SAFETY INVESTIGATION REPORT

CAA OCCURRENCE NUMBER 16/6701

PACIFIC AEROSPACE LTD 750XL

ZK-JPU

COLLISION WITH HIGH VOLTAGE POWER LINES

24 NM WEST OF GISBORNE AERODROME

12 DECEMBER 2016

Source: Operator

About the CAA

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

Following notification of an accident or incident, TAIC may conduct an investigation. CAA may also investigate subject to Section 72B(2)(d) of the CA 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 to prevent a similar occurrence arising in the future. The safety investigation does not seek to ascribe responsibility to any person but to establish the contributory factors to 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 regulatory intervention tools may be required to attain CAA safety objectives.

Contents

Page Number

Tables

Figures

Glossary of abbreviations:

ATSB	Australian Transport Safety Bureau
CAA	Civil Aviation Authority
CAR(s)	Civil Aviation Rule(s)
CPL(A)	Commercial Pilot Licence (Aeroplane)
E	east
ft	foot or feet
GPS	Global Positioning System
hrs	hours
kV	Kilovolt
m	metre(s)
MHz	megahertz
N	north
NM	nautical mile
NZDT	New Zealand Daylight Time
S	south
SMS	Safety Management System
s/n	serial number
SOP	Standard Operating Procedures
TRM	Team Resource Management
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
VHF	very high frequency
VNC	Visual Navigation Chart
W	west

Data summary

Aircraft type, serial number and registration:	Pacific Aerospace Ltd 750XL, s/n 117, ZK-JPU
Number and type of engines:	1 Pratt & Whitney PT6A-34AG
Year of manufacture:	2005
Date and time of accident:	12 December 2016, 0857 hrs[1]
Location:	Approximately 24 NM west of Gisborne Aerodrome Latitude: S 38° 44' 30.85" Longitude: E 177° 28' 37.41"[2]
Type of flight:	Ferry/positioning
Persons on board:	Crew: 1 Passenger: 1
Injuries:	Crew: 1 fatal Passenger: 1 fatal
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence	CPL(A)
Pilot-in-command's age	37 years
Pilot-in-command's total flying experience:	8518 hours
Investigator in charge:	Mr M Harris

[1] All times NZDT (UTC + 13 hours) unless otherwise specified
[2] World Geodetic System 1984 (WGS-84) co-ordinates

Executive summary

The pilot of a Pacific Aerospace Ltd 750XL, registered ZK-JPU was conducting a positioning flight between aerial topdressing tasks in the Gisborne region. The pilot of ZK-JPU elected to detour en route, to an area where a pilot from the same operator was also conducting aerial topdressing.

While flying low level, the aircraft struck a set of 110 kV high voltage power lines spanning the valley and subsequently impacted terrain.

The safety investigation identified the following contributory factors:

- A number of human factors influenced the pilot's decision-making to deviate from the original plan.
- The pilot had not conducted a hazard briefing for the area to be flown at low level. As a consequence the pilot did not have the most accurate and well informed mental model of the environment and hazards.
- Due to the limitations of an individual's attentional resource, it is likely the pilot experienced inattentional blindness due to their attention being engaged on the other aircraft,[3] leading the pilot to strike the high voltage power lines.

As a result of the safety investigation a number of safety actions have been raised regarding the purpose of the hazard identification process and its importance to pilots' mental models and decision-making. Furthermore, the implementation of a Team Resource Management (TRM) approach to agricultural aviation operations will provide pilots the support required when plans change. Ensuring pilots have the appropriate and pertinent information at the time reduces the risk of heuristics and biases influencing pilots' decision-making.

[3] A phenomenon where individuals fail to see something in their field of vision because they were focusing on something else.

1. Factual Information

1.1 History of flight

1.1.1 At approximately 0500 hrs, 12 December 2016, the pilot of ZK-JPU, arrived at Gisborne Aerodrome. The pilot was accompanied by the operator's recently employed (trainee) loader driver and already at the hangar was a senior loader driver. The pilot conducted the preflight checks of the aircraft for the day's agricultural aircraft operations.

1.1.2 Earlier that morning the Managing Director of the operator had called the pilot of ZK-JPU. The Managing Director requested that after finishing the first aerial topdressing task at Tauwharetoi Station and prior to the next planned task at Waimaha Station, the pilot complete a task at Pembroke Station. This was because the Managing Director was unwell and unable to undertake the Pembroke Station task as planned. The pilot of ZK-JPU agreed to the additional task.

1.1.3 The original work plan for the day was for both loader drivers to attend the first task at Tauwharetoi Station, with the senior loader driver providing oversight for the trainee loader driver. The pilot and the senior loader driver were then to proceed to the second task of the day, while the trainee loader driver was scheduled to return to the aerodrome with the loader truck from the first task. The expectation was for the pilot to go straight from the Tauwharetoi Station task to the Pembroke Station task and then proceed to Waimaha Station. Figure 1 shows the general geographic locations of the stations associated with the planned work for the day.

1.1.4 ZK-JPU departed Gisborne Aerodrome at approximately 0515 hrs with the pilot and both loader drivers on board. The aircraft was to operate from a nearby private airstrip (see Figure 1) where the loader truck was already located, as the task had been commenced the previous week. The aircraft landed at the airstrip at approximately 0530 hrs and the pilot assisted the senior loader driver to get the truck ready, double-checking the calibration of the weigh scales and fuel drain, before commencing the task at approximately 0600 hrs.

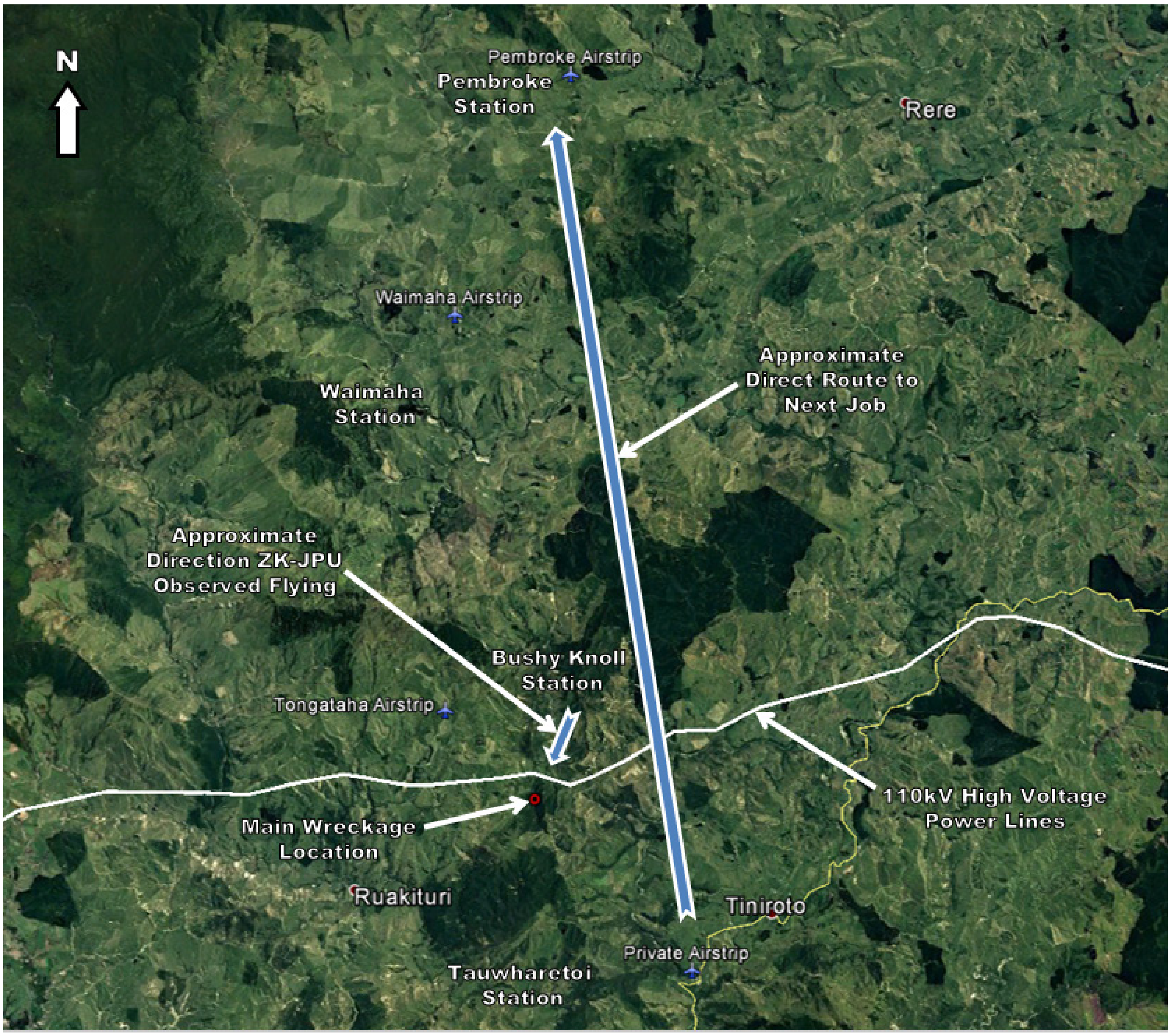


Figure 1:
General geographic locations of planned tasks for the day of the accident

1.1.5 On the day of the accident another pilot from the same operator, who was operating a similar Pacific Aerospace Ltd 750XL, ZK-XLA, was aerial topdressing an area of Bushy Knoll Station, operating off the Tongataha airstrip (see Figure 1). Bushy Knoll Station is to the north of Tauwharetoi Station, alongside the route to the next two tasks scheduled for ZK-JPU at Pembroke and Waimaha Stations.

1.1.6 The pilot of ZK-XLA commenced operating at approximately 0555 hrs and completed two to three loads before hearing the pilot of ZK-JPU over the radio at approximately 0615 hrs. The brief conversation that followed consisted of an exchange of greetings and description of locations and intentions. Both pilots then continued with their tasks without further direct communication.

1.1.7 On completion of the first task the pilot of ZK-JPU landed at the private airstrip and instructed the senior loader driver to pack up the gear and head back to base. The senior loader driver refuelled the aircraft with 100 litres of fuel, packed up the gear and gave the trainee loader driver the radio which had been used to communicate with the pilot.

1.1.8 After a 15 minute break the pilot of ZK-JPU was observed by the senior loader driver getting into the left seat of the aircraft and the trainee loader driver into the right seat. The senior loader driver observed ZK-JPU take off, and then departed the airstrip in the loader truck, to return to the aerodrome.

1.1.9 At approximately 0850 the pilot of ZK-XLA received a radio call from the pilot of ZK-JPU asking “are you breaking left or right?” followed by the pilot of ZK-JPU stating “I am to your left”. ZK-JPU was then observed by the pilot of ZK-XLA flying behind and to the left of ZK-XLA. The pilot of ZK-XLA advised the pilot of ZK-JPU that he was “sowing the boundary of Bushy Knoll Station [...] finishing my run and [...] turning right to head back to the airstrip”.

1.1.10 Spanning the valley near the boundary of Bushy Knoll Station, near to where the pilot of ZK-XLA was operating were a set of 110 kV high voltage power lines (consisting of six wires termed ‘conductors’, supported by towers). These conductors comprised the two circuits supplying electricity to Gisborne and the East Coast region. The span traverses the valley approximately east-west and the height above terrain at the mid-span of the bottom two conductors (the lowest point of the span) was approximately 200 ft.

1.1.11 At 0857 hrs the power supply to Gisborne and the East Coast was interrupted.

1.1.12 Finishing the topdressing run, the pilot of ZK-XLA commenced a right climbing turn in order to return to the airstrip and sighted ZK-JPU over his right shoulder. At this point the pilot of ZK-XLA noted that something was trailing from the left wing of ZK-JPU. Realising that the item trailing from ZK-JPU’s wing was a wire, the pilot of ZK-XLA transmitted “you are trailing wire’’, however no response was received from ZK-JPU.

1.1.13 The pilot of ZK-XLA witnessed ZK-JPU continue down the valley, slowly rolling to the left before impacting terrain, approximately 700 m further to the south. A post-impact fire ensued with the pilot of ZK-XLA observing “a lot of black smoke”.

1.1.14 The pilot of ZK-XLA immediately commenced circling the accident site and attempted to call the operator via cellphone. Unable to make contact the pilot activated the emergency communications facility on the flight following equipment installed in the aircraft and reported the accident to Gisborne Tower.

1.1.15 The accident occurred in daylight at 0857 hrs, approximately 24 NM W of Gisborne Aerodrome, at Latitude: S 38° 44' 30.85" Longitude: E 177° 28' 37.41".

1.2 Injuries to persons

Injuries	Crew	Passenger
Fatal	1	1

Table 1: Injuries to persons.

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed in the post-impact fire.

1.4 Other damage

1.4.1 The lower four of the six conductors were severed, and the upper two conductors were damaged.

1.5 Personnel information

Flying hours	All types	Relevant Type
Last 24 hours	2 (Estimated)	2 (Estimated)
Last 7 days	32	32
Last 30 days	123	123
Last 90 days	340	340
Total hours	Approximately 8518	Approximately 3210 since November 2013

Table 2: Pilot in command hours

1.5.1 The pilot, aged 37 years, held a Commercial Pilot Licence with a valid class 1 medical certificate for single pilot air operations carrying passengers, and a current Grade 1 agricultural rating.

1.5.2 The pilot commenced flying in 2005, and had accrued approximately 8518 hours on a number of single and twin engine piston and turboprop aircraft types, with 3210 hours recorded on the Pacific Aerospace Ltd 750XL since November 2013.

1.5.3 The pilot was experienced in low level operations as a result of working in both geological survey and agricultural roles, and was also a qualified aerobatic pilot. According to the CAA safety database the pilot had not been involved in any previous aviation accident or operational incident.

1.5.4 The pilot was off duty the day prior to the accident, and is estimated to have conducted approximately 2 hours flying on the day of the accident. The last entry made in the Pilot's Logbook was dated 8 October 2016.

1.5.5 Pilot currency and fatigue are not considered to be contributing factors in this accident.

1.5.6 The pilot was active in supporting and encouraging colleagues in their training and the use of procedures, and was known to get on well with new employees. From the commencement of the trainee loader driver's employment with the operator, they had been working with the pilot of ZK-JPU the whole time.

1.6 Aircraft information

1.6.1 The Pacific Aerospace Ltd 750XL is a single engine, turboprop aircraft. It is a low-wing monoplane of all metal construction and fixed tricycle undercarriage, developed from the Pacific Aerospace Ltd Cresco series of agricultural aircraft. It is powered by a Pratt & Whitney PT6A-34AG gas turbine engine, driving a three-bladed, constant-speed Hartzell propeller.

1.6.2 Pacific Aerospace Ltd 750XL, s/n 117 was manufactured in New Zealand in 2005. The aircraft was registered as ZK-JPU in May 2005 and subsequently issued a Certificate of Airworthiness in the restricted category by the CAA in September 2005. In 2015 ZK-JPU was modified in accordance with STC 11/21E/8 incorporating a carbon fibre composite hopper and various other associated agricultural equipment.

1.6.3 At the time of the accident the aircraft had accrued approximately 8028 total airframe hours. The last maintenance carried out on the aircraft was a 150 hour inspection at 7962.7 total airframe hours, on 25 November 2016. The last maintenance carried out on the engine was also a 150 hour inspection at 5694.6 total engine hours on 25 November 2016. No defects are suspected to have been present or contributing at the time of the accident.

1.7 Meteorological information

1.7.1 The Area Forecast current at the time of the accident was for a generally westerly flow over the area, with light winds at low levels and some rain shower activity to the north and west of the accident area.

1.7.2 The Metrological Aerodrome Report (METAR) from Gisborne Aerodrome about the time of the accident reported the surface wind as a very light northerly.

1.7.3 The pilot of ZK-XLA accessed the weather station situated in the vicinity of Tongataha Station before departing his home airfield at Wairoa, and found the wind to be light from the NW.

1.7.4 The senior loader driver working with the pilot of ZK-JPU on the first task of the day reported hearing conversation on the radio between the pilot of ZK-JPU and the pilot of ZK-XLA about what a good day it was.

1.7.5 At the time the accident occurred, no low cloud, significant reduction in visibility or turbulence was reported.

1.7.6 Weather was not a contributing factor in the accident.

1.8 Aids to navigation

1.8.1 The aircraft was equipped with a Tracmap agricultural GPS system, however, it could not be conclusively determined if the system was operating at the time of the accident.

1.8.2 It was not possible to determine whether a current Visual Navigation Chart, VNC C5 Bay of Plenty, 1:250,000 scale, was carried on board the aircraft at the time of the accident, however it was the operator’s and pilot’s normal practice to do so.

1.9 Communications

1.9.1 The aircraft was equipped with a VHF communication transceiver with pilot intercommunication system, enabling operational calls between the pilots, and the loader driver.

1.9.2 The senior loader driver working for the pilot of ZK-JPU reported hearing the pilots of ZK-JPU and ZK-XLA on the radio engage in general conversation about weather and location of operations.

1.9.3 No emergency or distress calls were heard from the pilot of ZK-JPU during the flight.

1.9.4 The aircraft was also equipped with a Spidertracks system which provided limited flight following of the aircraft.[4] The Spidertracks system installed in the aircraft operated by the operator have a radius function, which suspends position reports in a defined circular area around the current location and will only resume normal tracking once the aircraft leaves the defined area.

1.9.5 The operator's Standard Operating Procedures (SOPs) at the time of the accident was for the pilot to set the radius function upon commencement of a task and the radius defining the circular area was stipulated by the operator to be 7 NM. If transiting between tasks or to/from 'home' locations which are within a 7 NM radius of the last task, accurate tracking of the aircraft during this time would not be possible. Normal tracking would not be resumed until the aircraft travelled outside of the 7 NM radius.

1.9.6 CAA Safety Action 19A106 was raised with the operator recommending that the radius function be deactivated when departing the airstrip at the completion of a task, to improve aircraft tracking between tasks and to 'home' locations. In January 2017 the operator amended its SOPs to require pilots to deactivate the radius function when departing the airstrip at the completion of a task. It should be noted that the radius function setting of 7 NM did not contribute to the accident or survivability.

[4] The Spidertracks system is a satellite tracking device installed in the aircraft which provides position reports at a predetermined interval, to a web-based software package.

1.10 Aerodrome information

1.10.1 Not applicable.

1.11 Flight recorders

1.11.1 Not applicable.

1.12 Wreckage and impact information

1.12.1 The aircraft initially struck the six conductors spanning the valley, at approximately mid-span between Tower 89 and 90 (Figure 2). The aircraft was in an approximate 50-degree right bank, as shown in Figure 3a. The top two conductors severed the left wing tip and separated the left aileron, which were located in close proximity to the initial impact point (Figure 3b).

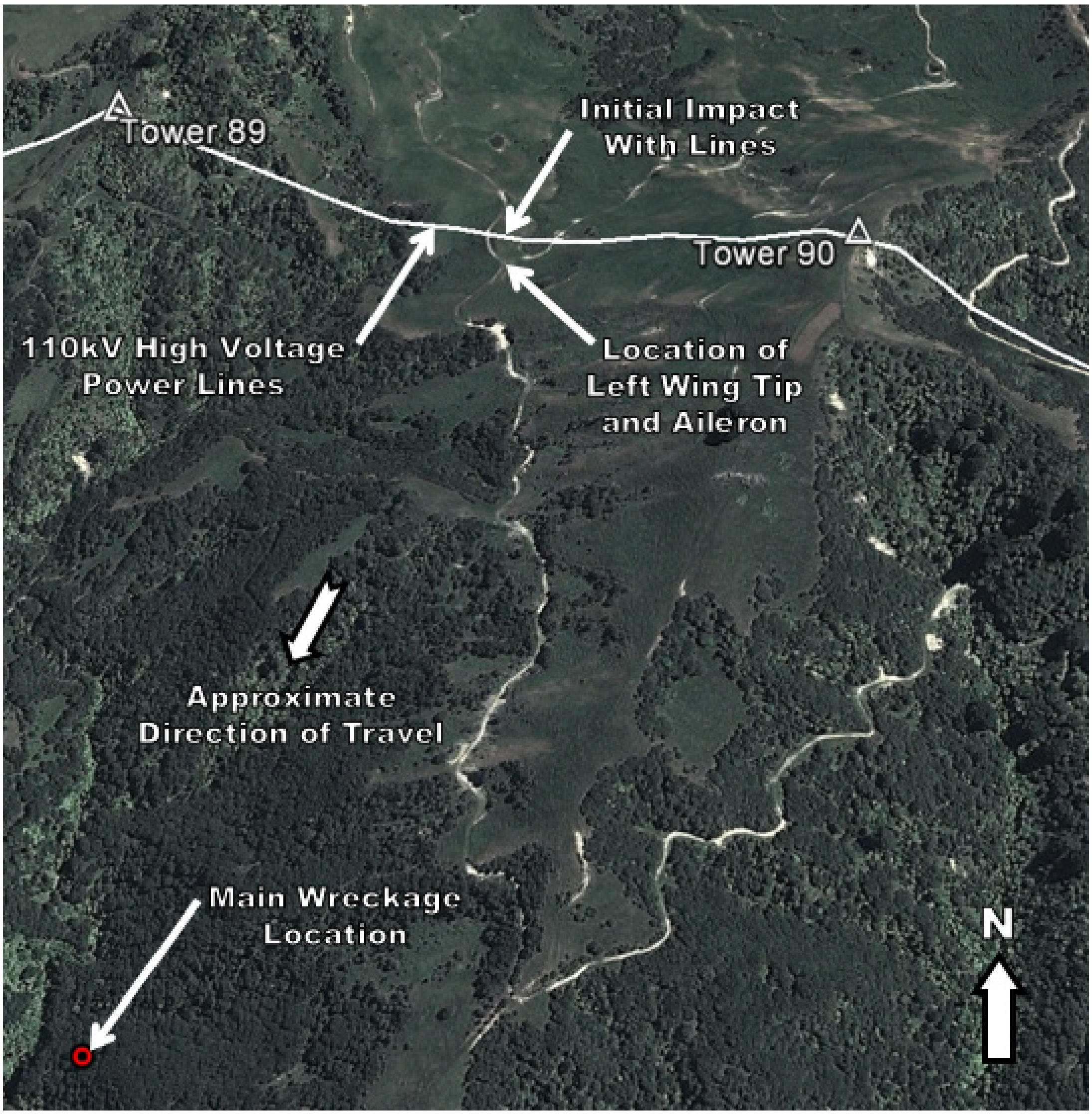
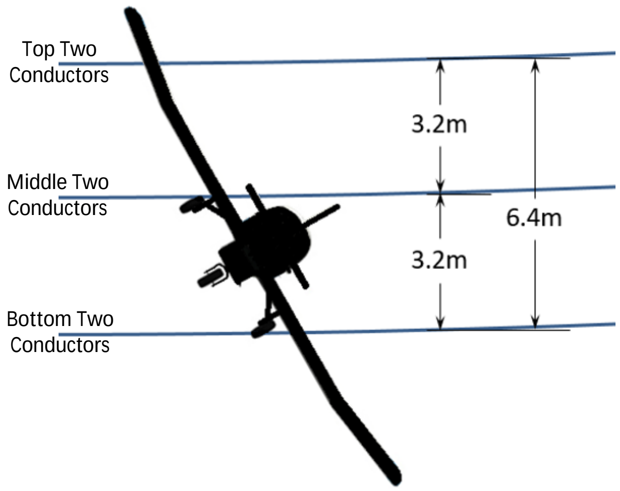
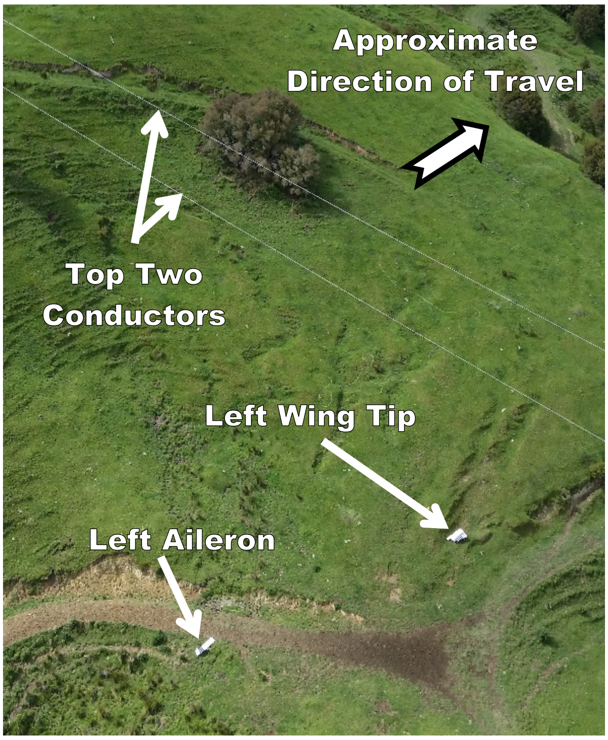


Figure 2:
Wreckage Locations in Relation to 110 kV High Voltage Power Lines



a) Approximate aircraft orientation (view from aft)



b) Left wing tip and aileron locations

Figure 3:
Initial impact with 110 kV high voltage power lines.

1.12.2 The aircraft then struck terrain, approximately 700 m to the south of the conductor span, in a steep left bank and an approximate 60 degrees nose-down attitude. Impact damage to the tree canopy was observed and a section of conductor remained suspended in a tree. The other end of the conductor was wrapped around the left inboard wing section.

1.12.3 Post-impact fire consumed the right inboard wing section, fuselage, cockpit and carbon fibre composite hopper.

1.12.4 As stated in the article titled ‘Hands Off the Accident Scene’ published in the May/June 2017 edition of the CAA *Vector* magazine;

> *‘Burned [sic] carbon fibre can produce airborne synthetic particles, similar to asbestos, and the smoke created by any carbon fibre-based fire is believed to be dangerous if inhaled.’*

1.12.5 Due to the hazardous nature of the burnt carbon fibre composite material used in the construction of the hopper, the wreckage and accident site were considered hazardous. The decision was therefore made not to recover the wreckage for detailed examination because of the implications to the health and safety of the investigation team and the local community.

1.12.6 Pre-impact integrity of aircraft control systems was established as far as possible at the accident site.

1.12.7 The propeller remained attached to the engine with all three propeller blades showing significant deformation. The engine and associated controls were subject to post-impact fire. The engine exhaust stacks showed ductile deformation.

1.13 Medical and pathological information

1.13.1 Post-mortem examination indicated that the pilot and trainee loader driver died of high energy impact injuries associated with the accident, with minimal compounding effects of smoke inhalation.

1.13.2 Results of toxicological testing showed no alcohol or drugs present in the blood of either the pilot or trainee loader driver.

1.14 Fire

1.14.1 Following impact with the trees and terrain, an intense fuel-fed fire consumed the majority of the aircraft. Due to the disruption to the aircraft the source of ignition could not be identified.

1.15 Survival aspects

1.15.1 The aircraft was equipped with an Emergency Locater Transmitter (ELT), which operated as intended.

1.15.2 The accident was not survivable due to high energy impact forces and post-impact fire.

1.16 Test and research

1.16.1 The Australian Transport Safety Bureau (ATSB) research report *Aerial Application Safety, 2015-2016 Year in Review* states that 'Wires themselves can be difficult to identify on their own as their colour can blend into the sky and may not be easily seen from different angles. Poles and insulators can be used as cues given difficulty of seeing wires until they are relatively close, there is normally very little time for pilots to respond to wires once spotted'. The report goes on to state '63 per cent of pilots knew where the wire was before they struck it' and that 'Striking a wire that they were aware of usually occurs when something changes [...] a last minute change of plan'.[5]

1.16.2 The book *Human Factors in Aviation* states 'a person's ability to gather information is critically influenced by that person's knowledge state or mental model of a task'.[6] Human factors research also suggests that individuals use mental models to reason and infer what will happen next in their world and what actions they need to take in order to get an optimal outcome, based on their understanding of how the world works within the current context.[7]

1.16.3 Researchers have stated that mental models are representations of the world based on the individual's knowledge and built on and continuously updated by sensation and perception.[8] Sensation is defined as the ability to detect or determine changes, picked up by sensory channels (visual, auditory, etc.). Perception is the meaning assigned to the changes detected, and the transfer of this information to the memory is controlled by the attentional processes.[9]

1.16.4 Studies have shown that it is possible to miss vital visual stimuli if attention is allocated to another task due to individuals having limited attentional resources. This phenomenon of failing to perceive what would appear to others as an obvious visual stimulus is termed 'inattentional blindness', or the 'looked-but-failed-to-see-effect'.[10]

1.16.5 Human factors researchers concur that experienced pilots make decisions in dynamic, real-world environments, under conditions of time pressure, dynamic goals and high risk etc., which can be considered naturalistic decision-making. A

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[5] Australian Transport Safety Bureau (ATSB). (2016). Aerial Application Safety 2015-2016 Year in Review. Research AR-2016-022.

[6] Wickens, C. D., & Flach, J. M. (1988). Information processing. In E. L. Wiener & D. C. Nagel (Eds.), *Academic Press series in cognition and perception. Human factors in aviation* (pp. 111-155). San Diego, CA, US: Academic Press

[7] Johnson-Laird, P.N. (2010). Mental models and human reasoning. *Proceedings of the National Academy of Sciences of the United States of America,* Vol.107(43), pp.18243-18250

[8] https://www.skybrary.aero/index.php/Situational_Awareness_(OGHFA_BN), section 4, Issues and Factors Involved. Accessed 01/08/2018

[9] https://www.skybrary.aero/index.php/Information_Processing#Sensing, Accessed 01/08/2018.

[10] Kennedy, K. D., Stephens, C. L., Williams, R. A. & Schutte, P. C. (2014). Automation and Inattentional Blindness in a Simulated Flight Task. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting,* Vol.58(1), pp.2058-2062

study describing the origins and contributions of naturalistic decision-making research into how people make decisions in real-world settings, states that 'People were using prior experience to rapidly categorize [sic] situations. People were relying on some kind of synthesis of their experience – call it a schema or a prototype or a category – to make these judgements'.[11]

1.16.6 Research considering the role of experience and expertise in decision-making suggests that 'experts often (but not always) make better decisions than novices'. This is considered to be due to their ability to rely on pattern recognition and rapid retrieval of choices from long-term memory structures, mental models.[12] These subconscious strategies or 'rules of thumb' work well in most circumstances, however, there are certain situations where they can lead to errors or cognitive bias and expertise does not guarantee immunity.

1.16.7 Confirmation bias is a prevalent example of a systematic error or flaw in the way people process information and make decisions. It can be described as the tendency to search for evidence, or interpret information that is consistent with a presently held view or understanding of the current situation, even in the light of contradictory information.[13]

1.16.8 Research conducted on decision-making in an uncertain world indicates that individuals will focus more on the outcomes of the choice of action that would be expected given their presently held view, rather than the truth of that view or belief itself. If the choice of action, assuming the belief holds true, provides outcomes that are perceived less negative and more positive, then individuals may be inclined to persist with (and try to confirm) the held belief.[12]

1.17 Organisational and management information

1.17.1 The operator was appropriately certified to conduct agricultural aircraft operations in accordance with Civil Aviation Rule (CAR) Part 137 *Agricultural Aircraft*

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[11] Klein, G. (2008). Naturalistic Decision Making. *Human Factors: The Journal of Human Factors and Ergonomic Society, Vol.50*(3), pp.456-460

[12] Wickens, C. D., Hollands, J. G., Banbury, S., Parasuraman, R. (2013). Engineering Psychology and Human Performance. Fourth Edition. Pearson Education Inc. *United States of America.*

[13] Walmsley, S. & Gilbey, A. (2017) Debiasing visual pilots' weather-related decision making. *Applied Ergonomics,* Vol.65, pp.200-208

Operations. Agricultural aircraft operation is defined in accordance with CAR Part 1 *Definitions and abbreviations* as; 'the operation of an aircraft on a single flight, or on a series of flights, including transit flights from a loading area to and from a treatment area'. A number of purposes for such flights are listed, including aerial topdressing.

1.17.2 Since taking over the role the Managing Director had devoted time to manage and improve the operation. This included the development of the Safety Management System (SMS), of which a significant proportion was complete at the time of the accident. Instructions and procedures in the SMS documentation, including those in relation to minimum altitudes, were compliant with the CARs.

1.17.3 In accordance with the CARs and as outlined in the operators SOPs, the flight to the next job was to be undertaken in accordance with the requirements of CAR 91.311 *Minimum heights for Visual Flight Rules (VFR) flights.*

1.17.4 CAR 91.311 *Minimum heights for VFR flights* states a pilot must not fly at a height of less than 500 ft above the surface, or at a height of less than 500 ft above any obstacle, person, vehicle, vessel, or structure that is within a horizontal radius of 150 m from the point immediately below the aircraft.

1.17.5 The operator requires pilots to manage their own workload, generally having three to four days' worth of work to organise. The intention being to allow the pilots the flexibility to plan work around weather and fatigue considerations. Pilots are paid for productive time but are not paid for transit between tasks. Work schedules were therefore discussed in direct contact between the pilots and the landowners or managers.

1.17.6 Due to the requirements to fly at a very low level in combination with high workloads, often challenging weather and in confined areas with the potential for obstacles, such as wires, agricultural aviation operations have inherent risks. In order to know what risks the pilot might be confronted with, the pilots are required to conduct a hazard briefing. The hazard briefings generally consist of the pilot calling the landowner or manager who would describe what was required to be done and what potential hazards were on the property. As part of the work package an email containing notes of any hazards would also be provided to the pilot.

1.17.7 The pilot of ZK-JPU had completed hazard briefings for the aerial topdressing tasks at Tauwharetoi, Pembroke and Waimaha Stations. However, the pilot had not conducted a hazard briefing for Bushy Knoll Station as there was no operational requirement for the pilot to be flying there at low level.

1.18 Additional information

1.18.1 The high voltage power lines are marked on the AIP New Zealand Visual Navigation Chart (VNC) C5 Bay of Plenty, 1:250,000 scale.

1.18.2 The maximum clearance between the ground and the lowest of the six conductors (approximately mid-span) was approximately 200 ft (61 m). The distance between the lowest and highest conductors was approximately 21 ft (6.4 m).

1.18.3 The conductors and supporting structures are not required to be physically marked in accordance with CAR Part 77 *Objects and Activities Affecting Navigable Airspace,* as the span and the supporting structures are lower than 120 m above ground level at their sites.

2. Analysis

2.1 The accident occurred as a result of the aircraft striking a set of 110 kV high voltage power lines, leading to the separation of the left wing tip and aileron. It could not be conclusively determined if the pilot and/or trainee loader driver were incapacitated as a result of the initial impact with the conductors; however it is considered likely that due to the impact forces and the height above terrain, there was insufficient time available to affect a recovery.

2.2 As far as the safety investigation could determine, there was no evidence of any mechanical issue which may have contributed to the accident. It is likely that the engine was operating at the time of impact with the conductors due to evidence of deformation on all three propeller blades, ductile deformation of the engine exhaust stacks, ignition of the fuel on impact and no distress or mayday call being heard from the pilot.

2.3 The safety investigation could not conclusively determine whether the pilot of ZK-JPU saw the conductors, however it is considered likely that the pilot's attention was engaged on the other aircraft and therefore it was possible that the pilot experienced inattentional blindness and failed to perceive the visual stimuli (either the conductors themselves spanning the valley or at least the tower structure on the ridgeline).

2.4 As established by the ATSB in its research into aerial application occurrences, many pilots knew where the wire was before striking it. It is likely that the pilot of ZK-JPU was aware there were power lines in the area as they were marked on the VNC and the pilot was familiar with the area having flown in the region both professionally and privately for a number of years.

2.5 The ATSB research suggests that pilots would usually strike a wire that they were aware of after some operational change occurred, such as a last minute change of plan. On completion of the first task at Tauwharetoi Station, the original work plan was for the pilot of ZK-JPU and the senior loader driver to proceed to the second task at Pembroke Station. The trainee loader was expected to return to the operations base with the loader truck. The pilot however, elected to change the plan and instructed the senior loader driver to return to the main base with the loader truck after completing the first task, instead of the trainee loader driver. It was also evident that the pilot decided to amend the original plan to transit directly to the next task at Pembroke Station, detouring via Bushy Knoll Station on the way.

2.6 The safety investigation could not conclusively determine why the pilot decided to take the trainee loader driver to the next task, however it is possible the pilot saw an opportunity to provide the trainee loader driver with an experience as part of their ongoing training. It could also not be conclusively determined as to why the pilot elected to deviate to where the fellow pilot was operating. It is considered however, likely that a number of human factors contributed to the decision-making.

2.7 Agricultural pilots generally cover large geographic regions, often working in remote areas and therefore it would be a rare occurrence to be operating in close proximity to another agricultural pilot, particularly a colleague. The fact that the fellow pilot was operating almost directly alongside the route to the next task would have meant a detour would not have taken much time. The pilot was also not on paid time, transiting between tasks, and so the operator would not have been disadvantaged by a short time delay.

2.8 The weather conditions at the time were also favourable for flying and therefore it is considered likely that the situational circumstances presented the pilot with a perceived rare opportunity to provide a valuable experience to the trainee loader driver. Influencing the decision-making may have been several social psychological principles, including, the scarcity heuristic and the availability heuristic, which can influence individuals' perception of risk.

2.9 The scarcity heuristic is the tendency to place a higher value on something that is perceived as rare and that might be easily lost. Compounding this is the availability heuristic, which is the tendency to rely on examples that immediately come to mind when making a decision. If nothing bad has ever happened in the pilots' experience then this can act as a baseline for perceiving risk, as opposed to an objective assessment of the risk. An incorrect baseline can result in the risk being seriously misestimated. As such, as a pilot gains experience of working in a high-risk environment, where little or no adverse consequences occur, the risks associated can become 'normalised'.[14]

2.10 The combined result of these psychological processes, interacting with confirmation bias, are frequently found to result in decision-making, that in hindsight could be considered poor or flawed. As such, when an opportunity presents itself, with apparent benefits and no perceived negative consequences (being easily brought to mind), individuals can be more motivated to deviate from rules, regulations and procedures, even though these acts may be considered unsafe.[15]

2.11 The pilot of ZK-JPU was experienced in low-level operations and according to CAA records had not been involved in an aviation accident or operational incident. Therefore, it is considered possible that pilots in this situation, being experienced

[14] Vaughan, D. (1996). The Challenger Launch Decision. Risky technology, Culture, and Deviance at NASA, University of Chicago Press. Chicago, IL.

[15] English, D. & Branaghan, R. J. (2012). An empirically derived taxonomy of pilot violation behavior. Safety Science 50(1), 199-209.

and having little or no previous exposure to adverse consequence from their actions and/or decisions, may be vulnerable to the decision-making and risk perception heuristics as stated earlier.

2.12 Although the pilot was most likely familiar with the area and likely aware of the hazard of the 110 kV high voltage power lines traversing the region, due to the fact that the pilot had not initially intended to fly at low level at Bushy Knoll Station, a hazard briefing had not been undertaken for the area.

2.13 The way by which experienced pilots make decisions in real world operational environments can be considered naturalistic decision-making. It is important, therefore, to have a clear and realistic picture of the operating environment, the task being undertaken and the associated hazards, in order to attain the best understanding and the most accurately informed mental model. Conducting and actively engaging in a hazard identification process provides information to help the pilot construct the appropriate mental model.

2.14 Not having conducted a hazard briefing for Bushy Knoll Station it is likely the pilot's mental model was not as accurate and well-informed as it could have been, and thus the pilot was relying on their attentional resources (with their associated limitations) to identify and respond to hazards.

2.15 In order to raise awareness of the importance of the hazard identification process CAA Safety Action 19A104 was raised for the CAA and industry to provide further education on the purpose of hazard identification within the agricultural aviation industry. In the September 2018 issue of the *New Zealand Agricultural Aviation Safety Update* the article 'Don't just tick boxes – make the plan, fly the plan' was published, which explained the purpose of the hazard identification process and its association with mental models and decision-making.

2.16 While the operator permitting pilots to make day-to-day decisions autonomously of management allowed the pilots the flexibility required to manage their workload efficiently, the opportunity is missed to oversee and support the pilots.

2.17 Having the pilots check in with the management team when changing plans or task sites would enable the operator to conduct improved flight following. Encouraging pilots to discuss decisions, such as plan changes, with either the management team or other staff members, may ensure the pilots have the appropriate and pertinent information at the time and reduce the risk of heuristics and biases influencing the pilot's decision-making.

2.18 CAA Safety Action 19A105 has been raised recommending the operator in collaboration with the industry implement a Team Resource Management (TRM) approach to agricultural aviation operations, utilising all personnel to assist with the safety of the operation, for example discussing plan changes and checking in with pilots prior to and after completion of the tasks.

3. Conclusions

3.1 The aircraft struck six 110 kV high voltage power lines.

3.2 The pilot likely experienced inattentional blindness, in that the pilot's attention was likely engaged on the other aircraft and thus the pilot failed to perceive the visual stimuli.

3.3 The pilot was appropriately rated and licensed to conduct the flight.

3.4 Research has shown that striking a wire that the pilot was aware of usually occurred because something changed, such as a last minute change of plan.

3.5 The pilot elected to change the plan at the last minute and detour during the positioning flight to an area where a pilot from the same operator was also conducting aerial topdressing.

3.6 The pilot did not conduct a hazard briefing for the area about to be flown and thus did not afford himself the most accurate and well informed mental model of the area the pilot elected to operate in.

3.7 Several human factors likely influenced the pilot's decision-making and risk perception leading to the decision to change the original plan and deviate from the minimum heights as stipulated by CAR 91.311 and operators SOPs.

3.8 The safety investigation did not identify any mechanical defects which may have contributed to the accident.

3.9 The accident was not survivable.

4. Safety Actions

4.1. CAA Safety Action 19A106 was raised recommending the operator require the flight following system radius function be deactivated on the completion of a task to improve flight following. In January 2017 this action was addressed by the operator with the amendment of the operator's Standard Operating Procedures, requiring pilots deactivate the flight-following system radius function when departing the airstrip at the completion of a task.

4.2. CAA Safety Action 19A104 was raised recommending the CAA and agricultural aviation industry provide awareness to pilots, explaining the purpose of the hazard identification process and its importance to a pilot's mental model and decision making. This action was addressed by the publication of the article 'Don't just tick boxes – make the plan, fly the plan' in the September 2018 issue of the *New Zealand Agricultural Aviation Safety Update*.

4.3. CAA Safety Action 19A105 has been raised recommending the operator in collaboration with the agricultural aviation industry implement a Team Resource Management (TRM) approach to agricultural aviation operations, utilising all personnel to assist with the safety of the operation, for example discussing plan changes and checking in with pilots prior to and after completion of the task.

4.4. Since the accident the following safety actions have also been implemented:

- In order to better support pilots and enabling them to concentrate on the aerial application tasks and the management of the associated risks, the operator has hired an Operations Manager. The Operations Manager's role is to manage the pilots' work schedule, in particular liaising directly with the landowners and ensuring the pilots have all the pertinent information required for the task.
- The electricity lines company responsible for the high voltage power lines held some discussions with the Electrical Industry, contractors, landowners and pilots in the area with regards to what steps could be taken to reduce the risk of wire strikes, particularly in relation to tasks requiring operations in close proximity to power lines. The electricity lines company also re-engaged with

parties from the original working groups formed to develop criteria for marking power lines, to review national high voltage transmission network policy and guidelines regarding minimising aircraft wire strike risk.

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