REPORT

No. 89-063

Two Piper PA38-112 Tomahawks

ZK-EVA and ZK-EQM

6 km east of Palmerston North

31 July 1989

Transport Accident Investigation Commission
Wellington, New Zealand

Price $12.00 (including G.S.T.)

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AIRCRAFT:	Two Piper PA38-112 Tomahawks	**OPERATOR:**	Manawatu Districts Aero Club
REGISTRATION:	ZK-EVA and ZK-EQM	**PILOT:**	Mr A Nicholson (ZK-EVA) Mr M Lamb (ZK-EQM)
PLACE OF ACCIDENT:	6 km east of Palmerston North	**OTHER CREW:**	Nil
DATE AND TIME:	31 July 1989 at 1728 hours	**PASSENGERS:**	One (ZK-EVA) One (ZK-EQM)

SYNOPSIS:
When the pilot of ZK-EVA attempted to join formation with ZK-EQM, the aircraft collided and ZK-EQM entered a spiral descent into a paddock. A portion of ZK-EQM struck the passenger of ZK-EVA. ZK-EVA returned to Palmerston North Aerodrome.

1.1 HISTORY OF THE FLIGHT:	1.2 INJURIES TO PERSONS:	1.3 DAMAGE TO AIRCRAFT:	1.4 OTHER DAMAGE
See Page 3.	**ZK-EVA** Pilot: Nil Pax: Fatal **ZK-EQM** Pilot: Fatal Pax: Fatal	**ZK-EVA:** Substantial; propeller and windscreen **ZK-EQM:** Destroyed	Nil

1.5 PERSONNEL INFORMATION:

Mr A. Nicholson — Flight Times

	Last 90 days	Total
All Types	150	836
On Type	134	377

Mr M. Lamb — Flight Times

	Last 90 days	Total
All Types	159	447
On Type	151	352

1.6 AIRCRAFT INFORMATION:

ZK-EVA: The aircraft had a valid Maintenance Release. Total airframe hours were 4434. The TSO of the Lycoming O-235 engine was 2349 hours. The all up weight and centre of gravity position were within limits. The aircraft contained adequate fuel for the flight.

ZK-EQM: The aircraft had a valid Maintenance Release. Total airframe hours were 5158. The TSO of the Lycoming O-235 engine was 793 hours. The all up weight and centre of gravity position were within limits. The aircraft contained adequate fuel for the flight.

1.7 METEOROLOGICAL INFORMATION:	1.8 AIDS TO NAVIGATION:	1.9 COMMUNICATIONS:
See Page 6.	Not applicable.	See Page 6.

1.10 AERODROME INFORMATION:	1.11 FLIGHT RECORDERS:	1.12 WRECKAGE AND IMPACT INFORMATION:
Not applicable.	Not applicable.	See Page 7.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION:	1.14 FIRE:	1.15 SURVIVAL ASPECTS:
See Page 7.	Did not occur.	The pilot of ZK-EVA survived this accident. The impact of ZK-EQM was not survivable.

1.16 TESTS AND RESEARCH:	1.17 ADDITIONAL INFORMATION:	1.18 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES.
See Page 8.	See Page 9.	Nil.

2. ANALYSIS:	3. FINDINGS:
See Page 9.	See Page 15.

4. SAFETY RECOMMENDATIONS:	5. APPENDICES:
See Page 15.	

* All times in this report are NZST (UTC + 12 hours)

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 Mr Lamb, the junior instructor of the Manawatu Districts Aero Club told the Chief Flying Instructor (CFI), Mr Nicholson, that he was going flying. Mr Nicholson told him "I'll see you up there" or words to that effect and Mr Lamb departed in ZK-EQM, taking with him as a passenger a student pilot who was also his girlfriend. Mr Lamb flew from the right hand seat as he had become accustomed to flying from this side.

1.1.2 Mr Nicholson asked another student pilot if he would like to accompany him and they departed in ZK-EVA to join ZK-EQM. Mr Nicholson was also flying from the right hand seat.

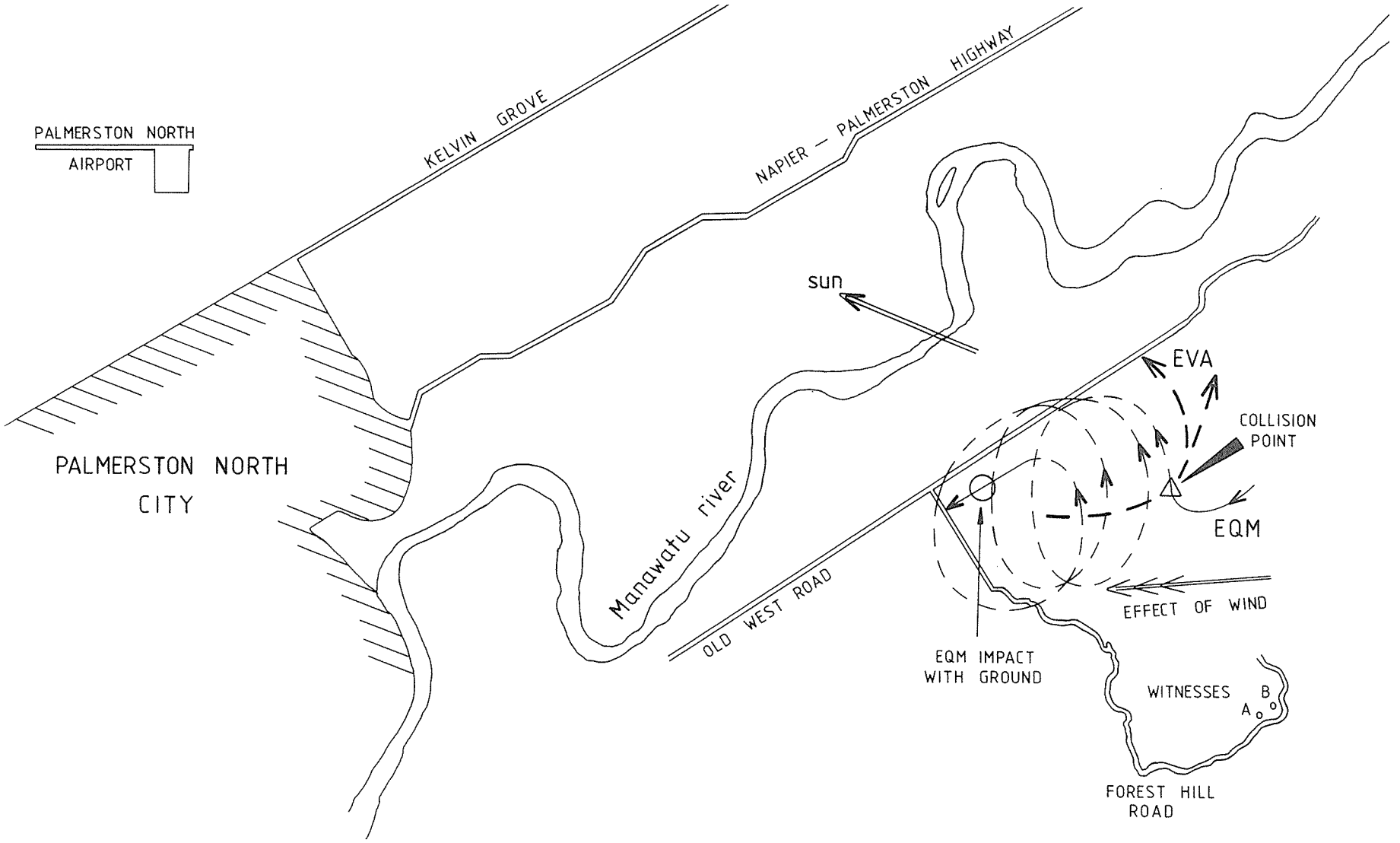
1.1.3 Mr Nicholson stated that he saw ZK-EQM "near the Manawatu Gorge" at two to three thousand feet amsl (see Diagram 1). He flew towards it intending to join formation in echelon port, i.e. to the left rear of ZK-EQM. ZK-EQM was in a steep turn to the right at the time, so Mr Nicholson dived ZK-EVA towards it and transmitted "tack tack tack" (simulating gunfire) on the radio telephone (RTF). He estimated the range at the time as 400 to 500 feet (122 m to 152 m).

1.1.4 Mr Lamb transmitted something to the effect of "that's unfair", to which Mr Nicholson replied "Let's do it". He explained that, although there had been no formation flying briefing, Mr Lamb would understand that ZK-EVA was going to join in echelon port, because previously they had spent some time working out formation positions and manoeuvres on pieces of paper. The intended separation between the aircraft was to be 1 m laterally and 2 m longitudinally.

1.1.5 ZK-EQM rolled out of its right turn and began to turn left and descend. Mr Nicholson stated that he "hustled" over to the left (so as to position ZK-EQM on his right, where he would have the better view) and dived ZK-EVA to close up on ZK-EQM.

1.1.6 At the last moment Mr Nicholson realised that the closing speed was too high and he started to roll ZK-EVA to the left in an attempt to clear ZK-EQM. He had the impression that the pilot of ZK-EQM tried to roll his aircraft to the right to increase the clearance, but this had the effect of raising ZK-EQM's left wing into the propeller disc of ZK-EVA. There was a loud bang and Mr Nicholson felt his aircraft shudder. He lost sight of ZK-EQM and headed his own aircraft towards Palmerston North Aerodrome. Mr Nicholson stated that the aircraft were heading south-west along the ranges at the time of impact.

1.1.7 Mr Nicholson then observed that his passenger was covered in blood and he transmitted a message to Air Traffic Control (ATC) requesting that the aircraft be met by an ambulance on arrival and stating that ZK-EVA had collided with ZK-EQM. The Controller arranged for the ambulance and then attempted to contact ZK-EQM. When no response was received he requested an aircraft that was airborne at the time to attempt to locate it. This aircraft spotted the wreckage of ZK-EQM and transmitted the position as "under the wires in the low flying area". A local helicopter promptly departed to the site and the aircraft remained overhead to act as a radio relay.



EQM & EVA FLIGHT PATHS

DIAGRAM 1

1.1.8 Because this was an off-aerodrome accident the New Zealand Fire Service (NZFS) was asked to attend. The NZFS vehicle's maps appeared to differ from those available to the Controller; they did not have any aeronautical information and neither set of maps had an overprinted "crash grid" for easy reference. The Controller tried to direct the NZFS vehicle by street directions, until a Police vehicle arrived on the accident site and was able to liaise with the NZFS vehicle. It was recommended to the Airways Corporation that they liaise with the NZFS to ensure that NZFS vehicles have available to them the maps used by Controllers for crash rescue, and that both sets of maps be overprinted with an easy reference grid.

1.1.9 Two witnesses (A and B, Diagram 1) heard the impact and saw the two aircraft immediately afterwards. Both thought that one of the aircraft (ZK-EVA) had flown straight on after the impact, in a northerly direction. The other (ZK-EQM) was seen to dive straight at first and then settle into a wide spiral descent at a moderate nose-down angle. One witness thought it made three to four circles before disappearing from view over the brow of the hill; the other thought six turns, possibly steepening towards the end. Both remarked on the lack of engine noise.

1.1.10 They realised that an accident had occurred and drove to the main road where they found the wreckage of ZK-EQM. The woman passenger was lying beside the wreckage, the pilot was still inside; both were dead. A Police vehicle arrived four or five minutes after the accident and a helicopter at about the same time. The NZFS vehicle arrived about 20 minutes later.

1.1.11 The accident occurred at sunset at about 1728 hours NZST. The wreckage of ZK-EQM was found in a paddock 3 km east of Palmerston North, National Grid Reference 192 360 NZMS 260 Sheet T24 "Palmerston North". Latitude 40°21'S longitude 175°42'E.

1.5 Personnel information

1.5.1 The pilot in command of ZK-EVA, Andrew James Nicholson, aged 38 commenced flying in 1973. He obtained Commercial Pilot Licence (Aeroplane) [CPL(A)] number 11187 in 1986 and a "C" Category Instructor Rating in 1988. This was upgraded to "B" Category on 21 July 1989 (one week before the accident). On obtaining his "B" Category he was appointed to the vacant position of Chief Flying Instructor.

1.5.2 Mr Nicholson stated that his experience in formation flying consisted of:

(a) Flying as a passenger with the Club formation team (which last flew about 8 years before)

(b) Flying in loose formation with Mr Lamb at 2 to 3 wingspans' spacing on a Club trip to Kaikoura about a month prior to the accident. The aircraft landed in formation both at Kaikoura and at Palmerston North on return.

He had been unable to get any training in formation flying, or in instructing others on how to fly in formation.

1.5.3 The pilot in command of ZK-EQM, Michael Thomas Lamb, aged 22, commenced flying training in April 1988 with Massey Flying College. He obtained CPL(A) number 25557 in March 1989 and a "C" Category Instructor Rating in May 1989.

1.5.4 Prior to the accident he had recorded 447 hours flight time, most of it on PA38 Tomahawk aircraft. In the preceding three months he flew a total of 159 hours.

1.5.5 At the time of the medical examination for the issue of his CPL(A) Mr Lamb was assessed as fit.

1.5.6 Mr Lamb's Pilot's Logbook recorded a 15 minute flight detailed as "Introduction to Formation" on 17 April 1989. There was no other reference to formation flying and no details were recorded of any flights on a club trip to Kaikoura.

1.5.7 Both passengers held valid Student Pilot Licences (Aeroplane).

1.7 Meteorological information

1.7.1 On the day of the accident a large anticyclone covered New Zealand. In the vicinity of Palmerston North the sky was clear and visibility was unlimited; the wind was a moderate easterly. The observations made at 1700 hours at Palmerston North Aerodrome were:

Wind:	080° at 15 knots
Visibility:	99 km
Cloud:	Nil
Temperature:	+10°C
Atmospheric Pressure:	1024.8 hPa QNH (i.e. reduced to mean sea level)

1.7.2 At 1728 the azimuth of the sun was 293°T. Its altitude was minus 1°27 (i.e. below the horizon) at sea level, but at 2000 feet about half of the sun's diameter would have been visible.

1.7.3 Pilots familiar with the area stated that, in the lee of the range of hills (where the aircraft were flying) there was likely to be moderate turbulence, but the CFI stated that there was none.

1.9 Communications

1.9.1 Both aircraft transmitted to ATC on the aerodrome frequency, 120.7 MHz before departure. Neither suggested that the aircraft would be joining formation nor that they intended to return as a formation. Neither advised ATC that they were changing frequency subsequently nor were they required to do so. The next thing that ATC heard on 120.7 MHz was that there had been a collision.

1.9.2 Mr Nicholson advised that the pilots had in fact changed frequency to 119.1 MHz. This frequency was not monitored by an ATC recording facility.

1.12 Wreckage and impact information

1.12.1 The wreckage of ZK-EQM lay in an open paddock, about 100 m west of the impact scars. These consisted of a line of scrapes, ending in a crater half a metre deep where the propeller was buried. There were substantial fuel stains on the ground in this vicinity. Pieces from the left wing tip were found at the beginning of the ground scar, then pieces from the inboard part of the left wing. Wheel gouges indicated that the aircraft had slewed as the left wing struck.

1.12.2 There was a trail of light debris between the impact scar and the main wreckage.

1.12.3 The main wreckage comprised the fuselage and engine, fin and tailplane, inboard left wing stub and right wing. The nose had buckled underneath the rest of the fuselage in the region of the cockpit.

1.12.4 Examination of the wreckage disclosed no pre-impact control defect, other than the aileron which had been damaged in the collision. There was a substantial quantity of fuel in the undamaged right tank.

1.12.5 ZK-EVA had returned to Palmerston North Aerodrome. Its canopy had a hole in the perspex in front of the left hand pilot's seat. One blade of the propeller exhibited impact damage on the leading edge; the rear of this blade showed a deep chord-wise gouge at mid-span and beside this gouge was a lead smear. The propeller had bulged forward away from the gouge. The spinner had a number of spiral scratches and a deep indentation at the end of one of these scratches; one of the retaining screws at the base of the spinner had been broken out of the spinner cone and two rivets had sheared. The steepest spiral scratch showed a forward movement of 170 mm in one quarter of a revolution.

1.12.6 The left aileron lead mass balance weight from ZK-EQM was found in the right rear corner of the cockpit of ZK-EVA. Deformation of the lead weight corresponded with the gouge and lead smear mark on the rear face of the propeller blade.

1.12.7 The only other marks on ZK-EVA identified as being due to the impact were light scratches on the front face of both propeller blades, spanwise and chordwise marks on the rear faces (particularly) of both blades and light indentations and scratching of the right upper engine cowling.

1.12.8 The wreckage of the left wing of ZK-EQM was laid out on a hangar floor. Most of the left aileron was missing, but those parts recovered matched exactly. The assembly disclosed propeller cut marks and moulding by the spinner of ZK-EVA which had struck the underside of the aileron and wing. The deep indentation on the spinner of ZK-EVA corresponded with moulding of the rear spar of ZK-EQM. The rear spar of ZK-EQM, inboard of the spinner strike, had been cut in a vertical downward direction and there were downward black paint marks where the end of the cut had been deflected back. (The backs of the propeller blades of ZK-EVA were painted black).

1.13 Medical and pathological information

1.13.1 Pathological evidence suggested that Mr Lamb had been handling the controls of ZK-EQM at the time of impact with the ground and that the passenger had not. The apparent absence of any attempt to experiment with the

use of the engine to control the aircraft's pitch angle or to enhance the rudder effectiveness with slipstream during the descent gave rise to the question of whether or not the pilot might have been incapacitated before impact, but no pre-impact injury could be distinguished.

1.13.2 No pre-existing deficiency which might have affected Mr Lamb's ability to control the aircraft was disclosed.

1.13.3 Toxicology did not disclose the presence of alcohol or any drug in the bodies of any of the deceased.

1.13.4 "The resulting injuries were of a nature and severity to be classified as being of marginal survivability. Although the passenger was alive and conscious on landing, his condition deteriorated rapidly, and he subsequently died in hospital."

1.16 Tests and research

1.16.1 A PA38, with two pilots, was flown at about 2000 feet amsl. The surface temperature was +11°C, and atmospheric pressure was 1009 hPa QNH. Attitude was measured by lines on the cockpit perspex with reference to ground attitude.

1.16.2 In straight and level flight, the maximum airspeed attained was 104 knots, and the corresponding engine speed was 2450 rpm. The attitude was 2° nose down.

1.16.3 The throttle was then closed rapidly. The rpm reduced to 1600 in less than one second; after 2 seconds the engine speed was 1450 rpm; after 4 seconds the airspeed was 85 knots, with 1220 rpm.

1.16.4 The aircraft was then dived until 2600 rpm were achieved with the throttle open. With this rpm, it was found that at 120 knots the attitude was 13° nose down; at 130 knots the attitude was 32° nose down.

1.16.5 At 75 knots, in level flight, the attitude was 4° above the horizontal.

1.16.6 ZK-EVA was jacked up and the left wing of ZK-EQM was reassembled on trestles with the moulded area near the tip against the spinner of ZK-EVA. The plan layout was determined by fitting the propeller of ZK-EVA to the principal cut in the left wing of ZK-EQM. The fuselage and tail of ZK-EQM were then placed in appropriate positions. The reconstruction is shown in Diagram 2. The relative bank angle of ZK-EVA to ZK-EQM was the minimum necessary for the wing of the former to clear the tail of the latter. (There were no scratch marks under the right wing of ZK-EVA, showing that it had not touched the tailplane tip of ZK-EQM).

1.16.7 The pitch difference shown in elevation is fortuitous, being the relative angles adopted by the aircraft when jacked and the wreckage as laid out. However:

(a) The difference in pitch angle is consistent with Mr Nicholson's statement that he was diving ZK-EVA towards ZK-EQM.

(b) The difference is consistent with the vertical cut in the spar of ZK-EQM. In flight, a propeller describes a helix through the air, and also relative to another aircraft with which it is closing, so if the aircraft pitch attitudes were the same, the cut would have been downward and forward.

(c) ZK-EQM was recovering from a steep turn and its airspeed would have been lower than normal: its nose would therefore have been higher than normal, in level flight (See 1.16.5).

1.16.8 An alternative layout is shown in diagram 3, where ZK-EVA is banked towards ZK-EQM instead of away from it. This layout would also fit the wreckage pattern.

1.16.9 The choice between these layouts is discussed at 2.1.

1.17 Additional information

1.17.1 The pilots had intended to achieve a lateral separation of 1 m between wingtips. This was in accordance with the requirements for the Royal New Zealand Aero Club's (RNZAC) competition rules for formation flying. By contrast, the Royal New Zealand Air Force (RNZAF) stipulated a minimum lateral spacing of 8 feet (2.44 m) for its pilots when they were flying Airtrainer aircraft.

1.17.2 Previously instructors who had taught formation flying had themselves first been taught to fly in formation, and had then been taught how to instruct in that art. However, with the downturn in general aviation activity in the years prior to this accident, little formation flying had taken place, and the continuity of instructor training had been lost. There were, at the time, few instructors competent to teach others how to instruct in formation flying.

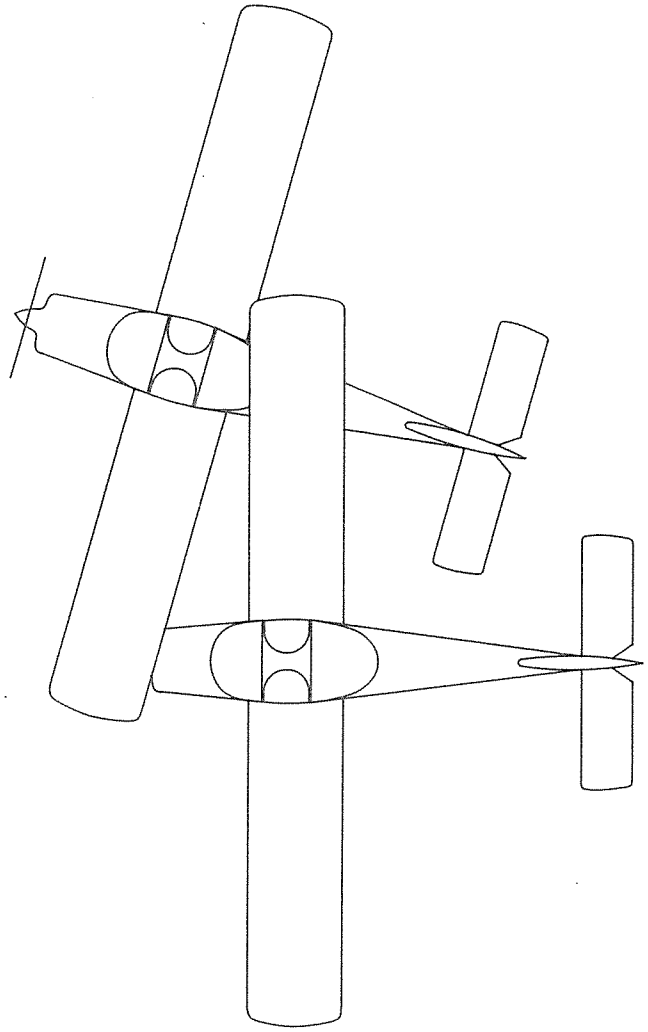
1.17.3 Instructors had previously used either the Royal Air Force Flying Manual, AP129 Volume II, or the Manual produced by the British Light Aviation Centre (BLAC) as the source material for briefings on formation flying. However, with few ex RNZAF personnel taking up employment as civil flying instructors, and with the BLAC Manual long out of print, both these sources of material had become difficult to find.

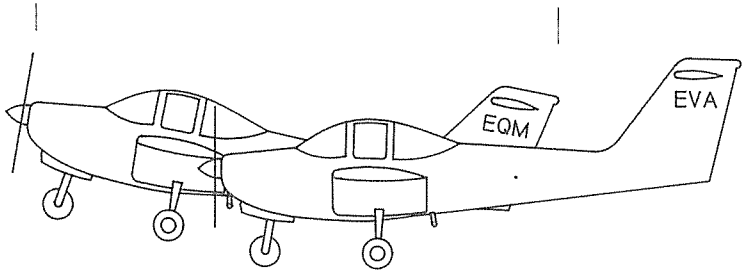
2. ANALYSIS

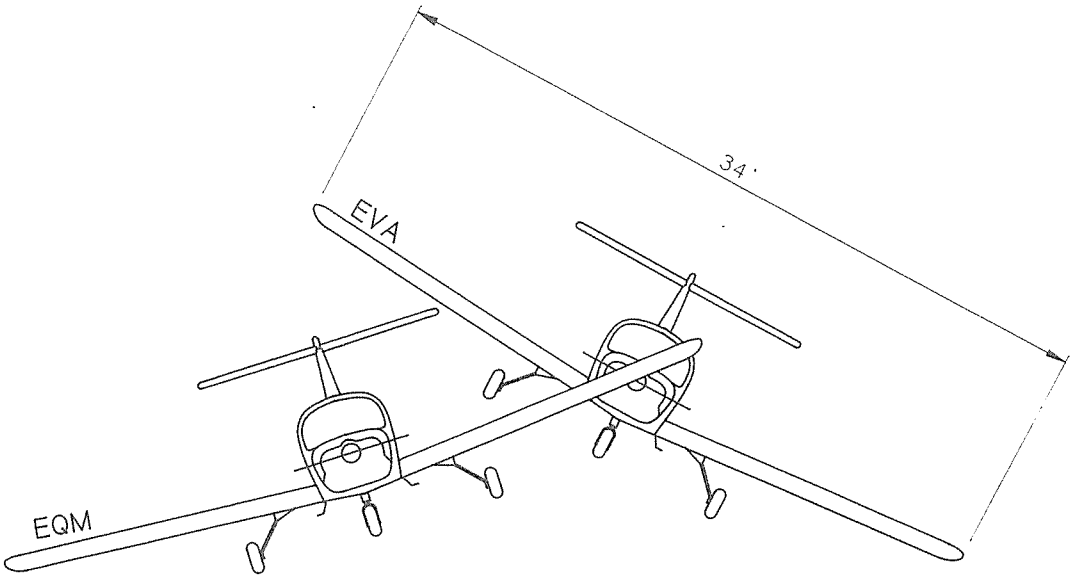
2.1 Impact Attitude

2.1.1 The reconstruction established the relative attitudes in plan view, and also that ZK-EVA was nose down with reference to the pitch attitude of ZK-EQM. However, any of a range of bank angles would meet the criterion of no contact with the tailplane of ZK-EQM.

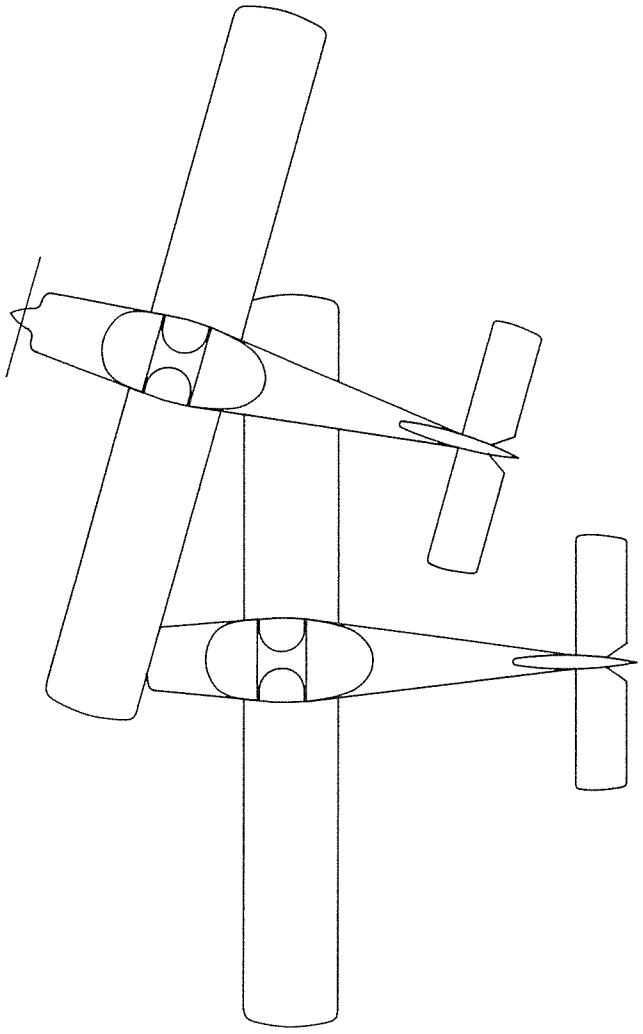
2.1.2 While there was some transfer of momentum between the two aircraft, it is unlikely to have been sufficient to raise the speed of the wingtip of ZK-EQM to the speed of ZK-EVA. Had this been the case, ZK-EQM would have yawed and rolled violently, whereas witnesses described the aircraft as carrying straight on after the impact. The implication is that the spinner of ZK-EVA stopped moving forward in contact with the skin of ZK-EQM, not because the spinner and wingtip were moving at the same speed, but because the blow was a glancing one, the wingtip then being thrown up and clear of the spinner. Confirmation of this proposition comes from the light scratching on the cowl of ZK-EVA, suggesting that there was relative motion fore-and-aft while the wing moved above the cowling, and by the absence of circumferential scratching on the spinner, which would have occurred had the relative forward speed been reduced to zero.

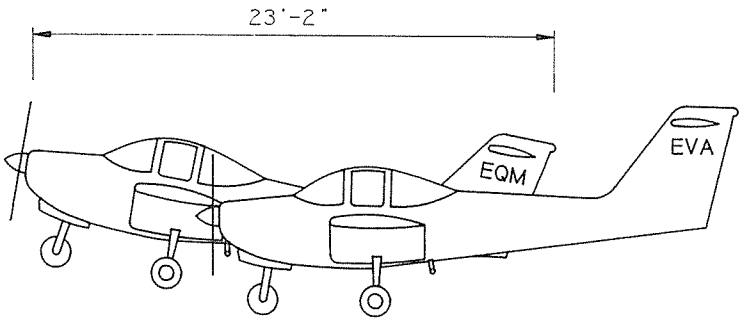


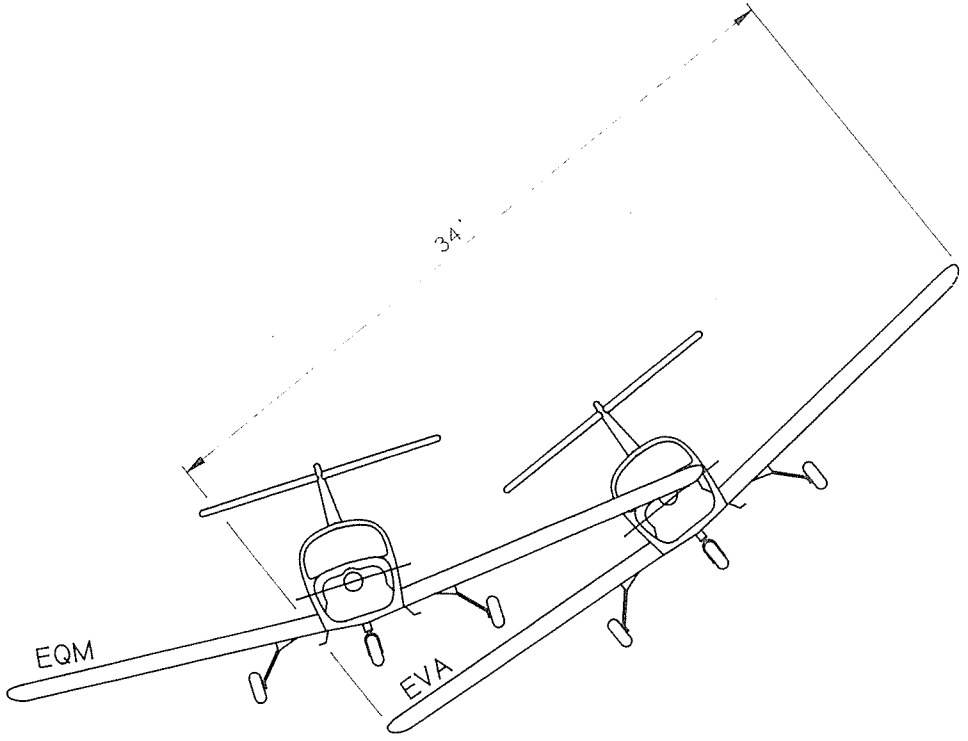




MID - AIR COLLISION ZK-EQM / ZK-EVA RECONSTRUCTION DIAGRAM 2







MID - AIR COLLISION ZK-EQM / ZK-EVA RECONSTRUCTION

DIAGRAM 3

2.1.3 If the relative bank angles were as shown in diagram 2, continued relative forward speed must inevitably have resulted in the wing of ZK-EVA striking the wing of ZK-EQM.

2.1.4 The relative bank angles shown in diagram 3, by contrast, allow for the glancing blow from ZK-EVA's spinner to deflect ZK-EQM's wingtip over the cowling of ZK-EVA, and the two aircraft could then part without further contact, as in fact happened. Diagram 3 is therefore representative of the relative attitudes of the two aircraft at impact.

2.2 Relative Speed at Impact

2.2.1 The propeller slash marks in the wing of ZK-EQM were, apart from the cut in the spar, tears rather than sharp cuts, so a precise spacing could not be determined. Besides, transfer of momentum between the two aircraft was likely to have resulted in a reducing relative speed as the aircraft closed after initial contact.

2.2.2 A better indication of relative speed at the moment of first contact was provided by the scars on the spinner. The steepest spiral, made at the highest relative speed, corresponded to the point of first contact. At 170 mm in one quarter turn, this corresponded to 27 knots at 1200 rpm, or 51 knots at 2300 rpm.

2.2.3 It was reasonable to accept the lower figure. Mr Nicholson, on becoming aware of the high closing speed, would have closed the throttle; the rpm reduced rapidly when the throttle was closed. ZK-EQM was recovering from a steep turn, in which its speed would have been reduced by the high drag of this manoeuvre. If, for example, its speed had reduced to 75 knots, then ZK-EVA's speed was about 102 knots, a speed which was easily attainable in a dive.

2.3 Discussion of Relative Attitude and Evasive Action

2.3.1 The relative attitude shown in diagram 3 implies that ZK-EVA and ZK-EQM were turning towards each other. Mr Nicholson advised that when he detected the excessive closing speed, he rolled ZK-EVA away from ZK-EQM. If the two aircraft were at the same bank angle initially (i.e. with wings parallel) it follows that ZK-EQM must have banked towards ZK-EVA. This would be consistent with the complete overlap of one semi-span, when the pilots had intended to have 1 m clear between their wingtips.

2.3.2 A possible explanation for this was that Mr Lamb may not, initially, have levelled ZK-EQM's wings when recovering from the steep turn, at the time Mr Nicholson was closing to join formation. If Mr Lamb then decided to level the wings in preparation for the formation practice, without realising that Mr Nicholson's aircraft was already close to him, the situation described above would have occurred. Mr Nicholson's aircraft would have had the setting sun behind it, so Mr Lamb would have had difficulty in seeing it.

2.3.3 The PA38, in common with many light aircraft, had a relatively low rate of roll. Even after achieving a relative bank sufficient to produce diverging flight paths, it would have taken some time for the flight paths to diverge sufficiently to avoid contact. By contrast, a looping plane manoeuvre would have been effective immediately, both because of the aircraft's more rapid response in pitch, and because of the much reduced depth of the target in the vertical plane. A part loop or bunt, depending on the circumstances, would therefore have been a more effective evasive manoeuvre.

2.4 Self Taught Formation Flying

2.4.1 Before commencing training in formation flying, with or without an instructor, a comprehensive briefing of all participants was essential. Matters which should have been covered in a first briefing included:

(a) **Leader:** which aircraft was to lead, the duties of the leader, how the aircraft were to be flown and how the lead would change.

(b) **Communications:** RTF procedures, callsigns, hand signals and emergencies.

(c) **Formation:** how the aircraft were to be spaced in the formations to be adopted, how to judge position, and safety margins.

(d) **Aircraft Handling:** how to manoeuvre the aircraft in formation; changing formation.

(e) **Joining and Breaking Formation**

It was necessary evidently that information on these points was to be available before such an exercise was attempted.

2.4.2 Instructors who were experts in teaching formation flying advised that formation flying could be self-taught in reasonable safety, but that this exercise had to approached with caution. Apart from a proper briefing immediately before every flight, necessary considerations included:

(a) A stabilised joining procedure, with the leader in straight and level flight, and the joining aircraft joining from below so that the perspective of the leading aircraft aided in estimating range and closing rate.

(b) Wide safety margins, to compensate for the absence of an instructor to take over in the event of, for example excessive closing rate or pilot-induced oscillation.

(c) Formations which allowed room for a safe breakway if an unsafe situation started to develop.

2.4.3 The approach that was adopted by the pilots of ZK-EVA and ZK-EQM was at variance with the ideal.

(a) There had been a loss of expertise within the Club, because of the lapse of time since there had been a formation team. The books which previously gave guidance on formation flying were long out of print. In the absence of information on how to go about formation flying, the pilots attempted to work out for themselves the factors that should have been included in a briefing. Their lack of knowledge was a causal factor in the accident, since the procedures they did adopt were far from optimum. It was recommended to the Royal New Zealand Aero Club that appropriate guidance material should be made available to members.

(b) Prior notes on pieces of paper were regarded as an adequate substitute for a proper briefing immediately before the flight. A full briefing was essential before introducing any new exercise. Before an exercise with which the instructors themselves were unfamiliar, it was even more necessary.

(c) The pilot of the formating aircraft attempted to join, after a mock attack, by diving on the leader, who was recovering his aircraft from a steep turn.

(d) The intended spacing was one metre between wingtips, based on the RNZAC Competition Rules. This was far too close for an initial attempt, and closer than the RNZAF permitted for trained pilots. (Consideration of the RNZAC Rules led to recommendations for a formal review of them).

2.4.4 The method by which the pilots attempted to teach themselves formation flying was hazardous in the extreme. It was adopted as a result of a lack of knowledge and information. However, the foolishness of performing any exercise for the first time without a proper briefing, and of attempting a first formation join-up from a mock attack, ought to have been apparent to both instructors.

2.5 Impact of ZK-EQM with the ground

2.5.1 The positions of the ground scars showed that ZK-EQM was still banked to the left at impact, the left wingtip and mainwheel striking the ground more or less together. Had the aircraft been intact before touchdown, this might have resulted in the aircraft being rolled back to level, and arriving safely if untidily.

2.5.2 However, the impact on the left wingtip caused the already weakened left wing to fail. The right wing still had flying speed, and it rolled the aircraft to the left until the remaining stub of the left wing dug into the ground. The aircraft then pivoted about this stub until the engine struck the ground.

2.5.3 At this secondary impact the fuselage folded at the cockpit. Although the subsequent deceleration forces during the ground slide were moderate, the secondary impact and consequent lack of occupiable cockpit space made the accident unsurvivable.

2.5.4 The damage to the left aileron might have locked the ailerons and thus precluded roll control with the ailerons, and this might account for the left bank at impact. Alternatively, the pilot may have decided to descend in a gentle spiral to an area suitable for a forced landing, and then found he had insufficient roll authority to level the wings before touchdown. In either case the secondary effect of rudder might have provided sufficient roll control to level the wings, especially if enhanced by propeller slipstream. Although the pilot did not appear to have experimented with the use of power to help control the aircraft during the descent, as an instructor, he would have been familiar with the secondary effects of controls and may have attempted to use this knowledge prior to touchdown. The engine was not affected by the collision, and there was sufficient fuel in the tanks, so power was available had he decided to use it.

3. FINDINGS

3.1 The aircraft were airworthy before impact.

3.2 The pilots were properly licensed for the proposed flight.

3.3 The pilots had been unable to obtain information on how to go about formation flying.

3.4 There was no proper briefing on formation flying before the flight.

3.5 The formating aircraft tried to join the leader by diving towards him from the direction of the sun.

3.6 The pilot of the formating aircraft did not detect the excessive closing rate until his aircraft was too close to the leader to overshoot safely.

3.7 The avoiding action taken by the pilot of ZK-EVA was ineffective.

3.8 The spinner of the formating aircraft struck the left aileron of the leading aircraft a glancing blow from below.

3.9 The propeller of the formating aircraft cut the left wing rear spar of the leading aircraft, and tore out the left aileron mass balance weight.

3.10 The mass balance weight seriously injured the passenger in the formating aircraft.

3.11 The formating aircraft returned to base without further incident.

3.12 The leading aircraft, ZK-EQM, made a gliding descent to paddocks suitable for a forced landing.

3.13 On touchdown the left wingtip of ZK-EQM struck the ground, and the already weakened left wing structure failed.

3.14 The subsequent roll caused the stub of the left wing to dig into the ground, and this in turn caused the nose to strike the ground.

3.15 It was not determined if the pilot could have levelled the wings of ZK-EQM before touchdown in the paddock.

3.16 The midair collision occurred as a result of inadequate planning and briefing of a first attempt at self-taught formation flying. A contributory factor was the absence of readily available information on formation flying.

5. SAFETY RECOMMENDATIONS

5.1 As a result of the investigation into this accident, it was recommended to the Air Transport Division, Ministry of Transport that the Division:

Require the RNZAC Rules for Formation Flying to be reviewed by an independent panel of pilots familiar with formation flying.

Foster courses in formation flying conducted by pilots experienced in formation flying, from the RNZAF or elsewhere.

5.2 It was recommended to the General Manager of the Airways Corporation that:

He arrange for liaison at local level throughout New Zealand, to ensure that Controllers and the drivers of potential rescue vehicles are equipped with the same maps, preferably overprinted with an easy reference grid.

5.3 It was recommended to the President of the Royal New Zealand Aero Club that:

The RNZAC compile briefing material for formation flying instruction and make it available to members.

M F DUNPHY
Chief Commissioner

11 February 1993