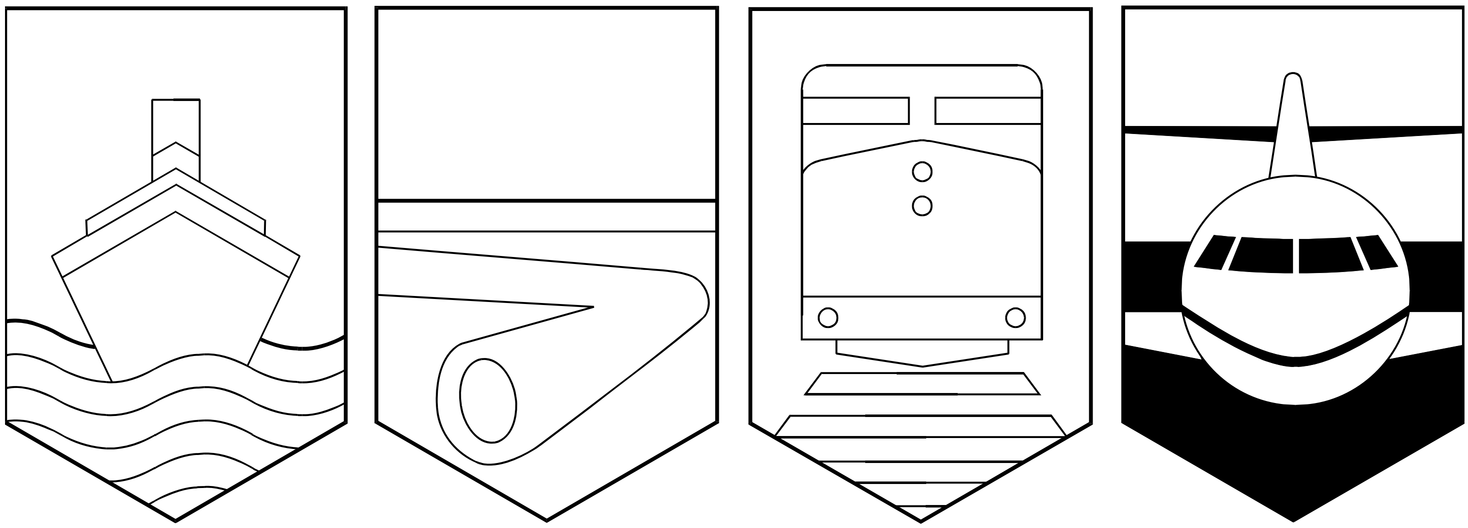
Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada



AVIATION OCCURRENCE REPORT

CONTROLLED FLIGHT INTO TERRAIN

BEARSKIN LAKE AIR SERVICES LTD.
BEECHCRAFT A100 C-GYQT
BIG TROUT LAKE AIRPORT, ONTARIO 3 mi NW
21 FEBRUARY 1995

REPORT NUMBER A95C0026

Canada

MANDATE OF THE TSB

The Canadian Transportation Accident Investigation and Safety Board Act provides the legal framework governing the TSB's activities. Basically, the TSB has a mandate to advance safety in the marine, pipeline, rail, and aviation modes of transportation by:

- conducting independent investigations and, if necessary, public inquiries into transportation occurrences in order to make findings as to their causes and contributing factors;
- reporting publicly on its investigations and public inquiries and on the related findings;
- identifying safety deficiencies as evidenced by transportation occurrences;
- making recommendations designed to eliminate or reduce any such safety deficiencies; and
- conducting special studies and special investigations on transportation safety matters.

It is not the function of the Board to assign fault or determine civil or criminal liability. However, the Board must not refrain from fully reporting on the causes and contributing factors merely because fault or liability might be inferred from the Board's findings.

INDEPENDENCE

To enable the public to have confidence in the transportation accident investigation process, it is essential that the investigating agency be, and be seen to be, independent and free from any conflicts of interest when it investigates accidents, identifies safety deficiencies, and makes safety recommendations. Independence is a key feature of the TSB. The Board reports to Parliament through the President of the Queen's Privy Council for Canada and is separate from other government agencies and departments. Its independence enables it to be fully objective in arriving at its conclusions and recommendations.

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Aviation Occurrence Report

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Bearskin Lake Air Services Ltd.
Beechcraft A100 C-GYQT
Big Trout Lake Airport, Ontario 3 mi NW
21 February 1995

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Synopsis

The Bearskin Lake Air Services Ltd. Beechcraft A100 was on a regular scheduled flight, under visual flight rules, to Big Trout Lake Airport, Ontario, with nine passengers and a crew of two on board. The crew were flying the aircraft over a lake about four miles northwest of the airport for a landing on runway 14 when whiteout conditions were encountered. The aircraft descended in controlled flight into the frozen surface of the lake. The crew and several passengers sustained serious injuries. Rescuers from the local community reached the aircraft about two hours after the crash and all eleven survivors were rescued within four hours.

The Board determined that, while the crew were manoeuvring the aircraft to land and attempting to maintain visual flying conditions in reduced visibility, their workload was such that they missed, or unknowingly discounted, critical information provided by the altimeters and vertical speed indicators. Contributing factors were the whiteout conditions and the crew's decision to fly a visual approach at low altitude over an area where visual cues were minimal and visibility was reduced.

Ce rapport est également disponible en français.

Table of Contents

1.0 Factual Information

1.1 History of the Flight

The crew of the Beechcraft A100, C-GYQT, were conducting a scheduled flight from Sioux Lookout, Ontario, to Big Trout Lake, Ontario, as Bearskin (BLS)[1] 324. BLS 324 departed Sioux Lookout with nine passengers and a crew of two at 1133 central standard time (CST)[2] and arrived in the vicinity of Big Trout Lake at approximately 1240. The captain briefed an instrument approach with a circling procedure to runway 14. On descent to the radio beacon, the crew reportedly encountered flight visibilities of one mile and were in visual contact with the ground. When the aircraft was less than five miles[3] from the airport, the crew heard a position report from another aircraft completing an approach to the airport. To ensure safe separation from the aircraft ahead, the captain elected to fly under visual flight rules to the southwest of the airport.

Air Traffic Services radar data was obtained from the Big Trout Lake radar source. The radar data indicated that the crew descended to about 150 feet above ground level (agl) approximately 4.5 miles from the end of the landing runway and maintained 200 to 300 feet agl for some 50 seconds prior to impact. Immediately prior to impact, the radar data indicated that the aircraft was about 3 1/2 miles from the runway at about 300 feet agl and descending at more than 1,200 feet per minute.

Throughout the approach, the first officer flew the aircraft visually with occasional reference to his instruments, while the captain navigated and maintained terrain clearance by visual reference to the terrain and issued instructions to the first officer. At approximately five miles from the runway, the crew turned onto the extended centre line of the runway and received a radio report from the other aircraft of local visibilities of less than 1/2 mile. The aircraft flew inbound over a wide expanse of lake, and the captain lowered the flaps in preparation for landing. Shortly thereafter, the captain became concerned with the reducing visibility and looked in the Company Approach Procedures binder that he held on his lap. The captain was aware of the danger of whiteout and intended to revert to instrument flight if whiteout were encountered. He had not previously removed the approach chart for Big Trout Lake and clipped it in the approach chart holder because he had discovered that the binder rings were broken and taped shut when he had performed his initial approach briefing. He intended to provide new approach information to the first officer so that a full instrument approach could be initiated from their current position. When the captain looked up from the binder, he observed the altimeter indicating a descent through 1,000 feet above sea level (asl) and called to the first officer, "Watch your altitude." Before a recovery could be initiated, the aircraft struck the frozen surface of the lake and bounced into the air. The captain initiated a recovery and then, concerned with the airworthiness of the aircraft, reduced power and attempted to land straight ahead. The aircraft crashed onto the frozen surface of the lake about 3/4 mile beyond the initial impact location.

All passengers and crew survived the accident. However, the crew and several passengers sustained serious injuries. Rescuers from the local community reached the aircraft about two hours after the crash and all survivors were rescued within four hours. The more seriously injured were experiencing the effects of hypothermia when rescued.

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1 See Glossary for all abbreviations and acronyms.

2 All times are CST (Coordinated Universal Time [UTC] minus six hours) unless otherwise stated.

3 Units are consistent with official manuals, documents, reports, and instructions used by or issued to the crew.

The accident occurred at 1248 CST, approximately three miles northwest of Big Trout Lake Airport, at latitude 53°49'N, longitude 089°53'W, at an elevation of 690 feet asl.

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	-	-	-	-
Serious	2	7	-	9
Minor/None	-	2	-	2
Total	2	9	-	11

1.3 Damage to Aircraft

The aircraft was damaged beyond economical repair.

1.4 Other Damage

The aircraft's main fuel tanks ruptured on impact, and the resulting fuel spill contaminated the snow in the area of the impact.

1.5 Personnel Information

	Captain	First Officer
Age	29	27
Pilot Licence	ATPL	CPL
Medical Expiry Date	01 Jul 1995	01 Mar 1995
Total Flying Hours	5,000	2,300
Hours on Type	1,500	800
Hours Last 90 Days	195	210
Hours on Type Last 90 Days	195	210
Hours on Duty Prior to Occurrence	3.5	3.5
Hours Off Duty Prior to Work Period	24	15

The crew was certified and qualified for the flight in accordance with the existing regulations.

The company has followed a policy of having all of their pilots receive crew resource management (CRM) training. The captain had received CRM training, but the first officer, who was a relatively new hire, had not received the training.

1.6 *Aircraft Information*

Manufacturer	Beech Aircraft Corporation
Type	King Air A100
Year of Manufacture	1974
Serial Number	B-189
Certificate of Airworthiness (Flight Permit)	Valid
Total Airframe Time	13,739 hr
Engine Type (number of)	PT6A-28 (2)
Propeller/Rotor Type (number of)	Hartzell HC-B4TN-3 (2)
Maximum Allowable Take-off Weight	11,500 lb
Recommended Fuel Type(s)	Jet-A, Jet A-1, Jet B
Fuel Type Used	Jet B

A review of available records indicated that the aircraft was equipped and maintained in accordance with existing regulations and approved procedures except for the following two discrepancies:

i. the propeller synchrophaser had been removed from the aircraft because of unserviceability, but this action had not been logged in the Journey Log; and,

ii. the radar altimeter (radalt) had been declared unserviceable [non-specific] in the Journey Log and subsequently logged in the Deferred Items Log section of the Aircraft Journey Log. However, the radalt had not been placarded unserviceable in the cockpit, as per the placarding requirements outlined in the company Maintenance Control Manual. The captain was aware of the unserviceability, and the radalt was not used during the approach. The radalt was found with its switch in the OFF position and the bug set at approximately 1,050 feet.

1.7 Meteorological Information

Big Trout Lake is served by an Automated Weather Observation System (AWOS) and a voice generation system. The AWOS provides up-to-the-minute weather information to the pilot via radio. Meteorologists use AWOS observations in the production of aerodrome and area forecasts.

The weather forecast for Big Trout Lake, issued at 0500 CST, and obtained by the crew prior to departure, indicated that for their time of arrival, there would be an occasional sky condition of 3,000 feet overcast with visibility greater than six miles in light snow. The weather forecast issued at 1100, just prior to their departure, was substantially the same. This forecast was amended at 1227 to an occasional sky condition of 1,000 feet overcast with visibility of one mile in light snow. However, the weather the flight encountered was localized and corresponded more closely to the visibility reports from the AWOS.

The AWOS report received by the crew before they began their approach procedures was made at 1212 and indicated that the cloud was scattered at 900 and 2,100 feet agl and the visibility was 1.3 miles in light snow. The weather report available from the AWOS by radio broadcast as the crew began their approach was made at 1239 and indicated that the sky was clear below 10,000 feet with visibility of 9/10 of a mile in light snow. The temperature was -14° Celsius, and the altimeter setting was 29.96 inches of mercury.

From the observations taken at the AWOS over the period of the occurrence, the visibility dropped from 9/10 of a mile at 1239 to 1/2 mile at 1300. The winds were from the south at 13 to 15 knots. The AWOS did not report any obscured or partially obscured ceiling in the precipitation.

1.8 Aids to Navigation

The airport is served by a non-directional beacon (NDB) located approximately 0.6 nautical miles (nm) west of the runway; the frequency of the NDB is 328 kilohertz (KHz), which was tuned to the aircraft's automatic direction-finder (ADF) radio. An interim Transport Canada Approved Company Instrument Approach Procedure, dated 07 November 1994, provides a circling approach to the runway with a minimum descent altitude of 1,280 feet asl and an advisory visibility of two miles. The elevation of the airfield specified by the chart is 777 feet. Company instrument approach procedure charts are issued on 8½- by 11-inch paper and are kept in three-ring binders by the company. The one binder provided in the occurrence aircraft was broken and the individual charts could not be easily removed by the crew. The captain placed the binder on his lap during the approach.

The aircraft was equipped with a global positioning system (GPS), which was not an approved navigation aid for instrument flight rules (IFR) navigation, and was used by the crew as a backup navigation aid.

1.9 Communications

The airport is located in uncontrolled airspace. An aerodrome traffic frequency (ATF) is designated within a 5 nm radius below 3,700 feet asl. Prior to descent into Big Trout Lake, the captain communicated on the company frequency with another Bearskin flight that had departed Big Trout Lake about 30 minutes earlier. The crew of the departing flight reported the weather as one mile in snow, with snow showers to the west. On arrival at Big Trout Lake, the captain communicated on the ATF with the crew of another company who were flying a right-hand visual approach to runway 14.

1.10 Aerodrome Information

Big Trout Lake is a certified airport operated by the Ontario Government. The airport elevation listed in the *Canada Flight Supplement* dated 08 December 1994 and used by the occurrence crew is 738 feet. This elevation is 39 feet lower than the elevation specified on the Company Approach plate. The elevation specified on the Company Approach plate is based on a more recent survey and is the correct airport elevation for Big Trout Lake. Runway 14/32 is gravel and 3,900 feet long by 100 feet wide. A RAMP radar site is located approximately 1,700 feet west of the threshold of runway 14.

1.11 Flight Recorders

The aircraft was not equipped with any flight recorders, nor was there any regulatory requirement for the aircraft to be so equipped.

1.12 Wreckage and Impact Information

The initial impact occurred on the frozen surface of Big Trout Lake approximately 3.4 nm northwest of the airport on the extended centre line of the runway and approximately 3.1 nm northwest of the RAMP radar site. The belly luggage pod was destroyed on first impact and the contents were strewn onto the ice. The trail of baggage and luggage pod debris was oriented on a heading of approximately 140˚ magnetic (M). Snow, which fell and was compacted by the wind after the occurrence, obliterated any potential evidence of wing or propeller strikes in the initial impact area.

The second (main) impact site was located on the ice surface of the lake approximately 2.7 nm northwest of the airport, slightly to the left of the extended centre line of the runway. The aircraft crashed while in a left bank, nose-low attitude, on a heading of approximately 071˚M. The nose and the underside of the fuselage were crushed and the fuselage was buckled in several places; however, the main shape of the cabin was retained and all windshields and windows maintained their integrity. The left wing attachment fittings were broken, and the left wing was buckled in several places. The top surface of the right wing appeared undamaged; however, the rear spar of the right wing was fractured, and the right inboard flap cables were stretched and internal sleeves displaced by the forward movement of the right wing during the impact. The rear fuselage was wrinkled and buckled in several areas and both rear horizontal stabilizer attachment brackets were broken, which allowed the stabilizer to move freely.

The landing gear were in the retracted position, and the flaps were extended to the 30˚ position. All primary flight controls were attached, and the continuity of controls was verified. The wings and horizonal stabilizer had a slight accumulation of rime ice along the leading edge. The strips of rime ice were about 1 to 1.5 inches wide and up to 1/8 inch thick. In several places, the thin strips of rime ice had been covered with oil during the impact sequence.

Both engines were displaced to the left by the downward and forward motion of the aircraft during the impact sequence. The propeller of the left engine was found approximately 150 feet behind the aircraft at the start of the second impact wreckage trail. All four blades of this propeller were still in the hub. Three of the four blades were severely curled along 3/4 of their respective lengths. Examination of the propeller mounting flange revealed that the mounting bolt threads had failed. All of the bolts were found in the propeller shaft mounting flange on the engine. The propeller and gearbox of the right-hand engine were detached as a unit and became trapped under the engine against the fuselage. The right propeller blades were severely curled in a manner similar to the left propeller blades. This evidence is consistent with the engines providing high power as reported by the crew.

All seats, with the exception of the crew seats and the bench seat at the back of the aircraft, had been removed by rescuers. Three seat-belt attachment fittings had broken during the impact. The captain's seat pan was badly deformed and the mounting structure under the seat was broken. The seat track attachments maintained their integrity, but the vertical seat posts had failed as the cabin floor was driven upwards. The shoulder harnesses from both of the pilot seats had been cut by rescuers, leaving only three or four inches of shoulder harness material at the inertia reel. The bulkheads separating the crew from passengers had also been removed by rescue personnel.

1.13 Medical Information

There was no evidence that incapacitation or physiological factors affected the crew's performance.

1.14 Fire

There was no fire either before or after the occurrence. Emergency response services (ERS) were not available.

1.15 Survival Aspects

1.15.1 First Aid Kit

Air Navigation Order (ANO) Series II, No. 11, the *Aircraft First Aid Kit Order*, requires that aircraft be equipped with first aid kits for the treatment of injuries likely to occur in flight or in minor accidents. One of the passengers was a nurse who treated the survivors using the aircraft first aid kit. She reported that the first aid kit was not adequate to deal with the injuries that the passengers received. In particular, there was a critical lack of pressure dressings to stop bleeding. The nurse improvised and used packed snow to control bleeding.

1.15.2 Survival Kit

ANO Series V, No. 12, the *Sparsely Settled Areas Order*, specifies the type of emergency equipment that must be carried on aircraft operating in the sparsely settled region of Canada. The order permits exceptions for air carriers as authorized in the air carrier's operations manual. The Bearskin Lake Air Services Operations Manual, which was approved by Transport Canada, exempted this flight from the requirement to carry a winter sleeping bag for each person on board.

All personal baggage and equipment was lost when the baggage pod was crushed during the initial impact. A small survival kit carried in the aircraft cabin contained some foil (space) blankets that were used to protect the most seriously injured. However, the nurse reported that hypothermia occurred in the two most seriously injured survivors who were immobile.

1.15.3 Emergency Locator Transmitter (ELT)

ANO Series II, No. 17, the *Emergency Locator Transmitter Order*, requires that information concerning the location and operation of the emergency locator transmitter be made available to the passengers by means of a readily visible placard located in the aircraft's cabin or by other equivalent means. After the crash, the passengers had difficulty understanding the placard and could only follow its instructions with the aid of the seriously injured captain. The crew members and the passengers had difficulty ascertaining if the ELT had activated automatically during the crash. When they attempted to activate the ELT manually, they also had difficulty in determining if it was activated. Eventually, the crew turned on the aircraft electrical power to hear the ELT tone on the aircraft radio. The ELT did function correctly, and a search and rescue aircraft was dispatched and evacuated the passengers and crew to Winnipeg.

The ELT is manually activated by a small toggle switch accessible through a push-in access panel approximately the size of a quarter coin. The access panel is located on the exterior of the aircraft fuselage just forward of the starboard stabilizer. The location is identified by a placard. The on/off positions of the toggle switch were difficult to identify when viewed through the small access panel.

1.16 Tests and Research

1.16.1 Altimeters

The aircraft was equipped with three pressure altimeters and one radar altimeter. The aircraft was not equipped with either altimeter reference markers or an altitude alerting system. The radar altimeter was not functional and not used by the crew. The pressure altimeter on the captain's side of the instrument panel was an encoding altimeter and required aircraft electrical power to function. Encoding altimeters provide the aircraft's altitude to air traffic control (ATC) radars via the aircraft's transponder. The pressure altimeter on the co-pilot's side of the instrument panel was not an encoding altimeter and did not require aircraft power to operate. The co-pilot's altimeter used a different static source than the captain's altimeter. The third pressure altimeter was a blind encoding altimeter and was not intended for crew use during flight. The blind encoding altimeter used the same static source as the co-pilot's altimeter. A switch was used to select either the captain's encoding altimeter or the blind encoding altimeter to provide the aircraft's altitude to ATC radars via the transponder. The selector switch was positioned to provide the blind encoding altimeter altitude to ATC radars at the time of the occurrence.

On the day following the accident, at approximately 1230, TSB investigators noted that the co-pilot's altimeter read 960 feet asl, and that the altimeter's sub-scale was set to 29.96 inches of mercury. The reading of the captain's altimeter was not considered valid since electrical power had been interrupted; however, the subscale was noted as set to 29.96 inches of mercury. The subscale settings of both altimeters corresponded to the altimeter setting transmitted by the Big Trout Lake AWOS at the time of the occurrence.

At the time that TSB investigators observed the co-pilot's altimeter reading of 960 feet asl, the Big Trout Lake AWOS altimeter setting was 29.69 inches of mercury. An Atmospheric Environment Service (AES) specialist in barometry used the preceding data to compute the altitude that the altimeter would have indicated if the correct altimeter setting, 29.69 inches of mercury, had been set on the co-pilot's altimeter. The computed altitude that the co-pilot's altimeter would have indicated for the atmospheric conditions at the time of the TSB observation was 710 feet asl, approximately the elevation of the lake surface.

The captain's and co-pilot's altimeters were tested and found to be working within required accuracy limits. At test altitudes of 500 and 1,000 feet, the captain's altimeter indicated 500 and 1,010 feet, and the co-pilot's altimeter indicated 500 and 990 feet.

1.16.2 Vertical Speed Indicators

Both the captain's and co-pilot's vertical speed indicators were tested and found to be calibrated in accordance with national standards and functioning well.

1.16.3 Horizontal Stabilizer Trim Actuator

The horizontal stabilizer trim actuator was tested and performed within acceptable parameters.

1.16.4 *Passenger Seat-Belts*

Two seat-belt attachment fittings from the occurrence aircraft and two new, similar fittings from the air carrier were subjected to strength testing. The applicable testing standard for seat-belt fittings is Federal Aviation Administration (FAA) Technical Standard Order C22. This standard requires that the belt fittings be designed to withstand loads of at least 1,500 pounds. All four fittings were tested to destruction under conditions specified in the standard; the two fittings from the occurrence aircraft failed at 1,596 and 2,218 pounds, and the two new fittings failed at 1,972 and 2,180 pounds.

1.17 *Organizational and Management Information*

The company has published standard operating procedures (SOPs) for the guidance of pilots of the Beech A100, Beech 99, and Metro aircraft. The amount of guidance provided in the Beech 99 and the Metro SOP with regard to approach procedures is significantly greater than that provided in the Beech A100 SOP. For example, the Beech 99 and Metro SOPs specify the approach briefing in detail and direct that both pilots have their approach charts displayed for the approach. The Beech A100 SOP does not have such specific guidance. The Beech 99 and the Metro SOPs discuss missed approach procedures and specify that, "The captain may also elect to carry out the missed approach at any time he may feel it is unwise to continue." There is no discussion of the missed approach procedure in the Beech A100 SOP. Company SOPs are not mandatory and do not require approval by Transport Canada. (See Section 4.1.)

1.18 *Additional Information*

1.18.1 *Whiteout*

The Transport Canada *Aeronautical Information Publication* (AIP), section Air 2.14(b), describes whiteout as an extremely hazardous visual flight condition. Whiteout occurs over an unbroken snow cover and beneath a uniformly overcast sky. Because the light is so diffused, the sky and terrain blend imperceptibly into one another, obliterating the horizon. The horizon, shadows, and clouds are not discernible, and sense of depth and orientation is lost; only very dark, nearby objects are discernible. In addition, the AIP indicates that whiteout can result from blowing snow and falling snow.

The real hazard in a whiteout is that pilots do not suspect the phenomenon because they may be in clear air. In many whiteout accidents, pilots have flown into snow-covered surfaces unaware that they have been descending, and confident that they could see the ground. Consequently, when pilots encounter the whiteout conditions described above, or even suspect they are in such conditions, they should immediately climb if at low level, or level off and turn towards an area containing sharp terrain features. Pilots should not continue the flight unless they are prepared to cross the whiteout area using instruments, and have the skills to do so.

1.18.2 *AWOS Visibility and Ceiling*

Transport Canada issued an Aviation Notice, dated 02 February 1995, in response to user concerns with the performance of some AWOS sensors. The Aviation Notice included an interim operational caution as follows:

> If aviation users encounter an AWOS report of clear below 10,000 feet (CLR BLO 100) when precipitation and reduced visibilities are also reported, it is a definite indication that this is an erroneous sky condition report. An analysis of minute-to-minute data at some sites indicates that this condition may persist, in some cases, for over an hour. Version 5.2 of the ceilometer

> algorithm has, in laboratory tests, almost eliminated false reports of this nature. This algorithm will be deployed as soon as possible after satisfactory field testing. Please consult NOTAM [Notice to Airmen] for the latest information on this subject.

NOTAM 940461 for Big Trout Lake was contained in the weather package carried by the crew. This NOTAM stated the following:

> CYTL AWOS. If aviation users encounter an AWOS ceilometer report of "CLR BLO 100" when reduced visibility, precipitation or surface obscuration are present, it is a definite indication that this is an erroneous sky condition report. In the event of any discrepancy between AWOS ceiling or visibility and that observed by a pilot in the vicinity, operations may be based on the ceiling, runway visibility or flight visibility as provided by pilot report.

1.18.3 AWOS Altimeter Setting

The crew of the Bearskin flight that had departed Big Trout Lake about 30 minutes prior to the occurrence reported that they had received an inaccurate AWOS altimeter setting. They set their altimeters to the aerodrome elevation while they were on the ground, but initially could not remember the resulting subscale setting. Several days later, they recalled a subscale setting that would have resulted in an altitude reading of about 100 feet high. The co-pilot's altimeter from the aircraft used by this crew was tested. It was found to be functioning correctly and well within calibration limits. At test altitudes of 500 and 1,000 feet, this altimeter indicated 490 and 980 feet. The crew of another air carrier had landed minutes before the occurrence and did not report any discrepancy with the AWOS altimeter setting. Both crews used a field elevation of 738 feet, obtaining the elevation from data stored in their respective GPS data bases. The information stored in the GPS data base is based on the *Canada Flight Supplement*.

The AWOS altimeter setting provided is the lower reading of two sensors. If a discrepancy of 0.04 inches of mercury exists between the dual sensors, the system will fail safe, and the altimeter setting will be missing from the AWOS weather report. An on-site calibration of the Big Trout Lake AWOS was conducted on 16 March 1995 by an Environment Canada technical service specialist. The dual pressure sensors were found to be well within calibration tolerances.

1.18.4 RAMP Radar Data

The transponder of the occurrence aircraft was transmitting aircraft altitude information to the Big Trout Lake radar site. The last transmission was received at 1248, when the aircraft was approximately 3.1 nm from the radar site, and gave the aircraft's pressure altitude as 800 feet asl. A pressure altitude of 800 feet asl corresponds to an actual altitude of 710 feet asl under the barometric conditions that existed at the time of the occurrence.

1.18.5 Controlled Flight into Terrain

Controlled flight into terrain (CFIT) accidents are those in which an aircraft, capable of being controlled and under the control of the crew, is flown into the ground, water, or obstacles with no prior awareness on the part of the crew of the impending disaster. Previous TSB reports have indicated that meteorological conditions were a significant factor in more than 50 per cent of these type of accidents, and that loss of situational awareness is a fundamental element in the cause of these types of accidents.

1.18.6 Situational Awareness

To make correct decisions when flying an aircraft, the crew must have an adequate knowledge of what is happening around them, that is, situational awareness. Without situational awareness, the crew has no starting point for correct decision making; appropriate action cannot be taken unless the information on which the decisions are based is valid.

1.18.7 Information Processing

A considerable body of research has been developed concerning information processing and decision making. This research has established that stress and high workload may lead to a narrowing of attention to the primary task at hand and to the most noticeable information source(s) as perceived by the pilot. The most noticeable information sources may not be the most objective, and under stressful conditions, important information may be missed or discounted without the awareness of the decision maker. Hence, the decision maker or pilot unknowingly may become less situationally aware, even though striving to retain a correct perception of the situation.

1.18.8 Ground Proximity Warning System

A ground proximity warning system (GPWS) is designed to issue visual and aural warnings to the flight crew when their aircraft is too close to terrain, or when its terrain closure rate, rate of descent, or glideslope deviation becomes excessive. The warnings are based on GPWS internal logic, radar altimeter information, and the aircraft's configuration. GPWS has prevented many accidents where, until the warning was sounded, the pilots had been unaware that the aircraft was in danger because of its proximity to the ground or water. The occurrence aircraft was not equipped with a GPWS and none was required by the regulations.

1.18.9 Approach Chart Holders

Company aircraft are equipped with approach chart holders. These holders are mounted on both control yokes and are designed to hold approach charts published in the *Canada Air Pilot*.

1.18.10 Visual Flight Rules

Visual flight rules (VFR) weather minima are specified in ANO Series V, No. 3. When the occurrence aircraft was manoeuvring southwest of Big Trout Lake, it was operating in uncontrolled airspace below 700 feet agl. The weather minima specified for these conditions are not less than one mile visibility and clear of cloud.

2.0 Analysis

2.1 Introduction

The investigation did not reveal any mechanical difficulties with the aircraft's engines nor with the aircraft's primary and secondary flight controls. This analysis will concentrate on the aircraft's altimeters, the AWOS altimeter setting, weather, and pilot decision making, all of which could have contributed to the occurrence. Additionally, survival issues will be discussed.

2.2 Aircraft Altimeters

The last recorded radar transponder information places the aircraft approximately 3.1 nm from the Big Trout Lake radar site, which corresponds to the approximate distance to the initial impact location. Consequently, the last blind encoding altimeter transponder transmission received by the Big Trout Lake radar source likely occurred immediately prior to the aircraft hitting the ice surface of the lake.

The last recorded transponder transmission received from the aircraft was from 710 feet asl. Because the known elevation of the surface of the lake is 690 feet asl, the blind encoding altimeter and the pitot static system it was using were likely functioning correctly. Additionally, because the blind encoding altimeter uses the first officer's pitot static system as its source, it is likely that the first officer's pitot static system was also functioning correctly.

The first officer's altimeter performed within limits during post-occurrence testing. Additionally, because its pitot static system was likely functioning correctly, the accuracy of its altitude reading would be solely dependent on the accuracy of its subscale setting. That altimeter setting of 29.96 inches of mercury was obtained from the Big Trout Lake AWOS; consequently, the accuracy of the altitude reading being used by the first officer was solely dependent on the accuracy of the Big Trout Lake AWOS altimeter setting. Additionally, because neither the captain nor the first officer noted any discrepancy between their respective altimeters during their flight, the accuracy of the captain's altimeter was also determined solely by the Big Trout Lake altimeter setting as transmitted to the crew.

2.3 Automated Weather Observation System

Calculations performed by the barometric specialist demonstrated that a setting of 29.96 would have produced an accurate altimeter reading at the time of the occurrence. Additionally, the AWOS fail-safe system did not activate, and the system was found to be functioning within allowable tolerances when tested against the regional standard. Therefore, it can be concluded that the AWOS measured and transmitted a valid altimeter setting of 29.96, which was properly set by the crew. Thus, the voice transmission of the AWOS at the time of the approach into Big Trout Lake was accurate.

The discrepancy reported by other Bearskin crew at Big Trout Lake on the day of the occurrence could not be resolved. However, the discrepancy could have resulted in part from the airport elevation difference of 39 feet between the actual elevation and that found in the *Canada Flight Supplement* and GPS data base. When this crew set the transmitted Big Trout Lake AWOS altimeter setting on the ground, their altimeters would have read 777 feet, the correct altitude of Big Trout Lake Airport published in the Company Approach Chart, instead of the published 738 feet in the *Canada Flight Supplement* dated 08 December 1994. Although the discrepancy could not be fully explained, another carrier that had landed at Big Trout Lake at the time of the occurrence did not report any altimeter setting problems while using the AWOS setting.

2.4 Decision Making on Approach

When the captain initially briefed the first officer for the instrument approach into Big Trout Lake, he noted that the only approach chart provided was in a binder and could not be readily removed. The captain accepted this condition, and consequently, to consult the chart during the approach, the captain had to hold the binder in his lap and look down to read the information. In addition, the chart was not readily accessible to the first officer.

The crew descended to 150 feet agl approximately 4.5 miles from the end of the landing runway and maintained 200 to 300 feet agl for some 50 seconds prior to impact. Given the weather conditions of one mile visibility in snow that were reported by the crew, and the monochromatic appearance of the snow-covered surface of the lake, the crew's decision to continue to fly visually at this altitude exposed the crew to the risk of experiencing whiteout conditions. The captain was aware of the danger, and intended to revert to an instrument approach if whiteout were encountered. Although the decision to fly close to the lake surface reduced the margin of safety and the time available to react to any loss of situational awareness in whiteout conditions, the decision did not contravene ANOs or the company SOPs.

This decision also caused an increase in the crew's stress and workload during the final approach phase, in that the crew were faced with maintaining terrain clearance visually at low level in adverse weather conditions. Thus, the crew had increased the likelihood of narrowing their attention to the primary task, that of maintaining visual terrain clearance, and to the most noticeable information source, the surrounding terrain. They had increased the likelihood of missing or discounting critical information provided by the altimeter and vertical speed indicator, without any awareness of doing so. Thus the crew's decision increased the possibility of the loss of situational awareness in whiteout.

Because the radalt was not serviceable, it was not used by the crew as a warning device. The radalt setting of 1,050 feet, as observed by the investigators, is consistent with the crew's statement that they had not used the radalt.

After the aircraft crossed the last chain of islands on track, about 3 1/2 miles from the runway, the Air Traffic Services radar data indicated that the aircraft was about 300 feet agl and was descending at more than 1,200 feet per minute. The first officer, who was flying the aircraft, did not stop the descent. Both his altimeter and vertical speed indicators were functioning accurately; however, it is unlikely that he was using them for altitude guidance. It is probable that he had unknowingly narrowed his attention to outside references for terrain clearance because of the stress and high workload of the low-level, visual approach. At this distance from the runway, the aircraft was over a wide expanse of lake, with the nearest shoreline in excess of a mile away. Thus, the visual cues required to maintain terrain clearance were beyond the one mile visibility reported by the crew. The absence of visual cues placed the crew in whiteout conditions. Because of a lack of visual altitude references in whiteout, it is unlikely that the first officer realized that he was ignoring instrument indications and that he was allowing the aircraft to descend into the terrain. Consequently, it is likely that the first officer lost situational awareness in whiteout conditions and was unable to take effective action.

The captain had become concerned about the reducing visibility as they flew towards the airport, and decided to conduct an instrument approach. He did not instruct the first officer to begin a missed approach, but instead looked at the company approach chart in order to rebrief the first officer on approach information. After he consulted the chart, he looked up and observed that the altimeter was indicating a descent through 1,000 feet asl. His direction to the first officer was the non-specific command, "Watch your altitude." Because of the low altitude of the aircraft and the high rate of descent, the first officer did not have time to assimilate and respond to the instruction. Consequently, the lack of timely action by the crew, when the first officer lost situational awareness in whiteout conditions, resulted in the aircraft descending into the terrain under controlled flight.

As noted, the radar altimeter was not serviceable and consequently was not used by the crew as a warning device. A GPWS, if installed and operable, would have provided constant warnings and cues to the crew of their proximity to the terrain.

2.5 *Survival Issues*

2.5.1 ELT

Although the posted instructions for the ELT met the regulatory requirement, they were difficult for passengers to understand in a stressful situation under harsh environmental conditions. In particular, the passengers could not see that they had indeed activated the switch, and they did not understand that the ELT would not emit an audible sound and only be transmitted on a radio frequency.

2.5.2 First Aid Kit

Although the first aid kit met the regulatory requirement, its contents were inadequate to deal with the type of injuries sustained in this accident. Under the harsh environmental conditions to which the passengers were exposed, their chances of surviving for an extended period were greatly reduced.

2.5.3 Survival Kit

The company was exempted from the need to carry sleeping bags in accordance with the Transport Canada approved Company Operations Manual. The company, however, had included foil-type survival blankets in a small kit in the aircraft. These foil blankets were critical in the reduction of hypothermia in the two most critically injured survivors. The lack of sleeping bags made it impossible to prevent hypothermia and might have resulted in more serious injury or death if rescue had been delayed.

2.5.4 Seat-Belt Attachment Fittings

The four seat-belt attachment fittings were tested and found to meet the required standard. Therefore, it is probable that the three that failed during the impact broke because the force of the impact exceeded the design limit of 1,500 pounds. Consequently, the failure of seat-belt attachment fittings in this survivable accident may indicate that the limit is set too low.

3.0 Conclusions

3.1 Findings

1. The crew was certified, trained, and qualified for the flight in accordance with existing regulations.

2. The airport elevation listed in the *Canada Flight Supplement* dated 08 December 1994 was incorrect and was 39 feet lower than the correct airport elevation of 777 feet shown on the Company Approach chart.

3. The aircraft altimeters were serviceable and set to the correct altimeter setting as reported on the AWOS.

4. The AWOS was transmitting the correct visibility at the airport and an erroneous sky condition report. However, operation into Big Trout Lake was based on the ceiling and flight visibility as reported by the occurrence crew. The occurrence crew reported the visibility as one mile.

5. The decision to fly visually at low level over the lake surface in one mile visibility increased the crew's stress and workload and exposed the crew to the risk of experiencing whiteout conditions; however, the decision did not contravene ANOs or company SOPs.

6. The first officer unknowingly missed critical altitude information when he lost situational awareness in whiteout conditions.

7. The crew did not react in a timely manner when whiteout conditions were encountered.

8. The instructions for operating the ELT were confusing to the passengers.

9. The lack of sleeping bags on board the aircraft, as permitted by the operating certificate, exposed the most critically injured survivors to hypothermia.

10. The foil blankets provided in the aircraft reduced the effects of hypothermia in the most critically injured survivors.

11. Three seat-belt attachment fittings failed in overload; the attachments met design specifications for strength.

12. The first aid kit met the standard required by regulations but was inadequate for the type of injuries sustained by the survivors.

13. The aircraft's radar altimeter was not serviceable.

14. The aircraft was not equipped with a GPWS, nor was one required by regulation.

15. The captain accepted an approach chart location that resulted in the only available approach chart not being readily accessible by either crew member.

16. The company SOPs for the Beech A100 provided minimal guidance with regard to approach procedures.

3.2 Causes

While the crew were manoeuvring the aircraft to land and attempting to maintain visual flying conditions in reduced visibility, their workload was such that they missed, or unknowingly discounted, critical information provided by the altimeters and vertical speed indicators. Contributing factors were the whiteout conditions and the crew's decision to fly a visual approach at low altitude over an area where visual cues were minimal and visibility was reduced.

4.0 Safety Action

4.1 Action Taken

4.1.1 Airport Elevation

Subsequent to this occurrence, the *Canada Flight Supplement* was amended to indicate the airport elevation of Big Trout Lake as 777 feet asl.

4.1.2 Visibility Requirement in Uncontrolled Airspace

In the proposed Canadian Aviation Regulations (CARs), the visibility requirement for aircraft operating under visual flight rules in uncontrolled airspace below 1,000 feet agl will be increased to two miles from the current one mile requirement. However, there will be provisions for Transport Canada (TC) to allow commercial operators to operate aircraft at lower visibilities provided that certain pilot training and aircraft equipment criteria are met.

4.1.3 Operating Instruction for ELTs

In this occurrence, the passengers had difficulty operating the ELT. A TSB Aviation Safety Advisory was forwarded to Transport Canada regarding the need for the placarding of clear instructions for the use of ELTs, with the suggestion that this requirement be considered in the new regulations.

4.1.4 Ground Proximity Warning System (GPWS)

Canadian regulations require only commercially operated, large turbo-jet powered aircraft (capable of carrying 10 or more passengers and with 15,000 kg or greater maximum certified take-off weight) to have GPWS installed. In the United States, all turbine powered (turbo-jet and turbo-prop) aeroplanes with 10 or more seats, notwithstanding their weight, require an operating GPWS. The aircraft in this occurrence, the Beechcraft A100, is certified for more than 10 seats; however, the Canadian regulation for GPWS is limited to turbo-jet powered aircraft only.

The Board believes that the increased level of safety provided by GPWS should not be related to an aircraft's type of propulsion; rather the requirement for GPWS installation should be based on the role of the aircraft and its passenger-carrying capacity. Therefore, the Board previously recommended that:

> The Department of Transport require the installation of GPWS on all turbine-powered IFR-approved commuter and airline aircraft capable of carrying 10 or more passengers.
>
> (A95-10, issued 21 March 1995)

Transport Canada replied that it would submit the GPWS issue to the Canadian Aviation Regulation Advisory Council (CARAC). The CARAC is establishing a sub-working group to look into safety systems, such as GPWS, traffic collision avoidance systems, and windshear avoiding systems.

4.2 Action Required

4.2.1 Post-Accident Survivability

As evidenced in this occurrence, accident survival can depend to a large extent on post-crash conditions. Notwithstanding that this operator had complied with all regulations, the first aid kit on board the aircraft was not adequate to deal with the injuries to the passengers, some survivors suffered from hypothermia as a result of insufficient protection from the elements, and the passengers had difficulty following the instructions for post-crash use of the ELT.

The issue of post-accident survivability has been an ongoing concern in commercial aviation. In 1986, following a PA-31 accident, the predecessor to the TSB, the Canadian Aviation Safety Board (CASB), expressed concern about the lack of survival equipment on small commercial passenger-carrying aircraft during winter operations, and recommended that:

> The Department of Transport, having due regard to space and weight limitations while benefitting from advances in available lightweight materials:
>
> a) prescribe a minimum list of survival equipment suitable for post-accident winter conditions; and
>
> b) require the carriage of prescribed survival equipment on aircraft operating during the winter on passenger-carrying flights under the provisions of Air Navigation Order Series VII, Numbers 3 and 6.
>
> (CASB 86-20, issued in 1986)

TC agreed with the recommendation. However, no significant revisions were made to the ANOs, and the provisions for waivers against the carriage of all or some of the survival equipment specified in the ANOs were retained. Thus, the company in this occurrence was not required to carry sleeping bags in the survival kits.

Following another accident near Bonaventure, Quebec, in 1989, in which three of the five surviving passengers on a small commercial aircraft suffered serious injuries and the contents of the aircraft first aid kit were inadequate, the TSB recommended that:

> The Department of Transport reconsider the feasibility and practicality of including a first aid kit specifically equipped for post-accident survival in the aircraft survival kit required by Air Navigation Order (ANO) Series V, No. 12.
>
> (TSB A91-23, issued in 1991)

In response, TC acknowledged that the requirements for first aid supplies might be insufficient for post-accident use. TC was, however, of the opinion that it was not practical to include additional first aid supplies in the survival kit, since some operators were able to waive the requirements for survival kits. An alternative was to improve the contents of the existing first aid kits. As such, the new CARs will require that the contents of the first aid kit(s) on aircraft be equal to those specified in the Aviation Occupational Safety and Health (OSH) regulation. OSH guidelines are used for the safety of employees at their work place, and, in this sense, the first aid kits will be an improvement. However, in the Board's view, the first aid kits will not fulfil on-site medical needs immediately following an aircraft crash and during the wait for rescue.

While data indicate that only a few aircraft accident survivors have had to spend considerable time awaiting rescue, the often harsh Canadian climate can very quickly put the lives of survivors in jeopardy. While the SARSAT[4] system greatly improves rescue response times over those of just a few years ago, the success of this system depends on a functioning ELT in the accident aircraft. Department of National Defence Search and Rescue statistics indicate that, including those instances where the ELT has not been armed, ELTs have not activated in 40 to 50 per cent of all aircraft accidents[5]. In 1991, TC commenced a two-year trial on a new generation of ELTs; however, ELTs designed to the standard of the improved TSOs are still not required in Canada.

As previously stated, the new CARs contain some revisions to the orders affecting post-crash considerations. CAR 602.61 states that sufficient survival equipment, given the season of the year, the geographical area, and anticipated seasonal climatic variations, must be carried for each person on board the aircraft. As with the previous ANOs, however, the CARs also provide for exceptions to the basic requirements. The Board recognizes the need for waivers given the wide differences in aviation operating conditions that can be encountered across Canada; it would not be practical to expect every air carrier to outfit its aircraft with all the equipment specified in the CARs under all conditions. However, the Board is concerned about the potential misapplication of any exemptions. For example, the CARs state that the carriage of survival equipment is waived on all multi-engine aircraft flying on designated air routes south of the Arctic Circle. Apparently, many air taxi and commuter operators--generally flying smaller, older multi-engine aircraft, operating between remote locations on self dispatch systems with minimal flight following, and comprising a segment of the commercial passenger industry having a higher accident rate than the industry as a whole--would not be required to carry survival equipment on their aircraft.

Aviation accident data indicate that there is a higher risk to safety in commercial aviation from factors related to human performance, such as those found in this occurrence, than from engine failures in single-engine aircraft (a factor on which the cited exemption seems to be based). The Board believes

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4 Search and Rescue Satellite system capable of detecting signal transmissions from activated ELTs.

5 In 1990, as a result of a Cessna 402 occurrence at Charlo, New Brunswick, in which the ELT did not function as intended (A88A0047 refers), the TSB identified a safety concern regarding the fact that such equipment, intended for emergency use, had such a high rate of failure.

that an approach for the granting of exemptions using risk indicators could better determine the survival equipment requirements on a carrier-by-carrier basis, thus ensuring that sufficient survival equipment is carried on board those aircraft where the potential need is greater.

This CFIT accident was typical, in that it occurred about 2 1/2 miles from the airport on approach. In Canada, 44 per cent of CFIT accidents occur during the approach phase. Fortunately, this accident occurred during the hours of daylight, and the ELT worked, facilitating the ground search. Night or bad visibility might have compromised the outcome, given the severe winter conditions.

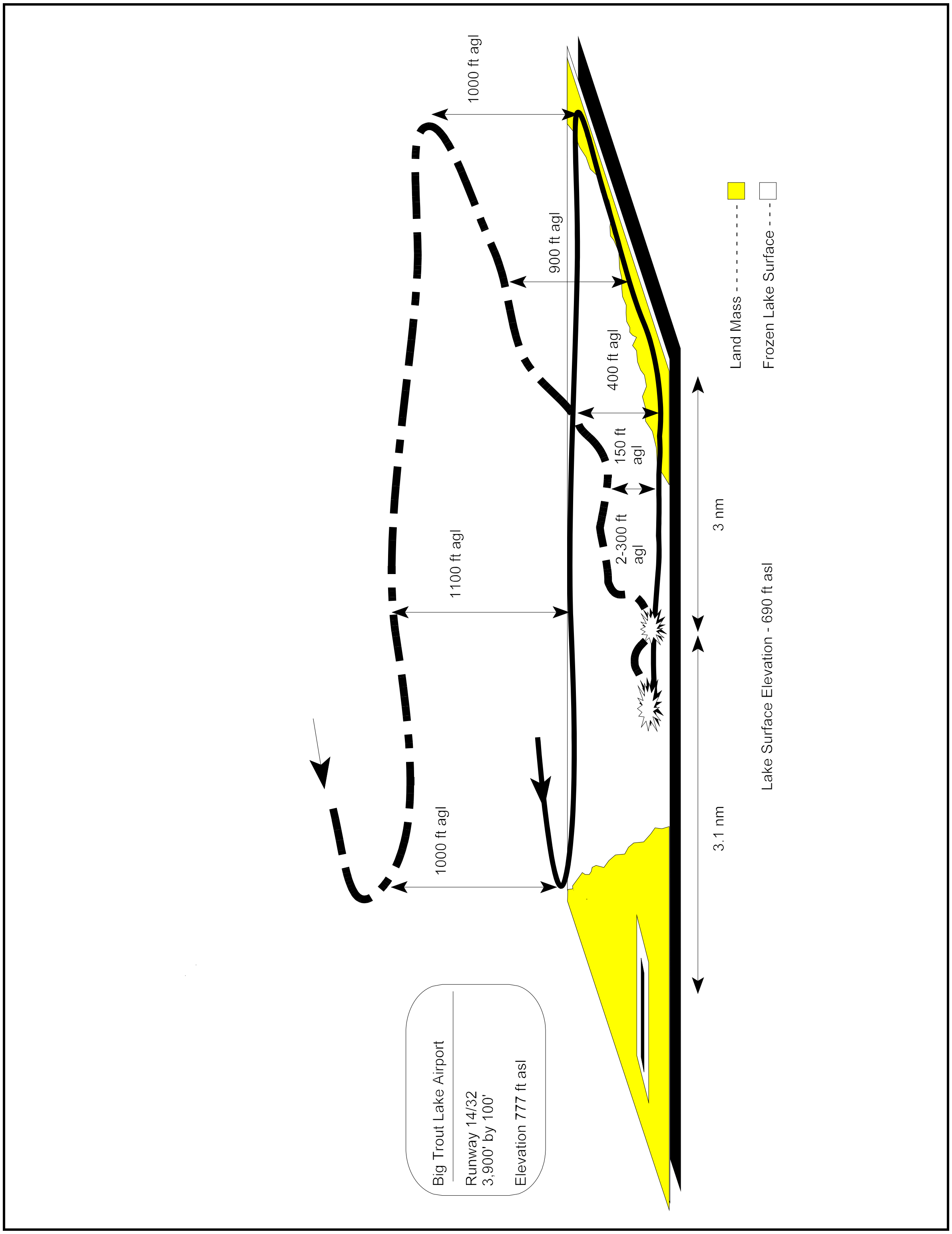
Notwithstanding previous recommendations made by the Board and by regulatory and industry working groups, and the improved TSOs for ELTs, safety deficiencies affecting post-crash survivability continue to exist, as exemplified by this accident. Without appropriate guidelines for the carriage of enhanced first aid kits for post-crash use, and for the granting of waivers regarding the carriage of survival equipment, and without the immediate upgrading of ELT requirements for all commercial passenger-carrying aircraft, accident survivors will continue to be put at risk as a result of delayed rescue, lack of preparedness for harsh climatic conditions, and/or inadequate first aid treatment. Therefore, the Board recommends that:

> The Department of Transport, using accepted risk management methodologies, create carrier-specific requirements for the carriage of first aid kits, survival equipment, and upgraded ELTs on all commercial aircraft.

A96-08

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson John W. Stants, and members Zita Brunet and Maurice Harquail, authorized the release of this report on 21 May 1996.

Appendix A - Approach Profile



Appendix B - List of Supporting Reports

The following TSB Engineering Branch Report was completed:

LP 060/95 - Seat-belt Attachment Tests - Beech.

This report is available upon request from the Transportation Safety Board of Canada.

Appendix C - Glossary

AES	Atmospheric Environment Service
agl	above ground level
AIP	Aeronautical Information Publication
ANO	Air Navigation Order
asl	above sea level
ATC	air traffic control
ATF	aerodrome traffic frequency
ATPL	Airline Transport Pilot Licence
AWOS	automated weather observation system
BLS	Bearskin Lake Air Services Ltd.
CARAC	Canadian Aviation Regulation Advisory Council
CARs	Canadian Aviation Regulations
CASB	Canadian Aviation Safety Board
CFIT	controlled flight into terrain
CPL	Commercial Pilot Licence
CRM	crew resource management
CST	central standard time
ELT	emergency locator transmitter
ERS	emergency response services
FAA	Federal Aviation Administration
GPS	global positioning system
GPWS	ground proximity warning system
hr	hour(s)
IFR	instrument flight rules
kg	kilogram(s)
lb	pound(s)
NDB	non-directional beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
OSH	Occupational Safety and Health
RAMP	Radar Modernization Project
SOP	standard operating procedure
TC	Transport Canada
TSB	Transportation Safety Board of Canada
UTC	Coordinated Universal Time
VFR	visual flight rules
'	minute(s)
"	second(s)
°	degree(s)
°M	degrees of the magnetic compass

TSB OFFICES

HEAD OFFICE

HULL, QUEBEC*
Place du Centre
4th Floor
200 Promenade du Portage
Hull, Quebec
K1A 1K8
Phone (819) 994-3741
Facsimile (819) 997-2239

ENGINEERING
Engineering Laboratory
1901 Research Road
Gloucester, Ontario
K1A 1K8
Phone (613) 998-8230
24 Hours (613) 998-3425
Facsimile (613) 998-5572

REGIONAL OFFICES

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Metropolitain Place
11th Floor
99 Wyse Road
Dartmouth, Nova Scotia
B3A 4S5
Phone (902) 426-2348
24 Hours (902) 426-8043
Facsimile (902) 426-5143

MONCTON, NEW BRUNSWICK
Pipeline, Rail and Air
310 Baig Boulevard
Moncton, New Brunswick
E1E 1C8
Phone (506) 851-7141
24 Hours (506) 851-7381
Facsimile (506) 851-7467

GREATER MONTREAL, QUEBEC*
Pipeline, Rail and Air
185 Dorval Avenue
Suite 403
Dorval, Quebec
H9S 5J9
Phone (514) 633-3246
24 Hours (514) 633-3246
Facsimile (514) 633-2944

GREATER QUÉBEC, QUEBEC*
Marine, Pipeline and Rail
1091 Chemin St. Louis
Room 100
Sillery, Quebec
G1S 1E2
Phone (418) 648-3576
24 Hours (418) 648-3576
Facsimile (418) 648-3656

GREATER TORONTO, ONTARIO
Marine, Pipeline, Rail and Air
23 East Wilmot Street
Richmond Hill, Ontario
L4B 1A3
Phone (905) 771-7676
24 Hours (905) 771-7676
Facsimile (905) 771-7709

PETROLIA, ONTARIO
Pipeline and Rail
4495 Petrolia Street
P.O. Box 1599
Petrolia, Ontario
N0N 1R0
Phone (519) 882-3703
Facsimile (519) 882-3705

WINNIPEG, MANITOBA
Pipeline, Rail and Air
335 - 550 Century Street
Winnipeg, Manitoba
R3H 0Y1
Phone (204) 983-5991
24 Hours (204) 983-5548
Facsimile (204) 983-8026

EDMONTON, ALBERTA
Pipeline, Rail and Air
17803 - 106 A Avenue
Edmonton, Alberta
T5S 1V8
Phone (403) 495-3865
24 Hours (403) 495-3999
Facsimile (403) 495-2079

CALGARY, ALBERTA
Pipeline and Rail
Sam Livingstone Building
510 - 12th Avenue SW
Room 210, P.O. Box 222
Calgary, Alberta
T2R 0X5
Phone (403) 299-3911
24 Hours (403) 299-3912
Facsimile (403) 299-3913

GREATER VANCOUVER, BRITISH COLUMBIA
Marine, Pipeline, Rail and Air
4 - 3071 Number Five Road
Richmond, British Columbia
V6X 2T4
Phone (604) 666-5826
24 Hours (604) 666-5826
Facsimile (604) 666-7230

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