Report 99-004

Cessna 206

ZK-EKJ

impact with mountainous terrain

by Mount Suter 17 km south of Milford Sound

18 April 1999

Abstract

On Sunday 18 April 1999 at around 1538 hours, ZK-EKJ, a Cessna 206 floatplane on a round-trip scenic flight from Te Anau to overhead Milford Sound, struck the top of a vertical craggy mountain ridge. The pilot and 4 passengers died during the impact.

The pilot probably attempted to cross the ridge crest at low level and might have misjudged the height of the ridge top because of visual illusions or distraction. Some localised turbulence or downdraughts and the fast speed of the aircraft may have contributed to the accident. Had the pilot applied a safe ridge crossing technique, including maintaining a sufficient height margin above the ridge, the accident could have been avoided.

The pilot was reported to have carried out unnecessary low flying and crossing of ridge crests with minimal clearance on scenic flights, on a number of occasions over several years before the accident.

The operator did not, adequately supervise the pilot, independently investigate an allegation of the pilot low flying or establish a system to control or monitor the pilot's performance and compliance with safety requirements.

The pilot's reported acts of unnecessary low flying were not made known to the Civil Aviation Authority. The operator's organisational shortcomings that probably contributed to the accident were not identified by or made known to the safety authority.

Safety recommendations were made to the operator's chief executive and the Director of Civil Aviation to address safety issues identified during the investigation.

The Transport Accident Investigation Commission is an independent Crown entity established to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. Accordingly it is inappropriate that reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

Transport Accident Investigation Commission
P O Box 10-323, Wellington, New Zealand
Phone +64 4 473 3112 Fax +64 4 499 1510
E-mail: reports@taic.org.nz Web site: www.taic.org.nz

Courtesy of The Southland Times

Cessna 206 floatplane
ZK-EKJ

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List of Abbreviations

amsl	above mean sea level
CAA	Civil Aviation Authority
CFIT	controlled flight into terrain
cg	centre of gravity
ELT	emergency locator transmitter
kg	kilograms
km	kilometres
NZST	New Zealand Standard Time (UTC + 12 hours)
UTC	Coordinated Universal Time

Aviation Accident Report 99-004

Data Summary

Aircraft type, serial number and registration:	Cessna U206G, U20604282, ZK-EKJ
Number and type of engines:	one Teledyne Continental IO-520-DCF
Year of manufacture:	1978
Date and time:	18 April 1999, 1538 hours[1]
Location:	by Mount Suter 17 km south of Milford Sound latitude: 44° 49.6′ south longitude: 168° 01.5′ east
Type of flight:	air transport, scenic
Persons on board:	crew: 1 passengers: 4
Injuries:	crew: 1 fatal passengers: 4 fatal
Nature of damage:	aircraft destroyed
Pilot's licence:	Commercial Pilot Licence (Aeroplane)
Pilot's age:	44
Pilot's total flying experience:	5325 hours reported as some 4500 hours on type
Investigator-in-Charge:	K A Mathews

[1] Times in this report are New Zealand standard time (UTC plus 12 hours)

1. Factual Information

1.1 History of the flight

1.1.1 On Sunday 18 April 1999 at about 1510 hours, ZK-EKJ, a Cessna 206 floatplane operated by Waterwings Airways (Te Anau) Limited, trading as Milford Sound Scenic Flights[2] (the operator), took off from Lake Te Anau, alongside Te Anau township, on a routine round-trip scenic flight to overhead Milford Sound and back to Te Anau. The pilot and 4 passengers were on board the aircraft.

1.1.2 The pilot of ZK-EKJ (the pilot) contacted Milford Sound Aerodrome Flight Information Service by telephone for a weather briefing before the flight departed.

1.1.3 The flight was planned to take about one hour. The records for the aircraft showed that it had enough fuel for about 1.6 hours of flying.

1.1.4 The aircraft departed normally. Shortly after take-off the pilot tried to contact Milford Flight Service via the high frequency transceiver[3] in the aircraft, but after a short delay Queenstown Information responded and asked the pilot if they could help. The pilot replied, "just airborne Te Anau, five POB [persons on board], we're doing a Milford overhead, overhead Milford at four five, over." Queenstown acknowledged, "Roger overhead Milford four five and Milford QNH[4] one zero zero two." The pilot read back the QNH.

1.1.5 The pilot's usual route was to fly north via Lake Te Anau to its head, pass near Lake Erskine, circle Mount Tutoko to the north-east of Milford Sound, circle Milford Sound township and return via the western side of Lake Te Anau to land on the lake near Te Anau township.

1.1.6 The aircraft climbed to an altitude of about 6000 feet above mean sea level (amsl). The pilot gave a position report 12 km south of the head of Lake Te Anau at about 1530 hours advising, "Billy Burn 6000 north." The pilot's voice was reported to have sounded normal during the transmission, which was the last radio call the pilot was heard to make.

1.1.7 From Billy Burn the direct route at about 6000 feet amsl was along the Neale Burn valley on the western side of the Earl Mountain Range to near Lake Erskine. (See figure 1.) The pilot of another aircraft who was in the area at about the same time crossed the Earl Mountains south of Lake Erskine. He reported that there was some cloud along the tops of the Earl Mountains and that the visibility was good. He said there was some turbulence and downdraughts in the area, especially below about 8000 feet amsl.

1.1.8 The direct route to the accident site from near Lake Erskine was across the mountain ridge between Pyramid Peak, situated to the east of Lake Erskine and to the north of Flat Top Peak, and Mount Suter to the north-east. The lowest point along the ridge was some 6000 feet amsl. The aircraft crossed the head of Falls Creek and struck the mountain ridge that was directly ahead and running in an easterly direction from Mount Suter. (See figures 1 and 2) The height of the ridge was around 6400 feet amsl and the aircraft impacted approximately 60 feet below the crest on the southern side.

1.1.9 On 18 April 1999 at 1655 hours, the aircraft was reported missing when it was overdue at Milford Sound and Te Anau and after initial attempts to locate the aircraft did not disclose its whereabouts. A search for ZK-EKJ involving aeroplanes and helicopters began that evening. The wreckage was subsequently located on 21 April, at about 1015 hours, after a search involving 100 flying hours.

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[2] As documented on the operator's current air service certificate.
[3] A combined radio transmitter and receiver.
[4] An altimeter sub-scale setting representing current barometric pressure.

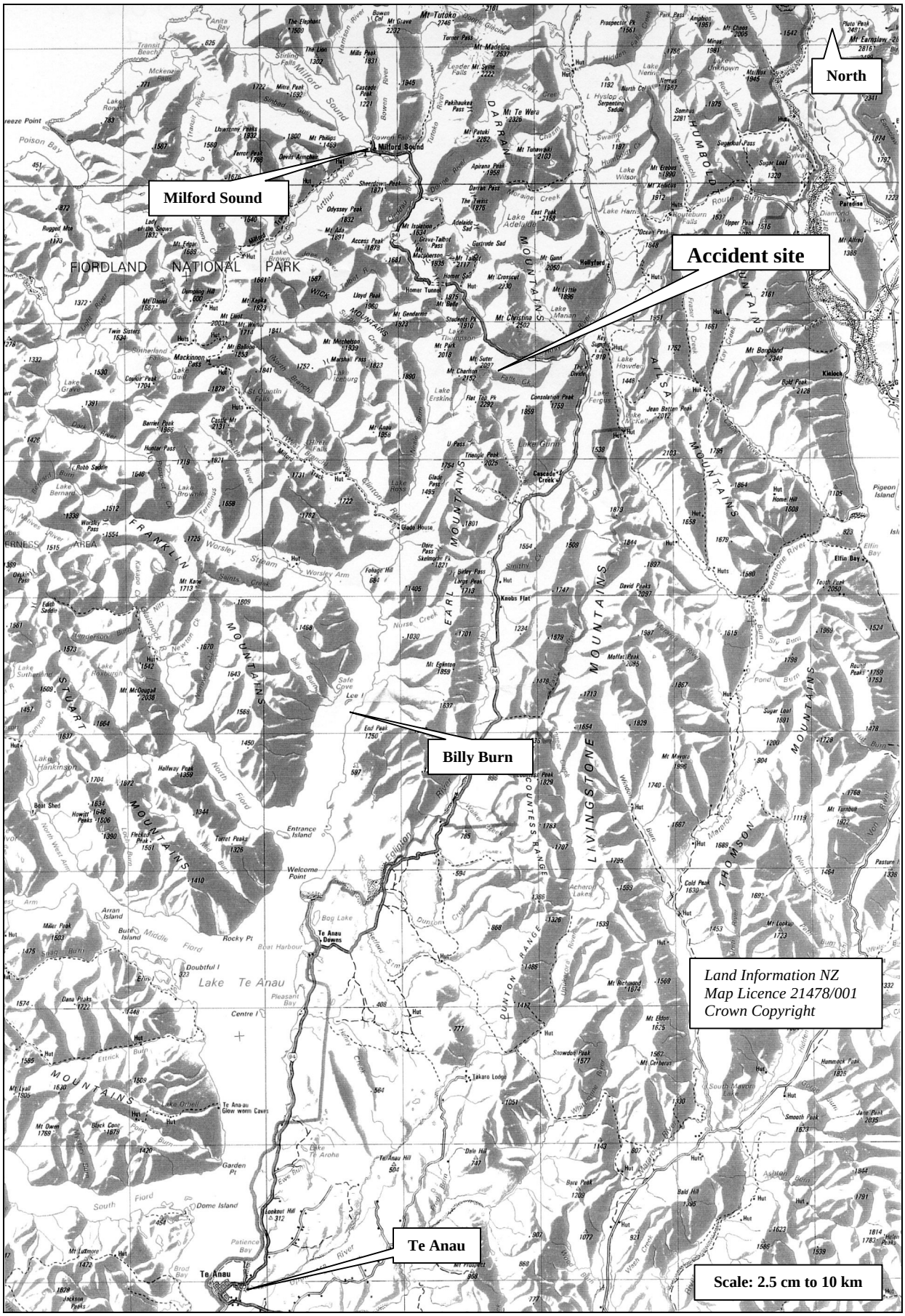

Figure 1
General area and accident site chart

1.1.10 The accident occurred on 18 April 1999 at about 1538 hours. The accident site was on the south face of a craggy vertical mountain ridge, 600 metres east of Mount Suter, 17 km south of Milford Sound, at an elevation of approximately 6340 feet amsl, in Fiordland National Park. Latitude: 44° 49.6' south, Longitude: 168° 01.5' east.

1.2 Injuries to persons

1.2.1 The aircraft occupants died as a result of the impact.

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed.

1.4 Pilot information

Background

1.4.1 The pilot was a male aged 44 years. He held a Commercial Pilot Licence (Aeroplane), a Class 1 medical certificate valid until 4 September 1999 with no restrictions, various aircraft type ratings, including a rating for floatplane operations in the Cessna 206, and a category D flight instructor rating.

1.4.2 The pilot completed his commercial pilot training at Queenstown in July 1988. His total flying experience amounted to 5325 hours at the time of the accident. Examination of his last pilot logbook showed he had flown 857.9 hours in ZK-EKJ since 25 September 1997. The operator advised that the pilot had amassed some 4500 flying hours in the aircraft.

1.4.3 The pilot was working full-time for the operator as a pilot and he had been stationed at Te Anau for the past 8 years to operate ZK-EKJ. He was not paid a salary but was remunerated per flying hour. The pilot managed the Waterwings Te Anau-based operation for the owner, who lived in Queenstown. The owner was the chief executive as well as operations manager, chief pilot and maintenance controller. The pilot was one of the operator's senior pilots and he had responsibility for the day-to-day running of the Te Anau-based operation and reported to the owner. The owner did not directly supervise the pilot's flying operations. Another pilot living in Te Anau did some occasional relief flying for the pilot.

1.4.4 ZK-EKJ was the only floatplane and Waterwings aircraft based at Te Anau. The pilot carried out scenic flying and other commercial operations in the Fiordland and Queenstown areas using the aircraft. During the winter months the aircraft utilisation was low and the pilot would take leave or carry out some relief flying at Queenstown for the operator.

Checking

1.4.5 Regulation 76 and 77 annual competency checks were carried out on the pilot. His most recent competency check was completed on 16 September 1998 in ZK-EKJ, which included a biennial flight review.

1.4.6 The last 3 annual competency checks were completed by a flight examiner who worked for another operator. The check sheets signed by the examiner remarked that the pilot had flown to a good standard (above average). The examiner did not supervise the pilot throughout the year and he had little contact with him apart from the annual checks. The examiner said he debriefed the pilot at the end of each check and discussed any concerns he had with the pilot. The examiner said that, following the annual checks, he did not report to the owner. The examiner believed the owner was overseas each time the checks were completed.

1.4.7 The examiner said that the pilot was a competent handler of the aircraft and confident in his own abilities. He said that during the checks the pilot showed some tendency to fly lower or closer to terrain than was necessary during precautionary landings. The examiner said he discussed the tendency, and low flying generally, with the pilot, reminding him not to fly unnecessarily low unless it was warranted. The examiner said the pilot was accustomed to flying near obstacles because it was often a necessary part of floatplane operations when taking off and departing and when landing on the water in some inlets and fiords. The annual competency check sheets did not record the examiner's discussion with the pilot.

1.4.8 The pilot had accumulated most of his flying experience in the Fiordland and Queenstown areas. He had flown the route between Te Anau and Milford Sound many times during the 8 years he had worked for the operator. In August 1988 the Civil Aviation Division of the Ministry of Transport approved the pilot to operate into and out of Milford Sound Aerodrome.

Work hours and requirements

1.4.9 On Sunday 18 April, the day of the accident, the pilot started duty at about 1430 hours. He had been off duty the day before the accident. On 16 April he had flown for about 45 minutes. He was off duty on 15 April.

1.4.10 In the 7-day period before the accident the pilot had flown 14 hours. In the 7-day period from 8 April to 14 April the pilot flew each day amassing approximately 22 flying hours. During one of the 7 days he flew a local flight for about 20 minutes only. The most he flew in one day during the 7-day period was 4 hours. He was off duty on 7 April.

1.4.11 From March 24 to April 6, a 14-day period, the pilot flew every day. He amassed approximately 23 flying hours during that period. The most he flew in one day was 3 hours and the least was 35 minutes. From March 9 to March 18, a 10-day period, the pilot flew every day for a total of about 30 hours. The least he flew on one day in that period was 30 minutes. From 20 February to 26 February, a 7-day period, the pilot flew every day for a total of about 30 hours. The least he flew on one day in that period was 2.8 hours. From 5 February to 14 February, a 10-day period, the pilot flew every day for a total of about 47 hours. The least he flew on one day in that period was 1.5 hours.

1.4.12 During April, up until the accident, the pilot had flown 33.3 hours. He had flown 67.2 hours during March, 94.9 hours during February, 87.4 hours during January and 68.5 hours during December 1998.

1.4.13 The operator's operations manual at the time allowed a pilot to fly a maximum of 105 hours per month, 35 hours per week or 8 hours per day. The normal maximum duty time was 11 hours daily and 200 hours per month. A pilot was to have a recreation period of not less than 24 hours free of all duties once in every 7 consecutive days.

1.4.14 The pilot's flight and duty time record sheets provided by the operator covered only the period from 1 March to 8 March 1999. A study of the pilot's logbook and other flight records showed that the pilot probably did not exceed his work duty hour limitations, except on 2 possible days in February.

Other information

1.4.15 Following the accident the Commission received reports directly from 11 passengers who had flown with the pilot on separate flights in ZK-EKJ during the period 1996 to March 1999. Reports were also received from 10 other people who knew the pilot, or had observed his flying. Several other reports were received from people who had heard comments about the pilot's flying. Some reports were made by people who approached the Commission during the investigation. Some passenger names were supplied and the Commission also located other passengers and witnesses. The Commission had not previously received such a number of reports about a pilot's flying during the course of an investigation. The operator said that it had not received a passenger complaint, nor had the Civil Aviation Authority (CAA) advised it of any complaints from passengers apart from one complaint made several years earlier (see 1.4.22).

1.4.16 Two passengers who flew with the pilot about 3 weeks before the accident wrote to the Commission expressing concerns about their flight and its proximity to terrain. They supplied a video recording of some of the flight to illustrate their concerns.

1.4.17 All the passenger reports received directly by the Commission, except for one report of a short flight, stated that the pilot flew the aircraft low across terrain, flew low through passes and cut across the top of ridgelines with very little clearance above the ridge tops. A passenger who was familiar with aircraft reported that the pilot flew up to ridgelines from below and "popped" over the top of the ridges at low level. The passenger also said the pilot "whipped" low across passes and got close to terrain. Another passenger said the pilot struck the tops of trees with the floats of the aircraft. Several of the passengers said that they were frightened and did not intend to fly in small aircraft again.

1.4.18 The passengers had not complained to either the CAA or the operator. Some passengers said that they had not complained because the flight was something that they would do only once, or they were unsure how, or to whom, they could make a complaint. One passenger said she complained to her employer who told another operator. There were no passenger information cards carried in the aircraft explaining how passengers could make a complaint if they were concerned over any aspect of the flight.

1.4.19 A passenger, who was also a pilot experienced in mountain flying, felt uncomfortable and apprehensive during his flight with the pilot. The pilot did not know that the passenger was also a pilot. The passenger said the pilot flew straight at ridges at right angles and crossed them close to their tops. He said the pilot climbed directly toward ridges and then crossed them close to their tops, rather than orbiting to gain altitude first. During descent the pilot approached straight at ridges perpendicularly, at a fast speed, and crossed them close to their tops. The flight was carried out in good weather conditions.

1.4.20 A pilot who operated in the area and knew the pilot said he had become increasingly concerned about the floatplane operation. He believed the pilot flew with "little margin". He said other people who knew the pilot well had expressed concerns to him over the pilot's flying and the floatplane operation.

1.4.21 Other pilots and other personnel working in the aviation industry, who had either observed the pilot's flying or worked with him, reported that the pilot had a tendency for low flying and would often fly low and close to terrain and other obstacles. A pilot who worked for a different operator received some training from the pilot in ZK-EKJ several years before the accident. He said the pilot flew too close to obstacles and that he advised him not to do so. The witnesses and some other local people advised that the pilot had a reputation for unnecessary low flying.

1.4.22 In late 1993, during a private function at their home, 2 passengers who had taken a charter flight with the pilot about 9 months earlier, showed an off-duty CAA safety information officer a video recording one of them had taken during the flight. The passengers, who held New Zealand Private Pilot Licences, expressed concern that the pilot flew too close to terrain and low across ridgelines, on several occasions. The CAA officer gave credence to the passengers' concern and contacted the operator's chief executive, advising him to speak to the pilot about the report. The chief executive indicated that he would talk to the pilot so the CAA officer took no further action.

1.4.23 After the accident the passengers sent the CAA officer the video recording. One of the passengers subsequently contacted the Commission and sent the Commission the original recording. The passenger confirmed the concern about the flight and believed that the pilot's flying was "dangerous" and "pretty alarming". The passenger said there were at least 3 low runs and thought that the pilot flew "right on the limit" with "never any margin for error".

1.4.24 The pilot's widow, however, provided the Commission with character references and reports from some other people who had flown with the pilot, worked with him or knew him personally. The operator provided a character reference. The references and reports indicated that the pilot was held in high regard as a person and for being a competent pilot. These reports and references did not indicate that the pilot carried out any unnecessary low flying. Both the pilot's widow and the operator denied that the pilot carried out unnecessary low flying.

1.5 Aircraft information

1.5.1 ZK-EKJ was a Cessna U206G, serial number U20604282, single-engine all-metal aircraft, constructed in the United States in 1978. The aircraft had been issued with a non-terminating Certificate of Airworthiness in the standard category. ZK-EKJ was registered to the operator in early 1986, around which time floats were fitted to the aircraft. The aircraft was listed in the operator's operations specifications as being approved for air transport operations. The operator's maintenance manual, approved by the CAA, required the aircraft to be maintained in accordance with its approved manufacturer's maintenance programme.

1.5.2 ZK-EKJ was maintained under contract by a Te Anau aircraft maintenance firm. The aircraft had accumulated 7175 hours since manufacture and 19.6 hours since its last inspection, recorded as having been completed on 8 April 1999. This inspection was performed in accordance with the Cessna Progressive Care Programme and was an Operation #2 inspection. An 800-hour float inspection was made at the same time.

1.5.3 The aircraft was fitted with a 300 horsepower Teledyne Continental IO-520-DCF engine, serial number 282962R. Manufactured in 1993, the engine was modified to F model standard in September 1997 and had accumulated 921 hours since new. At the last inspection a new vacuum pump, left-hand muffler assembly and oil filter adapter were fitted. In February 1999, the left air duct for the heater installed in the aircraft was replaced. A carbon monoxide detector was fitted to the instrument console to provide an early warning of any carbon monoxide ingress to the cabin of the aircraft. There were no reports made by the pilot or the relief pilot of any carbon monoxide ingress to the cabin.

1.5.4 A McCauley 3-bladed variable-pitch propeller, serial number 780190, was fitted to the aircraft. The propeller assembly had accumulated 886 hours since overhaul.

1.5.5 Records indicated that the airframe, engine, propeller and ancillary components were maintained in accordance with the provisions of the operator's maintenance manual. Inspections were required at least every 50 hours. All relevant airworthiness directives were recorded as being complied with. The last annual review of maintenance was completed in October 1998. The aircraft was carrying several minor defects on the day of the accident, none of which should have limited its performance. The direction indicator had been removed for servicing but all other flight instruments were recorded as being serviceable.

1.5.6 The maximum allowable all-up weight of the aircraft was 3600 pounds (1587.6 kg). At this weight the forward centre of gravity (cg) limit was 42.5 inches (1080 mm) aft of datum, and the rearward cg limit was 49.75 inches (1264 mm) aft of datum. The calculated weight of ZK-EKJ at take-off was 3430 pounds (1555.8 kg) and the cg was determined to be within limits at about 45.8 inches (1163 mm) aft of datum.

1.5.7 ZK-EKJ was equipped with a fuel tank in each wing, each with a capacity of approximately 115 litres. On most scenic flights it was normal practice for the pilot to fill the aircraft to about 75 pounds (47 litres) per tank. As the dip stick for measuring fuel quantity would not give an accurate reading while the aircraft was afloat, the pilot would confirm the fuel quantity dispensed into the tanks by looking into each tank. The aircraft was refuelled shortly before departing on the accident flight, that was to have taken about one hour to complete. The total fuel load of 150 pounds (68 kg) in the aircraft would have provided about 1.6 hours endurance. The accident occurred about 30 minutes into the flight.

1.5.8 The aircraft was equipped with 6 lifejackets located in the seat pockets on the back of the seats. The 2 forward jackets were located in the front side pockets. A basic survival kit was carried, comprising a bucket containing a billy, matches and some packaged food.

1.6 Meteorological information

1.6.1 The Meteorological Service of New Zealand Limited (MetService) provided an aftercast of the weather situation existing at the time of the accident, which is summarised as follows:

> On 18 April 1999 a strong but slowly moderating south-westerly flow prevailed over the South Island. This flow had been preceded by a cold southerly outbreak over most of the country.
>
> During the day, a weak warm-frontal trough moved north-eastwards over the south of South Island, reaching Canterbury by evening. The milder air behind the front helped subdue showers during the afternoon and turn the flow southerly through north-south oriented valleys. The airmass was also warming aloft due to the air subsiding as pressures rose. This subsidence provided for a gradual lowering of the inversion[5], further suppressing shower activity.
>
> Reports from weather stations in the local region indicated excellent visibility with scattered cloud during the afternoon. Queenstown reported a light southwest wind, while Milford Sound had a light northwesterly. Reports from Mount Belle and Consolidation Peak record the wind reaching 60 km per hour, suggesting the wind in the early afternoon was southerly at about 30 knots and was being steered by the topography. Precipitation was reported on both the eastern and western sides of the Homer Tunnel during the day.

[5] A reversal of the usual temperature gradient in the atmosphere with the temperature increasing with height.

At about the time of the accident, flight satellite imagery was taken which showed mostly clear skies east of the Fiordland Mountains, including over Lakes Te Anau and Manapouri. Cloud could be seen in the flow over the high ground to the east and northeast of these lakes.

The Invercargill radiosonde[6] balloon observation made at midday was considered representative of the accident area. The observation indicated a general south-westerly flow of about 30 to 35 knots over the area with a significant inversion based at about 2000 metres (about 6500 feet). The inversion had lowered over the preceding 12 hours. The temperature profile below 4000 metres (about 13,100 feet) was warming during the morning. The sounding indicated ideal conditions for strong lee wave[7] activity over the mountains. With a typical surface temperature and dewpoint of about 10.5° C and 4.5° C respectively, in the Queenstown area, the cloud base in the lift against the mountains would have been somewhere around the 1050 metre (3500 feet) mark amsl with tops to about 2200 metres or 7200 feet.

A flow between 20 to 35 knots over hilly terrain was considered sufficient to generate pockets of severe mechanical turbulence. On 18 April, such winds were present over much of the lower South Island. With winds increasing with height and an inversion present, as in this situation, lee waves develop down wind of a mountain ridge. Vertical motions in the order of 10 to 15 metres per second would have been possible at the time of the accident. These values may have been exceeded by the additional effects of mechanical turbulence generated by the ridge to the south of the accident site.

Lee wave amplitude is at its maximum in a stable layer of air. On 18 April the inversion, stable air, was at about 6500 feet. Further, the wave is most developed at peak heating time, when surface temperatures reach their maximum. With the accident occurring at about 1540 hours, and at around 6000 feet, the upward and downward motions were probably at their greatest.

Earl Range, one of the tallest barriers in the region, would have deflected the general south-westerly flow to produce a more southerly component for the wind in the area of the accident. This wind would have been accelerated, to as much as 60 to 70 knots, as it crossed the ridge just to the south of the accident site. The airflow would then have descended rapidly on the leeward side (north of the accident site). Downward motions of 20 to 30 metres per second may have been experienced there. Turbulence in this area could have been severe.

1.6.2 Pilots flying in the area around the time of the accident reported generally good visibility with light to moderate turbulence up to about 8000 feet. A layer of broken cloud lay between 8000 feet and 9000 feet, and some cap cloud lower down. A pilot who probably flew a similar route to that taken by ZK-EKJ, at about the same time of the accident, reported cloud along the tops of the Earl Mountains and noticeable lift (updraughting air) on the western slopes. Another pilot said that it was a good flying day but the wind was from a bad direction making lower level operations unsuitable. He flew at a high altitude due to the wind conditions and thought the pilot should also have been able to operate at a suitable higher level.

[6] An instrument for measuring temperature, pressure and humidity at successive atmospheric levels, which transmits the measurements by radio. The balloon has a radar target so that upper winds can be determined.

[7] A system of stationary air waves (also called *standing waves* or *mountain waves*), sometimes of large amplitude, forming, under certain conditions, over or to the lee of mountain ranges or hills which presents a mechanical obstruction to the wind. The waves are sometimes shown by the presence of lens-shaped (lenticular) cloud near the wave crests.

1.6.3 Milford Sound Aerodrome and Queenstown Flight Information Service advised that the pilot would occasionally have the local weather information faxed through to the operator's office in Te Anau. The pilot's standard practice, nevertheless, was to telephone Milford Sound Aerodrome Flight Information Service to gain an up-to-date weather report for the local area before getting airborne. On the day of the accident the pilot contacted Milford Sound at least twice during the day to get a weather briefing. The pilot's widow advised that the pilot obtained his last weather briefing just before he departed on the accident flight.

1.6.4 The Milford Sound Aerodrome Flight Information Service reported the weather in the afternoon to be good, with a light and variable surface wind tending westerly. Some cloud at 3000 feet had dissipated but there were still a few clouds at 7000 feet (1 to 2 oktas[8]). Reports received by the Milford Sound Flight Service, from pilots in the area, said the wind aloft was generally southerly and increasing to 30 knots. Comment was also made about there being turbulence below 8000 feet. Cloud was reported around an area called The Divide, near Lake Fergus, about 8 km east of the accident site.

1.6.5 Fresh snow had fallen in the mountain ranges during the days preceding the accident. The snow was enough to cover most of the mountains tops down to about 4000 feet. Snow below this level did not settle for long. Because of the vertical aspect of the rock face struck by the aircraft, much of the rock surface was free of snow and still visible when the aircraft was located 3 days after the accident.

1.6.6 The sun was calculated to have been at 314 degrees true with an elevation of 22.5 degrees, at the time of the accident.

1.7 Navigation aids

1.7.1 The flight was a visual scenic flight, without the need for navigational aids.

1.8 Communications

1.8.1 The aircraft was equipped with high frequency and very high frequency transceivers for normal air to air and air to ground communications. Radio communications before the accident were normal which indicated the transceivers were working correctly.

1.9 Wreckage and impact information

1.9.1 The accident site was at the head of the Falls Creek valley, on the south face of a craggy vertical mountain ridge, 600 metres east of the summit of Mount Suter, 17 km south of Milford Sound, and at an elevation of approximately 6340 feet amsl. Mount Suter has an elevation of some 6900 feet amsl and forms part of the sheer rock face boundary at the western extremity of the Falls Creek valley. The ridgeline, which the aircraft struck, sloped down to the east and formed the northern boundary of the valley.

1.9.2 ZK-EKJ was on a northerly heading, about 015 degrees true, upright and in a wings level attitude when it struck the mountain face perpendicularly, about 60 feet below the ridge crest. There was no evidence of any significant nose low or nose high attitude at impact. Fragmentation of the aircraft indicated that it had hit the ridge at high speed. Most of the wreckage then tumbled some 3000 feet down the near-vertical mountain face, almost directly beneath the impact point. No fire occurred.

[8] Eighths of sky cover.

1.9.3 All major components of the aircraft were accounted for at the site. A helicopter lifted the majority of the wreckage off the mountain to a suitable location for examination. Structural damage was consistent with severe impact with terrain. Each wing had sustained similar severe compression damage from their leading edges rearwards. The flaps were in the up position. No fuel remained in the tanks because of the disruption. Both fuel tank caps were fastened to their respective tanks.

1.9.4 The pre-impact integrity of the control system was established as far as practicable, given the fragmentation that had occurred.

1.9.5 The engine had separated from the fuselage at impact and was found about 100 metres to the west of the main wreckage. The engine accessories separated from the engine either during impact or when the engine tumbled down the mountain face. The engine crankcase and cylinders remained attached but were extensively damaged. Initial inspection of the remaining engine assembly did not disclose any evidence of pre-impact failure, but it was sent to a facility for further examination. The propeller was identified at the impact point but was unable to be recovered.

1.9.6 The aircraft fragmentation prevented any examination of the cockpit instrumentation or the cockpit controls and their settings.

1.9.7 No cargo or baggage was on board the aircraft, except for the normal aircraft equipment and some small personal items belonging to the occupants.

1.10 Medical and pathological information

1.10.1 Post-mortem examination did not reveal anything that would have affected the ability of the pilot to control the aircraft. There was no medical or pathological evidence of pilot incapacitation or impairment. The post-mortem evidence indicated that the pilot was probably operating the controls of the aircraft at the time of impact.

1.10.2 The pilot's most recent medical assessment was on 4 March 1999 and he was issued a Class 1 medical certificate valid until 4 September 1999. Periodic medical surveillance did not indicate any medical problem relevant to the accident.

1.10.3 The pilot was observed to be in good health and spirits and behaving normally in the days preceding the accident flight.

1.11 Survival aspects

1.11.1 The occupants died from multiple injuries sustained during the impact. The injuries were consistent with severe longitudinal deceleration resulting from the aircraft impacting the mountain face in a level attitude, at high speed, and the trauma from a fall of some 3000 feet down a sheer craggy mountain face. The accident was not survivable.

1.11.2 The aircraft was equipped with an emergency locator transmitter (ELT) and first aid kit. The ELT was destroyed during the impact and did not activate.

1.12 Tests and research

1.12.1 A sample of the 100 octane avgas stored in the operator's bulk fuel tank was taken after the accident and tested. All test results were within acceptable specification limits for the fuel.

1.12.2 The Commission's examination of the remaining engine assembly showed no evidence of pre-impact mechanical disruption, or that the engine was incapable of delivering normal power prior to impact.

1.12.3 The engine assembly was sent to an approved engine overhaul facility for disassembly and independent strip examination. The examination showed normal component wear patterns. There were no indications of abnormal wear or any failure that could have caused an engine failure or power loss, prior to impact. There was evidence indicating that the engine was subject to a sudden stoppage while it was rotating at a speed consistent with at least normal cruise power.

1.13 Organisational and management information

1.13.1 The operator had a valid air service certificate and was approved by the CAA to conduct air transport services carrying passengers and goods for hire or reward. The owner was the chief executive and aviation document holder who also performed the roles of operations manager, chief pilot and maintenance controller.

1.13.2 In addition to ZK-EKJ based at Lake Te Anau, the operator had a fleet of two Cessna 207 and one Cessna 172 aircraft based at Queenstown Aerodrome, which were used for scenic flights and other commercial operations. The operator's main operation was at Queenstown where the owner lived.

1.13.3 Most of the operator's pilots were paid by the flying hour. Junior pilots were paid a salary. The chief executive said that ZK-EKJ flew extensively for about 9 months of the year and the pilot received a good income as a result. The operator's other senior pilot at Queenstown did not have any concerns over the remuneration arrangements and said he earned a good income. He said that if a flight was started but could not be completed because of weather or other problems the pilot was still paid for the flight.

1.13.4 The senior pilot said that the various operators at Queenstown did not fly in adverse weather conditions to try and gain a competitive edge over one another. He said the operator's pilots were not encouraged or pressured to fly in poor weather conditions. He said if passengers arrived to take a pre-booked scenic flight and the weather conditions were unsuitable, the flight would be cancelled. He said that the passenger's fares would be refunded if flights were not completed as advertised.

1.13.5 The operator's operations manual included sections on weather and terrain clearance minima. Terrain clearance was to be not less than the minima specified by civil aviation regulations, which included flying no lower than 500 feet above terrain, unless taking off or landing, during emergency situations or being caught in deteriorating weather conditions.

1.13.6 Copies of the operator's operations manual and operations specifications issued to the pilot were located at the operator's Te Anau base office.

1.13.7 In August 1992, an upgraded copy of the operator's training manual was sent to all the operator's pilots. Pilots were required to acknowledge receipt of the manual and read it. The manual contained various sections, including a mountain flying section.

1.13.8 The mountain flying section included discussion on meteorological effects in the mountains, such as wind. The manual stated that the basic rule for safe ridge crossing was to cross a ridge diagonally so an aircraft could turn away should it be carried below the ridge crest by downdraughting air, or experience a loss of power. Ample clearance above the ridge crest was to be maintained.

1.13.9 The mountain flying section also discussed escape routes and stated that the golden rule for flight in the mountains was that aircraft must never be placed in a position that, in the event of engine failure or encountering strong downdraughting air and turbulence, some option was not left open to the pilot to either recover the situation or to at least force land the aircraft. A pilot was to fly at a safe height where possible and avoid crossing all features at right angles so that in the event of trouble the aircraft could be turned away towards lower ground. The section concluded by saying that flight in mountainous areas could be safe and routine only if pilots were fully aware of the significant factors that differentiated it from normal operations, knew how to cope with the differences and flew the aircraft accordingly. The conclusion ended saying that there are no substitutes for knowledge, common sense and experience to which the number of serious accidents in mountainous areas bear witness.

Organisational factors

1.13.10 Following the accident an organisational specialist was employed by the Commission to examine the operator's operation to determine if there were any organisational shortcomings that may have contributed to the accident.

1.13.11 In particular the specialist endeavoured to determine if the chief executive:

- had taken reasonable steps to ensure that all foreseeable risks associated with the floatplane operation were identified and quantified
- had put in place appropriate defences, barriers and safeguards necessary to minimise the likelihood of accidents arising out of the identified risks.

Some of the means by which defences can be applied include:

- risk management policies, standards and controls
- procedures, instructions and supervision
- training, briefings and drills.

1.13.12 The principal observations made by the specialist were that:

- there was no evidence that the operator was routinely carrying out an analysis of the risks associated with the floatplane operation
- there was no evidence that the operator was maintaining effective defences to minimise the likely risks to the floatplane operation
- enforcement of safe flight operation procedures appeared to have been casual or ad hoc
- supervision practices appear to have been non-existent with the floatplane operation
- there did not appear to have been any training of significance
- there was evidence of an anti-CAA culture resulting in an overt policy of minimal compliance with civil aviation legislation
- the reported instance of the pilot flying unsafely was either ignored or dismissed.

1.13.13 The specialist observed that, from an organisational factors perspective, there was strong evidence that the operator had developed a casual and inconsistent approach to the maintenance of safe flight operations. The operator had omitted to identify, or take adequate steps to guard against, the foreseeable operational risks. The operator omitted to take active steps to independently investigate an allegation of the pilot low flying on a charter flight several years before the accident. The operator did not maintain an ongoing programme of active pilot supervision and performance monitoring. With regard to the operator's training manual the chief executive said that the pilots were presented with their own copy of the manual and taken through it over an hour or so. When the specialist asked about pilot refresher training the chief executive indicated that he did not have the capacity to carry out refresher training.

Operator surveillance

1.13.14 The Civil Aviation Act, section 15, gave the Director of Civil Aviation authority to require or carry out safety and security inspections and monitoring. Under the section, the director may (in part) require any person who holds an aviation document, or operates any aircraft, to undergo or carry out such inspections and such monitoring as the director considers necessary in the interests of civil aviation safety and security.

1.13.15 The Civil Aviation Act 1990 established a clear precedence of organisational responsibility. Section 12 of the act required (in part) each participant (operator) who held an aviation document that authorised the provision of a service within the aviation system to:

- establish and follow a management system, if required by rules, that will ensure compliance with the relevant prescribed safety standards and conditions
- provide supervision and training to all employees so as to maintain compliance with relevant prescribed safety standards and conditions, and to promote safety
- provide sufficient resources to ensure compliance with the relevant safety standards and conditions.

1.13.16 The Director of Civil Aviation advised that relevant educational material, such as Vector and Safety Link publications, that addresses the issues of management responsibilities is routinely sent to operators. The educational material also promoted general aviation safety co-ordinator training courses run by the authority.

1.13.17 The operator was subject to annual audits and random spot checks by the CAA. The most recent CAA audit on 9 March 1999 sampled the operator's flight operations and maintenance procedures.

1.13.18 The audit report for the 9 March audit recorded 6 instances (findings) where the operator was not complying with civil aviation legislation (non-compliance). Two instances included some deficiencies that related to flight and duty time record keeping. Two pilots were not recording duty hours correctly, and one of the pilots exceeded 200 hours duty in January and flew for 8 consecutive days in February.

1.13.19 The pilot's flight and duty records only covered the first week in March 1999, but an inspection of his logbook by the auditors found 4 instances between December 1998 and February 1999 where he exceeded the 6-day limitation for consecutive flying, and in one period he had flown for 14 consecutive days. There were no instances found where the pilot had exceeded the flight time limitations.

1.13.20 The other 4 audit findings for the March audit included: the operator's records not recording pilots' route and aerodrome qualifications, pilots not always signing load sheets, no record on the load sheets of the aircraft cg being within limits and no biennial flight review certification in the owner's logbook. The audit report recorded that the operator had taken action to rectify the findings by the time the report was finalised on 20 April 1999, but follow-up action by CAA auditors the following month showed that some findings had not been corrected.

1.13.21 An occurrence summary report, dated July 1998, was attached to the 9 March audit report. The occurrence summary stated that the CAA had received an anonymous complaint that the operator's chief pilot, operations manager and maintenance controller (the owner, chief executive) was rarely on the job and away a lot of the time, leaving the aircrew unsupervised. The operator said that it had not been advised of this report.

1.13.22 In May 1997, the chief executive had left for an extended overseas holiday without first establishing suitable replacements for the other positions he held. Consequently, the operator was not complying with the provisions of the air service certificate. The CAA subsequently advised the operator to stop air transport operations until replacements for the chief pilot, operations manager and maintenance controller positions were made and accepted by the CAA. The pilot was temporarily accepted as acting chief pilot and operations manager responsible for flight operations. Another person was accepted as back-up maintenance controller. The operator's operations and maintenance manuals were amended in April 1998 to record the back-up chief pilot and maintenance controller and the procedures to be adopted when the chief executive was absent.

1.13.23 The CAA audit report for March 1998 did not record any deficiencies and no findings were made against the operator.

1.13.24 The audit report for the CAA December 1996 audit recorded 2 instances where the operator was not following its own documented procedures and 4 instances where the operator was not complying with relevant civil aviation legislation. These findings included: inaccurate aircraft placarding and marking, an aircraft had an overdue annual inspection and no fire extinguisher, and no forms were available for pilots' route and aerodrome qualifications. The report stated that the maintenance issues resulted from a loss of maintenance control. The audit report recorded that the 6 findings had been rectified by the time the audit report was finalised.

1.13.25 The CAA said that the chief executive showed hostility toward its auditors during audits and that he generally displayed aggression towards the CAA. The CAA's files for the operator contained letters that the chief executive had written to the CAA. Some of the letters indicated aggression toward the CAA.

1.13.26 The CAA said that it had not received complaints about the pilot low flying. The auditors were unaware of reports of the pilot low flying and risk taking.

1.13.27 The CAA said that its auditing staff held some concerns about the chief executive's attitude and the operator's safety culture. However, because the audits were essentially safety compliance audits the concerns were not recorded on the audit reports.

1.13.28 The CAA advised that during routine audits a general aviation document holder's compliance with section 12 of the Civil Aviation Act would be determined to some extent by examining the documentation required to support the requirements of the section, and by examining the operator's compliance with civil aviation rules. Document holders were not asked to demonstrate how in practice they proactively fulfilled section 12 requirements. The audits did not specifically examine the culture and organisational functioning of a document holder's organisation.

1.13.29 On 1 September 1999, following a period of development, the CAA introduced a new audit quality index assessment system, which is designed to establish "a level of confidence". The system requires auditors to assess an operator's organisational culture and internal functioning in 10 areas and rate the performance of the organisation in those areas against a standard scale. The system is only applied to routine audits. The areas are those generally covered by an audit, be it a programmed (customised) audit or an audit against a rule part. The stated aim of the system is to provide a level of confidence in an aviation certificate holder's adherence to rules, regulations and documented procedures. The stated objectives of the system are to act as an early warning system, to provide visibility and a check process for the CAA.

1.13.30 The Director of Civil Aviation advised that by 28 February 2003 at the latest, the operator and other similar operators who wished to continue to provide air transport services will have to comply with the new civil aviation rules being introduced. Certain new requirements and procedures need to be established prior to certification under the new rules. The relevant elements of the systems required for re-certification include procedures to ensure:

- that a safety policy is in place, including a procedure for safety occurrence investigations
- that personnel and customer feedback are monitored to identify existing problems or potential causes of safety problems
- that problems or potential problems are corrected and checked to ensure the effectiveness of the correction
- that the organisation's procedures achieve the aims of its safety policy
- the ongoing management effectiveness, including regular reviews and feedback to personnel.

Prior to the issue of a general aviation air operator certificate under the new rules, an operator must satisfy the Director of Civil Aviation that resources will be provided that enable the provision of the operations listed in the applicants exposition (manuals).

1.13.31 The Director of Civil Aviation advised that with the new civil aviation rules in place, future auditing of operators certified under those rules would incorporate the requirements for management systems as a part of normal compliance. The director said that aviation documents have a set life, not longer than 5 years, which ensures that a full re-certification process takes place when the period expires. Re-certification requires a 100 percent compliance assessment. General aviation operators currently being certified under the new rules are generally gaining certificates valid for not more than 2 years, to ensure early re-assessment. The director said the CAA also already uses special-purpose audits as an established tool in cases where doubt arises over an operator's compliance or good safety practices.

2. Analysis

2.1 The accident site was remote; there were no survivors and no eyewitnesses to the accident. The Commission's analysis of the probable cause is based primarily on the conclusions it has been able to draw from the physical evidence (such as its site and wreckage inspection) and its experience of accidents and incidents of this type.

2.2 The accident flight started as a routine round-trip scenic flight in a serviceable and properly maintained aircraft. The pilot was experienced and familiar with the route and weather conditions. He was used to flying across the mountainous terrain of the Fiordland region and he was used to assessing and handling the weather conditions common to the region. His commercial flying experience had been gained mostly by flying ZK-EKJ for the operator from Lake Te Anau during the previous 8 years.

2.3 Given the pilot's extensive experience flying in the Fiordland region he should have been accustomed to handling the varying weather conditions, including updraughting and downdraughting airflows, common in mountainous areas. The pilot should also have been aware of the need to maintain escape options in the event the aircraft encountered a downdraught he wished to escape from or if the aircraft experienced a systems failure.

2.4 The weather conditions at Te Anau were reported to be very good with a clear sky when the aircraft took off on the scenic flight. The aircraft departed and climbed without incident to abeam Billy Burn where the pilot gave the position report advising that he was at 6000 feet and flying north. The pilot's radio transmissions did not suggest that he was experiencing any difficulty with the weather or the aircraft. He did not request any additional weather information from other pilots or from flight information.

2.5 The weather conditions over the route and in the general area of the accident were suitable for scenic flying, despite the strong southerly wind. Throughout the day a number of other aircraft from Queenstown had flown to Milford Sound, and passed near the area of the accident, without difficulty.

2.6 The pilot probably encountered significant lift in smooth updraughting air on the western side of the Earl Mountains as he approached Lake Erskine. Some turbulent eddies and possible downdraughting air may have been present in the immediate area of the accident, being in the lee of the Earl Mountain range by Lake Erskine. However, because the head of the Falls Creek valley immediately before the accident site was steep and narrow, the strong southerly airflow should have passed over the valley and not descended into it, precluding the possibility of any significant large-scale downdraughts before the accident site, or updraughts at the site. There might have been some localised turbulence in the immediate accident area and the possibility of large-scale downdraughts on the north side (the lee) of the mountain ridge struck by the aircraft.

2.7 As ZK-EKJ approached the head of the Falls Creek valley, if the pilot could not maintain altitude because of downdraughts or if the aircraft engine lost power, he had escape options of turning the aircraft to the east and flying down the valley toward lower terrain, or crossing the ridgeline, which sloped down to the east, at a lower altitude. There was no evidence of any evasive manoeuvre, which would have been expected following a power loss or uncontrollable loss of height. This suggests that the pilot was either unaware of or unconcerned about any downdraughts and that a power loss had not occurred. The pilot would have been aware of any rapid height loss if the aircraft had encountered a sudden large-scale downdraught. No one heard the pilot make any distress or urgency radio transmissions.

2.8 There was no evidence found which indicated that a loss of control, an in-flight break-up, a power loss or other aircraft systems failure contributed to the accident. There was some evidence showing that the engine was delivering power at the time of impact. There was no evidence of pilot impairment, fatigue or other personal factors that could have affected the pilot's ability to control the aircraft.

2.9 Examination of the accident site, including the impact signature, wreckage distribution, impact damage, wreckage and fragmentation showed that the aircraft struck the mountain ridge perpendicularly in about straight and level controlled flight at high ground speed, on a northerly heading. There was no evidence suggesting the pilot had attempted to turn away from the ridgeline or had attempted a pull-up manoeuvre to avoid hitting the ridge. There was no obvious nose high or nose low aircraft attitude at impact. There was no evidence showing that the pilot had attempted to cross the ridgeline at an angle to facilitate turning away, a normal mountain flying technique for crossing mountain ridges, which allows an aircraft to be turned away if it cannot reach or maintain a safe ridge crossing height.

2.10 The aircraft probably continued at around 6000 feet amsl after the pilot's position report at Billy Burn and crossed the ridge to the south of the accident site at around the same altitude in updraughting air. The pilot may have expected to continue in updraughting air once the aircraft crossed the ridge and approached the accident site. The meteorological evidence suggests that the aircraft might have encountered localised tailwinds up to 70 knots as it crossed the ridge, thus causing the aircraft to have a high groundspeed. Consequently, the aircraft would have crossed the head of the Falls Creek valley rapidly (around 15 seconds) to the accident site, allowing little opportunity for the aircraft to have climbed or descended during that period to 6340 feet amsl, the approximate elevation of the impact point. The evidence of a high-speed impact in level flight, with attendant aircraft fragmentation, supports the probability of a strong tailwind.

2.11 The meteorological evidence, including reports from other pilots flying in the area at the time, showed that the pilot should have been able to fly ZK-EKJ at a safe height along the route and above any ranges or ridgelines he needed to cross. Although turbulent conditions existed below about 8000 feet amsl in the strong southerly flow there were no reports of extreme meteorological conditions, or any evidence that the aircraft had encountered extreme conditions that caused it to impact the mountain face out of control.

2.12 The pilot did not have to fly the route he elected and alternative routes around, or under, any areas of cloud were available to him. He could have varied his chosen route if the general weather or turbulence made it advisable, if localised areas of cloud had obscured terrain he wished to cross or if cloud had obscured other features of interest.

2.13 There was no evidence of any significant event, such as a large-scale downdraught, out-of-control situation or sudden power loss, which could have affected the aircraft and prevented the pilot taking effective evasive action. The available evidence, conversely, showed that the aircraft was in straight and level controlled flight when it struck terrain. The evidence would suggest, therefore, that the pilot probably crossed the ridgeline to the south of the accident site at low level and then attempted to cross the ridge impacted by ZK-EKJ with minimal clearance. Flying low across mountain ridgelines leaves little margin for errors of judgement and no height buffer in the event the aircraft encounters turbulence or a sudden downdraught.

2.14 Numerous reports made directly to the Commission from some of the pilot's previous passengers, observers and other pilots, showed that he had, from time to time, over several years before the accident engaged in unnecessary low flying. The low flying included flying low across mountain ridgelines, and flying low through mountain passes, during turbulent conditions, with minimal clearance with passengers on scenic flights. Passengers who flew with the pilot 3 weeks before the accident provided the Commission with a video recording of some of their flight. The recording indicated that the aircraft was flying near terrain in noticeable turbulence, significantly lower than 500 feet above terrain and, on one occasion, within an estimated 50 feet above treetops.

2.15 The Commission also viewed the video recording sent to it and the CAA officer. This recording clearly indicated that the pilot flew close to terrain in good weather and significantly lower than 500 feet above terrain in some noticeable turbulence. On 4 occasions the aircraft appeared to cross ridgelines with minimal clearance, probably within 50 feet.

2.16 The accident circumstances suggest that the pilot probably flew in a manner similar to reports of some of his previous low flying. Turbulence or a sudden downdraught encountered by the aircraft, as it was about to cross the ridgeline, may have caused it to impact the ridge. The high inertia of the aircraft due to its fast groundspeed would have afforded the pilot little or no opportunity to react and prevent the impact.

2.17 The pilot may have misjudged the height of the top of the ridgeline ahead of him. Mount Christina, a prominent mountain reaching some 8200 feet amsl, was situated directly ahead of the aircraft and some 4 km north of the accident site. The visual effects of the mountain in the background blending with the foreground, and some recent snow in the area, or shadow, might have combined to create an optical illusion obscuring the top of the ridgeline. The pilot's experience in mountain flying and his familiarity of the route and its features, however, makes this an unlikely occurrence. The sun, positioned some 60 degrees to the left of the aircraft heading and with an elevation of around 22 degrees, would not have affected the pilot's forward vision. The Commission's experience has been that pilots can be distracted pointing out some features of interest to passengers. This is a possible explanation for the pilot not being aware of how quickly the aircraft was approaching terrain.

2.18 The pilot did not have to fly the passengers to another location by a certain time. Consequently, he was not under pressure to meet any schedule and he should not have been pressured to complete the flight in poor weather. In the prevailing conditions the pilot should have been able to maintain a safe height above terrain in accordance with the operator's operations manual and civil aviation requirements. Had the pilot maintained a suitable minimum height above terrain and endeavoured to cross the ridgeline at an angle with an adequate height buffer the accident could have been avoided.

Human factors

2.19 Reports made directly to the Commission indicate that the pilot had engaged in unnecessary low flying on a number of occasions over several years before the accident. His low flying extended to commercial operations with passengers, in particular during scenic flights. By low flying the pilot engaged in unsafe acts, violated civil aviation rules for low flying and took unnecessary risks.

2.20 A flight examiner who carried out the pilot's last 3 annual competency checks had detected a tendency for the pilot to fly low and close to terrain unnecessarily, during the precautionary landing phase of the checks. The examiner discussed the tendency and low flying in general with the pilot following the checks. He did not discuss the pilot's tendency with the operator because the pilot was an experienced senior pilot and the examiner believed that the chief executive was overseas for extended periods when the checks were completed.

2.21 Reports made directly to the Commission indicate that the pilot did not always follow the operator's operations manual provisions regarding low flying or apply the documented principles for safe mountain flying contained in the training manual.

2.22 Human factors research, including the Commission's experience, shows that pilots involved in routine flights, such as scenic flights, can be motivated to add interest to the flights by taking some unnecessary risks. Such pilots may have wanted to add extra interest to their flights or believed the passengers would enjoy the thrill of low flying. This is particularly so when a pilot's scenic flights cover the same or similar routes during good weather at higher altitudes. Similar factors could have had an influence in relation to this particular accident.

2.23 The pilot's reported practices of low flying from time to time and not always following documented safety procedures are regarded in human factors literature as latent failures[9]. These latent failures eventually combined with some local triggering events to bring about the accident. The local triggering events could have included the turbulent conditions in the area of the accident, the speed of the aircraft, visual illusions that affected the pilot's judgement, or distraction. The pilot probably breached the immediate or last defences against the accident by not maintaining a sufficient height margin above the ridge and by not applying a correct ridge crossing technique.

2.24 Although the aircraft was probably in controlled flight when it struck terrain, general aviation, single-pilot visual daytime scenic flights, do not fall into the current generally accepted international classification for controlled flight into terrain (CFIT) accidents. CFIT studies typically relate to multi-crew, air-transport aircraft operating under instrument flight procedures. Nevertheless, some parallel human factors issues identified in studies relating to CFIT accidents, such as crew performance and system shortcomings, have been identified in this accident and addressed in the report.

The operator

2.25 The ultimate accountability for the establishment and maintenance of a safe working environment rests with the senior executives of an organisation. The operator's chief executive, who was also the operations manager and chief pilot, had the greatest capacity to influence the organisational and safety culture of Waterwings – that is the beliefs, values, norms and assumptions that the organisation held about itself. The chief executive was directly responsible for supervision of the pilot and for ensuring that appropriate flying and safety standards were maintained.

2.26 In commercial flying operations that involve an element of risk the senior managers must take reasonable steps to ensure that all foreseeable risks associated with the operation are identified and quantified, and that appropriate defences, barriers and safeguards are put in place and maintained to minimise the likelihood of accidents. The accountability of senior management extends to active monitoring of the functioning, and the ongoing maintenance, of those defences.

2.27 During the investigation the chief executive was not able to provide evidence that he had taken responsibility for maintaining a coherent safety culture within his organisation, or that he had adequate measures in place to ensure the ongoing safe operation of ZK-EKJ from Te Anau. He had not routinely carried out a risk analysis, maintained effective defences or taken reasonable steps necessary to ensure that the foreseeable risks associated with the operation had been identified, quantified and adequately guarded against. The organisational specialist regarded the chief executive's responses to questions asked about identifiable risks and appropriate defences as naïve. These answers and the observations made indicated that the operator had a lack of appreciation for civil aviation rules. The chief executive did not supervise the pilot or have an established system for pilot supervision, control, and performance or safety compliance monitoring.

2.28 The Commission has over the years gained its own experience of organisational factors issues that may contribute to incidents or accidents. Through this experience, including other supporting information gathered during this investigation, the Commission has reviewed the independent organisational specialist's report and agrees with the conclusions drawn by the specialist.

[9] Failures that may lie dormant for long periods, sometimes many years, before they combine with active failures and local triggering events to bring about an incident or accident.

2.29 Letters the chief executive sent to the CAA, and discussion with CAA staff, indicated that the chief executive had developed a hostile attitude toward the CAA and some of its employees. This was strongly evident during the investigation where the chief executive expressed disdain for the CAA and exhibited an indifferent attitude to civil aviation rules and regulations. Consequently, similar attitudes and values may have been conveyed to those staff flying under his direction.

2.30 The last CAA audit of the operator was completed in the month before the accident. The audit report identified 6 instances where the operator was not complying with civil aviation legislation. These instances included the operator not maintaining appropriate records for pilot flight and duty times, pilots exceeding their duty hours and the pilot exceeding the 6-day limitation for consecutive flying. Although the operator assured the CAA auditors at the completion of the audit, and during the auditors' follow-up action, that the audit findings were being rectified, the operator was unable to provide flight and duty time records for the pilot after the accident, except for the first week in March. In addition, examination of the pilot's logbook and other records indicated that he might have exceeded the 6-day limitation for consecutive flying after the audit up until the time of accident.

2.31 In 1997, the operator was not complying with the requirements of its air service certificate, when the chief executive was on an extended overseas holiday and had not made arrangements for replacements for the other management positions he held. Consequently, the CAA advised the operator to stop air transport operations until the situation was rectified. Although procedures were established in April 1998 to correct the supervision problems, the CAA received an anonymous complaint in July 1998 that the chief executive was often away leaving the pilots unsupervised.

2.32 The accident occurred because the pilot probably performed an unsafe act of unnecessary low flying. However, the operator probably contributed to the accident, or increased the likelihood of the unsafe act occurring, by not establishing and maintaining an ongoing programme of active pilot supervision and control, by not monitoring the pilot's performance and compliance with relevant safety requirements and by not independently investigating an allegation of the pilot low flying several years before the accident. The operator, by not actively supervising, controlling and monitoring the pilot's performance and compliance with safety requirements constituted a latent failure within the context of the organisational factors accident prevention framework. The inadequate procedures showed that there were organisational shortcomings with the operator.

2.33 Furthermore, the accident circumstances, the information gathered during the investigation, the recorded instances of pilots being unsupervised, and some findings recorded on 2 of the last 3 CAA audit reports, indicate that the chief executive had not exercised his responsibilities as the operator's aviation document holder, in accordance with the requirements of section 12 of the Civil Aviation Act.

2.34 This accident demonstrates the operator's fundamental lack of awareness of the significance of section 12 of the Civil Aviation Act, in that the onus for establishing and maintaining a safe operation lay with the operator and not the CAA.

The safety authority

2.35 The CAA carried out regular safety audits on the operator. The audits did not specifically examine the operator's culture or organisational functioning. Under the audit model the CAA assessed the document holder's (the chief executive) compliance with section 12 of the Civil Aviation Act, to some extent, by auditing the operator to ensure that it followed its own documented procedures and the rules prescribed by the CAA. Compliance was checked against the relevant rules, rather than against the higher-level requirements of section 12 of the act. The chief executive was, therefore, not asked to demonstrate how he complied in practice with section 12 of the act.

2.36 The information gathered during the investigation suggests that the operator considered that the onus was on the CAA to set the standards and for it to then prove that the operator was not complying with those standards. This outcome is contrary to the intent of the act as it had the effect of the operator casting the CAA in the role of an adversary. The operator's sentiments emphasised minimising rather than maximising compliance with the act.

2.37 The CAA's operator re-certification programme and its audit quality index system, under development at the time of the accident and introduced some months later, could help to address some of the organisational concerns and auditing issues identified during this investigation. However, in order to get operators to achieve the intent of the Civil Aviation Act the CAA may need to enhance its audit model so that each air transport aviation document holder is required to show, firstly: that a management system is being maintained which ensures that an operator's employees comply with the relevant prescribed safety standards and conditions, that the employees receive effective supervision, monitoring and training and that the necessary resources are provided and, secondly: how the management system is being followed, in practice. The adoption of such an approach could have helped the chief executive to take responsibility to meet his obligations as the owner and operator of an air transport operation.

2.38 Section 15 of the Civil Aviation Act empowers the Director of Civil Aviation to require or carry out such inspections and monitoring as the director considers necessary in the interests of civil aviation safety.

2.39 The concerns the CAA had about the operator, the chief executive's attitude toward the CAA and its requirements, the instances of pilots being unsupervised, and some audit findings, including the finding regarding a loss of maintenance control, were warning signals that there may have been organisational shortcomings with the operator. The warning signals might have justified a deeper systemic audit of the operator.

2.40 If the CAA auditing process had periodically, or with reasonable justification, systemically examined the operator's culture and functioning, and required the chief executive to show how he was meeting his responsibilities under section 12 of the Civil Aviation Act, it is probable that the CAA could have identified the operator's organisational shortcomings and ensured the operator corrected them.

3. Findings

Findings and safety recommendations are listed in order of development and not in order of priority.

3.1 The pilot was appropriately licensed, authorised and fit to conduct the flight.

3.2 The pilot was experienced on scenic and other flying operations over and around the Fiordland region.

3.3 The aircraft was approved for the type of operation being conducted.

3.4 The aircraft had a valid Certificate of Airworthiness and its records indicated that it had been maintained appropriately, was airworthy and operating within the required maintenance period.

3.5 The weight and the balance of the aircraft were within limits.

3.6 There was no evidence that an aircraft systems failure or a loss of control contributed to the accident.

3.7 There was no evidence that the pilot had attempted any evasive manoeuvre to prevent the aircraft from striking the ridge.

3.8 The evidence indicates that the aircraft was in controlled straight and level flight at the time of impact.

3.9 The weather was suitable for scenic flying.

3.10 The accident circumstances indicate that the accident occurred because the pilot probably carried out an unsafe act of low flying and attempted to fly across the ridge too close to its crest.

3.11 Local environmental factors, the speed of the aircraft or pilot distraction may have contributed to the accident.

3.12 The accident probably would not have occurred if the pilot had maintained a suitable height margin and used a proper ridge crossing technique.

3.13 The pilot on occasion had carried out unnecessary low flying and risk taking with passengers on commercial operations.

3.14 There was no obvious mechanism for passengers to report unsafe acts to the CAA.

The operator

3.15 The operator had not established a proper safety culture.

3.16 The operator had not carried out an ongoing analysis of the foreseeable risks of the operation and had not maintained effective defences to counter the risks.

3.17 The operator had not established an ongoing programme for active pilot supervision, control and performance and compliance monitoring.

3.18 The chief executive, as the operator's aviation document holder, seemed unaware of his responsibilities under section 12 of the Civil Aviation Act.

3.19 The chief executive did not discharge his responsibilities properly and, therefore, probably contributed to the accident.

The safety authority

3.20 Had the CAA auditing process systemically examined the operator's organisational functioning and culture, and required the chief executive to show how he was meeting his responsibilities, the organisational and safety culture shortcomings that probably contributed to the accident might have been identified and rectified.

Summary of factors relating to the accident

3.21 The following failures and possible environmental factors were identified as contributing to the accident:

Active failure

- the pilot's probable unsafe act

Possible environmental factors

- the wind conditions
- the speed of the aircraft
- visual illusions
- pilot distraction

Latent failures

- the pilot's unnecessary risk taking
- the pilot not always following documented safety procedures
- the operator not actively supervising the pilot or monitoring his performance and compliance with safety requirements
- the chief executive dismissing a prior allegation of the pilot low flying
- the chief executive's indifferent attitude to civil aviation safety rules and regulations
- the chief executive not discharging his responsibilities in accordance with the requirements of the Civil Aviation Act
- the operator's organisational shortcomings
- the absence of organisational factors auditing by the CAA.

4. Safety Recommendations

4.1 On 19 October 1999 the Commission recommended to the chief executive of Waterwings Airways (Te Anau) Limited that he:

4.1.1 Implement, without delay, effective pilot supervision, training, performance and safety compliance monitoring of the day-to-day flight operations (047/99); and

4.1.2 Develop pro-active monitoring strategies such as occasionally using passengers to carry out spot, passive checks to report on the conduct of flights. (048/99)

4.2 On 27 October 1999 the chief executive of Waterwings Airways (Te Anau) Limited responded as follows (in part):

4.2.1 Safety recommendation 047/99. Our operation is at present under the old regulations and is monitored constantly by the CAA. We are an approved training organisation. For the last eight years we have been trying to gain compliance under the new rule system. As you will well understand this has been a very frustrating process as the goal posts kept getting shifted. We are, this week, finally, able to submit a formal application that we believe will document how our operations have been run to date.

The main difference once the approval is received, I think, will be in the documenting of systems already in place that we implemented, updated and improved upon in terms of our specific operations.

4.2.2 Safety recommendation 048/99. One system that we are proud of, and have had in force for many years, is our monitoring of pilot, and indeed all staff, performance. We see this as vital to a people oriented operation.

Our pilots have a business type card that they have to give to every passenger carried by them. As you can see [from an enclosed example] the pilot is not only identified by name but also by his photograph, the company name and address and contact telephone number are clear and even the aircraft in [the pilot's] case is depicted. To my knowledge we are the only operator who do this.

In over thirty years of flying you can imagine I have flown every relative of mine, many hundreds of friends, and indeed since 1982 Waterwings has had a stated policy of all locals fly free.

Our pilots continually fly my friends, acquaintances, relations, many local people, and overseas visitors to my home. Whenever this happens I always ask, "What was the trip like?" and "What was the pilot like?"

We have very good procedure monitoring systems in place such as regular pilots safety meetings, and those set out above. These systems are currently being documented. The CAA in due course ought to be able to provide these to you once the approval has been given.

Our new, soon to be released (hopefully) exposition very fully sets out the systems by which we will document and implement these. For instance every time a friend or relation flies with a pilot their reactions to the above questions will be noted on the individual pilot files that we have always kept.

My company is a very small operation and we have always been a very close-knit unit, doing what we do together and always striving to be better.

4.2.3 We believe we have always adopted these recommendations and acted in accordance with them.

As stated, we are awaiting approval by the CAA of our documentation, which will be implemented as soon as CAA has appraised it.

In addition to the above I would like to point out that the Milford Sound and Queenstown Users Liaison Group (monitored by the CAA at every meeting) have a safety officer system compiled of one pilot from every company (who cannot be management staff), who form a separate committee to observe and note any incidents or safety issues. These if serious are brought to the notice of operators immediately or if of a less serious nature are promulgated at regular meetings.

4.3 On 2 November 1999 the Commission recommended to the Director of Civil Aviation that he:

4.3.1 Examine the CAA auditing process and determine if it needs to be enhanced by periodically, or with reasonable justification, requiring general aviation document holders involved in air transport operations to demonstrate, to the auditors, how in practice they follow, and maintain, an appropriate safety management system (049/99); and

4.3.2 Consider requiring early re-certification under appropriate civil aviation rules (which embody the management system approach to safety) of those general aviation air transport operators, which, in his assessment, appear to be at risk because of a poor safety culture, poor attitudes, or poor systems or practices, and ensures that there are no undue delays in the certification of other operators (077/99); and

4.3.3 Emphasise to all senior managers of air transport operations the need for them to be aware of their responsibilities, including:

- identifying the foreseeable risks to their operations
- putting in place suitable defences to minimise those risks, which might go beyond what the generic rules require
- maintaining those defences (050/99); and

4.3.4 Recommend to all air transport operators that they develop pro-active monitoring strategies such as occasionally using passengers to carry out spot, passive checks to report on the conduct of flights (051/99); and

4.3.5 Initiate rule making to require information to be available and visible to passengers on air transport flights, such as on cards in seat pockets, that outlines the operating standards and how passengers can contact the operator or the CAA if they have any concerns about safety. (056/99)

4.4 On 19 November 1999 the Director of Civil Aviation responded as follows:

4.4.1	I will adopt [safety recommendation 049/99] with the note that the CAA constantly reviews the adequacy of all its processes. In this sphere of activities the CAA has already initiated changes to the scope and content of its audit process to cover the more integrated and quality system features that will be required of operators when they become certified under Part 119. To that extent, the actions to implement the recommendation have already been taken.
4.4.2	I adopt [safety recommendation 077/99]. Note that certification under Part 119's new rules is currently considered by the CAA as a condition for re-entry when holders of transitional certificates are subject to exit action, either suspension or imposition of conditions, under Section 17 of the Act.
4.4.3	I adopt [safety recommendation 050/99] and will implement it by writing to the Chief Executive Officers of all air transport operators before the end of the year.
4.4.4	I adopt [safety recommendation 051/99] and will address the requirement of the recommendation in the same correspondence as mentioned above for 050/99.
4.4.5	I adopt [safety recommendation 056/99]. Due to the need to consider other rule-writing priorities and the need for extensive consultation, I am unable to specify a timeframe to complete the task.

Approved for publication 1 December 1999

Hon. W P Jeffries
Chief Commissioner