Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT

A99P0006

CONTROLLED FLIGHT INTO TERRAIN (CFIT)

KELOWNA FLIGHTCRAFT AIR CHARTER LTD.

DOUGLAS DC-3C C-GWUG

MAYNE ISLAND, BRITISH COLUMBIA

13 JANUARY 1999

Canada

Aviation Investigation Report

Controlled Flight into Terrain (CFIT)

Kelowna Flightcraft Air Charter Ltd.
Douglas DC-3C C-GWUG
Mayne Island, British Columbia
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Report Number A99P0006

Synopsis

Kelowna Flightcraft flight 300 (KFA300), a Douglas DC-3C, serial number 32963, was on a night visual flight rules flight from Vancouver International Airport, British Columbia, to Victoria International Airport. En route, the aircraft collided with trees on Mount Parke, a hill on Mayne Island, about 14 miles from Victoria International Airport. The initial impact occurred about 900 feet above sea level. The aircraft then fell into a valley, where a post-crash fire occurred. The aircraft was destroyed. The two pilots, who were the aircraft's sole occupants, sustained fatal injuries. The crash occurred at 0633 Pacific standard time.

Ce rapport est également disponible en français.

1.0 Factual Information

1.1 History of the Flight

The accident aircraft, a Douglas DC-3C, C-GWUG, was owned and operated by Kelowna Flightcraft Air Charter Ltd. (Kelowna Flightcraft) and was under charter to Purolator Courier Ltd. (Purolator). Since April 1998, the aircraft had been dedicated to transporting cargo on a route between Vancouver and Nanaimo, British Columbia. On occasion, it was also used for flights to Victoria to meet Purolator's scheduling or cargo-loading contingencies. On the day of the accident, the aircraft, operating as KFA300, was rerouted and tasked to fly from Vancouver to Victoria and then proceed to Nanaimo. This change was precipitated by the delayed arrival of Purolator's Boeing 727 at Vancouver because of inclement weather in the Toronto/Hamilton, Ontario, area. Warning of this route change was passed to the crew members with their pre-flight planning package, which included filed instrument flight rules (IFR)[1] flight plans for the Vancouver-to-Victoria and Victoria-to-Nanaimo legs of the trip. The captain of the occurrence flight cancelled his IFR flight plan and refiled visual flight rules (VFR) on first contact with air traffic control.

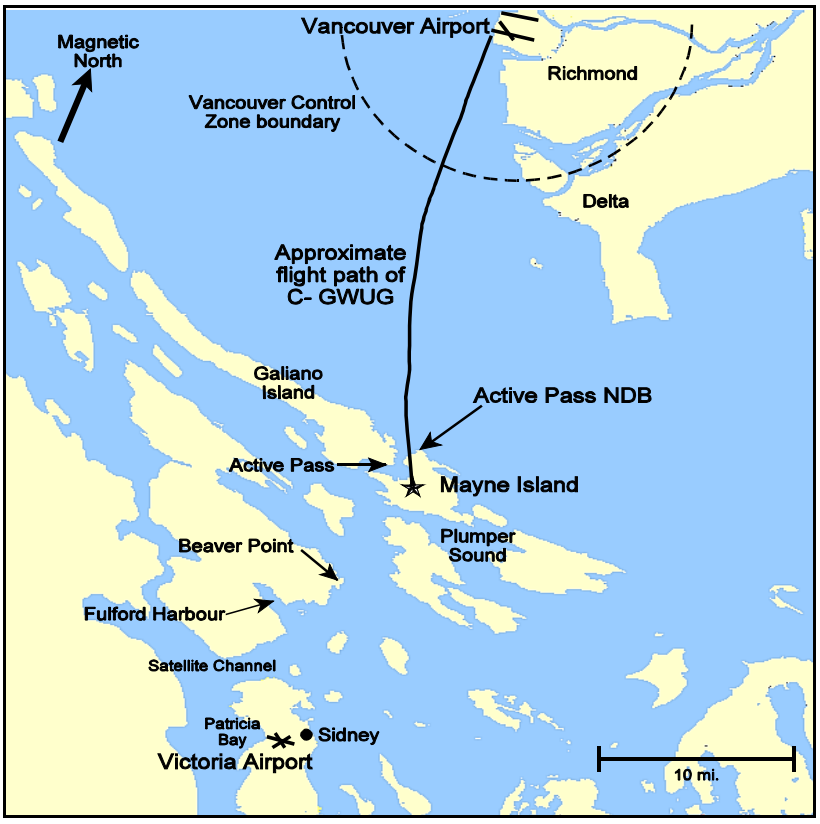

Figure 1 - Aircraft routing and crash site

Vancouver tower cleared KFA300 for take-off at 0622 Pacific standard time (PST)[2] from runway 26L. After take-off, the aircraft turned left on a track toward Active Pass, as seen in Figure 1. During the departure climb, the captain requested an altitude of

[1] See Appendix A—Glossary for abbreviations and acronyms.

[2] All times are PST (Coordinated Universal Time [UTC] minus eight hours).

1000 feet above sea level (asl); the tower controller approved this request.[3] Recorded radar data indicate that the aircraft climbed to and levelled at 1000 feet asl and then accelerated to a steady en route ground speed of 130 knots.

The aircraft left the Vancouver control zone at 0626 and entered Class E (controlled) airspace. There are no special requirements for VFR aircraft operating within this class of airspace, nor are any specific services required of the air traffic control system. As the aircraft approached the Gulf Islands, it descended slightly and remained level at 900 feet asl. It crossed about 0.25 nautical mile (nm) west of the Active Pass non-directional beacon (NDB) at 0632 while remaining steady at 130 knots (ground speed) and level at 900 feet asl.

At 0633:04, the aircraft descended to 800 feet asl for about nine seconds. The last radar data show the aircraft at 900 feet asl and 130 knots. The last radar-depicted position of the aircraft is on a bearing of 189 degrees (true) and 21.8 nm from the Sea Island radar source, coincident with the crash location.

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	2	-	-	2
Serious	-	-	-	-
Minor/None	-	-	-	-
Total	2	-	-	2

1.3 Damage to Aircraft

The aircraft was destroyed by impact damage and by a post-crash fire.

1.4 Other Damage

An unoccupied house and an adjacent shed received minor damage. Another out-building, 40 feet southeast of the house, was struck by aircraft debris and destroyed by the post-crash fire.

[3] The air traffic control "approval" of this requested altitude was based on issues of conflict resolution between IFR and VFR aircraft, rather than on issues related to terrain clearance.

1.5 Personnel Information

	Captain	First Officer
Age	55	50
Pilot Licence	ATPL	ATPL
Medical Expiry Date	February 1999	May 1999
Total Flying Hours	18 000	9000
Hours on Type	9500	430+
Hours Last 90 Days	49.6	57.1
Hours on Type Last 90 Days	49.6	57.1
Hours on Duty Prior to Occurrence	1	1
Hours Off Duty Prior to Work Period	12	12

Both pilots involved in this accident held valid Canadian airline transport pilot licences (ATPL) and were qualified DC-3 captains. The captain had acquired more than 18 000 hours of flight time over a 30-year career, with about 9500 hours on the DC-3. He had previously owned and operated a commercial flying business and was experienced in managing flight operations.

The first officer had about 9000 hours of total flying time. He had acquired about 430 hours on DC-3 aircraft while employed with Kelowna Flightcraft. In addition, he had about 6 years of previous experience on DC-3's while serving with the Canadian Forces (hours on type undetermined). As a military pilot, he had been involved in maritime and search-and-rescue operations over his 20-year career and had held positions as a flight safety officer, instructor, and instrument check pilot on the DC-3.

Company officials described both pilots as competent, reliable, and mature employees who had demonstrated an ability to operate the aircraft in a safe and efficient manner. From all indications, they were both well rested before commencing duty on the day of the occurrence.

1.6 Aircraft Information

1.6.1 General

Manufacturer	Douglas Aircraft
Type and Model	DC-3C
Year of Manufacture	1944
Serial Number	32963
Certificate of Airworthiness	Valid (standard)
Total Airframe Time	20 123.4 hours
Engine Type (number of)	Pratt & Whitney R-1830-92 (2)
Propeller/Rotor Type (number of)	Hamilton Standard 23E50-473 (2)
Maximum Allowable Take-off Weight	26 900 pounds
Recommended Fuel Type(s)	100 LL AVGAS
Fuel Type Used	100 LL AVGAS

The aircraft was manufactured in 1944 and was purchased by Kelowna Flightcraft in the late 1980s for use in coastal cargo operations. It was inspected and maintained daily by a maintenance team in Vancouver. No maintenance issues were outstanding at the time of the accident.

1.6.2 Airworthiness

A review of available documentation shows that the accident aircraft was certificated, equipped, and maintained in accordance with existing regulations and approved procedures.

1.6.3 Weight and Balance

Load manifest records revealed that the aircraft was loaded with 5052 pounds of cargo, which included four items that were handled under dangerous goods regulations. The dangerous goods had been packaged and loaded by Purolator and were accepted by the crew before the flight. The aircraft's total weight at the time of the accident is estimated to have been 25 500 pounds. The aircraft's weight and load distribution were within the certificated limits.

1.7 Meteorological Information

1.7.1 General

Sunrise for the day of the accident was 0804. The flight was conducted during the hours of darkness, beneath an overcast layer.

1.7.2 Minimum Weather Requirements

This flight was conducted in controlled airspace, except for the final 43 seconds to impact. Canadian Aviation Regulation (CAR) 602.114 describes the minimum visual meteorological conditions required for VFR flight in controlled airspace. In general terms, this regulation requires that, for an aircraft operating with visual reference to the surface, the flight visibility be at least 3 statute miles (sm), and the distance of the aircraft from cloud be at least 500 feet vertically and 1 mile horizontally. The regulation also requires a pilot to remain at least 500 feet above the ground when operating in a control zone.

1.7.3 Pre-flight Planning Information

The Kelowna Flightcraft dispatcher sent a flight information package by fax to the Purolator pilots' lounge in Vancouver for use by the crew members of KFA300 during their pre-flight planning. The weather and notice to airmen (NOTAM) information contained in that package had been generated by Skyplan Services Ltd., a commercial provider of weather and operational information.

1.7.4 Terminal Forecasts

The terminal forecast provided in the pre-flight planning package indicated that, for the time of the flight, Victoria could expect a ceiling as low as 2000 feet above ground level (agl). Victoria's forecast was subsequently amended at 0550 to indicate temporary ceiling conditions as low as 800 feet asl. It was not determined whether the crew members had received this updated information because the amendment to the Victoria terminal forecast occurred while they were completing their pre-flight planning activities.

1.7.5 Weather Observations

The 0600 weather for Vancouver, valid for the time of departure, reported wind from 080 degrees true at 9 knots, a visibility of 10 sm, a few clouds at 800 feet agl, a scattered layer of cloud at 1500 feet agl, and an overcast ceiling at 4700 feet agl. The ceiling and visibility values reported in this observation met the VFR weather requirements. The overcast layer at

4700 feet agl would have reduced available ambient lighting by obscuring celestial illumination. This updated weather information was available to the crew on the Vancouver automatic terminal information service (ATIS) and from the Vancouver air traffic controllers.

The actual weather conditions for Victoria at 0600 were marginal VFR, which is defined in *Aeronautical Information Publication* as involving ceilings between 1000 feet and 3000 feet or visibility values between 3 sm and 5 sm. The 0600 weather observation showed wind from 120 degrees true at 11 knots, visibility of 12 sm, a few clouds at 400 feet agl, and a broken ceiling at 1000 feet agl.

A special weather observation was issued for Victoria at 0621 that recorded wind from 120 degrees true at 8 knots, visibility of 12 sm, a few clouds at 400 feet agl, and an overcast ceiling at 800 feet agl. The 800-foot overcast ceiling reported in this observation was worse than the forecast conditions provided in the pre-flight planning package, but was consistent with the amended terminal forecast issued at 0550.

Updated weather information for the Victoria airport was available to the crew of the accident aircraft, before departure and while in flight, from Vancouver tower, Victoria ATIS, Victoria terminal, Victoria tower, and from any flight service station (FSS) that was within range of their radio transmitters (that is, Victoria FSS, Vancouver FSS, or Nanaimo FSS). The TSB could find no communication record showing that the crew of the accident flight contacted any of these above-mentioned agencies for updated weather at Victoria.

1.7.6 Automatic Terminal Information Service

Victoria tower generated three different ATIS messages between 0600 and 0633, the time the accident occurred. These changes were required because of variable weather conditions. Victoria ATIS information "Bravo", valid at the time KFA300 departed from Vancouver, reported a ceiling at 1000 feet and a visibility of 12 sm. Other pilots who had flown with this crew reported that the crew's routine was to tune in to the Victoria ATIS on the ground at Vancouver (before departure) to receive the ATIS message as soon as possible after take-off.

The Victoria ATIS changed at 0628 to information "Charlie", based on the special observation that was taken at 0621. ATIS "Charlie" indicated that the ceiling had dropped to 800 feet agl. It was not determined whether the crew of KFA300 received ATIS "Charlie".

1.7.7 Marine Observer's Report

A professional mariner on a vessel in Plumper Sound reported that the lights on a marine radar tower and a communications tower, co-located at the top of Mount Parke on Mayne Island, were obscured by a low cloud layer and, thus, not visible at the time of the accident.[4] In addition, all of Heck Hill, southeast of Mount Parke, was just visible in haze. Based on these observations, the ceiling over Mayne Island was estimated at about 800 feet asl.

1.8 Aids to Navigation

The Active Pass and Victoria NDBs, as well as the Vancouver and Victoria VORs (very high frequency omni-directional ranges), were serviceable and functioning at the time of the occurrence.

1.9 Communications

Communication records with various air traffic control specialties were reviewed in detail but revealed no information that would shed light on the accident.

1.10 Aerodrome Information

Victoria International Airport is a certified aerodrome operated by the Victoria International Airport Authority. The airport supports three intersecting runways. At the time of the accident, the ATIS indicated that the active runway was runway 09.

Canada Flight Supplement depicts several VFR arrival and departure routes for Victoria International Airport.[5] The Beaver Point arrival route is normally used when runway 09 is in use. This arrival procedure depicts a routing, direct from Active Pass to Beaver Point (near the south end of Fulford Harbour), followed by a right turn through Satellite Channel, westward, until a left turn can be completed near Patricia Bay to establish a final approach to runway 09.

NOTAM number 990013, valid for Victoria at the time of the accident, restricted commercial operators from using the published VFR arrival/departure procedures for Victoria International Airport at night. This NOTAM was included in the pre-flight planning package for the crew of KFA300.

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[4] Plumper Sound is southeast of Mayne Island and in line with the accident aircraft's flight path.

[5] Arrival and departure procedures depict a suggested track over the ground. They do not take into account obstacle clearance requirements that are imposed on commercial air transport operations.

1.11 Flight Recorders

The aircraft was not equipped with either a flight data recorder or a cockpit voice recorder, nor was this equipment required by regulation.

1.12 Wreckage and Impact Information

Broken treetops at the accident site indicate that the aircraft initially struck trees at the 900-foot level on the ridge of Mount Parke, at latitude 48°50'24" North and longitude 123°17'24" West. The swath cut through the treetops was about 200 feet long and 70 feet wide. It was oriented on a magnetic bearing of 150/330 degrees and was level along its length and width. The impact point was near the peak of a ridge. As a result, the height of the trees at the point they were struck varied from approximately 60 feet, at the beginning of the swath, to 40 feet, at the crest of the ridge. The diameter of the trees at the point they were struck ranged from 5 to 15 inches.

Aircraft wreckage found at the base of the trees along the crash swath included the following items:

- the outer portions of the left and right wings, 19 and 11 feet long, respectively, including their wing tips and ailerons;
- pieces of engine cowl, including cowl flaps;
- the outboard four feet of one horizontal stabilizer;
- portions of both elevators; and
- assorted small pieces, such as plexiglass.

A large piece of fabric from a control surface remained in the treetops.

After passing through the trees on the ridge top, the aircraft continued over a cliff in the direction of flight for approximately 1100 feet while dropping about 600 feet to the valley floor.

The propellers were found within 30 feet of each other, located in line with the flight path and 500 feet short of the main wreckage area. The propellers had broken off the engines at the engine front cases and were still attached to the reduction gears. Each propeller had retained all three blades. Some indications of rotational scoring were present on the face of the blades, although the blades showed little leading edge damage. Some blades showed minor twisting and bending damage.

Most of the aircraft came to rest on the valley floor, 30 feet east-southeast of an unoccupied house. The major elements of that wreckage field included both engines, along with the aircraft's centre-wing section, landing gear, fuselage, and empennage. The main landing gear was found in the retracted position.

Based on wreckage information, primarily the flight path through the trees, it is concluded that the aircraft was in controlled level flight at initial impact.

1.13 Medical Information

The captain had completed his medical examination in December 1998, and his licence was valid, based on the medical examiner's 90-day validation. He was required to wear glasses while operating an aircraft.

The first officer was medically fit, held a valid licence, and was required to have glasses available while operating an aircraft.

The TSB was unable to determine whether the crew members were wearing corrective lenses at the time of the accident.

1.14 Fire

A post-crash fire largely destroyed the aircraft and its cargo.

1.15 Survival Aspects

The initial impact with the trees violated the integrity of the cockpit. The subsequent impact with the terrain and the post-crash fire are characteristic of an accident that is not survivable.

1.16 Tests and Research

Not applicable.

1.17 Organizational and Management Information

Kelowna Flightcraft conducts operations under CARs Sections 703 (Air Taxi), 704 (Commuter), and 705 (Airline). These services are provided in accordance with operating certificate number 3718, which was issued by the Minister of Transport under the authority of the *Aeronautics Act*.

Kelowna Flightcraft has its head office in Kelowna, British Columbia, and operates a number of subsidiary bases throughout Canada. The DC-3 operation in Vancouver was established to service a contract with Purolator. The accident aircraft and the assigned personnel were dedicated to that operation. The DC-3 was authorized to conduct freight operations under IFR, VFR, and night VFR conditions.

1.18 Additional Information

1.18.1 Obstacle Clearance Requirements

The Kelowna Flightcraft DC-3 operation was governed by Part VII of the CARs. CAR 705.32 requires Section 705 operators to conduct night VFR flight at least 2000 feet above all obstacles within 5 nm of track. The highest obstacle along the accident aircraft's track to the accident site is 1040 feet asl. Consequently, to comply with this regulation, this crew would have been required to fly at 3040 feet asl or above. CAR 705.32 was not being adhered to on the night of the accident. A review and integration of Nav Canada aircraft movement reports, recorded radar data, and eyewitness statements revealed that the Kelowna Flightcraft DC-3 crews on this route consistently cancelled their IFR plans and proceeded under VFR, as they did on the night of the accident. Additionally, based on available information, most night VFR flights conducted by this aircraft over the two-month period preceding the accident were not in accordance with CAR 705.32.

Flight crews are required to conduct their operations in accordance with a company operations manual (COM) approved by Transport Canada (TC), as well as all other applicable operating rules and regulations. There is an onus on the flight crew and the company to ensure that their actions are within the scope of good airmanship and regulatory compliance. At the time of the accident, the Kelowna Flightcraft COM did not reflect the restrictive conditions imposed by CAR 705.32 on night VFR flight. A previous investigation (TSB Report No. A97C0215) identified a similar deficiency with another company's COM. Consequently, on 25 September 1998, the TSB forwarded Aviation Safety Advisory number 980001-1 to TC. In part, that advisory stated:

> The other pilots employed by the operator were interviewed after the accident; they were not familiar with the obstacle clearance requirement found in the CARs[. . .] The company operations manual, approved by Transport Canada (TC) on 06 June 1997, did not refer to the requirements for an obstacle clearance height for night VFR and its applicable weather minima.

While attempting to determine the reason for these deficiencies, TSB investigators found that, with the introduction of the CARs in the mid-1990s, TC had promulgated a sample COM to the air carriers in the Pacific Region. This sample manual was issued to aid the air carriers in their development of new COMs that would be compliant with the revised regulations. Kelowna Flightcraft used that sample manual to develop its COM. On subsequent review, it became apparent that the sample COM produced by TC did not include references to CAR 705.32 on minimum obstacle clearance requirements for night VFR operations. TC subsequently issued *Commercial and Business Aviation Advisory Circular* (CBAAC) number 0153, dated 12 March 1999,

reiterating CARs requirements for night VFR operations. In addition, TC provided advance notice that the generic operations manual would be amended on the next cycle to include all relevant regulations related to night VFR flight by commercial operators.

1.18.2 Aircrew Monitoring

Kelowna Flightcraft did not have a company-designated check pilot for the DC-3 aircraft type. As a result, flight checks on the DC-3 aircrew were routinely conducted by a TC inspector. The most recent route check was conducted on 06 November 1998. A review of the records shows that the flight was conducted at night and under IFR. All preceding flight checks were conducted under daylight VFR conditions.

1.18.3 Operational Control System

Kelowna Flightcraft operates under a Type C operational control system. This is a pilot self-dispatch system where operational control is delegated to the captain by the director of flight operations. Use of this procedure allows the captain to exercise authority over the formulation, execution, and amendment of the company's operational flight plan.

The company planned and dispatched its cargo flights under IFR. Specifically, IFR flight plans had been filed and were centre-stored. IFR publications and planning tools had been provided to the flight crews involved, and no VFR publications had been issued to the crews by the company. Although night VFR flight was approved in the company's operating certificate and although there was no specific internal direction restricting night VFR operations, the company's stated expectation was that all flights were being conducted under IFR. However, Nav Canada aircraft movement reports indicate that, over the previous two-month period, this aircraft conducted daily flights between Vancouver and either Victoria or Nanaimo and that most of these flights were conducted at night and under VFR.

1.18.4 Flight Monitoring Processes

Dispatch personnel are on duty and available 24 hours a day to provide pre-flight services to the pilots and, according to the COM, to monitor the progress of the flights. System operations control is also responsible for keeping all concerned departments informed of any expected changes or irregularities in flight operations. The COM also requires flight followers to advise the director of flight operations of any operational situations or concerns that may require his/her involvement. In addition, a copy of the operational flight plan is left with the departure station agent and is retained for at least 24 hours after departure of the flight. At the completion of a flight, the captain was required to send the operational flight plan to the company's system operations control in Kelowna through the company mail system. These records were required

to be retained for at least six months to allow an opportunity for TC to audit an individual flight. Other documents, including the journey log pages, the flight report, and the operational irregularities report (if any) are sent by fax to operations control.

1.18.5 Elevated Risk for Operations in Mountainous Terrain

The TSB noted the following in its report of a safety study, number 90-SP002, on VFR flight into adverse weather:

> The accident data, both in Canada and in the United States, clearly indicate that mountainous terrain is most unforgiving to VFR pilots when weather conditions are poor: 51% of the Canadian VFR-into-IMC [instrument meteorological conditions] accidents occurred in mountainous or hilly terrain. VFR aircraft often transit the mountains through narrow valleys, where they may be subjected to strong winds and severe turbulence. Weather conditions, which are highly changeable due to local effects, and variations in topography combine to create areas where VFR flights operate at high risk.

1.18.6 Controlled Flight into Terrain

Controlled flight into terrain (CFIT) accidents are those in which an aircraft, under the control of the crew, is flown into terrain or water with no prior awareness on the part of the crew of the impending disaster.

1.18.7 Ground Proximity Warning Systems

Ground proximity warning systems (GPWS) are designed to provide a warning to the crew of an impending collision with terrain. GPWS installations are governed by CAR 605.37, which requires GPWS equipment to be installed in all turbo-jet-powered aircraft that are greater than 33 069 pounds in weight and that have a type certificate authorizing the carriage of 10 or more passengers. This regulation does not cover DC-3 operations because the aircraft does not meet the CAR's propulsion or weight criterion. In this occurrence, the aircraft involved was not equipped with a GPWS, an altitude alerting system, or a radar altimeter.

1.18.8 CFIT Safety Concerns

In its report on occurrence A90H0002, the TSB noted with concern that between 1976 and 1990 there were 170 CFIT accidents, with 152 fatalities, involving Canadian-registered, commercially operated small aircraft. In that same report, the Board indicated that, since GPWS became

mandatory equipment on larger passenger-carrying aircraft, the number of CFIT accidents has decreased markedly for these aircraft. However, smaller aircraft do not require this type of warning equipment.

The Flight Safety Foundation in the United States recognizes CFIT as the single greatest risk to aircraft, crews, and passengers. This type of accident can occur during most phases of flight, but CFIT is more common during the approach and landing phases.

The Air Line Pilots Association has expressed similar safety concerns and supports a position that all commercial aircraft should be equipped with some form of terrain avoidance warning system, regardless of power plant type.

1.18.9 Dangerous Goods

Dangerous goods can only be transported by air provided certain regulations and procedures are strictly followed. In Canada and the United States, the national standards for the carriage of dangerous goods are embodied in the International Air Transport Association (IATA) dangerous goods regulations. In general terms, the procedures involved in the transportation of dangerous goods are aimed at ensuring all links in the transportation chain know what dangerous goods they are transporting, how to properly load and handle them, and what to do if an incident or an accident occurs either in flight or on the ground.

The accident flight was transporting small amounts of dangerous goods. Although personnel involved in the transportation industry were aware of the items, the first responders were not aware of the presence of the dangerous goods; therefore, they were at an increased risk during their response activities on the site.

The US National Transportation Safety Board (NTSB) found a similar problem during its investigation of a fire aboard a DC-10 aircraft operated by the Federal Express Corporation (NTSB report PB98-910403). That aircraft made an emergency landing at Newburgh, New York, on 05 September 1996. The NTSB noted that US Department of Transport regulations do not adequately address the need for hazardous materials information on file at a carrier to be quickly retrievable in a format useful to emergency responders. As a result of that investigation, the NTSB recommended that regulators

> require, within two years, that air carriers transporting hazardous materials have the means, 24 hours per day, to quickly retrieve and provide consolidated, specific information about the identity (including proper shipping name), hazard class, quantity, number of packages and locations of all hazardous materials on an aeroplane in a timely manner to emergency responders.

There is, at present, no efficient, rapid communication capability in place in Canada to mitigate the risk to personnel who are not directly involved in the transportation system but who may have an increased risk of exposure to dangerous goods in the event of a crash.

1.18.10 Coroner's Inquest

Between 25 and 29 October 1999, the British Columbia Coroner's Service held an inquest into the death of the occurrence pilots. Evidence was taken under oath from representatives of Kelowna Flightcraft, TC, TSB, the Royal Canadian Mounted Police (RCMP), Nav Canada, and a number of witnesses representing the families or other interested agencies. During that inquest, the company chief pilot and the director of operations, as well as a number of TC inspectors, stated that they were unaware that the DC-3 operation was being conducted consistently under VFR and without regard for the obstacle clearance requirements outlined in the CARs.

2.0 Analysis

2.1 General

Based on a review of the aircraft's maintenance logs and on an examination of other available data, it is considered unlikely that this accident was caused by a mechanical malfunction. This conclusion is supported by radar information regarding aircraft speed, heading, and altitude and by physical evidence at the impact site.

Although the Board recognizes a possibility that some unknown mechanical problem or increased workload may have distracted the crew before impact, the essential safety issue remains that the flight was being conducted at night, under VFR, and well below the minimum obstacle clearance prescribed by the CARs. In part, these obstacle clearance requirements, in conjunction with minimum weather requirements, are in place to mitigate the inherent risks associated with night VFR flight. Operations below these minima increase the risks associated with the flight.

This analysis will concentrate on how a night VFR operation, conducted below minimum obstacle clearance altitudes, may have started and, more significantly, how it could have continued despite a number of monitoring safeguards (defences) designed into the commercial aviation system.

2.2 VFR Operation

The accident flight was typical of previous flights conducted by the crew members. Their consistent practice was to cancel their IFR flight plan and proceed under visual flight rules that applied to day, rather than night, operations. Although the reason for this practice is unknown, it is likely that crews perceived some form of time, cost, or efficiency advantage from selecting VFR, rather than IFR, flight.

2.3 Obstacle Clearance

The CARs require that night VFR commercial operations be conducted above a minimum obstacle clearance altitude as a defence against CFIT accidents. The obstacle clearance rules are independent of the VFR weather limits. When properly applied, this regulation restricts the opportunity for a pilot to choose VFR operations over IFR operations in reduced weather conditions.

It is possible that the crew members involved, like others in the aviation industry, were not aware of the night VFR obstacle clearance regulation. This lack of awareness would not be unique: two previous TSB investigations (TSB Report Nos. A97C0215 and A98P0303) identified

similar deficiencies in other companies' COMs, as well as a lack of awareness by other companies and their flight crews of the night VFR obstacle clearance requirements for controlled airspace.

2.4 Weather

The crew received their pre-flight weather package at 0530. Based on the information available to them when flight planning, they would have expected the lowest ceiling at Victoria to be temporarily 2000 feet agl.

The Victoria ATIS changed three times in one-half hour because of changing weather conditions. The crew routinely would obtain Victoria ATIS either on the ground in Vancouver or just after take-off. If that procedure was followed on the day of the accident, the crew would have received ATIS information "Bravo". That recording indicated a ceiling of 1000 feet at Victoria. A subsequent special observation indicating an 800-foot ceiling was likely not received by the crew because it was transmitted on ATIS information "Charlie", commencing at 0627, about six minutes before the crash. Based on this timing, it is unlikely that the crew was aware of the presence of an undercast layer at 800 feet. The lowest ceiling likely expected would have been 1000 feet. This assessment is consistent with radar information that shows the aircraft descending to a level flight altitude of 900 feet, slightly lower than the anticipated cloud base.

The ceiling over Mayne Island at the time of the accident was reportedly about 800 feet asl. The initial impact site was above this elevation and, therefore, above the probable cloud base. It is probable that the aircraft inadvertently entered or flew above the low cloud ceiling before striking the trees on Mayne Island.

Radar and crash site data show that the aircraft was in level flight at impact. Therefore, it is likely that the crew hit the trees on Mayne Island without any warning of the collision.

2.5 Flight Monitoring

Crews involved in this operation routinely cancelled their centre-stored IFR flight plans and proceeded under VFR. The company's operations certificate allowed the operation to be conducted under day and night VFR, as well as under IFR. Until this accident occurred, Kelowna Flightcraft had no internal direction to restrict VFR flight.

Despite a range of safeguards governing commercial operations, neither the company flight followers, the chief pilot, the director of flight operations, nor the TC inspectors involved were aware that the DC-3 operation was being conducted consistently under VFR and without regard for, or knowledge of, the obstacle clearance requirements outlined in the CARs.

2.6 Equipment

A GPWS could have warned the crew of an impending collision with terrain, but this aircraft was not so equipped. Although such equipment is required on larger passenger-carrying jet aircraft, the requirement does not extend to dedicated cargo aircraft or to propeller-driven aircraft operating under Part VII of the CARs. GPWS equipment is a recognized defence against CFIT accidents and could be used to enhance safety in other high-risk operational environments. Had this type of equipment been installed on the accident aircraft, the likelihood of this accident occurring would have been reduced.

2.7 Dangerous Goods

The aircraft was carrying a small amount of dangerous goods. These items were packaged in accordance with governing directives, were listed on the manifest, and were known to be present by the crew of the aircraft and by others in the transportation system. However, air traffic control, search and rescue personnel from the Department of National Defence, and other first responders were not aware of the presence of the dangerous goods. This lack of knowledge placed the first responders at increased risk after the crash.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. The accident flight was not conducted in accordance with the night obstacle clearance requirements of Canadian Aviation Regulation (CAR) 705.32.

2. The Kelowna Flightcraft company operations manual did not reflect the restrictive conditions imposed on night visual flight rules (VFR) flight by CAR 705.32. Such information might have prevented the accident by ensuring the crew's awareness of those night obstacle clearance standards.

3. As the aircraft approached Mayne Island, it encountered a low cloud ceiling that was based about 800 feet and that reduced visual reference with the surface.

4. When the aircraft struck trees, it was being flown in controlled, level flight at an altitude below the surrounding terrain.

5. The aircraft was not equipped with a ground proximity warning system or any other similar system that could warn the crew of an impending collision with terrain. Such systems were not required by regulation.

3.2 Findings as to Risk

1. Kelowna Flightcraft flight operations personnel were not aware that most of the DC-3 flights were being conducted under VFR.

2. First responders were not aware of the presence of the dangerous goods and were therefore at increased risk during their response activities on the site.

3.3 Other Findings

1. Transport Canada officials responsible for monitoring this operation were not aware that most of the DC-3 flights were being conducted under VFR at night and below the required obstacle clearance altitudes.

4.0 Safety Action

4.1 Action Taken

The Kelowna Flightcraft company operations manual was amended on 14 January 1999 to reflect the restrictive conditions imposed on night visual flight rules (VFR) flight by CAR 705.32.

Kelowna Flightcraft issued a memorandum to all its pilots on 15 January 1999 to highlight the minimum obstacle clearance regulations related to *Canadian Aviation Regulations* (CARs) Part VII operators. The memorandum additionally stated that, until further notice, night VFR flights are not authorized without the consent of the director of flight operations or the company chief pilot.

Kelowna Flightcraft installed an Internet-based flight monitoring system into its system operations control. This system, called Flight Explorer, allows for real-time monitoring of company aircraft while in flight and displays a number of operational parameters, including, in part, aircraft type, departure time, route of flight, altitude, and estimated time of arrival.

Transport Canada (TC) issued *Commercial and Business Aviation Advisory Circular* (CBAAC) number 0153, dated 12 March 1999, reiterating the CARs requirements for night VFR operations and providing advance notice that the generic operations manual would be amended on the next cycle to include all relevant regulations related to night VFR flight by commercial operators.

TC issued CBAAC number 0161, dated 31 August 1999, detailing a new requirement for all CARs Section 703 (Air Taxi), 704 (Commuter), and 705 (Airline) operators to undergo mandatory training for the avoidance of controlled flight into terrain (CFIT) accidents.

TC raised two notices of proposed amendments to the CARs aimed at restricting night VFR operations for Section 704 and 705 operators. These notices of proposed amendments are currently being processed through the Canadian Aviation Regulation Advisory Council.

The British Columbia Chief Coroner held an inquest into the deaths of the two pilots. Recommendations from the coroner have been forwarded to the Minister of Transport for consideration, and all have received a positive response. One recommendation was that "Transport Canada pursue the requirements of installing ground proximity warning systems (GPWS) in all aircraft operating under CARs 703, 704, and 705." In his response to that recommendation, the Minister of Transport explained the current regulations regarding GPWS and stated that TC is committed to harmonizing its regulations, as much as possible, with the US Federal Aviation Administration's terrain avoidance warning system final rule.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 17 May 2001.

Appendix A—Glossary

agl	above ground level
asl	above sea level
ATIS	automatic terminal information service
ATPL	airline transport pilot licence
CARs	*Canadian Aviation Regulations*
CBAAC	*Commercial and Business Aviation Advisory Circular*
CFIT	controlled flight into terrain
COM	company operations manual
FSS	flight service station
GPWS	ground proximity warning system
IATA	International Air Transport Association
IFR	instrument flight rules
IMC	instrument meteorological conditions
Kelowna Flightcraft	Kelowna Flightcraft Air Charter Ltd.
NDB	non-directional beacon
nm	nautical mile(s)
NOTAM	notice to airmen
NTSB	National Transportation Safety Board
PST	Pacific standard time
Purolator	Purolator Courier Ltd.
RCMP	Royal Canadian Mounted Police
sm	statute mile(s)
TC	Transport Canada
TSB	Transportation Safety Board of Canada
UTC	Coordinated Universal Time
VFR	visual flight rules
VOR	very high frequency omni-directional range
'	minute(s)
"	second(s)
°	degree(s)