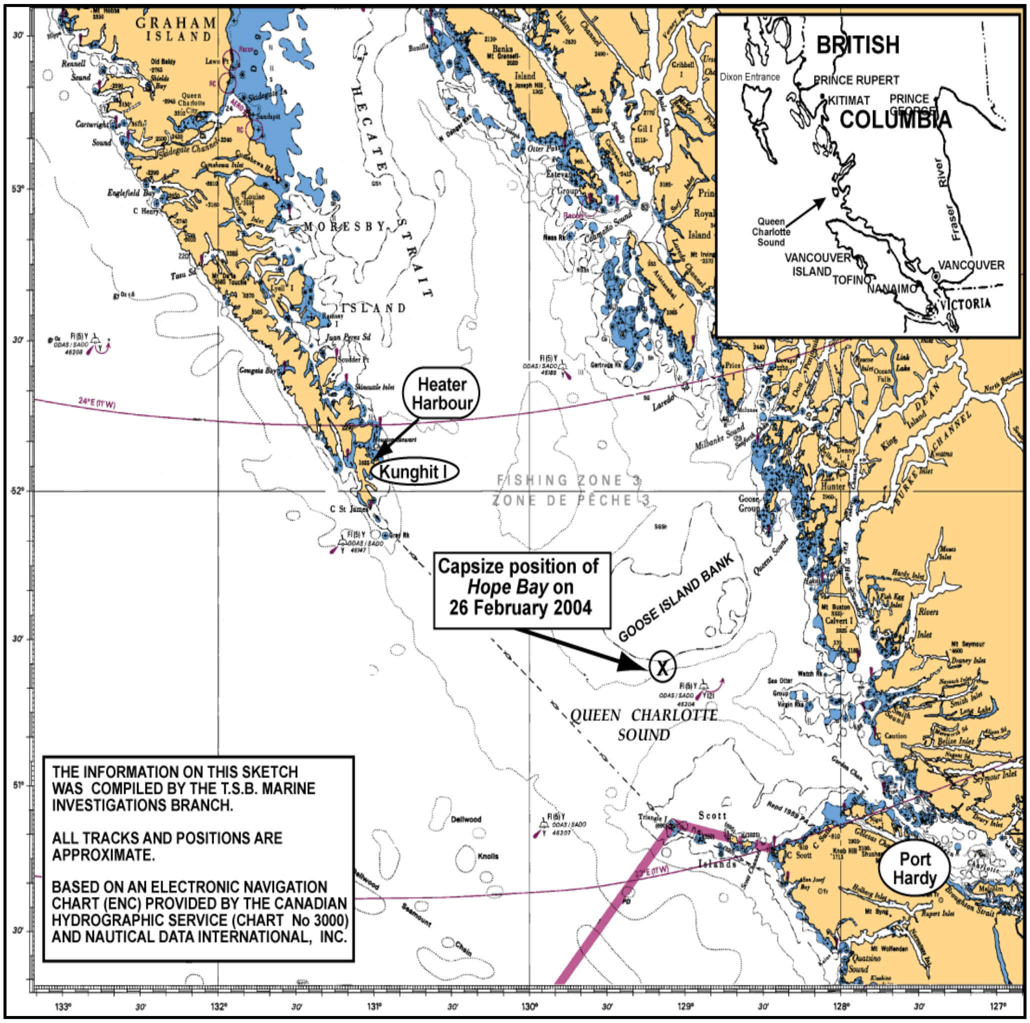

Figure 2. Chart of the occurrence area

On the following morning, 25 February 2004, with conditions forecast to improve late that afternoon, the *Hope Bay* departed the anchorage at approximately 1145 and began a southeasterly voyage towards a fish-processing plant in Port Hardy. Both paravanes were deployed, and the top half of the dutch door between the galley and the exterior working deck was latched ajar, allowing fresh air to circulate through the vessel.

Soon after leaving Heater Harbour, sea water was being shipped onto the working deck through the freeing ports in the vessel's bulwarks and occasionally over the stern. The *Hope Bay* was considered a "wet boat" as it was common for sea water to cover the entire surface of the *Hope Bay*'s main working deck to a depth in excess of 8 cm whenever the vessel was making way while heavily laden.

During the afternoon and evening, the vessel proceeded on a southeasterly course. Shortly after 2300, the skipper initiated a very high frequency (VHF) radio telephone call with another fishing vessel during which he expressed concern about the slow rolling motion of the *Hope Bay* and was considering making a northerly alteration of course toward Hakai Pass. Instead, he decided to continue on the established course toward Port Hardy. He then passed the wheelhouse watch to the mate and retired to his cabin. The fishery observer and the engineer were resting in their bunks in the forward part of the vessel.

When the vessel was about two miles southwest of Goose Bank, southeast seas became more turbulent. The vessel pitched and rolled violently before heeling sharply to starboard. The skipper returned to the wheelhouse and assumed the conduct of the vessel. He reduced speed and, with the *Hope Bay* heeling to starboard, placed the helm hard to port in an attempt to bring the vessel upright. When those manoeuvres failed, he ordered the two crew members and the fishery observer to don immersion suits and prepare to abandon the *Hope Bay*. Being preoccupied with the emergency, and with no time to don an immersion suit, the skipper wore a floater coat.

At 0000 on 26 February 2004, a distress call was broadcast on VHF Channel 16, giving the vessel's position as 51°23.22' N, 129°8.71' W. The call was acknowledged by Marine Communications and Traffic Services (MCTS) in Prince Rupert, B.C.

The skipper, the two crew members, and the fishery observer made their way from the wheelhouse to the port side of the exterior boat deck. The skipper ordered the fishery observer to activate and launch the vessel's emergency position indicating radio beacon (EPIRB), which was fitted in a bracket fixed to the wheelhouse bulkhead. While attempting to do so, the device slipped from the observer's hand and fell to the working deck below. It floated free of the vessel and began transmitting.

At the same time, the mate and engineer lifted the inflatable liferaft from its metal cradle atop the wheelhouse. The liferaft fell to the boat deck where its painter became entangled in the vessel's rigging. The raft then rolled into the sea over the starboard bulwarks and inflated. By order of the skipper, attempts were made to free it by the mate and engineer, however, with the *Hope Bay* heeling heavily to starboard, water began downflooding through the partially open dutch door until the vessel capsized, trapping the liferaft underwater. Without benefit of the liferaft, all persons abandoned the vessel by jumping into the sea.

Events Following the Capsizing

The fishery observer clung to a food freezer which floated free from the boat deck of the *Hope Bay*. The skipper initially clung to the fishery observer, while the two crew members floated nearby.

Meanwhile, at 0003 on 26 February 2004, Prince Rupert MCTS communicated the vessel's distress to Joint Rescue Coordination Centre (JRCC) Victoria. This set in motion search and rescue (SAR) operations. A total of two air and four marine resources were used. A SAR technician rescued the fishery observer from the water and recovered the bodies of two crew members. The body of the skipper was recovered later. At 1416, JRCC closed the *Hope Bay* rescue operation.

Vessel Certification

The vessel was issued a Ship Inspection Certificate (SIC 29) for a commercial fishing vessel not exceeding 150 tons gross tonnage on 30 December 1999, but this had expired on 31 December 2003.

Personnel Certification and Experience

The skipper of the *Hope Bay* held a Transport Canada (TC) Certificate of Competency as Master of a Home Trade vessel of under 350 gross tons, issued on 23 January 1997. He had over 20 years' experience in the commercial fishing industry, including some 10 years in command of the *Hope Bay*.

Neither of the two crew members held certificates of competency, nor were they required to. Both crew members had worked as fishers for more than 10 years. The fishery observer had sailed on the vessel on two previous occasions. Neither the crew members nor the fishery observer had received Marine Emergency Duties training nor was it required. Consequent to the changes in the *Crewing Regulations*, Marine Emergency Duties (MED) training for fishers is now mandatory and is being phased in with completion by April 2008.

Weather

At 1410, 24 February 2004, the Pacific Weather Centre of Environment Canada issued a forecast for Queen Charlotte Sound, predicting southeasterly gales that night.

At 1030, 25 February 2004, the Weather Centre predicted the southeasterly gale force winds to back NE and ease to 15 to 25 knots in the afternoon, easing again to NE 10 to 20 knots at night with seas of 3 to 4 m subsiding to 3 m. The outlook was for winds backing to moderate to strong NW.

The gale warning ended at 1600, 25 February 2004. Winds were predicted to be northeasterly 20 to 30 knots, easing to 5 to 15 knots overnight, with wave heights of 2 to 3 m.

At 0030 on 26 February 2004, Environment Canada's West Sea Otter Group weather buoy located within 15 miles of the vessel's last reported position recorded the wind coming from 140° (T) at a mean wind speed of 16 knots gusting to 21 knots with a significant wave height[5] of approximately 2 m.

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[5] Significant wave height refers to the mean of the one-third highest waves encountered during a period of time.

Environment

At approximately 2330, 25 February 2004, the vessel was in the vicinity of a relatively shallow portion of Queen Charlotte Sound known as Goose Bank. The depth over the area, which covers an area of approximately 800 square miles, is typically 25 to 30 fathoms, with the surrounding depth at least 60 fathoms. Fishers familiar with Queen Charlotte Sound are aware that waves near the perimeter of Goose Bank can become steep and erratic.

Vessel Construction and Modification History

The *Hope Bay,* previously named the *Leroy and Barry,* was constructed in 1967 as a seiner with one large fish hold. In May 1977, this was subdivided into No. 1 port and starboard, and No. 2 port and starboard fish holds, and No. 3 hold. In 1986 the vessel was modified from a seiner to a trawler.

Vessel Stability

As a small fishing vessel of closed construction built before July 1977 and not employed in catching herring or capelin, the *Hope Bay* was not required to have its stability data assessed or approved by TC under the *Small Fishing Vessel Inspection Regulations* (SFVIR). However, a stability report approved on 07 May 1982 stipulated that there be no more than five tons of water ballast in the after peak tank[6] when the vessel is fully loaded. This limit ensures adequate freeboard when fully loaded.

The TSB carried out a post-occurrence stability analysis to assess the transverse stability of the vessel prior to and at the time of capsizing. Taking into consideration modifications made to the vessel after May 1982, current lightship characteristics were determined.

At the time of the occurrence, the vessel had a near-full load of fish, salt water, and ice. Diesel oil tanks Nos. 1 and 2 (P and S) were at about 80% of their capacity. Diesel oil tanks No. 2 (P & S) were likely exceeding their five-ton limit.

The post-occurrence stability analysis was carried out using various down-flooding points, such as the hatches or the dutch door. This was done in a static environment – i.e., one with no wind or waves – for a full load trawling (FLT) condition. The results show the vessel would have met the stability criteria of STAB 4, but that the hatches would have been awash and even immersed at a relatively small angle of heel (15˚ for hatch No. 1). For this condition, the freeboard of the deck at midships would be about 0.42 m (1.38 feet).

The wind and wave effects at various angles of encounter and wave lengths were later considered in a more realistic environment – again, with the vessel in FLT condition. Results show that the vessel's ability to right itself was reduced significantly, below the STAB 4 criteria.

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[6] The port and starboard after peak tanks were converted for use from water ballast to diesel oil.

Covers for Openings into Holds and Deck Scuttles

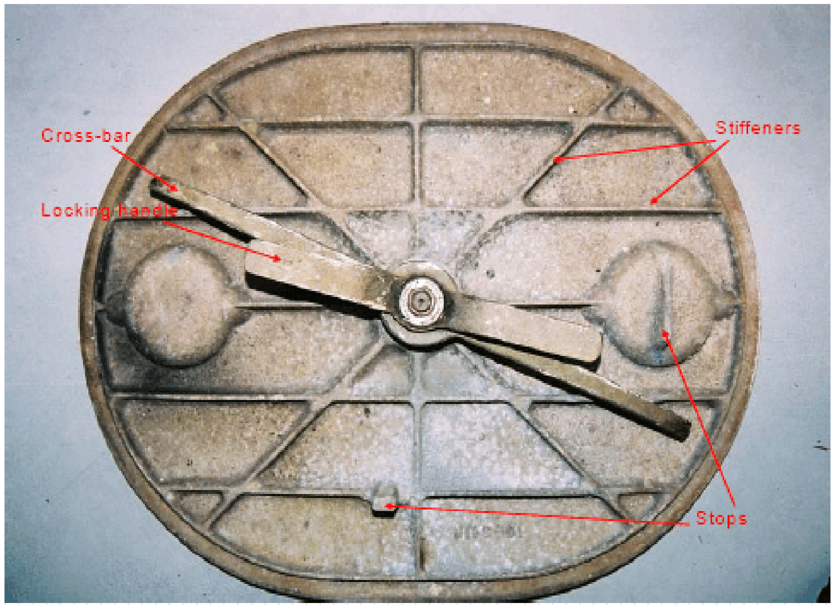

Photo 2. Underside of manhole cover similar to those on the working deck.

Five hatch covers, six manhole covers, and four deck scuttle covers located aft of the accommodation provided access to below-deck compartments. Each cover was designed to be weathertight, and each was on a coaming 15 cm above the deck plating except for No. 1 fish hold hatch coamings, which were 30 cm above the deck. The hatch covers were designed to close and seal tightly against a gasket and were secured in position by means of a bolting arrangement. The deck scuttles were 30.5 cm in diameter, and the closing arrangement was similar to that of the manhole covers. Entry into, and exit from, the holds was via oval-shaped manholes in the weathertight hatch covers / working deck (see Photo 2).

The TSB has carried out extensive testing to two manufacturers' designs of single cross-bar type manhole covers similar to those used on board the *Hope Bay*. This has revealed several inherent safety deficiencies:

- the operator is unable to see the cross bar when it is tightened from the deck of the vessel. There is a lack of visual and reliable tactile feedback that the cover has been correctly closed.

- an aluminum cover tends to warp under the influence of excessive loads and does not provide an effective seal.

- the short lever arm of the tee handle used for tightening does not allow sufficient torque to be created. In conjunction with the tubular nature of the O-ring, this creates a condition where the cross bar loses its initial pre-tension and becomes free.

- a combination of too-short cross bar stops and the large clearance between the spindle head and cover allows the cross bar to slip past the stops, leaving the cover inadequately secured.

- the design of the cover and the cross bar does not allow uniform distribution of the tightening force along the oval cover's long axis. Under an applied load, the cross bar acts as a fulcrum, allowing the opposite end of the cover to lift off the O-ring.

- the left-hand thread and consequent clockwise-to-open rotational direction of the spindle is counterintuitive, leading to incorrect operation.
- the manufacturers of the manhole covers do not provide their customers with operating or maintenance instructions.
- an unsecured manhole cover is vulnerable to being lifted off by wave action, leaving a compartment open to downflooding.

These deficiencies make the covers prone to water leakage.[7]

Lifesaving Equipment

The *Hope Bay* carried lifesaving equipment as required by regulations. This equipment included an eight-person inflatable liferaft, a four-person boat, two life rings, five universal size immersion suits, five lifejackets, and an EPIRB.

Liferafts are commonly stowed on top of the accommodation and wheelhouses of fishing vessels. In this instance, the liferaft was atop the wheelhouse in the vicinity of the boom and rigging. When deployed, it became entangled in the rigging and was unusable when the vessel capsized on top of it. There was no time for the crew to attempt to launch the four-person boat, which was lashed to the boat deck.

The Board has previously addressed shortcomings in liferaft stowage and accessibility.[8] In response, TC issued Ship Safety Bulletin (SSB) 09/1993, highlighting the recommended practice for the stowage of throw-over type inflatable liferafts. One recommended practice was that liferafts should be stowed such that, when lifted from their cradles, they can be deployed over the side of the vessel. In addition, TC initiated a study to consider methods of improving the stowage of life-saving equipment on board fishing vessels. One objective was the development of a low-maintenance, cost-effective, safe, and efficient system for the stowage and deployment of small liferafts. However, the study was never completed. In the proposed *Fishing Vessel Safety Regulations,* anticipated to be completed in 2008, TC intends to pursue provisions that will require all liferafts to be stowed such that they will float free if a fishing vessel capsizes and sinks.

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7 A detailed description of the manhole cover and its deficiencies is provided in the report titled *Single Cross Bar-Type Manhole Covers - M04W0034*, dated 15 February 2005, and is available upon request.

8 TSB Recommendation M93-03.

Immersion Suits Worn by Personnel

Two crew members and the fishery observer donned immersion suits supplied by their employers. Examples of the two types of suits worn can be seen in Photo 3. The fishery observer, who wore a newer-model suit, (shown in the left-hand photograph) was recovered after three hours of cold water immersion. When rescued, the wearer's undergarments were wet to the waist but he was still warm.

Photo 3. Typical universal size immersion suits used by personnel.

By comparison, cold water filled the suits of both crew members who succumbed to hypothermia. The immersion suits used by the two crew members were approximately 15 years old. One crew member's suit was found to be partially unzipped in the area of the neck and face seal. The second crew member's suit had a pinhole on the right biceps area. The design of these suits required the cuffs to be tucked inwards to prevent water from entering at the wrists. It is not known whether the cuffs of the crew members' suits were tucked in, but it is known that the manufacturer's instructions accompanying each suit at the time of purchase did not include this information.

Immersion Suit Standard

The Canadian General Standards Board[9] (CGSB) immersion suit standard was developed under the premise that the suit would be used for 'rapid uncontrolled use.'[10] The standard is intended to increase survival capability by reducing thermal shock upon entry into cold water, delaying the onset of hypothermia during immersion in cold water, providing acceptable flotation, and minimizing the risk of drowning. The current standard

Suit Size	Body Height (cm)	Body Mass (kg)
Adult		
Small	120 to 170	40 to 100
Universal	150 to 200	50 to 150
Jumbo	170 to 220	100 to 150 or greater
Custom	Any height	Any mass
Child	100 to 150	18 to 40

Table 1. CGSB Marine Abandonment Suit Sizes

9 Canadian General Standards Board Immersion Suit Systems CAN/CGSB-65.16-99.

10 The suit must fit most people and be able to be donned rapidly.

employs height and weight criteria[11] for suit sizing. Suits are available in three adult sizes (small, universal, jumbo) and one child size. They can also be custom fit (see Table 1). However, the majority of suits are of the universal size.

The provision of a specific level of thermal protection is the main criterion in the production of immersion suits. Manufacturers meet or exceed CGSB thermal protection requirements by maintaining a balance between the loss of heat associated with water ingress into the suit and minimizing heat loss through increased insulation. There is a maximum acceptable leakage specified in the standard.

To assess thermal protection, tests are conducted using both humans and mannequins[12]. Human subjects, selected from defined areas along the regression line for height and weight of the general population, are used to determine the amount and location of water ingress when jumping into water from a height of at least 3 m and swimming on one's back in a pool with a water temperature of not less than 18˚C. A mannequin is next used to determine the suit's thermal insulation. The same amount of water as found in the jump test and three times that recorded in the swim test is introduced in the previously identified locations and the mannequin is immersed in turbulent water with a wave height of 40 cm and 2˚C.

General Practices Respecting Immersion Suits

The CGSB standard requires that information at the point of sale be made available regarding the use of the suit system, and should include the following:

- a description of the suit system;
- its maintenance and cleaning instructions, and
- depiction of donning instructions on the exterior of the storage container.

However, the investigation revealed that:

- the buyer seldom takes the time to look at instructions prior to purchasing a suit;
- the seller does not always make the buyer aware of the features/ limitations of the suit;
- immersion suits are not tried for size either at the time of purchase or later for maintenance purposes, and
- practice drills to don the suit are rarely carried out. Instead, suits are usually purchased and then stowed until an emergency arises.

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11 The data used is 1997 Canadian Forces Land Forces anthropometric survey.

12 For information on test procedures see Canadian General Standards Board Immersion Suit Systems CAN/CGSB-65.16-99. For jump test procedure see Section 8.1.6.1 (a). For leak test procedure see Section 8.1.6.1 (b). For thermal protection testing procedures see Section 8.1.6.2.

Safety Issues of Immersion Suits

The Board, concerned by the risks exposed to Canadian fishers in survival situations in hostile waters, has apprised TC of the following issues in a number of investigation reports:

- shortcomings in the maintenance of immersion suits[13]
- lack of donning drill requirements[14]
- insufficient training and education[15]
- expediting the regulatory process regarding immersion suit carriage requirement[16]

In response:

- TC has proposed an amendment to the SFVIR that would make the carriage of anti-exposure or immersion suits for each member of the complement mandatory. However, due to opposition from some fishing interest groups, who cited the cost and discomfort of wearing such suits, the amendment did not receive approval.

- TC issued SSB No. 11/2000 emphasizing that an immersion suit:

  - should be unpacked and inspected periodically;

  - should be refolded at different locations before re-storing to minimize stresses on welded/glued seams and reduce material failures that could result in leaks;

  - zippers must be maintained and lubricated at regular intervals;

  - repairs must be done by the manufacturer, an agent authorized by the manufacturer, or any other manufacturer who can demonstrate a proficiency acceptable to TC; and

  - should be maintained onboard as per manufacturer's instructions.

The IMO [17] has established guidelines for periodic testing of immersion suits; however, such testing is not required in Canada.

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[13] via TSB Reports M90L3034, M95W0013

[14] via MSA 07/00, TSB Report M00N0009

[15] via MSI 24/91, TSB Report M90L3034

[16] via TSB Recommendation M92-07, TSB Report M90N5017
Safety Concern - TSB Report M98L0149

[17] Document DE 46/13

Under the SFVIR, TC does not require small fishing vessels (some 19 500 vessels across Canada) to carry immersion suits, placing those aboard at risk. However, the Workers' Compensation Board of British Columbia (WCBBC) requires a good-quality, properly fitting suit to be on board for each crew member. In the proposed Fishing Vessel Safety Regulations, TC intends to require fishing vessels under 24 m to carry immersion suits for each member of the complement. Vessels on voyages nearer to shore may carry anti-exposure suits in lieu of immersion suits.[18]

Both the CGSB standard and the WCBBC require that an individual should be able to unpack and properly don the immersion suit unassisted within two minutes.

Analysis

Problems associated with the lack of adequate stability and watertight integrity, as well as factors affecting crew survivability, continue to compromise fishing vessel and crew safety. As the vessel sank and was not available for visual inspection, the condition of the watertight integrity of the vessel was evaluated. The analysis is presented within the context of these three elements.

Vessel Stability

In the sea conditions encountered by the *Hope Bay*, the working deck would have been periodically submerged by wave crests passing along the vessel's hull and would be awash through the freeing ports. In quartering or beam seas, the vessel would be rolling, and the combined effect of rolling and periodic submergence of the deck at side created an accumulation of water on deck. Under such circumstances, the effect of the sea state is considered a contributing factor, especially once the vessel reached Goose Bank and encountered the steep waves known to exist in that area of rapidly shallowing water.

After analyzing the cumulative effect of wind, waves, and water on deck in the FLT condition, it was determined that the freeboard and the vessel's ability to right itself was reduced to about 55% of the STAB 4 criteria. At this stage, with a relatively small reserve of stability and the deck periodically awash, the weathertight integrity of deck openings became critical.

In case of any flooding, the vessel would be in a vulnerable condition, and any of the following factors would exacerbate the situation:

- movement of liquids in the slack diesel oil or fresh water tanks;
- rudder hard to port;
- extra weight from undocumented items;
- extra weight from fish trapped in the net on the after drum;
- varying buoyancy forces along the hull caused by moving through wave crests and troughs;

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18 TC's Winter/Spring 2005 consultation paper on the proposed Fishing Vessel Safety Regulations, which are expected to be completed in 2008.

- height of some waves encountered by the vessel exceeding the significant wave height; and
- period of waves similar to the natural rolling period of the vessel.

Considered individually and in a static environment, these factors should not have a serious adverse impact on the vessel's stability. However, in a dynamic environment, their cumulative effect could produce an additional heeling moment and heeling angle sufficient to overcome the small margin of stability, leading to the vessel's capsize. Downflooding through deck openings or the dutch door would ultimately have eliminated the vessel's ability to retain positive stability. As designed, the vessel should have had sufficient stability to withstand the sea conditions encountered. For it to have thus capsized, downflooding had to have taken place through deck openings into below-deck compartments. This is consistent with the study that concluded that the decks of the vessels with this design would be wet and that watertight integrity is paramount for safe operation of these vessels.[19]

Source of Downflooding

There is no information to suggest that the hatch covers were defective. They were bolted down, and not used at sea during fishing operations, further reducing the likelihood of water ingress from this source. Closing arrangements for deck scuttles were similar to those of the manholes, and neither type of cover provided the operator with any indication that they were securely closed. It is therefore likely that either the manhole covers or the deck scuttles were the primary source of water ingress.

As Nos. 1 and 2 fish holds were filled with fish, salt water, and ice, ingress of water through their respective manhole and fish scuttle covers would have had little effect on the vessel's stability. However, No. 3 hold was empty - and it had sufficient capacity to capsize the vessel should it flood under the conditions prevalent at the time. As the deck scuttles for the No. 3 hold had not been used for a number of years, this leaves the manhole opening to the No.3 hold as the most likely primary source of the downflooding. Calculations show that an opening as little as 3.5 cm^2 – which would be consistent with a gap around a loose manhole cover – would flood half the compartment over a period of 10 hours. Any flooding in excess of this would cause the vessel to heel. The upper part of the dutch door was open while the vessel was heeling heavily to starboard; ultimately, this would have created a major downflooding point, eliminating the vessel's ability to retain positive stability.

Accessibility of Liferafts

In this occurrence, the vessel capsized on top of the liferaft, rendering it inaccessible.

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[19] Following the sinking of the *Lady Audette II* and the *Lady Dorianne II*, TC commissioned a study of the *Leroy and Barry (Hope Bay),* entitled *Stability in Waves, Project No. 20.94. National Physical Laboratory, Ship Divvision, England, 1 June 1973.*

In situations where the crew is forced to abandon a vessel, protection from the serious adverse effects of being immersed in cold water is a major factor in survival. Ideally, a crew, wearing immersion suits, attempts to abandon the vessel and board the liferaft without entering the water. To facilitate rapid abandonment, liferafts are to be stowed in a location from which they can be readily launched. However, it is common for liferafts to be positioned on top of the wheelhouse where they are unlikely to interfere with fishing operations. In such circumstances, crew members must make their way to the top of the wheelhouse to release a liferaft from its cradle.

As the wheelhouse top does not always extend to the ship's side, and as there is no means to readily launch a liferaft from such a stowed position, crew members must lower it to the main deck before deploying it over the side of the vessel. The difficulty of completing this operation is significantly increased as a vessel pitches and rolls.

A vessel's size and the limitations imposed by its operational requirements pose challenges for liferaft stowage. Some challenges include:

- A liferaft stowed at the main deck level forward of the accommodation will occasionally be subjected to wind and waves during inclement weather and can be lost at sea.

- A liferaft stowed high above the main deck level, or on the centre line, poses problems because it has to be manhandled in difficult circumstances.

- A liferaft positioned near either the port or starboard side will be difficult to launch if the vessel is heeling in the opposite direction.

Taking into consideration the design and layout of the vessel, options are available to help ensure that liferaft stowage is in an optimum position for ready deployment. These include:

- a stowage location adjacent to the ship's side;
- a cradle design allowing the ready launch of the liferaft clear of the vessel's side;
- the provision of a mechanical launching mechanism with minimum maintenance requirements; and
- the provision of a physical barrier to prevent fouling of the rigging during launch.

Immersion Suit Performance[20]

A properly fitted and well-maintained immersion suit is essential to prolonging survival in the water. The death of two crew members who were wearing abandonment suits would suggest that excessive sea water entered the suits, reducing their thermal protection. The pinhole on the right biceps of one suit, combined with likely leakage at the untucked wrist seals, and the unfastened neck and face seal zipper on the other suit, would account for this.

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[20] A detailed report *Immersion Suit Issues - M04W0034* is available upon request.

Validation of Immersion Suit Testing

Actual conditions of use will usually exceed testing-standard requirements. In practice, the wearer is likely to abandon a vessel under emergency circumstances that include hostile conditions such as open seas, large waves, swells, and near-freezing sea temperatures. The wearer may well have to swim face down while attempting to clear a sinking vessel, or have his or her face frequently covered by a series of approaching waves, some of which could exceed 40 cm – the criteria established for suit testing.[21]

Moreover, because the swim test – an integral part of the standard – must be conducted in controlled facilities, the test has never been validated against realistic conditions.

Universal Size and Testing Criteria

The immersion suit standard uses both height and weight criteria for sizing. Testing methods for the universal size immersion suit may not account for all body types. As a result, some wearers may not properly fit into the universal suit size and may be at risk.

The use of other criteria beyond height and weight might better aid suit design, allowing for improved fit of seals and more closely fitting suits.[22] However, such an approach may also require more suit sizes, negating the principle of a universal suit size.

Donning Drills

Deaths due to inadequate maintenance and inspection of suits continue to be a problem. Although donning drills increase user familiarity with an immersion suit and reduce donning time, drills that include immersion in water can also ensure that:

- the suit is in a good state of repair, and
- the suit fits well and forms an effective seal at the face and wrists.

Despite initiatives taken by regulatory agencies to educate fishers on the need to conduct donning drills, the problem persists. Buyers seldom take time to read suit instructions, nor do they don a suit prior to its purchase, and sellers seldom inform buyers of suits' features and limitations. Additionally, all necessary information is not always available at the point of sale. Fishers, therefore, will continue to be at risk of having both improperly sized and poorly maintained immersion suits which, when used in an emergency, will not provide the necessary level of thermal protection. A rigorous, targeted approach to raise awareness of the advantages of donning immersion suits on a periodic basis will help foster this practice and ensure that immersion suits are fit for their intended service.

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[21] As noted in the Weather section of this report, significant wave height in the area was reported as 2 m.

[22] The clothing industry, for example, sizes garments according to a number of variables, including chest circumference, waist girth, and neck circumference.

Findings as to Causes and Contributing Factors

1. The loaded condition of the vessel and the sea conditions encountered made the vessel vulnerable to shipping water on deck and through the freeing ports.

2. The vessel lost transverse stability in a manner consistent with the accumulated free surface effect of water shipped and retained on deck and water downflooding into interior spaces.

3. It is most likely that water on deck first flooded into the No. 3 hold through a leaking manhole cover or deck scuttle, and subsequently through the open dutch door, until the vessel lost all positive stability and capsized.

4. An effective immersion suit drill, including immersion in water, would have identified incorrect sizing and maintenance-related issues.

Findings as to Risk

1. The design of the manhole cover has deficiencies that may allow water ingress and thus detrimentally affect stability.

2. As the swim test used for testing immersion suits has never been validated against realistic weather and sea conditions, suit performance may be inadequate in conditions normally encountered.

3. The universal size immersion suits may not fit every body type equally well, permitting excess water leakage into the suit and thereby reducing thermal protection.

4. The common and less-than-optimal positioning of the liferaft on small fishing vessels hampers rapid deployment in an emergency, depriving the crew of valuable lifesaving equipment.

Safety Action

Action Taken

Standards for Marine Abandonment Suit Systems

On 19 August 2004, the Transportation Safety Board (TSB) sent Marine Safety Advisory (MSA) 04/04 to the Marine Abandonment Immersion Suit System Committee of the Canadian General Standards Board (CGSB), identifying a concern that universal size immersion suits do not fit all body types equally well.

In response, the committee amended the standard Immersion Suit Systems (CAN/CGSB-65.16-2005)[23] so that the following information will be made available to purchasers of suits at the point of sale:

- the effectiveness of the suit system in preventing hypothermia and possibly death depends upon it fitting well enough to prevent the ingress of water;
- although the universal size immersion suit system has been designed to fit the majority of individuals, the suit does not fit all body types equally well;
- a reminder that each person takes the initiative, where possible, to ensure that his/her immersion suit system is properly sized;
- a description of the suit system;
- instructions for maintenance and cleaning;
- instructions concerning the fitting and operation of a personal locator light;
- instructions on the operation of the inflatable element, if any, and instructions on when and how to use it.

The standard was also amended to require the following:

- proper donning procedures and other operational instruction on the use of the suit system shall be simple and obvious;
- instructions for donning and wearing shall be on the exterior of the stowage container;
- these instructions shall also be available in a form suitable for mounting on a bulkhead and insertion into the ship's training manual as applicable.

The committee also indicated that Transport Canada has funded research to confirm the validity of the leakage test. This will include testing representative suits at sea under realistic conditions. In addition, TC has funded research to examine whether height and weight are the best criteria for designing universal-size suits, and, if not, to provide recommendations for improving the sizing criteria.

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[23] Published November 2005.

Donning Drills and Durability Aspects of Immersion Suits

On 12 October 2004, TSB sent MSA 05/04 to TC, which was copied to the Marine Abandonment Immersion Suit System Committee of the CGSB, informing both parties of the potential deficiency associated with poor-fitting, poorly maintained immersion suits and the absence of regular donning of suits during safety drills.

In response, TC indicated it would consider formally including the importance of regular maintenance and inspection of immersion suits in the syllabus of training courses for inspectors. In October 2006, the Marine Safety National Training Program (NTP) incorporated the subject of maintenance and inspection of immersion suits, as part of the Lifesaving Module in the Vessel Inspection Course, which is mandatory for all Marine Safety Inspectors in Transport Canada.

In a separate response to MSA 05/04, the Committee indicated it recommended to TC that it implement a program of regular donning drills, regular inspection, and maintenance schedules for suits, and that an expiry date be established to denote each suit's wearability.

Marine Emergency Instruction Concerning Immersion Suits on Canadian Fishing Vessels

On 01 November 2004, TSB sent MSA 06/04 to all TC-approved Marine Emergency Duties (MED) course providers in Canada, which was copied to TC, again noting the safety risks associated with poor-fitting, poorly maintained immersion suits and the absence of regular donning of suits during safety drills.

In response, TC indicated that it has revised TP 4957 - *Marine Emergency Duties Training Program*, after circulation to marine schools for comments. The final version of TP 4957 will come into force at the same time as the relevant section of the new *Canada Shipping Act 2001*, on 01 July 2007.

One immersion suit manufacturer has submitted for CGSB approval a set of printed donning instructions to be made available at the time of purchase. The instructions will advise the purchaser to:

- tuck in wrist seals, and
- obtain a complete inspection by a certified inspection/repair facility at least every two years.

Adequacy of Single Cross Bar-Type Manhole Covers

On 15 February 2005, TSB sent MSA 01/05 to TC concerning potential deficiencies associated with single cross bar-type manhole covers, specifically, of the potential for water to leak into below-deck compartments.

TC responded that at the present time there is no requirement for manhole covers to be type-approved. However, the proposed Fishing Vessel Construction Standard, due to come into force in late 2007, will require manhole covers to be type-approved and subjected to hose test. In the interim, TC is in the process of issuing a Ship Safety Bulletin (SSB) concerning the potential safety deficiencies of manhole covers. To date, no SSB has been issued.

In June 2005, Pacific Coast Fishermen's Mutual Marine Insurance Company advised its members, and the fishing industry as a whole, of the potential deficiencies associated with this type of manhole cover and its single-bar type of locking mechanism.

Safety Concern

The proposed Fishing Vessel Construction Standards were initially due to come into force in late 2006 but are now due in late 2007. These standards will require manhole covers to be type-approved and be subject to a hose test. Currently there are no requirements for such covers to be type-approved.

In the interim, TC was to consider issuing a Safety Bulletin to bring the potential safety deficiencies of these covers to the attention of mariners nationally. The issue was also to be brought to the attention of regional TC inspectors.

To date, no Bulletin has been issued and the Board is concerned that the delay in issuing of the Fishing Vessel Construction Standards and the lack of a Bulletin warning the industry of the safety deficiencies relating to manhole covers continue to put vessels and their crews at risk.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 13 June 2007.

*Visit the Transportation Safety Board's Web site (**www.tsb.gc.ca**) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.*

Appendix A - List of Supporting Documents

The following TSB reports were completed and are available on request:

- *Stability Report M04W0034 Small Fishing Vessel Hope Bay*.
- *Single Cross Bar-Type Manhole Covers - M04W0034*, dated 15 February 2005.
- *Immersion Suit Issues - M04W0034*

Appendix B - Glossary

B.C.	British Columbia
CGSB	Canadian General Standards Board
cm	centimetre
EPIRB	emergency position indicating radio beacon
FLT	full load trawling
IMO	International Maritime Organization
JRCC	Joint Rescue Coordination Centre
kg	kilogram
kW	kilowatt
m	metre
MCTS	Marine Communications and Traffic Services
MED	Marine Emergency Duties
MSA	Marine Safety Advisory
MSI	Marine Safety Information Letter
N	north
N.B.	New Brunswick
NE	northeast
P & S	port and starboard
SAR	search and rescue
SFVIR	*Small Fishing Vessel Inspection Regulations*
SIC	Ship Inspection Certificate
SSB	Ship Safety Bulletin
STAB 4	*Stability, Subdivision and Load Line Standards - Section 4*
T	true
TC	Transport Canada
TSB	Transportation Safety Board of Canada
VHF	very high frequency
W	west
WCBBC	Workers' Compensation Board of British Columbia
°C	degree Celsius