CAA SAFETY INVESTIGATION REPORT

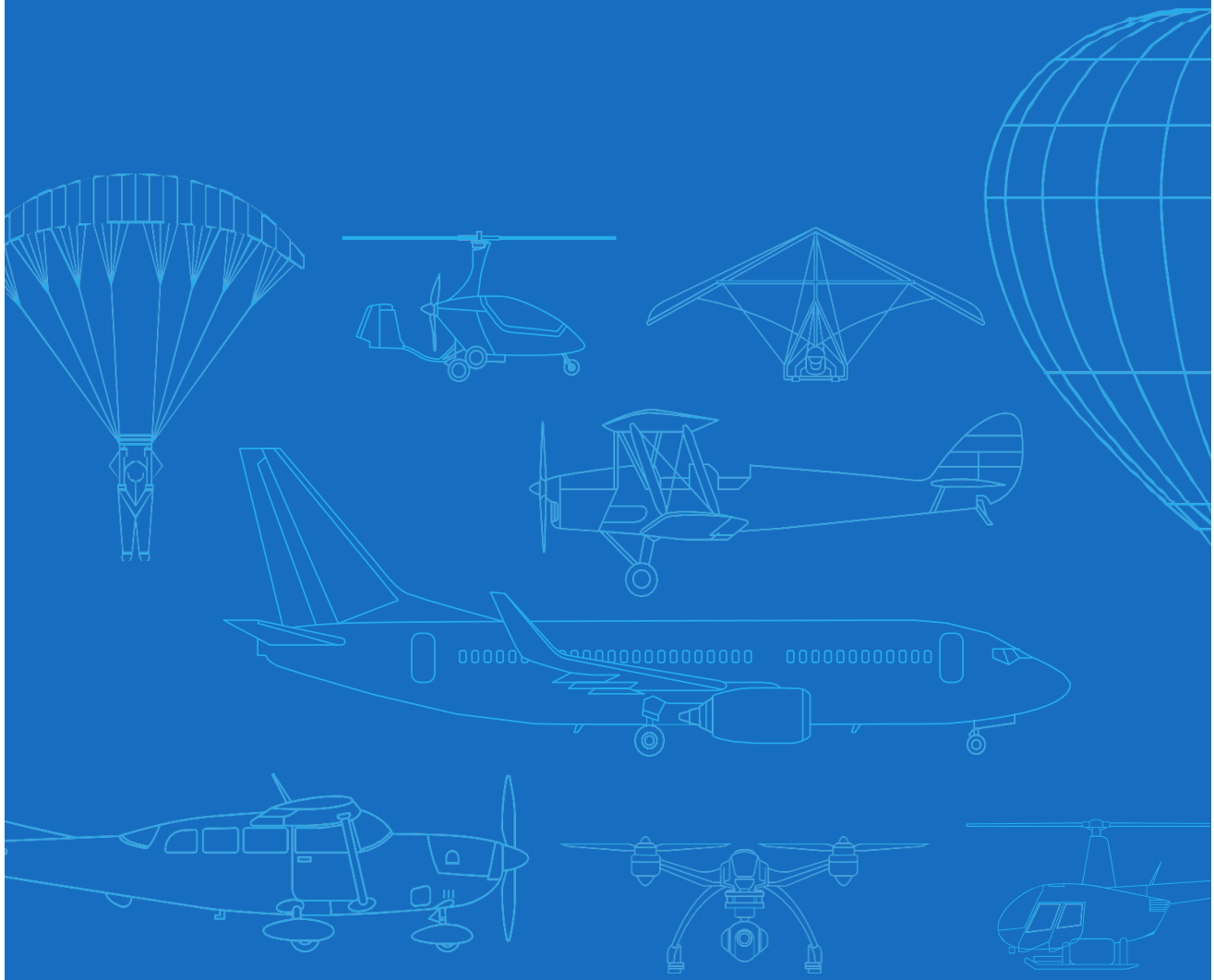
CIVIL AVIATION AUTHORITY OF NEW ZEALAND
Te Mana Rererangi Tūmatanui o Aotearoa

Controlled flight into terrain

ZK-COM Cessna 172G

Upper Waikaia Valley, Southland

03 February 2021



CAA Final report 21/529

Executive summary

At 1723 hours New Zealand Daylight Time[1] on 03 February 2021, the Rescue Coordination Centre (RCC) received a distress alert from an Emergency Locating Transmitter (ELT) fitted to ZK-COM, a Cessna 172G (the aircraft). The RCC tasked a rescue helicopter from Queenstown to fly to the position of the last known ELT transmission, but the crew could not locate the aircraft due to heavy cloud cover in the area.

Earlier that day, the aircraft had departed Cromwell at 1709, and it had crashed into a hillside in the upper Waikaia Valley at about 1722 en route to Gore. The pilot was found by a ground search party early the next morning inside the wreckage of the aircraft, but he had not survived the accident.

The CAA safety investigation determined that the accident likely occurred as a result of the pilot flying in conditions of reduced visibility[2], and then inadvertently impacting terrain.

The investigation identified that the following key factors contributed to the accident:

Human factors	• it is likely that the pre-flight weather assessment carried out by the pilot did not include all of the forecast weather along the entire route • the route flown and the decision to continue took the aircraft towards deteriorating weather and an area with limited options for the pilot to divert • the aircraft configuration and airspeed were not suitable for conditions of reduced visibility
Environmental factors	• a moving frontal system meant the weather was likely suitable for flying at the destination but not along the route flown • the local terrain and weather conditions likely led to orographic cloud formation at the location of the accident, which likely blocked the pilot's only escape route.

[1] New Zealand Daylight Time is Coordinated Universal Time (UTC) + 13 hours
[2] Civil Aviation Rule Part 91.301 requires a minimum flight visibility of 5 km for VFR flights

Safety Lessons

The investigation identified the following safety lessons:

Thorough pre-flight planning, including checking forecast weather conditions along the route using appropriate sources, selecting the most suitable route and assessing alternative routes in case the weather deteriorates, enables a pilot to anticipate and make timely decisions to divert or turn back.

Regularly practicing mountain flying, low flying, and flying in the reduced visibility configuration with an instructor, is important to reinforce initial training and to keep flying skills current for pilots. These skills give a pilot more options and time to make good decisions when faced with adverse weather conditions.

Biennial flight reviews (BFR) are an opportunity to practise and improve skills in non-normal operations, and to simulate bad weather and en route diversions or decision making. It is important for private aircraft owners who are based away from a flight training environment to ensure they are flying with an instructor regularly to maintain skill currency.

Pilots should always have an escape route when flying in valleys, and preferably more than one, so that if weather conditions change rapidly and a turn back is required, a safe route out of valleys, through passes or saddles is available to them. Pilots should not enter a valley if their only known escape route is not certain to remain open.

What Happened

On the day of the accident, the pilot departed Cromwell Racecourse aerodrome at 1709 for a private flight to Gore aerodrome (refer Figure 1), which was a flight the pilot had done numerous times and on a regular basis.

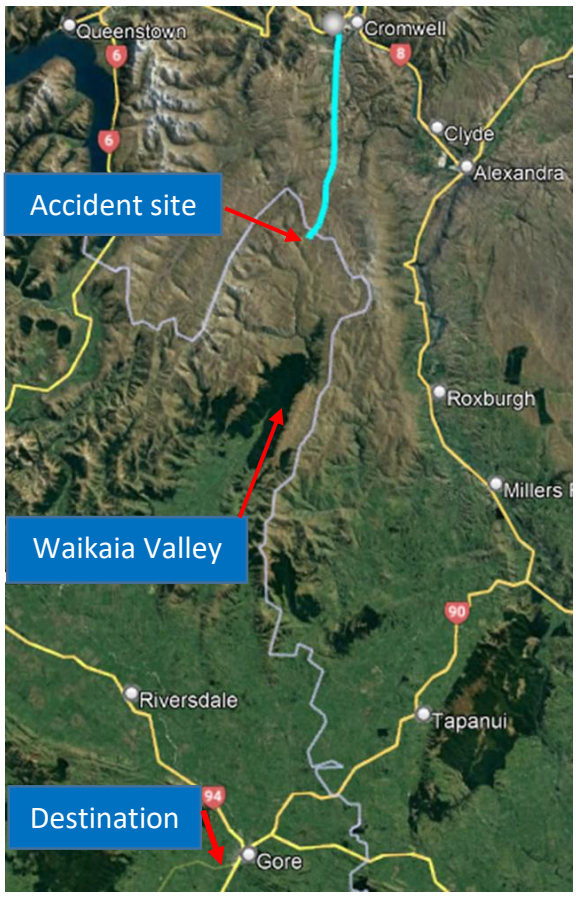


Figure 1 ZK-COM flight overview

According to flight track data (refer Figure 2) received from the ADS-B[3] equipment fitted to the aircraft and by an MLAT[4] system operated by Airways, the pilot initially flew in a southerly direction and climbed to 4900 feet above mean sea level (AMSL). After the aircraft passed abeam Clyde it turned to the south-east briefly before turning back towards the south. It tracked towards a saddle between the Old Woman and Old Man Ranges, and after crossing the saddle at 5000 feet AMSL (about 200 feet above terrain) it entered the east branch of the upper Waikaia Valley.

[3] Automatic Dependent Surveillance–Broadcast (ADS-B) is an aircraft surveillance system that receives accurate and precise location data from a satellite constellation and then broadcasts this information through a transponder.

[4] MLAT or multilateration is a ground-based network of transceivers that send and receive radio signals from aircraft equipped with transponders. The system measures the time taken to receive these signals to pinpoint the location of aircraft in flight.

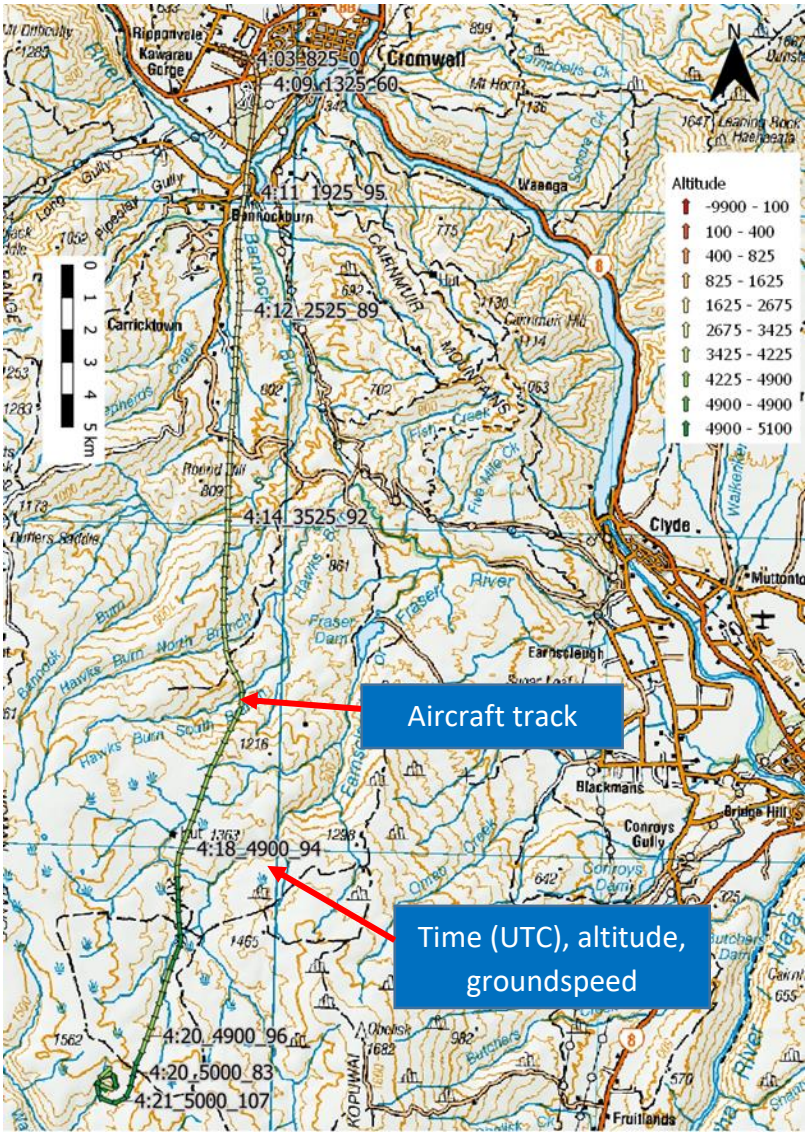


Figure 2 Aircraft ADS-B and MLAT track overlaid on topomap

Shortly after crossing the saddle the aircraft turned to the right, back towards the north and then continued turning in a series of right-hand orbits[5] and descended to 4800 feet AMSL in a valley. After the second orbit and while on an easterly heading, the aircraft struck terrain at high speed in a steep right wing down angle of bank, at an elevation of 4790 feet on the eastern side of the valley (refer Figure 3).

[5] In aviation an orbit is when an aircraft carries out a circular holding pattern or manoeuvre before carrying on, either in the original direction of flight or another direction.

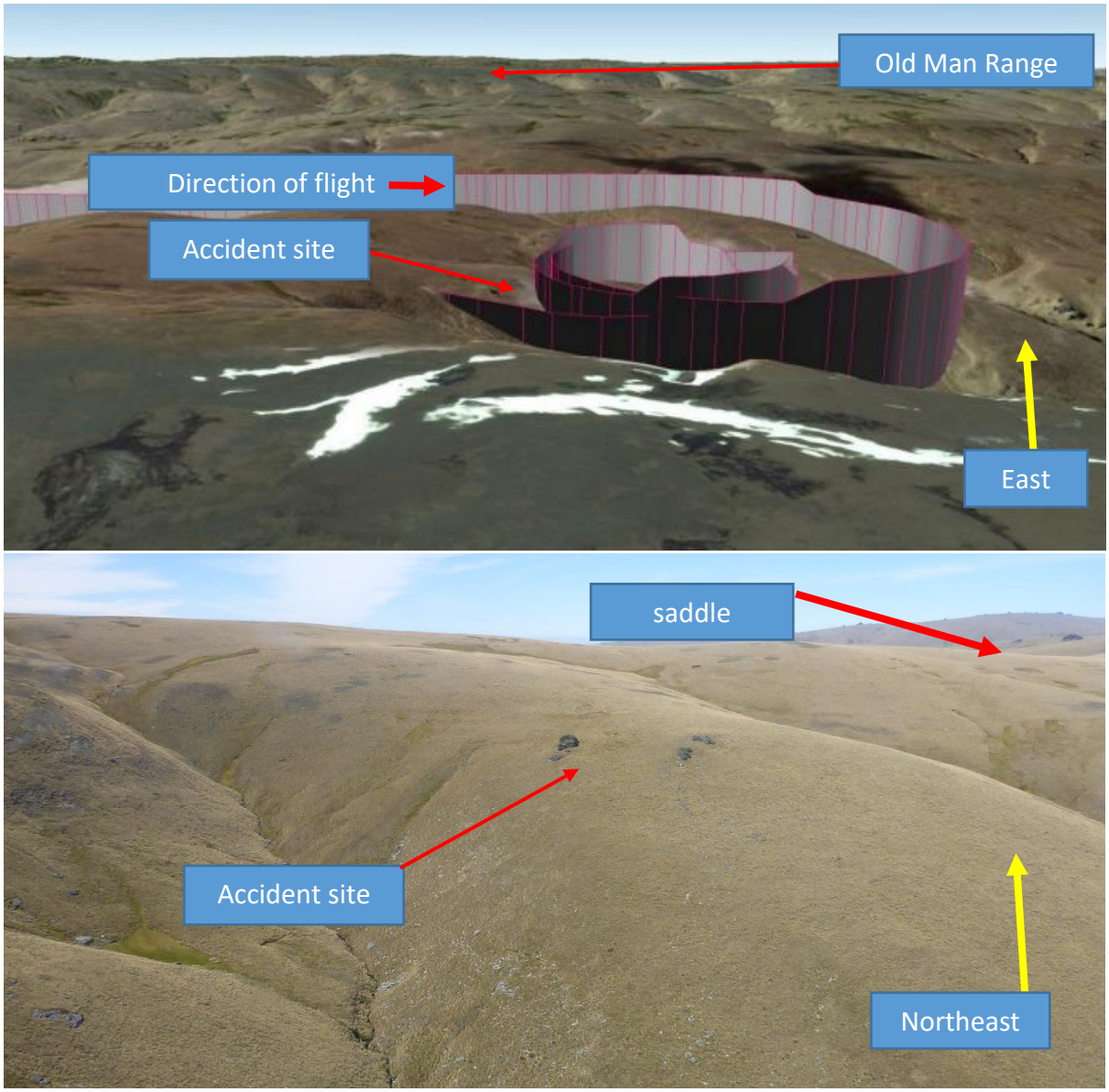


Figure 3 Vertical profile of aircraft orbiting, and location of the accident site (for illustrative purposes)

The flight

The purpose of the flight was for the pilot to travel from his normal place of residence in Cromwell to the family farm in Gore. It was a flight the pilot had carried out numerous times, and on a regular basis over a ten-year period. At times the pilot had flown the trip twice a week, but typically it was either a weekly or fortnightly occurrence.

The flight typically involved flying in a southerly direction between the Old Woman and Old Man Ranges and down the Waikaia Valley to land at Gore aerodrome. A longer alternative route if cloud prevented flying over the higher terrain south of Cromwell, was to follow the Clutha River past Alexandra and Roxburgh in a south easterly direction, before turning to the southwest and flying over Tapanui towards Gore. The pilot had flown this route several times in the previous six months.

The weather

Aviation weather forecasts covering the day of the accident and issued for the Central Otago area forecast there would be a south-westerly flow initially, with a southerly change late in the afternoon. The wind on the ground at Queenstown airport was forecast to turn southerly and increase to 18-28 knots (kts) sometime between 1600 and 1800 local time. The cloud at Dunedin airport was forecast to lower to 1200 feet above ground level (AGL) temporarily between 1500 and 2000 as a cold front moved through Otago from the south.

The closest aerodrome forecast to the point of departure and the accident site was Alexandra, and this forecast a change of the 2000 feet AGL wind to 15kts from the south between 1600 and 1800. The closest aerodrome forecast to the destination was Invercargill, which initially forecast southerly wind and broken[6] cloud cover at 3000 feet AGL, with rain and broken cloud at 1200 feet AGL temporarily between midday and 1700.

To assist the safety investigation, the CAA Chief Meteorologist was asked to provide a summary of the likely weather conditions in the area at the time of the accident.
The summary concluded that there was a weak cold front moving up from the south with cloud extending into the southern Central Otago region, and a heat low to the northwest. The general air flow was south to south-east across the region and strengthened during the afternoon and early evening. There was no significant turbulence or icing forecast for the region.

The actual weather conditions in the area 39 minutes after the accident were described by the search and rescue helicopter crew as heavy thick cloud sitting on top of the terrain with more rolling in very quickly. The pilot used the radar altimeter[7] to estimate the tops of the cloud at about 700 feet AGL (5500 feet AMSL), and when they departed this has increased to 1300 feet AGL (6100 feet AMSL). The wind they encountered was from a southerly direction at around 15 knots and flying conditions were generally smooth, and although they could hover above the area they could not see through the cloud to the ground.

A Metservice Search and Rescue (SAR) weather briefing was received after the accident, which covered the night and following morning in the area of the accident. It forecast a broken cloud layer from 2500 feet AMSL with the tops at 8000 feet AMSL, and winds from the south-west at 15 knots. The Land SAR team encountered thick fog while searching for the aircraft, with visibility reduced to 100 metres in the vicinity of the accident site about four hours later.

A witness from Alexandra recalled seeing cloud covering the upper third of the northern and eastern flanks of the Old Man Range at around the time of the accident and described it as

[6] Broken cloud is 5/8ths to 7/8ths or oktas of cloud cover obscuring the sky.
[7] A radar altimeter is an airborne electronic device capable of measuring the height of the aircraft above terrain immediately below the aircraft using transmitted and received radio signals.

thick grey orographic[8] cloud that was moving in from a southerly direction. A second witness from Alexandra stated that he saw a defined cap of cloud on top of the Old Man Range late in the afternoon on the day of the accident, and that the wind was stronger than forecast.

Two other witnesses, one in the Moa Flat area about 20 km south of Roxburgh, and another on the Old Woman Range, both commented on the rapid deterioration in weather and the sudden increase in wind and cloud from the south, leading up to the time of the accident. Witnesses in the Gore area recalled the passing of a slow-moving front at around midday, with heavy cloud base at 600-800 feet AMSL and a southerly wind at about 10 knots accompanying the front. At the time of the accident the weather had cleared at Gore behind the front.

A weather station and webcam were installed at the family farm about 10 km east of Gore, and the pilot would often call ahead to check weather conditions at Gore aerodrome. The weather station at the farm recorded a southerly change and increase in wind at about 1300 on the day of the accident, indicating the passage of the front. The pilot had called a family member prior to departing to confirm his arrival time at the farm, although no evidence could be identified to confirm he had checked the weather conditions with anyone at Gore aerodrome. It is likely he used the weather station and webcam to check the weather conditions in the vicinity of Gore prior to departing.

The pilot had used a flight navigation application (App) on his phone called Air Navigation Pro during the flight. This displayed the aircraft's position and groundspeed in flight based on the GPS location of the pilot's phone, and it could also provide aviation weather forecasts and briefings for pilots before flight. However, at the time of the accident the App did not support aviation weather briefings for the operating system used on the pilot's phone. The pilot's MetFlight[9] account was also checked for any recent access to aviation weather forecasts and briefings, however the pilot had not signed in since 2013.

The pilot

The pilot had an estimated[10] 920 hours total flight time, with most of those hours flying ZK-COM, which the pilot had owned since 2000. The pilot held an aeroplane private pilot licence (PPLA), and in January 2021 had been issued a NZCAA Class 2 Medical Certificate, which was valid at the time of the accident. According to logbook entries and the

[8] Orographic clouds are clouds that develop in response to the forced lifting of air by topographical features on the earth's surface, such as mountains.
[9] Metflight General Aviation is a free aviation weather forecasting and reporting service from Metservice NZ.
[10] The pilot had not recorded all of the flights in a logbook, so an estimate was made with information available from logbooks, aircraft tech logs, and Air Navigation App flight times.

information in the NZCAA pilot database, the last documented Biennial Flight Review (BFR[11]) completed by the pilot had been in November 2015, which expired in November 2017. The investigation could not locate any evidence that the pilot had a current BFR at the time of the accident. The pilot had been a member of the Gore Aero Club but was not actively participating in club activities or using the club instructors, aircraft, or facilities around the time of the accident, and had not been an active member for several years.

The aircraft

ZK-COM (refer Figure 4), a Cessna 172G four-seater aircraft, had been owned by the pilot for over twenty years, and since 2019 the aircraft was co-owned by the pilot and a syndicate partner. At the time of the accident the aircraft had accrued about 5757[12] hours total flight time.

The aircraft was overdue for a Biennial Review of Airworthiness (RA[13]) at the time of the accident, with the last one completed on 31 January 2019[14]. The next scheduled maintenance inspection was a 100-hour check at 5794 hours, and an annual inspection due on 5 March 2021. In May 2020 the aircraft had been fitted with ADS-B equipment, and a portable GPS unit was removed, as the pilot had begun using the Air Navigation Pro App to display maps and position information in flight on his phone.

The other syndicate partner reported no mechanical issues with the aircraft prior to the accident, and there were no open defects in the aircraft technical log. The engine was inspected at an overhaul facility after the accident, and no pre-existing defects were found that would have prevented normal operation. The propeller displayed typical damage signatures from impacting terrain with significant power being delivered by the engine.

Figure 4 ZK-COM

[11] A Biennial Flight Review (BFR) is a two-yearly flight check with an instructor, required to be carried out by PPL holders to demonstrate their competency in normal and abnormal flying procedures.
[12] Flights had not been recorded in the aircraft tech log for two months prior to the accident.
[13] A Biennial Review of Airworthiness (RA) is carried out every two years to check that the aircraft has met all of the ongoing maintenance requirements over the two-year period, to ensure continued airworthiness.
[14] The scheduled due date for the RA was 31 Jan 2021, although this date can be extended by 10% for planning. An entry is normally made in the tech log to record this, however there was no such entry.

Why it happened

The investigation covered human factors, environmental factors, and mechanical factors. The key findings are listed below and then described in more detail:

Human factors	• It is likely that the pre-flight weather assessment carried out by the pilot did not include all of the forecast weather along the entire route
	• the route flown and the decision to continue took the aircraft towards deteriorating weather and an area with limited options for the pilot to divert
	• the aircraft configuration and airspeed were not suitable for conditions of reduced visibility
Environmental factors	• a moving frontal system meant the weather was likely suitable for flying at the destination but not along the route flown
	• the local terrain and weather conditions likely led to orographic cloud formation at the location of the accident, which likely blocked the pilot's only escape route
Mechanical factors	• no mechanical factors were identified.

Human factors

Pilot's pre-flight weather assessment

The pilot had likely checked the weather conditions near the destination by accessing a webcam at the family farm at Pukerau, about 15km northeast of Gore aerodrome. However, there was no record of the pilot accessing the online aviation weather briefing service from MetFlight, in order to assess the weather forecast to be encountered between the departure point and the destination. There was also no evidence found of the pilot contacting anyone at Gore aerodrome to check weather conditions at the destination.

If the pilot had accessed the MetFlight information, it would have provided forecasted areas of broken cloud with bases of between 1500 to 2500 feet AMSL and tops greater than 10000 feet AMSL over most of the Southland region, with visibility reducing to 6km in showers of rain (refer Appendix A). The weather synoptic chart also depicted a cold front moving north, from a position over the Foveaux Strait at 1300 to a position abeam Cromwell at 1900. It is possible that the pilot may have delayed his departure or changed his route had he been aware of the forecast weather.

Route flown and the decision to continue towards an area of reduced visibility

A comparison of three flights in October and November 2020 found that the pilot had carried out two flights from Cromwell to Gore which initially followed the same route towards the Old Man Range, but prior to reaching the upper Waikaia Valley the pilot had turned towards the east and then flown down the Clutha River. A third flight carried out by the pilot followed a direct line between Cromwell and Gore (refer Figure 5).

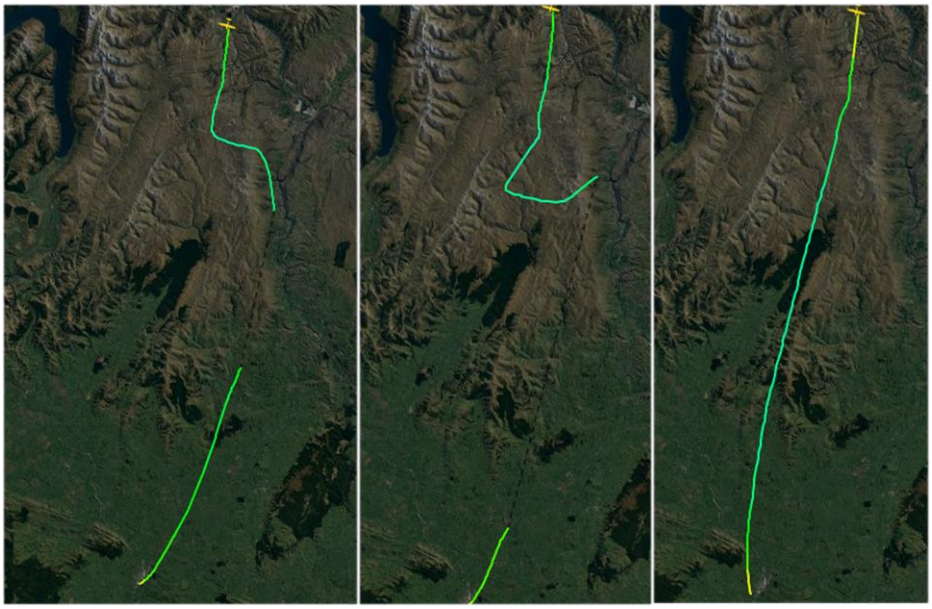


Figure 5 Previous flights

It is likely that the pilot had encountered adverse weather en route on two of the flights and had diverted around an area of cloud or poor visibility and flown along the Clutha River. The third flight was likely conducted in weather conditions that enabled the pilot to fly directly to the destination.

It could not be established why the pilot carried on in a direct line to his destination on the day of the accident, despite the presence of bad weather along this route and the likelihood of having to breach Civil Aviation Rules in order to do this[15]. The pilot may have been able to see down into the upper Waikaia Valley when he approached the Old Man Range and intended to descend below cloud into the Waikaia Valley rather than divert to the east and past Alexandra and Roxburgh.

The frontal band of cloud that was moving north up the lower South Island extended out off the east coast, so the alternative route along the Clutha River would have likely been affected by cloud and reduced visibility as well. However, the lower and more open terrain of this route would have allowed the pilot more time to assess weather encountered and more space to turn around and return to Cromwell if required.

[15] Civil Aviation Rule Part 91.311 requires a minimum height of 500 feet above the surface for VFR flights.

Aircraft configuration and airspeed in reduced visibility conditions

The recommended aircraft configuration and airspeed for flying at low level or in reduced visibility is 15-20 degrees of flap extended and about 65-70 kts. This enables a pilot to safely reduce speed to allow more time to assess and react to obstacles, and it reduces the radius of turns.

The last recorded flight tracking datapoint indicated the aircraft was travelling at 109 kts groundspeed just prior to impact with terrain (refer Figure 6). The average[16] airspeed flown during the two orbits carried out immediately before impact was estimated at about 100 kts, and the height varied between 150 to 300 feet above ground. An inspection of the aircraft wreckage established that the aircraft was configured without the flaps extended at the time of the accident.

Low flying or simulated reduced visibility flying is carried out during initial pilot training, and proficiency is normally demonstrated by pilots during a BFR with an instructor. The pilot had not completed a BFR since 2015, and so he had likely not practised flying in this configuration under supervision for at least five years.

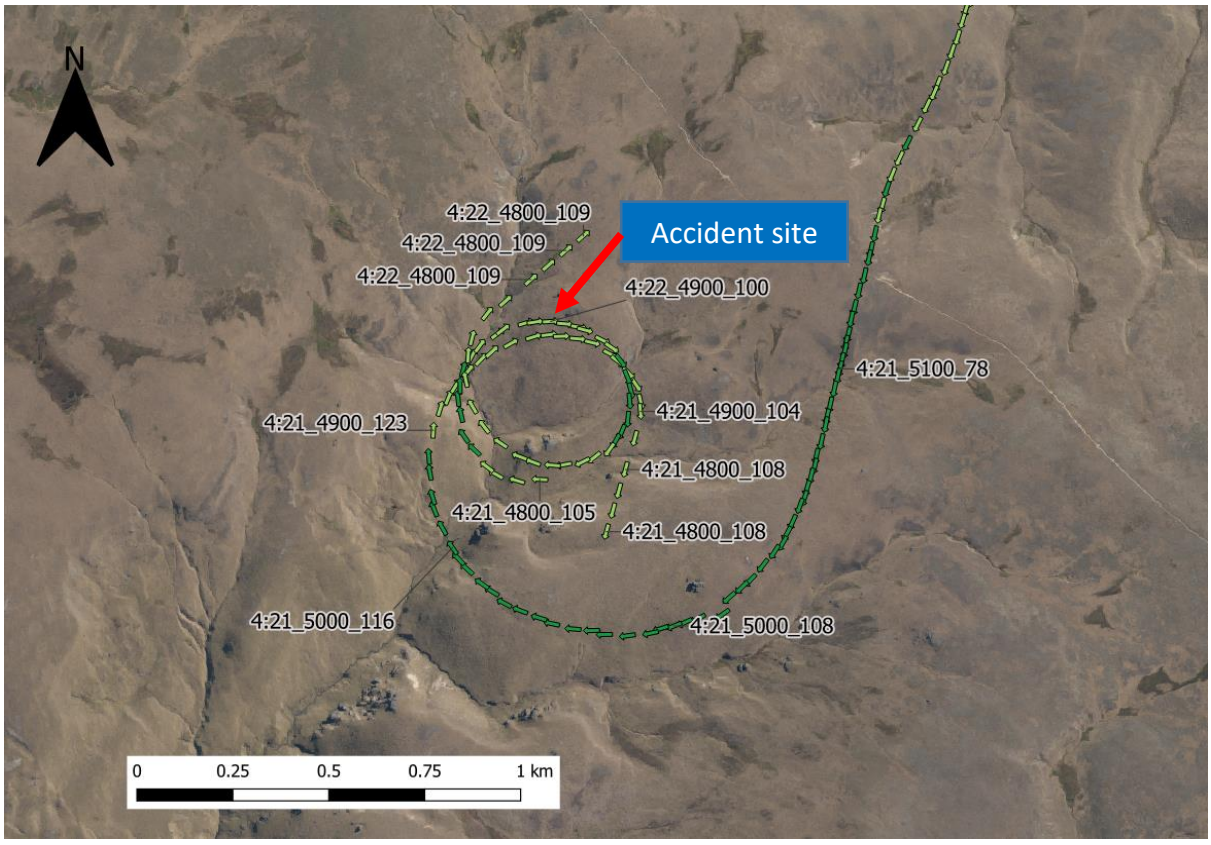


Figure 6 MLAT flight track data; time (UTC) altitude (AMSL) groundspeed (Kts).
(Straight lines of arrows indicates predicted flight path after a loss of signal)

[16] Due to the southerly wind, the groundspeed of the aircraft varied during the orbit, increasing when there was a tailwind (heading North), and decreasing when there was a headwind (heading South).

Environmental factors

Weather patterns and cloud formation

February in the South Island is typically a settled time of year regarding weather patterns, however there are still occasions when frontal systems pass up the lower South Island from the south with associated cloud and rain. The pilot may not have anticipated low cloud along the route on the day of the accident, and the live weather displayed by the farm webcam likely would have showed relatively clear weather near the destination (refer Figure 7), due to a hole in the cloud cover over Gore.

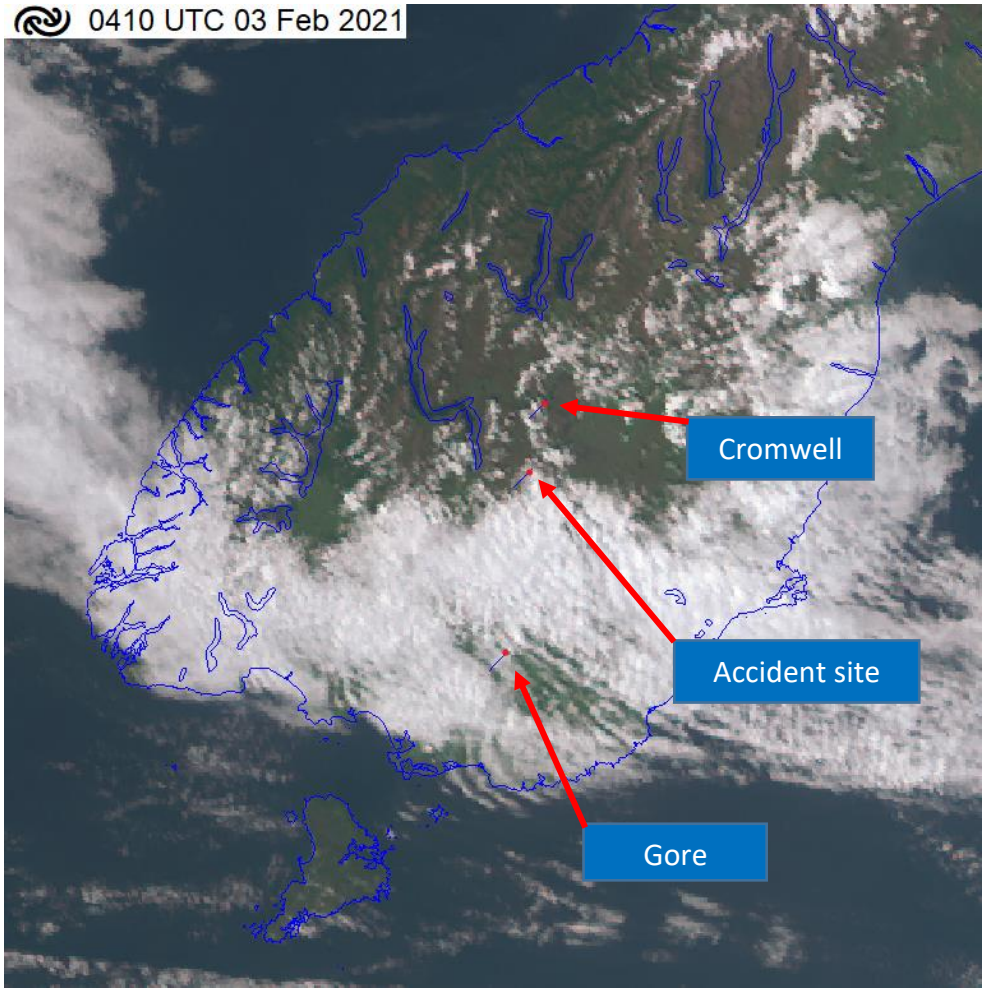


Figure 7 Satellite photo of cloud (image scan captured at 0519 NZDT, four minutes prior to the accident), and locations of the departure, accident site, and destination.

The forecast cloud layer associated with the front situated along the flight route, started at between 1500 and 2500 feet AMSL and the tops were over 10000 feet AMSL. The pilot would not have been able to see past the cloud cover to see what conditions were like behind the front, and the cloud likely extended out to the east and over the lower Clutha River by the time the aircraft reached the Old Man Range.

Witnesses recall seeing orographic cloud forming on top of the Old Man Range at around the time of the accident, and for some time afterwards. The forming of this cloud was likely the arrival of the front in the Alexandra area, and the formation of orographic cloud would have been caused by the southerly wind channelling a moisture laden air mass up the Waikaia Valley and over the Old Man Range. The formation of this type of cloud can be very fast as a front approaches, and the cloud formed on the windward side of the hill feature is pushed up against the terrain.

The pilot might have been able to see into the upper Waikaia Valley as the aircraft passed abeam the Old Man Range and may have thought it was clear underneath the visible cloud. However, this was likely the higher-level cloud at the leading edge of the cold front, with lower-level cloud behind and underneath it that was probably not visible initially.

After entering into the head of the Waikaia Valley the pilot likely encountered orographic cloud that was rapidly forming, due to cold moist air moving up the valley from the south. After orbiting the aircraft to assess the weather conditions and the options to either continue or turn back, it is likely the area became covered in cloud that blocked the saddle the pilot had crossed, which was the only escape option due to the lower-level cloud along the Waikaia Valley.

The orbital patterns flown by the pilot progressively moved towards terrain likely due to the southerly wind pushing the aircraft north, and after the second orbit the aircraft struck terrain in a steep angle of bank. This was likely caused by the pilot having reduced visibility due to cloud or rain, and because the pilot could not see the terrain until it was too late to avoid it.

What was learned

Safety lessons

Thorough pre-flight planning, including checking forecast weather conditions along the route using appropriate sources, selecting the most suitable route and assessing alternative routes in case weather deteriorates, enables a pilot to anticipate and make timely decisions to divert or turn back[17].

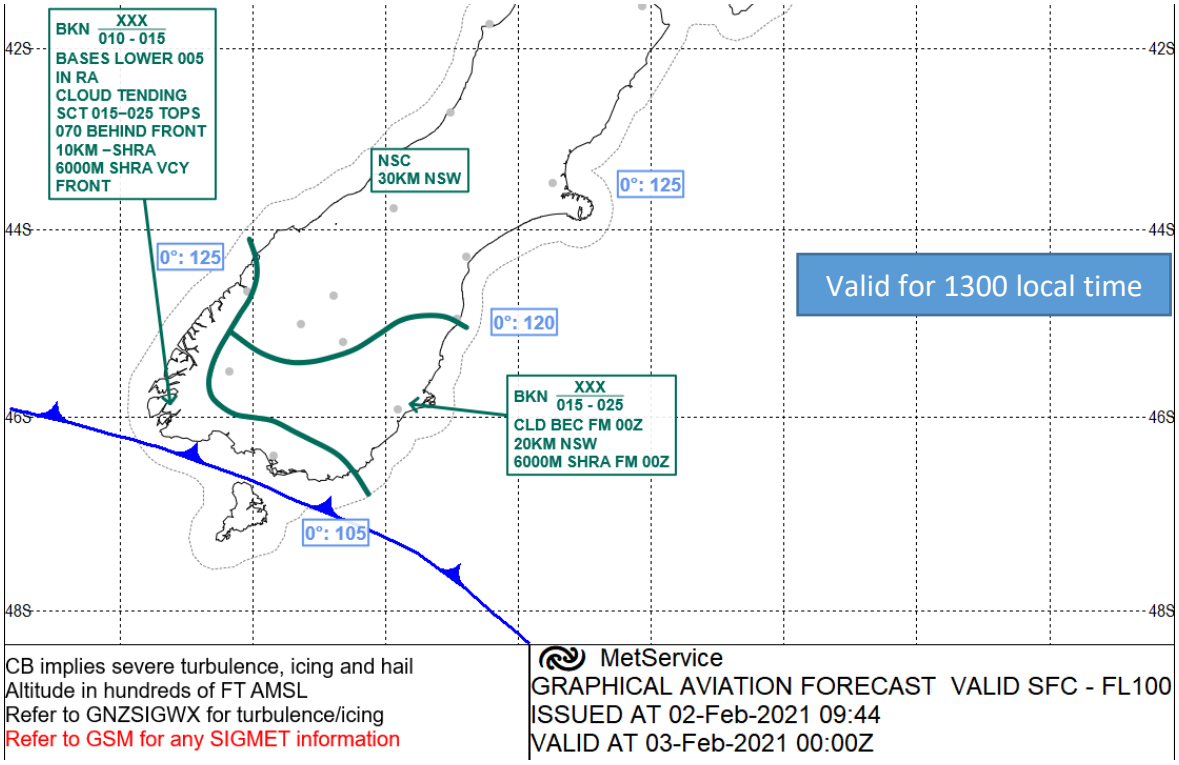
Regularly practicing mountain flying, low flying, and flying in the reduced visibility configuration with an instructor is important to reinforce initial training and to keep flying skills current for pilots. These skills give a pilot more options and time to make good decisions when faced with adverse weather conditions[18].

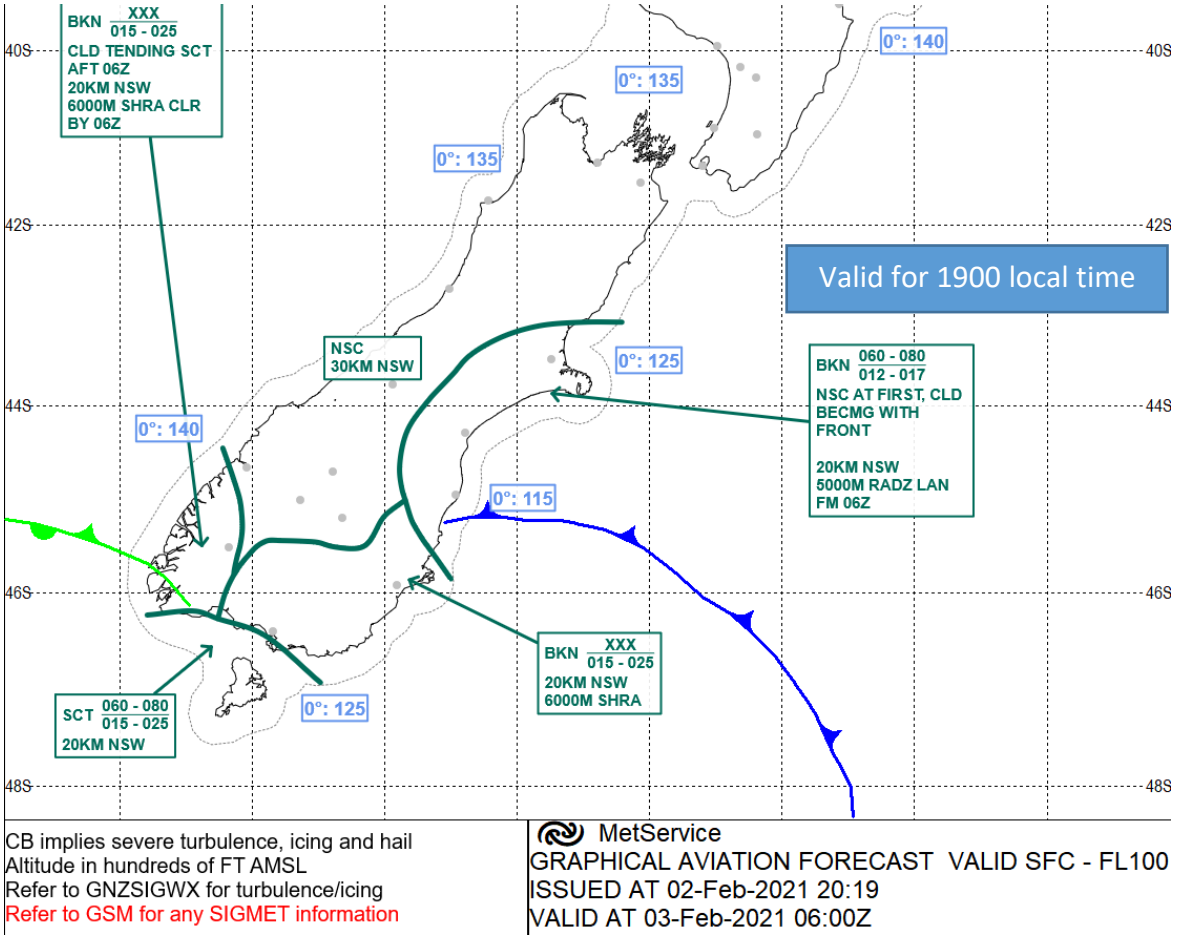
Biennial Flight Reviews (BFR) are an opportunity to practise and improve skills in non-normal operations, and to simulate bad weather and en-route diversions or decision making. It is important for private aircraft owners who are based away from a flight training environment to ensure they fly with an instructor regularly to maintain skill currency.

Pilots should always have an escape route when flying in valleys, and preferably more than one, so that if weather conditions change rapidly and a turn back is required, a safe route out of valleys, through passes or saddles is available to them. Pilots should not enter a valley if their only known escape route is not certain to remain open[19].

[17] Repeat safety lesson, refer 2020-12-14-Safety-Investigation-Report- ZK_TNB (aviation.govt.nz)
[18] Repeat safety lesson, refer CAA occurrence 19/6687 - ZK-SGO (aviation.govt.nz)
[19] Repeat safety lesson, refer CAA Occurrence Number 15/1129 (aviation.govt.nz)

Appendix A: Metservice weather forecast





About the CAA

New Zealand's legislative mandate to investigate an accident or incident is prescribed in the Transport Accident Investigation Commission Act 1990 (the TAIC Act) and Civil Aviation Act 1990.

Following notification of an accident or incident, TAIC may conduct an investigation. CAA may also investigate subject to Section 72B(2)(d) of the Civil Aviation Act which prescribes the following:

> **72B Functions of Authority**
>
> (2) The Authority has the following functions:
>
> (d) To investigate and review civil aviation accidents and incidents in its capacity as the responsible safety and security authority, subject to the limitations set out in Section 14(3) of the Transport Accident Investigation Commission Act 1990

The purpose of a CAA safety investigation is to determine the circumstances and identify contributory factors of an accident or incident with the purpose of minimising or reducing the risk to an acceptable level of a similar occurrence. The safety investigation does not seek to ascribe responsibility to any person but to establish the contributory factors of the accident or incident based on the balance of probability.

A CAA safety investigation seeks to provide the Director of Civil Aviation with the information required to assess which, if any, risk-based intervention tools may be required to attain CAA safety objectives.

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