Transport Accident Investigation Commission

Final report
Tuhinga whakamutunga

Aviation inquiry AO-2020-001
Pacific Aerospace Cresco 08-600, ZK-LTK
Impact with terrain
Kourarau Hill, Masterton
24 April 2020

March 2022

The Transport Accident Investigation Commission
Te Kōmihana Tirotiro Aituā Waka

No repeat accidents – ever!

"The principal purpose of the Commission shall be to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future, rather than to ascribe blame to any person."

Transport Accident Investigation Commission Act 1990, s4 Purpose

The Transport Accident Investigation Commission is an independent Crown entity and standing commission of inquiry. We investigate selected maritime, aviation and rail accidents and incidents that occur in New Zealand or involve New Zealand-registered aircraft or vessels.

Our investigations are for the purpose of avoiding similar accidents in the future. We determine and analyse contributing factors, explain circumstances and causes, identify safety issues, and make recommendations to improve safety. Our findings cannot be used to pursue criminal, civil, or regulatory action.

At the end of every inquiry, we share all relevant knowledge in a final report. We use our information and insight to influence others in the transport sector to improve safety, nationally and internationally.

Commissioners

Chief Commissioner	Jane Meares
Deputy Chief Commissioner	Stephen Davies Howard
Commissioner	Richard Marchant
Commissioner	Paula Rose, QSO

Key Commission personnel

Chief Executive	Martin Sawyers
Chief Investigator of Accidents	Harald Hendel
Investigator-in-Charge for this inquiry	Hamish Johnstone
Commission General Counsel	Cathryn Bridge

Notes about Commission reports
Kōrero tāpiri ki ngā pūrongo o te Kōmihana

Citations and referencing

The citations section of this report lists public documents. Documents unavailable to the public (that is, not discoverable under the Official Information Act 1982) are referenced in footnotes. This report does not cite information derived from interviews during the Commission's inquiry into the occurrence.

Photographs, diagrams, pictures

The Commission owns the photographs, diagrams and pictures in this report unless otherwise specified.

Verbal probability expressions

For clarity, the Commission uses standardised terminology where possible.

One example of this standardisation is the terminology used to describe the degree of probability (or likelihood) that an event happened, or a condition existed in support of a hypothesis. The Commission has adopted this terminology from the Intergovernmental Panel on Climate Change and Australian Transport Safety Bureau models. The Commission chose these models because of their simplicity, usability, and international use. The Commission considers these models reflect its functions. These functions include making findings and issuing recommendations based on a wide range of evidence, whether or not that evidence would be admissible in a court of law.

Terminology	Likelihood	Equivalent terms
Virtually certain	> 99% probability of occurrence	Almost certain
Very likely	> 90% probability	Highly likely, very probable
Likely	> 66% probability	Probable
About as likely as not	33% to 66% probability	More or less likely
Unlikely	< 33% probability	Improbable
Very unlikely	< 10% probability	Highly unlikely
Exceptionally unlikely	< 1% probability	

Figure 1: Pacific Aerospace Cresco 08-600, ZK-LTK
(Credit: Jordan Elvy, Jetphotos)

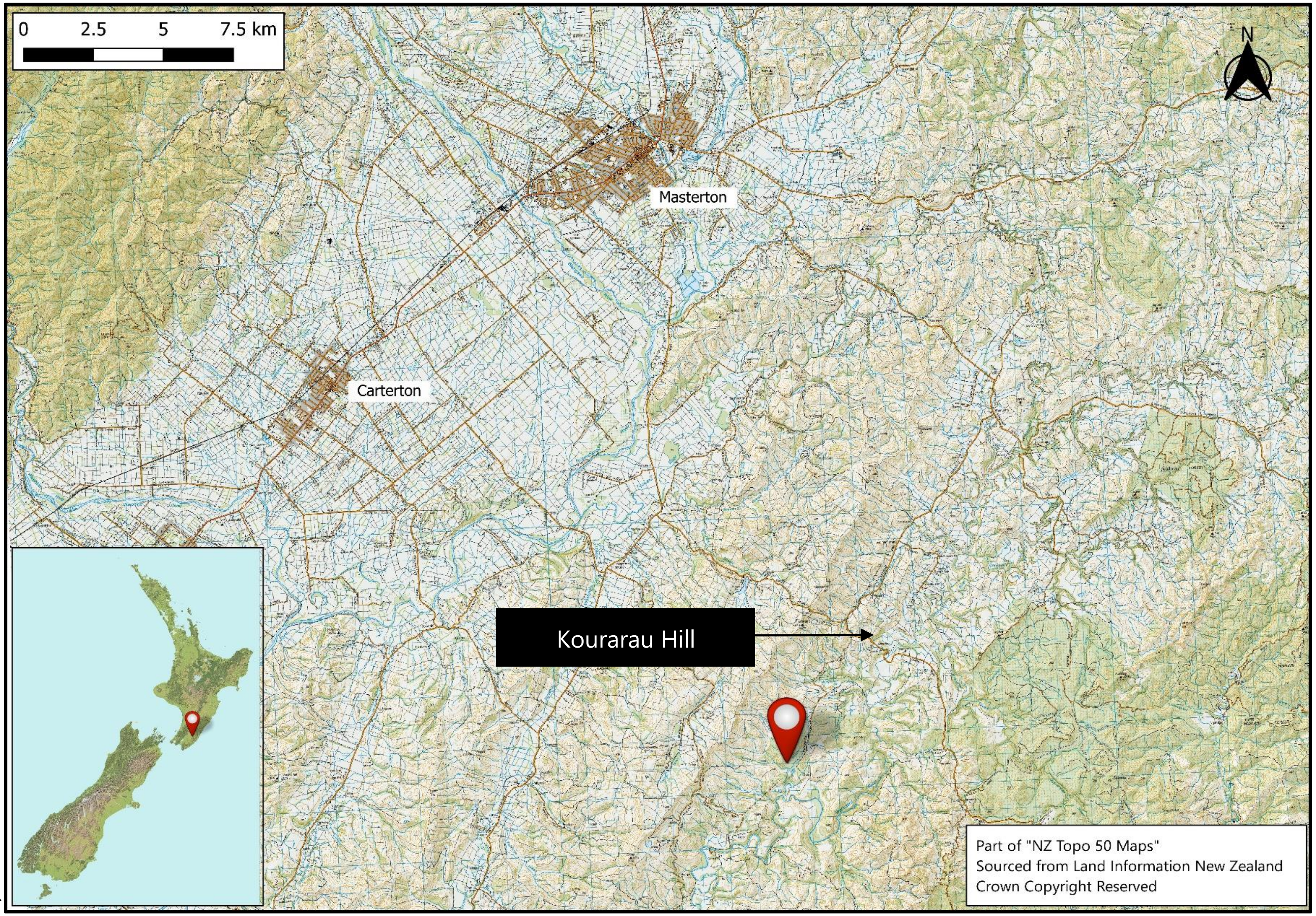

Figure 2: Location of accident

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Rārangi take

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1 Executive summary

Tuhinga whakarāpopoto

What happened

1.1. On 24 April 2020 the pilot of a Pacific Aerospace Cresco 08-600 aircraft, registered ZK-LTK (the aeroplane), was conducting agricultural flight operations spreading superphosphate fertiliser on a farm in the Kourarau Hill area, near Masterton.

1.2. The airstrip was a typical topdressing airstrip, with a downward slope and a left bend of about 5 degrees partway down the strip, in the direction of take-off. The ground at the end of the airstrip dropped sharply away to a valley that ran perpendicular to the direction of the airstrip.

1.3. On the commencement of the third topdressing flight, witnesses reported, the aeroplane accelerated normally from the loading point. However, the aeroplane did not follow the direction of the airstrip around to the left, as it had done during the previous two flights. Instead, the aeroplane continued in a straight line from the load point and subsequently struck uneven terrain off to the right of the airstrip. The impact with the uneven terrain caused the right main undercarriage assembly to fracture off and damage the right wing and flap.

1.4. The aeroplane descended into the valley, striking a tree with the right-hand wing, then continued across the valley floor and impacted the far side of the valley, coming to rest inverted.

1.5. The aeroplane was destroyed by the impacts and a post-crash fire. The sole pilot occupant did not survive the accident sequence.

Why it happened

1.6. After departing the loading point, the aeroplane did not turn to align with the airstrip direction, as it had on previous occasions. The evidence did not show any attempt by the pilot to correct this deviation from the previous, and ideal, two take-off paths.

1.7. The absence of any corrective action by the pilot, including discontinuing the take-off, correcting the take-off path after encountering uneven and rough ground, dumping the load and/or making a radio call to the loader driver, could indicate the pilot was incapacitated and therefore was incapable of performing such actions.

1.8. The aeroplane's veering off the airstrip and striking rough terrain caused the right main undercarriage attachment bolts to break and the complete undercarriage assembly to separate. The undercarriage assembly then struck and partially dislodged the right wing flap.

1.9. The Transport Accident Investigation Commission (the Commission) examined a range of factors that either singularly or in combination may have caused the accident, including weather, mechanical, aircraft load, airstrip and medical factors. All factors, except medical, were discounted as possible contributing factors.

1.10. Because of the lack of evidence available to the investigation, the reason for the aeroplane's deviation from the normal flight path could not be determined conclusively.

1.11. After an extensive analysis of the available evidence, including no evidence of any action being taken after the aeroplane deviated, the Commission concluded that it is **about as likely as not** that the pilot was incapacitated. There was no definitive evidence to support this finding directly; rather it was reached through a process of eliminating the **unlikely** scenarios.

What we can learn

1.12. No new safety issues were identified, and no recommendations have been made.

2 Factual information

Pārongo pono

Narrative

2.1. On 24 April 2020, the pilot of a Pacific Aerospace Cresco 08-600 aircraft, registered ZK-LTK (the aeroplane), was conducting agricultural flight operations spreading superphosphate fertiliser[1] on a farm in the Kourarau Hill area, near Masterton. The pilot departed Hood Aerodrome, near Masterton, at 0643[2] and landed at the farm airstrip[3] from which they would be operating at 0655. The farmer and a loader driver were on site and beginning the set-up for the day when the pilot arrived. The farmer remained at the airstrip to observe the operation and to take photographs.

2.2. Spreading operations commenced at 0700, with the first and second flights taking about four minutes each, with about a one-minute turnaround to reload between flights. The loader driver reported talking to the pilot on the radio during the first two flights. The take-off path used for the first two flights had a left turn of about 5 degrees, approximately a third of the way down the take-off roll[4] from the loading point (see Figure 3).

2.3. The third flight take-off roll commenced at about 0710 with the same weight of product as loaded in the previous two flights. The aeroplane was observed by witnesses to accelerate normally. Wheel marks on the airstrip indicated the aeroplane did not turn left as required. Rather it continued in a straight line from the loading point area, crossing increasingly uneven and rough terrain.

2.4. The aeroplane impacted solid terrain off to the right-hand side of the airstrip. The right main undercarriage[5] was seen to separate from the aeroplane at this time. The aeroplane then descended into the valley, striking a tree on the valley floor with the right-hand wing, dislodging the outer part of the wing. The aeroplane then rolled inverted and continued across the valley floor. The aeroplane impacted the ground at the base of the up-sloping terrain, sliding a further 20 metres up the slope. A subsequent fire destroyed most of the wreckage.

2.5. The pilot did not survive the accident sequence.

2.6. An agricultural pilot from another company, who was operating nearby, noticed the smoke from the wreckage and landed on the same airstrip soon after the accident to render assistance if possible. A local helicopter pilot operating in the vicinity at the time also attended the scene to render assistance.

[1] A manufactured fertiliser containing plant-available phosphorus and sulphur.

[2] Times are in New Zealand standard time (co-ordinated universal time + 12 hours) and expressed in the 24-hour format.

[3] A strip of ground set aside for the take-off and landing of aircraft.

[4] The portion of the take-off procedure during which an aircraft is accelerated from a standstill to an airspeed that provides sufficient lift for it to become airborne.

[5] A wheeled structure beneath an aircraft that supports the aircraft on the ground. Also known as the landing gear.

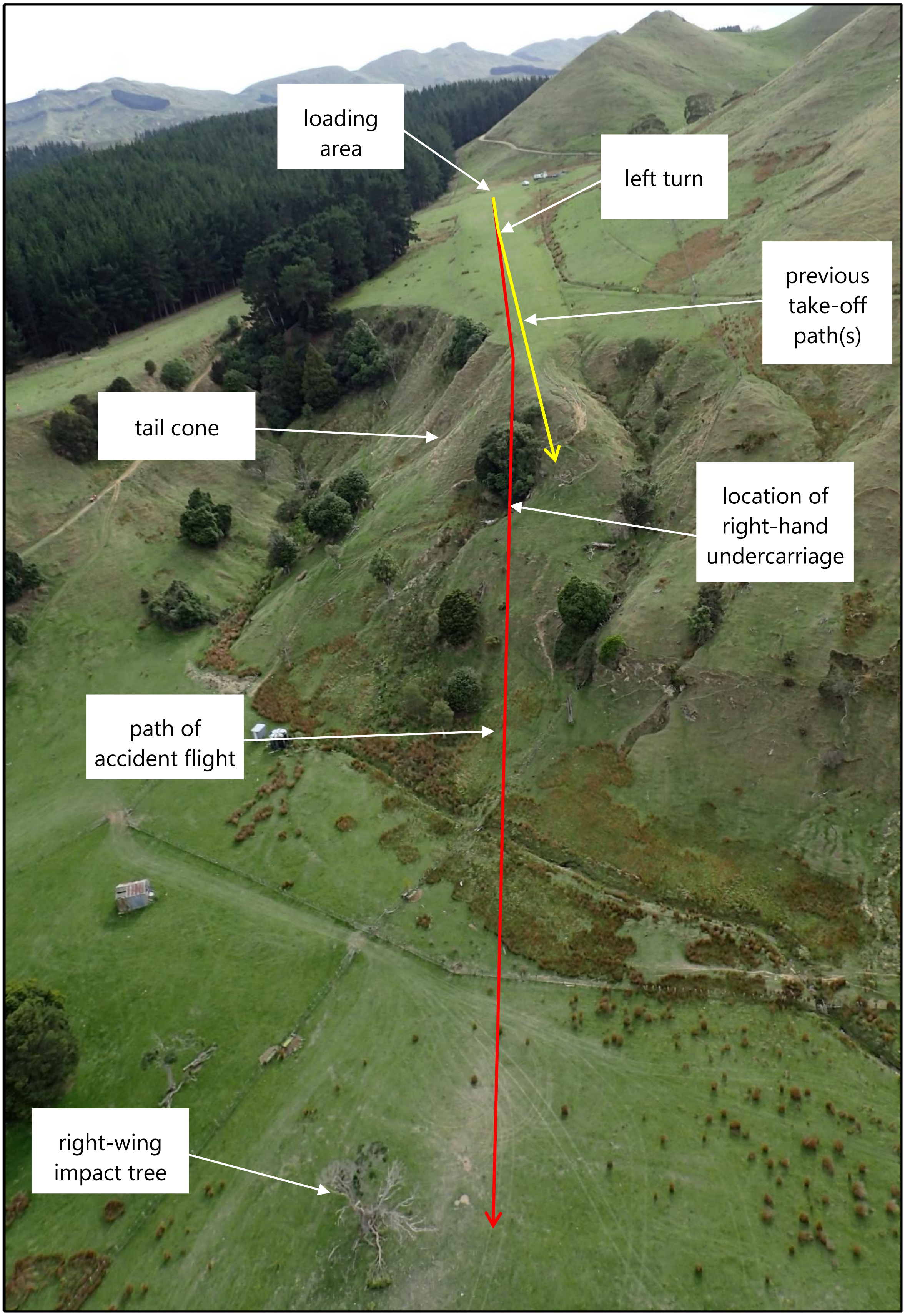

Figure 3: Reverse view of airstrip

Site information and damage to the aeroplane

2.7. The aeroplane was destroyed as a result of its striking the tree, and the ground impacts. A post-impact fire consumed much of the wreckage. The remaining wreckage, other than the outboard portion of the right wing and right main undercarriage, was distributed over a relatively small area at the impact site. See Figure 3, Figure 4 and Figure 5. An examination of the wreckage and accident site identified:

- the aeroplane was found inverted about 20 metres up slope from the final impact point
- all available flight-control-system components were assessed for control continuity and function, with no pre-existing defects identified
- the propellor blades, located at the final point of impact, showed rotational damage, indicating the engine was delivering power at the time of ground impact
- the outboard portion of the right wing was found near a tree located about 70 metres before the main wreckage site
- the right undercarriage leg and wheel, as a complete assembly, were found at the base of the slope at the end of the airstrip
- the tail cone was found down the slope, next to the end of the airstrip on the right-hand side (see Figure 3).

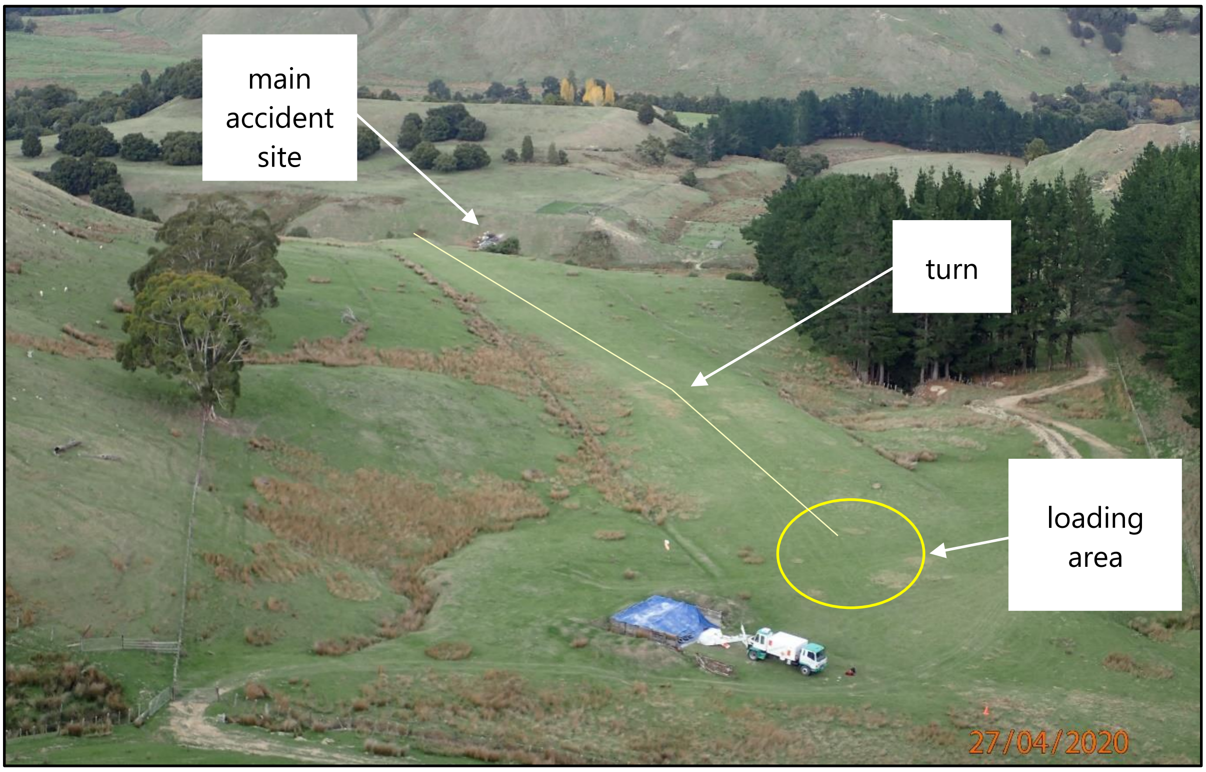

Figure 4: The airstrip from behind the loading area

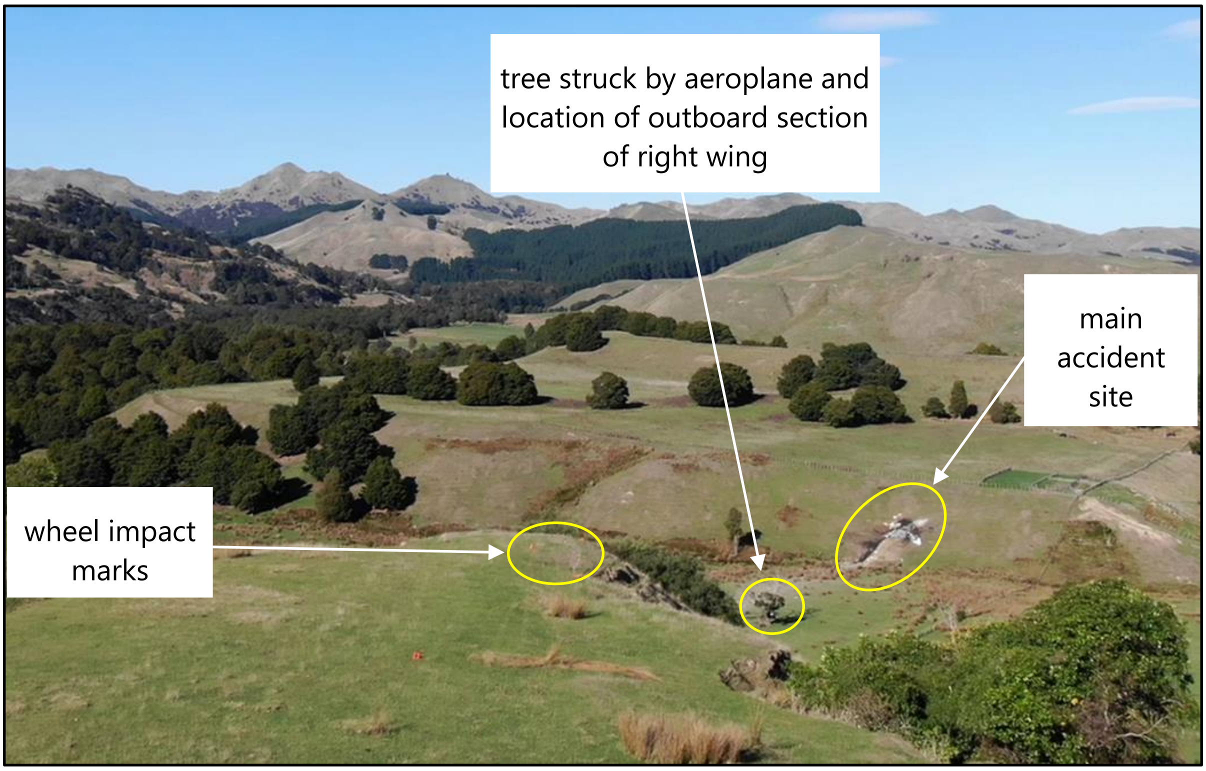

Figure 5: Accident site from the end of the airstrip

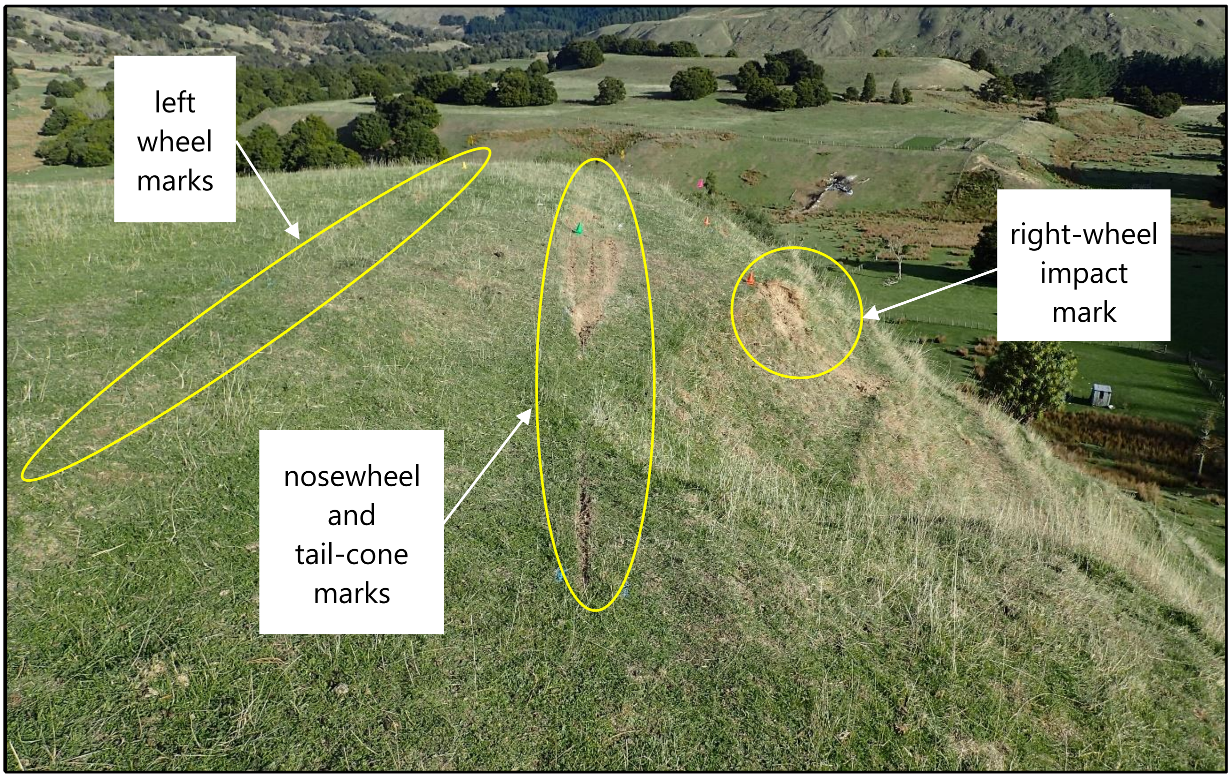

Figure 6: Ground scars at the end of the airstrip

Figure 7: Undercarriage missing and right-hand-wing damage (Credit: G Saunders)

Personnel information

2.8. The pilot, aged 55, held a Commercial Pilot Licence – Aeroplane with Agricultural Grade 1, Topdressing[6] and Chemical Ratings.

2.9. The pilot had more than than 15,000 hours' total flying time, of which 12,000 had been agricultural flying, including more than 8,700 in the Pacific Aerospace Cresco 08-600.

2.10. The pilot had flown about 20 hours in the previous seven days, and about 110 hours in the previous 28 days. The pilot's most recent agricultural and pilot competency check on the Cresco had been completed six months before the accident, in October 2019.

2.11. The pilot held a current Class 1 medical certificate for operations "other than single pilot air operations carrying passengers"[7], valid until June 2020.

2.12. The pilot had been with the Ravensdown Aerowork Limited (the operator), for more than 10 years and was one of the operator's more experienced and senior pilots. They were well respected by fellow pilots.

2.13. Witnesses stated the pilot appeared in good health on the day of the accident and expressed no concerns of anything unusual.

2.14. The pilot's medical history was reviewed by an aviation medical specialist, and nothing of relevance could be identified.

[6] The aerial application of fertilisers over farmland using agricultural aircraft.

[7] Civil Aviation Rules Part 67 – Medical Standards and Certification, section 67.61 states that a Class 1 medical certificate is valid for up to six months for single-pilot air operations carrying passengers if the applicant is 40 years of age or more, and 12 months in all other cases.

2.15. The post-crash fire severely limited the autopsy examination. The examination was therefore inconclusive regarding identifying any potential contributing factors to the accident. Toxicology tests were negative for any performance-impairing substances.

Aircraft information

2.16. ZK-LTK was a Pacific Aerospace Cresco 08-600, manufactured in 2002.

2.17. The Cresco was a New Zealand-built aeroplane with a low wing, fixed tricycle undercarriage and dual side-by-side controls, with the pilot occupying the right-hand seat. The hopper[8] was mounted behind the pilot, with an an emergency load-jettison lever located by the pilot's left thigh. This lever allowed the pilot to rapidly jettison the contents of the hopper in an emergency.

2.18. The Cresco was powered by a 750-shaft horsepower Pratt & Whitney PT6-34 Ag turbine engine and fitted with a Hartzell three-bladed, constant-speed, full-feathering and reverse-pitch propeller

2.19. The aeroplane's most recent maintenance check had been a 150-hour inspection on 29 January 2020, at the operator's own maintenance facility.

Meteorological information

2.20. At the time of the accident, the weather at Masterton Airport was recorded as:

- wind: 040 degrees magnetic at 3 knots[9]
- QNH (mean sea level pressure): 1011 hectopascals
- temperature: 11 degrees Celsius
- dew point: 10 degrees Celsius
- visibility: 20 kilometres
- cloud: few[10] 24,000 feet (7,315 metres) above ground level.

2.21. Witnesses reported that the weather during the morning of the accident was fine with little to no wind.

Airstrip information

2.22. The farm airstrip was located approximately 12 nautical miles (22 kilometres) south-south-west of Hood Aerodrome near Masterton. The farm airstrip was a one-way[11] grass strip, orientated in a north-south direction and measuring 317 metres from the loading point to the end of the usable area, where it dropped away sharply.

2.23. About 130 metres from the loading point, a left turn of approximately 5 degrees was required to remain in the centre of the airstrip. The terrain on both sides of the airstrip was rough and undulating.

[8] Part of an agricultural aircraft used to store chemicals to be spread.
[9] One knot equals one nautical mile (and 1.852 kilometres) per hour.
[10] One-eighth to two-eighths of cloud coverage.
[11] An airstrip that can only be used for taking off and landing from the same direction, in this case from the south.

2.24. The usable area of the airstrip had recently been mowed in preparation for operations, in accordance with the operator's airstrip preparation guidelines made available to clients.

2.25. At the time of the accident the airstrip was not included in the operator's airstrip register. Normal practice was to update the register during, or at the completion of, an operation. A pilot was responsible for making the final decision on the suitability and safety of an airstrip for operations.

Tests and research

2.26. The right main undercarriage separated from its mount point in the right wing as a whole assembly early in the accident sequence. To establish the likelihood of this being a causal factor in this accident, a specialist in metallurgy examined the right main undercarriage. The specialist determined that:

> …The leg failed from the wing structure as a result of the wheel being forced backwards and upwards into the wing structure as a result of a single high load impact. Failure will have occurred to the lower support clamp before a significant bending load was applied to the upper bolts. There was no evidence of any pre-existing damage to the clamping system such as fatigue or significant loss of section due to corrosion.

Organisational information

2.27. The operator held a Civil Aviation Rules Part 137 – Agricultural Aircraft Operations certificate issued by the Civil Aviation Authority of New Zealand. The operating certificate permitted the operator to conduct agricultural operations in accordance with its exposition.

2.28. The operator had an internal check and training system as part of its Safety Management System.

2.29. As part of the operator's quality assurance programme, the chief pilot conducted both announced and unannounced spot checks of base pilots. The operator conducted regular team meetings with all pilots, utilising online group meeting applications when face-to-face meetings were restricted by COVID-19 protocols.

2.30. The operator, as part of its Safety Management System, had a database for recording farm airstrip details that included risk assessments. The database application was accessible to all of the operator's personnel to enable them to enter and update details for each airstrip utilised. Due to the large number of airstrips and the infrequent use of some of those airstrips, not all airstrips had been recorded at the time of the accident. The policy was that a pilot would enter and provide details of, or update the database each time an airstrip was used. The pilot was using this airstrip for the first time since the database had been developed, so they would have been expected to enter the relevant details after using it.

3 Analysis
Tātaritanga

Introduction

3.1. The pilot was conducting a routine agricultural spreading operation when the aeroplane did not follow the required take-off path that had previously been taken, and hit uneven terrain, impacting the valley floor. An intense fire followed, destroying much of the evidence that would otherwise have been available to the investigation. Because of the lack of evidence, the reason for the aeroplane deviating from the normal flight path could not be determined conclusively.

3.2. The following section analyses the circumstances surrounding the event to identify those factors that increased the likelihood of the event occurring or increased the severity of its outcome.

Avenues of inquiry

3.3. The Transport Accident Investigation Commission (Commission) considered the available evidence, and in the analysis the following were considered for their likelihood as causal factors in this accident.

Fatigue

3.4. Flight and duty records and interviews with the pilot's family, the loader driver and the farmer suggest it was **likely** the pilot was well rested on the morning of the accident. The witnesses reported that the pilot's demeanour prior to the accident had not indicated any cause for concern regarding their health or wellbeing, including stress levels and general fitness to fly.

Distraction

3.5. There is no evidence to indicate the pilot was distracted during the take-off roll. It is **likely** that in the event of a distraction sufficient to cause a deviation from the previous ideal take-off path, there would have been some evidence of the pilot's attempt to correct the deviation and return to the optimum take-off path. The pilot was by all accounts competent and experienced and should have been able to manage most distractions, for example an unanticipated radio call or a cockpit light, easily.

3.6. Sunstrike. The early time of day[12], combined with high ground to the east of the airstrip and the high overcast cloud, resulted in flat light conditions at the time of the accident (see Figure 8). This made it **exceptionally unlikely** that the pilot suffered sunstrike during the accident sequence – noting that this was their third take-off in 10 minutes and there had been no previous problems reported or observed.

[12] https://www.sunrise-and-sunset.com has sunrise at 0657 at Masterton.

Figure 8: ZK-LTK landing immediately prior to accident flight
(Credit: G Saunders)

3.7. Other visual distractions. Witnesses did not report any visual obstructions, for example birds or smoke in the cockpit, being present at the time of the accident. If the pilot had had a visual obstruction during the take-off roll, some evidence of it would have been expected, such as actions being taken to remedy the situation or evidence of avian debris.

3.8. The Commission found no evidence that the pilot had become distracted or that their situational awareness had been compromised by external factors during the take-off roll.

Mechanical failure

3.9. Powerplant. Witness reports and wreckage evidence show that is was **very likely** the engine had been delivering full power during the take-off roll and at the time of impact.

3.10. Airframe. There was no evidence to indicate a failure of the aircraft system, such as a failure of flight controls or steering, during the take-off roll. Damage to the right-hand wing and flap after the undercarriage had been dislodged was considered **highly likely** to have been a consequence of the accident sequence, rather than a causal factor.

3.11. Undercarriage. An expert analysis of the undercarriage attachment points showed that the undercarriage had been dislodged in a single high-impact event during the accident sequence and had been a result of the accident and not a causal factor. According to pilots experienced on this aircraft type, the subsequent damage to the control surfaces on the right-hand wing, and the dissymmetry of lift that resulted, would have made the aeroplane uncontrollable from that point onwards.

Overload

3.12. The Commission conducted an independent verification of the accuracy of the load cell installed on the loader truck.[13]

3.13. The load records showed that the load of product on the accident flight, at 1,700 kilograms, was the same as in the previous two flights. The aeroplane would have therefore been lighter on the third take-off due to fuel consumption.

3.14. A weight-and-balance calculation based on the recorded load for the flight confirmed the aeroplane had been within flight manual limits.

Pilot training and competency

3.15. The pilot had most recently undergone a competency check in October 2019 (six months prior to the accident). The pilot was very experienced in agricultural operations and the Cresco type of aeroplane.

3.16. The loader driver and other company pilots stated that the pilot had previously shown no reluctance in jettisoning loads if conditions required, and had done so on at least one occasion. It was normal practice for a pilot to move their left hand to the aeroplanes' jettison handle once full power had been selected for take-off.

3.17. Training and competency were therefore not considered causal factors in this accident.

Airstrip suitability

3.18. Witness evidence was that the airstrip was suitable for agricultural operations on the day. This accident happened on the third flight of the day, and the pilot had not expressed any concerns to the loader driver or the farmer regarding the condition of the airstrip on the previous two flights. Another agricultural pilot who was working locally at the time of the accident, and who landed shortly after the accident to render assistance if required, commented that, in their view, the airstrip was a typical farm airstrip and posed no unusual hazards or challenges.

Organisational influences

3.19. An examination of the operator's Safety Management System, incident register, exposition and manuals, which contained its policies and procedures, did not identify any historical or systemic issues that may have been relevant to or causal factors in this accident.

Substance use

3.20. Apart from caffeine, no other drugs were detected in the pilot's blood during the toxicology examination conducted post-mortem.

Pilot incapacitation

3.21. The absence of any corrective action by the pilot, including discontinuing the take-off, correcting the take-off path after encountering rough ground, dumping the load and/or making a radio call to the loader driver, could have indicated that the pilot was incapacitated and therefore was incapable of performing such actions.

[13] The fertiliser product was examined and determined to be free flowing, enabling an emergency jettisoning of the load should this be demanded.

3.22. The lack of evidence of any corrective action, either singularly or in combination, suggests it is **about as likely as not** that the pilot was not able to take such actions. Such actions might have included a course correction, braking, emergency jettisoning of the load and/or a radio call.

3.23. The Civil Aviation Authority of New Zealand has published Medical Information Sheet 012 – Medical Incapacitation on the range of conditions that can be classed as medical incapacitation (Civil Aviaton Authority of New Zealand, 2010). See Appendix 1.

Conclusion

3.24. There was no evidence that the pilot attempted to take remedial action at any stage during the take-off sequence. A well trained and experienced agricultural pilot would be expected to recognise and take corrective action if their take-off path was to differ significantly from their previous take-off paths.

3.25. After an analysis of the available evidence and after dismissing those potential causes deemed to be unlikely, it was found that it was **about as likely as not** that the pilot was incapacitated early in the take-off roll, prior to the point that a turn was required to maintain the optimum line on the airstrip. There was no definitive evidence to support this finding directly; rather, the finding was reached through a process of eliminating the **unlikely** scenarios.

4 Findings

Ngā kitenge

4.1. The pilot did not make the necessary left turn during the take-off roll to align with the strip centreline, so the aeroplane continued the take-off roll in a straight line.

4.2. The right-rear undercarriage struck uneven ground with sufficient force to break the undercarriage mounting brackets and dislodge the undercarriage assembly from the aeroplane.

4.3. The right main undercarriage subsequently struck the right flap, resulting in a partial dislocation of the flap. This **very likely** resulted in the aeroplane becoming uncontrollable.

4.4. The pilot was **about as likely as not** to have been incapacitated early in the take-off roll.

5 Safety issues and remedial action

Ngā take haumanu me ngā mahi whakatika

General

5.1. Safety issues are an output from the Commission's analysis. They typically describe a system problem that has the potential to adversely affect future operations on a wide scale.

5.2. Safety issues may be addressed by safety actions taken by a participant, otherwise the Commission may issue a recommendation to address the issue.

5.3. No new safety issues were identified.

6 Recommendations

Ngā tūtohutanga

General

6.1. The Commission issues recommendations to address safety issues found in its investigations. Recommendations may be addressed to organisations or people and can relate to safety issues found within an organisation or within the wider transport system that have the potential to contribute to future transport accidents and incidents.

6.2. In the interests of transport safety, it is important that recommendations are implemented without delay to help prevent similar accidents or incidents occurring in the future.

New recommendations

6.3. No new recommendations were issued.

7 Key lessons

Ngā akoranga matua

7.1. There are no key lessons.

8 Data summary
Whakarāpopoto raraunga

Aircraft particulars

Aircraft registration:	ZK-LTK
Type and serial number:	Pacific Aerospace Cresco 08-600: SN: 030
Number and type of engines:	one Pratt & Whitney PT6A-34AG turbine SN: PCE-PH0386
Year of manufacture:	2002
Operator:	Ravensdown Aerowork Limited
Type of flight:	agricultural
Persons on board:	one

Crew particulars

Pilot's licence:	Commercial Pilot Licence (aeroplane)
Pilot's age:	55
Pilot's total flying experience:	about 15,000 total flight hours (8,700 on type)

Date and time	24 April 2020, 0710
Location	Kourarau Hill, Masterton latitude: 41°09´ 24″ south longitude: 175° 43´ 40″ east
Injuries	fatal
Damage	aeroplane destroyed

9 Conduct of the Inquiry
He tikanga rapunga

9.1. On 24 April 2020, the Civil Aviation Authority of New Zealand notified the Commission of the occurrence. The Commission subsequently opened an inquiry under section 13(1) of the *Transport Accident Investigation Commission Act 1990* and appointed an investigator in charge.

9.2. The accident and initial scene investigation occurred under COVID-19 Alert Level 4 restrictions. This did not limit the investigation but did place additional requirements and demands on investigators when accessing the site, conducting interviews and gathering other evidence.

9.3. On 25 April 2020 three Commission investigators conducted an examination of the accident scene.

9.4. On 27 April 2020 the wreckage was removed from the accident site and transported to the Commission's technical facility in Wellington for further detailed examination.

9.5. Between 25 and 27 June 2020 interviews were conducted with witnesses. Relevant documentation relating to maintenance and the operator was obtained.

9.6. On 29 October 2020 interviews were conducted with the operator.

9.7. On 24 November 2021 the Commission approved a draft report for circulation to three interested persons for comment.

9.8. None of the Interested Persons wished to make comment on the draft report.

9.9. On 22 February 2022 the Commission approved the final report for publication.

Glossary
Kuputaka

airstrip	a strip of ground set aside for the take-off and landing of aircraft
take-off roll	the portion of the take-off procedure during which an aircraft is accelerated from a standstill to an airspeed that provides sufficient lift for it to become airborne
undercarriage	a wheeled structure beneath an aircraft that supports the aircraft on the ground. Also known as the landing gear

Citations
Ngā tohutoru

Civil Aviation Authority of New Zealand. (2010, December). *Medical certification*. Retrieved from Civil Aviation Authority of New Zealand.: https://www.aviation.govt.nz/assets/publications/medical-information-sheets/mis012-medical-incapacitation.pdf

Appendix 1 Civil Aviation Authority Medical Information Sheet – Medical Incapacitation (CAA MIS 012)

CAA MEDICAL INFORMATION SHEET

Medical Incapacitation

CAA MIS 012

Incapacitation is a reduction in your ability to do things (*functional capacity*). Numerous medical conditions have the potential to cause incapacitation. Medical incapacitation can take many forms, including:

- Gradual onset (e.g. slowly evolving severe headache) to sudden onset (e.g. a fit or convulsion) incapacitation;
- Partial (e.g. weakness in one arm) to complete (e.g. loss of consciousness) incapacitation;
- Temporary (e.g. a faint) or permanent (e.g. severe spinal injury with lower limb paralysis) incapacitation;
- Subtle (e.g. disordered thinking) to obvious (e.g. loss of consciousness and collapse) incapacitation;
- Changes of physical capabilities (e.g. paralysis), the senses (e.g. loss of vision), behaviour (e.g. impulse control and risk taking behaviour), or mental function (e.g. disordered thinking).

A simple faint (or syncope), for example, might result in an obvious, temporary, sudden onset, and complete incapacitation while a small stroke or TIA (mini-stroke) might result in a subtle and partial incapacitation that only effects complex calculations. Although these two examples describe very different types of medical incapacitation they are both likely to result in a reduction in aviation safety.

The risk of medical incapacitation is therefore an important matter that must be considered for CAA medical certification.

Why is medical incapacitation an aviation safety problem?

Incapacitation is an aviation safety concern because:

- The reduced functional capacity can impair performance to a significant* extent;
- The incapacitating medical condition may result in unsafe behaviour; and
- Many medical conditions that cause incapacitation also result in an increased risk of other future incapacitating events.

Reductions in functional capacity cover a very wide spectrum of impairment. Some examples of reduced functional capacity (e.g. minor weakness in one hand) have only a relatively small impact on aviation safety and, after appropriate investigation, may not result in any loss or reduction in medical certification status. Others (e.g. widespread paralysis or loss of consciousness), however, are clearly incompatible with safe aviation.

Some medical conditions (e.g. a stroke) can result in incapacitation and can also lead to changes in behaviour. Sometimes the altered behaviour (e.g. reduced impulse control or increased risk taking behaviour) will not be compatible with aviation safety.

Someone who has suffered an incapacitating stroke or TIA (See MIS 11 'Strokes and Transient Ischaemic Attacks' for further information on these) usually has an ongoing increased risk of future strokes, TIAs, or heart attacks. Similarly someone who has suffered recurrent

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faints may be at risk of further faints in the future, and the level of that risk may be unacceptable. Conversely most isolated faints, while they are usually very incapacitating (loss of consciousness), are simply a normal response to an abnormal situation (e.g. pain) and do not, in themselves, signify an increased future risk of incapacitation.

Surely aviation safety demands a zero risk of medical incapacitation?

While zero risk of medical incapacitation would seem to be desirable it is an entirely unattainable goal. It is simply not possible, based on the medical tools and information available, to determine that someone has a zero chance of suffering a medical incapacitation event.

Zero risk of medical incapacitation is not possible, but a high risk would not be acceptable from an aviation safety perspective. To provide consistent safety outcomes, and consistent medical certification decisions, the CAA endeavours to apply risk criteria or thresholds to conditions that cause, or predispose to, medical incapacitation.

A risk threshold is a level, usually numerical, above which the risk is unacceptable and below which the risk may be acceptable.

How are people with "excessive" incapacitation risk identified?

It is possible to identify some groups of people who have an increased risk of medical incapacitation and to test those people further to determine whether that risk is excessive or not. For example a person with a lifelong history of epilepsy will probably have an excessive risk of medical incapacitation, usually in the form of another fit or convulsion. Conversely a person who has suffered a single faint associated with a painful or disturbing event, and is otherwise perfectly healthy, is unlikely to be viewed as having an excessive incapacitation risk.

An in-between example would be a person who has had a small heart attack but is perfectly healthy with entirely normal heart tests six months afterwards (See MIS 8 'After *a Heart Attack or Coronary Artery Stents'*). They may be assessed as representing an acceptable risk for class 2 medical certification, but not an acceptable risk for single-pilot professional air operations carrying passengers.

What risk thresholds does the CAA use for medical incapacitation?

The aviation medical safety legislation uses word-pictures to describe the medical risk thresholds. An example of such a word-picture can be found in the phrase 'likely to interfere with' that is used in the definition of "aeromedical significance" in Rule 67.3(a) (See 'Looking at the law section of this MIS).

In an effort to provide safety, clarity, and consistency the CAA has, as a matter of policy, interpreted the legislated word-pictures in terms of numerical risk values, usually expressed in per year percentages. The incapacitation thresholds used by the CAA are generally such that, all other matters being acceptable:

1. Someone with an incapacitation risk in excess of 4 - 5% per annum is unlikely to be issued any class of CAA medical certificate;

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2. Someone with an incapacitation risk of 2% per annum, or greater, but lower than 4% per annum is unlikely to be issued a class 1 or 3 medical certificate, but may be issued a class 2 medical certificate, with or without conditions;
3. Someone with an incapacitation risk of 1% per annum, or greater, but lower than 2% per annum is unlikely to be issued an unrestricted class 1 or 3 medical certificate, is likely to be eligible for a restricted class 1 or 3 medical certificate (e.g. precluding single-pilot air operations carrying passengers in the case of class 1), and is likely to be eligible for unrestricted class 2 medical certification;
4. Someone with an incapacitation risk of less than 1% per annum is likely to be eligible for the unrestricted issue of any class of CAA medical certificate.

But the risk of incapacitation can't be proven, so surely it's unfair to make medical certification decisions this way?

It is certainly not possible to determine, with absolute certainty, that any individual is going to suffer a medical incapacitation event.

It is possible, however, to identify features that show an individual to belong to a population (or group of people) that has an increased chance of suffering a medical incapacitation event. This is the approach that the CAA takes, and we endeavour to apply the best available medical evidence to assess the medical risk of pilots and air traffic controllers. In the absence of strong, high quality, medical evidence to suggest otherwise we treat an individual pilot as having a medical incapacitation risk similar to the population risk that best characterises that pilot.

An example of this approach can be found in the case of smokers. Some smokers do not suffer premature heart attacks but, on average, people who smoke are at higher risk of suffering a heart attack. For aviation safety purposes we view a smoker to be at an increased risk of a heart attack, even though it is possible that any particular individual will not suffer such an event. Accordingly we may direct further investigation to showing that the heart is actually ok before issuing a medical certificate (See MIS 007 'Cardiovascular Risk').

While some people feel it is unfair that they have been singled-out (for example because their cardiovascular risk is considered excessive) this is entirely consistent with the principles of risk management and the needs for medical safety, and consistent medical certification decision-making, in aviation.

What about the '1% rule'?

The so-called '1% rule' is not actually a rule but was an early example of considering numerical risk thresholds in the context of aviation medical safety. The phrase's reference to 1% comes from a calculation that linked a medical incapacitation risk of <1% per annum, in a two-crew airline flight environment, with an airline hull-loss accident likelihood of less than 1 per 10 million flying hours.

Using this model, the CAA's current approach to medical incapacitation risk more closely resembles a '2% rule', although we do not limit our safety consideration of medical incapacitation risk to multicrew airline operations.

What about cardiovascular risk?

The CAA's handling of cardiovascular risk applies a similar approach, but uses slightly different thresholds. Details of our approach to cardiovascular risk assessment can be found in MIS 007 'Cardiovascular Risk'.

What if I don't agree with a decision concerning my incapacitation risk?

You are always able to seek review of CAA medical certification decisions. Some people seeking review of decisions use the Convener process, some make an Appeal to the District Court, and some use other methods. For further information on review / appeal options you may wish to consult the Medical Information Sheet on the topic (MIS 005 'What Are My Review Options?').

Looking at the law

Civil Aviation Act

Section 27B(1) of the Act allows for a medical certificate to be issued to an applicant who meets the medical standards "unless the Director has reasonable ground to believe that the applicant has any characteristic that may interfere with the safe exercise of the privileges to which the medical certificate relates".

Section 27B(3) of the Act, describing the flexibility process that can be applied to applicants who do not meet the medical standards, includes a requirement for an applicant being "not likely to jeopardise aviation safety".

These are both examples of word-pictures being used in the legislation to describe risk thresholds.

Civil Aviation Rule Part 67: Medical Standards

Rules 67.103(b)(1) (Class 1), 67.105(b)(1) (Class 2), and 67.107(b)(1) (Class 3) include provisions that require an applicant to have no medical condition that is of aeromedical significance*

This reference to "aeromedical significance" is expanded further in Rule 67.3(a): "A medical condition is of aeromedical significance if, having regard to any relevant general direction, it interferes or is likely to interfere with the safe exercise of the privileges or the safe performance of the duties to which the relevant medical certificate relates".

Rules 67.103(d)(4) (Class 1), 67.105(d)(4) (Class 2), and 67.107(d)(4) (Class 3) require an applicant to have no excessive cardiovascular risk factors unless normal myocardial perfusion can be demonstrated.

These are also examples of word-pictures being used in the legislation to describe risk thresholds.

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Kōwhaiwhai - Māori scroll designs

TAIC commissioned its four kōwhaiwhai, Māori scroll designs, from artist Sandy Rodgers (Ngāti Raukawa, Tūwharetoa, MacDougal). Sandy began from thinking of the Commission as a vehicle or vessel for seeking knowledge to understand transport accident tragedies and how to avoid them. A 'waka whai mārama' (i te ara haumaru) is 'a vessel/vehicle in pursuit of understanding'. Waka is a metaphor for the Commission. Mārama (from 'te ao mārama' – the world of light) is for the separation of Rangitāne (Sky Father) and Papatūānuku (Earth Mother) by their son Tāne Māhuta (god of man, forests and everything dwelling within), which brought light and thus awareness to the world. 'Te ara' is 'the path' and 'haumaru' is 'safe' or 'risk free'.

Corporate: Te Ara Haumaru - the safe and risk free path

The eye motif looks to the future, watching the path for obstructions. The encased double koru is the mother and child, symbolising protection, safety and guidance. The triple koru represents the three kete of knowledge that Tāne Māhuta collected from the highest of the heavens to pass their wisdom to humanity. The continual wave is the perpetual line of influence. The succession of humps represents the individual inquiries.

Sandy acknowledges Tāne Māhuta in the creation of this Kōwhaiwhai.

Aviation: Ngā hau e whā - the four winds

To Sandy, 'Ngā hau e whā' (the four winds), commonly used in Te Reo Māori to refer to people coming together from across Aotearoa, was also redolent of the aviation environment. The design represents the sky, cloud, and wind. There is a manu (bird) form representing the aircraft that move through Aotearoa's 'long white cloud'. The letter 'A' is present, standing for a 'Aviation'.

Sandy acknowledges Ranginui (Sky father) and Tāwhirimātea (God of wind) in the creation of this Kōwhaiwhai.

Maritime: Ara wai - waterways

The sections of waves flowing across the design represent the many different 'ara wai' (waterways) that ships sail across. The 'V' shape is a ship's prow and its wake. The letter 'M' is present, standing for 'Maritime.

Sandy acknowledges Tangaroa (God of the sea) in the creation of this Kōwhaiwhai.

Rail: rerewhenua - flowing across the land

The design represents the fluid movement of trains across Aotearoa. 'Rere' is to flow or fly. 'Whenua' is the land. The koru forms represent the earth, land and flora that trains pass over and through. The letter 'R' is present, standing for 'Rail'.

Sandy acknowledges Papatūānuku (Earth Mother) and Tāne Mahuta (God of man and forests and everything that dwells within) in the creation of this Kōwhaiwhai.

Transport Accident Investigation Commission

Recent Aviation Occurrence reports published by the Transport Accident Investigation Commission (most recent at top of list)

AO-2019-003	Diamond DA42 aeroplane, impact with terrain, 22 nautical miles south-southeast of Taupo, Kaimanawa Ranges, 23 March 2019
AO-2018-005	MD Helicopters 600N, ZK-ILD, Engine control malfunction and forced landing, Ngamatea Station, 14 June 2018
AO-2018-001	Tandem parachute UPT Micro Sigma, registration 31Z, Double malfunction, Queenstown, 10 January 2018
AO-2018-006	Robinson R44, ZK-HTB Loss of control Stevensons Arm, Lake Wanaka 21 July 2018
AO-2017-009 and AO-2017-010	Commission resolution to close aviation inquiries Boeing 787, near Auckland, New Zealand, 5 and 6 December 2017
AO-2019-001	Airbus Helicopters AS350, ZK-HEX, Forced landing, Wakefield, Nelson, 17 February 2019
AO-2017-004	MBB BK117 A-3 helicopter, ZK-IED, Loss of control, Porirua Harbour, 2 May 2017
AO-2017-002	Robinson Helicopter Company R22, ZK-IHA, Impact with terrain, Near Reefton, 27 March 2017
AO-2017-003	ATR72, ZK-MCY, Landing gear failure, Nelson, 9 April 2017
AO-2015-003	Robinson R44, Main rotor blade failure, Waikaia, Southland, 23 January 2015
AO-2015-007	Airbus Helicopters AS350BA, ZK-HKU, Collision with terrain, Fox Glacier, 21 November 2015
AO-2017-007	Airbus A320 VH-VGY, Descent below clearance limit, Christchurch, 6 August 2017

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