



**Report 98-009**

**Cessna 177B Cardinal**

**ZK-DKL**

**impact with mountainous terrain**

**near Mount Aurora, 11 km north-east of Mount Cook**

**14 September 1998**

### **Abstract**

On Monday 14 September 1998 at about 1152 hours, ZK-DKL, a Cessna 177B Cardinal on an air transport scenic flight across the Mount Cook region struck a snow-covered mountain face 11 km north-east of Mount Cook. The pilot and two passengers died as a result of the impact.

The aircraft probably encountered a strong laminar downdraught before entering a thin cloud layer before impact. Although ample escape options were available to the pilot to turn ZK-DKL away from the rising terrain and cloud ahead, he did not make a timely decision to do so. Why the pilot did not make a timely turn away could not be explained.

The pilot might have persevered for too long expecting to encounter an updraught, or some distraction could have diverted the pilot's attention from the safe operation of the aircraft, which prevented him from recognising that ZK-DKL was descending quickly toward the cloud layer and mountainous terrain until shortly before the aircraft entered cloud. Alternatively, the pilot might have been unaware of or misjudged the intensity of any downdraught ZK-DKL encountered.

The pilot may have believed he had crossed the Main Divide to the west; consequently once ZK-DKL entered the cloud he most likely elected to go on in order to break out of the cloud, as he knew the conditions were clear ahead on the west coast.

The cause of the accident was not established.

No safety deficiencies were identified requiring recommendations.



**Cessna 177B Cardinal  
ZK-DKL**

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## Glossary of terms

aerology	the study of the atmosphere, especially away from ground level
empennage	the tail unit of an aircraft including the horizontal tailplane, fin and rudder
entropy	a measure of the availability of a system's thermal energy for conversion into mechanical work
föhn gap	the gap between the mountain ranges and the leading edge of the associated upper wave cloud (lenticular) on the leeward side of the ranges in mountain wave conditions
föhn wind	a descending warm dry wind which blows to the lee of a mountain range
front	the leading edge of an advancing mass of cold or warm air
hectopascal	a unit used for meteorological atmospheric pressure measurements
pre-frontal	weather conditions preceding the passage of a front
rotor	a large closed, probably violent, eddy with a horizontal axis which is produced in the lee of mountains or hills that are crossed by a stable airstream, usually near the crest of a mountain wave
mountain waves (also called <i>lee waves</i> or <i>standing waves</i> )	a system of stationary air waves (standing 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
synoptic	a general view of weather conditions
tephigram	aerological diagram in which the principal rectangular axes are temperature (T) and entropy ( $\phi$ ); hence T $\phi$ -gram
transceiver	a combined radio transmitter and receiver

## List of abbreviations

amsl	above mean seal level
AOD	aft of datum
CAA	Civil Aviation Authority
CAR	Civil Aviation Rules
cg	centre of gravity
E	east
ELT	emergency location transmitter
fpm	feet per minute
front	the leading edge of an advancing mass of cold or warm air
GPS	Global Positioning System
hPa	hectopascals
IFR	instrument flight rules
kg	kilograms
km	kilometres
NTSB	National Transportation Safety Board
NZST	New Zealand Standard Time (UTC + 12 hours)
OMM	Operations Maintenance Manual
S	south
UTC	Coordinated Universal Time
VFR	visual flight rules
VHF	very high frequency

# Transport Accident Investigation Commission

## Aviation Accident Report 98-009

<b>Aircraft type, serial number and registration:</b>	Cessna 177B, 177-01944, ZK-DKL
<b>Number and type of engines:</b>	One Lycoming 0-360-A1F6D
<b>Year of manufacture:</b>	1973
<b>Date and time:</b>	14 September 1998, 1152 hours <sup>1</sup>
<b>Location:</b>	11 km north-east of Mount Cook Latitude: 43° 31.4' S Longitude: 170° 14' E
<b>Type of flight:</b>	Air transport, scenic
<b>Persons on board:</b>	Crew: 1 Passengers: 2
<b>Injuries:</b>	Crew: 1 fatal Passengers: 2 fatal
<b>Nature of damage:</b>	Aircraft destroyed
<b>Pilot's licence:</b>	Commercial Pilot Licence (Aeroplane)
<b>Pilot's age:</b>	29
<b>Pilot's total flying experience:</b>	1306 hours 80 hours on type
<b>Investigator-in-charge:</b>	K A Mathews

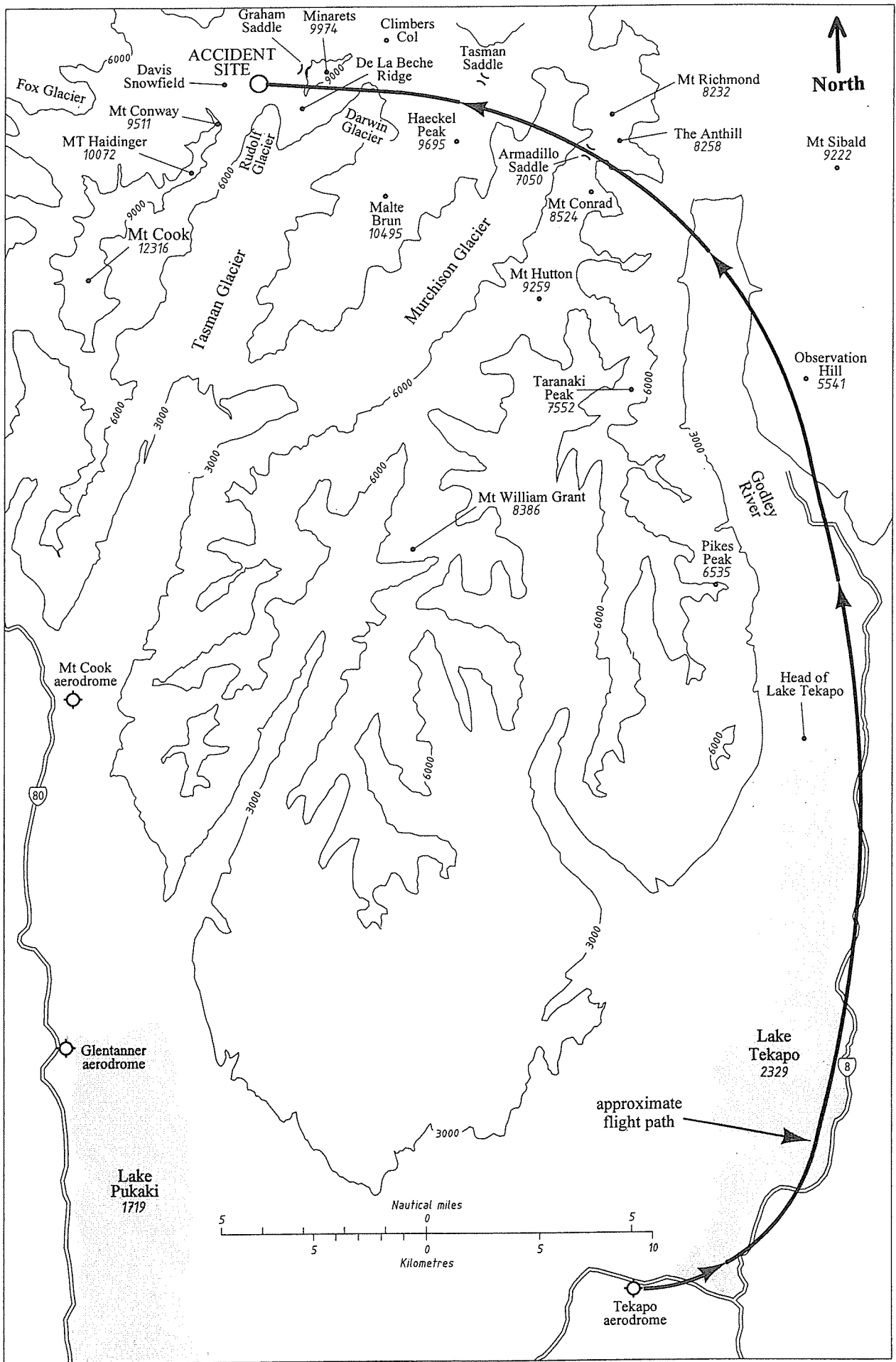
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<sup>1</sup> Times in this report are NZST (UTC plus 12 hours)

# 1. Factual Information

## 1.1 History of the flight

- 1.1.1 On Monday 14 September 1998 at about 1114 hours, ZK-DKL, a Cessna 177B Cardinal operated by Air Safaris and Services (NZ) Limited (the operator), departed from Tekapo Aerodrome on a standard visual flight rules (VFR) scenic flight over the Mount Cook region. The pilot and two female Japanese tourists were on board the aircraft.
- 1.1.2 The flight was planned to follow the standard route over the head of Lake Tekapo, the Godley River valley, Armadillo Saddle, Tasman Saddle, across the Main Divide near Climbers Col or Graham Saddle, circle around the western side of Mount Cook to Tasman Glacier, orbit and descend to land at Glentanner Aerodrome. (See figure 1.)
- 1.1.3 The complete flight was to take about 55 minutes and depended upon suitable weather conditions in the area. As the flight progressed, the pilot could shorten the route or alter it if the Main Divide could not be crossed, or if unsuitable weather prevailed generally in the Mount Cook region.
- 1.1.4 Earlier that morning the pilot of ZK-DKL (the pilot) flew a Cessna 207 aircraft from Tekapo Aerodrome to Glentanner Aerodrome and completed a return scenic flight from Glentanner over the Mount Cook region uneventfully, including over the area of the accident. The scenic flight left from Glentanner Aerodrome at about 0910 hours. The pilot returned to Tekapo in the Cessna 207 at about 1020 hours. The flight from Glentanner to Tekapo took some nine minutes.
- 1.1.5 Two groups of passengers were waiting at Tekapo Aerodrome for a scenic flight. A change of numbers in one group required the pilot to switch aircraft to ZK-DKL. The aircraft had been prepared for flight earlier that morning by another pilot, who had fuelled it with 35 litres of 100 octane avgas the previous day. The total quantity of fuel on board was 100 litres, the standard fuel load, which gave a flight endurance of some 2.2 hours. One litre of oil was added to the engine. The pilot said he was comfortable with the change of aircraft when asked by the other pilot about the change.
- 1.1.6 The pilot was observed to be his usual self and in good spirits the morning before flying ZK-DKL.
- 1.1.7 The pilot briefed the two passengers on relevant safety issues and checked the aircraft. He advised the passengers to keep their seatbelts fastened and warned them that the flight conditions might be bumpy. One passenger was seated in the front right seat next to the pilot, and the other passenger behind the pilot's seat. The rear seat passenger operated a video camera for most of the flight, and both passengers used a 35 mm still camera to take photographs.
- 1.1.8 Five aircraft including ZK-DKL departed from Tekapo Aerodrome within about twenty-five minutes of one another with the different groups of passengers. All five aircraft were to fly a similar route and to land at Glentanner Aerodrome. A Nomad aircraft left first at about 1110 hours, followed by ZK-DKL about four minutes later. A Cessna 207 followed ZK-DKL some three minutes later, which was followed in turn by a second Nomad about eight minutes after that. The last aircraft, also a Nomad, took-off at about 1135 hours. A flight plan for each flight was lodged with Christchurch Flight Information Service.



**Figure 1**  
**Approximate flight path of ZK-DKL**



- 1.1.9 The video recording recovered from the camera on board ZK-DKL showed that the aircraft departed and proceeded normally to near Darwin Glacier where the recording stopped. The flight followed the planned route and was uneventful to Darwin Glacier where the pilot gave a position report, advising that he was at Darwin Corner at 11 100 feet and proceeding west towards Graham Saddle. Shortly before the recording stopped the pilot's voice was captured on the recording advising the passengers that Tasman Glacier was below on the right. The pilot's voice sounded normal
- 1.1.10 About four minutes earlier, the pilot had asked the preceding Nomad pilot what the weather conditions were like to the west of the Main Divide. The Nomad pilot had crossed the Main Divide at around 10 500 feet above mean sea level (amsl) and he reported that the conditions were clear from over the Fox Glacier area to the south and around the western side of Mount Cook. He suggested to the pilot that it was suitable to proceed in that direction via Graham Saddle, rather than the usual Climbers Col area further to the north, as cloud had obscured the Col and the Northern Franz Josef Névé. He said he advised the pilot to keep plenty of height on when approaching Graham Saddle as he had experienced downdraughting air on the eastern side of the Main Divide.
- 1.1.11 The preceding Nomad pilot said that a helicopter had crossed the Main Divide, traversing from west to east, at the southern end of Graham Saddle ahead of his aircraft. The Nomad pilot estimated the height of the helicopter to be about 9200 feet amsl, and he had a brief exchange with the helicopter pilot regarding their respective positions. The Nomad pilot wondered why the helicopter was at a low height crossing the Main Divide, and believed it would have encountered turbulent conditions at that level on the lee side of the ranges.
- 1.1.12 After the pilot had given his position report at Darwin Corner, the pilot of the Cessna 207 following ZK-DKL said he asked the pilot if he intended to cross the Main Divide to the west. The pilot advised that was his intention.
- 1.1.13 When the pilot gave his position report at Darwin Corner the pilot in the faster Cessna 207 was at an altitude of about 11 500 feet near Tasman Saddle. The pilot of the Cessna 207 was trying to see ZK-DKL as he knew that he should overtake the slower aircraft at about Graham Saddle. Consequently he took advantage of updraughting air to gain altitude quickly to establish a safe height above ZK-DKL, and to obtain a good height buffer above the Main Divide in order to cross it safely.
- 1.1.14 The Cessna 207 pilot levelled his aircraft at about 12 500 feet and saw ZK-DKL at least 2000 feet below him on his left, above the Main Divide. He said that ZK-DKL was proceeding normally, flying parallel with the Cessna 207 on a westerly heading and flying above a localised tongue of cloud which had pushed over the Main Divide into the head of Rudolf Glacier. In that position ZK-DKL would have flown in the lee of the Minarets. He advised the pilot on his very high frequency (VHF) transceiver that he could see ZK-DKL and that their aircraft were well clear of each other. The pilot did not respond. Being satisfied that his aircraft was well clear of ZK-DKL, the Cessna 207 pilot continued and crossed the Main Divide to the west. He was not unduly concerned about the progress of ZK-DKL, although he thought it should have been somewhat higher to give it more of a height buffer above the Main Divide.
- 1.1.15 Some ten seconds later the following Nomad pilot called the pilot on his VHF transceiver and asked him what his position was, as he had not heard him give the usual position report at Graham Saddle. The pilot responded, "Standby Mike". The response was the last communication from the pilot. The pilots in the other aircraft also heard the response. One pilot thought there may have been an edge to the pilot's voice, but the others did not detect anything unusual.

- 1.1.16 The pilots of the Cessna 207 and second Nomad aircraft became concerned when they had not heard anything further from the pilot, and attempted to establish VHF transceiver contact with him on area and company frequencies, without success. The operator's chief pilot was flying the third Nomad aircraft and was near the head of Lake Tekapo when contact was lost with the pilot. The chief pilot, who had been listening to the radio communications, asked the second Nomad pilot to confirm that he had tried to contact the pilot on both area and company frequencies. The chief pilot then asked him to listen on the emergency location transmitter (ELT) frequency of 121.5 megahertz. The second Nomad was then over Fox Glacier and its radio equipment did not receive any ELT signals.
- 1.1.17 The operator's Tekapo Aerodrome staff member had been listening to the radio communications and asked the chief pilot if she should activate the emergency plan. He told her not to activate it as checks still needed to be made to establish if the pilot had diverted to another aerodrome. About seven minutes later when the chief pilot was approaching the head of the Murchison Glacier, and he had not received any confirmation on the pilot's whereabouts, he asked the Tekapo Aerodrome staff member to put the "Aircraft Down on Grand Traverse Emergency Plan" into action. A short time later near Tasman Saddle the chief pilot, who had selected the ELT frequency on one transceiver, heard a weak ELT signal. He immediately told the staff member that he had received an ELT signal.
- 1.1.18 The chief pilot's Nomad was equipped with an ELT direction finder and a Global Positioning System (GPS). He used the direction finder to establish that the source of the ELT signal was near Graham Saddle. A uniform layer of cloud covered the western slopes of Graham Saddle and a tongue of cloud had spilled over the Main Divide to the east of Graham Saddle, into the upper Rudolf Glacier area. As a consequence the chief pilot was not able to visually identify the source of the ELT signal.
- 1.1.19 The chief pilot recorded the GPS co-ordinates and geographic location of the most likely position for the source of the ELT signal. He relayed this information to the pilot of the first Nomad who, by then, had landed at Glentanner Aerodrome. The pilot of the first Nomad off-loaded his passengers and flew to the Graham Saddle area to hold station over the suspected location of ZK-DKL. In the meantime the chief pilot, who had a full load of passengers on board his aircraft, remained in the area until the first Nomad arrived.
- 1.1.20 Reports from pilots indicated that there was a strong north to north-westerly wind over the Main Divide which created updraughts and downdraughts. The chief pilot reported that the flying conditions were smooth despite the strong wind, and that his aircraft had no difficulty maintaining sufficient altitude in the area, including on the lee side of the Main Divide. He descended the Nomad on the lee side of the Main Divide to about 9500 feet amsl, and established that the height of the tops of the uniform cloud layer to the west of the Main Divide, including the tongue of cloud to the east, was similar. The Nomad had no difficulty climbing back to a higher altitude.
- 1.1.21 When the first Nomad arrived in the area the chief pilot flew to Glentanner Aerodrome. The pilot of the first Nomad reported that, despite the deteriorating weather, his aircraft had no difficulty maintaining a safe altitude in the area of Graham Saddle. He said he encountered some patches of light to moderate turbulence at 9000 feet amsl near De La Beche Ridge, in the lee of Graham Saddle.

- 1.1.22 A rescue helicopter took-off from Glentanner Aerodrome at about 1230 hours for Graham Saddle, shortly after the first Nomad took up station over the area. The helicopter arrived in the area about ten minutes later and picked up a strong ELT signal. The helicopter pilot started a search but the weather conditions prevented him from locating ZK-DKL, the suspected source of the ELT signal. He said the cloud base in the Rudolf Glacier valley was about 7500 feet amsl with moderate to severe turbulence and that good surface definition was lost above about 6000 feet amsl. He reported that the weather conditions deteriorated rapidly while he was in the area. The deterioration included an increase in the wind strength and a continual lowering of the cloud base.
- 1.1.23 The rescue helicopter returned to Glentanner Aerodrome to refuel. A second rescue helicopter attempted to fly to the area to continue the search, but it turned back and returned to Glentanner because of poor weather conditions.
- 1.1.24 The next day further attempts were made to locate ZK-DKL, but severe weather conditions in the area prevented the rescue helicopters from carrying out an effective search, positioning ground search parties or finding the aircraft.
- 1.1.25 At around 0930 hours on 16 September 1998 the weather cleared sufficiently for the rescue helicopters to subsequently locate the wreckage of ZK-DKL. None of the occupants had survived.
- 1.1.26 The accident occurred at about 1152 hours on 14 September 1998. The accident site was on a snow-covered mountain face, about 0.5 km on the eastern side of the Main Divide near Mount Aurora, 2 km southwest of Graham Saddle, at an elevation of around 8500 feet amsl, in Mount Cook National Park. Latitude: 43° 31.4' S, Longitude: 170° 14' E.

## **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 Other damage**

- 1.4.1 Nil.

## **1.5 Fire**

- 1.5.1 No fire occurred.

## **1.6 Pilot information**

- 1.6.1 The pilot of ZK-DKL was a male aged 29 years. He held a Commercial Pilot Licence (Aeroplane) and an instrument rating. He held a Class 1 medical certificate valid until 17 May 1999 with no restrictions. He held various aircraft type ratings including a rating for the Cessna 177.
- 1.6.2 The pilot started his flying training in August 1993 at Wanaka and successfully completed his Commercial Pilot Licence training at Nelson in December 1994. He gained a multi-engine instrument rating at Ardmore in April 1995, but had not completed an instrument competency check since then. His total flying experience amounted to 1306 hours. He had flown 80 hours in the Cessna 177 aircraft type. Of these hours 76 had been in the operator's Cessna 177.

- 1.6.3 The pilot started full-time employment as a pilot with the operator during September 1996 and was paid a salary. During the previous year he worked full-time for a different operator at Wanaka flying a Cessna 180 on skydiving sorties, and part-time for another operator on freight flying operations.
- 1.6.4 During his time with the operator the pilot primarily carried out scenic flights across the Mount Cook region, similar to that planned during the accident flight. When he started working for the operator he completed a type rating on the Cessna 207, a biennial flight review, local route and aerodrome qualifications and a maintenance of pilot skills check.
- 1.6.5 As part of his introduction to scenic flying in the Mount Cook region, the pilot went as an observer on a number of flights with the operator's senior pilots. He was subsequently given an all-up weight check in the Cessna 207 and a number of route checks over the area with the operator's check pilots. Following a successful formal route check by the operator's chief pilot, the pilot was authorised to carry out limited air transport operations in October 1996. Further route and proficiency checks followed several weeks later and again in December 1996.
- 1.6.6 The pilot's operations were supervised by the operator's senior pilots, in particular the chief pilot and the operations managing director, as he gradually gained experience with heavier loads and in less than ideal weather conditions. Over the following twelve months the pilot's flying was supervised constantly as he progressed towards becoming fully conversant with the area, the weather conditions and the operating requirements in the Mount Cook region.
- 1.6.7 Further routine competency checks were carried out on the pilot as part of the operator's standard six-month pilot route and proficiency checks, and as the pilot gained ratings on other aircraft types. During September 1997 the pilot successfully completed a biennial flight review, route and aerodrome qualifications and maintenance of pilot skills check. The operator's chief pilot or check pilots also carried out random spot route checks on the pilot. The last check occurred during February 1998.
- 1.6.8 The pilot completed a six-month flight competency check during March 1998. His most recent flight competency check occurred on 13 September 1998, the day before the accident. The flight check included a biennial flight review and maintenance of pilot skills check by the chief pilot in a Cessna 206. The pilot completed the competency check successfully. The comments recorded on the check sheet by the chief pilot indicated that the pilot had flown to a high standard.
- 1.6.9 During route competency checks the escape options available to be used if an engine failed, or if adverse weather was encountered, were pointed out and discussed with the pilot. The operator's policy of maintaining safe distances from terrain and sufficient altitude when crossing mountain ranges was stressed.
- 1.6.10 The pilot had accumulated some 750 hours of flying experience while working for the operator over a two-year period, mostly in the Mount Cook region. His flying experience included 105 hours in 1996, 378 hours in 1997 and 267 hours in 1998 up to 13 September. The operator advised that the previous twelve-month period had been particularly windy, and as a result the pilot had been frequently exposed to strong winds, mainly from the west or southwest. During that period the north to northwest wind had been less common.
- 1.6.11 The pilot had been rostered on duty the 4 days before the accident and had recorded a total of 32 duty hours, 8 hours each day. He was off duty on Wednesday 9 September. He was rostered on duty for the 3 days before that and was off duty on Saturday 5 and Friday 4 September.

- 1.6.12 The pilot had recorded 78 duty hours in the first 14 days of September, 190 hours during August, 173 hours during July and 132 hours during June. He started duty each day about 0900 hours and finished around 1700 hours. He had regular periods off duty for one or two consecutive days. On the evening before the accident the pilot remained at home. He advised another pilot that he was studying for a meteorology examination.
- 1.6.13 In the 7-day-period before the accident, the pilot had flown 6.4 hours, including one hour in the Cessna 177. In the 30-day-period he had flown 28.2 hours, including 7.7 hours in the Cessna 177, and in the 90-day-period he had flown 68.2 hours.
- 1.6.14 The operator and the pilot's previous employer considered the pilot to be competent and of a good solid average ability in his flying performance. They held him in high regard. The pilot's peers and supervisors held similar views. The comments written on the pilot's flying competency check sheets indicated he had performed to a high standard during his checks. He was known to be conservative with his flying, to give himself wide margins and not to take risks. He would avoid flying close to cloud, or flying above cloud any longer than necessary. He would promptly report any aircraft deficiencies, seek advice or query flight conditions during a flight if he was uncertain over any aspects of his flight.
- 1.6.15 The passengers on the pilot's previous flight the morning of the accident said that they had enjoyed their flight with the pilot very much, and found him to be "affable, competent, reassuring and confident".
- 1.6.16 The pilot had worked in the tourism industry for a number of years before taking up flying. He was fluent in the Dutch, German and English languages.

## **1.7 Aircraft information**

- 1.7.1 The Cessna 177B is an all-metal single-engine high-wing light aircraft of conventional design, fitted with a fixed tricycle undercarriage. The cabin layout comprises pilot and front passenger seating, a centre double passenger seat and provision for an auxiliary seat at the rear of the cabin. Cessna 177B, ZK-DKL, serial number 177-01944, was manufactured in the United States in 1973. The operator purchased ZK-DKL during 1996 from its principal maintenance contractor.
- 1.7.2 ZK-DKL was listed in the operator's Operations Specifications as being approved to conduct air transport operations. The Operator's Maintenance Manual (OMM), approved by the Civil Aviation Authority (CAA), required the aircraft to be maintained in accordance with its approved manufacturer's maintenance programme. The aircraft had been issued a non-terminating Airworthiness Certificate in the standard category.
- 1.7.3 The aircraft records indicated that ZK-DKL was maintained in accordance with the provisions of the OMM. The OMM stated the aircraft was to be given a maintenance inspection at least every six months or 60 flying hours, whichever occurred first. The flying hours could be extended to 70 hours in certain circumstances, but the normal cycle of completing four inspections every 240 flying hours had to be maintained.
- 1.7.4 The most recent maintenance inspection was recorded as having been completed on 14 July 1998. The inspection included an annual maintenance review. The operator's CAA approved aircraft Maintenance Status Certificate was valid from that time for a further 55 flying hours, until the aircraft accumulated a total of 5965 aircraft hours or 14 January 1999, whichever occurred first. When the accident occurred the aircraft had flown 47.5 hours since the last inspection and amassed a total of 5957.5 flying hours. The maintenance required before the next inspection was a compass swing and a radio equipment and altimeter check, due during October 1998. No known defects were recorded as outstanding at the time of the accident. All relevant Airworthiness Directives were recorded as being complied with.

- 1.7.5 The aircraft was fitted with a 180 horse-power Lycoming 0-360-A1F6D engine, serial number L-17859-36A. Maintenance records indicated that at the time of the most recent inspection on 14 July 1998 the engine had amassed 5910 operating hours since new, and 258.2 hours since overhaul. The propeller, a McCauley B2D34C208, serial number 733091, had a recorded time in service at the last inspection of 741.3 hours since overhaul.
- 1.7.6 The flight reference instruments fitted to the aircraft included an artificial horizon, turn and bank indicator, direction indicator and compass. A suction gauge and carburettor temperature gauge were also fitted.
- 1.7.7 In the two months since the last maintenance inspection of the aircraft and its components, up to the time of the accident, there were no malfunctions or defects reported with the aircraft or its systems. Another pilot flew the aircraft on the day before the accident and reported that it performed normally.
- 1.7.8 The aircraft was equipped with two fuel tanks, one in each wing. At the time of the accident ZK-DKL probably had about 72 litres of fuel on board giving an endurance of about 1.6 hours. Following the accident the all-up weight of the aircraft was calculated to have been around 2142 pounds (973 kg) at the time of impact. The maximum authorised all-up weight was 2500 pounds (1135 kg). At an all-up weight of 2142 pounds the permissible centre of gravity (cg) forward limit was 101.4 inches (2576 mm) aft of datum (AOD), and the aft limit 114 inches (2896 mm) AOD. The cg was calculated to be around 105.6 inches (2682 mm) AOD.
- 1.7.9 In accordance with the rate-of-climb data in the aircraft owner's manual, the aircraft should have been able to climb at about 400 feet per minute (fpm) at 2200 pounds (999 kg) in standard atmospheric temperatures at 11 000 feet amsl.
- 1.7.10 The operator's other pilots who flew ZK-DKL advised that it performed adequately at high altitude when operated at an appropriate weight similar to that at the time of the accident. The pilots were not uncomfortable flying the aircraft up to altitudes of around 12 000 feet amsl. They advised that the aircraft would achieve a greater rate of climb than the operator's normally aspirated Cessna 207 at typical scenic operational weights.
- 1.7.11 ZK-DKL replaced a Piper PA28-140 aircraft which was less powerful and smaller than the Cessna 177. The operator had used the PA28 for a number of years from Tekapo Aerodrome on scenic flights across the Mount Cook region, and on other general flying activities. The operator advised that the PA28 had been operated without incident and that the operator needed a small economical four-place aircraft for carrying small freight items or one or two passengers.
- 1.7.12 ZK-DKL was not fitted with supplemental oxygen equipment for the pilot or passengers. Civil Aviation Rules Part 91 required the use of supplemental oxygen by the pilot and passengers if their aircraft was operating between 10 000 feet amsl and 13 000 feet amsl for longer than 30 minutes, or above 13 000 feet amsl.

## **1.8 Meteorological information**

- 1.8.1 In an aftercast of the weather situation existing at the time of the accident the Meteorological Service of New Zealand Limited (MetService) provided information which is summarised as follows:

On 14 September 1998 a cold front over the western Tasman Sea was moving towards New Zealand and an increasing north to northwest flow covered the South Island.

Satellite pictures taken at about the time of the flight show that the South Island west of the Southern Alps was covered by predominantly low cloud and the east of the divide was mostly clear. At about 1145 the leading edge of the high cloud associated with the cold front had spread over the eastern areas in the south. There was a distinct narrow line clear of cloud just east of the divide marking the föhn gap. The north of the föhn gap was abeam Lake Wanaka at 1145 and had extended north to about the headwaters of the Rakaia River, and north of the site of the accident, by about 1345.

The 1100 wind sounding taken at Hokitika showed about 30 knots in the layer between 7 and 10,000 feet. Winds across the tops of the mountain ranges increase as the air accelerates to cross the ranges. The increased speed can be two or three times the free air speed indicated by Hokitika. The speed can be even greater if there is an inversion just above the mountain range.

The Invercargill tephigram showed an inversion at about 11 - 12,000 feet at midnight on 13 September and at about 14,000 feet at midday on 14 September with stable air below. It is probable that the Invercargill soundings were typical of the atmosphere in the region of the accident.

The freezing level was about 10,000 feet and airframe icing was not a problem unless the aircraft ventured into cloud above the tops of the divide or to the west. The air was probably too dry for carburettor icing to have been a problem also.

The increased wind across the tops of the mountain range probably generated severe turbulence, including rotors and a very strong downdraught just east of the divide.

The mainly clear skies east of the ranges and the föhn gap in the frontal cloud indicate stable air with strong descending motion and associated turbulence. It is likely these conditions were at their worst close to the range forming the divide and just below the mountain tops. With only limited information on conditions in the area of the accident, it is not possible to give an estimate of the speed of the downdraughts.

- 1.8.2 The operator's other pilots who had been flying in the area at the time of the accident reported that up until about 1000 hours the weather conditions were clear over the Main Divide, and to the east. A strong north to northwest airflow existed but smooth flying conditions generally prevailed. The pilot discussed the weather conditions with a helicopter pilot at Glentanner after he had completed his first flight, and they agreed that despite there being a strong wind the flying conditions were relatively smooth. At that time Mount Cook radio reported wind gusts of up to 40 knots on the ground at Mount Cook Aerodrome. Conditions were reported as pre-frontal. A slow deterioration in the weather was forecast and observed.

- 1.8.3 The flying conditions were reported by the operator's other pilots as being generally smooth at about the time of the accident. They said the north to northwest wind usually produced a benign laminar airflow. They also reported that the conditions were clear east of the Main Divide including the Tasman valley. Cloud had obscured Climbers Col and the area north of Tasman Saddle, and had pushed up against the western side of the Main Divide to just north of Fox Glacier. The Franz Josef N ev  was generally covered in cloud but the Davis Snowfield and Fox Glacier N ev  and its upper icefall were clear of cloud, as was Mount Cook. The cloud tops were about 9500 feet amsl. There was cloud across the top of Graham Saddle and to the north and northwest at about 9000 feet amsl, and a localised tongue of cloud had extended into the head of Rudolf Glacier, with its top also at about 9000 feet amsl. Ski plane activities from Mount Cook Aerodrome to Tasman Glacier had been cancelled from about 1100 hours on the day of the accident because of strong wind on the ground at Mount Cook and Tasman Glacier. (See also 1.1.10, 1.1.11, 1.1.14, 1.1.18, 1.1.20, 1.1.21 and 1.1.22.)
- 1.8.4 A helicopter pilot advised that on the day of the accident he took-off from Fox Glacier in his helicopter and, at the approximate time of the accident, crossed the Main Divide to the eastern side, south of Graham Saddle. (See 1.1.11.) He said that a strong wind was blowing from the north or northwest and that conditions were turbulent. He said he observed cloud which resembled a roll of candy floss on the lee side of the saddle over Rudolf Glacier. He said the cloud was hugging the surface and that it was not a thick layer. He thought there would have been significant downdraughting air associated with the conditions he observed directly on the lee side of Graham Saddle.
- 1.8.5 The video camera recording and still photographs taken from on board ZK-DKL supported the weather conditions reported by the other pilots. The recording and photographs showed that the flight had proceeded normally to the Darwin Glacier area in clear weather conditions and well away from the mountain ranges. The aircraft did not appear to be rocked by turbulence at altitude.
- 1.8.6 The operator advised that the north or northwest wind normally provided a laminar benign airflow, unlike the westerly wind which could produce significant turbulence, standing (mountain) wave and rotor conditions. The operator said the northerly wind did not normally produce strong sustained downdraughts in the lee of the Main Divide, because of the direction of the wind-flow with respect to the Divide. The operator preferred the north or northwest wind as it usually provided predictable flying conditions favourable for scenic flights. Updraughts and downdraughts were often encountered in the Mount Cook region, and the operator's pilots were taught how to take advantage of updraughting air, where to expect downdraughts, and how to avoid or escape from downdraughts if necessary. Pilots were taught to keep a safety margin of some 1000 feet above any mountain ridges they were crossing, and in conditions of strong mountain wave development to have a 2000 foot clearance when crossing ridgelines from the down-wind side.
- 1.8.7 The operator said that before flying each day the pilots would view the current MetService general synoptic weather chart on the Internet for an overview of the weather situation. From Tekapo Aerodrome the operator and the pilots were able to observe the general weather conditions in the Mount Cook region east of the Main Divide. The operator would also obtain weather reports from Glentanner, Mount Cook and Franz Josef on the west coast, as well as from pilots operating in the region. The operator had a current contract with the MetService for access to CAA-approved weather information.



- 1.8.8 The operator's pilots advised that they studied the known and forecast weather conditions before any scenic flying activities. The operator's senior pilots would then decide if any flying should go ahead. If any uncertainty existed over the weather conditions the operator would send an exploratory flight into the region to determine more accurately the existing conditions, before flights began. The senior pilots considered the weather was suitable for scenic flying before the scenic flights left with the groups of passengers.
- 1.8.9 The chief pilot completed a return scheduled flight from Tekapo Aerodrome to Christchurch that morning, landing at Tekapo shortly after the pilot departed on the accident flight. He said that he had been monitoring the weather conditions and agreed with the assessment made by the operator's other senior pilots, that the weather was suitable for the scenic flights.
- 1.8.10 The chief pilot said the conditions were generally good for scenic flying and that scenic flights were sometimes carried out in conditions somewhat worse than those existing on the morning of the accident. The main factor in determining whether a flight should go ahead was the wind, as passenger comfort was important. The south-westerly wind was the worst wind for creating turbulent flying conditions. The north to northwest wind was preferred as it generally provided laminar airflows and a smoother ride above the ridge lines.
- 1.8.11 The MetService and pilots reported that the dry atmospheric conditions around the time of the accident were not conducive to carburettor icing.

## **1.9 Navigation aids**

- 1.9.1 Not applicable.

## **1.10 Communications**

- 1.10.1 The aircraft was fitted with two VHF transceivers for normal air to ground and air to air communications. The communications before the accident were normal and indicated the transceivers were working correctly up to that time.

## **1.11 Aerodrome information**

- 1.11.1 Not applicable.

## **1.12 Flight recorders**

- 1.12.1 Not applicable.

## **1.13 Wreckage and impact information**

- 1.13.1 The site of the accident was on a snow-covered mountain face, about 0.5 km on the eastern side of the Main Divide near Mount Aurora, 2 km southwest of Graham Saddle, at an elevation of around 8500 feet amsl. The mountain face sloped about 45 degrees.
- 1.13.2 The wreckage of ZK-DKL was not readily visible from the air as it was almost entirely buried in snow and ice. Only the empennage could be seen. The empennage was attached to the fuselage by its control cables only, as its supporting structure had broken on impact. Subsequent examination of the site and wreckage, after sufficient snow and ice had been removed, showed the aircraft was upright, on a westerly heading, wings level and in slight nose-down attitude at the time of impact. All components of ZK-DKL were accounted for at the site.

- 1.13.3 A helicopter lifted the aircraft wreckage off the mountain. The wreckage was transported by road to a suitable location for examination. Structural damage was consistent with severe impact with terrain. Both main wing leading edges had sustained severe compression damage, being pushed back to their main spar. Each wing had sustained similar damage. The engine was pushed back against the firewall which collapsed, causing disruption to the cockpit, its instruments and controls. The propeller damage and twisting of its spinner suggested the engine was delivering some power at impact. The flaps were in the up position, as selected.
- 1.13.4 No fuel remained in the tanks because of the disruption to the wings, but the fuel tank caps were securely fastened. Residual wetness and a smell of fuel at the site and in the tanks suggested there was fuel in the tanks at the time of the accident. The fuel selector was found selected to both tanks, being in the BOTH position.
- 1.13.5 The pre-impact integrity of the control systems was established as far as practicable given the disruption that had occurred.
- 1.13.6 Inspection of the engine disclosed no evidence of pre-impact malfunction, but it was sent to an overhaul facility for further examination. (See 1.16.) The propeller was attached to the crankshaft normally and the crankshaft rotated freely.
- 1.13.7 Despite the disruption that had occurred to the forward cabin area the following observations and readings were made:
- altimeter set to 1010 hPa (no altitude reading available from the instrument)
  - mixture full rich
  - throttle full in
  - propeller pitch control about one cm out (normal for climb)
  - fuel shut off in the normal ON position
  - fuel selector selected to BOTH
  - fuel primer in and locked
  - magneto switch selected to BOTH
  - carbon monoxide Dead Stop indicator clear; dated 10 August 1998
  - cowl flaps selected to the full open position
  - flaps selected up
  - carburettor heat control on slightly
  - cabin heat selected off
  - windscreen defrost selected off
  - number one VHF transceiver selected on
  - number two VHF transceiver selected on
  - transponder selected to 1200.
- 1.13.8 No cargo or baggage was on board the aircraft, except for the normal aircraft equipment including survival gear, and some small personal items belonging to the occupants. The equipment and survival gear had been suitably restrained. The occupant restraint system was intact, and the seats had not dislodged from their attachments.
- 1.13.9 The 35 mm still camera and video recorder were recovered from ZK-DKL and their film and tape were developed. The last photograph and video recording were taken near Darwin Glacier, about three minutes before the accident, even though unused film and tape remained in the cameras.

## **1.14 Medical and pathological information**

- 1.14.1 Post-mortem and toxicological examination did not reveal anything which 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 examination indicated the pilot was gripping the control yoke with both hands at the time of impact.
- 1.14.2 The pilot's most recent medical examination was on 1 May 1998. He held a Class 1 medical certificate valid until 17 May 1999. Periodic medical surveillance did not indicate any medical problem relevant to the accident.
- 1.14.3 The pilot was observed to be in good health and spirits and behaving normally before the accident flight. The video recording showed the pilot talking normally to the passengers before the flight and indicated that he was in good spirits. The passengers on the pilot's previous flight the morning of the accident did not observe anything untoward, and found him to be professional in the way he conducted that flight. In the days before the accident the pilot was acting normally.

## **1.15 Survival aspects**

- 1.15.1 The pilot and passengers died from internal injuries sustained during the impact. The injuries were consistent with severe longitudinal deceleration resulting from the aircraft impacting a snow-clad mountain face in a level attitude, at about cruising speed.
- 1.15.2 The front seat occupants were restrained by upper torso restraints, and the rear seat passenger by a lap restraint. The aircraft was equipped with an ELT, first aid kit and survival gear appropriate for alpine conditions.

## **1.16 Tests and research**

- 1.16.1 The engine and propeller from ZK-DKL were taken to an approved overhaul facility for examination and testing. Following some minor repairs because of accident impact damage, the engine was mounted on a test stand and subjected to six test runs at varying power settings.
- 1.16.2 The engine ran satisfactorily throughout the tests. The tests showed that mechanical failure of the engine and propeller had not occurred during the accident flight, and that the engine should have performed satisfactorily throughout the flight up to the time of impact.
- 1.16.3 The dual magneto system was rig-tested separately and found to perform normally.
- 1.16.4 The altimeter from ZK-DKL was examined by an approved overhaul facility. Although the altimeter was damaged during the accident, the examination showed that it should have displayed normal altitude information throughout the accident flight.
- 1.16.5 A sample of the 100 octane avgas stored in the operator's tank was taken the day after the accident and tested. All test results were within acceptable specification limits for the fuel.

## **1.17 Organisational and management information**

### **The operator**

- 1.17.1 The operator's organisational and management structure was examined by a representative from the National Transportation Safety Board (NTSB). The assessment was carried out because the operator's managing director of operations had worked for the Commission as an assessor.

- 1.17.2 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.
- 1.17.3 The operator was based at Tekapo Aerodrome and used a fleet of five twin turbine-engined Nomad and seven single piston-engined Cessna aircraft. Operations carried out included air transport scenic flights over the Mount Cook region, instrument flight rules (IFR) and VFR general charters and some scheduled IFR flights under contract. The operator had a satellite base at Franz Josef which was maintained by a base pilot. The base pilot operated a Cessna 177 and a Cessna 207.
- 1.17.4 The operator had been involved in scenic flying operations in the Mount Cook region for some thirty years, up to the time of the accident. During that period the operator had developed and expanded the operation to its present level. The operator had not had a previous accident throughout that time, except for an off-runway landing in a Nomad, because of a probable engine problem, during take-off from Tekapo Aerodrome some ten years earlier.
- 1.17.5 The managing director of operations was a part owner of the operation. He was the operator's maintenance controller. Maintenance of the aircraft fleet was carried out under contract by an aircraft maintenance company located at Dunedin. The operator's chief pilot was also the training and safety officer and reported to the managing director of operations.
- 1.17.6 The operator had established a system for ongoing pilot checking and training (see section 1.6), and the chief pilot had updated and revised the training manual during the six months before the accident. Ongoing six-month pilot competency checks were carried out either by the chief pilot or the operator's other check pilots, in addition to other checks such as type ratings or instrument rating renewals. During the six-month checks additional items were carried out, such as low flying and remote airstrip operations. The chief pilot said pilots were encouraged to ask for instruction and flying practice, during the six-month checks, in those areas not usually practised during normal operations or tested during annual competency checks. Pilots were examined on their knowledge of the contents of the operations manual, pertinent Civil Aviation regulations and aircraft technical knowledge and performance. In addition to at least two relevant route checks each year, pilots were asked to plan, but not undertake, a flight to another part of the country. Pilots spoken to indicated that they looked forward to routine proficiency checks as doing them enhanced their professionalism.
- 1.17.7 The operator's chief pilot commented to the NTSB representative that he had not failed any pilots during their proficiency checks, but worked with them if necessary to ensure that they reached the required standards of professionalism and competence. The operator's assessment and standards section in its training manual detailed the minimum standards necessary for a pilot to pass a check flight. If these standards were not met then the manual listed the actions to be taken.
- 1.17.8 Emergencies and ways to escape from potentially dangerous situations were simulated during training and competency checking. Pilots were given training on how to recognise and avoid the potentially unsafe situations that might require optimum pilot technique in order to escape them. The operator emphasised the need for timely decision-making and the early choice of alternatives.
- 1.17.9 The operator described to the NTSB representative that the pilot had gained in confidence during the six months before the accident. As a result the representative wondered if the pilot had developed the necessary skills to escape from a situation requiring optimum pilot technique. The operator said that the pilot's gaining in confidence related in part to increased confidence in the pilot's ability to handle potential situations that could require optimum pilot technique. The operator also advised that its operating requirements were established to help prevent a pilot getting into a situation on a passenger flight where optimum pilot technique would be required. As a result this was an area unlikely to be practised, except during routine competency checks.

- 1.17.10 The operator's pilots were full-time employees on salaries with no incentive payments. The pilot turnover rate was low and several pilots had been with the operator eight or more years. The chief pilot had been chief pilot for the operator for nearly four and a half years. He had previously worked for the operator for about three years as a pilot before leaving to fly for a commuter airline. He worked for the commuter airline for about four years before returning to the operator to take up his current position. He held an Airline Transport Pilot Licence, instructor rating and airline flight examiner rating. He was checked by the CAA some three months before the accident.
- 1.17.11 The operator's Operations Manual was in the process of being updated at the time of the accident. The manual was itemised into various sections. The sections included detailed information on weather in the Mount Cook region, remote area operations, emergencies on scenic flights, flight over mountains and minimum altitudes. Each pilot had a copy of the manual and was required to have it with them on a flight. A copy of the pilot's manual was recovered from ZK-DKL. The manual had been amended and signed by the pilot.
- 1.17.12 Minimum vertical and horizontal terrain clearances were specified in the Operations Manual and pilots were taught to apply them to their operations. The Operations Manual stated that as a general guide the crossing height over a pass or ridge line was to be increased by 300 feet for each 10 kts of estimated wind strength, and a 2000 foot clearance was required in strong mountain wave development. (See 1.8.6.) In addition, pilots were to plan flight paths which would enable them to turn away from the pass or ridge line if necessary.
- 1.17.13 The operator said that pilots were taught not to attempt to out-climb downdraughts they encountered, but to keep the speed of their aircraft up and fly away from the downdraught if necessary to, preferably, an area of updraughting air. Pilots would often take advantage of updraughting air to gain altitude quickly to establish an altitude buffer. The altitude of aircraft on a typical scenic flight on a windy day could oscillate between 9500 feet and 11 500 feet amsl in smooth air. Pilots needed to be able to operate their aircraft for short periods at altitudes high enough to give them a safety buffer above the mountain peaks and to allow for any encounter with a downdraught. The height of some peaks along the Main Divide exceeded 10 000 feet amsl.
- 1.17.14 The weather section in the operator's Operations Manual detailed the varying conditions that prevailed in the Mount Cook region, in particular wind conditions. The section stated that the region was subject to severe and often rapidly changing weather conditions, and that, in general, wind was the main problem encountered on scenic flying operations. The section stated that apart from the points covered in the manual, experience in the region was the most valuable qualification for dealing with various wind conditions, as experience enabled pilots to make sensible judgements when selecting routes.
- 1.17.15 The operator's managing director of operations, chief pilot and other senior pilots supervised all operations. Before any scenic flights over the Mount Cook region, the operator's senior pilots would study the known weather conditions before deciding if operations should go ahead. (See 1.8.8 and 1.8.9.) The operator advised that a conservative approach was adopted when assessing weather conditions to determine if scenic flights should begin or continue.

- 1.17.16 The operator's pilots said that they were not under any undue pressure to begin a flight, or to continue with one if they were concerned about any aspect of the flight. The operator advised that pilots were required to alter their routes, shorten them, or abandon their flights altogether and return to the departure point, if the weather deteriorated during a flight and a pilot consequently became concerned about the safe progress of the flight. Pilots said they were not pressured to fly in adverse conditions, but were actively encouraged not to do so. The managing director of operations said he often emphasised to the pilots the philosophy that if they became uncomfortable with their situation during a flight or, figuratively speaking, found themselves sitting on the edge of their seat over a course of action they had taken then they should not be there. If this occurred pilots were to immediately change to a known safe option.
- 1.17.17 The operator had developed a system of reimbursing passengers part of their fare if the full advertised scenic flight was not completed. Alternatively, passengers could pay for the flight they undertook after its completion. The system was intended to stop passengers gaining an unrealistic expectation about the outcome of a flight, thus minimising the potential for pilots to be pressured by the passengers to continue in unsuitable conditions.
- 1.17.18 During the investigation process a positive camaraderie was observed among the operator's employees with emphasis on safety, team work and professionalism. All the employees spoken to held the operator in high regard.

#### **Operator surveillance**

- 1.17.19 The operator was subject to CAA surveillance, including programmed audits and random spot checks, to assess the operator's operations by a systematic sampling of activities. The object of the audits and checks was two-fold. First, it was to establish the level of compliance with Civil Aviation legislation and with the conditions attached to an aviation document. Second, it was to find the degree to which the operator conformed with any document forming, in whole or in part, the standards or conditions on which the issue and the continuing of an aviation document depended. The prime system adopted by CAA to assess operator safety was to measure compliance with relevant Civil Aviation legislation.
- 1.17.20 The most recent CAA check of the operator was a spot check which occurred two weeks before the accident. Two aircraft and their operational status were checked. No findings or concerns were raised as a result of the check.
- 1.17.21 The most recent CAA audit of the operator and aerodrome inspection occurred during March 1998. The audit sampled the maintenance system, and included an inspection of several aircraft. As flights were being conducted at the time, the opportunity was taken to review passenger handling and briefing practices. The aerodrome facilities were inspected and found to be well maintained and in good order. No findings were raised as a result of the inspections and audit.
- 1.17.22 During January 1998, a CAA audit of the operator's airline security programme was carried out on those operations providing regular air transport passenger services with aircraft certificated with a seating capacity of greater than nine passenger seats. The audit report stated that of particular significance was the fact the operator applied the airline security programme and its associated safety principles across all its operations. The report commented that a healthy attitude and commitment to security and associated safety issues was displayed by management and personnel. The quality management system was found to be practical and well documented, and the internal audit frequency and record keeping were considered excellent. No findings were raised as result of the audit.

- 1.17.23 During November 1997, a CAA audit of the operator's flight operations and training and an inspection of the Franz Josef base were carried out. Actual flight operations were not sampled because of adverse weather conditions. The audit report noted that although the operator had not totally complied with all required legislation, the operator was trying very hard to do so. Although some systems discussed during the audit were not to the required standard, processes were in place to ensure the systems were being developed. The quality assurance system was noted as one such system. The audit report also noted that the Franz Josef base was like the other parts of the organisation, "well run" and a credit to its base pilot. The report also noted that the company (operator) was "very well run" and operated by personnel who took pride in their work and themselves, and that all of the operator's staff could be credited for contributing to the running of the operation. No findings were raised as a result of the audit.
- 1.17.24 A CAA spot check of the operator was carried out during February 1997. The check examined activities in relation to the operator's approved domestic airline security programme. The spot check report stated the operator was complying with the necessary legislative requirements and conforming with its approved airline security programme. The report noted that the operator had a responsible attitude to security. One finding, an observation, relating to some additional training in airline security being desirable, was noted on the report.
- 1.17.25 The operator had an established system for independent audits by another aircraft operator. The most recent audit was carried out during January 1998. The audit examined whether the requirements of the recent Civil Aviation rule changes had been implemented. One corrective action finding relating to the use of an old Ministry of Transport defect record card was noted on the report. The report noted that all the other aspects of the operator's activities were "very satisfactory", and that the auditor was impressed by the operator's attitude to quality.

## 2. Analysis

- 2.1 The accident flight started as a routine event in a serviceable and well maintained aircraft. The pilot was familiar with the route, weather conditions and operation. ZK-DKL had been properly prepared for flight, and a sufficient quantity of fuel was on board. The two passengers were suitably seated and restrained, and briefed by the pilot before departure. The pilot was accompanied by, and in radio contact with, four of the operator's other pilots who were flying aircraft on the same or a similar route.
- 2.2 The aircraft was at an all-up weight appropriate for the flight, and significantly less than its maximum allowable weight. No cargo nor baggage was on board the aircraft, apart from the standard aircraft equipment and some small personal items belonging to the aircraft occupants, including camera equipment. The aircraft balance was well within limits.
- 2.3 The operator's senior pilots, including the chief pilot, had examined the known and forecast weather conditions before departure, and had considered them suitable for the planned scenic flights. In addition, the pilot had successfully completed a flight over the area of the accident earlier that morning and knew at first hand what the conditions were like at that time.
- 2.4 The pilot was competent and authorised to carry out the flight. He had successfully carried out several hundred scenic flights across the Mount Cook region, on the same or similar routes, during the previous two-year period. He had experienced the seasonal wind variations over two years and was used to handling the windy conditions that were common to the region. The prevailing north to northwest wind on the day of the accident, however, had been less common than the southwest wind during the previous twelve-month period. Consequently the pilot would have been less accustomed to any peculiarities of that wind than to those of the southwest wind.

- 2.5 Although ZK-DKL was lower powered and smaller than the operator's other aircraft types, it was at a weight suitable for it to perform adequately throughout the planned flight. The aircraft, at its weight before the accident, was reported to have a better rate of climb than a normally aspirated Cessna 207 at typical scenic operational weights. The aircraft had climbed normally to 11 100 feet and was performing adequately at that level for some time before the accident. Regardless of the aircraft type flown, pilots who are experienced in mountainous terrain flying will plan escape options, if their aircraft encounters a downdraught it cannot out-climb and they wish to escape from. Most general aviation aircraft would be unable to out-climb some of the downdraughts encountered in mountainous terrain. A routine part of mountain flying should be to conduct a flight according to the performance available in the particular aircraft. The operator had safely operated a PA28, smaller and of lower performance than the Cessna 177, on scenic flights across the Mount Cook region for a number of years, before it was replaced by ZK-DKL.
- 2.6 The operator had developed a comprehensive system of training for its pilots on safe flying in the Mount Cook region. The training included aircraft performance limitations, handling the typical weather conditions and the maintenance and use of escape options. The operator closely supervised pilots new to the operation. The new pilots were allowed to build up experience in a controlled way until they became competent and qualified to read and anticipate the weather conditions in order to plan and conduct their flights safely.
- 2.7 The flight was routine to Darwin Glacier where the pilot gave the position report stating that he was at 11 100 feet. A Nomad pilot had crossed the Main Divide ahead of ZK-DKL without difficulty at 10 500 feet. He advised the pilot what the conditions were like across the Divide and to the west, and where best to cross the Divide, before ZK-DKL had reached Darwin Glacier. At his reported altitude at Darwin Glacier, the pilot would have been able to see the Graham Saddle area clearly and the general conditions across the Divide.
- 2.8 The pilot was in continual radio contact with the other pilots and able to discuss or clarify any issues with them or advise them of any difficulties. He was accustomed to using the discreet company radio frequency during a flight to discuss various issues with the operator's other pilots. The only time he indicated that he might have been encountering some difficulty or uncertainty was when he responded "standby" to another pilot, shortly before the accident. The pilot's response suggests he was preoccupied at that time with some other event requiring his attention.
- 2.9 The preceding Nomad pilot advised the pilot to keep plenty of height on when he crossed the Main Divide. Had the pilot maintained his last reported altitude of 11 100 feet he should have crossed the Divide safely. If he was aware that ZK-DKL was not maintaining altitude he could have turned away and chosen an alternative route.
- 2.10 The meteorological evidence, including pilot reports, indicated that there was a strong laminar stable north-westerly airflow across the Main Divide with the probability of strong downdraughts in the lee of the Divide. Potential, therefore, existed for ZK-DKL to encounter such a downdraught after it had passed Darwin Corner and approached the Divide. Had the pilot been aware that ZK-DKL encountered a downdraught that he wished to escape from, he had a number of escape options open to him. There was little cloud east of the Main Divide and the Tasman Glacier valley was clear of cloud. The logical and best escape option for the pilot, once he had reached Darwin Glacier, was to turn down wind into the Tasman valley, away from rising terrain. Additionally, the pilot was under no pressure to fly the route that he did and he could have varied it. The operator's pilots were accustomed to having to vary their chosen route if the weather made it advisable. Had the pilot experienced a problem with ZK-DKL, such as a power loss, he had excess altitude available to him in addition to the escape options, to avoid getting himself into a precarious situation.



- 2.11 ZK-DKL was last seen on top of, and close to, a tongue of cloud that had spilled over the Main Divide and into the upper reaches of Rudolf Glacier. In that position the aircraft was in the lee, probably below the tops, of the Main Divide. In the strong north-westerly airflow the aircraft probably encountered a significant downdraught that pushed it into the cloud. With the reported position of ZK-DKL above the tongue of cloud and the accident site the aircraft had to have descended into the cloud.
- 2.12 From Darwin Glacier the aircraft most likely continued on a westerly heading and descended to around 9100 feet amsl just above the tongue of cloud, where it was last seen. Over this distance the aircraft lost some 2000 feet in altitude, or an average of about 667 fpm, during the estimated three minutes it probably took for the aircraft to fly to that point from Darwin Corner. Shortly before the aircraft entered the cloud it would have been directly in the lee of the Main Divide where any downdraughts would have intensified. Consequently the aircraft probably sustained a rapid height loss when it approached and entered the cloud layer, up to the accident site. If the pilot had been aware that ZK-DKL was unable to maintain a safe altitude, before it approached the cloud layer, he could have simply turned left into the Tasman valley. The pilot, however, made no apparent attempt to turn away from the cloud and rising terrain ahead.
- 2.13 Once the aircraft entered cloud the pilot had the choice of continuing on a westerly heading if he believed he had crossed the Main Divide, or turning on to a southerly heading away from the rising terrain.
- 2.14 A plausible explanation for the aircraft continuing ahead immediately before and after it had entered the cloud is that the pilot believed he had crossed the Main Divide. He knew the conditions were clear on the west coast directly ahead of ZK-DKL, and if he decided he had crossed the Divide, the only choice was to continue. To turn left to the south in that situation would have taken ZK-DKL directly toward the Divide. About one half of a kilometre separated the accident site from the western side of the Divide.
- 2.15 ZK-DKL might have nearly crossed the Main Divide at some point, but as it descended closer to the layer of cloud that was obscuring the Divide the pilot would have lost some vital visual cues. As a consequence the pilot may not have been able to determine accurately his position immediately before entering the cloud. As the aircraft approached the cloud the earlier escape options open to the pilot would have become minimised, or no longer available. Visual illusions can occur where cloud blends with snow-covered mountain faces, and any such illusion could have been an additional factor in deceiving the pilot as to his exact position.
- 2.16 When the pilot realised he could not prevent ZK-DKL from entering the cloud, and assuming he believed he was over or west of the Main Divide, he was faced with an urgent decision over what action he needed to take. As the cloud layer was limited in extent, the pilot probably reasoned in the short time available to him that the safest or only option was to go on until clear of the cloud.
- 2.17 In the strong stable north-westerly airflow prevailing at the time of the accident, significant downdraughts were probably present in the lee of the Main Divide, especially below the tops of the ridge lines. The operator's pilots reported that the stable laminar airflow was relatively smooth and that downdraughts were present. The operator's Nomad pilots who searched for ZK-DKL shortly after the accident, however, said that they were able to maintain altitude at or below the level of the Main Divide tops on the lee side of Graham Saddle, although this involved them using the prevailing airflow to the best advantage.

- 2.18 There was no evidence of a loss of control, power loss or other aircraft systems failure that could have contributed to the loss of height by ZK-DKL and its subsequent impact with terrain. There was no evidence of pilot impairment, fatigue or other personal factors that could have affected the pilot's ability to control the aircraft. Although ZK-DKL was flying at 11 000 feet shortly before the accident without any supplemental oxygen for its occupants, it was at that altitude for only a short period and operating in accordance with Civil Aviation legislation. Consequently the pilot's performance should not have been affected by a lack of oxygen.
- 2.19 Pilots flying scenic flights across the Mount Cook region needed to be able to operate their aircraft between 10 000 feet and 13 000 feet amsl for short periods without supplemental oxygen, for safety considerations when crossing the ranges and for passenger comfort.
- 2.20 As the pilot, in the circumstances, should not have knowingly descended or allowed ZK-DKL to descend below the tops of the Main Divide, the height loss can be attributed only to the presence of an insidious downdraught and possible undetected descent. As the aircraft approached the tongue of cloud the further height loss was probably caused by a downdraught that exceeded the climb performance of the aircraft. There was some evidence the pilot had climb power selected at the time of impact.
- 2.21 Why the pilot did not recognise earlier that ZK-DKL was descending toward the tongue of cloud with the probability of entering it, and make a timely turn away from the cloud, could not be explained. The aircraft could have encountered a subtle laminar downdraught that may have been unnoticed by the pilot, after it passed Darwin Glacier. The pilot may have recognised his predicament only shortly before ZK-DKL entered the cloud, when his options for turning away were no longer available, or at best minimal. As the aircraft descended and approached De Le Beche Ridge and the lee of the Minarets, any downdraught probably intensified and increased the rate of descent of the aircraft. The tops of the Minarets were around 10 000 feet amsl and the aircraft was probably at or below the level of the tops as it passed by.
- 2.22 Flying into cloud on a VFR flight with high terrain in close proximity is usually hazardous, and pilots should avoid doing so. A number of cues were available to alert the pilot that he was descending, such as the flight reference instruments in the aircraft, and the strong external vertical parallax information from the tops of the Main Divide. Pilots experienced in flying at low levels across mountainous terrain will normally be accustomed to recognising any descent from the cues outside the cockpit, without reference to the flight instruments.
- 2.23 The pilot, therefore, may have simply persevered for too long with what had worked for him in the past, thus delaying any decision to turn away. The pilot may have been aware of the high terrain around him and persevered with the descent, expecting to encounter an updraught which would enable him to continue above the cloud layer. In such an environment short horizontal and vertical distances can separate updraughts from downdraughts, and the pilot was probably aware of this.
- 2.24 An additional factor might have been that the pilot did not recognise the developing precarious situation early enough to correct for it because of his comparative unfamiliarity with the idiosyncrasies of the northerly wind. The pilot was more accustomed to the typical turbulence and vertical air movements of the west to south-westerly wind common during the previous twelve-month period. Consequently he might have misjudged the intensity of any downdraught because of a lack of significant turbulence associated with the northerly wind.

- 2.25 The pilot could also have been distracted by one or both of the passengers, or some other event in the cabin that required his attention, which prevented him from recognising that ZK-DKL was descending in a downdraught. What is significant is that both cameras stopped filming near Darwin Glacier, despite there still being unused film in each camera. The operator advised that tourists commonly photograph or video record the scenery past Darwin Glacier extensively, since some of the more spectacular scenery for filming exists beyond that point. The sudden stop in filming suggests the passengers at least were preoccupied by some other event once the aircraft passed Darwin Glacier.
- 2.26 A range of distractions could have occurred, including: a passenger feeling ill or dizzy, a passenger inadvertently unlatching a door or dropping a camera, or the appearance of a large insect such as a bumble-bee in the cabin.
- 2.27 There was no evidence that any of the aircraft occupants had vomited, or that the passengers had interfered with the controls. The operator's pilots were all aware of the potential for unsafe distractions by passengers. The pilots were accustomed to dealing with any passenger distractions, and the operator had emphasised the importance of not allowing any distractions to interfere with the safe operation of their aircraft.

### **The operator**

- 2.28 During the investigation process the operator's managers demonstrated that they had taken responsibility for actively developing a coherent safety culture, and that they had adequate measures in place to ensure the safe operation of their aircraft.
- 2.29 The operator's Operations Manual, although in the process of being updated at the time of the accident, was comprehensive and included a detailed section on weather in the Mount Cook region. All the operator's pilots had their own copies of the manual and demonstrated they were aware of its contents.
- 2.30 Pilot supervision and competency checking and training were of a high standard and exceeded the requirements specified by the CAA.
- 2.31 The operator had researched and identified the likely risks of operating scenic flights across the Mount Cook region. Consequently the operator had put in place suitable defences to counter the known risks.

## **3. Findings**

Findings 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 flying operations over the Mount Cook region.
- 3.3 The aircraft was approved and appropriate for the type of operation being conducted.
- 3.4 The aircraft had a valid Certificate of Airworthiness, and its records indicated it was airworthy and operating within the required maintenance period.
- 3.5 There was no evidence of an aircraft systems failure or loss of control that could have contributed to the accident.

- 3.6 The aircraft weight and balance were within limits and appropriate for the flight.
- 3.7 The pilot and the operator's senior pilots had studied the relevant current meteorological information for the Mount Cook region before the flight departed.
- 3.8 The weather conditions were suitable for the flight.
- 3.9 The aircraft probably encountered a strong downdraught, after the pilot's last reported position, which caused it to lose a significant amount of altitude in a short period of time.
- 3.10 The pilot probably did not recognise that ZK-DKL was descending quickly into a perilous situation until it approached a cloud layer.
- 3.11 The aircraft entered the cloud layer and the pilot lost external visual reference before impact with the mountain face.
- 3.12 Visual illusions could have heightened any positional uncertainty the pilot was experiencing as the aircraft descended and approached the cloud layer.
- 3.13 The pilot may have believed he had crossed the Main Divide before entering the cloud, and continued expecting to break out of the cloud into clear conditions.
- 3.14 The pilot had ample opportunity and options available for a timely turn away from the Main Divide ahead of ZK-DKL, until shortly before entering the cloud layer.
- 3.15 The pilot did not make a timely decision to turn away from rising terrain ahead.
- 3.16 The pilot may have persevered with his descent, expecting to encounter an updraught and overfly the cloud layer and rising terrain ahead.
- 3.17 The pilot might have misjudged the intensity of any downdraught ZK-DKL had encountered.
- 3.18 Distraction of the pilot by the passengers, or some other event in the aircraft cabin, could have prevented the pilot from recognising that ZK-DKL was descending inadvertently.
- 3.19 The operator had a coherent safety culture functioning within its organisation, including a comprehensive system of pilot checking and training and supervision, and suitable defences were in place to counter the known operational risks.
- 3.20 No reason for the cause of the accident was established.

Approved for publication, 31 March 1999

Hon. W P Jeffries  
Chief Commissioner