



Cargo Airplane Strikes Frozen Sea During Approach in Whiteout Conditions

The pilots descended below minimums during an NDB approach to a remote Canadian airport. They were heads-up, seeking visual references, when the de Havilland Twin Otter struck the ice in a controlled, shallow descent.

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FSF Editorial Staff

On March 19, 1999, a de Havilland DHC-6-300 Twin Otter, operated by Provincial Airlines on a cargo flight, was destroyed when it struck the frozen surface of the Labrador Sea during a nondirectional beacon (NDB) approach to Davis Inlet (Newfoundland, Canada) Airport. The captain received serious injuries; the first officer was killed.

The Transportation Safety Board of Canada (TSB) said, in its final report, that the causes of the controlled-flight-into-terrain (CFIT) accident were the following:

- “The captain decided to descend below the minimum descent altitude (MDA) without the required visual references; [and,]
- “After descending below MDA, both pilots were preoccupied with acquiring and maintaining visual contact with the ground and did not adequately monitor the flight instruments; thus, the aircraft flew into the ice.”

The accident airplane was being operated on an unscheduled flight from Goose Bay to Davis Inlet, which is 155 nautical miles (287 kilometers) north-northeast of Goose Bay. Davis Inlet Airport has a 2,500-foot (763-meter) by 75-foot



(23-meter) gravel runway that is near the shoreline and is parallel to the shoreline.

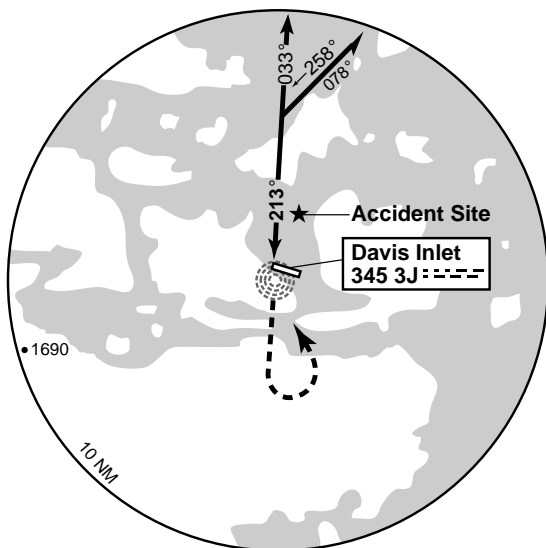
The airport has one instrument approach — an NDB approach that terminates with a missed approach or with a circling approach to the runway (see Figure 1, page 2). The MDA is 1,340 feet, and the published advisory visibility¹ is three statute miles (five kilometers).

“The approach procedure is to the north-northeast of the airport and, for the most part, over the ocean,” the report said. “The missed approach point is at the NDB [about 0.2 nautical mile (0.4 kilometer) south-southwest of the airport].”

The captain, 51, had an airline transport pilot license and 16,000 flight hours, including 2,500 flight hours in type. He had flown 105 hours, all in type, during the 90 days preceding the accident and had been off duty 48 hours before reporting for the flight.

The captain was employed by Provincial Airlines in September 1998 and completed a pilot-proficiency check by a Transport Canada (TC) inspector on Oct. 20, 1998. He was assigned to the company’s base in Goose Bay.

**Plan View of NDB A Approach
Procedure; De Havilland DHC-6-300;
Davis Inlet, Newfoundland, Canada;
March 19, 1999**



NDB = Nondirectional beacon
NM = Nautical miles

Source: Transportation Safety Board of Canada

Figure 1

“Except for a few minor items, the inspector noted that the pilot completed a well-flown check flight,” the report said. “After completing a line indoctrination [comprising] four flights, the captain was released to line operations. ... The captain was the most senior and [most] experienced pilot based at Goose Bay.”

The first officer, 22, had a commercial pilot license and 500 flight hours, including 70 flight hours in type. He had flown 70 hours, all in type, during the 90 days preceding the accident and had been off duty 72 hours before reporting for the flight.

The first officer was employed by Provincial Airlines on Nov. 2, 1998.

“This was his first job with a commercial air operator,” the report said. “He completed a successful pilot-proficiency check on 18 November 1998. The TC inspector noted that he demonstrated acceptable proficiency for [first officer] duties on the Twin Otter.”

The airplane was manufactured in 1984 and had accumulated 30,490 hours.

“The [Twin Otter] was certified to operate in icing conditions; however, it is considered susceptible to ice-contaminated-tailplane stall (ICTS) under certain conditions,” the report said.

“Consequently, the aircraft manufacturer has published specific operating instructions to be followed when operating in icing conditions in order to avoid ICTS.

“These instructions specify that the flight crew ensure correct operation of the airframe deicing system before extending wing flaps and that the wing flaps should not be set beyond 10 degrees while operating in icing conditions.”

The accident airplane was equipped for flight in instrument meteorological conditions (IMC). The equipment included a radio altimeter, which was found set to 1,300 feet (five feet above the minimum descent height).

The airplane previously had been equipped with a ground-proximity warning system (GPWS), but the system had been removed. The report said that a GPWS, although not required by regulation, would have reduced the likelihood of the accident.

The aircraft was equipped with a cockpit voice recorder, which recorded audio data for the last 32 minutes of the flight. The aircraft was not equipped with, and was not required by regulation to be equipped with, a flight data recorder.

Cargo was loaded aboard the airplane the night before the accident. The company operations manual requires that flight crews complete a weight-and-balance form, but the accident crew did not comply with the requirement. An entry in the “journey logbook” indicated that the cargo weighed 2,739 pounds (1,242 kilograms).

Investigators found that eight steel doors had been secured properly, but that the remainder of the cargo — including two 400-pound (181-kilogram) wood-burning stoves — had not been secured properly.

“Personnel at the Goose Bay base lacked appreciation for the importance of correct loading and securement practices,” the report said. “The [captain] did not ensure that the cargo was properly loaded and safely secured.”

Although an entry in the journey logbook indicated a fuel weight of 2,000 pounds (907 kilograms), refueling records indicated that the airplane had a maximum fuel load of 2,520 pounds (1,143 kilograms).

“The aircraft operational empty weight was 7,741 pounds [3,511 kilograms],” the report said. “Adding the operational empty weight to the cargo’s recorded weight (2,739 pounds) and the calculated fuel load (2,520 pounds), the total aircraft weight would have been 13,000 pounds [5,897 kilograms]. The maximum takeoff weight for the Twin Otter is 12,500 pounds [5,670 kilograms].”

Before departing from Goose Bay, the captain obtained weather information from St. John’s Flight Service Station. The

accident report said that the forecast weather conditions were below the requirements for visual flight rules (VFR) flight.

The area forecast indicated that overcast ceilings at 1,500 feet to 3,000 feet, with cloud layers to 13,000 feet, and visibilities from three statute miles to six statute miles (10 kilometers) in light snow could be expected along the route.

“Scattered, embedded convective-type cloud was also expected to reduce visibility to between 0.25 [statute mile (0.40 kilometer)] and three statute miles in moderate or light snow, ice pellets and blowing snow,” the report said. “Frequent stratus precipitation ceilings at 200 [feet] to 1,000 feet were also forecast.”

A terminal area forecast (TAF) for Davis Inlet Airport was not available. A TAF for Nain, Newfoundland — about 45 nautical miles (83 kilometers) northwest of Davis Inlet — included a 1,500-foot overcast, five statute miles (eight kilometers) visibility in light snow and blowing snow, and surface winds from 300 degrees at 20 knots, gusting to 30 knots.

The airplane departed from Goose Bay at 0815 local time on a defense visual flight rules (DVFR) flight plan [which was required for flight in the Canadian coastal air defense identification zone].² The captain was the pilot flying.

“When [IMC was] encountered en route, [the captain] continued under the VFR flight plan,” the report said.

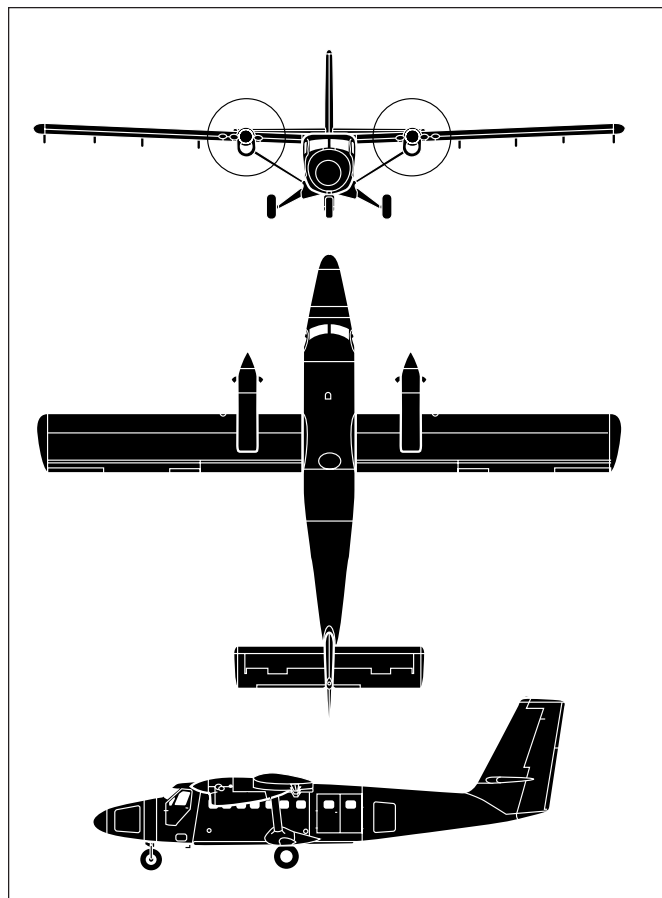
The flight encountered icing conditions at Davis Inlet, and the crew selected the deice system. The report said the deice system removed ice from the wings.

“Five minutes before arriving overhead the airport, the flight crew transmitted on the traffic advisory [frequency] and the universal communications (UNICOM) frequency their intentions to conduct the NDB A instrument approach at Davis Inlet,” the report said.

The first officer occasionally observed snow-covered terrain during the approach. At the MDA, the crew did not observe visual references required to continue the approach and conducted a missed approach.

“On the second approach, the captain flew outbound from the beacon at 3,000 feet until turning on the inbound track,” the report said. “It was decided that if visual contact of the surface was made at any time during the approach procedure, they would continue below the MDA in anticipation of the required visual references.”

When the airplane was established on the final approach course, the crew extended the flaps 10 degrees and the captain began a descent at 1,500 feet per minute. Before the airplane descended to the MDA, the first officer occasionally observed snow-covered terrain.



De Havilland Canada DHC-6 Twin Otter

The twin-turboprop, fixed-gear, short-takeoff-and-landing de Havilland Canada DHC-6 Twin Otter first flew in May 1965. The original production model, the DHC-6-100, has accommodations for two pilots and up to 18 passengers, a maximum takeoff weight of 11,579 pounds (5,252 kilograms) and Pratt & Whitney PT6A-20 engines, each rated at 579 shaft horsepower (432 kilowatts).

The DHC-6-200, introduced in 1968, has a longer nose and a larger aft baggage compartment.

The DHC-6-300, introduced in 1969, has accommodations for up to 20 passengers, a maximum takeoff weight of 12,500 pounds/5,700 kilograms and PT6A-27 engines, each rated at 620 shaft horsepower (462 kilowatts). Maximum landing weight is 12,300 pounds (5,579 kilograms).

Maximum cruise speed at 10,000 feet is 182 knots. Maximum rate of climb at sea level is 1,600 feet per minute. Maximum single-engine rate of climb at sea level is 340 feet per minute. Stall speed with flaps retracted is 74 knots. Stall speed with flaps extended is 58 knots.

Source: *Jane's All the World's Aircraft*

At MDA, the airplane was in whiteout conditions, which the report defined as occurring “over unbroken snow cover and beneath a uniformly overcast sky; the terrain is virtually devoid of visual cues, and the eye no longer discerns the surface or terrain features.”

The report said, “In the final stages of the descent, the [first officer] acquired visual ground contact; 16 seconds before impact, the captain also acquired visual ground contact. At eight seconds before impact, the crew selected maximum propeller revolutions per minute.”

The airplane struck terrain two nautical miles (four kilometers) from the airport. The report did not include the time of the accident.

“The wreckage pattern was consistent with a controlled, shallow descent,” the report said. “During the breakup, the cockpit was destroyed and all of the cabin-area cargo exited through the front of the aircraft. The absence of damage to load-securing attachment points and the absence of load-restraining devices indicated that the load had not been restrained.”

The report said that there was no indication that the unrestrained cargo shifted in flight.

About one hour after the accident, the pilot of another company airplane conducted the NDB A approach to Davis Inlet Airport. He said that he encountered moderate mixed icing conditions during the approach and conducted a missed approach because he did not observe any visual references required to land. He diverted the flight to Nain.

The report said that, although the accident airplane was operated in icing conditions, there was no indication of an ICTS. The crew adhered to ICTS-prevention procedures by selecting the deicing system and limiting flap extension to 10 degrees.

“The tail-deicing system functioned normally during the flight,” the report said. “Had ICTS occurred, the aircraft would have struck the ice in a steep nose-down attitude, rather than [at] a shallow impact angle.”

Provincial Airlines, based in St. John’s, Newfoundland, operated several aircraft types from several satellite bases. Goose Bay was the satellite base for Twin Otter operations. The company also operated Beech King Airs, Britten-Norman Islanders, Fairchild Metros and Piper Navajos from satellite bases in Halifax, Nova Scotia; Sault Ste. Marie, Ontario; and Vancouver, British Columbia.

Operations at Goose Bay were monitored by TC inspectors on Feb. 2, 1999.

“The monitoring consisted of one ramp check, which was conducted with the accident crew, and one in-flight inspection, which was conducted with two other Goose Bay pilots,” the report said. “No anomalies or deficiencies were identified.”

The report said that although the pilots attended a crew resource management (CRM) course conducted by TC two weeks before

the accident, they did not apply CRM concepts during the flight, such as adherence to standard operating procedures (SOPs), including altitude callouts.

“The captain had significant overall flying experience and approximately 2,500 hours on the Twin Otter,” the report said. “The [first officer] had relatively little flying experience and very little experience on the Twin Otter. Studies have shown that inappropriate pairings of pilots (according to experience levels and personality traits) have been contributing factors in aircraft accidents. The practice of CRM should reduce this risk.

“[Nevertheless], the captain frequently disregarded SOPs and either discouraged or ignored inputs and prompts from the [first officer] on the conduct of the flight, indicating that important CRM concepts were not being applied [during the accident flight].”

The report said that failure in CRM was among the most common causes and contributing factors identified by Flight Safety Foundation in CFIT accidents and approach-and-landing accidents (ALAs). The report included a reference to *Flight Safety Digest*, “Killers in Aviation: FSF Task Force Presents Facts About Approach-and-landing and Controlled-flight-into-terrain Accidents,” Volume 17 (November–December 1998) and Volume 18 (January–February 1999).

The report said that the following CFIT/ALA factors identified by the Foundation were involved in the Twin Otter accident:

- “Poor professional judgment: not executing a missed approach in the absence of visual cues;
- “Omission of action/inappropriate action: omission of [an] approach briefing [and] altitude callouts; failure to check the radio altimeter; failure to call out ‘runway in sight/no contact’ at MDA; and omission of checklist items;
- “Failure in CRM: continuing an approach in adverse conditions; descent below MDA prior to acquiring visual cues in whiteout conditions; absence of standard callouts and briefings; and failure to recognize deviations from standard/approved procedures ...; and,
- “Lack of positional awareness.”

The report said that the following findings of the accident investigation indicate that TC’s safety oversight of Provincial Airlines was deficient:

- The company’s aircraft-loading practices at Goose Bay were inadequate;
- The company’s supervision of the Goose Bay operation was deficient;

- The crew did not adhere to SOPs; and,
- The crew deliberately operated the airplane below the MDA without adequate visual references for landing.

The report said that similar findings resulted from investigations (involving other operators) of the following accidents:

- On Feb. 27, 2000, a Piper PA-31-350 Chieftain struck trees 3.5 nautical miles (6.5 kilometers) from the runway during a night, visual approach to Stony Rapids, Saskatchewan.³ The pilot and one passenger were seriously injured, and five passengers received minor injuries. The report said that relevant findings included the following:
 - “The pilot executed a missed approach on his first NDB approach. During the second missed approach, after momentarily seeing the runway, he decided to conduct a visual approach, descending below [the MDA] in an attempt to fly under the cloud base; [and,]”
 - “The maximum allowable takeoff weight of the aircraft was exceeded by about 115 pounds [52 kilograms]”;
- On Jan. 4, 1999, a Beech 1900C struck the frozen surface of a lake during a localizer/distance-measuring equipment approach to Saint-Augustin, Quebec.⁴ None of the 12 occupants was injured. The report said that relevant findings included the following:
 - “The captain (chief pilot) set a bad example to the pilots under him by using a dangerous method — that is, descending below the MDA without establishing visual contact with the required references and using the [GPWS] to approach the ground;
 - “The crew did not follow the company’s [SOPs] for the briefing preceding the approach and for a missed approach; [and,]”
 - “The GPWS ‘minimums’ alarm sounded at a height that did not leave the captain time to initiate [a] pull-up and avoid striking the ground because of the aircraft’s rate of descent and other flight parameters”;
- On Jan. 20, 1998, the pilot of a Chieftain observed flames from the right-engine cowl and shut down the engine during a night takeoff at Sanikiluaq, Northwest Territories.⁵ The airplane struck terrain one nautical mile (two kilometers) from the runway. None of the four occupants was injured. The report said that relevant findings included the following:

- “The aircraft exhaust system was modified in contravention of the manufacturer’s recommendations and the regulations;
 - “The company had three different directors of maintenance in 1997. That position was vacant on the day of the accident;
 - “An inspection of the records and the files for the aircraft revealed several deficiencies in records management;
 - “The persons in charge of maintenance authorized the aircraft to be used while deficiencies had not been corrected;
 - “TC had not made regular audits of the company since 1992; [and,]”
 - “Only one review of the maintenance department was conducted, in September 1994. The last review of the maintenance department was conducted after the accident, in February 1998, and several deficiencies concerning the maintenance department and the company were found; the review resulted in the suspension of the company operating certificates”;
- On Dec. 9, 1997, an Embraer Bandeirante struck terrain about 400 feet (122 meters) from the runway during an NDB approach to Little Grand Rapids, Manitoba.⁶ The captain and three passengers were killed; the first officer and 12 passengers received serious injuries. The report said that relevant findings included the following:
 - “The aircraft was flown in marginal weather at low level, below the minimum en route altitude for commuter operations and below the MDA for the NDB A approach to Little Grand Rapids. The MDA for the approach was 1,560 feet ... 555 feet above the airport elevation;
 - “At takeoff ... the aircraft was [about 1,000 pounds (454 kilograms)] heavier than the relevant maximum allowable weight;
 - “The weight-and-balance report that was submitted to TC, required for the importation [of the accident airplane], contained numerous discrepancies. The report was not reviewed for accuracy by TC;
 - “The company, which had been an air taxi operator, did not effectively manage either the addition of the more complex commuter operations or the introduction of the larger Bandeirante aircraft;
 - “The difficulty that the company had in the transition to commuter operations and the introduction of the Bandeirante aircraft was underestimated by TC;

– “There were inadequacies in TC’s oversight, whereby the post-certification audit of the company was not conducted, thus eliminating an important mechanism by which TC could have found and addressed the inadequate safety-management practices, nonconformance with pilot-training requirements and related operating irregularities; [and,]

– “The pilots had passed their flying-proficiency [tests] and medical tests, but they had not completed elements of pilot-training requirements concerning servicing and operational control, and right-seat conversion as prescribed by TC. Also, no company pilot had received required training in the use of on-board survival [equipment] or emergency equipment”; and,

• On July 30, 1997, the pilot lost control of a Bell 206B while maneuvering in IMC to locate a landing pad about 45 nautical miles [83 kilometers] north of Mackenzie, British Columbia.⁷ The pilot was killed when the helicopter struck terrain. The report said that relevant findings included the following:

– “The weather was such that the flight could not likely be completed in visual meteorological conditions;

– “The pilot’s work/rest schedule increased the probability of him making fatigue-related errors;

– “According to company records, the pilot had, on several occasions, exceeded the legislated flight-[time limitations] and duty-time limitations of the Canadian Aviation Regulations [CARs];

– “TC audits carried out after the accident revealed deficiencies in the company’s control of maintenance and operational activities;

– “Following [a] 1992 TC audit, deficiencies related to the company’s air operator certificate and the approved maintenance organization certificate were either not eliminated or were allowed to re-emerge; [and,]

– “The pilot did not hold an instrument rating.”

The report said that the accident investigations resulted in the following common findings related to regulatory oversight:

- “Descent below MDA without adequate visual references;
- “Nonadherence to SOPs;
- “Operating under [VFR] when in [IMC];
- “Operating the aircraft in an overweight condition; and,

- “Inadequate company supervision of operations or maintenance.”

The report said, “Generally, these accidents [involved] smaller commercial operators or [occurred] during operations in remote areas where oversight is difficult. In these operations, there were clear indications that a culture was allowed to exist in which crews and operators operated outside the safety regulations, with catastrophic consequences.

“It is recognized that effective safety oversight of smaller [operations] or remote operations is a challenging task. Notwithstanding this challenge, the level of acceptable risk should not be greater for passengers and crews who fly on aircraft operated by smaller operators or who operate in or into remote areas, simply because oversight is difficult.

“It is also recognized that there have been initiatives undertaken by TC to reduce the level of risk in these operations. However, these [accidents] and other accidents indicate that more needs to be done. It appears that the traditional methods of inspection, audit, general oversight and regulatory penalties have had limited success in fostering appropriate safety cultures in some companies and individuals; consequently, unsafe conditions continue to exist and unsafe acts are still being committed.

“These serious accidents indicate that some operators and crews have disregarded safety regulations and, consequently, put passengers and themselves at an unnecessary and unacceptably high level of risk.

“In these accidents, findings indicate that, in certain areas of commercial operations, the safety oversight efforts of TC have been somewhat ineffective. Therefore, [TSB] recommends that [TC] undertake a review of its safety-oversight methodology, resources and practices, particularly as they relate to smaller operators and those operators who fly in or into remote areas, to ensure that air operators and crews consistently operate within the safety regulations.”

[In response to the TSB recommendation, TC said that the following are recent examples of continuous review and improvement of its safety-oversight program and practices:]⁸

- Replacement in October 1996 of Air Navigation Orders with CARs. TC said that the CARs are “easier to understand and, therefore, easier for operators to follow”;
- Establishment in 1996 of the Safety of Air Taxi Operations (SATOPS) Task Force, which produced a final report in May 1998. TC said that it worked with industry to implement 71 recommendations from the final report. “The number of accidents, on an annual basis, in the air taxi sector has been diminishing steadily and significantly since 1998,” TC said. “For instance, the number of accidents involving fixed-wing, small

commercial operators ... dropped from 94 in 1998 to 63 in the year 2000. This would indicate that implementing the SATOPS Task Force recommendations is having the intended effect”;

- Publication in December 1999 of *Flight 2005: A Civil Aviation Safety Framework for Canada*. TC said, “This framework document identifies six evolving directions which represent the principal adjustments that [TC] needs to make to maintain and enhance aviation safety as the industry grows and regulatory resources are likely to remain static:
 - “Adopting a data-driven approach to enhancing aviation safety. This includes collecting and making more accessible the type of data that will support a proactive approach to safety;
 - “Using a risk-based approach to resource allocation to support those activities which will achieve the greatest safety benefit;
 - “Fostering and strengthening partnerships to put into effect the concept that responsibility for safety is shared by the regulator and the aviation community;
 - “Implementing safety-management systems in aviation organizations;
 - “Taking account of human [factors] and organizational factors in safety-management practices; and,
 - “Communicating effectively with the aviation community on safety”; [and,]
- Completion in July 2001 of an external review by DMR Consultant Group of TC’s commercial-operations safety-oversight program. TC said, “In January 2001, the second phase of the DMR report concluded that [TC] is moving in the right direction and provided some recommendations to enhance its performance. In July 2001, further analysis of the results of the DMR report was provided to [TC] for consideration. [TC] is currently reviewing the results of this analysis to address recommendations and to review the need for further activities.”♦

[FSF editorial note: This article, except where specifically noted, is based on Transportation Safety Board of Canada Aviation Investigation Report A99A0036, *Controlled Flight Into Terrain: Provincial Airlines Limited, De Havilland DHC-6-300 Twin Otter, C-FWLQ, Davis Inlet, Newfoundland,*

2 nm NNE, 19 March 1999. The 36-page report contains diagrams, appendixes and a glossary.]

Notes

1. Transport Canada (TC). *Aeronautical Information Publication*, “Rules of the Air and Air Traffic Services.” Jan. 25, 2001. Section 9.20.3 said, “Published landing visibilities associated with all instrument approach procedures are *advisory only*. ... They are not limiting and are intended to be used by pilots only to judge the probability of a successful landing when compared against available visibility reports at the [airport] to which an instrument approach is being carried out.”
2. TC. *Aeronautical Information Publication*, “Rules of the Air and Air Traffic Services.” Oct. 7, 1999. Section 3.9 said, “In order to ensure that the air traffic system (ATS) is aware that VFR [visual flight rules] flights will be operating into or within the ADIZ [air defense identification zone], ATS requires that pilots file a [defense] flight plan”
3. Transportation Safety Board of Canada (TSB). Aviation Investigation Report: *Controlled Flight Into Terrain, Athabaska Airways Ltd., Piper Navajo Chieftain PA-31-350, C-FATS, Stony Rapids, Saskatchewan, 27 February 2000*. Report no. A00H0001.
4. TSB. Aviation Investigation Report: *Controlled Flight Into Terrain, Régionnair Inc., Beechcraft 1900C, C-FOI, Saint-Augustin, Quebec, 4 January 1999*. Report no. A99Q0005.
5. TSB. Aviation Investigation Report: *Engine Fire and Crash on Takeoff, Air Nunavut Ltd., Piper PA31-350 Navajo Chieftain, C-FDNF, Sanikiluaq, Northwest Territories, 20 January 1998*. Report no. A98Q0007.
6. TSB. Aviation Occurrence Report: *Collision with Terrain, Sowind Air Limited, Embraer EMB-110P1 Bandeirante, C-GVRO, Little Grand Rapids, Manitoba, 09 December 1997*. Report no. A97C0236.
7. TSB. Aviation Investigation Report: *Collision With Terrain, Northern Mountain Helicopters Inc., Bell 206B (Helicopter), C-GVQK, Bear Valley, British Columbia, 30 July 1997*. Report no. A97P0207.
8. TC. *Responses to Transportation Safety Board Recommendations*. <www.tc.gc.ca/tcss/tsb/Air/A99A0036/A99A0036_E1.htm> Dec. 10, 2001.



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