Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT

A00A0076

COLLISION WITH WATER

DEPARTMENT OF TRANSPORT
AIRCRAFT SERVICES
(CANADIAN COAST GUARD)
BELL 212 C-GCHG
CABOT ISLAND, NEWFOUNDLAND
10 MAY 2000

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.

Aviation Investigation Report

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Department of Transport Aircraft Services (Canadian Coast Guard)
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Synopsis


Figure 1 - C-GCHG slinging at Cabot Island

The Canadian Coast Guard Bell 212 helicopter, serial number 30625, departed Newtown, Newfoundland, on a visual flight rules flight to Cabot Island, Newfoundland, a small island six miles offshore. The aircraft was delivering fresh water to the lighthouse keeper's residence, carrying four 40-gallon plastic barrels on each delivery. The barrels were slung in a net 120 feet under the helicopter. The aircraft flew to Cabot Island, where ground personnel detached the load of full barrels from the lanyard hook and then reattached the lanyard hook to a similar load of nearly empty barrels for the return flight. Shortly after the aircraft's departure on the return flight, a worker on the island noticed a splash. Small pieces of aircraft wreckage and the netload of barrels were observed floating a short distance from the shore. The pilot, who was the sole occupant, was fatally injured in the crash.

Ce rapport est également disponible en français.

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1.0 Factual Information

1.1 History of the Flight

The Canadian Coast Guard (CCG) Bell 212 helicopter (CTG 305) was re-supplying the lighthouse keeper's residence on Cabot Island with fresh water by means of three sets of four 40-gallon barrels slung in a net 120 feet under the aircraft. During each mission, four full barrels were lifted from a staging area at Newtown and flown six nautical miles (nm) east to Cabot Island, where the netload was detached from the bottom of the lanyard by ground crew. A similar load of empty barrels was reattached to the lanyard hook and slung back to Newtown, where they were exchanged for a load of four full barrels and replenished. One complete cycle required about 15 minutes to complete.

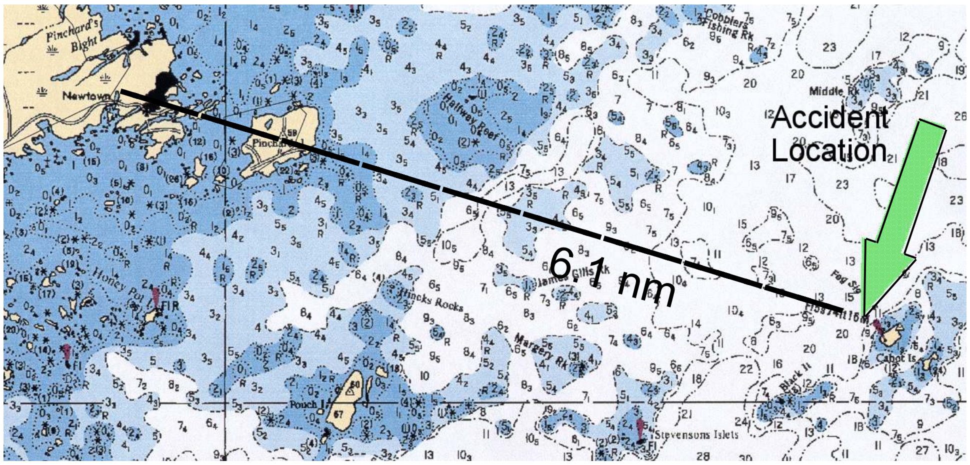

Figure 2 - Resupply mission

On the day of the occurrence, the pilot commenced slinging operations at 1000 Newfoundland daylight time (NDT).[1] He had completed 21 deliveries, stopping to refuel at a local refuelling facility at 1140, 1420, and 1635. During the last stop, the pilot ate a light meal before recommencing operations at about 1650. At about 1700, CTG 305 departed the staging area with a slung load of four full water barrels. During the trip to Cabot Island, the pilot radioed the ground crew, advising them to prepare items for the completion of the day's flying. The pilot then passed a message to St. John's Coast Guard Radio at 1702 that operations were proceeding normally. This was the last radio transmission from CTG 305. The helicopter arrived in the hover over Cabot Island at about 1705. Ground personnel exchanged the netload of full barrels for a similar netload of nearly empty barrels for the return flight. The aircraft then departed the island into wind on a northerly heading. Shortly after the aircraft's departure, a worker on the island noticed a splash. Small pieces of aircraft wreckage and the netload of barrels were observed floating a short distance from the shore, and rescue efforts were initiated. The pilot, who was the sole occupant, was fatally injured in the crash. The aircraft was destroyed, and approximately 200 litres of the aircraft's fuel and oil were released into Bonavista Bay.

[1] All times are NDT (Coordinated Universal Time minus two and one-half hours).

1.2 Personnel Information

The pilot was 39 years old and held a valid commercial helicopter licence. His medical expiry date was 01 May 2001. The pilot had a total of 5012 flying hours, with 236 hours on type. In the last 90 days, he had flown 82 hours, with 31 hours on type. He had been on duty for 9 hours before the occurrence.

1.3 Aircraft Information

Manufacturer	Bell Helicopter Textron
Type and Model	Bell 212
Year of Manufacture	1974
Serial Number	30625
Certificate of Airworthiness	Issued 07 April 1988 - Amended
Total Airframe Time	12 001 hours
Engine Type (number of)	Pratt & Whitney PT6T-3 (2)
Maximum Allowable Take-off Weight	11 200 pounds

The CCG helicopter was based in St. John's and was maintained and flown by Transport Canada personnel.

A review of the aircraft documentation indicated that the aircraft was maintained in accordance with existing regulations and approved procedures. All modifications, mandatory Airworthiness Directives, and required maintenance had been completed. The aircraft had flown 57.6 hours since the completion of the last scheduled major overhaul on 15 April 2000. Aircraft records after the maintenance overhaul did not indicate any outstanding or recurring maintenance items. The aircraft'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 was either required by regulation. It was not equipped with an underwater locator beacon, nor was it required. The helicopter was equipped with emergency floatation devices, commonly referred to as "pop-out floats". Pop-out floats can be inflated before ditching, and are meant to increase the survivability of a ditching by delaying the time at which a helicopter will begin to sink.

1.4 Meteorological Information

There is no formal weather observation system in place at Cabot Island. However, the sky was clear, the wind was northerly at about 30 knots, and the outside air temperature was about two degrees Celsius. Water temperature records were reviewed by the Bedford Institute of Oceanography: the water surface temperature was found to be between one-half and one degree Celsius.

1.5 Communications

The pilot was in direct radio communication with ground personnel at the staging area and at Cabot Island. The pilot also had radio contact with St. John's Coast Guard Radio. There were no communications from the pilot after departure from the island on the final leg.

1.6 Wreckage and Impact Information

1.6.1 Wreckage Location

The floating debris was located immediately and recovered by local surface craft. Underwater search operations commenced on May 11 at 2300 using an underwater remotely operated vehicle. The underwater search, which was hampered by adverse weather, rough bottom conditions, and extensive underwater currents, continued until aircraft debris was located late in the evening on May 20. The main wreckage and the pilot were located the next day, 0.3 nm west-northwest of Cabot Island at a depth of 110 feet. The debris field was about 250 feet long, with the main cabin area to the northeast. The distribution of wreckage items was consistent with the tidal current. Less-dense components, such as the main rotor, panels, and the tail boom, were deposited to the southwest (see Appendix A). The wreckage was approximately 600 feet farther out from, and in line with, the estimated location of the floating netload of barrels observed immediately after the accident.

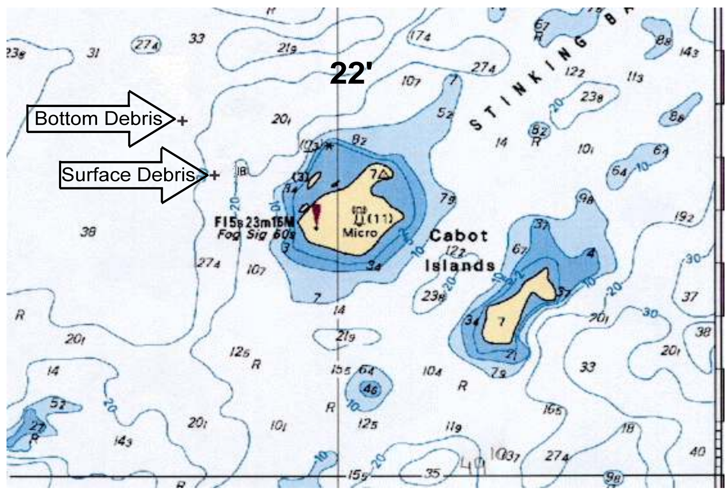

Figure 3 - Wreckage location

1.6.2 Wreckage Examination

Major components recovered from the ocean floor included the following: the aircraft cabin, both engines, the detached main rotor, the main transmission and surrounding structure, the tail boom, the detached tail rotor, and the 42- and 90-degree tail-rotor-drive gearboxes.

There was massive deformation to the aircraft structure due to water impact. As well, there was damage from in-flight rotor strikes and salt water corrosion. Rotor strike marks indicated that the main rotor had detached from the helicopter before water impact. Main-rotor strikes were evident on the right side of the main fuselage and the tail boom. The tail boom had been struck twice by the main rotor, near the front at the baggage compartment, and aft of the 42-degree tail-rotor gearbox. There was crushing damage from water impact on the left side of the main fuselage and at the top of the tail boom, indicating that the tail boom separated from the fuselage before impact. The aircraft's various components were examined to the degree possible; no indication of a pre-existing mechanical malfunction was found. Damage patterns indicated that all the cabin and cockpit doors were closed at impact. The aircraft cargo release switch was found in the “armed” position. It is likely that this switch was armed throughout the mission to allow the pilot to immediately jettison the load.

The main rotor was found in the southwest portion of the debris field. The tail rotor was recovered with other tail-rotor drive components in the middle portion of the debris field, just south of the fuselage cabin. An examination of the tail rotor revealed that the tail-rotor drive had separated in flight as a result of overload forces generated during the break-up sequence. The failure sequence of the tail-rotor components could not be determined.

Damage patterns showed that the lower portion of the slinging hook assembly and the hook retaining ring had been torn rearward from the aircraft. These components were not found. The absence of crushing damage to components adjacent to the lower hook assembly indicates that the lower hook assembly was not on the aircraft at water impact. Impact marks show that the upper hook assembly was displaced 30 degrees to the rear at water impact. The slung load and the lifting equipment were recovered in good condition, with no indication that the equipment had contacted the helicopter. The plastic water barrels were inside the lifting net: three of the barrels were undamaged, the top of the fourth barrel had broken off.

A discolouration was noted inside a crazed portion of the shattered windscreen. Witnesses had reported bird activity in the area, and a bird strike was considered as a possible source for the discolouration. This portion of the windscreen was analyzed in an attempt to determine if a bird had struck the windscreen; however, lab analysis could not determine the source of the discolouration.

1.7 Survival Aspects

The pilot was found inside the aircraft. Because of the severe impact forces, the accident was not survivable. The pilot’s lap belt had been only loosely attached, and the shoulder strap portion of the pilot’s safety belt was not attached to the lap belt. The pilot was not wearing a life jacket or a helicopter passenger transportation (immersion) suit. A life raft was stowed in the cabin; however, it was not readily accessible to the pilot because a floor-to-ceiling cargo net was installed across the cabin, separating the cockpit from the cabin. The pop-out floats were not inflated, before or after the impact, and were recovered inside their protective cases which had been partially opened by impact forces.

1.7.1 Use of Shoulder Harness

The accident pilot routinely wore the available shoulder harness; however, the range of body motion required during the vertical-reference operation likely precluded shoulder harness use. Normally, the pilot occupies the right pilot’s seat; however, to clearly see the long line and the load, the pilot occupies the left seat during vertical-reference missions and leans markedly to the left. The approved shoulder harness does not allow the pilot to adopt this body position. It is a widespread practice for pilots not to use the shoulder straps during vertical-reference flights and to loosen the seatbelt portion to allow for increased range of motion. This helicopter had been configured and was approved for left-seat vertical-reference operations.

During the high hover, the helicopter is inside the "avoid" area of the helicopter's height/velocity curve. Operations in the avoid area are risky because a successful autorotation is unlikely. Canadian Aviation Regulations (CARs) 605.24(5)(b) and 605.27(3) require that a helicopter used for external load operations be equipped with a seat and a safety belt that includes a shoulder harness for each person on board the aircraft. At least one pilot must be seated at the flight controls with the safety belt fastened during flight time.

The TSB is aware of seven other helicopter accidents since 1985 in which available shoulder harnesses were not worn during long-line operations.[2] While it is unknown if the shoulder harnesses would have lessened injuries in these instances, studies have shown that approximately 70 per cent of all serious and fatal injuries in helicopter accidents occur primarily to the head, spine, torso, and neck. An analysis of helicopter crash dynamics by Coltman[3] showed that, of the personnel who experienced a helicopter crash, only 9 per cent of those who were wearing a shoulder harness had severe injuries, compared with 34.3 per cent of those who wore only a lap belt.

1.7.2 Cold Water Survival

A person suddenly immersed into cold water (less than 15 degrees Celsius) faces four significant survival hurdles: cold shock, swimming failure, hypothermia, and post-rescue collapse. The first three are immediate hazards: cold shock can kill an unprotected person within 5 minutes, swimming failure can be fatal in 15 minutes, and fatalities from hypothermia can occur in 30 minutes. An immersion suit and a life jacket provide immediate protection from these hazards, and a life raft provides longer-term protection by allowing survivors to remove themselves from the water. Neither the pilot nor the others transported over water that day wore immersion suits or were otherwise equipped to survive a ditching into the frigid water. Immersion suits were not required by regulation. Because the pilot sustained fatal injuries at impact, his degree of protection for water survival was not a factor.

1.7.3 Survival Equipment—Flights Over Water

Subsections (4) and (5) of CAR 602.63 outline the regulatory requirements for the carriage of a life raft in helicopters:

> (4) No person shall operate over water a single-engined helicopter, or a multi-engined helicopter that is unable to maintain flight with any engine failed, at more than 25 nautical miles, or the distance that can be covered in 15 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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2 TSB report Nos. A85P0023, A87P0086, A91W0149, A93W0159, A94W0162, A97P0094, and A99P0075.

3 Joseph W. Coltman, *Analysis of Rotorcraft Crash Dynamics for Development of Improved Crashworthiness Design Criteria*, US Department of Transport, 1985.

> (5) 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.

The Transport Canada *Operations Manual for CCG Helicopters* applies the more stringent single-engine requirements to all its helicopters. In practice, however, a life raft is considered to be standard equipment on all flights. The operations manual also requires that one life preserver be on board and worn by each person when operating over water. In this occurrence, the pilot had a life preserver on board. However, he did not wear it, possibly because it interfered with his ability to position himself in the cockpit during vertical-reference operations.

CAR 602.63 also sets the requirement for immersion suits:

> Where a helicopter is required to carry life rafts pursuant to subsection (4) or (5), no person shall operate the helicopter over water having a temperature of less than 10°C unless:
> (a) a helicopter passenger transportation suit system is provided for the use of each person on board; and,
> (b) the pilot-in-command directs each person on board to wear the helicopter passenger transportation suit system.

The operations manual states that, for multi-engine helicopters, wearing of immersion suits is mandatory when flying over water at distances greater than 15 nautical miles from ship, shore, or continuous ice capable of supporting the helicopter.

1.8 Tests and Research

A representative flight was undertaken using another Bell 212 under similar conditions of wind and weight. It confirmed that the pilot's workload during the hover at the slinging area would have been quite high. The flight also showed that the pilot could have completed a climbing turn to an estimated en route altitude of 500 feet within the distance between the island and the accident site.

1.9 Additional Information

1.9.1 Accidents Related to Load Dragging

Sixteen Canadian helicopter slinging accidents where the load dragged or the lifting equipment became snagged were reviewed. A major effect noted in these occurrences was a sudden and extreme change in aircraft attitude. If the drag was directly to the rear, a sudden nose-down attitude resulted. Proximity to the ground leaves little time for a pilot to react. If the drag is sufficient, internal hook components may be displaced from the normal range of travel and may disrupt other components.

1.9.2 Mast Bumping

The Bell 212 has a teetering semi-rigid rotor system. The blades are free to flap vertically to compensate for various in-flight aerodynamic forces. On teetering semi-rigid rotor systems, the flapping angle is restrained to specific limits: on the Bell 212, a static stop on the blade yoke limits flapping by contacting the surface of the rotor mast. Exceeding the flapping limit in flight produces yoke-to-mast contact, commonly known as “mast bumping”. Fully developed mast bumping is usually catastrophic because the mast separates at crush points, which occur when the yoke static stops strike the mast violently. In forward flight, excessive flapping may result from inappropriate pilot response to low-G manoeuvres, the failure or loss of flight controls or rotor components, or external forces acting on the aircraft.

2.0 Analysis

2.1 General

The pilot was trained and experienced in slung-load operations and vertical-reference flying, and he had dealt proficiently with the mission throughout the day. The operation had proceeded smoothly until after the aircraft departed the island staging area on the final leg. Weather conditions were suitable for the operation. The investigation did not reveal any pre-existing mechanical discrepancies that could have led to the occurrence.

A radio call made minutes before the accident indicates that the pilot believed that the aircraft was functioning normally. The absence of any distress call from the pilot suggests that the onset of the accident was sudden and severe and that there was no opportunity to make a distress call. While slinging, one of the first considerations during a critical emergency is to jettison the slung load. The load was not jettisoned before the aircraft contacted the water, further suggesting that there was no emergency condition of which the pilot was aware and that the accident involved a sudden and severe initiating event.

2.2 Load/Water Contact

The loss of the hook assembly toward the rear of the aircraft, the disruption of flight controls around the hook assembly, the occurrence of mast bumping, and the suddenness of the accident are circumstances consistent with the load contacting the water. For load/water contact to occur, the helicopter would have had to descend after departing the island. However, the investigation was not able to ascertain the aircraft's flight profile during this portion, and no reason for descent was established.

2.3 Mast Bumping

A characteristic of in-flight rotor/mast separation accidents is the differing resting locations of the rotor and the airframe. After separation, the airframe descends ballistically on its last track. The rotor, however, may continue to fly a substantial distance before impact. In this occurrence, the location of the main rotor within the debris field suggests that the rotor/mast separation took place at a low altitude. The flight profile did not require low-G manoeuvres, and it is unlikely that an experienced pilot would inadvertently induce low rotor loading during a routine mission over a flat surface. It is likely that drag forces from the load/water contact caused a sudden aircraft upset, mast bumping, and main-rotor separation. In-flight damage to the flight controls caused by the hook assembly tearing away could have contributed to excessive flapping angles and may also have prevented the pilot from recovering from the sudden aircraft upset.

2.4 Safety Harness Use

Because of the severe impact forces, a shoulder harness would not have saved the pilot's life, even if it had been used. Nevertheless, external load operations involve increased risk, and use of available safety equipment would seem to be in order. This and other accidents involving vertical-reference operations have shown that the seat belt and shoulder equipment provided is ill-suited to the task of vertical-reference flying during external load operations. Pilots performing these types of flights should not need to shed available and required protective equipment in order to perform a task involving increased risk.

2.5 Survival Equipment—Flights Over Water

Regulations for survival equipment are based on time and distance to an emergency landing site. For a person immersed in frigid water, however, flying time and distance are irrelevant. The major factor is being able to survive in the water until the life raft is inflated and/or until rescue arrives. Because survival equipment requirements are based on time and distance criteria, the carriage of adequate equipment is not ensured even though the dangers of sudden immersion in cold water are serious and immediate. Requirements for immersion suit use should be independent of the requirement to carry a life raft and should be based on factors such as the type of aircraft, type of operation, water temperature, air temperature, flight time from shore, and potential rescue time. The criteria should also recognize the potential effects of heat stress from wearing immersion suits during flight operations and should include guidance on this matter.

2.6 Underwater Locator Beacons

The expeditious location of underwater aircraft wreckage is important for humanitarian reasons and is essential for investigative purposes. Examination of aircraft wreckage is a fundamental part of an accident investigation, and it is particularly important in those accidents where a recorder has not been installed on an aircraft and/or the crew do not survive. An underwater locating device, installed and operating, would likely have led to the wreckage being located more quickly.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. During departure from the island, the helicopter descended, for undetermined reasons, to an altitude that allowed the load to contact the water.

2. Drag forces on the hook assembly during load/water contact resulted in loss of the hook assembly, disruption of flight controls, loss of aircraft control, and rotor/mast separation.

3.2 Findings as to Risk

1. The pilot did not wear the required shoulder harness or life jacket because these items interfered with his ability to conduct the vertical reference operation. This is a common practice among pilots who are required to perform these operations.

2. Immersion suits were not required by regulation and were not worn, and the pilot did not have ready access to the on-board life raft. In a less-severe ditching occurrence, such items could increase survivability.

3. Recovery of the aircraft was delayed because it was not equipped with an underwater locator beacon. Such equipment was not required by regulation.

4.0 Safety Action

4.1 Action Taken

4.1.1 Underwater Locator Beacon Installation

On 06 November 2000, the TSB forwarded an Aviation Safety Information Letter to Transport Canada (TC) suggesting that other carriers with a high level of exposure to over-water operations consider the installation of an underwater locator beacon in their aircraft not equipped with flight data recorders. TC responded on 12 December 2000, indicating that an article will be published in the newsletter *Aviation Safety Letter* to reflect this suggestion to industry. An article was published in Issue 4/2001 of *Aviation Safety Letter* on the installation of an underwater locator beacon.

TC has undertaken to install underwater beacons on all helicopters that operate in support of the Canadian Coast Guard, regardless of passenger seating capacity.

4.1.2 Safety Harness Use

On 20 February 2001, the TSB forwarded an Aviation Safety Advisory to TC asking that consideration be given to investigating and requiring other means of personnel restraint for use during vertical-reference operations. TC responded to this advisory on 02 May 2001, stating, in part:

> . . . The certification requirements for pilot restraint systems are described in Airworthiness Manual (AWM) 527 and 529. Since July 1, 1986 (AWM First Edition) paragraph 785 has required that "Each pilot's seat must have a combined safety belt and shoulder harness with a single-point release that allows the pilot, when seated with the safety belt and shoulder harness fastened, to perform all of the pilot's necessary functions." This requirement has been retroactively imposed upon all rotorcraft manufactured after September 16, 1992 regardless of certification basis (AWM 527.2 and 529.2). In addition, CAR 702.44 requires all Aerial Work aircraft to have the pilot seat and any seat beside the pilot seat equipped with a shoulder harness and CAR 605.27 (3) requires that at least one pilot shall keep a safety belt fastened at all times.
>
> Transport Canada's mandate is to regulate safe aviation operations. Transport Canada has approved safe pilot restraint systems and has promulgated regulations regarding their installation and use. It is the responsibility of the industry to comply with the regulations, and if warranted, apply for an approval of a configuration to meet its operational needs.

The Board agrees that it is the responsibility of the industry to comply with the regulations. However, the approved shoulder harnesses do not allow the pilot to "perform all of the pilot's necessary functions", as stated above. The Board believes that further consideration of this issue is warranted by TC.

4.1.3 Survival Equipment—Flights Over Water

On 26 February 2001, the TSB forwarded an Aviation Safety Advisory to TC asking that consideration be given to revising the criteria for survival equipment carriage, and use on over-water flights. TC responded on 02 April 2001, indicating that a working group has been convened to examine the issue of offshore operations and make recommendations. The working group will consider, inter alia, the requirements for the carriage of survival equipment, survival equipment use, and the accessibility of the equipment.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 22 November 2001.

Appendix A—Wreckage Distribution Diagram