Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A05A0155

COLLISION WITH WATER

TRANSPORT CANADA AIRCRAFT SERVICES
MBB BO105 (HELICOPTER) C-GGGC
MARYSTOWN, NEWFOUNDLAND AND LABRADOR, 2.5 nm E
07 DECEMBER 2005

Canada

Aviation Investigation Report

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Summary

The Messershmitt-Bolkow-Blohm (MBB) BO105 helicopter (registration C-GGGC, serial number S617) was being used for various tasks associated with the upkeep and operation of lighthouse and coastal navigation facilities in the Burin Peninsula area of Newfoundland and Labrador. While returning to Marystown in the late afternoon of 07 December 2005, with one pilot and one passenger on board, the helicopter encountered heavy snow showers and, at about 1628 Newfoundland standard time, the helicopter crashed into the water of Mortier Bay, east of Marystown. Both the pilot and the passenger survived the water impact and escaped from the helicopter. However, the pilot perished from hypothermia, and the passenger drowned.

Ce rapport est également disponible en français.

Other Factual Information

Weather

The Atlantic graphic area forecast (GFA)[1] weather chart, issued at 0751 Newfoundland standard time,[2] forecast the weather in the Burin Peninsula area, Newfoundland and Labrador, to be ceilings of 2500 feet above sea level (asl), visibility of two to six statute miles (sm) in light snow showers with scattered areas of stratocumulus clouds giving ceilings of 400 feet asl and visibilities of ½ sm in snow. The winds were forecast to be from the west gusting to 30 knots.

History of the Flight

The Canadian Coast Guard (CCG) helicopter, operated by Transport Canada (TC) Aircraft Services Directorate (ASD) as call sign CG352, was based in St. John's, Newfoundland and Labrador. On the day of the accident, the first task was to move personnel and supplies to the Green Island lighthouse, which is located 7 nautical miles (nm) off the southern tip of the Burin Peninsula. CG352 was then to proceed to Marystown, Newfoundland and Labrador, to pick up a CCG technician and transport the technician to various coastal navigation facilities around the Burin Peninsula.

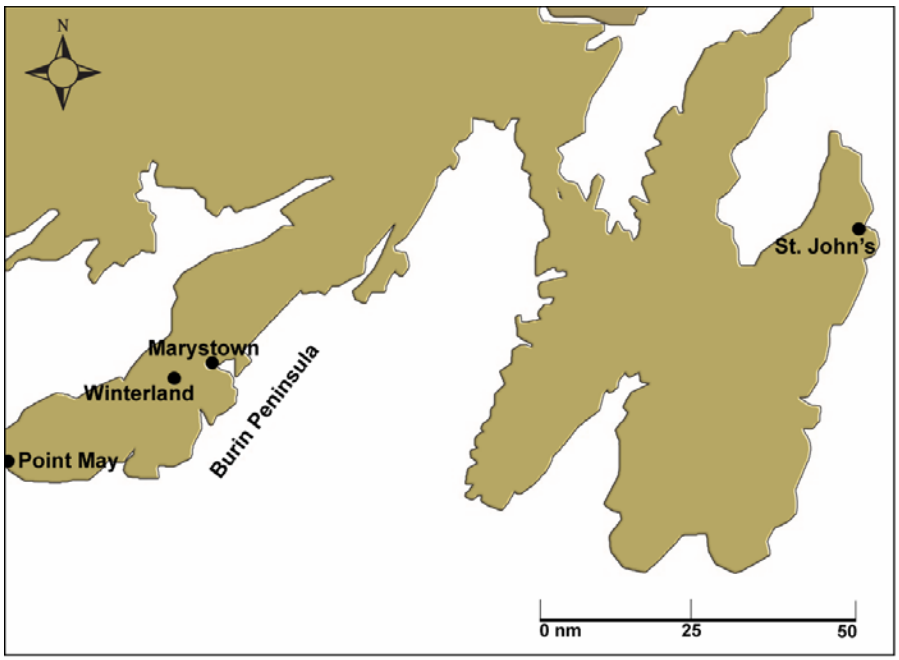

Figure 1. Burin Peninsula area

On the morning of the accident, the pilot filed a visual flight rules (VFR) flight plan in St. John's for the day's flying in the Burin Peninsula area. The final destination on the flight plan was Marystown with an expected arrival time of 1500. Flight following for CG352 was through the

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

2 All times are Newfoundland standard time (Coordinated Universal Time minus three and one-half hours).

CCG's Marine Communications and Traffic Services (MCTS). CG352 departed St. John's at 1029 with one passenger. After take-off, the pilot contacted MCTS advising of his departure and intentions.

The first leg was to the Winterland Airport, located 7.5 nm west of Marystown, for a fuel stop. The flight was uneventful until about 4 nm east of Marystown, where the helicopter encountered a heavy snow squall. Because of the reduced flight visibility, the pilot descended to a lower altitude, reduced speed, and followed the northern shore of Mortier Bay towards Marystown. Because of the weather conditions, the helicopter landed at the Marystown shipyard at about 1148. The pilot radioed the MCTS advising of the unscheduled landing, and the helicopter was shut down. About 30 minutes after landing, the weather improved significantly. The pilot and passenger cleared the helicopter of snow, and continued the flight to the Winterland Airport, where the helicopter was fuelled. Another snow squall at the Winterland Airport delayed departure for about 30 minutes.

When the weather cleared, the helicopter was flown to a rendezvous point at Point May on the southern tip of the Burin Peninsula. A change of keepers at the Green Island lighthouse was completed at about 1400. The pilot radioed the MCTS that he was en route to the Winterland Airport for fuel, and would then proceed to the staging area in Marystown to meet with the CCG technician. The helicopter was refuelled once more at the Winterland Airport, and then was flown to the Marystown staging area, landing at about 1452. The pilot advised MCTS of the helicopter's movements during the flight.

At 1501, while on the ground at Marystown, the pilot used the helicopter's cellular telephone to contact the Halifax Flight Information Centre (FIC). During the call, the pilot extended his flight plan to 1700, the end of local evening twilight, and received a weather update from the FIC. The FIC advised that weather radar showed moderate radar echoes west of Marystown, moving from the west to the east, indicating the possibility of snow showers in the Marystown area. At this time, light snow was falling at the Marystown staging area.

After loading the helicopter, the pilot and his passenger flew to a helicopter landing pad at Go By Point, at the entrance to Mortier Bay. This was a very short flight because Go By Point is only 3 nm southeast of Marystown (see Appendix A). The Go By Point landing pad is situated on steep and rocky terrain next to a marine navigation light (see Photo 1). At 1517, the pilot reported to the MCTS that he had landed at Go By Point and anticipated one hour of work. He then shut down the helicopter, and he and the passenger disembarked.

Photo 1. Go By Point looking north

While at Go By Point, the pilot took several photographs. In two photographs, he captured the navy vessel Her Majesty's Canadian Ship (HMCS) *Goose Bay* approaching the entrance to Mortier Bay. The photographs showed sunny conditions, and the sky to the west, south, and east was clear with unrestricted visibility. The last photograph was of HMCS *Goose Bay* adjacent to Go By Point as it sailed north into Mortier Bay for Marystown. The ship was at this position at 1526. At 1530, security cameras, located at Cow Head, 3.5 nm north of Go By Point on the northern shore of Mortier Bay, showed a heavy snow shower underway. The security cameras recorded uninterrupted snowfall from 1530 until 1630, with intermittent periods of heavy snow and reduced visibility. HMCS *Goose Bay* encountered worsening weather during its transit into Marystown: from sunny and clear at Go By Point to overcast with visibility reduced at times to 100 yards in snow squalls.

There were no radio communications from the pilot to MCTS after departure from the Go By Point pad. Therefore, the exact time of the helicopter's departure from Go By Point is not known. After departing Go By Point, the helicopter circled small Duck Island, which is just east of Go By Point, at a low altitude. Work was planned the following day at Duck Island, and the pilot and passenger were likely assessing the landing point at the island. The helicopter then proceeded north over the eastern shore of the entrance to Mortier Bay following the shoreline around the north side of Mortier Bay. At that time, it was not yet dark, and light snow was falling at Go By Point. The helicopter continued north along the eastern shore of the channel entrance, crossing Spanish Room Point about 1 nm south of Cow Head. The helicopter then proceeded west towards Marystown along the northern shore of Mortier Bay. When last observed, the helicopter was about 1 nm east of Marystown, flying slowly at low altitude, in heavy snow and in near dark conditions.

According to Transport Canada's operations manual for CCG helicopters (OM), flight operations in uncontrolled airspace are not authorized "…when the reported visibility is less than one (1) mile. Visual reference to the surface must be maintained at all times. If visibility is deteriorating during a flight the PIC [pilot-in-command] must decide to slow down, land and/or reverse course early enough to avoid losing visual reference." As the visibility deteriorates, pilot workload rises appreciably as it becomes necessary to maintain constant attention to outside visual cues.

The passenger in the helicopter was carrying a cellular telephone, which was continuously on the cellular network on the day of the accident until 1628. This time is consistent with estimates of the time of the accident. At 1800, one hour after the expected time of arrival as indicated on the flight plan, and in accordance with normal procedures, the helicopter was reported overdue to the Joint Rescue Coordination Centre (JRCC) by the Halifax FIC. A search was then initiated using ground, sea, and air resources. The bodies of the pilot and passenger were located and recovered from the water near Gould's Cove later that night.

Wreckage and Impact Information

The helicopter was equipped with an underwater locator beacon (ULB). The ULB is designed to activate upon immersion and to transmit an acoustic signal at 37.5 kilohertz (kHz). This signal propagates well in water and is normally easily detected using portable hydrophone detection equipment. An intensive hydrophone search for the beacon was commenced on

09 December 2005, but the beacon signal could not be detected. Test beacons were then lowered to the bottom. These were easily detectable at distances of over 1 sm. A malfunction of the helicopter's ULB was suspected.

The area was then searched using side-scanning sonar with remotely operated vehicles investigating the sonar contacts. The helicopter was located on 17 December 2005, 1000 feet northeast of Big Head, in about 100 feet of water. All major components were accounted for and were near the main fuselage. The close distribution of wreckage items on the sea bottom was consistent with a helicopter that was intact when it struck the water.

The helicopter was recovered on 18 December 2005 and was shipped to TSB facilities in Dartmouth, Nova Scotia, for further examination. Examination of the helicopter did not reveal any pre-existing mechanical abnormalities that could have contributed to the occurrence.

Impact marks showed that there were two distinct collisions with the water. The first impact was tail low, in forward flight. This impact tore open the cloth covering of the pop-out floats, and removed the spoiler from the lower belly of the helicopter. The tail boom, including the tail rotor, would have been immersed in the water. The tail boom was torn from the helicopter fuselage in an upward direction towards the right. The impact also deformed the engine and transmission deck, causing the failure of both engine drive shafts from the main transmission. The helicopter then skipped off the water, and rotated because of the loss of tail rotor drive. The second impact was rearward. Both of the front seats were found with their seat backs leaning markedly backwards. Also, the liferaft mount, which is located between the front seats, failed at the forward attachment bolts, pinning the liferaft firmly against the centre rear passenger seat.

Both of the helicopter's engines were operating at the time of impact, with the damage to both engine input shafts suggesting that the engines were delivering significant power. The helicopter is certified for flight in falling or recirculating snow provided the particle separator, engine anti-ice and continuous ignition switches are selected to ON. These switches were found in the OFF position.

Personnel Information

The pilot held a valid medical certificate and commercial helicopter licence. He was not instrument rated and did not have a night endorsement. The pilot had been flying helicopters for the CCG in Newfoundland for 27 years. He was highly regarded as a competent pilot and had accumulated over 20 000 helicopter flying hours. In the previous 30 days, he had flown 21 hours, and in the previous 90 days, he had flown 42 hours, all on the MBB BO105. The pilot had received recurrent ground and flight training in November 2005 and had successfully completed an annual pilot proficiency check (PPC) in November 2005. He also received pilot decision making (PDM) and human factors training in November 2005.

Helicopter Information

The accident helicopter was manufactured in 1983. It was maintained by TC ASD personnel and flown by TC ASD pilots. A review of the documentation indicated that the helicopter had been maintained in accordance with existing regulations and approved procedures. All

modifications, mandatory airworthiness directives, and required maintenance had been completed. The helicopter had flown about 6530 total hours, including 1438 hours since the completion of the last scheduled major airframe inspection (OPS 4) on 28 December 2000. It had undergone a 100-hour inspection on 14 October 2005, about 42 flight hours before the accident flight. The helicopter's technical records did not indicate any outstanding or recurring maintenance items.

The helicopter's weight and centre of gravity were within the prescribed limits. The helicopter was not equipped with a flight data recorder or a cockpit voice recorder, nor were they required by regulation.

The helicopter was equipped with emergency flotation devices, commonly referred to as pop-out floats. The floats are meant to increase the survivability of a ditching[3] by slowing the rate at which a helicopter will sink. If the helicopter is to be flown over water at airspeeds below 60 knots, the pilot should normally arm the pop-out floats. The float arm switch was found in the OFF position.

Survival Aspects

In a water impact or a capsizing event, the occupants of a helicopter face serious and immediate survival challenges. The need to escape from a capsized helicopter is immediate, but egress can be difficult due to injuries, disorientation, cold water shock, and/or the inability to breath. Commercial offshore helicopter operators and the petroleum industry have recognized the importance of helicopter egress and survival training. In these types of operations, egress and water survival training is mandatory for all crew and passengers. None of those who flew on CG352 on the day of the accident had received helicopter emergency egress/water survival training. Regulations do not require this training, and it was not required by the operator. However, training was offered annually to ASD employees who wished to receive it.

Survival Equipment Installations

In addition to the emergency pop-out floats that are used during a ditching, CCG helicopters carry a liferaft and, in accordance with applicable *Canadian Aviation Regulations* (CARs), two emergency locator transmitters (ELTs): a type AF[4] and a type W.[5] With the exception of the

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3 Ditching is defined as an emergency landing on the water, deliberately executed, with the intent of abandoning the helicopter as soon as practical.

4 Type AF—automatic fixed. This type of ELT is automatically set in operation by an inertia switch when the aircraft is subjected to crash deceleration forces acting in the aircraft's flight axis.

5 Type W—water-activated. This type of ELT transmits automatically when immersed in water. It is waterproof, floats, and operates on the surface of the water. It should be tethered to survivors or liferafts.

type AF ELT, all of this equipment requires manual deployment and activation. In this accident, both ELTs and the liferaft remained inside the helicopter and sank with it. Consequently, no emergency signal was detected by search and rescue (SAR) equipment, and no liferaft was available for the survivors. When the helicopter was recovered, both ELTs and the liferaft were found mounted in their brackets. Had there been an ELT signal from the helicopter, naval and CCG rescue vessels were immediately available to respond.

Various survival equipment installation options exist that can improve the probability of surviving a capsized helicopter. Automatically deployed pop-out floats, liferafts, and floating crash position indicators are available. Man-portable backpacks exist, which contain a single-place raft and survival equipment. There are small emergency position indicating radio beacons (EPIRBs) capable of notifying SAR, which can be carried on a lifejacket.

The United Kingdom Civil Aviation Authority has recently completed a report on helicopter ditching and crashworthiness.[6] The report, which summarizes the results of research undertaken over about 12 years, provides further information towards improving the survivability and the safety of offshore operations.

Lifejackets and Immersion Suits

The OM requires wearing lifejackets on any flight over water. The pilot wore a lifejacket; the passenger did not, although there were several available inside the helicopter. The water surface temperature was 6°C. Neither the pilot nor the passenger wore a helicopter passenger transportation (immersion) suit. The pilot was wearing his CCG flight uniform, which had several layers. The passenger was wearing a one-piece insulated coverall.

During the investigation of a previous fatal CCG helicopter crash (TSB report A00A0076), the TSB identified regulatory shortcomings regarding requirements for survival equipment and cold water immersion suits during over-water flights. The requirements are based primarily upon the flight time or distance from shore. The CARs requirement to carry a liferaft[7] states:

> No person shall operate over water a multi-engined helicopter that is able to maintain flight with any engine failed at more than 50 nautical miles, or the distance that can be covered in 30 minutes of flight at the cruising speed filed in the flight plan or flight itinerary, whichever distance is the lesser, from a suitable emergency landing site unless life rafts are carried on board and are sufficient in total rated capacity to accommodate all of the persons on board.

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6 United Kingdom Civil Aviation Authority, Paper 2005/06, *Summary Report on Helicopter Ditching and Crashworthiness Research*, http://www.caa.co.uk/docs/33/2005_06.PDF, accessed 31 October 2006.

7 CARs Section 602.63, subsections (4) and (5)

The accident helicopter carried a liferaft even though there was no regulatory requirement to do so. The CARs requirement for immersion suit use[8] specifies that, where a helicopter is required to carry liferafts, it shall not be operated over water having a temperature of less than 10°C unless a helicopter passenger transportation suit is provided for each person on board. Because there was no regulatory requirement for the accident helicopter to carry a liferaft, there was no regulatory requirement to wear an immersion suit.

On 26 February 2001, the TSB sent a Safety Advisory (A010009-1) to TC Civil Aviation suggesting that TC Civil Aviation consider revising the criteria for survival equipment carriage and use on over-water flights so that the criteria would be more relevant than time and distance requirements alone. On 02 April 2001, TC Civil Aviation responded to the Safety Advisory. It agreed that changes to the regulations may be warranted, and stated that it would convene a working group to examine the issue of offshore operations and make recommendations.

The OM requirements for immersion suit use are more stringent than those found in CARs. The OM states that immersion suits are mandatory in multi-engine helicopters when they are flown over water more than 15 nm from ship, shore, or continuous ice capable of supporting the helicopter. Under these criteria, immersion suit use was not mandatory for the coastal flights flown on the day of the accident because, although much of the flying done by CG352 was over water, none of it was beyond 15 nm from shore. The use of immersion suits is encouraged in the OM. However, in practice, the suits are not normally worn on over-water CCG flights unless the mandatory conditions apply. The accident pilot had been provided with two immersion suits: an older wet suit and a newer dry suit. Neither suit was used. Although passenger transportation suits were available in St. John's, none of the passengers flown that day were aware of or offered passenger transportation suits.

Direct-to-Airframe Helmet Connection

After the accident, an examination of the pilot's aviation helmet found that the end fitting of the communication cord was fractured at the point where it attached to the helicopter. The communication cords for front seat occupants connect to receptacles located on the overhead centre console. When the helicopter was recovered, the metal pins from the end fitting were still inside the receptacle. Metal remnants from the connection show that the cord was being pulled sideways, towards the pilot's door, when the fracture occurred. A downward pull is required to release the connection. A break test of a similar fitting required a 70-pound pull before the cord failed.

After water impact or a helicopter capsizing, a quick unimpeded egress through any available exit is vital to survival. An attached communication cord that will not release cleanly may impede this egress. In the past, CCG BO105 helicopters had been fitted with an intermediate pig-tail communication cord for helmet connections. Instead of plugging the helmet cord into the helicopter's receptacle, the helmet cord was instead plugged into this intermediate cord. The helmet connection plug can release cleanly from the intermediate pig-tail cord receptacle as it is pulled in the direction of travel during egress.

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[8] CARs Section 602.63, Subsection (7)

Liferaft Mounting Bracket Failure

When the helicopter struck the water, the secondary and most substantial impact was rearward. During the rearward impact, the liferaft mounting bracket, located between and just behind the two cockpit seats, failed. When the helicopter was recovered, the liferaft was found pinned against the centre rear passenger seat. The liferaft mounting bracket forward attachment bolts had pulled through the mount frame. When the forward right attachment failed, the base of the mounting bracket rode up over the seat belt attachment bolts, and the bracket was effectively jammed in this aft position. The liferaft mount installation was in accordance with a Limited Supplemental Type Certificate (LSTC O-LSH94-2029/D) issued to TC ASD on 22 December 1994.

At the time of approval of the LSTC, the mounting frame was analyzed following criteria in Section 27.561 of the United States *Federal Aviation Regulations* (FARs) for "Emergency Conditions" (1-1-88 Edition). This edition of the FARs did not require an analysis of rearward or sideward impact forces. Therefore, no analysis was done for these conditions. The current edition of Section 27.561 of the FARs requires that sideward and rearward impact forces be considered.

Underwater Locator Beacon Failure

The ULB from the accident helicopter (model DK120, serial number DT1218) was examined by the TSB Engineering Laboratory. When the ULB was placed in room temperature water, it transmitted normally. However, when the water temperature was lowered to near freezing, the signal quickly dropped off and was no longer detectable using the hydrophone detection gear. Other ULBs from TC ASD helicopters were also examined, and one (serial number DT1226, which was removed from ASD maintenance stores) was found to have the same signal failure at low temperatures. It was found that the signal failure was due to the delamination of a metal coating on a ceramic resonating ring. The delamination occurred immediately beneath a solder joint on the outer portion of the ring. The combined effect of the delamination and the cold temperatures was to remove the electrical connection to the ring, shifting the beacon signal frequency from 37 kHz to 166 kHz, which is beyond the detectable range of the locating equipment.

Transport Canada Aircraft Services Directorate Operational Issues

TC ASD operates a mixed fleet of helicopters and fixed-wing aircraft. TC ASD supports helicopter and fixed-wing flight operations for the Department of Fisheries and Oceans Canadian Coast Guard. In addition, TC ASD supports flight operations for other government agencies. A review of previous TC ASD accidents and incidents has shown a recurrence of previously identified safety issues.

On 10 May 2000, a CCG Bell 212 helicopter crashed into the water near Cabot Island, Newfoundland and Labrador, killing the pilot (TSB report A00A0076). The TSB investigation found that the pilot was neither

- equipped to survive either a less severe accident or a controlled ditching into the frigid water,
- wearing an immersion suit or a lifejacket, nor
- wearing the supplied shoulder harness, as required by CARs.

The TSB sent a Safety Information Letter (A000048-1) and two Safety Advisories (A010009-1 and A010006-1) to TC Civil Aviation concerning these issues, and identified these issues in its final report.

On 07 May 2005, a CCG BO105 helicopter crashed during slinging operations near Bella Bella, British Columbia (TSB report A05P0103). The pilot was not wearing the supplied shoulder harness. On 31 May 2005, the TSB sent a Safety Information Letter (A050014-1) to TC Civil Aviation and TC ASD, outlining that, despite the CARs requirement and a previous Safety Advisory (A010006-1) in 2001, helicopter slinging operations without upper-body restraint were still occurring at TC ASD.

Also related to the Bella Bella accident, the TSB sent a Safety Advisory (A050015-1) to TC Civil Aviation and TC ASD pointing out that the currently installed liferaft mount fixtures in their BO105 helicopters presented a head strike hazard during an accident. Although the risk of head injury was mitigated somewhat for the pilots because they wear helmets as required by the OM, any passenger seated in the left front seat would be exposed to this risk because the OM does not require helmet use by passengers. The Safety Advisory suggested that TC ASD may wish to modify the fixtures, or limit use of the front seats to persons wearing protective head gear. On 20 September 2005, TC ASD responded to the Safety Advisory, stating that it would undertake a complete review of the applicable LSTC. TC ASD also indicated that it would consider adding padding to the fixture, and that it would review the requirement for helmets to be worn in helicopters with this installation.

The pilot of CG352 was wearing an aviation helmet. The passenger in CG352 was seated in the front seat and was not wearing protective head gear. As of December 2005, the suggested modifications had not been made to the liferaft mounts, protective padding had not been added, and passengers were still being flown in the front seat without helmets. Line BO105 pilots contacted by TSB investigators were unaware of the head strike hazard. TC ASD management had not formally warned line pilots of the head strike hazard, or required that front seat passengers wear protective head gear.

Analysis

General

The examination of the helicopter did not reveal any technical anomalies. Therefore, this analysis will focus on environmental factors, the pilot's decision to conduct the final trip to Go By Point and return, and the survival and organizational factors.

The weather encountered during the day's flying was generally consistent with the GFA. There were VFR conditions throughout most of the period, but with scattered towering cumulus clouds (TCUs) giving areas of ½ sm visibility in snow showers; conditions that were below the operator's VFR limit of 1 sm. On two occasions before the accident flight, the pilot had encountered brief but heavy snow showers. On both occasions, the pilot complied with instructions in the OM and took appropriate alternate action. The first occasion required a landing near Marystown, and the second required a ground delay at the Winterland Airport.

The Accident Flight

There is no direct information about the pilot's decision making related to the final flight of the day from Marystown to Go By Point and return. Although there were still TCUs in the area, the weather at Marystown before the departure was suitable for visual flight, and Go By Point was only a few minutes of flying time away with sunny and clear weather. The pilot, who was highly experienced in these operations, had earlier dealt successfully with a snow squall in Mortier Bay. It is likely that the pilot believed that the trip to Go By Point and the return to Marystown could be completed safely and before dark.

The weather encountered by HMCS *Goose Bay* and the images from the security camera near Cow Head indicate that the weather in the northern part of Mortier Bay worsened considerably shortly after CG352 landed at Go By Point. Conditions in the northern part of the bay were, at times, well below ½ sm. While on the landing pad at Go By Point, the pilot would have had only a limited view of the sky to the northwest, the direction from which the worsening weather conditions were approaching.

When the helicopter departed Go By Point to return to Marystown, only light snow was falling. It appears that the weather conditions prevented a direct flight to Marystown and that the pilot chose to fly the slightly longer route around the northern perimeter of Mortier Bay (see Appendix A). However, the helicopter would have gradually encountered heavier snowfall as it flew north and then west over the coast towards Marystown. Once established on a westerly heading towards Marystown, it would have been difficult to turn around when severely reduced visibility was encountered because a turn to the right would have required flight into rapidly rising terrain with a possibility of encountering whiteout conditions. A turn to the left would have placed the helicopter out over the water and caused the pilot to lose visual contact with the coast.

With the need to maintain constant attention to outside visual cues, the pilot would have been experiencing an increased workload. This may have distracted him from selecting the particle separator, engine anti-ice, and continuous ignition switches that are required for flight in snow, and from arming the pop-out floats as he reduced airspeed below 60 knots in reduced visibility over the water. The helicopter continued along the northern coast until Mortier Bay narrowed, then executed a left turn towards the east (downwind), likely in an attempt to return to the better weather conditions at Go By Point.

Maintaining a reduced groundspeed in lowered visibility, as prescribed in the OM, would have been difficult in the gusty downwind (30 knots) conditions over the water. The pilot may have lost sight of land as the helicopter flew across the opening to Little Bay. Reduced visibility in

darkness and re-circulating snow, lack of fixed visual references over the water, and turbulence may all have contributed to pilot disorientation. It is likely that the pilot flared rapidly to slow the helicopter. The tail contacted the water heavily, breaking off and causing the subsequent loss of control.

Survival Equipment Installations

Because there was no emergency signal to notify SAR of the accident, rescue efforts were not initiated until one hour after the flight planned estimated time of arrival. Without a liferaft, the pilot and passenger were not equipped to survive prolonged cold water immersion. In the absence of an ELT signal, initiation of a SAR response relies on either witness action or the flight plan notification time.

The survival equipment installed on the accident helicopter exceeded regulations. However, it was not available to assist the survivors after the accident. The existing regulations may be appropriate in the event of a successful controlled ditching, but they do not ensure protection during a capsizing event. Had electronic SAR signalling been available, a search could have begun immediately.

Lifejackets

The direct flight from Marystown to Go By Point was short and was likely conducted almost entirely over land. The passenger may have been anticipating a similar routing back. This could explain why he was not wearing a lifejacket during the return trip. It is also possible that it was an oversight. If he had worn a lifejacket, he may not have drowned; however, even if he had used a lifejacket, hypothermia would have been an immediate threat to his survival.

Immersion Suits

Most CCG helicopter operations occur near shore. Therefore, even though the helicopters may be operating over water, immersion suits are not required by either the CARs or the OM because they are typically well within the distance-from-shore requirements. It is common practice during CCG flights for immersion suits to be worn only when mandatory. As a result, pilots and passengers are often exposed to prolonged periods of operations over sometimes frigid water without appropriate protection.

The OM requirements for immersion suit use are more stringent than CAR requirements, but are also based on distance-from-shore criteria that are inadequate to ensure proper protection. For survivors in frigid water, the distance from shore is not relevant. Survivors may be injured or suffering from cold shock, which can severely limit mobility. The immediate concern for survivors who are immersed in frigid water is to survive long enough to inflate and enter their liferaft, or to stay alive in an immersion suit until help arrives. Using immersion suits and aviation lifejackets would have increased the chance of survival.

Liferaft Mounting Bracket Failure

The liferaft was unavailable after the impact because it was pinned against the centre rear passenger seat. If a passenger had been in the centre rear passenger seat, it is possible that the passenger could have been pinned between the liferaft and the seat. There was an increased risk to those on board because the liferaft mounting bracket was not able to withstand a survivable rearward impact.

Organizational Issues

Safety deficiencies identified during the TSB investigations in 2000 continue to exist in TC ASD operations. The non-use of shoulder harnesses, lifejackets, and immersion suits continue.

At the time of this accident, the liferaft mount head strike hazard identified in May 2005 had not been addressed. BO105 pilots were unaware of the hazard, and passengers continued to be carried in the front seat without head protection.

The frequency of accidents and serious occurrences, the recurrence of identified operational shortcomings, and the lack of progress in mitigating several identified deficiencies are matters of concern that suggest organizational shortcomings at TC ASD.

The following TSB Engineering Laboratory reports were completed:

LP 136/2005 – ULB Analysis;
LP 001/2006 – Instrument Examination;
LP 003/2006 – Examination of Tail Rotor Short Shaft.

These reports are available from the Transportation Safety Board of Canada upon request.

Findings as to Causes and Contributing Factors

1. The helicopter encountered a heavy snow shower and, while attempting to fly out of the snow, the pilot likely became disoriented.

2. The pilot lost control of the helicopter when the tail broke off after contacting the water during a rapid flare.

3. The survival equipment fitted to the helicopter sank with it, and was not available to aid the survivors after the accident.

4. The occupants of the helicopter were not wearing sufficient personal survival equipment to enhance their potential survival in the frigid water.

Findings as to Risk

1. Although the liferaft mount had been previously identified as a potential head strike hazard, the passenger was seated in the front seat without head protection.

2. At the time of the occurrence, Transport Canada Aircraft Services Directorate management had not taken steps to mitigate the liferaft mount head strike hazard.

3. The liferaft mount failed, pinning the liferaft against the centre rear passenger seat.

4. The emergency locator transmitters on board sank to the bottom and were not able to signal search and rescue of the accident. Therefore, search and rescue efforts did not begin until one hour after the flight's planned estimated time of arrival.

5. The pilot's egress was impeded by a direct-to-airframe helmet cord connection.

6. None of the passengers flown on the day of the accident were provided with immersion suits, nor were such suits required by the regulator (Transport Canada) or the operator (Transport Canada Aircraft Services Directorate).

7. None of those who flew on CG352 on the day of the accident had received helicopter emergency egress/water survival training, nor was such training required by the regulator (Transport Canada) or the operator (Transport Canada Aircraft Services Directorate).

8. At the time of the accident, the operator had not adequately addressed several identified operational shortcomings.

9. The frequency of accidents and serious occurrences, the recurrence of identified operational shortcomings, and the lack of progress in the mitigation of several identified deficiencies are matters of concern that suggest organizational shortcomings at Transport Canada Aircraft Services Directorate.

Other Finding

1. The underwater locator beacon did not transmit a detectable acoustic signal.

Safety Action Taken

Transportation Safety Board of Canada

On 20 March 2006, the TSB sent a Safety Information Letter (A060016-1) to Transport Canada (TC) Civil Aviation and Aircraft Services Directorate (ASD) regarding the signal failure of the underwater locator beacon (ULB).

On 28 March 2006, the TSB sent a Safety Advisory (A060012-1) to TC ASD suggesting that it consider the need to revise its mandatory operations manual requirements for immersion suit use to include the more relevant risk factors related to its helicopters' performance characteristics and operating environment.

Survival equipment on the accident helicopter was installed as required by regulation, yet it was not available to assist the survivors after the accident. On 09 May 2006, the TSB sent a Safety Advisory (A060020-1) to TC ASD suggesting that it consider the adequacy of its helicopter survival equipment installations so as to improve occupant survivability in a capsized helicopter event.

With respect to direct-to-airframe helmet cord connections, other operators may have aircraft with these connection types and may be unaware that these connections can impede egress in an emergency. On 09 May 2006, the TSB sent a Safety Advisory (A060019-1) to TC Civil Aviation suggesting that it advise the aviation community that these connection types may impede egress and that an intermediate cord can help mitigate this hazard. In response to this Safety Advisory, TC Civil Aviation published an article in the 4/2006 edition of the *Aviation Safety Letter* explaining the egress hazard related to direct-to-airframe helmet cord connections and suggesting the use of intermediate cords to mitigate the hazard.

On 09 May 2006, the TSB sent a Safety Advisory (A060021-1) to TC ASD suggesting that, as part of its review of the liferaft mounting bracket Limited Supplemental Type Certificate, it may wish to conduct an analysis of the structure so as to improve its ability to withstand survivable impact forces, particularly rearward. Also, the Safety Advisory suggested that TC ASD may wish to consider steps to prevent the mounting bracket and liferaft from jamming against the passenger seat belt mounting bolts should a failure occur.

On 02 June 2006, the TSB sent a Safety Advisory (A060023-1) to TC ASD suggesting to re-evaluate all levels of its organization so as to become more proactive in identifying risks and deficiencies, and more responsive in communicating and mitigating already identified risks associated with its operations.

Helicopter Operations Safety Working Group

TC ASD and the Canadian Coast Guard (CCG) have established a Helicopter Operations Safety Working Group to review safety equipment, training, and procedures, and to make recommendations for improvements. This group has taken action on passenger helmets and survival equipment, and is reviewing the policy on wearing immersion suits as well as helicopter egress training. As a result of the efforts of the joint working group, the following actions have occurred:

- Lifejackets have been standardized for passengers and crews, and reflective tape is to be added to the edging of the cover of the jackets and a large orange patch added to the back.

- Laser flares have been purchased and sent out to the CCG bases to be attached via a cord and rings to each of the standardized high-visibility Switlik lifejackets, model HV-35C also identified as S7200-2, and inserted in the customized pouch.

- Helmets have been purchased and issued for front seat passengers in all helicopters and their use is mandatory in CCG helicopters.

- The installation of a fixed intermediate helmet cord for both front seat positions in all BO105 helicopters is nearing completion.

Transport Canada Aircraft Services Directorate

TC ASD is in the process of implementing a Safety Management System, adding the position of an assistant chief pilot helicopter position and a flight operation quality assurance position all intended to improve, where necessary, existing communication, documentation, and risk assessment practices.

Proposals have been generated for modifying the liferaft rack to prevent head injuries.

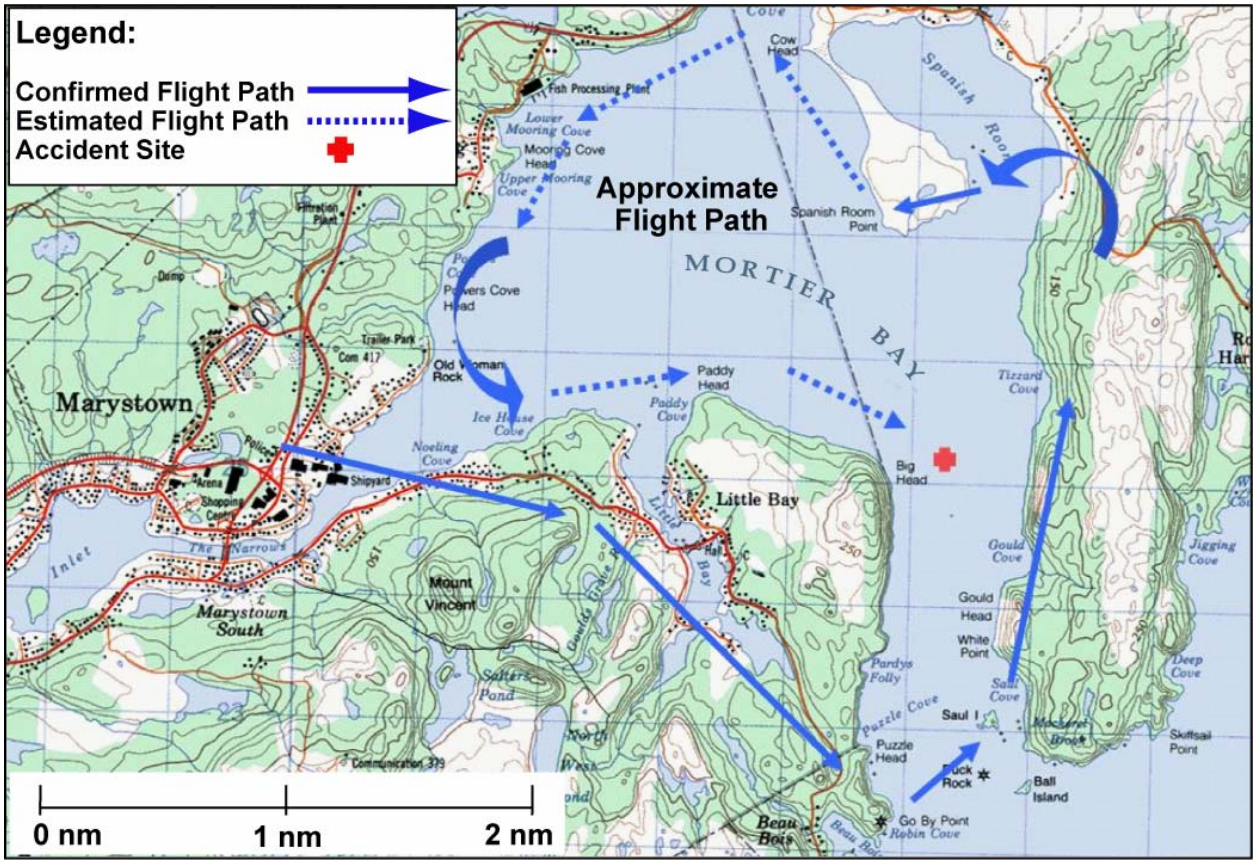
Underwater Locator Beacon

All of the TC ASD ULBs within the batch of serial numbers affected by the Dukane recall have been replaced. To determine the extent of the delamination problem, the manufacturer cold tested the 11 beacons returned by TC ASD. One other beacon was found to have failed in a similar manner. The manufacturer is attempting to determine the cause of the metal delamination and the potential scope of the failure. Once this has been accomplished, the manufacturer will consider a further course of action.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 01 November 2006.

*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 – Helicopter Routing



Appendix B – Glossary

AF	automatic fixed (type of emergency locator transmitter)
ASD	Aircraft Services Directorate
asl	above sea level
CARs	*Canadian Aviation Regulations*
CCG	Canadian Coast Guard
ELT	emergency locator transmitter
EPIRB	emergency position indicating radio beacon
FARs	*Federal Aviation Regulations*
FIC	Flight Information Centre
GFA	graphic area forecast
HMCS	Her Majesty's Canadian Ship
JRCC	Joint Rescue Coordination Centre
kHz	kilohertz
LSTC	Limited Supplemental Type Certificate
MBB	Messershmitt-Bolkow-Blohm
MCTS	Marine Communications and Traffic Services
nm	nautical miles
OM	Transport Canada's operations manual for CCG helicopters
PDM	pilot decision making
PIC	pilot-in-command
PPC	pilot proficiency check
SAR	search and rescue
sm	statute miles
TC	Transport Canada
TCUs	towering cumulus clouds
ULB	underwater locator beacon
VFR	visual flight rules
W	water-activated (type of emergency locator transmitter)
°C	degrees Celsius