Report 07-012, Fletcher FU24-950EX, ZK-EGV, collision with terrain near Opotiki, 10 November 2007

Report 07-012

Fletcher FU24-950EX
ZK-EGV

collision with terrain

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Abstract

At about 1320 on 10 November 2007, a Fletcher FU24-950EX aeroplane, registered ZK-EGV, was engaged in aerial top-dressing of a farm near Opotiki when it descended into trees in a small gully about 600 metres from the area being top-dressed. The pilot, the only occupant, was killed.

ZK-EGV was a Pratt & Whitney Canada PT6A turbine-powered version of the Fletcher. No technical reason was found for the accident. However, the pilot was engaged in a lengthy cellphone conversation at the time of the accident, and that distraction and pilot fatigue were considered contributory factors in the accident.

The Commission recommended that the Director of Civil Aviation address the following safety issues identified during the investigation:

- the use of cellphones by pilots
- the procedure for checking of pilot competency on single-seat aeroplanes
- the installation requirements for emergency locator transmitters.

Photo courtesy of Super Air Limited

Fletcher FU24-950EX, ZK-EGV

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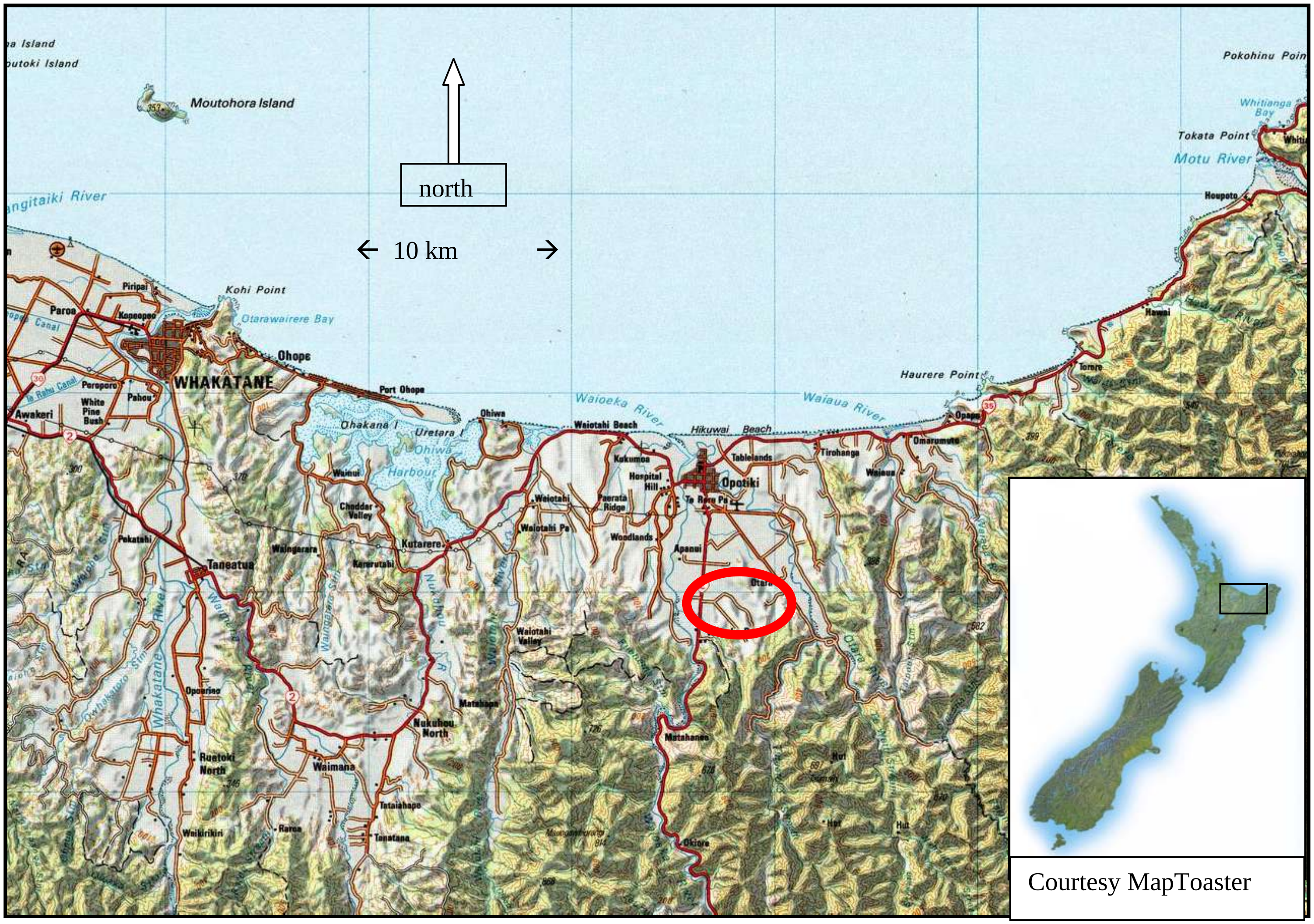

Figure 1
Location of the accident, near Opotiki, Bay of Plenty

Abbreviations

CAA	Civil Aviation Authority
CAR	Civil Aviation Rule
cm	centimetre(s)
GPS	global positioning system
hp	horsepower
IFR	instrument flight rules
kg	kilogram(s)
KIAS	knots indicated air speed
km	kilometre(s)
L	litre(s)
m	metre(s)
MHz	megahertz
psi	pound(s) per square inch
RPM	revolution(s) per minute
STC	supplemental type certificate(s)
UTC	coordinated universal time
VFR	visual flight rules

Glossary

hopper	a tank installed inside an agricultural aeroplane for holding wet or dry products that are released through a spreader while flying over the area to be treated
loader	a special-purpose truck with a bucket-crane for transferring products from a storage bin to an aeroplane hopper, and usually also fitted with aeroplane refuelling equipment
sowing	the aerial application of a product, whether seed, superphosphate or something else
supplemental type certificate	an approval issued by the Civil Aviation Authority (CAA) that allows changes to— (1) the type certificate category or type acceptance certificate category; or (2) the type design; or (3) the flight manual; or (4) the operating limitations; or (5) any special conditions prescribed on the type certificate or type acceptance certificate
type certificate	an approval issued by the relevant civil aviation authority that includes— (1) the type design (2) the operating limitations (3) the type certificate data sheet (4) the applicable airworthiness design standards (5) for an aircraft type, the flight manual (6) any other conditions or limitations prescribed for the product

Acknowledgement

The Transport Accident Investigation Commission (the Commission) acknowledges the assistance of the Transportation Safety Board of Canada and the United States Federal Aviation Administration in this investigation.

Data Summary

Aircraft registration:	ZK-EGV
Type and serial number:	New Zealand Aerospace Industries Limited FU24-950EX, 244
Number and type of engines:	one Pratt & Whitney Canada PT6A-34AG turboprop
Year of manufacture:	1977
Operator:	Super Air Limited
Date and time:	10 November 2007, 1320[1]
Location:	5 kilometres (km) south of Opotiki, Bay of Plenty latitude: 38° 04.4´ south longitude: 177° 18.6´ east
Type of flight:	agricultural, top-dressing
Persons on board:	crew: one passengers: nil
Injuries:	crew: fatal passengers: nil
Nature of damage:	aeroplane destroyed
Pilot's licence:	commercial pilot licence (aeroplane)
Pilot's age:	38 years
Pilot's total flying experience:	approximately 5250 hours
Investigator-in-charge:	P R Williams

[1] All times in this report are in New Zealand Daylight Time (UTC + 13 hours) and expressed in the 24-hour mode.

1 Factual Information

1.1 History of the flight

1.1.1 On the afternoon of Friday 9 November 2007, the pilot of ZK-EGV, a specialised agricultural aeroplane powered by a turbine engine, began a task to sow 80 tonnes of superphosphate over a farm situated in low hills 5 km south of Opotiki township and 4 km from the Opotiki aerodrome. The pilot was familiar with the farm's airstrip where he loaded the product, and with the farm. After 6 or 7 loads, the wind was too strong for top-dressing, so the pilot and loader-driver flew back to their base at the Whakatane aerodrome, about 40 km away.

1.1.2 At Whakatane, the aeroplane's fuel tanks were filled. Later that day, the pilot replaced the display for the aeroplane's precision sowing guidance system, which had a software fault.

1.1.3 The next morning, 10 November 2007, the pilot bicycled about 6 km from his house to the Whakatane aerodrome. The loader-driver said that the pilot looked "pretty tired" from the effort when he arrived at the aerodrome at about 0545.

1.1.4 After the aeroplane had been started using its internal batteries, the pilot and loader-driver flew to complete a task at a farm west of Whakatane. The pilot's notebook recorded that he began the task at 0610 and took 45 loads to spread the remaining 68 tonnes of product, an average load of 1511 kilograms (kg).

1.1.5 The loader-driver said that the pilot had determined about 2 months earlier that the scales on the loader used at that airstrip were "weighing light" by about 200 kg, so the loader-driver allowed for that difference.

1.1.6 After that task, the pilot and loader-driver flew back to the farm south of Opotiki where they had been the previous afternoon. A different loader at that airstrip had accurate scales, and the loader-driver said that he loaded 1500 kg each time, as requested by the pilot. The fertiliser that remained in the farm airstrip storage bin after the accident was found to be dry and free flowing.

1.1.7 The sowing task at this farm began at 1010 and the pilot stopped after every hour to uplift 180 litres (L) of fuel, which weighed 144 kg. During the last refuel stop, between 1226 and 1245, he had a snack and a drink. Sowing recommenced at 1245 with about 3 minutes between each load, the last load being put on at about 1316.

1.1.8 The loader-driver said the wind at the airstrip was light and the pilot did not report any problem with the aeroplane. After the last refuel, the top-dressing had been mostly out of sight of the loader-driver. When the aeroplane did not return when expected for the next load, the loader-driver tried 3 or 4 times to call the cellphone installed in the aeroplane. This was unsuccessful, so at 1338 he followed the operator's emergency procedure and called 111 to report that the aeroplane was overdue.

1.1.9 Telephone records showed that on 10 November 2007 the aeroplane cellphone had been connected for a total of more than 90 minutes on 14 voice calls, and had been used to send or receive 10 text messages. Correlation of the call times with the job details recorded by the pilot suggested he sent most of his messages while the aeroplane was on the ground.

1.1.10 Nearly all of the calls and messages involved a female work colleague who was a friend. The pilot initiated most calls by sending a message, but each time that the signal was lost during a call, the friend would stop the call and immediately re-dial the aeroplane phone; so, in some cases, consecutive connections were parts of one long conversation. The longest session exceeded 35 minutes. The nature of the calls could not be determined, but the friend claimed the content of the last phone call was not acrimonious or likely to have agitated the pilot. The friend advised that the pilot had said he often made the phone calls to help himself stay alert.

1.1.11 At 1153, in a phone call to his home, the pilot indicated that the job was going well and he might be home by about 1400. In one call to the friend, the pilot said that he was a bit tired and that he hoped the wind would increase enough that afternoon to force him to cancel the next job.

1.1.12 At 1308:45, the friend called the aeroplane phone and talked with the pilot until the call was disconnected at 1320:14. The friend said that while the pilot had been talking, the volume of his voice decreased slightly then there was a "static" sound. Apart from the reduced volume, the pilot's voice had sounded normal and he had not suggested anything untoward regarding the job or the aeroplane. The friend immediately called back, but got the answerphone message from the aeroplane phone. Two further attempts to contact the pilot were unsuccessful, but the friend did not consider that anything untoward might have happened.

1.1.13 An orchardist who was working approximately 3 km from the farm being top-dressed had heard an aeroplane flying nearby for some hours before he heard a loud sound that led him to fear that there had been an accident. He noted that the time was 1320 and immediately began to search the surrounding area.

1.1.14 After the loader-driver's emergency call, the Police organised an aerial search, which found the wreckage of the aeroplane at 1435 on the edge of a grove of native trees, approximately 600 metres (m) northwest of the area being top-dressed (see Figure 2). The pilot had been killed. His body was not removed until 26 hours after the accident, because of a Police concern not to disturb the wreckage until aviation accident investigators were present.

1.1.15 The CAA began an investigation that day into the accident and the Commission sent an investigator to help determine whether there were any similarities with another Fletcher accident that the Commission was then investigating.[2] On 19 November 2007, because of potential issues that concerned regulatory oversight, the Commission started its own inquiry.

1.2 Wreckage and impact information

1.2.1 The aeroplane was destroyed and, although fuel had spilled from the ruptured tanks, there was no fire. Some trees, a small area of swampy ground and about 15 m of farm fence were damaged.

1.2.2 The aeroplane's right wing tip had struck trees up to 20 m high at the western end of a native bush reserve adjacent to the farm block being top-dressed. The aeroplane had then descended in a right-wing-low attitude through further trees, some up to 30 centimetres (cm) in diameter, until impacting on marshy ground at the bush edge. After sliding for approximately 20 m, the aeroplane came to rest, tilted slightly to the right on a slight upslope, against a boundary fence (see Figure 3). The fuselage forward of the cockpit was canted upward about 15^{o} and severely distorted.

1.2.3 Other areas of bush and the paddocks between the farm block that was being top-dressed and the obvious accident area were searched as well as possible from the ground and air. No evidence was found to suggest the aeroplane had struck an object earlier or that any load had been jettisoned.

1.2.4 The descent angle through the trees averaged 27^{o}, but had progressively steepened and was about 45^{o} when the nose struck the marsh. The vertical distance from the first tree impact until ground impact was approximately 22 m, and the horizontal distance was approximately 40 m.

[2] Commission report 07-010, Fletcher FU24-950, ZK-DZG, in-flight fin failure and loss of control, Pukenui Forest, Northland, 22 November 2005.

1.2.5 Both wings were severely damaged by multiple tree strikes. The left wing was attached, but the outer half of the outboard wing had been sheared off early in the impact sequence. The remainder of the outer left wing had been almost separated and was split open along the trailing edge. The inboard fuel tank had been hit from below and partly rolled under the wing. The outboard tank was lying just ahead of the wing. The left wing flap hung down on broken hinge brackets, but the skin damage did not indicate whether the flaps had been lowered prior to impact.

Figure 2
Accident scene, looking to the east

1.2.6 The right wing tip and aileron were sheared off, with fresh wood found in the inside panels around the break. The next approximately 60 cm of the wing were not recovered, but were determined to be among a few pieces seen high in the trees near the start of the impact path. The remainder of the outer right wing had been removed by another tree strike.

1.2.7 The inboard right wing had pivoted about the rear attachment and penetrated the fuselage side before completely detaching. It was found alongside the fuselage, inverted and with the tip forward. The fuselage was folded about 20^{o} to the right through the point of penetration. Both right-wing fuel tanks had detached and were punctured. There was an obvious, but light, smell of fuel 24 hours after the accident, and signs of fuel in the marsh.

1.2.8 The tail fin forward attachment, which had been modified with a doubler, had been wrenched out as a result of a tree or branch strike, and the stabilator[3] had dislocated rearwards and to the left. The outer right half of the stabilator had been detached when it impacted on a stump, end on, at about the first point of ground impact. The rudder had slight damage, but had detached as a result of the fin being disrupted.

[3] The stabilator combined the stability function of a horizontal stabiliser with the pitch-control function of an elevator.

1.2.9 The pilot's harness was correctly fastened, with the inertia reel unlocked. The passenger harness was not fastened. There was a known risk that the unfastened passenger's right lap belt could obstruct the elevator torque tube bell crank by the cockpit right-side wall or an aileron pulley below the passenger seat. However, the belt was found clear of that area and there was no sign of the flight controls having been obstructed.

Figure 3
Accident scene

1.2.10 The pilot's helmet was found outside the cockpit, but he had been seen to be wearing it at the last refuel. The helmet had damage that was consistent with its having been worn during an impact.

1.2.11 The power lever was at a position just short of the full power stop, but bent inboard to be behind the propeller pitch lever, which was at the (maximum) fine pitch position. The side of the power lever had marks that indicated the lever had exceeded the limit stop at times.[4] The engine fuel lever was at OFF, but the fuel shut-off valve was in the ON position.

1.2.12 The airspeed indicator read zero, and the altimeter sub-scale was set to 1021 hectopascals.[5]

1.2.13 All of the circuit breakers on the instrument panel were set, except those labelled INST and GEN RESET, which were out, and GPS and GEN, which were missing. All switches were in the OFF position, except that the GEN RESET switch was in the ON position and the MASTER electrical switch was missing. The anomalous switches and circuit breakers were situated on the lower-right quadrant of the panel, apart from the global positioning system (GPS) circuit breaker, which was located at the top-left corner.

[4] The CAA reported that similar marks had been seen on the power levers of Fletcher ZK-DZG and other turbine-powered Fletchers inspected during the CAA's investigation into the ZK-DZG accident.
[5] The subscale is usually set so that the altimeter indicates altitude, that is, height above sea level for the actual atmospheric conditions. A hectopascal is 100 pascals, the unit of pressure in the International System of Units.

1.2.14 The control column was jammed under the instrument panel lower edge. The flight controls were inspected, as far as the wreckage allowed, and no anomalies were found. The stabilator trim tab was close to neutral at the control surface, as was the electric control in the cockpit. The flap lever and the adjacent hopper sowing lever were both upright compared with the floor. The flap lever was in the 30^{o} notch[6] and the sowing lever closed. The cockpit heating lever was in the COLD position.

1.2.15 The tips of all 3 propeller blades were missing, and none was found. The position of the blade counterweights showed that the blades were close to the beta range. The spinner was crushed on one side, and the 2 blades in contact with the ground were bent rearwards around the engine.

1.2.16 The engine exhaust stacks were twisted and the reduction gearbox case was fractured. The power turbine blades had no obvious damage. The compressor intake duct and screen were largely free of leaves or other debris. On the accessories section of the engine, the starter-generator had broken from its mount and fallen onto the air control line from the fuel control unit to the propeller governor. The fuel control unit was partially separated from the engine. Maintenance engineers said this type of damage was common after a propeller strike.

1.2.17 The fibreglass hopper was split open, and the spreader and deflector had been torn to the left, but remained attached to the aeroplane. An estimated 300 kg of fertiliser were in the hopper or spilled around it.

1.2.18 No signal was received from the emergency locator transmitter, and the unit could not be accessed until nearly 72 hours after the accident. The mode switch was found in the ARM position, but the coaxial antenna had been pulled from the unit. The operating light was not blinking, which indicated either that the unit was not transmitting or that the battery was flat.

1.2.19 The airframe fuel filter had caught some barely visible foreign matter, but the engine fuel filter was clean. The stainless steel fuel collector tank contained specks of dirt and other material that was not further analysed.

1.2.20 The aeroplane batteries were found outside their container in the rear fuselage, but the electrical connections were intact. There was no sign that arcing had occurred between any battery terminal and the fuselage structure. The pre-impact condition of the batteries was not determined.

1.3 Aeroplane information

1.3.1 The Fletcher FU24 was a New Zealand-manufactured agricultural aeroplane with a low wing, an all-flying tail-plane, or stabilator, un-powered flight controls and a fixed tricycle undercarriage. A fibreglass hopper was located behind the pilot. There was provision in the cockpit to carry a second person, typically the loader-driver, on ferry flights, but dual controls were not fitted. The initial power plant was a 225 horsepower (hp) piston engine, but engine power had been progressively increased. Starting in about 1998, some Fletchers had been modified by the installation of turbine engines. In 2007, almost half of the hours flown in Fletcher aeroplanes in New Zealand were flown in turbine-powered variants.

1.3.2 ZK-EGV was manufactured at Hamilton in November 1977 as a Fletcher model FU24-950 with a 400 hp piston engine. The aeroplane log book had no flying recorded for more than a year before the operator assumed ownership in October 2002, after which the aeroplane remained out of service until the completion of a conversion from piston to turbine power.

[6] The normal landing flap setting was 40^{o}.

1.3.3 On 1 July 2004, the CAA issued ZK-EGV with an airworthiness certificate in the restricted category for agricultural operations. The airworthiness certificate was non-terminating as long as the aeroplane was maintained in accordance with the operator's maintenance programme and applicable Civil Aviation Rules (CAR), which the aeroplane's log books indicated it had been. The previous annual review of airworthiness had been completed on 11 October 2007.

1.3.4 A Brno starter-generator driven from the accessories gearbox on the rear of the engine provided electrical power for aeroplane systems. The generator charged two 12-volt automotive batteries, an approved modification, which provided engine starting and back-up power. The batteries were installed in a box in the rear fuselage.

1.3.5 A decal on the instrument panel read:

> With hopper outlet deflector SLM 125 fitted, Max. Speed # KIAS
> [*The # represents numerals that were scratched out.*]

The hopper outlet deflector reference should have been to SLM 161.[7] The flight manual included the applicable supplement, which gave the maximum indicated air speed as 116 knots. The operator attributed the placard error to an oversight.

1.3.6 The aeroplane was fitted with an AG-NAV® system for the precise application of top-dressing materials. The system was contained largely within a unit mounted in the instrument panel, which displayed a plan view of the task progress. Steering guidance was indicated by a "light bar" mounted above the display. The system used position data from the GPS[8], input task details and the hopper door position.

1.3.7 The GPS and AG-NAV systems were powered directly from the aeroplane battery. The circuit was protected by in-line fuses.

1.3.8 As set up in ZK-EGV, the system recorded data every 0.2 seconds when sowing, otherwise every second. The sowing and flight path data for 20 records (that is, 4 seconds when sowing and 20 seconds when not) was held in a memory buffer before being saved to a hard drive. Only the hard drive data was recoverable.

1.3.9 On 11 October 2007, an Artex ME406 emergency locator transmitter beacon was installed to the left of the pilot's seat. The beacon was connected by a coaxial cable to an antenna located on the upper rear fuselage. The beacon manufacturer and the CAA, through its Advisory Circulars 43-11, "Emergency locator transmitters" and 43-14, "Avionics, installations – Acceptable technical data", instructed that a beacon should be installed as far aft as practicable and with the minimum practicable cable length to the antenna. The aim of aft installation and a short cable run was to minimise the chance of damage to either the unit or the cable in an accident.

1.3.10 The beacon battery pack was connected to a counter that recorded any activation, including a serviceability test, but the counter did not record the times of activation.

Conversion to turbine power

1.3.11 On 4 December 2003, a 550 hp Pratt & Whitney Canada PT6A-11AG turbine engine and a Hartzell HC-B3TN-3D/T10282N propeller were installed in ZK-EGV. Related modifications included an 18-inch (46 cm) fuselage extension behind the cockpit, 2 more fuel tanks, lengthened nose gear and revised engine instruments. Thereafter, the aeroplane model was referred to as a Fletcher FU24-950EX.

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[7] SLM was an abbreviation for a modification of the operator's design.
[8] The GPS used signals received from 3 or more of a constellation of satellites to determine the receiver's position. When combined with certain computing functions, a GPS receiver could be a very accurate navigation tool.

1.3.12 On 4 June 2004, the CAA issued supplemental type certificate (STC) 3/21E/1 for the conversion package. The CAA said that the nature and extent of the modifications did not justify a new aeroplane type certificate. The STC stated, in part:

> Because of the extensive changes to the original design, it is a requirement of the STC that pilots flying this aircraft must have completed a type rating course that is acceptable to the [CAA].

1.3.13 The engine and propeller control levers had the following names and settings:

Fuel lever	OFF - START - FLIGHT
Propeller pitch lever	FEATHER - FINE PITCH
Power lever	REVERSE - START IDLE - FLIGHT IDLE - FULL POWER

1.3.14 Under normal circumstances, the engine was controlled solely by the power lever, with the pilot setting an indicated torque.

1.3.15 Oil pressure, from the engine, was required to move the propeller blades towards fine pitch and beyond that into the ground, or "beta", range. A loss of oil pressure to the propeller would cause the blade pitch to coarsen towards the feather position.

1.3.16 On 10 August 2006, the PT6A-11AG engine was removed because of excessive carbon in the oil, and replaced with a PT6A-34AG engine of 750 hp. The propeller was compatible with the PT6A-34AG engine and was retained, and the engine output was limited to 550 shaft hp. The flight manual supplement for the PT6A-34AG engine stated that there were no changes to the (previously used PT6A-11AG) engine operating limitations or procedures, but that "engine torque must not exceed 42.5 pounds per square inch (psi)". The PT6A-11AG maximum torque was 42.6 psi and the maximum propeller revolutions per minute (RPM) were 2200.

1.3.17 Using the formula[9]

propeller RPM **x** torque **x** k = shaft hp

where the factor "k" was 0.00581, the PT6A-34AG take-off power at 42.6 psi and 2200 RPM was 545 shaft hp.

1.3.18 The form CAA 337, "Design change – Application for approval of Technical Data / Conformity Certificate – Major Modification, Major Repair", recorded that the PT6A-34AG engine power had been de-rated by fitting a "tamper proof control stop". The intended control stop was a stainless steel sleeve fitted to the lever end of the control cable, which allowed a small amount of movement to ensure that 550 hp were obtainable under the normal range of atmospheric conditions. Instead of the sleeve, an adjustable stop, accessible to a pilot, was fitted to ZK-EGV.

1.3.19 The technical data for the change to a PT6A-34AG engine was initially approved on 8 August 2006, but a flight manual supplement for the modification was not issued until 17 November 2006. By then, the repaired PT6A-11AG engine had been re-installed in the aeroplane.

1.3.20 The operator said that after the aeroplane hit a sheep on 12 June 2007, an inspection for structural damage had been carried out, but no written record of that inspection was found. A PT6A-34AG engine, serial number PCE-PH0410, was installed because of difficulty in finding a replacement PT6A-11AG engine. The propeller, serial number BUA30454, was overhauled and refitted, and the aeroplane returned to service on 17 September 2007.

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[9] Source: Pratt &Whitney Aircraft of Canada PT6A-34AG specific operating instructions.

1.3.21 The flight manual procedure “Engine Failure – During Flight” read in part:

power lever	START IDLE
propeller lever	FEATHER
jettison hopper load	
fuel lever	OFF
fuel shut-off valve	OFF
establish best glide speed	(70-75 KIAS)
select safe landing area …	

if altitude and cause of engine failure permit … carry out in-flight engine re-start
if engine re-start is not possible, carry out a forced landing.

The minimum altitude to attempt an in-flight engine re-start was 3000 feet.

1.3.22 The flight manual procedure “Emergency Landing – Without Engine Power” read in part:

jettison hopper load	
establish best glide speed	(70-75 KIAS)
radio	transmit MAYDAY[10]
flaps	as required
safety harness	retract, lock
trim	set
master switch	OFF.

Fuel system

1.3.23 Two interconnected fuel tanks formed the leading edge of each wing, giving a total fuel capacity of 410 L, of which 70 L were unusable under all conditions and 170 L unusable under manoeuvring flight conditions. The operator said that although top-dressing was accepted as manoeuvring flight, the 170 L limitation was not strictly observed.

1.3.24 There was one fuel gauge for each wing, with the minimum indicated fuel 70 L per tank. The standard fuel consumption for the FU24-950EX when top-dressing was 180 L per hour. A minimum of 30 minutes’ (90 L) reserve fuel was required at the place of intended landing.

1.3.25 The digital fuel-flow computer was the only engine instrument with any memory. At the start of each day’s flying, a pilot would enter into the fuel-flow computer the actual fuel on board, normally full tanks. At each subsequent refuel, the refuel quantity would be added to the displayed “Fuel Remaining”. The Fuel Remaining was a nominal value, because it relied on the starting quantity input by the pilot, from which was deducted the actual fuel used while the engine was operating. A placard on the instrument panel warned that the fuel-flow instrument should not be relied upon to determine the fuel quantity on board. The operator had programmed the computer to give a visual warning when the remaining fuel was 120 L.

1.3.26 The Fuel Remaining figure when electrical power was removed from the instrument was displayed again when electrical power was next applied. After the accident, the displayed Fuel Remaining was 184 L and the Fuel Used was 103 L. No low-fuel warning illuminated.

1.3.27 The Fuel Used closely matched the expected consumption for 35 minutes of flying, if the fuel flow computer had been updated after the refuel. The sum of Fuel Remaining and Fuel Used, 287 L, was the best estimate for the total amount of fuel on board ZK-EGV when the fuel-flow computer had been updated after the refuel that was completed between 1226 and 1245.

1.3.28 The flight manual procedure “Fuel System Failure” read, in part:

Ensure fuel boost pump is switched on.

[10] The international radiotelephony signal to advise of a distress situation.

Weight and balance

1.3.29 The fuselage extension accommodated a larger fibreglass hopper to allow the weight capacity of the hopper, 1269 kg, to be fully used with lower-density products. The maximum hopper load was placarded on both sides of the aeroplane adjacent to the hopper mouth.

1.3.30 The aeroplane's empty weight, following the initial conversion to a turbine engine, was 1378 kg. The empty weight included 70 L (56 kg) of unusable fuel. The aeroplane flight manual listed the maximum take-off weight in the agricultural category as 2457 kg, or 2880 kg if the overload provision of CAR 137.103[11] was applied.

1.3.31 The estimated take-off weight of ZK-EGV following the refuel at 1245 was as follows:

aeroplane empty weight	1378 kg	
pilot weight (estimated)	105	
fuel (217 L)	174	(does not include the 70 L in empty weight)
fertiliser	1500	
take-off weight	3157 kg	

Cellphone installation

1.3.32 On 25 August 2005, an existing cellphone installation in ZK-EGV was replaced. A voltage converter connected the hands-free kit to the same electrical circuit that powered the pilot's headset and microphone, and to a very-high-frequency radio transceiver.

1.3.33 The CAA Advisory Circular 43-14, "Avionics, installations – Acceptable technical data", provided for certain avionics modifications, including cellphones, and read in part:

> The modification is to be recorded by completing the appropriate section of the Form CAA 337 quoting the applicable appendix of this Advisory Circular. The aircraft modification section of the maintenance records must be updated to reflect the incorporation of the modification.
>
> The certification of release to service in respect of avionics modifications embodied using this Advisory Circular as approved technical data, must be issued by an appropriately qualified person. It is important to recognise that this Advisory Circular only provides for the approval of the technical data.
>
> A new Form CAA 2129[12] must be completed for all changes in the avionics equipment installation in accordance with AC43-10. Where a change is made in accordance with this Advisory Circular, the *Mod Ref* [modification reference] column of the Form CAA 2129 adjacent to the entry for the equipment being installed or removed should provide a reference to the applicable aircraft logbook entry.

1.3.34 Appendix 9 of Advisory Circular 43-14 specifically covered the installation of a cellphone. The last 2 steps of the related technical instructions were as follows:

> Amend the aircraft's Form CAA 2129 …
>
> Make a certified statement of release to service in accordance with Rule 43.105, detailing the work carried out and conformity with this appendix.

1.3.35 The operator said that the cellphone replacement had been a minor design change that was covered by Advisory Circular 43-14. Although a form CAA 337 had been raised, neither the form nor a description of the work carried out had been entered into the aeroplane logbook. A new form CAA 2129, "Aircraft radio station/Equipment approval levels", had been completed, but the *Mod Ref* given by the operator was Advisory Circular 43-14 Appendix 9, not "the applicable aircraft logbook entry". Form CAA 2129 had a contradictory instruction regarding

[11] See paragraph 1.10.2.
[12] Form CAA 2129 was entitled "Aircraft radio station – equipment approval levels".

the *Mod Ref*, in that it said the reference should quote "the appropriate modification approval or service bulletin number". The Commission observed that engineers at some other maintenance organisations had also incorrectly completed the *Mod Ref* column of form CAA 2129.

1.3.36 There was no CAR that prohibited the use of a cellphone during an agricultural operation. Although the use of cellphones was ordinarily prohibited on aircraft operating under instrument flight rules (IFR)[13], pilots were instructed to use them to attempt to contact air traffic control in the event of a loss of radio communications.[14] In-flight use of a cellphone by a pilot was implicated in an earlier aeroplane accident that was investigated by the Commission.[15]

Cockpit environment

1.3.37 Cockpit ventilation was provided by air vents. Heating was provided by compressor bleed air ducted from the engine, and the flow controlled by a handle. The flight manual required that a carbon monoxide indicator, visible to the pilot, be on the instrument panel. The operator said that a detector was fitted to each of its aeroplanes, and the Velcro base for such a detector was on the instrument panel of ZK-EGV. The detector itself was not found.

1.3.38 A number of friends and associates of the pilot said that he often complained about the Fletcher cockpit being too hot and that the turbine-powered ZK-EGV smelled of engine exhaust fumes. Some said his work clothes smelled strongly of turbine fuel. Anecdotally, pilots found the cockpit fumes worse in the PT6-powered Fletcher than in the Walter turbine-powered version. One friend quoted the pilot as saying that he suffered from fumes badly and the smell made him lethargic. Another said that the pilot used eye drops frequently to counter the effects of fumes.

1.3.39 A notebook found in ZK-EGV contained a record kept over a few months of one summer of the air temperature inside and outside the cockpit. The cockpit temperature was typically 5°C warmer than the air outside, and on some afternoons had reached 34°C. The pilot was known to drink plenty of water and orange juice when flying, and had done so on 10 November 2007.

Recent maintenance

1.3.40 On 6 November 2007, a scheduled 150-hour check of the aeroplane was completed at the operator's main base. During that check, the stabilator was replaced because of corrosion and the left rudder control cable was replaced. The appropriate duplicate inspections were carried out. The inspection check sheet recorded that the aeroplane batteries had been inspected for condition, security, corrosion and electrolyte level, and that the battery box condition had also been checked. Samples of fuel were drawn from the wing tanks and the collector sump in the fuselage and checked for the presence of water and other contaminants. No anomalies were recorded.

1.3.41 After the check, the pilot departed in ZK-EGV to fly back to Whakatane, but he returned soon afterwards to have the stabilator trim tab adjusted. Adjustment of the trim tab after replacement of the stabilator was not unusual, and the adjustment was not recorded in the log book.

1.3.42 The combined "Daily Flying Sheet" and "Technical Log" (technical log) included a record of the mandatory daily post-flight inspections of the vertical tail fin leading edge that were required by airworthiness directive DCA/FU24/176C. ZK-EGV had been flown on 3 days since 6 November 2007, but whether the fin had been inspected on those days was not recorded.

1.3.43 At the end of 8 November 2007, the aeroplane had accrued about 12 466 flight hours and the engine about 116 total hours. The propeller had accrued about 760 hours, or about 116 hours since overhaul.

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[13] CAR 91.7 refers.
[14] Aeronautical Information Publication New Zealand, page ENR 1.15-5.
[15] Commission report 03-004, Piper PA31-350 Navajo Chieftain, ZK-NCA, controlled flight into terrain, near Christchurch Aerodrome, 6 June 2003.

Previous incident

1.3.44 On 8 February 2007, while top-dressing, the pilot found that the stabilator had jammed. He recovered the aeroplane successfully to Whakatane. During rectification, part of a discarded bolt was found to have jammed a control cable pulley.

1.4 Personnel information

1.4.1 The pilot began flying training in August 1995 and was issued with a private pilot licence (aeroplane) in September 1997. He obtained a Fletcher type rating in February 2002 and a commercial pilot licence (aeroplane) in April 2002. He passed the "Basic Turbine Knowledge" examination in April 2002.

1.4.2 The pilot was employed by the operator as a loader-driver prior to starting training in May 2002 as an agricultural pilot. Since then, all but 7 hours of his flying had been in various models of the Fletcher. In September 2004, after completing 1000 hours of productive agricultural flying, he obtained a grade 1 agricultural rating (aeroplane). He had been based at Whakatane aerodrome since early 2003.

1.4.3 In July 2003, the pilot obtained a type rating for the Walter turbine engine model of the Fletcher and completed 3.5 hours of dual agricultural training in that model. The operator did not have a Pratt & Whitney Canada PT6A-powered aeroplane that was equipped with dual controls, but the pilot was issued with a type rating for that version in January 2004, as permitted by CAR 61.55(d), and was then allocated ZK-EGV.

1.4.4 On 14 April 2005, the pilot completed an annual agricultural pilot competency assessment, combined with a biennial flight review, in ZK-EGV. On 29 March 2006, he logged a flight of one hour and 20 minutes as pilot-in-command in ZK-EGV, with the flight detail described as "Whakatane-Hamilton-[biennial flight review]-Whakatane". The attached certification described the flight as an annual currency check only.[16] Elsewhere in his log book, the pilot had recorded that a return flight from Whakatane to Hamilton took one hour and 20 minutes.

1.4.5 Three months later, the pilot logged a 20-minute dual flight as another biennial flight review, but it was flown in a Cresco, a different aeroplane type from a Fletcher and one for which the pilot was not rated. The flight was certified as an annual currency check. The operator's then chief pilot said that a Cresco had been used because no dual PT6-powered Fletcher was available at the time, and a dual flight in the Cresco was more useful than a check pilot observing another pilot's handling from the ground. On 26 June 2007, again in a Cresco, the pilot flew a combined annual competency assessment and biennial flight review of 25 minutes' duration.

1.4.6 On 6 November 2007, after a 3-day break from flying, the pilot flew ZK-EGV to the operator's main base at Hamilton for a scheduled maintenance check, after which he flew the aeroplane back to Whakatane. On 7 November, he was on duty for about 12.5 hours, but took the operator's prescribed breaks. He worked at least 7.5 hours on 8 November, the last day for which completed flying details were available.

1.4.7 The pilot's employment agreement provided for a 10-minute break after each 2 hours of continuous work, and a half-hour meal break to be taken within each 5-hour period worked. On 8 November, the pilot took many 10-minute breaks, but not the half-hour meal break.

1.4.8 The operator's records indicated that the pilot had worked 8.5 hours on Friday 9 November. He was home by mid-afternoon, but later he returned to the aerodrome to replace the precision sowing guidance system on ZK-EGV. That night, he attended to the operator's paperwork for about 90 minutes, as he usually did on work days.

[16] The relevant CAR 61.707 was titled "currency requirements", but required a demonstration of competency. See section 1.9.

1.4.9 The pilot's wife said that he slept well and always ate a good breakfast and lunch. Acquaintances generally described him as being very keen on his work and having a well balanced life. He was considered a capable pilot by the operator and work acquaintances.

1.4.10 On 20 September 2003, the pilot received minor injuries, and his loader-driver at the time received serious injuries, when the (different) Fletcher in which they were flying collided with trees when returning to the departure airstrip because of poor weather conditions. An investigation by the CAA was inconclusive as to the cause of that accident, but information given to the Commission during the present investigation suggested the pilot might have been trying to follow a "bad weather" route that he had loaded into his own hand-held GPS unit.

1.4.11 In October 2003, the operator warned the pilot about his extensive use of cellphones, including the message function, while flying, and against using a hand-held GPS while at low level. The pilot had agreed that he sent text messages while on ferry flights, but not when at low level or while top-dressing. He pledged that he would stop the practice.

1.4.12 In 2004, the pilot had to land on a farm airstrip because the fuel quantity was insufficient to allow him to reach his Whakatane base with the required reserve. The incident was possibly due to a faulty fuel meter on the loader used, but was not reported to the operator.

1.4.13 On 12 June 2007, while taking off on a top-dressing flight in ZK-EGV, the pilot was talking on the aeroplane cellphone to the friend when the aeroplane hit a sheep on the airstrip. The pilot exclaimed that he had hit a sheep and was abandoning the take-off and ending the call.

1.4.14 The pilot's total logged flying experience to 8 November 2007 was 5243 hours, of which 4889 hours were in Fletchers of various models, and 3338 hours in ZK-EGV. He flew only ZK-EGV between 14 September and 10 November 2007. His logged productive top-dressing experience exceeded 4300 hours.

1.5 Meteorological information

1.5.1 At midday on 10 November 2007, a large anticyclone in the Tasman Sea extended a ridge over New Zealand. Automatic weather stations in the Bay of Plenty region reported light or steady winds of less than 13 knots during the day. The temperature at Whakatane at 1300 was 18^{o}C.

1.5.2 People in the Opotiki area said the weather in the early afternoon was fine. A local pilot said it was "beautiful for flying", with a sea breeze of about 5 knots at Opotiki. The farmers of 2 properties adjacent to the accident site said the wind was gusty during the early afternoon, but the orchardist said the wind on the plain was no more than 3 knots. The loader said the wind and conditions at the airstrip were "good".

1.5.3 At 1300, the sun was at its highest elevation for the day.

1.6 Radio communication

1.6.1 The aeroplane radio was examined after the accident by a specialist and found to be operable. The frequency in use was 133.475 megahertz (MHz), which was not identified with any other operator, aerodrome or agency. The standby frequency was set to 118.6 MHz, that for traffic at or in the vicinity of Whakatane aerodrome.

1.6.2 There was no requirement for the pilot to have maintained radio communications with any agency on 10 November 2007, but he was required to listen on frequency 119.1 MHz while operating within 10 nautical miles (18 km) of Opotiki aerodrome.

1.6.3 No distress radio call was heard from ZK-EGV.

1.7 Medical and pathological information

1.7.1 The pilot's Class 1 medical certificate had been issued on 13 January 2007 and was valid until 13 January 2008. The certificate was endorsed "subject to medical surveillance", the requirement being to obtain every 2 years an ophthalmologist's report on a longstanding eye condition. The last report had been received in December 2005. Medical opinion was that the eye condition would not have distracted or impaired the pilot, or been a factor in this accident.

1.7.2 The loader-driver said that he had no concern for the pilot's fitness to fly on 10 November 2007.

1.7.3 Detailed post-mortem toxicology found no raised carbon monoxide or fuel-related chemicals in the pilot's blood, but determined that the pilot "... had consumed alcohol sometime before flying. These results do not suggest that alcohol was consumed immediately before, or during, the flight".

1.7.4 The autopsy report by the Regional Forensic Pathology Adviser stated that the pilot had died as a result of multiple injuries "… consistent with horizontal force, relative to the deceased in the seating position". The autopsy also found that the pilot's heart[17] and liver were enlarged, the latter exhibiting severe fatty change. Together, these findings suggested the pilot had regularly consumed alcohol to the extent that there was physical harm. An independent professor of forensic and aviation pathology in Australia confirmed those findings. The specialist considered that, in view of the reported accident circumstances, it was very unlikely that the pilot had suffered a medical incapacitation or impaired mental or physical performance as a result of his heart condition, although the possibility could not be ruled out entirely.

1.7.5 In answer to the standard medical examination question concerning alcohol consumption, the pilot had written that he drank 3 cans of beer per week and usually drank at weekends. His wife said that he would often have a beer when he got home from work and perhaps another after dinner, on most nights of the week during summer. However, she said that, since the middle of October 2007, in preparation for his next annual medical examination, he had had almost no alcohol. A close friend of the pilot said that he had "cut back" his drinking, but had not stopped altogether. Enquiries of other associates of the pilot did not reveal concerns for recent excessive drinking by the pilot.

1.8 Tests and research

Engine and accessories

1.8.1 The engine manufacturer, Pratt & Whitney Canada, examined the engine under the supervision of an investigator from the Transportation Safety Board of Canada. That investigator also attended the inspection and test of the engine's accessories, except for the test of the fuel control unit, which was performed in the United States by Honeywell under the supervision of a Federal Aviation Administration investigator.

1.8.2 The fuel control unit had impact damage and was partially separated from the accessories drive. The damage precluded testing. Disassembly revealed an elongated bellows with indications of impact damage on 2 of the convolutions. The bellows unit was forwarded to Honeywell, where testing confirmed the bellows had no leaks or corrosion, and functioned correctly in a slave unit.

1.8.3 The inspection report concluded, in part:

> In general, the anomalies noted during examination of the fuel control unit were consistent with impact damage. The deformation observed on the bellows did not compromise the integrity of the bellows. The damage to the fuel control unit drive-body and the direction of the twist observed in the fuel control unit plastic coupling suggests that the fuel control unit driveshaft stopped turning at impact while the pump continued to rotate.

[17] The diagnosis was dilated cardiomyopathy.

1.8.4 Examination of the compressor bleed valve found that in its free state with the piston fully retracted, there was a gap between the piston and the housing. The compressor bleed valve was tested in accordance with the engine overhaul manual and no anomalies were recorded. The bleed valve was disassembled and it was noted that the diaphragm had been pinched between the periphery of the housing and the cover. Otherwise, all components of the valve were in good condition. The report concluded that "testing confirmed that the pinched diaphragm did not impair the performance of the valve".

1.8.5 Pratt & Whitney Canada could not suggest the engine power output at impact, but its report concluded that:

> The engine displayed contact signatures to its internal components characteristic of the engine producing power at the time of impact.
>
> The engine displayed no indications of any pre-impact anomalies or distress that would have precluded normal operation prior to impact.
>
> There were no indications of any pre-impact distress or operational dysfunction to any of the engine components including the controls and accessories examined.

Propeller

1.8.6 The propeller hub and blade remnants were inspected under the Commission's supervision at an approved overhaul facility.

1.8.7 No evidence was found of any pre-existing defect or assembly anomaly in the hub. The blades appeared to have been driven towards the beta pitch range by high impact forces, which the overhaul staff said was not an uncommon finding.

1.8.8 Staff at the overhaul facility viewed photographs of the propeller blades, taken after the 12 June 2007 sheep strike. They considered that the damage appeared to be well within straightening limits. They also commented that, as long as all repair criteria were met, propeller blades could be straightened a number of times before becoming unworkable.

1.8.9 The propeller governor was tested in Canada in accordance with the component manufacturer's test sheet, and some deviations from the production specification were noted. The engine manufacturer said the apparent discrepancies were not impact related. The manufacturer also said the governor should have functioned satisfactorily in normal operation, although it might have limited propeller RPM to 95% or less in the reverse thrust range. The operator confirmed later that the governor had been rigged to about 95% RPM in reverse, as per the engine maintenance manual.

Fuel

1.8.10 The aeroplane fuel-supply tank on the loader was checked for water on the day of the accident and none was found. Fuel samples taken from the aeroplane collector tank and the loader truck were analysed by an independent laboratory and compared with a reference sample. The loader sample was acceptable in all respects, but the aeroplane sample was a yellow-green colour rather than being clear and bright. The laboratory suggested that the colour, and relatively high evaporation residues, could have been due to a dissolved ester or vegetable oil, but doubted that their concentration would have caused an engine malfunction. Otherwise, the aeroplane fuel sample was satisfactory.

AG-NAV equipment

1.8.11 The stored AG-NAV data was retrieved by a specialist agent. Experienced agricultural pilots agreed that the data indicated the pilot had been flying efficient and tidy patterns. The pilot was sowing 3 runs per hopper load.

1.8.12 The data ended at a recorded time of 1319:15, when the aeroplane was completing a right-hand dumb-bell turn after the first run of a new load (see Figure 4). During the turn, the aeroplane climbed about 400 feet and the (ground) speed decreased to about 75 knots. The average ground speed on this flight was 112 knots, and the maximum 140 knots. The maximum permissible indicated air speed with the hopper deflector fitted was 116 knots.

1.8.13 Comparison with the sowing patterns of earlier loads suggested that at the end of the second run the pilot would have turned left slightly and pulled up before making a right-hand dumb-bell turn leading into the third run. The second run was to the northwest, and the accident site was about 280 m west of the widest of the reversal turns made on previous sowing runs in that area.

1.8.14 The system was checked after the accident and functioned satisfactorily in navigation mode, but the associated GPS receiver was inoperative.

1.8.15 The GPS receiver was examined by its maker. The power plug socket receptacles were worn, and a pin on one of the sockets was partly retracted. Damage to the power and data cable sheathing was determined to be accident related. The unit operated normally when fitted with replacement cables. No evidence of a power surge or short-circuit was found. The maker considered that the worn sockets could have caused intermittent operation and the retracted pin could have caused the GPS to stop operating.

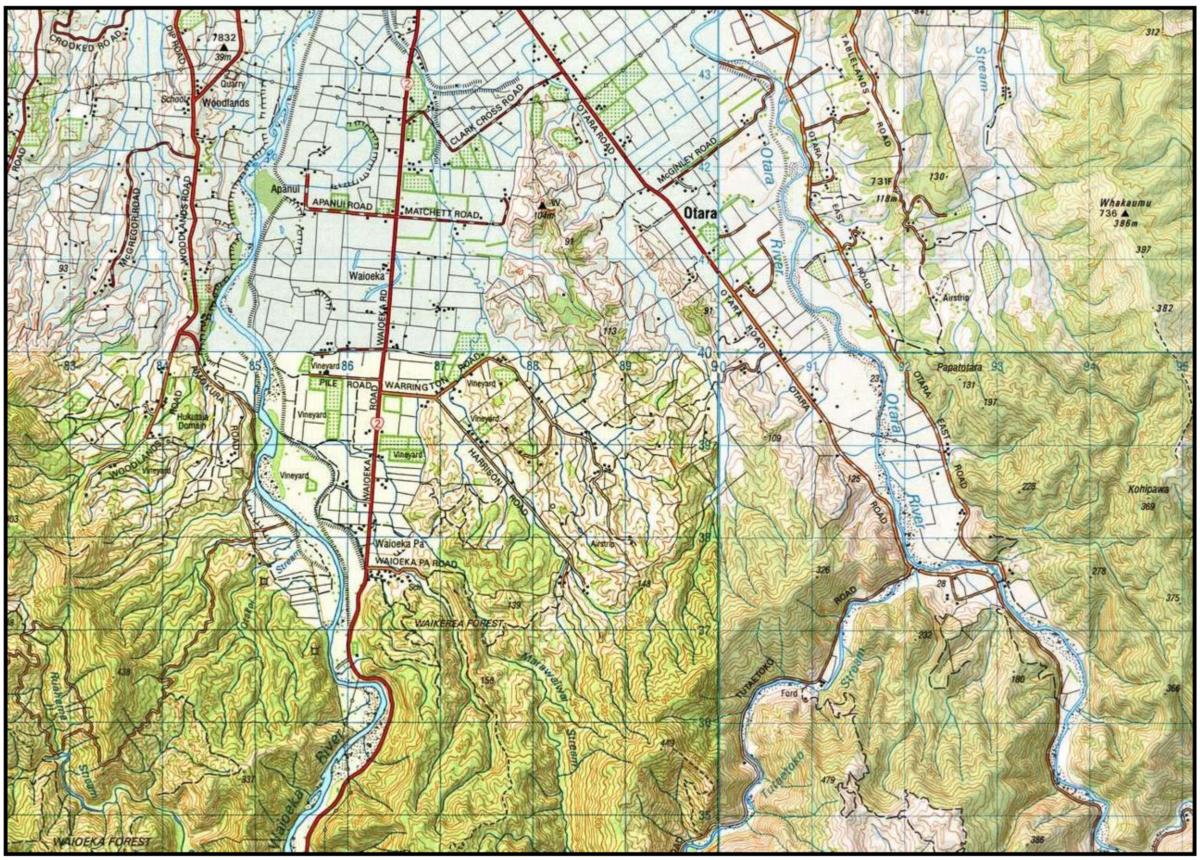

Figure 4
Approximate flight paths before the accident

Avionics

1.8.16 The aeroplane cellphone was destroyed. The hands-free kit and voltage converter were examined by the kit maker. No fault was found with the hands-free kit and it operated correctly with a phone that was similar to the one in ZK-EGV.

1.8.17 The main converter circuit was faulty, which the kit maker said would likely have caused the converter output voltage to fail. However, such a failure would not have affected the pilot's microphone, which would have continued to supply an input to the phone. The phone connection to the network should have been maintained by its internal battery.

1.8.18 The kit maker suggested scenarios that might explain the interference noise heard by the friend on the last conversation with the pilot, but these relied on the failure of the radio internal voltage regulator. The diode that protected the radio from over-voltage was undamaged.

1.8.19 The emergency locator transmitter was examined and tested at an approved repair centre. Since installation, the beacon had been activated 6 times for a total duration of almost 94 hours. Some of the activations would have been for test purposes, but the total time suggested that the beacon had activated at impact and continued to transmit, but without being connected to the antenna, until the battery pack went flat. The beacon passed a serviceability test.

1.9 Organisational and management information

1.9.1 The operator originated during the 1980s with the amalgamation of small operators and a major fertiliser company, which later became the sole shareholder. In late 2007, the operator had a fleet of 19 aeroplanes and employed 17 pilots. The main base was at Hamilton aerodrome, but the aeroplanes and pilots were based at 13 locations elsewhere in the North Island.

1.9.2 The operator's Agricultural Operations Manual included the following requirements in regard to continued pilot competency:

> GENERAL REQUIREMENTS
> Company pilots will complete an Agricultural Competency Assessment covering normal, non-normal and emergency situations in an aircraft type normally flown by the pilot, within the previous twelve months prior to flying on agricultural Operations.
>
> PILOT COMPETENCY ASSESSMENT
> All pilots with less than 2000 productive [hours] flight time will;
> (a) Demonstrate Competency in flight to the satisfaction of the Company Competency Assessor, and
> (b) Be observed working in an Aerial Agricultural Operation.
>
> At the discretion of the Chief Pilot, other Pilot Competency may be observed from the ground by the Company Competency Assessor.

1.9.3 The Agricultural Operations Manual referred to the use of CAA Flight Test Standards Guides for assessment standards, but none of the Guides applied specifically to agricultural operations or to Category E flight instructors[18] (who typically conducted the operator's pilot assessments).

1.9.4 The CAR requirement for pilot competency read, in part:

> **61.707 Currency requirements**
> (a) … the holder of an agricultural rating must not exercise the privileges of the rating unless,—
> (1) within the preceding 12 months, the holder has successfully demonstrated the holder's continued competency in accordance with rule 61.701(a)(5) or (b)(3) as applicable; and …
> (2) the flight instructor or flight examiner who conducts the competency demonstration certifies the successful completion of the check in the pilot's logbook in accordance with rule 61.29.

[18] CAR 61.305, "Privileges and limitations", permitted a Category E flight instructor to give technical and flight instruction in agricultural operations, conduct type ratings on agricultural aircraft and conduct pilot competency checks for the issue or renewal of an agricultural rating.

1.9.5 The applicable part of CAR 61.701 read, in part:

> **61.701 Eligibility requirements**
> …
> (b) To be eligible for the issue of a Grade 1 agricultural rating … a pilot must—
> …
> (3) have demonstrated competency (orally and in flight) in agricultural operations— …
> (ii) to the holder of an appropriate current Category E flight instructor rating who must conduct that demonstration under the authority of an agricultural aircraft operator certificate issued in accordance with Part 137.

1.9.6 The operator did not have an FU24-950EX equipped with dual flight controls; few agricultural aeroplanes were so equipped. Many did not have a second cockpit seat, but even if they did, passengers were not permitted to be on board during top-dressing flights. Experienced flight examiners told the Commission that such obstacles to competency checks limited their means of "conducting" competency checks, and had led to ground-based observations of pilots' performances or the use of aeroplanes for which pilots were not rated. A common method was for the flight examiner to fly with the subject pilot at a medium altitude to observe the pilot's handling of normal and emergency drills, and to then observe from the ground while the pilot performed the top-dressing role.

1.9.7 The Commission heard anecdotal evidence that practical compliance difficulties had led to the cursory checking of some pilots within the agricultural aviation industry, and in some cases to the check being a paper exercise. The CAA was aware of the practical difficulties faced by agricultural operators in conducting pilot competency checks.

1.9.8 An agricultural pilot who had met the annual competency provisions of CAR 61.707 was specifically exempted by CAR 63.39 from having to complete a biennial flight review.

1.10 Additional information

1.10.1 On 1 December 2002, another operator's Fletcher collided with the ground during an apparent go-around attempt from a landing approach with a full hopper. That pilot was seriously injured, but the cause of the accident was not officially determined.[19] The pilot later recalled that the day had been hot and that during the previous refuelling break he had lain down and promptly gone to sleep. He said he thought that when he resumed flying after the refuel, he must have gone through the motions of operating the hopper without actually moving the sowing lever, and gone around from the approach because something felt unusual, but without realising that he still had a full hopper. The pilot believed that dehydration was a factor in his accident.

1.10.2 In January 2007, the CAA commenced an Agricultural Aircraft Safety Review in response to concerns for the high accident and incident rate for agricultural aeroplanes. Particular concerns were the appropriateness of CAR 137.103, "Maximum take-off weight", which permitted an agricultural aeroplane to be operated at take-off at weights greater than the maximum certificated take-off weight, and issues related to conversions to turbine power. The Review was published on 23 December 2008, and the CAA planned further consultation with industry participants in regard to its findings.

2 Analysis

2.1 The pilot was engaged in a straightforward top-dressing task at a familiar farm, and the fertiliser was free flowing. The weather was favourable, with a moderate temperature, and the pilot was taking appropriate steps to stay hydrated. There was no medical evidence found to suggest that the cockpit environment was contaminated.

[19] CAA occurrence 02/3469.

2.2 The pilot had not expressed concern for any aspect of the aeroplane performance during any of the phone calls he made that day, nor to the loader-driver during any refuel break, the last one of which ended 35 minutes before the accident. Although the operator could not produce a record to confirm a structural inspection had been carried out after the sheep strike of 12 June 2007, the aeroplane had undergone a satisfactory scheduled inspection only 4 days before the accident, and no evidence was found of prior damage that might have contributed to the accident. Similarly, although the lack of certification that the mandatory post-flight checks of the fin leading edge had been completed meant that the aeroplane was technically not airworthy, there was no evidence that any part of the structure was unserviceable prior to, or during, the flight.

2.3 Two factors associated with the accident that were unusual were the ceasing of recorded sowing data and the way that the cellphone call ended.

2.4 Examination of the AG-NAV equipment, GPS and cellphone found no common factor for the data stoppage and the ending of the phone call. However, an intermittent antenna connection was found that could have caused the GPS data drop-out and loss of sowing data. The AG-NAV had been replaced the night before because of a suspected software fault, but that could have been a sign of a problem that re-occurred on this flight.

2.5 The AG-NAV data stoppage could have led to a loss of precision sowing guidance, which would have forced the pilot to revert to basic methods for determining the next sowing line. The amount of fertiliser found in and around the hopper indicated that the pilot had continued with the second run without precision guidance. There would then have been one more sowing run, after which the pilot would have landed and been able to find the reason for the fault. He did not mention to his friend to whom he was talking at the time that he had a problem, which could mean, for example, that he was not aware of it or that he was not concerned by it.

2.6 The pilot had previously been warned about the use of cellphones and similar distractions while working at low level. He had pledged to stop the practice, but not done so. His cellphone use during the sheep strike accident in June 2007 not only breached the operator's instructions, but also presented an unnecessary safety risk. In December 2007, the operator clarified its aeroplane cellphone policy. In February 2008, the policy was further amended to ban the use of cellphones while on agricultural operations.

2.7 The CARs prohibited the use of cellphones, other than for emergency use, on aircraft operating under IFR, but there was no prohibition on their use during flights operated under visual flight rules (VFR), such as agricultural flying. The safety issue of pilots using cellphones was comparable to the currently unresolved issue of drivers of road transport vehicles using cellphones. The Commission recommended that the Director of Civil Aviation address the aviation safety issue.

2.8 The gradual reduction in volume of the last call before it ended would not be explained by the pilot turning his head, for example, to look for the cause of the AG-NAV failure, because he had a helmet-mounted microphone. Although it should have been second nature for him to pull up away from the ground before manoeuvring or attempting to trouble-shoot a problem, the possibility that he did look around the cockpit for the cause of the failure, perhaps a tripped circuit breaker, could not be excluded. The "static" noise was most likely the sound of the aeroplane entering the trees.

2.9 The accident site was approximately 280 m beyond the widest ground tracks of turns made off earlier sowing runs on the block being top-dressed. The location strongly suggested that the pilot had made the initial left turn after sowing, but not completed the expected right turn to reverse direction for the last run of that hopper load.

2.10 The aeroplane damage indicated that it had substantial energy, or speed, at ground impact. The energy could have been due to the aeroplane having remained level and at sowing speed before entering the trees, or been the result of a dive from the high point of a reversal turn.

2.11 If the pilot had experienced some sort of problem mid-way through the reversal turn, whatever the turn direction, the aeroplane would have been at the highest point and the slowest speed of its flight path, and the pilot's options to manoeuvre would have been reduced. If the turn had been commenced to the left, treeless forced landing areas, albeit still rough, would have been available in the opposite direction from the bush tract that the aeroplane entered. If the turn had been started to the right and continued to the left, there were fewer areas suitable for a forced landing. The right wing low attitude and evident high speed at which the aeroplane entered the trees were not consistent with the pilot planning to conduct a forced landing.

2.12 A plausible scenario was that the pilot turned left off the sowing run, but, for some reason, did not pull up before commencing a right turn for the reversal. The higher ground speed while remaining in level flight would account for the distance the aircraft was beyond the previous turns, and the high energy of the impact.

2.13 At the time of the accident, the sun was near its highest elevation for the day and was therefore unlikely to have interfered with the pilot's vision or lookout while he was manoeuvring.

2.14 Although the flap lever was found in the 30^{o} detent, that position was not reliable because of the extensive disruption to the cockpit floor and all of the flying controls. The underside of the flaps did not have significantly more damage than the upper surfaces, which would have been expected if the flaps had been lowered.

2.15 No single conclusive reason, such as sudden incapacitation, was found to explain why the pilot did not pull up, but the circumstances suggested a combination of factors involving distractions and fatigue.

2.16 The distractions were the assumed AG-NAV failure and the use of the cellphone. The AG-NAV failure would have been a low-grade distraction for an experienced agricultural pilot, and easily overcome by his resorting to basic sowing methods until the aircraft was landed after 2 more runs.

2.17 The use of cellphones by agricultural pilots flying at low level was not uncommon, and the pilot evidently did so regularly. On the day of the accident, the pilot initiated most call sessions with the friend, but if he was busy or inclined to, he could have ignored or stopped a call. Because he continued to accept frequent and lengthy calls from the friend, the Commission considered it likely that the calls had an emotional element that could have affected his concentration and thereby exposed him to a higher risk of misjudging his flight path during low-level operations.

2.18 The only reference to impaired performance of any sort was the pilot himself saying that he was tired and looking for an excuse not to do the next job that day. His most recent workload had been high, but he had had good opportunities for rest and was said to have slept well. However, he began this day with a period of exertion, on a bicycle, which was probably at a level that was more than he was used to and that might have caused him some short-term physical distress.

2.19 Although the pilot was generally complying with the operator's flight and duty time scheme, the scheme did not account for the number of take-offs and landings performed. Take-offs and landings were generally acknowledged as periods of higher stress and workload for a pilot. The accident occurred after more than 7 hours of work and more than 90 take-offs and landings for that day.

2.20 The multiple factors that can affect the likelihood of reduced alertness and fatigue mean one cannot conclude the extent to which the pilot was fatigued. However, those factors that were shown to be present on this flight would be expected to combine in their effect.

2.21 If the pilot was in a state of partial fatigue, with his attention also diverted to the prolonged cellphone call, the further distraction of the AG-NAV failure and his consideration of whether to correct it then or wait until the next landing might have been enough to distract him from close attention to his flight path.

2.22 The post-mortem report indicated that the pilot's health had been damaged by his long-term pattern of alcohol consumption. Although the toxicology report concluded that he had consumed alcohol some time prior to the accident flight, it was not possible to estimate reliably whether such consumption would have affected his cognitive performance or level of fatigue or alertness on this flight.

2.23 The possibility that the pilot got drowsy and was drifting off to sleep, even though he was talking on the phone, was not excluded. It would seem unlikely if he had recognised the AG-NAV failure and manually judged the second sowing run, but it was not known whether he was aware of that failure or how he flew that sowing run.

2.24 The pilot of the Fletcher that crashed during an attempted go-around with a full hopper (see paragraph 1.10.1) said he believed fatigue and dehydration were factors in his accident. The unusually high level of risk and intense task concentration to which agricultural pilots are constantly exposed when top-dressing probably becomes normalised, to the extent that they may fail to recognise the added risk of further distractions and increasing fatigue.

2.25 The positions of the engine and cockpit controls were inconsistent with the pilot having initiated an emergency checklist for either an engine failure or a fuel system failure. The control positions were unreliable because of the impact disruption, but the absence of any sign that he had jettisoned the remaining load supported the conclusion that the pilot had not performed a checklist or taken immediate action in response to an aeroplane malfunction.

2.26 The propeller and reduction gearbox damage indicated that the propeller was delivering substantial power at first impact. It was possible that the starter-generator then detached, damaging the fuel control unit and causing the engine to immediately run down. Engine run-down would explain the absence of debris, such as leaves, on the engine air intake screen. The propeller blade damage also indicated that the propeller had not been turning at ground impact. Examination confirmed that the engine had been under power, although the power level could not be estimated.

2.27 Although the fuel flow computer was not considered reliable for determining the fuel level in the tanks, the fuel used was almost exactly what would be expected 35 minutes after a refuel, if the pilot had reset the computer immediately before take-off. If he had not used the computer at all, the fuel used would have been greater, being the amount since the computer was last set. Therefore, it was likely that the pilot was using the fuel flow computer appropriately, and that about 184 L remained on board at impact. That amount of fuel was sufficiently more than the minimum fuel for manoeuvring flight to be able to exclude fuel exhaustion leading to possible engine stoppage and a forced landing attempt.

2.28 The estimated take-off weight of 3157 kg exceeded by 277 kg, or 9.6%, the overload permitted by CAR. The take-off weight was likely to have been typical for that day, as the pilot's standard refuel had been 180 L and his standard hopper load 1500 kg.

2.29 The Commission was persuaded that overloading was not uncommon within the agricultural aviation industry. The routine operation of an aeroplane at gross weights and hopper weights well in excess of those approved was bound to affect the aeroplane's fatigue life and had the potential to cause catastrophic structural failure. As overloading was specifically examined in the CAA Agricultural Aircraft Safety Review and would be the subject of further industry consultation, the Commission did not make a recommendation regarding this safety issue.

2.30 Although the cockpit looked to have sufficient occupiable space after the accident, the volume would have been reduced by distortion during the ground impact, as shown by the control column being jammed under the instrument panel. Aircraft structures typically rebound after the removal of the impact load. Although the pilot's harness was properly secured, the reduction in cockpit volume and the high-energy impact meant the accident was not likely to have been survivable.

Engine conversion and other modifications

2.31 The technical data for the engine modifications, both the initial conversion from piston to turbine and the replacement of the PT6A-11AG engine with a PT6A-34AG version, was properly approved, but the power lever control stop was not the tamper-proof item intended by the designer. The requirement for a flight manual supplement for the change to a PT6A-34AG engine was identified and met retrospectively. In spite of these discrepancies, the turbine conversion was considered not to be a factor in the accident.

2.32 If a pilot observed the published propeller RPM and torque limits, the take-off power of the PT6A-34AG engine was within the certified 550 shaft hp limit of the PT6A-11AG installation. Marks on the power lever indicated that the lever had been moved forward of the control stop at times, but it could not be shown that the engine had been operated at excessive power levels. If it had been, the propeller was capable of absorbing the higher power, but the technical data for the PT6A-34AG engine had not been approved on that basis.

2.33 Demanding excessive engine power can lead to stresses on the engine installation and the rest of the aeroplane that were not contemplated in the design. Unless exceedances are detected and appropriate engineering inspections completed afterwards, the aeroplane fatigue life would likely be affected, and to an unknown degree. Therefore, it was important that engine performance be monitored so that exceedances could be detected and appropriate maintenance action taken. However, as the CAA Agricultural Aircraft Safety Review had examined issues related to turbine engine modifications that would be the subject of further industry consultation, the Commission did not make a recommendation regarding this safety issue.

2.34 The CAA had been confident in its processes regarding the engine modifications and the issuing of the STC for the Fletcher FU24-950EX. However, the STC reference to "extensive changes", and its requirement that pilots have specific type ratings for aeroplanes with turbine engine replacements, seemed to contradict the rationale for an STC. A new type certificate might have been justified.

2.35 This issue was recognised in the CAA Agricultural Aircraft Safety Review, which concluded, among other findings, that "the Director's power to specify the special conditions or later certification basis for extensive STC modifications is not clearly defined. As a result CAA policies regarding amendments to type certificate [sic] and approval of STCs may have been inconsistently applied". However, none of the potential issues concerning regulatory approvals or oversight that contributed to the Commission's decision to take over this investigation from the CAA materialised.

2.36 Although the fitting of a cellphone to ZK-EGV might have been a minor modification, the operator was required to record the work done in the aeroplane log book.

2.37 The emergency locator transmitter installation was not in accordance with the manufacturer's instructions or the CAA's recommendations. It was highly likely that the non-conformance was the cause of the antenna cable being pulled from the unit and contributed to the unit's transmitted signal not being received. As the current CAA advice concerning installation of emergency locator transmitters was not mandatory, the Commission recommended to the Director of Civil Aviation that he specify more stringent requirements for their installation.

Pilot's competency

2.38 An annual check of competency was an established requirement for all professional pilots, but restrictions with the configuration of agricultural aeroplanes could make compliance difficult. Ground-based observation of a pilot's performance, although not explicitly permitted by CARs, had become an established method in the industry and was provided for by the operator. CARs exempted a pilot from a biennial flight review if an annual competence check was completed, but exemption did not appear justified if a competence check was ground based only.

2.39 On 14 April 2005, the pilot was certified as having demonstrated competence and completed a biennial flight review in ZK-EGV. However, the aeroplane was not equipped with dual flight controls; therefore the flight examiner could not have conducted the dual training required for a biennial flight review. With a flight examiner on board, top-dressing was not permitted; therefore some of the check was assumed to have been ground based. The certification did not state whether that was so. Therefore, the status of the certification for that flight was unclear.

2.40 The flight on 29 March 2006, also in ZK-EGV, was logged by the pilot as a biennial flight review, but it was certified as a competency check. The flight duration did not allow time for training or assessment. It was unclear whether the CAR requirements were met on this flight.

2.41 The use of a Cresco aeroplane for conducting the pilot's last 2 annual competency flights had been thought by the operator to be a reasonable way to meet the intent of the CAR, even though the operator's procedures required competency checks to be conducted in an aeroplane type normally flown by the pilot being checked. Because the pilot was not rated on the Cresco, he could not be pilot-in-command, so those 2 flights did not qualify as competency checks. The operator subsequently accepted that the Cresco could not be used for checking non-rated pilots.

2.42 Therefore, although the pilot was undoubtedly current in terms of recent flying, and a very capable pilot as shown by his handling of the jammed stabilator incident, it was likely that the check flights that he had flown since April 2005 had not met the CAR requirements and were therefore invalid.

2.43 There was no suggestion that the pilot considered he was not legally current or competent. The operator knew the practical difficulties of competency checks, but followed normal industry practice in an effort to comply. The Commission heard anecdotal evidence that led it to believe that the checking of some pilots within the agricultural aviation industry had been, at best, cursory. In order to uphold the integrity of the CAR system, the CAA ought to address the known compliance difficulty. The Commission recommended that the Director of Civil Aviation address that safety issue.

3 Findings

Findings are listed in order of development and not in order of priority.

3.1 The reason for the aeroplane colliding with trees was not conclusively determined. However, the pilot was affected by a number of fatigue-inducing factors, none of which should have been significant on its own. The combination of these factors and the added distractions of a prolonged cellphone call and a minor equipment failure were considered likely to have diverted the pilot's attention from his primary task of monitoring the aeroplane's flight path.

3.2 Although pilot incapacitation could not be ruled out entirely, it was considered that the pilot's state of health had not directly contributed to the accident.

3.3 The potential distraction of cellphones during critical phases of flight under VFR was not specifically addressed by CARs.

3.4 Apart from the probable failure of the GPS sowing guidance equipment, no evidence was found to suggest that the aeroplane was unserviceable at the time of the accident, but its airworthiness certificate was invalid because there was no record that the mandatory post-flight checks of the vertical tail fin had been completed in the previous 3 days.

3.5 The installation of a powerful turbine engine without an effective means of de-rating the power created the potential for excessive power demands and possible structural overload, but this was not considered to have contributed to the accident.

3.6 The pilot was an experienced agricultural pilot in current practice. Although he had met the operator's continued competency requirements, the operator's method of conducting his last 2 competency checks was likely to have made them invalid in terms of the CAR requirements.

3.7 Although the aeroplane was grossly overloaded and the hopper load exceeded the structural limit on the take-off prior to the accident, neither exceedance contributed to the accident, and the aeroplane was not overloaded at the time of the accident.

3.8 The emergency locator transmitter did not radiate a useful signal because of damage to the antenna socket on the unit. The installation was also not in accordance with the manufacturer's instructions or the recommended practice.

4 Safety Actions

4.1 On 7 December 2007, the operator reminded its pilots that aeroplane cellphones were for operational use when aeroplanes were in ferry flight or parked on the ground.

4.2 On 12 February 2008, the operator amended its cellphone policy as follows:

> **Planes**
> The use of cellphones refers to both voice and text messaging.
> The use of the cellphone is prohibited during agricultural operations.
> The cellphone can be used when the plane is at ground idle or during ferry flights at or above 500 Feet AGL.

4.3 The CAA has taken the following relevant actions:

- in April 2006, the CAA sent a letter to all agricultural aeroplane operators reminding them to ensure that their pilots observed aircraft airspeed limitations
- in December 2008, the CAA published its Agricultural Aircraft Safety Review, which examined aeroplane overloading, turbine engine conversions and other industry operational issues. The Review was to be the subject of further industry consultation before the CAA proposed corrective actions.

5 Safety Recommendations

Safety recommendations are listed in order of development and not in order of priority.

5.1 On 19 March 2009, the Commission recommended to the Director of Civil Aviation that he:

5.1.1 Address the safety issue whereby the Civil Aviation Rules are silent on the use of cellphones during critical phases of flight by pilots of aircraft operated under visual flight rules. (007/09)

5.1.2 Address the practical difficulties of conducting competency checks for pilots of single-seat aircraft that have led to a degree of disregard for some aspects of the pilot currency requirements. (008/09)

5.13 Address the safety issue of emergency locator transmitters sometimes being installed in a way that affects their crash survivability. (009/09)

Approved on 19 March 2009 for publication

Hon W P Jeffries
Chief Commissioner

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