Report 97-002

Cessna 310Q

ZK-KIM

loss of control after take-off

near Queenstown Aerodrome

3 January 1997

Abstract

On Friday 3 January 1997, at 1357 hours, Cessna 310Q aeroplane ZK-KIM, on a private flight to Ardmore, was turning after take-off from Queenstown when it entered a spin or spiral dive which led to a collision with the ground. The pilot and all five passengers were killed.

The position of the Remarkables Range, in relation to runway 14, restricted the space available and precluded a normal visual horizon reference for the pilot during the turn.

Inadvertent mishandling of the aircraft by the pilot probably resulted from his inexperience and lack of mountain flying skills. Misloading could have adversely affected the handling qualities of the aircraft.

Transport Accident Investigation Commission

Aircraft Accident Report 97-002

Aircraft type, serial number and registration:	Cessna 310Q, 0825, ZK-KIM
Number and type of engines:	Two Continental IO-470-VO6
Year of manufacture:	1973
Date and time:	3 January 1997, 1357 hours[1]
Location:	1.9 km south east of Queenstown Aerodrome Latitude: 45° 02' south Longitude: 168° 45' east
Type of flight:	Private
Persons on board:	Crew: 1 Passengers: 5
Injuries:	Crew: 1 fatal Passengers: 5 fatal
Nature of damage:	Aircraft destroyed
Pilot in command's licence:	Private Pilot Licence (Aeroplane)
Pilot in command's age:	25
Pilot in command's total flying experience:	183 hours 14 hours on type
Investigator in charge:	J J Goddard

[1] All times in this report are NZDT (UTC + 13 hours)

1. Factual Information

1.1 On Friday 3 January 1997, the pilot and his five friends prepared to return to Ardmore in ZK-KIM, after a holiday in Queenstown. They had flown to Queenstown from Ardmore on 26 December 1996.

1.2 At about 1230 hours the pilot had a conversation with a local airline pilot in the terminal building at Queenstown Airport. He received advice about local aircraft traffic and other general operational matters. After this he went to the control tower where he filed a visual flight rules (VFR) flight plan with the flight information officer on duty. The planned route of ZK-KIM was to Ardmore via Nelson, where an intermediate landing was to be made.

1.3 The pilot and his friends then loaded their baggage onto the aircraft, and the pilot completed a load sheet, leaving a copy at the terminal building.

1.4 The passengers and pilot then boarded the aircraft. The engines were started and it was taxied further away from the terminal building where an engine run-up was performed. The aircraft was then taxied to the fuel pumps and shut down. The pilot refuelled it, adding a total of 71 litres of Avgas to the main tanks in the wing tips.

1.5 At 1344 hours the pilot called Queenstown Ground by radiotelephone (RTF), requesting "VFR departure for Nelson via Bungy Bridge, for the Crown Saddle." Queenstown Ground responded, "Kilo India Mike, roger. Runway 14, surface wind is 210 degrees at 9 knots, QNH 1013. Cleared Bungy Bridge." The pilot acknowledged this by reading back, "1013, and runway 14. Cleared Bungy Bridge. Kilo India Mike."

1.6 At 1349 hours the pilot called Queenstown Tower. The controller responded, "Kilo India Mike, taxi to holding point Alfa. Caution the other light aircraft taxiing into the GA (general aviation) park." This was acknowledged, and as ZK-KIM was taxiing the pilot was further cleared across the main sealed runway to holding point Echo, the holding point at the threshold of grass runway 14.

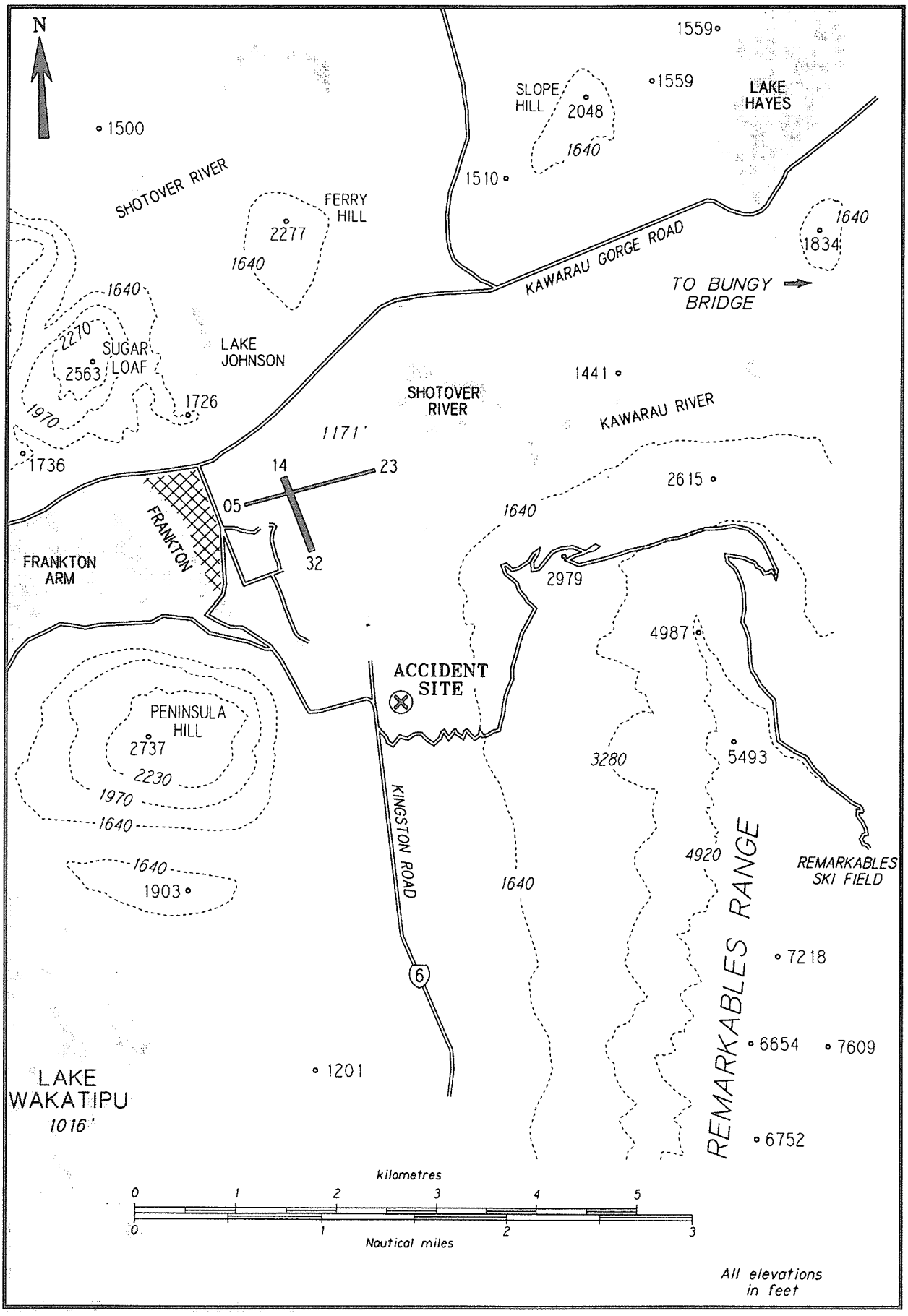
1.7 After four other aeroplanes had taken off, three using various lengths of runway 14, and one using runway 23, ZK-KIM was cleared to line up on runway 14, at 1351 hours.

1.8 At 1355 hours Queenstown Tower called, "Kilo India Mike, Cherokee ahead vacating to the south, cleared for take-off." This was acknowledged, and no further RTF transmissions were recorded from the aircraft.

1.9 ZK-KIM was observed to commence its take-off promptly on the grass runway. After crossing over the sealed runway 23 during the take-off roll, the aircraft became airborne in about two-thirds of the length of runway 14 and made a shallow initial climb, with the undercarriage retracting in a normal manner.

1.10 The aircraft climbed straight ahead to the south of the aerodrome, reaching a height variously estimated at between 700 and 1000 feet. At that stage it was seen to start a turn to the left. Initially the turn was at a normal bank angle, but then the aircraft was seen to pitch up into a steeper climb attitude, while the bank increased to a very steep angle.

1.11 ZK-KIM then rolled and pitched down into a steeply banked spiral dive, or spin, which continued without any observed recovery until the aircraft collided with a span of 33 kV and 11 kV power conductors, and with the ground beneath. An explosion occurred on impact, followed by fire.



Queenstown Aerodrome and surrounding terrain

1.12 The accident was observed by the air traffic control personnel in the control tower, who alerted rescue services promptly. This was in spite of a temporary complete loss of electrical power to the tower, caused by the accident.

1.13 The airport rescue fire service crew responded quickly, and arrived at the accident site, 3 km away by road, within five minutes, followed by local Police and Fire Service units. They doused the fire and ascertained that there were no survivors among the six occupants.

1.14 The accident site was in a substantially level grass field 1.9 km south-east of the southern boundary of Queenstown Aerodrome, at an elevation of 1100 feet above mean sea level. It was 500 m to the left of the extended centreline of runway 14. The field was bounded by State Highway 6 to the west and by the lower slopes of the Remarkables Range to the east.

1.15 An examination of the wreckage was made on site, and subsequently after its removal to a hangar, with the assistance of specialist representatives from the aircraft and engine manufacturers.

1.16 The ground marks and general disposition of the wreckage were consistent with a steep nose-down, erect and nearly wings-level impact at moderate to high speed. There was no evidence of rotation of the aircraft, which was on a heading of about 170° M at impact. The left wing tip had severed five power wires in mid-span, just before the aircraft struck the ground beneath them. There was evidence of electrical arcing on the ground from the wires.

1.17 The wreckage was severely disrupted by impact forces, with some items scattered up to 35 m away by rebound forces. It had been further damaged by the post- impact fire which consumed some of the light alloy structure. It was possible, however, to establish that the aircraft had been complete before the ground impact. No evidence of a bird strike was found.

1.18 The pre-accident continuity of the airframe and engine control cables was established, but not the positions of controls and trims. The flaps and undercarriage were retracted. The left fuel selector valve was in the "L MAIN" position, while the right one had been forced beyond its normal range of travel by structural disruption. No significant evidence was available from instruments or switch positions.

1.19 Damage to the engines and propellers was generally similar, except that the left propeller was separated from the crankshaft flange. Both propellers showed rearward bending and minor rotational damage.

1.20 No fuel was available from the wreckage, but two centres of the fire had been at the wing tip main fuel tanks, indicating the presence of appreciable quantities of fuel in them.

1.21 The engines were stripped and examined at an engine overhaul facility. They had both been in good condition, consistent with the hours run, and nothing was found to suggest other than normal operation. The spark plugs, however, were found to be well worn, with the electrodes eroded beyond normal limits. Several spark plugs from each engine did not function properly on a normal bench test. The magnetos performed normally on test, but their timing could not be verified because all four had broken away from the engines. No contamination was present in the fuel injection systems, and traces of fuel were evident.

1.22 The propellers were sent to the manufacturers in the United States for specialist disassembly and inspection, under the supervision of a Federal Aviation Agency representative. Witness marks showed that the blade angles of each propeller had been near to or at the fine pitch stops. Damage to each propeller was similar, and consistent with each engine developing a moderate to low power output.

1.23 Maintenance records indicated that ZK-KIM had been maintained in accordance with the operator's maintenance manual. The next scheduled maintenance, a 100 hour inspection, would have been due on its return to Ardmore. No significant non-scheduled maintenance had been carried out recently.

1.24 The aircraft had logged a total time of 3747 hours, and the engines had each logged a total time of 404 hours since factory remanufacture. ZK-KIM was equipped with appropriate instruments, autopilot and radio navaids to an approved standard for single-pilot instrument flight rules operations.

1.25 The auxiliary fuel tanks had been drained and placarded "UNSERVICEABLE" in February 1996, as a result of a fuel leak. The aircraft had been operated since then on the main fuel tanks only.

1.26 The current aircraft technical log and daily flight record was lost in the accident, so no record of recent defect action, or inoperative equipment was available. It was reported that the right alternator drive belt tension had been adjusted by an aircraft engineer during the week at Queenstown.

1.27 A sample of fuel from the facility at Queenstown used to refuel ZK-KIM was analysed. This met the specifications for Avgas 100.

1.28 The scattered baggage was recovered and found to weigh 208 pounds (lb) (94 kg). The disposition of its stowage between the rear cabin baggage area and the wing lockers could not be determined. Most of the baggage was in bulky travel bags.

1.29 The load sheet left by the pilot showed a take-off weight of 5300 lb (2404 kg), with a baggage weight of 154 lb (70 kg) and a fuel weight of 474 lb (215 kg). The maximum authorised weight of the aircraft was 5300 lb.

1.30 The quantity of fuel on the aircraft was calculated using the last refuel to capacity, on 1 January 1997, the probable fuel used afterwards on that day, and the 71 litres added before the accident flight. This gave a fuel load of 516 lb (234 kg). This figure, together with the measured baggage weight, gave an estimated take-off weight of up to 5396 lb (2447 kg). The centre of gravity (CG) of the aircraft was calculated, using the most favourable baggage distribution possible, to lie at the aft limit specified in the aircraft flight manual.

1.31 The pilot had commenced his flying training at Ardmore on PA 38 aircraft in August 1994, and completed his Private Pilot Licence in January 1995. Since then he had mostly flown single-engine Cessna types on cross-country flights around northern North Island. He had made two previous flights to South Island; one to Queenstown in January 1996, and one to Wanaka in April 1996. During December 1996 he had been doing further training towards obtaining a Commercial Pilot Licence.

1.32 His multi-engine flying training had started in October 1996, and he had flown 7 hours dual, all on the Cessna 310, to complete his type rating on 19 November 1996. Since then he had made two short cross-country flights in the Cessna 310 from Ardmore before the trip to Queenstown.

1.33 His total time of 183 hours included some 6 hours of instrument flight training, and 5 hours of night circuits, all on single-engine aircraft. His logbook showed no record of training in spinning, aerobatics or mountain flying techniques.

1.34 He had made a local flight of 30 minutes from Queenstown in ZK-KIM on 1 January 1997. This flight was from runway 23, and had been completed uneventfully.

1.35 The post-mortem and toxicological investigation of the pilot showed no abnormalities which may have affected his ability to conduct the flight. Normal analyses for alcohol and cannabinoids could not be performed, however, because suitable samples were not available.

1.36 The weather at Queenstown Aerodrome at the time of the accident was recorded by Queenstown Tower as:

Surface wind	240° M at 10 knots
Visibility	70 km
Cloud	2 octas cumulus 6000 feet
Temperature	+20 ° C
QNH	1012 hPa

1.37 The Queenstown 1400 METAR was:

Surface wind	260°M at 9 knots, varying 220° to 300°
Visibility	70 km
Cloud	scattered 5000 feet
Temperature/Dewpoint	18/11° C
QNH	1013 hPa

1.38 Witness accounts and video records of the accident site confirmed that it was a fine clear sunny day. A video made immediately after the accident showed the smoke plume up to a height of several hundred feet moving from the south, and a surface wind from the south or south-east at an estimated five knots.

1.39 Queenstown Airport is a public aerodrome situated on a level area of land some 2 km square, adjacent to Frankton Arm, at the north-east corner of Lake Wakatipu. It lies at the western end of the Kawarau Valley, amid mountainous terrain, at an elevation of 1171 feet amsl.

1.40 The main runway, 05/23, is 1519 m long, with a paved surface, and is approximately aligned with the valley to the east and the Frankton Arm of Lake Wakatipu to the west. The secondary runway, 14/32, is 944 m long, with a grass surface. It is approximately aligned with the south arm of Lake Wakatipu to the south but has rising terrain 1 km away to the north. Circuit patterns are prescribed as left hand for runways 05 and 14, and right hand for runways 23 and 32.

1.41 Increasing jet airline traffic led to the establishment of air traffic control in 1994, with Queenstown Tower providing aerodrome and approach control services within the new Queenstown Control Zone and Terminal Area. Since then a policy had been developed to encourage light aircraft to take off from runway 14 when the main runway 23 was in use. This was principally because the taxiway for runway 23 was too close to the runway to allow adequate separation between aircraft taxiing on it and large aircraft which were landing or taking off on the runway. The resulting low runway utilisation caused delays in the traffic flow, which were alleviated by the use, where appropriate, of runway 14 for take-off.

1.42 The Remarkables Range of mountains is a major local feature. It lies to the east and south-east of Queenstown Airport, with its steep west face including several peaks of over 7000 feet. The lower slopes rise to reach 2170 feet amsl (the normal 1000 foot circuit height) at a position 2 km east of the end of runway 14, and to over 5000 feet within 4 km. This effectively means that an aircraft flying a normal circuit from runway 14 has to be turned onto the downwind leg within a 1 km radius of the end of the runway, to ensure compliance with minimum safe height regulations.

1.43 Peninsula Hill (Deer Park Heights) lies a similar distance away from Queenstown Airport, but to the south-west. It is an isolated hill rising to 2735 feet amsl, but would present a similar restriction to circuit traffic if a right hand circuit was prescribed for runway 14.

1.44 It was observed that the light aircraft of local operators, when departing from runway 14 on commercial scenic flights, commonly turned right after take-off to fly around the south side of Peninsula Hill, and that if one did make a left turn the pilot would specifically advise Queenstown Tower of this. This was in spite of a left hand circuit being prescribed for this runway.

1.45 A flight evaluation of the left hand circuit from runway 14 was made on a day with a light southerly wind, using a PA 34 twin-engined aeroplane. This was not completely representative of ZK-KIM because the PA 34 was at reduced weight, and this type achieves its performance at slower airspeeds, but the initial climb and crosswind turn were flown at a speed, height and position comparable to the accident flight. The crosswind turn was flown with 30° of bank at 105 to 110 knots, and was completed with an estimated margin of 300 m from the mountainside. During the turn the pilot's view ahead was of terrain with no horizon visible. Attitude reference was maintained by the normal mountain flying technique of mentally projecting horizon reference points ahead, and by use of the aircraft's artificial horizon.

1.46 A video camera which was badly damaged by impact and heat was recovered from the wreckage. The damaged video tape was extracted and repaired. This showed some of the accident flight, and was taken by the passenger in the right rear seat of the aircraft.

1.47 The video sequence commenced with the aircraft taxiing into position on runway 14. After holding position for 30 seconds the take-off proceeded apparently normally for 35 seconds, with the aircraft lifting off and climbing to about 100 to 200 feet, and with normal engine sounds recorded. The sound of the aircraft stall-warning horn commenced during lift-off, and ceased after 11 seconds. The video recording had paused, to resume after some undetermined interval for a further 7 seconds. Damage to this latter, repaired, part of the tape resulted in substantial image degradation with intermittent synchronisation and audio, so that little useful evidence could be seen. The intermittent audio record, however, did include engine sound which was substantially similar to the earlier sound, and the sound of the stall-warning horn.

1.48 The normal take-off distance, using the parameters applicable to ZK-KIM at maximum authorised weight, on the grass runway at Queenstown, was calculated from data in the Cessna 310Q aircraft flight manual. The ground roll was 2390 feet (729 m), and the take-off distance to 50 feet above ground level was 2740 feet (835 m). The accelerate/stop distance was similarly calculated to be 4550 feet (1387 m) on the grass runway, or 3800 feet (1158 m) if the runway was paved. The maximum climb performance was calculated as 1410 feet per minute at an airspeed of 107 knots.

2. Analysis

2.1 The circumstances of this accident, as described by witnesses and from the site evidence, indicated that the pilot had lost control of the aircraft during the crosswind turn while it was departing from the Queenstown runway 14 circuit. The observed manoeuvre, of the aircraft pitching up somewhat, increasing bank to a very steep angle, then rolling and pitching down, described either a stall leading to a spin, or an overbank leading to a yaw/pitch/roll into a spiral dive. The three elements which could have been involved with this loss of control were the aircraft, the pilot and the environment. These elements were considered in order to determine what effect each might have had.

2.2 The aircraft flying control systems had probably not failed because the evidence from the wreckage indicated continuity and completeness. A control jam could not be ruled out but the probability of such an occurrence leading to the actual manoeuvre was considered unlikely.

2.3 A well-known situation which has led to a loss of control with twin-engined aeroplanes is a loss of power on one engine. This is most critical shortly after take-off when an aeroplane may not have accelerated to reach its take-off safety speed, and may have undercarriage and flaps extended, which increase drag. This asymmetry of thrust can yaw the aeroplane into a spiral dive unless prompt and correct measures are taken by its pilot. In the case of ZK-KIM the aircraft was beyond this most critical stage; the undercarriage was retracted and it had apparently accelerated to a normal climb speed before climbing to at least 700 feet. A loss of power at that stage should have been within the capability of the pilot to control without much difficulty. In any event, the evidence from the engines and propellers indicated that neither engine had failed. The indication of moderate to low power output, resulting from the propeller investigation, may have been brought about by the pilot having pulled back both throttle controls during an attempt to recover control of the aeroplane.

2.4 The worn spark plugs found during the engine investigation had the potential to cause either engine to misfire, or to develop less than normal power output. There were no witness reports of audible misfiring, however, and the video tape recovered from the wreckage had recorded normal engine sounds during the take-off.

2.5 A degradation of take-off and climb performance, perhaps as a result of reduced power available, overloading or high density altitude could have led the pilot to climb the aircraft at a reduced speed, making it more susceptible to mishandling in the turn, and perhaps leading to an inadvertent stall. The actual take-off performance achieved, however, was substantially in line with the data in the Cessna 310Q aircraft flight manual, with ZK-KIM becoming airborne in about two-thirds of the 944 metre-long runway 14. The subsequent climb performance was more likely to reflect the speed flown and any reduction from full power made by the pilot, but ZK-KIM had evidently climbed to between 700 and 1000 feet within 1.9 km of the end of runway 14. The maximum climb performance from the aircraft flight manual, of 1410 feet per minute at 107 knots, was equivalent to 1410 feet in 3.3 km, or 812 feet in the 1.9 km distance covered by ZK-KIM. It was concluded that the aircraft had performed substantially in accordance with the aircraft type data, and that normal engine power had been developed throughout the take-off.

2.6 The take-off weight of ZK-KIM was estimated to have been up to 5396 lb, 96 lb (43 kg) or 1.8% in excess of the maximum authorised weight. This probably occurred because the pilot had underestimated the baggage weight and fuel quantity. It was evident, however, that he had taken some trouble in loading the aircraft and completing his load sheet, and this small overload was probably not of practical significance. The achieved aircraft take-off performance also indicates that this was the case.

2.7 The position of the CG was estimated to lie at the aft limit, using the most favourable baggage distribution possible. This assumed that baggage was put into the wing lockers up to the authorised 120 lb, and the remaining 88 lb in the rear of the cabin. If the baggage had been loaded in the rear cabin up to the authorised 160 lb, with the remaining 48 lb in the wing lockers, the CG would have been 0.8 inches behind the aft limit. Since the authorised CG range at maximum weight was 6.35 inches, this worst case represented a position 12.5% behind the aft limit.

2.8 The actual distribution of baggage between the wing lockers and the rear cabin could not be determined, but the shallow wing lockers may have been difficult to load with 120 pounds of the bulky baggage found. Because of this, it was possible that the actual CG of ZK-KIM was somewhere between the aft limit and 12.5% behind the aft limit.

2.9 The handling qualities of the aircraft would have been affected by an aft location of the CG, but this effect could not be quantified because the actual CG position was not determined. However, the general tendency would have been to make the aircraft less stable in pitch, and to make the elevator control lighter and more responsive, as well as making the aircraft easier to stall inadvertently and control more difficult to recover if a stall should occur.

2.10 The pilot's total flying experience was low for the type of aeroplane he was flying. The Cessna 310 type is more complex, faster and has a higher wing loading than most other twin-engined types commonly used for initial multi-engine training, and much more so than any other single-engine type the pilot had previously flown. He had, however, completed his type conversion training successfully, and was thus qualified to fly the aeroplane.

2.11 The pilot's experience on the Cessna 310 type was his only multi-engine experience, and was low. His total of 14 hours included 7 hours of dual instruction, and the remaining 7 hours in command was flown on 4 flights. It is probable that he was still gaining familiarity with the cockpit layout and complexity of the Cessna 310, as well as adjusting to its increased speed of operation and different control responses. His earlier flights had been completed without event, however, so he probably was coping with the aircraft under routine circumstances. He was in current flying practice, with a total of 53 hours in the last 90 days. All his flying in the Cessna 310 had been in the last 90 days.

2.12 The majority of the pilot's flying experience had been on cross-country flights around northern North Island. While this would have provided valuable experience of navigation and of various aerodromes, it was unlikely to have exposed him to the particular problems of mountain flying which occur when constrained within valleys bounded by high terrain. He had made two previous flights to South Island; to Wanaka and to Queenstown a year earlier. While some aspects of mountain flying could have been presented to him on these flights, it was equally possible that none did occur, especially if his earlier take-off from Queenstown had been from the main runway.

2.13 The pilot had received no training in mountain flying techniques. This was normal, as mountain flying is not part of the syllabus for either private or commercial pilot licences for aeroplanes. (Such training is a requirement for helicopter licences, however). In addition, his training had been in Auckland, where mountain flying training would be difficult to make effective because of the limited nature of mountain and valley systems in the area.

2.14 The weather at the time of the accident was obviously good - it was a fine clear sunny summer day. The surface wind was light and variable - reported as 210° at 9 knots on take-off, and varying 220° to 300° in the 1400 METAR. There was evidently a light southerly breeze at the site shortly after the accident, and the smoke plume indicated a southerly wind up to a height of several hundred feet. The net effect of the variable wind on the takeoff, climb and turn was probably not significant. This light wind was unlikely to produce much orographic turbulence. Some convective thermal activity would have been likely by that time of day, but it probably would have generated only light to moderate turbulence, with which the pilot would be familiar.

2.15 The position of the Remarkables Range in relation to the normal left hand circuit from runway 14 at Queenstown was obviously significant, in that it restricted the size of a circuit which could be flown, or made advisable a non-standard procedure when departing from the circuit. No information was promulgated on this, but it appeared that some non-standard departure procedures were used by local operators as a routine.

2.16 The restricted circuit did not appear to cause a problem with slower aeroplanes which used less distance for take-off, as circuit training with light single engine types was carried out without particular difficulty. Similarly a departure from runway 14 via Bungy Bridge, after a left crosswind turn, would not be a problem with such aircraft.

2.17 The aircraft of local operators which turned right after take-off from runway 14 were mostly on commercial scenic flights, and departing to the west anyway, so that a right turn around Peninsula Hill would have been expedient as well as prudent airmanship.

2.18 Most of the locally operated twin-engined aeroplanes which took off from runway 14 were types such as Twin Otter, Islander or Nomad aircraft which, while having substantially shorter take-off performance and slower climb speeds than the Cessna 310 type, were larger aircraft with greater seating capacity. Because of this, ZK-KIM was probably given a clearance for runway 14 by Queenstown Tower without it seeming unusual or inappropriate, either to the controller or to the pilot. This clearance in fact represented an offer to the pilot to use this runway, with the option for him to request the main runway if he required it, but it was unlikely that the pilot, given his level of experience, would have considered declining the clearance and requesting the use of runway 23.

2.19 A pilot of a light twin-engined aeroplane could be expected to routinely plan the available options for rejecting a take-off should an engine failure occur, and select a runway which offers maximum opportunities. While such aircraft are required to be able to climb away on one engine after accelerating to a specified take-off safety speed, they mostly have a phase after getting airborne, but before reaching that speed, where an immediate landing ahead is a strongly advised and safer option, if practicable. Because of this it is good airmanship to use a runway long enough to provide this option if one is available. This is in contrast to larger air transport aeroplanes which are required to be able to climb away should an engine fail after a decision speed (below take-off speed) has been reached, or to be able to stop on the runway if an engine fails up to that decision speed.

2.20 In the case of ZK-KIM on runway 14, the aircraft was able to take-off and climb normally within the available runway length with both engines operating. However it was apparent from the accelerate/stop distance of 4550 feet (1387 m) calculated from the aircraft flight manual, that this option was precluded for the most critical part of the take-off by the use of grass runway 14. On the other hand, the use of runway 23, which was 1519 m long and had a paved surface, would have provided this option with length to spare. The use of runway 14 for take-off meant that the extra safety provided by a twin-engine aeroplane was not available at the most critical part of the take-off. In addition, the course of action for a pilot of a single-engine aeroplane suffering an engine failure, of making a forced landing ahead, would have been more difficult to adopt with ZK-KIM because of the control difficulties associated with asymmetric thrust while deciding what to do, and because of the higher speed of the type of aircraft.

2.21 This analysis of the rejected take-off requirements of ZK-KIM is not directly relevant to the accident, however, because the aircraft had completed the take-off normally and was well beyond the critical phase when the loss of control occurred. It did indicate that the pilot may not have given prominence to the extra take-off considerations affecting multi-engine aeroplanes compared with the single-engine aircraft he was more familiar with, because the main, paved runway 23 would have been available on request, with some extra taxiing required, and perhaps a short delay.

2.22 The use of runway 14 was relevant to the accident, however, because it led to the aircraft flying to the position where the loss of control occurred. The circumstance that the aircraft was in the crosswind turn of this left hand circuit, with the Remarkables Range ahead of it when the loss of control occurred, suggests that this restricted circuit pattern was a factor in the accident.

2.23 There were three ways in which this restricted circuit could have influenced the pilot to mishandle the aircraft and thus cause the loss of control. These were:

- The absence of information on the restricted space in the circuit.
- The restricted space itself within which the aircraft was turning.
- The absence of a normal horizon reference ahead of the aircraft during the turn.

2.24 It is probable that the pilot had no appreciation of the restricted space for the left hand circuit. Nothing was promulgated about it in the Visual Flight Guide, and he would have seen other local aeroplanes departing off runway 14, some turning left, without event. While it would be scarcely possible for him to be unaware of the Remarkables Range itself, its position close to the runway 14 circuit might not have been obvious to him until he encountered it for the first time. His lack of background in mountain flying would not have prepared him to anticipate the potential problem. The surprise element, of starting a routine crosswind turn and then finding his view ahead full of steep mountainside, could have prompted an overreaction in trying to abruptly tighten the turn. Any mishandling while doing this could have led to an inadvertent stall or spiral.

2.25 The space available to turn the aircraft to the left in the area of the accident, at 700 to 1000 feet, was limited but might have been sufficient to complete a positively flown medium to steep turn, albeit closer to the mountainside than prescribed in minimum safe height regulations. This would have required a familiarity with visually judging the turning radius of the aircraft in relation to the terrain, as well as familiarity with mountain flying to be able to relate to the visual cues available. The pilot of ZK-KIM was inexperienced in the type, which was faster than other types he had flown, and thus with an appreciably greater turning radius. His lack of mountain flying experience would have made it difficult for him to assess the cues during the turn and this, along with an anxiety to complete the turn, may have led him to try to turn too tightly.

2.26 On the initial climb after take-off, the pilot would have had a reasonably normal horizon reference in his view down the south arm of Lake Wakatipu, with a generally mountainous skyline some far distance ahead. Upon starting the left turn towards the Remarkables Range, his view ahead would have rapidly become one of close and steep mountainside, with the skyline 30° to 40° above the horizon. With no mountain flying experience to use to establish surrogate visual horizon references during the turn, or with little instrument flying experience to prompt him to use the artificial horizon instrument in the aircraft, he would be likely to mishandle the pitch and roll attitudes of the aircraft through inadequate references available to him.

2.27 It was concluded that the loss of control did not result from any malfunction of the aircraft. The loss of control probably did result from inadvertent mishandling by the pilot, which was induced by the restricted space for the turn and by the visual presence of the Remarkables Range. The mishandling may have been exacerbated by the aft location of the centre of gravity of the aircraft.

3. Findings

3.1 The pilot was appropriately licensed and rated for the flight.

3.2 The pilot was inexperienced in flying the Cessna 310 aeroplane type.

3.3 The pilot had no training in or significant experience of mountain flying techniques.

3.4 Training in mountain flying techniques is not included in the syllabus for aeroplane licences.

3.5 The aircraft had a valid Certificate of Airworthiness and had been appropriately maintained.

3.6 The spark plugs in each engine were worn beyond normal limits.

3.7 The spark plugs did not cause any significant malfunction of either engine.

3.8 The aircraft was capable of normal operation.

3.9 The aircraft was probably overloaded by a small amount.

3.10 The overloading of the aircraft did not significantly affect the flight.

3.11 The distribution of the load in the aircraft may have caused its centre of gravity to lie outside the aft limit.

3.12 The centre of gravity position could have adversely affected the handling qualities of the aircraft.

3.13 The aircraft was being turned on the crosswind leg of the circuit after take-off from runway 14 at Queenstown when a loss of control occurred.

3.14 The aircraft entered a spin or spiral dive, resulting in a collision with the ground.

3.15 The position of the Remarkables Range restricted the space available for the crosswind turn after take-off.

3.16 The position and size of the Remarkables Range precluded a normal visual horizon reference for the pilot during the crosswind turn.

3.17 Mountain flying skills were necessary for the pilot to make the crosswind turn safely after take-off from runway 14.

3.18 The loss of control probably resulted from inadvertent mishandling by the pilot.

4. Safety Recommendations

4.1 It was recommended to the Director of Civil Aviation that he:

4.1.1 Amend the NZAIP-VFG to include information that the space available for the runway 14 circuit at Queenstown is limited and that visual reference problems may be encountered as a result of the position of the Remarkables Range, (032/97) and;

4.1.2 Include mountain flying in the training syllabus for Private Pilot and Commercial Pilot Licences (Aeroplane), as is the case for helicopter licences, (033/97) and;

4.1.3 Advise flight training organisations that they should actively teach pilots to recognise when they should decline an Air Traffic Control clearance, and how to request an alternative clearance, (034/97).

4.2 In reply, the Director of Civil Aviation was prepared to accept all three recommendations. It was planned that these would be implemented by:

4.2.1 In the case of recommendation 032/97, by requiring the holder of the Queenstown Part 139 Aerodrome Operating Certificate to publish the relevant information in the New Zealand AIP.

4.2.2 In the case of recommendation 033/97, by considering the recommendation as a request for the amendment of the relevant Advisory Circular to Part 61.

4.2.3 In the case of recommendation 034/97, by communicating the message through the Flight Training Division of the Aviation Industry Association, the Instructors' Council of the Royal New Zealand Aero Club, and other appropriate means of communication.

4.3 It was expected that all three recommendations would be complied with by the end of 1997.

11 June 1997

Hon. W P Jeffries
Chief Commissioner

Glossary of aviation abbreviations

AD	Airworthiness Directive
ADF	automatic direction-finding equipment
agl	above ground level
AI	attitude indicator
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
amsl	above mean sea level
AOD	aft of datum
ASI	airspeed indicator
ATA	actual time of arrival
ATC	Air Traffic Control
ATD	actual time of departure
ATPL (A *or* H)	Airline Transport Pilot Licence (Aeroplane *or* Helicopter)
AUW	all-up weight
°C	degrees Celsius
CAA	Civil Aviation Authority
CASO	Civil Aviation Safety Order
CDI	course deviation indicator
CFI	Chief Flying Instructor
C of A	Certificate of Airworthiness
C of G (*or* CG)	centre of gravity
CPL (A *or* H)	Commercial Pilot Licence (Aeroplane *or* Helicopter)
DME	distance measuring equipment
E	east
ELT	emergency location transmitter
ERC	Enroute Chart
ETA	estimated time of arrival
ETD	estimated time of departure
°F	degrees Fahrenheit
FAA	Federal Aviation Administration (United States)
FL	flight level
ft	foot/feet
g	acceleration due to gravity
GPS	Global Positioning System
h	hour
HF	high frequency
hPa	hectopascals
hrs	hours
HSI	horizontal situation indicator
HT	high tension
IAS	indicated airspeed
IFR	Instrument Flight Rules
IGE	in ground effect
ILS	instrument landing system

IMC	instrument meteorological conditions
in	inch(es)
ins Hg	inches of mercury
kg	kilogram(s)
kHz	kilohertz
KIAS	knots indicated airspeed
km	kilometre(s)
kt	knot(s)
LAME	Licensed Aircraft Maintenance Engineer
lb	pound(s)
LF	low frequency
LLZ	localiser
Ltd	Limited
m	metre(s)
M	Mach number (e.g. M1.2)
°M	degrees Magnetic
MAANZ	Microlight Aircraft Association of New Zealand
MAP	manifold absolute pressure (measured in inches of mercury)
MAUW	maximum all-up weight
METAR	aviation routine weather report (in aeronautical meteorological code)
MF	medium frequency
MHz	megahertz
mm	millimetre(s)
mph	miles per hour
N	north
NDB	non-directional radio beacon
nm	nautical mile
NOTAM	Notice to Airmen
NTSB	National Transportation Safety Board (United States)
NZAACA	New Zealand Amateur Aircraft Constructors Association
NZDT	New Zealand Daylight Time (UTC + 13 hours)
NZGA	New Zealand Gliding Association
NZHGPA	New Zealand Hang Gliding and Paragliding Association
NZMS	New Zealand Mapping Service map series number
NZST	New Zealand Standard Time (UTC + 12 hours)
OGE	out of ground effect
okta	eighths of sky cloud cover (e.g. 4 oktas = 4/8 of cloud cover)
PAR	precision approach radar
PIC	pilot in command
PPL (A *or* H)	Private Pilot Licence (Aeroplane *or* Helicopter)
psi	pounds per square inch
QFE	an altimeter subscale setting to obtain height above aerodrome
QNH	an altimeter subscale setting to obtain elevation above mean sea level
RNZAC	Royal New Zealand Aero Club
RNZAF	Royal New Zealand Air Force
r.p.m.	revolutions per minute
RTF	radio telephone or radio telephony

s	second(s)
S	south
SAR	Search and Rescue
SSR	secondary surveillance radar
^{o}T	degrees true
TACAN	Tactical Air Navigation aid
TAF	aerodrome forecast
TAS	true airspeed
UHF	ultra high frequency
UTC	Coordinated Universal Time
VASIS	visual approach slope indicator system
VFG	Visual Flight Guide
VFR	visual flight rules
VHF	very high frequency
VMC	visual meteorological conditions
VOR	VHF omnidirectional radio range
VORTAC	VOR and TACAN combined
VTC	Visual Terminal Chart
W	west