AVIATION INVESTIGATION REPORT
A01W0261

CONTROLLED FLIGHT INTO TERRAIN

DEH CHO AIR LTD.
PIPER PA-31-350 NAVAJO CHIEFTAIN C-GIPB
FORT LIARD, NORTHWEST TERRITORIES
15 OCTOBER 2001

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Synopsis

A Piper PA-31 Navajo Chieftain, C-GIPB, serial number 31-7852170, departed Yellowknife, Northwest Territories, at 2043 mountain daylight time on a night instrument flight rules (IFR) charter flight to Fort Liard. One pilot and five passengers were on board. On arrival at Fort Liard, in conditions of moderate to heavy snow, the pilot initiated a non-directional beacon approach with a circling procedure for Runway 02. At about 2233, the aircraft struck a gravel bar on the west shoreline of the Liard River, 1.3 nautical miles short of the threshold of Runway 02, and 0.3 nautical mile to the left of the runway centreline. The aircraft sustained substantial damage, but no fire ensued. Three passengers were fatally injured, and the pilot and two passengers were seriously injured. The emergency locator transmitter activated and was received by the search and rescue satellite system, and two Canadian Forces aircraft were dispatched to conduct a search. The wreckage was electronically located the following morning, and a civilian helicopter arrived at the accident site approximately 10 hours after the occurrence.

Ce rapport est également disponible en français.

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1.0 Other Factual Information

1.1_ History of the Flight

The Piper PA-31-350 had been chartered by NWT Community Mobilization to transport Deh Cho band administrators from Fort Liard to Yellowknife, Northwest Territories (NWT) and return. The aircraft had departed Fort Liard at 0745[1] on the day of the occurrence, and had arrived in Yellowknife at 0930. The aircraft was scheduled to leave Yellowknife at 1900 to return to Fort Liard; however, the flight did not depart until 2042 because of passenger delays. Considering the weather and late departure, the pilot and passengers discussed delaying the flight until the following day but decided to leave that night. The pilot informed the passengers that he was certified for night flying, and that he felt the weather around Fort Liard would be suitable for the flight.

The pilot filed an IFR flight plan from Yellowknife direct to Fort Liard, with Fort Nelson, British Columbia, as the alternate. The flight was initially cleared direct from Yellowknife to Fort Liard at 6000 feet. At 2055, the pilot was advised by Edmonton Centre that the Fort Simpson altimeter was 30.12. At 2059, he was informed that the minimum safe altitude within 25 nautical miles (nm) of Fort Liard was 6300 feet. He requested 8000 feet and was cleared to maintain 8000 feet within controlled airspace. At 2150, he was advised that the Fort Simpson altimeter was 30.10, and the Fort Nelson altimeter was 29.86. At 2152, he received from Edmonton Centre the weather conditions at Fort Nelson as reported by a special weather observation taken at 2128: ceiling 1100 feet overcast; visibility 1½ miles in snow; and, altimeter 29.86. The pilot acknowledged the transmissions and all readbacks were correct. At 2159, the pilot advised he was crossing the 150 degree radial of the Fort Simpson VOR (very high frequency omnidirectional range) at 51 DME (distance measuring equipment). No further transmissions were received from the aircraft. The pilot did not express any concerns about the aircraft during the flight, and there was no warning of the impending impact.

The airspace around Fort Liard is uncontrolled. Fort Nelson is approximately 96 nm southeast of Fort Liard, and Fort Simpson is approximately 132 nm northeast of Fort Liard.

The search and rescue satellite system (SARSAT) received the first emergency locator transmitter (ELT) signal at 2242. The ELT signal position was initially identified as being approximately 40 miles south of Fort Liard. Deh Cho Air initiated overdue aircraft procedures at 2340. The SARSAT "CASE" was formed at 0033 on October 16, following reception of the ELT signal by a second orbiting satellite, which indicated the ELT signal position was approximately 19 miles southeast of Fort Liard. The Rescue Coordination Centre (RCC) dispatched a Hercules aircraft from Winnipeg, Manitoba, at 0155 and a Twin Otter aircraft from Yellowknife at 0220. Both aircraft were equipped with onboard pointer type homing equipment.

At 0520, the Twin Otter overflew the SARSAT predicted site at 3400 feet above ground level (agl) but, due to IFR fuel considerations, it had to continue to Fort Nelson before attempting to home in on the ELT signal. Initial communication with the Twin Otter indicated the ELT was transmitting within two miles of the SARSAT predicted position, based on aural null indications with the very high frequency (VHF) squelch off.

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[1] All times are MDT (Coordinated Universal Time minus six hours) unless otherwise noted.

The Hercules arrived over the same area, near Lake Bovie, NWT, at 0545, but was unable to pick up a signal. The SARSAT system allocated a high confidence to the predicted position, and it was therefore believed that the Hercules was in the right area, even though the crew was not detecting a good ELT signal. Flares were dropped in the immediate area for approximately 45 minutes, in order to determine if the cloud base would permit a descent to visual conditions. Based on the ambient conditions, a cloud penetration descent procedure was not carried out. As the Hercules flew further to the west, a stronger ELT signal was detected. At about 0645, the Hercules crew located the accident site electronically, one nautical mile south of Fort Laird. A civilian helicopter was dispatched from Fort Liard, beneath the weather, and visually located the accident site at 0832, 10 hours after the occurrence. The aircraft had come to rest upright, with the nose landing gear detached and the main landing gear collapsed. The fuselage, wings, engines, and propellers sustained substantial damage, all attributable to the impact forces.

1.2 Pilot Information

	Pilot-in-Command
Age	23
Pilot Licence	Commercial
Medical Expiry Date	01 Nov 2002
Total Flying Hours	1157
Hours on Type (includes logged dual, PIC & SIC)	77
Hours Last 90 Days	141
Hours on Type Last 90 Days	77
Hours on Duty Prior to Occurrence	16.5 hours
Hours Off Duty Prior to Work Period	39

The pilot experienced severe retrograde amnesia, as a result of head injuries sustained during the accident, and was not able to provide information relating to the accident.

The pilot held a commercial pilot licence, valid for all single-pilot, non-high performance, single- and multi-engine land and sea aeroplanes, and a Group 1 instrument rating. He also held a Class 2 aerobatic instructor rating. He had been hired by Deh Cho Air on 05 August 2001 and had received all of the required company training for the PA-31, including controlled flight into terrain (CFIT) training. He had passed a Transport Canada (TC) pilot proficiency check (PPC) on the PA-31 on 20 August 2001. The pilot had flown single pilot on a PA-31 passenger-carrying charter once previously, on a visual flight rules (VFR) flight. One leg of that flight had been during daylight hours, and the return leg had been at night.

A review of the pilot's flying schedule, beginning from the time he was hired by Deh Cho Air, did not reveal excessive flying activity, and he was well rested prior to departing Fort Liard on the morning of the occurrence. *Canadian Aviation Regulations (CAR) 700.16* provides for a maximum of 14 consecutive hours of flight duty time in any 24 consecutive hours. The pilot reported for work at 0600 and his authorized 14-hour duty day would have ended at 2000, prior to his expected return to Fort Liard. *CAR 700.16* provides for an extension of

flight duty time beyond 14 hours where the flight duty time includes a rest period. Where the flight duty time includes a rest period, flight duty time may be extended by one-half the length of the rest period, up to a maximum of three hours. The pilot was provided with a day room in Yellowknife to rest. He checked into the room at 1400 and checked out at 1900. During his five-hour rest period, the pilot was observed eating in the hotel restaurant between 1410 and 1440, and he made at least two phone calls, one at 1600 and one at 1822.

It is known that the human circadian pattern of sleep and wakefulness alternates in parallel with the environmental light/dark cycle, and with the oscillatory nature of most physiological, psychological, and behavioural functions. An individual sleeping during the day is in direct opposition to physiological programming to be awake.[2] The diminishing effects of fatigue on pilot performance, including judgment, are well known. During nighttime hours, reaction time and cognitive reasoning can be significantly impaired. It could not be determined if the quality of the rest obtained by the pilot during his rest period was sufficient to offset the effect of acute fatigue on the pilot's physical and cognitive performance later that night.

The regulatory standard for commercial operation of an aeroplane with passengers on board in IFR flight without a second-in-command (SIC) requires that the pilot have a minimum of 1000 hours of flight time, which shall include, if the type to be flown is multi-engine, 100 hours on multi-engine aeroplanes. In addition, the pilot shall have 50 hours of simulated or actual flight in instrument meteorological conditions (IMC), and a total of 50 hours flight time on the aeroplane type. The pilot had logged a total of 1157 flying hours, including flights on the day of the occurrence. His personal log indicated he had 77 hours on PA-31 aircraft, including dual, pilot-in-command, and second-in-command time. His company multi-flight training record indicated he had received 6.5 hours of dual on the PA-31; however, his log book recorded 20.3 hours of PA-31 dual. It was determined that much of the PA-31 dual he had logged, prior to obtaining his PPC, involved revenue flights that he had flown for familiarization. He had also logged 14 hours of multi-engine dual during revenue flying with a previous employer. While this experience would be considered valuable for familiarization and the building of local knowledge, it would not qualify as dual, since revenue flights are not considered training. This familiarization experience would not have qualified as flight experience toward a higher license. The *CAR* define "flight time"; however, they do not define or prescribe standards for "flight familiarization", "flight experience", or "dual", and therefore do not fully address flight time "quality". Personal log records plus the estimated flight times for the day of the occurrence, indicated the pilot had accumulated 127 hours of multi-engine experience, including 77 hours on the PA-31. Twenty-eight hours of that experience, including 14 hours on the PA-31, would not have qualified as experience toward a higher license.

Several weeks before the occurrence the pilot, flying as SIC from the left seat, had lost situational awareness during a non-directional beacon (NDB) approach into a northern aerodrome. He flew through the intercept for the inbound course, initiated the final descent late, and overflew the missed approach point prior to reaching the minimum descent altitude (MDA). He continued to descend for some distance past the missed approach point, and possibly past the runway, without the runway in view. He commenced the missed approach procedure on command by the pilot-in-command. The pilot-in-command assumed control and completed another approach and the landing from the right seat. The circumstances of the incident had been related to the training pilot and the operations manager verbally, and therefore informally, and may not have been reported at all to the chief pilot. The company took no action following the incident.

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[2] Flight Safety Foundation Flight Safety Digest, February 1997, *Final Report: Principles and Guidelines for Duty and Rest Scheduling in Corporate and Business Aviation*, p. 4.

The pilot had not completed five night take-offs and landings in an aircraft of the same type or class in the previous six months; therefore, he did not meet the night recency requirements necessary to carry passengers, as specified in *CAR 401.05 (2)*. Flight crew members were responsible to track their flight and duty times. The company did not track crew flight times for purposes other than to ensure that pilots did not exceed the number of hours that CAR allows for in a specified period of time, in order to prevent fatigue, and therefore the company's system for monitoring fight time was not an ideal source for information relating to qualifications for specific operations.

There was nothing found to indicate that incapacitation or physiological factors had affected the pilot's performance.

1.3 Aircraft Information

Manufacturer	Piper
Type and Model	PA-31-350
Year of Manufacture	1978
Serial Number	31-7852170
Certificate of Airworthiness	Date of Issue 20 January 1986
Total Airframe Time	11 520 hours
Engine Type (number of)	Lycoming TIO-540-J2BD (1) Lycoming LTIO-540-J2BD (1)
Propeller/Rotor Type (number of)	McCauley B3DF36C526 (1) McCauley B3DF36C527 (1)
Maximum Allowable Take-off Weight	7368 pounds
Recommended Fuel Type(s)	100 LL
Fuel Type Used	100 LL

Maintenance records indicate that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

The aircraft had been modified with the addition of aerofoil vortex generators, in accordance with Boundary Layer Research Ltd. *Supplemental Type Certificate* No. SA00039SE, which increased the maximum take-off weight from 7000 pounds to 7368 pounds. The weight and centre of gravity were within the prescribed limits on departure from Yellowknife and at the time of the occurrence.

The aircraft departed Yellowknife with full fuel, which was sufficient for approximately four hours and twenty minutes of air time in cruise configuration. This met all regulatory requirements for the planned flight.

The aircraft was equipped with a functioning two-axis autopilot, as required for single-pilot IFR flights. All autopilot switches were found in the OFF position during the wreckage examination.

1.4 Meteorological Information

VFR weather conditions with high overcast cloud and good visibility were present in Fort Liard for most of the day. The weather began to deteriorate significantly at approximately 2150. The aircraft was heard and observed flying over Fort Liard at approximately 2230, and information downloaded from the onboard global positioning system (GPS) indicated that the accident occurred at 2233.

The general area weather report provided to the pilot during his telephone weather briefing in Yellowknife included the following: the Fort Nelson/Fort Liard areas were being influenced by a wave entering the province of BC, midway along the Alaskan Pan Handle; a warm front extended from there to the "elbow of Alberta", and was moving toward the Fort Nelson area; and, significant snow was to be expected with the advancing warm front with 5 to 10 centimetres forecast for the Fort Nelson/Fort Liard area. An analysis of the aviation routine weather reports (METAR) for Fort Nelson and Fort Simpson show that the advancing warm front was close to Fort Nelson at 2028, where the clouds had lowered to 1100 feet overcast with visibilities of 1.5 statute miles in snow. The frontal system reached the Fort Simpson area at 0400 to 0600 on October 16.

The pilot's first call for a weather briefing was at 1822. He was apprised of the advancing warm front and associated snow, and was informed of a Notice to Airmen (NOTAM) that advised the flashing strobe runway end identification lights at Fort Liard were unserviceable.

The pilot originally filed his IFR flight plan with the Yellowknife Flight Service Station (FSS) during the 1822 phone call, with an expected departure time of 1900. He called again at 1928 to revise his departure time to 1950, and a third call was made at 2008 revising the departure time to 2025. The pilot queried about the en route weather at this time. At 2000 at Fort Nelson, there was overcast cloud at 3000 feet agl, and at Fort Simpson there was broken cloud at 21 000 feet agl. The leading edge of the cloud associated with the advancing warm front was somewhere between Fort Nelson and Fort Simpson. It was not known whether the leading edge of the cloud had reached the Fort Liard area at that time; however, it had already reached Fort Nelson. Altocumulus castellanus cloud was presently in the Fort Liard area, and the ceiling in Fort Nelson had gone from 8000 feet agl to 3000 feet agl. The FSS briefer advised that if the flight arrived in Fort Liard soon, it [the weather] shouldn't be too bad.

When the accident occurred, the Fort Liard Community Aerodrome Radio Station (CARS) was closed. As there was no observer on duty, no official weather observation was taken near the time of the accident. An analysis of the meteorological situation in Fort Liard was prepared by Environment Canada, after the accident, using the observations of the automatic weather observation and recording station (WJL) at Fort Liard, satellite pictures, and observations at the surrounding stations. The analysis indicated that a thick cloud band moved over Fort Liard at about 2200, producing heavy snow showers, and that the visibility at the airport should have dropped to ½ to 3 statute miles in snow with obscured/precipitation ceilings of 500 to 1200 feet agl. During the overnight period, 14 centimetres of wet snow fell at Fort Liard. This indicated that compared to the surrounding stations, Fort Liard received heavier snow showers of longer duration. Witnesses at Fort Liard estimated the ground visibility to be ½ to 1½ miles in snow at the time of the accident, and using information from surrounding reporting stations, the altimeter setting was estimated to be 29.92 or 29.93 at the time of the accident.

Throughout the night, the temperature at the Fort Liard airport remained constant at minus one degree Celsius. While moderate icing may have been present in cloud during the approach to Fort Liard, there was no visible indication of airframe ice on the aircraft at the time the rescuers arrived.

1.5 Communications

The Fort Liard Airport is served by a CARS that operates from 0800 to 1600 Monday to Friday except holidays. The CARS was closed and the radio at the company base was unmanned at the time of the occurrence.

A call-out occurs when an observer/communicator is called back to the CARS station by an owner, operator, or pilot to provide services outside the established hours of operations. The call-out fee is $149.80 for a call-out period of up to four hours. Deh Cho Air received approval for night and IFR operations in May 2000. CARS call-out records indicated Deh Cho had not requested any call-outs between May 2000 and the time of the occurrence.

Automated weather observation systems (AWOS) provide a method of acquiring and disseminating weather information from sites where human observers cannot be supported continuously. An AWOS comprises meteorological sensors, a data processing system, a communications system, and an optional voice generator module (VGM). An associated system is the limited weather information system (LWIS), which is used at aerodromes where a full weather observation program is not justified, but where support for a Canada Air Pilot approach is required. Where a VGM, a VHF radio and a telephone are connected to an AWOS or LWIS, weather information gathered at one minute intervals is available to pilots by VHF radio or by telephone. Recent increases in air traffic at Fort Liard had prompted deliberation involving the Northern Air Transport Association (NATA), Nav Canada, the Government of the Northwest Territories, the Government of Nunavut, and operators. There was no support among stakeholders from whom comments were solicited by way of letter, for increasing the hours of operation of the CARS, and no suggestion that an AWOS would be a means to increase the hours of weather observation.

1.6 Aerodrome Information

The runway at the Fort Liard airport is 2956 feet long and 100 feet wide, and has a gravel surface.[3] Airport elevation is 706 feet above sea level (asl), with rising terrain to the south and northwest. The runway lights are

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

controlled by an aircraft radio control of aerodrome lighting (ARCAL) system, and the runway edge lights and threshold lights were operating at the time of the occurrence. The unidirectional flashing strobe runway identification lights were unserviceable, as communicated in the applicable NOTAM. Lighting comprised of threshold and runway end lights and low-intensity runway lights. An abbreviated precision approach path indicator (PAPI), set at 3.3 degrees, provides visual approach guidance.

Fort Liard Airport had a single NDB instrument approach, for company use only, to Runway 20. (See Appendix A). An instrument approach to Runway 02 requires a circling procedure. The circling minimum descent altitude is 894 feet above the aerodrome elevation and the advisory visibility is 2½ statute miles for aircraft manoeuvring at up to 140 knots. The NDB was serviceable at the time of the occurrence.

1.7 Flight Recorders

The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), and neither was required by regulation. Aircraft typically used in 703 operations are not fitted at manufacture with the electrical infrastructure required to support a FDR, and the installation of FDRs in these category of aircraft would require expensive system upgrades to accommodate a FDR. A lightweight, comparatively inexpensive alternative to an FDR is a cockpit video digital recorder (CVDR). While CVDR technology exists to record the instrument panel and the view forward from an aircraft in flight, there is no regulatory requirement or schedule to install this equipment in commercially-operated, non-FDR equipped aircraft. A functioning crash-protected CVDR may have allowed investigators to reconstruct the flight sufficiently to better understand the circumstances that led to the accident, and to identify when and why the altitude deviation occurred. There have been numerous other recent 703 fatal occurrences where the availability of CVDRs would have provided investigators a better opportunity to identify safety deficiencies related to the occurrence.

The National Transportation Safety Board (NTSB) recently forwarded *Safety Recommendation No. A-99-60* to the Federal Aviation Administration (FAA). The recommendation urging the installation of crash-protected CVDRs on all turbine-powered aircraft not currently required to be equipped with an FDR once an applicable technical standard order has been issued. The recommendation has not yet been implemented. TSB has not addressed this deficiency, with regard to 703 operations, in the past.

1.8 Wreckage and Impact Information

The landing gear was extended and the flaps were in an intermediate position when the aircraft struck the gravel bar. The wreckage trail was approximately 450 feet long and the aircraft was oriented on a heading of 015 degrees magnetic. The runway heading was 021 degrees magnetic. Wreckage examination indicated that the aircraft had contacted the ground in approximately a five-degree nose-low and 5-to 10-degree left-wing-low attitude.

The wreckage was examined at the accident site, and no indication of a malfunction was found. The aircraft was structurally intact, and the flight control systems were continuous at impact. Propeller blade damage and twist was consistent with both engines producing considerable power at the time of impact. The switches for the wing lights, landing lights, taxi lights, and anti-collision lights were found in the OFF position.

The annunciator panel and four of the flight instruments from the left instrument panel were forwarded to the TSB Engineering Branch for examination. Filament assessment of the light bulbs in the 12 individual segments of the annunciator panel indicated that no annunciator warning lights were illuminated at impact. The airspeed indicator did not provide any reliable information regarding the indication at impact. The attitude gyro indicated the pitch attitude was approximately five degrees nose-down at impact. Both aircraft altimeters were found set at 30.12.

1.9 Survival Aspects

The aircraft remained upright and the impact forces did not significantly compromise the survival space in the cabin or cockpit areas. Because of injuries, the survivors were not able to exit the aircraft on their own. All occupants were found in their respective seats when rescue personnel arrived at the accident site the following morning.

The pilot and three passengers were seated in forward facing seats. Two cabin passengers were seated in rear-facing seats. The pilot and the passenger seated in the right cockpit seat were not wearing available shoulder harnesses. The pilot sustained severe head injuries and the passenger sustained fatal head injuries due to impact forces. These injuries may have been prevented or reduced in severity had the upper torsos of these occupants been restrained by the shoulder harnesses. The company *Standard Operating Procedures (SOP)* for the PA-31 states that the lap-belt shall be worn at all times, and the shoulder harness shall be worn for take-off and landing. *CAR* require each front seat of an aircraft of this age and category to be equipped with a safety belt that includes a shoulder harness. A safety belt, as defined in the regulations, includes a shoulder harness where one is available. The regulations require all crew members to have their safety belts fastened during take-off and landing, and require the pilot-in-command to direct all persons on board the aircraft to fasten safety belts during take-off and landing. A search of the TSB database identified numerous aircraft accidents where the occupants did not use the available shoulder harnesses and suffered injuries or more serious injuries as a result.

1.10 Emergency Locator Transmitter

The aircraft was fitted with a Dorne and Margolin DM ELT-6C, 121.5 MHz, ELT. The ELT transmitted at impact. The aircraft remained upright and the ELT remained attached to the antenna and the mounting bracket. The ELT did not activate during field testing following the accident. The ELT was subsequently bench tested by an approved ELT test repair facility and by the manufacturer, and no discrepancies were noted. Although the SARSAT indicated the ELT signal position was approximately 19 miles southeast of Fort Liard, the inaccuracy is not considered to be an anomaly. For a 121.5 MHz ELT the SARSAT system is considered to be functioning within specs if its position accuracy is within 20 nm 90 per cent of the time. The reason for the imprecision of the satellite location error was not determined. Other ELT location anomalies have occurred in areas between the Yukon border and Great Slave Lake, possibly due to magnetic interference.

The accuracy of the position generated by the SARSAT system is very dependent on the quality of the distress beacon signal that is detected. The stability of a 406 MHz frequency is much greater than that of the 121.5 MHz transmissions; therefore, the accuracy of the position generated is also greater. *Technical Standard Order C126 (TSO-C126)* prescribes the minimum performance standard that 406 MHz ELTs must meet in order to be identified with the applicable TSO marking. 406 ELTs provide advantages over 121.5 MHz ELTs; identification of the aircraft and operator; and, when interfaced with the onboard GPS or flight management system, the latitude and longitude of the crash site. Most Canadian marine vessels over 20 metres in length are required to be fitted with 406 MHz emergency position indicating radio beacons (EPIRBs) since 1989. Although 406 ELT technology has the potential to significantly reduce search costs, loss of life, and suffering for survivors, there are no regulatory requirements or schedules for Canadian registered aircraft to be fitted with 406 MHz ELTs. NTSB recently recommended (*Recommendation Number A-99-62*) to FAA that all automatic ELTs installed on passenger aircraft hire meet the requirements of TSO C126 or equivalent alternative technology. The recommendation has not been implemented. TSB has not addressed this deficiency in the past.

1.11 Organizational and Management Information

The operator held a valid air operator certificate, issued in accordance with *CAR Part VII Commercial Air Services*. The company operated two single-engine and three twin-engine aircraft—Cessna A185F, Cessna U206F, Britten Norman BN. 26-26, Piper PA 31-350, Beech 100—under *CAR Part VII, Subpart 3, Air Taxi Operations*. The air operator certificate approved the PA-31 for single-pilot passenger and cargo flights in VFR and IFR day and night operations. The main company base is located at Fort Liard.

The company management team comprised an operations manager and a chief pilot. While not required in a 703 operation, a safety officer had also been designated within the company. The operations manager resided semi-permanently in Fort Liard and was on leave at the time of the occurrence; he was available through a cellular phone. The chief pilot normally resided in Calgary and flew the King Air mostly out of Edmonton; he was on medical leave at the time of the accident. His duties included the supervision of all assigned flight crew. The company operations manual required that, when either the operations manager or the chief pilot was absent, another qualified person was be appointed to the position, and the operations manager and the chief pilot had an informal understanding that when one was not at work, the other would complete the duties of both managers. The safety officer had attended the TC Company Aviation Safety Course. He was not IFR rated, and was unfamiliar with IFR operations. The operations manager, the chief pilot, and the PA-31 training pilot were

all highly experienced with commercial aviation operations, having a combined total flying time in excess of 40 000 hours.

The company employed one VFR and two IFR base pilots in Fort Liard. The accident pilot was not qualified on the company Britten-Norman Islander, and the other two pilots were dispatched to complete a two-crew Islander charter for an oil company on the day of the occurrence. A significant percentage of the company business involved oil company charters in the Islander and the PA-31 aircraft, and these flights were dispatched as two-crew flights in accordance with the client's demands. NWT Community Mobilizations advised they had requested two pilots at the time the charter was booked. It was determined that, at minimum, the client expected that two pilots would be assigned to the flight; however, because the bulk of the negotiations for the charter were made verbally, by telephone, neither NWT Community Mobilizations nor Deh Cho Air could produce documentation to prove that a formal request for two pilots had or had not been made. The company had an out-of-town pool of qualified part-time pilots to draw on when the extended work load required them; however, a second pilot was not available locally on the day of the flight, and the flight was dispatched as a single-pilot IFR flight.

1.12 Additional Information

1.12.1 Search and Rescue Procedures

Aircraft dedicated primarily to the search and rescue (SAR) role in Western Canada are based at Comox, British Columbia, and at Winnipeg, Manitoba. Fort Liard is located within the Winnipeg region, and the response time to locate a Hercules to the Fort Liard area from Winnipeg is normally five to seven hours. Secondary northern SAR capability is provided by Twin Otter aircraft located in Yellowknife; however, this resource is dedicated to several tasks in addition to SAR, and is dependent on the availability of flight crew and aircraft.

1.12.2 Altimeter Setting Procedures

Both aircraft altimeters were found set at 30.12, which was the setting for Fort Simpson at 2000. This difference would result in the altimeter reading 200 feet too high. The altimeter error for cold air temperature (interpolated temperature of zero degrees Celsius) would be an additional 20 feet at 200 feet agl.

CAR 602.127 (2) states the following: "No pilot-in-command of an IFR aircraft shall commence an instrument approach procedure unless the aircraft altimeter is set to an altimeter setting that is usable at the aerodrome where the approach is to be conducted". The company approach to Fort Liard did not provide for the use of a remote altimeter setting.

1.12.3 Circling Procedures

The *Aeronautical Information Publication (A.I.P. Canada)* describes a circling procedure as an IFR procedure that is conducted by visually manoeuvring an aircraft, after completing an instrument approach, into position for landing on a runway which is not suitably located for a straight-in landing. Due to the airport and environmental variables that can be involved, there is no single procedure that will apply in all circumstances. The *AIP* identifies four typical circling manoeuvres that will ensure the aircraft remains within the protected area while conducting a circling approach; the selection of the procedure to accomplish a safe landing rests with the pilot. The pilot is required to keep the runway in sight after initial visual contact, and to remain at the circling MDA until a normal landing is assured. The *AIP* states that with the runway in sight at the circling MDA, the pilot should execute the missed approach if there is any doubt that the ceiling and visibility are inadequate for manoeuvring safely to the point of touchdown.

The operations manager favoured a teardrop circling procedure to Runway 02 and had explained the manoeuver to other company pilots in the past. The procedure require the pilot to fly over the airport on a heading reciprocal to the runway heading, then turned 30 degrees to the right and fly outbound for one minute, and then do a rate one turn back to the airport and establish the aircraft on final approach. A pilot using this non-typical method may have been unable to maintain visual reference to the runway, as required during a circling approach, during the time the aircraft was travelling away from the airport.

1.12.4 Controlled Flight into Terrain (CFIT)

The Flight Safety Foundation defines a CFIT accident as "one in which an aircraft, under the control of the crew, is flown (unintentionally) into terrain, obstacles, or water with no prior awareness on the part of the crew of the impending collision."[4] This accident was characteristic of a CFIT occurrence.

1.12.5 Radio Altimeter and Ground Proximity Warning Systems

The aircraft was not fitted with a radio altimeter or a ground proximity warning system (GPWS) and, while either type of equipment provides a defence against controlled flight into terrain accidents, neither was required by regulation. GPWS equipment is required on all turbojet aircraft that have a maximum certified take-off weight greater than 33 069 pounds and carry 10 or more passengers. The requirement does not extend to 703 air taxi operations even though their operations may be conducted single-pilot, at night, in IFR meteorological conditions, in high-risk areas, and often without the benefit of radio monitoring and other support that is normally provided to larger aircraft. This has been identified as a factor in other recent TSB investigation reports: A98P0303, A00H0001, and A01W0269.

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[4] Flight Safety Foundation Flight Safety Digest, April-May 1996, An Analysis of Controlled-flight-into-terrain (CFIT) Accidents of Commercial Operators, 1988 Through 1994, p. 4

1.12.6 Accident Rate in 703 Operations

Canadian air operators engaged in an air transport service or in aerial work involving sightseeing operations and operating a single-engine aircraft or a multi-engine aircraft, other than a turbojet-powered aeroplane, that has a maximum take-off weight of 19 000 pounds or less and a seating configuration, excluding pilots seats, of nine or less, fall under the 703 Air Taxi category of commercial operations. TC established the Safety of Air Taxi Operations (SATOPS) Task Force in January 1996 to address the high accident rate among 703 operations. The resulting report contained 71 recommendations to improve the safety of the air taxi sector. TC intends to evaluate SATOPS in the near future by examining the actions taken to implement the recommendations and the safety effect of the work done. Recent statistics indicate that the accident rate for 703 operations has declined in recent years; however, it is still significantly higher than the accident rate in 704 and 705 operations. The accident rate per 100 000 hours in year 2001 was 0.4 for 705 Airline operations, 2.5 for 704 Commuter operations, and 4.2 for 703 Air Taxi operations.

2.0 Analysis

2.1 Introduction

For undetermined reasons, the pilot did not maintain adequate altitude during a night circling approach in IMC and the aircraft flew into the ground short of the runway. The aircraft was equipped for the flight in accordance with the regulatory requirements and field examination of the wreckage gave no indication of a pre-occurrence mechanical problem contributing to the accident. The pilot did not express any concerns about the aircraft during the flight and the passengers received no warning of the impending impact with the ground. The accident is highly characteristic of a CFIT occurrence. The analysis will discuss why the accident occurred and address the following latent factors and safety deficiencies:

- organizational and management factors
- environmental conditions
- circling procedures
- search and rescue
- survivability
- 703 accident rate
- cockpit video digital recording

2.2 Organizational and Management Factors

Several available system defences were missing or not used. An after-hours CARS observer/ communicator call-out was not requested and Fort Liard did not have equipment such as AWOS with a voice generated module; therefore, the pilot did not have a valid altimeter setting available for the approach or a current weather report for Fort Liard. The airport facilities were minimal for a night, IFR, non-precision approach, and the aircraft was not fitted with a radio altimeter or a GPWS. Radio altimeters and GPWS are recognized defences against CFIT accidents and have been proven to enhance safety in high-risk operational environments. Single-pilot IFR requires a pilot to perform under conditions of high workload, and the combination of pilot inexperience, a night IFR flight in IMC conditions, single-pilot operation, minimal approach aids, and a circling procedure placed the pilot in a high risk situation. Had a radio altimeter with an altitude warning or a GPWS been installed in the aircraft, the likelihood of this accident occurring would have been reduced.

The quality of rest that the pilot obtained during the five hours that he was booked into a day room could not be determined. It is known that he interrupted his rest period at least three times, once to eat lunch, and twice to make phone calls. The performance of a night, non-precision, circling approach in IMC at the end of the duty day would have commanded a high degree of skill, attention, and task loading. While there was no indication that the pilot was suffering from chronic fatigue, he may have been experiencing the effects of acute fatigue. Whether acute fatigue was a factor in the occurrence could not be determined.

A safety management system is a management process by which an organization identifies aviation risks and develops programs and procedures to minimize those risks. The reasons for an occurrence can often be traced back to identifiable organizational and management factors. An examination of whether the company's policies, procedures, and practices are in concert and accurately reflect a sound safety philosophy is key to understanding the role of such factors in an occurrence. In this occurrence, there were clear indications that, although the management system appeared to have all the resources in place to provide operational guidance and support, there were deficiencies in its application that led to conflicting messages, and a potential for a less than optimal focus on safety. For example:

- While the company had in place a management complement of an operations manager, a chief pilot, and a safety officer, the lack of full-time management on site and the unfamiliarity of the safety officer with IFR operations had the potential for not adequately managing operational risks. This was indicated by the fact that, on the day of the accident, those responsible for operational control were not in a position to monitor the operational aspects of the flight, including the developing weather, and the flight was dispatched as single-pilot despite the pilot's limited experience in IFR operations and in the northern environment, and despite his demonstrated weakness in non-precision IFR skills in the recent past.

- There were apparent gaps between operational procedures and operational practice, for example:

  - while a CARS operator could be called out after hours for a fee, the company practice was not to do so, thus the pilot did not have an altimeter setting appropriate for the approach, nor the latest weather for the airport ;

  - the system that the company had in place to track crew flight and duty times to prevent fatigue and ensure that pilots did not exceed the number of hours that CAR allows for in a specified period of time was not an ideal source for information relating to qualifications for specific operations, such as single pilot IFR and night. Therefore, while the pilot held the licences and endorsements necessary for the flight, he did not meet the night recency requirements necessary to carry passengers, as stated in the *CAR*. As well, the pilot only met the single pilot IFR requirements of CAR 723.86 (1) by utilizing flight time that would not qualify as flight experience for a higher licence, and therefore he probably did not have the minimum time required for single pilot IFR.

- Although not required by regulations, the aircraft was not equipped with any equipment to warn the pilot of an impending flight into terrain, despite the high-risk environment in which this company operated.

These examples demonstrate that, at the time of the occurrence, deficiencies in the safety management of the company placed risk management responsibilities almost entirely on the pilot and negated the potential for safe operation. Further, the nature of the deficiencies were such that they could have been identified through a more effective safety management system. While the company had taken the initiative to voluntarily appoint a safety officer and there appeared to be a safety program in place, the program may not have been directed at the needs.

2.3 Environmental Conditions

The pilot had obtained thorough weather briefings and was cognizant of the warm front was approaching Fort Liard. Between the time the aircraft left Yellowknife and it arrived at Fort Liard, the weather conditions at Fort Liard worsened, as forecast, due to the arrival of the warm front, and the ceiling and visibility were reduced significantly in snow.

Night visual approaches are demanding, especially in areas where the lack of adequate external visual clues are not compensated for with other defences, and the visual manoeuvring necessary to accomplish the circling approach in the existing environmental conditions would have been challenging for a single pilot. Provided the pilot had initially achieved visual reference to the runway, he would have been attempting to fly the aircraft visually with a partial instrument scan, rather than with primary reference to the instruments, in an environment that provided few external visual clues because of darkness and reduced visibility. His primary forward and vertical runway visual approach references would have been the PAPI lights and the runway lights. The runway was located very close to the town site, and, in the existing conditions, illumination from the residential and street lights may have diminished the cues provided by the airport lighting. The falling snow and the lack of functioning flashing strobe runway identification lights would have further reduced the conspicuity of the runway environment.

2.4 Circling Procedures

Descent below the MDA on an IFR approach during the circling phase is predicated on the pilot maintaining sufficient visual reference to complete the landing safely. The pilot may have been using a non-typical circling procedure, which would have required him to re-establish visual contact with the runway environment on final approach; however, this could not be determined. Loss of visual reference to the runway at any point during the circling procedure requires a pilot to initiate a missed approach and conduct another approach or proceed to the alternate airport. At impact, the aircraft was on a heading of approximately 015°, approximately 1.3 nm WSW of the airport and 0.3 nm left of the runway centreline. This would indicate that the pilot had insufficient visual reference to align the aircraft with the runway during the final approach, and that he had elected to continue the approach without the necessary visual references.

The use of the Fort Simpson altimeter setting was unauthorized, as the approach chart did not provide for a remote altimeter setting. Use of this altimeter setting would have resulted in the pilot operating the aircraft 200 feet lower than what was indicated on the altimeter, and may have contributed to a loss of vertical situational awareness.

2.5 Search and Rescue

The ELT functioned at impact and the accident occurred in close proximity to the community; however, 10 hours passed between the time of the occurrence and the time rescue personnel arrived at the accident site. Although the SARSAT system functioned as designed, the predicted position of the ELT was at the outer limits of the acceptable range of accuracy for the system. Opportunities for local community searchers to identify and access the accident site earlier were hampered by initial inaccuracy of the SARSAT location information, by the time required to locate SAR aircraft to the Fort Liard area, and by darkness and poor weather conditions. The availability of a 406 ELT may have reduced the SAR time significantly.

2.6 Survivability

Neither the pilot nor the right front seat passenger were wearing their available shoulder harness. It is probable that the level of injury sustained by these occupants would have been significantly less had the shoulder harnesses been utilized.

2.7 703 Accident Rate

At present, the accident rate per 100 000 hours in Canadian 703 Air Taxi operations is approximately 10 times greater than the equivalent rate in 705 Airliner operations. The difference is due largely to the more stringent operating standards that apply to 705 operations, and to the proportionately greater utilization of well supported airport environments by higher level commercial operations. This would suggest that more effort is required on the part of industry and the regulator to reduce the continuing high accident rate in 703 category operations.

2.8 Cockpit Video Digital Recorder (CVDR)

The pilot was unable to provide useful information regarding the final minutes of the flight and the aircraft was not fitted with a flight recording device. Investigators therefore were unable to determine if the altitude deviation resulted from procedural error, situational awareness error, distraction, or another undetermined reason. The availability of a CVDR would have allowed investigators to reconstruct the actual flight path of the aircraft, to better determine why the altitude deviation occurred.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. For undetermined reasons, the pilot did not maintain adequate altitude during a night circling approach in IMC and the aircraft struck the ground.

2. The pilot and front seat passenger were not wearing available shoulder harnesses, as required by regulation, which likely contributed to the severity of their injuries.

3.2 Findings as to Risk

1. The aircraft was not fitted with, and was not required to be fitted with, a GPWS or a radio altimeter.

2. The pilot used an unauthorized remote altimeter setting that would have resulted in the cockpit altimeters reading approximately 200 feet higher than the actual altitude.

3. The pilot did not meet the night recency requirements necessary to carry passengers, as specified in *CAR 401.05 (2)*.

4. Risk management responsibilities had been placed almost entirely on the pilot.

5. While the company had taken the voluntary initiative to appoint a safety officer, and appeared to have a safety program in place, the program may not have been directed at the needs.

3.3 Other Findings

1. Approximately 28 hours of flight time that the pilot had logged as multi-engine dual would not have qualified as flight experience for the issue of a higher license.

2. *CAR* do not define “flight familiarization”, “flight experience”, or “dual”, and therefore do not address flight time “quality”.

3. Opportunities for local community searchers to identify and access the accident site earlier were hampered by initial inaccurate SARSAT location information, by the time required to locate SAR aircraft to the Fort Liard area, and by darkness and poor weather conditions.

4. The decreased time required to alert the SAR system and the higher degree of accuracy permitted by the utilization of a 406 MHz ELT, particularly one interfaced with the onboard GPS, would have likely permitted rescuers to access the site in a more timely manner.

5. 703 Air Taxi operations continue to have a much higher accident rate than 704 Commuter and 705 Airline operations.

4.0 Safety Action Taken

As a result of this occurrence, Deh Cho Air initiated the following:

1. Any multi-engine night flights or IFR flights will be dispatched with two crew on board until further notice (*Deh Cho Air Company Directive No. 2 issued 19 October 2001*).

2. Effective immediately all crew shall wear shoulder harnesses without exception (*Deh Cho Air Company Directive No. 3 issued 19 October 2001*).

3. All pilots shall use the FLIGHT DUTY program provided on the company computer to record and keep track of their duty and flight times (*Deh Cho Air Directive No. 4 issued 21 October 2001*).

4. Any Deh Cho Air IFR flight arriving after the local Fort Liard CARS operating times will have a call out initiated so that current weather and airport information will be provided to the incoming flight. This call out will be coordinated through the flight watch person (*Deh Cho Air Directive No. 6 issued 01 November 2001*).

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 06 December 2002.

NDB RWY 20

FORT LIARD
FORT LIARD, N.W.T.

APRT RADIO
122.1 (MF 5 NM)
O/T TFC 122.1

ELEV **706**
TDZE 20 **706**

CYJF

FOR COMPANY USE ONLY

Verify runway unobstructed when A/G Advisory not available.

Rising terrain to south and northwest.

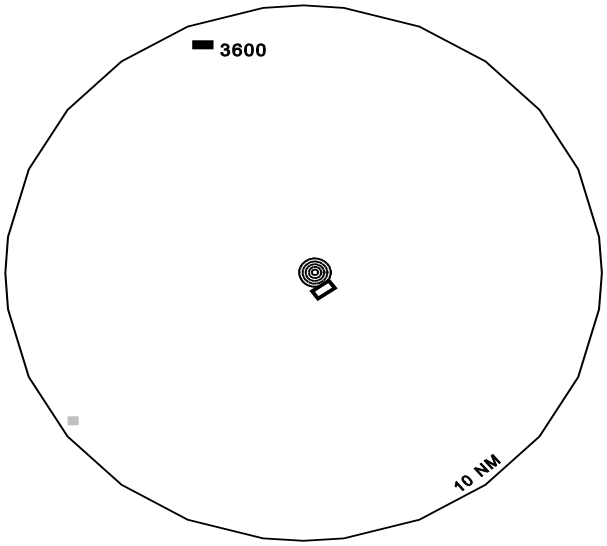
*DEPARTURE PROCEDURE
Rwy 02 - -
CLB HDG 020 to 2000 then climbing right turn drct to YJF NDB. Shuttle non-standard (max 200 KT) within 10 NM. INBD 220 to MEA BPOC.

Rwy 20 -1/2-
Requires a minimum climb gradient of 510 FT/NM to 1000. CLB HDG 200 to 2200 then left turn to YJF NDB. Shuttle non-standard (max 200 KT) within 10 NM. INBD 220 to MEA BPOC.

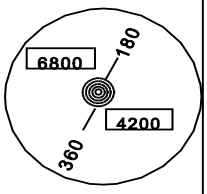
- or -

SPEC VIS -
Climb visual over YJF NDB to conduct the published missed approach BPOC.

Predicated on an Area Forecast.



MSA YJF 25 NM

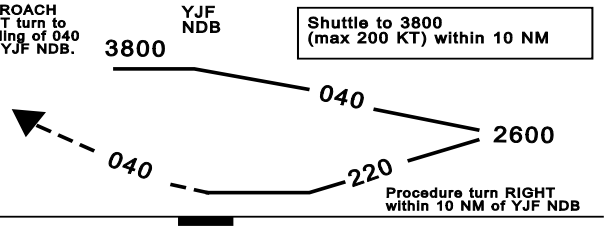


DEPARTURE CLIMB RATE V/V (FPM)

GROUNDSPEED	90	120	140	160	180	200	250
510 FT/NM	765	1020	1188	1360	1530	1698	2125

SAFE ALT 100 NM 10,000

MISSED APPROACH
Climbing LEFT turn to 3800 on heading of 040 LEFT turn to YJF NDB.



Shuttle to 3800 (max 200 KT) within 10 NM

CATEGORY	A	B	C	D
NDB	**1600**	(894)	21/2	NOT AUTHORIZED
CIRCLING	**1600**	(894)	21/2	NOT AUTHORIZED
TAKE-OFF	Rwys 02, 20: *			NOT AUTHORIZED
ALTERNATE	1200-3		1900-3	NOT AUTHORIZED

Knots	70	90	110	130	150
Min: Sec					

NDB RWY 20
PRINTED 30 MAR 95
EFF

N60 14 06 W123 28 01
CHANGES: Dep Proc: both rwys
Profile view: Shuttle note box
Bar under entry zone alt
Minima box: NDB
Landing chart: Correct hazard beacon hgt

VAR 29E

FORT LIARD
FORT LIARD, N.W.T.
NAD 83

Appendix A - Fort Liard NDB 20 Company Approach Plate

Reproduction - Not for navigational use

Appendix B - CVDR Occurrence Information

Following are some recent Western Region accidents. In all of these accidents it is probable that the availability of cockpit video digital recorder (CVDR) information would have allowed investigators to better reconstruct the events leading to the accident, and to better identify the active failure and the safety deficiencies associated with the accident.

A00W0177 - Cessna 208, 2 fatal, report public - The RCMP Cessna 208 Caravan was departing Teslin Lake with the pilot and one RCMP engineer on board. Shortly after take-off the aircraft was seen to pitch up into a steep climb, stall, then descend at a steep angle onto the water. The aircraft was destroyed and both occupants sustained fatal injuries. The pilot likely experienced spatial disorientation, but this is not certain.

A00W0217 - Short Brothers SC-7 Skyvan, 3 fatal, report public - The Short Brothers SC-7 Skyvan was on a VFR flight to Port Radium, NWT. For undetermined reasons, the aircraft descended below the elevation of terrain surrounding the airstrip, resulting in a controlled flight into terrain accident. The aircraft was destroyed and the three occupants sustained fatal injuries. There were no witnesses to the event.

A01W0118 - Cessna 310, 2 fatal, report public - The Cessna 310 was being used as a bird dog in fire-fighting operations. The aircraft likely stalled during a low-level turning from which recovery was not possible, but the time and conditions of the actual impact are unknown. Both occupants sustained fatal injuries. There were no witnesses and the aircraft was destroyed in an intense post-impact fire.

A01W0190 - Eurocopter AS 350 BA, one serious injury, report public - The Eurocopter AS 350 BA helicopter was landing under high-density altitude conditions. As the helicopter entered a low hover prior to landing, the pilot lost directional control and the low rotor horn sounded. The helicopter contacted the terrain and rolled onto the right side. The helicopter sustained substantial damage and one of the six occupants was seriously injured. The investigation was impeded early on because of the discrepancy in the testimonies of the five passengers and the pilot with regard to which way the helicopter rotated prior to impact.

A01W0261 - Piper PA 31, 3 fatal, 3 serious injuries, report not yet public - The Piper PA-31 Navajo Chieftain initiated a non-directional beacon approach with a circling procedure for runway 02 at Fort Liard, NWT. The aircraft struck the ground 1.3 nautical miles short of the threshold of the runway and sustained substantial damage. Three of the six occupants sustained fatal injuries and the remaining three sustained serious injuries. The investigation established that the pilot did not maintain adequate altitude, for undetermined reasons, during a night circling approach in IMC.

A01W0297 - Eurocopter EC120B, two minor injuries, report not yet public - The Eurocopter EC120B helicopter was on a training flight east of the Yellowknife airport. After approximately 25 minutes of flight, during a power-on approach to a large clearing, the rotor speed decayed and the low rotor rpm warning sounded at a height of about 150 feet above ground. The pilot entered an autorotation, the helicopter landed hard. The helicopter was substantially damaged. The pilots sustained minor injuries. The reason for the loss of power has not been determined.

A01W0304 - Cessna 172, 4 fatalities, report not yet public - The Cessna 172 became overdue on a VFR flight in the NWT. The wreckage was located two days later on a steep slope about 300 feet below the top of a 1400-foot mountain. The four occupants were deceased and the aircraft was substantially damaged. The

accident appears to be weather related; however, as there were no witnesses and no survivors, the circumstances leading up to the accident and at the time of the impact are unknown.

A02W0057 - Eurocopter AS 350 D, one serious injury, two minor injuries, report not yet public - The pilot was attempting to land the Eurocopter AS 350 D in mountainous terrain when the helicopter experienced gusty winds and an increased sink rate on short final. The pilot aborted the approach and turned downhill but was unable to stop the sink rate. The decent continued, the low rotor horn sounded, and the helicopter settled into trees and rolled onto the right side. The pilot sustained serious injuries and the two passengers sustained minor injuries. The helicopter was substantially damaged. No mechanical discrepancies have been identified during the investigation. There was a TV news camera on board the aircraft that was being operated intermittently, prior to the accident. The recording provided partial information; however, the film sequence was incomplete in the moments immediately prior to impact.

A02W0064 - R22, one fatal, report not yet public - The Robertson R22 Beta helicopter had struck the ground on the perimeter of a natural gas well site. The pilot sustained fatal injuries and the helicopter was destroyed. There were no witnesses and the investigation was unable to determine with any degree of certainty why the helicopter had crashed.

A02W0100 - Eurocopter AS 350 D, two minor injuries, field investigation completed, no report - The Eurocopter AS350B was landing on an access road to drop off a fire-fighting team. The pilot observed a loss of power and heard the low rotor warning horn during the approach as he lowered the collective to maintain control. The helicopter began an uncommanded right turn and landed hard on the right shoulder of the road. The tail boom broke away and the helicopter rotated clockwise through several revolutions before rolling onto the right side. A fire erupted and destroyed the helicopter except for the engine and tail boom. Two of the five occupants sustained minor injuries. The field investigation and engine examination determined that it was doubtful if a loss of power had occurred; however, a decision has been made to not investigate further because of the lack of useable information.

A02W0173 - Piper PA-34, two fatalities, report not yet public - The Piper PA-34 was on an IFR flight from Edmonton to High Prairie, Alberta, with one pilot and one passenger on board. The aircraft did not arrive in High Prairie and the wreckage was located in a densely wooded area approximately seven nautical miles southeast of the High Prairie airport. Both occupants sustained fatal injuries and the aircraft was destroyed. There were no witnesses, and to date, the investigation has not been able to determine what happened.

All of these aircraft were being operated as state or commercial aircraft at the time of the occurrence. In all but one occurrence, passengers were on board the aircraft at the time of the accident. In all cases the quality of the investigation was diminished because of the limited data available. As stated previously in this report, aircraft typically used in 703 operations are not fitted at manufacture with electrical infrastructure required to support a flight data recorder (FDR), and the installation of FDRs in these category of aircraft would require expensive system upgrades to accommodate an FDR. A light-weight, comparatively inexpensive alternative to an FDR is a cockpit video digital recorder (CVDR).

Appendix C - List of Supporting Reports

The following TSB Engineering Branch Report was completed:

LP 096/2001 - PA-31 Flight Instrument and Annunciator Panel Examination

Appendix D - Glossary

agl	above ground level
AIP	Aeronautical Information Publication
ARCAL	aircraft radio control of aerodrome lighting
asl	above sea level
AWOS	automated weather observation system
CAR	Canadian Aviation Regulations
CARS	Community Aerodrome Radio System
CFIT	controlled flight into terrain
CVDR	cockpit video digital recorder
CVR	cockpit voice recorder
DME	distance measuring equipment
ELT	emergency locator transmitter
EPIRB	emergency position indicating radio beacon
FAA	Federal Aviation Administration
FDR	flight data recorder
FSS	Flight Service Station
GPS	global positioning system
GPWS	ground proximity warning system
IFR	instrument flight rules
IMC	instrument meteorological conditions
LWIS	limited weather information system
MDA	minimum descent altitude
MDT	mountain daylight time
METAR	aviation routine weather report(s)
MHz	megahertz
NATA	Northern Air Transport Association
NDB	non-directional beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
NTSB	National Transportation Safety Board
NWT	Northwest Territories
PAPI	precision approach path indicator
PPC	pilot proficiency check
RCC	Rescue Coordination Centre
SAR	Search and Rescue
SARSAT	Search and Rescue Satellite System
SATOPS	Safety of Air Taxi Operations Task Force (TC)
SIC	second in command
SOP	Company Standard Operating Procedures
TC	Transport Canada
TSB	Transportation Safety Board of Canada
TSO	Technical Standard Order
VFR	visual flight rules
VGM	voice generator module

VHF	very high frequency
VOR	VHF omnidirectional range