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Report 08-001, Cessna 152 ZK-ETY and Robinson R22 ZK-HGV, mid-air collision, Paraparaumu, 17 February 2008

CONFIDENTIALITY ORDERS

Pursuant to sections 11(1) and (2) of the transport Accident Investigation Commission Act 1990, section 4 of the Commission of Inquiry Act 1908, and Rules 42 of the District Court Rules 1947, and in order to give effect to the section 14B (2) (d) of the Transport Accident Investigation Commission Act 1990:

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The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

Report 08-001

Cessna 152 ZK-ETY
and
Robinson R22 ZK-HGV

mid-air collision

Paraparaumu

17 February 2008

Cessna 152, ZK-ETY

Robinson R22 Beta II, ZK-HGV

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Abbreviations

AFIS	aerodrome flight information service
AIP	aeronautical information publication
ARA	annual review of airworthiness
ATC	air traffic control
ATSB	Australian Transport Safety Bureau
AWIB	aerodrome and weather information broadcast
CAA	Civil Aviation Authority (of New Zealand)
CAR(s)	Civil Aviation Rule(s)
CFIT	controlled flight into terrain
CO	carbon monoxide
FAA	Federal Aviation Administration (of United States)
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
km	kilometre(s)
m	metre(s)
MBZ	mandatory broadcast zone
MHz	megaHertz
NTSB	National Transportation Safety Board (of United States)
UTC	coordinated universal time
VFR	visual flight rules

Glossary

annual review of airworthiness	an annual inspection of an aircraft to check its general condition and, among other things, that its documentation is correct and specified maintenance has been completed
autorotation (simulated)	a simulated engine failure where the helicopter is established in a powered-off descent (the equivalent of a stabilised glide approach for an aeroplane). Approaching the ground the helicopter would be flared or pitched up, and either power reintroduced to terminate in a hover or, by using the energy remaining in the blades, a controlled landing made
CFIT	when an airworthy aircraft under control of the crew is flown unintentionally into terrain. CFIT is more common during the approach and landing phases of flight, often under instrument flight rules and during non-precision instrument approaches
QNH	an atmospheric pressure setting, giving altitude above mean sea level

Data Summary

Aircraft registrations:	**ZK-ETY**	**ZK-HGV**
Type and serial numbers:	Cessna 152, 15285023	Robinson R22 Beta II, 3735
Number and type of engines:	1 Lycoming O-235-L2C	1 Lycoming O-360-J2A
Year of manufacture:	1981	2004
Operator:	Kapiti Districts Aero Club	HELiPRO
Date and time:	17 February 2008 at 1112[1]	
Location:	Paraparaumu latitude: 40° 54.2′ south longitude: 174° 59.8’ east	
Type of flight:	training	flight test
Persons on board:	one pilot	one flight examiner one pilot
Injuries:	one fatal	2 fatal
Nature of damage:	destroyed	destroyed
Pilots-in-command licences:	student pilot (aeroplane)	commercial pilot licence (helicopter)
Pilots-in-command ages:	17	30
Pilots-in-command total flying experience:	25 hours	2674 hours
Investigator-in-charge:	I R M^{c}Clelland	

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

Executive Summary

On 17 February 2008, a mid-air collision between a light aeroplane and a small helicopter over Paraparaumu resulted in the deaths of 2 student pilots (aged 17 and 19 years) and a flight examiner (aged 30). Both aircraft were destroyed and several homes and commercial premises damaged, but no persons on the ground were injured.

The pilot of the aeroplane was following a standardised joining procedure for a sealed runway that took it into the path of the helicopter operating on a parallel grass runway. Had the conflict been recognised, the pilot of the aeroplane should have given way to the helicopter under general conflict-avoidance rules.

The investigation determined that the 3 pilots were concentrating on flying their aircraft and planned manoeuvres to the detriment of maintaining an effective lookout. Despite the pilots of both aircraft making appropriate radio calls that should have alerted the other and ensured adequate separation was maintained, as the 2 aircraft closed on each other, the pilots appeared to have made no attempt to continue their lookout until positively identifying the other aircraft and turning away. All pilots have a responsibility to maintain a good lookout and avoid a collision, regardless of who has the right of way.

A review of international standards and relevant research taken together with the accident circumstances found no evidence to support a review of pilot minimum age limits in New Zealand, with pilot competency being a more relevant consideration than age.

The potential for a mid-air collision at Paraparaumu, with its parallel runways and multiple and diverse operations, had been well recognised, but little had been done to mitigate the risk. Why the regulator did not act on the recommendation of a 1996 risk assessment to introduce specific joining procedures could not be explained. Neither the aircraft operators based on the aerodrome, the aerodrome owner and operator nor the regulator had maintained a coordinated approach to identifying and managing safety issues and risks at the aerodrome.

The absence of an air traffic control or information service on the aerodrome was not considered a significant factor, as the pilots were almost universally operating in accordance with visual flight rules where “see and avoid” is the primary and final defence in avoiding a collision. Further, there had been no appreciable change in the rate of near misses or other traffic conflicts since the removal of a staffed air traffic service. But there may have been a general reluctance among pilots to report such incidents.

Mid-air collisions are rare events. There was no evidence found in a review of New Zealand and international data that the risk of impact damage to property or people on the ground near aerodromes merits consideration of a specific response for Paraparaumu or elsewhere. However, future planners and regulators need to be aware of the risks to ensure continued safe operations around aerodromes.

Since the accident the aerodrome operator has held several user meetings, and conducted a risk review of aerodrome operations that has recommended a range of changes to aerodrome configuration, circuit procedures and requirements that should reduce the risk of mid-air collisions. The regulator has issued a general reminder to pilots of circuit procedures at uncontrolled aerodromes, and issued improved aeronautical charts containing circuit and runway information for Paraparaumu Aerodrome, including the adoption of specific joining procedures.

The Transport Accident Investigation Commission has recommended to the Director of Civil Aviation that he act to increase his staff’s promotion of safe management of flying activities at all aerodromes and help educate pilots on effective visual scanning and active listening to radio calls. Further, to review operations at aerodromes around New Zealand with similar circuit patterns to help prevent future mid-air collisions.

(Note: this executive summary condenses content to highlight key points to readers and does so in simpler English and with less technical precision than the remainder of the report to ensure its accessibility to a non-expert reader. Expert readers should refer to and rely on the body of the full report.)

Location map

Factual Information

1.1 History of the flights

1.1.1 On the morning of Sunday 17 February 2008, the student pilot of ZK-HGV[2], a Robinson R22 helicopter, was scheduled to sit a flight test for the issue of his private pilot licence (helicopter). The helicopter pilot arrived at the HELiPRO (the helicopter operator) facilities on Paraparaumu Aerodrome where he had been training, at about 0800, and together with his regular instructor prepared ZK-HGV (the helicopter) for a short training flight before the scheduled flight test later that morning.

1.1.2 A light northerly wind was present, so a circuit based on grass runway 34 was used during the flight. The training flight lasted about 30 minutes and consisted mainly of autorotations onto the grass runway. The instructor commented that the helicopter pilot was competent in flying autorotations and was ready for the flight test. The helicopter pilot then prepared the helicopter and relevant documents while waiting for the flight test examiner to arrive.

1.1.3 At about 0945, the student pilot of ZK-ETY[3], a Cessna 152 aeroplane, arrived at the Kapiti Districts Aero Club (the aeroplane operator) facilities on Paraparaumu Aerodrome, where he had been conducting his flying training. The aeroplane pilot had flown an instructional flight with another instructor the previous day, involving steep turns, and was next scheduled to fly a solo flight to consolidate the exercises. The aeroplane pilot met the duty instructor and together they reviewed the aeroplane pilot's logbook and discussed the weather and exercise planned for the day. The aeroplane pilot and instructor agreed the weather was suitable for the flight and the aeroplane pilot would conduct the exercises in an area about 15 km north of Paraparaumu.

1.1.4 The aeroplane pilot was allocated ZK-ETY (the aeroplane), so went and checked the aeroplane in preparation for the flight. The duty instructor observed the aeroplane pilot from inside, but joined him to help position the aeroplane for fuelling. Sufficient fuel was added to give a flying endurance of about 3 hours. The aeroplane pilot returned inside and completed a flight authorisation form, which he handed to the duty instructor. Together they reviewed the form and made several changes before the duty instructor signed the authorisation.

1.1.5 At about 1025 the aeroplane pilot started the aeroplane and at 1028 called "Paraparaumu Traffic" on the local radio frequency of 118.3 megaHertz (MHz) and advised he was taxiing from the Aero Club for runway 34 seal.[4] At 1036 the aeroplane pilot reported that he was taking off from runway 34 seal, climbing to 2500 feet and vacating to the north. Over the next 30 minutes the aeroplane pilot made 6 radio calls on 118.3 MHz, reporting that he was operating in the Peka Peka – Te Horo area at 2500 feet.

1.1.6 During this time, the helicopter flight examiner arrived and with the helicopter pilot prepared for the flight test. At 1052, the helicopter pilot transmitted on 118.3 MHz that he was backtracking to line-up[5] runway 34 grass. At 1053 the helicopter pilot called "Hotel Golf Victor is rolling on grass 34, right-hand circuit". In the next 16 minutes the helicopter pilot made 9 radio transmissions while operating in the circuit for runway 34 grass. Each transmission included the words "grass 34".

1.1.7 At 1108, the helicopter pilot was observed by several witnesses around the aerodrome to fly a straight-in autorotation onto runway 34 grass.[6] At 1109:30[7], the helicopter pilot transmitted "Paraparaumu Traffic – Hotel Golf Victor enters and lines up grass 34".

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[2] For clarity, hereafter the student helicopter pilot is referred to as the helicopter pilot.
[3] For clarity, hereafter the student aeroplane pilot is referred to as the aeroplane pilot.
[4] Two runways were in operation at the time, runway 34 seal and parallel runway 34 grass, and had been for most of the morning.
[5] To "line-up" is the positioning of the aircraft on the runway ready for take-off.
[6] Initiating the simulated engine failure when on final approach to the runway, but still at circuit altitude of 1000 feet.

1.1.8 At 1109:44, the aeroplane pilot reported "Paraparaumu Traffic – Echo Tango Yankee overhead Waikanae River mouth[8] 1500 feet for standard overhead rejoin 34 seal". At 1110:00 the helicopter pilot transmitted "Paraparaumu Traffic – Hotel Golf Victor rolling grass 34, extending upwind leg".[9] Pilots of 3 other aircraft were then heard to make radio calls, one advising 2 miles west and vacating, the second reporting east of Kapiti Island and joining downwind, and the third lining up on runway 34 seal.

1.1.9 At 1111:20, the aeroplane pilot transmitted "Paraparaumu Traffic – Echo Tango Yankee overhead the field 1500 feet, commencing standard overhead rejoin 34 seal". At 1111:58, the helicopter pilot transmitted "Paraparaumu Traffic – Hotel Golf Victor is close in downwind grass 34, practice 180 autorotation to the centre grass 1000 feet".[10] There were no intervening calls from other aircraft between these 2 transmissions.

1.1.10 Soon afterwards witnesses saw the 2 aircraft converge and collide near the northern boundary of the aerodrome and immediately fall to the ground. The witnesses reported that neither aircraft took any avoiding action. After the collision, several witnesses reported hearing an engine running at high speed before suddenly stopping.

1.1.11 The helicopter pilot and flight examiner died when the helicopter impacted on a commercial building. The aeroplane fell onto a roadway of a residential cul-de-sac about 230 m away. The aeroplane pilot survived the collision and ground impact, but died about 5 hours later of his injuries. No persons on the ground were injured and there was no fire (see Figure 1 for a description of the area).

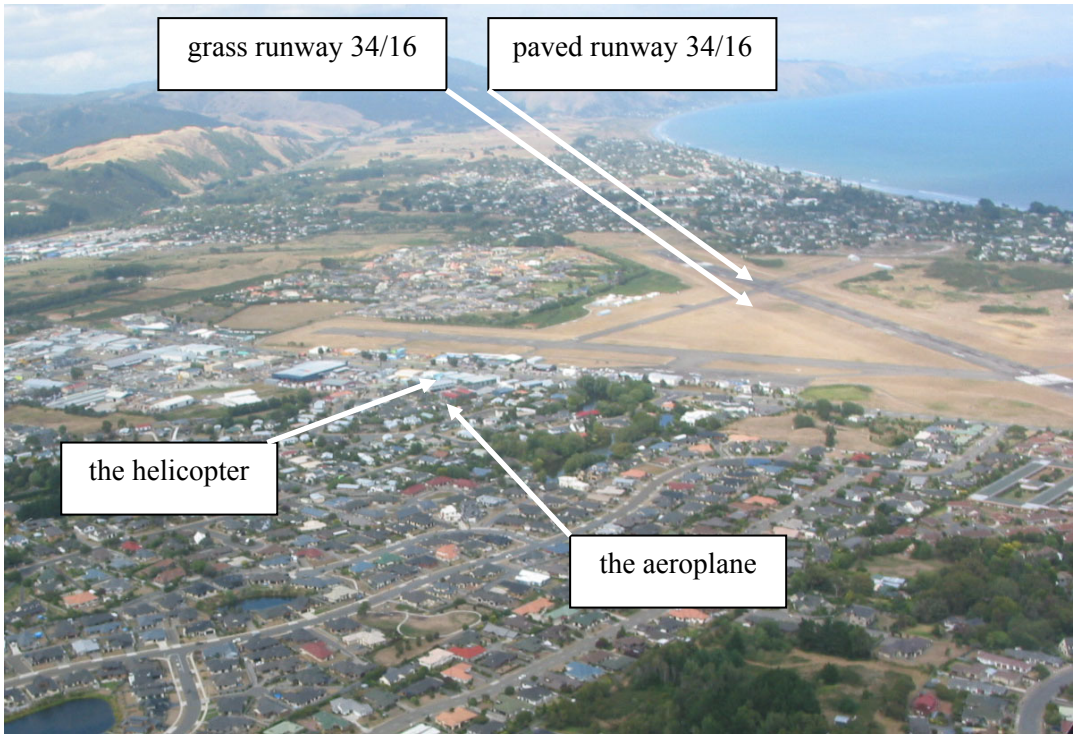


Figure 1
Aerial view of site
(looking south)

[7] Timings for radio transmissions refer to the start of the transmission.
[8] About 4 km north-east of the aerodrome.
[9] Instead of turning right at 500 feet after take-off as normal, the pilot indicated he was delaying the turn.
[10] An autorotation initiated while flying downwind, followed by a turn through 180º to terminate into wind.

1.2 Site and impact information

1.2.1 The wreckage of the 2 aircraft was spread over about 2 hectares to the north-east of Kapiti Road which bounded the northern side of the aerodrome. An initial examination of the site confirmed that the 2 aircraft had broken up in the air, with major components, for example the engine from the aeroplane and the main rotor blades from the helicopter, found separated from the 2 aircraft (see Figure 2).

1.2.2 Soon after being alerted of the accident, emergency services were in attendance and secured the general area. Some wreckage, mainly small pieces of fuselage, was collected by members of the public and either handed to the Police or placed in piles. Despite this, flight-critical items, such as the engine, rotor blades and flight controls, were not moved and an accurate survey of the site was possible.

1.2.3 The main wreckage of the aeroplane had fallen inverted on a roadway, with the wings still attached to the fuselage. The tailplane had separated in flight and was found about 90 m from the fuselage. The engine and some accessories had also separated from the aeroplane as it descended, with several items penetrating the roofs of nearby houses.

1.2.4 The fuselage of the helicopter had broken through the roof of a hardware company, with a section of the tail boom, including the tail rotor assembly, remaining on the roof. The tail rotor blades displayed no rotational damage.[11] The main rotor blades had separated from the aircraft at the hub attachment area and sections of both blades were found about the wreckage site. Following an initial examination and survey of the site, the wreckage was removed for further examination.

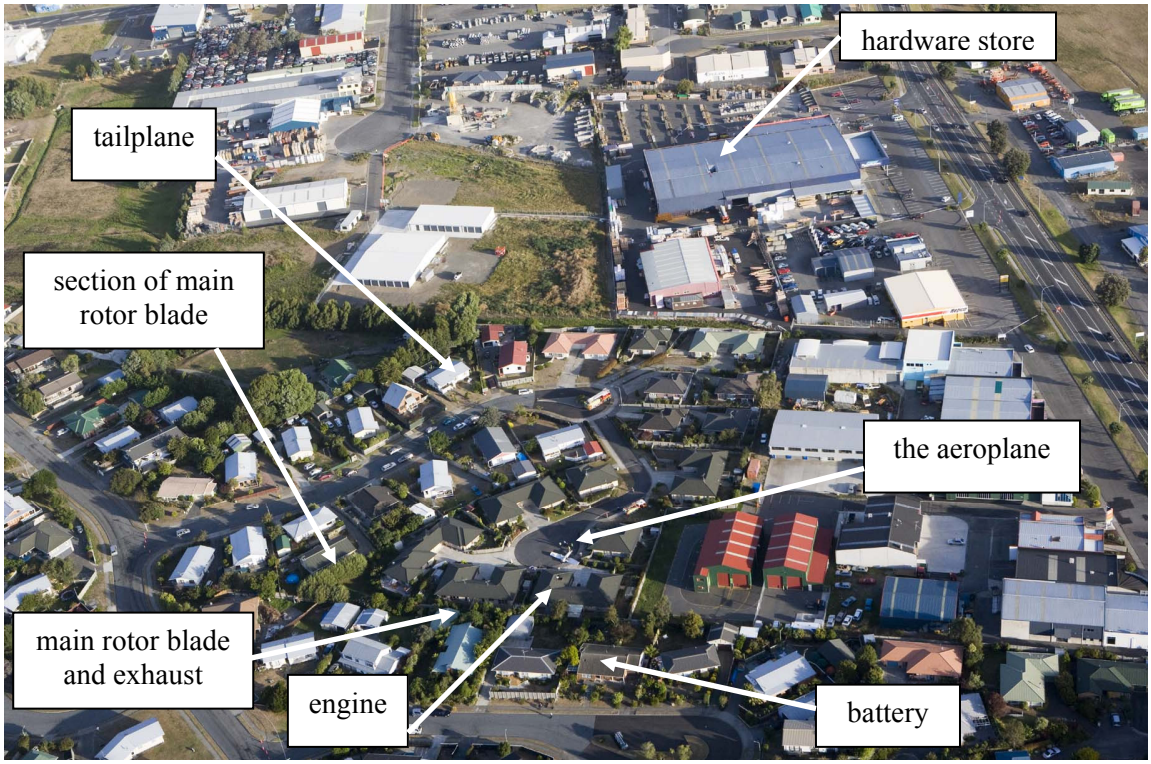


Figure 2
Accident site
(looking east)

[11] Damage occurring while the components were rotating or turning, as they would do during normal operation.

Wreckage information

1.2.5 All major components of both aircraft were accounted for. The exhaust muffler for the aeroplane was found entwined in a section of main rotor blade from the helicopter, about 25 m from the aeroplane fuselage. This, together with additional witness marks on the mast of the helicopter and the nose wheel and engine cowling of the aeroplane, showed that the 2 aircraft had collided at about 90º to each other, with the left side of the helicopter colliding with the right side of the aeroplane near the front. Marks along the left side of the fuselage of the aeroplane indicated the second main rotor blade had struck this side of the aeroplane before separating from the rotor hub.

1.2.6 Examination of the wreckage of the aeroplane found the following switch and lever positions:

pitot heat	OFF
navigation lights	OFF
anti-collision light	ON
landing light	OFF
throttle	mid range
mixture lever	fully rich
carburettor heat lever	fully in – OFF
engine primer	fully in
master	BOTH
flap lever	set to 10º (but moveable and some distortion present)

Note: Examination of the aeroplane confirmed that the flaps were jammed in the fully retracted position.

1.2.7 Because of the damage, no useful information was able to be obtained from the instruments, levers and controls of the helicopter.

Other damage

1.2.8 The hardware store and 3 houses sustained moderate damage, and several other houses sustained minor damage. A large section of the hardware store was closed for nearly one week to enable repairs to the building. Some stock was also ruined when the store's fire sprinkler system was ruptured during the accident.

1.2.9 Direct material costs for the accident, including the 2 aircraft, damage to houses and the hardware store, were estimated to be about $410 000.

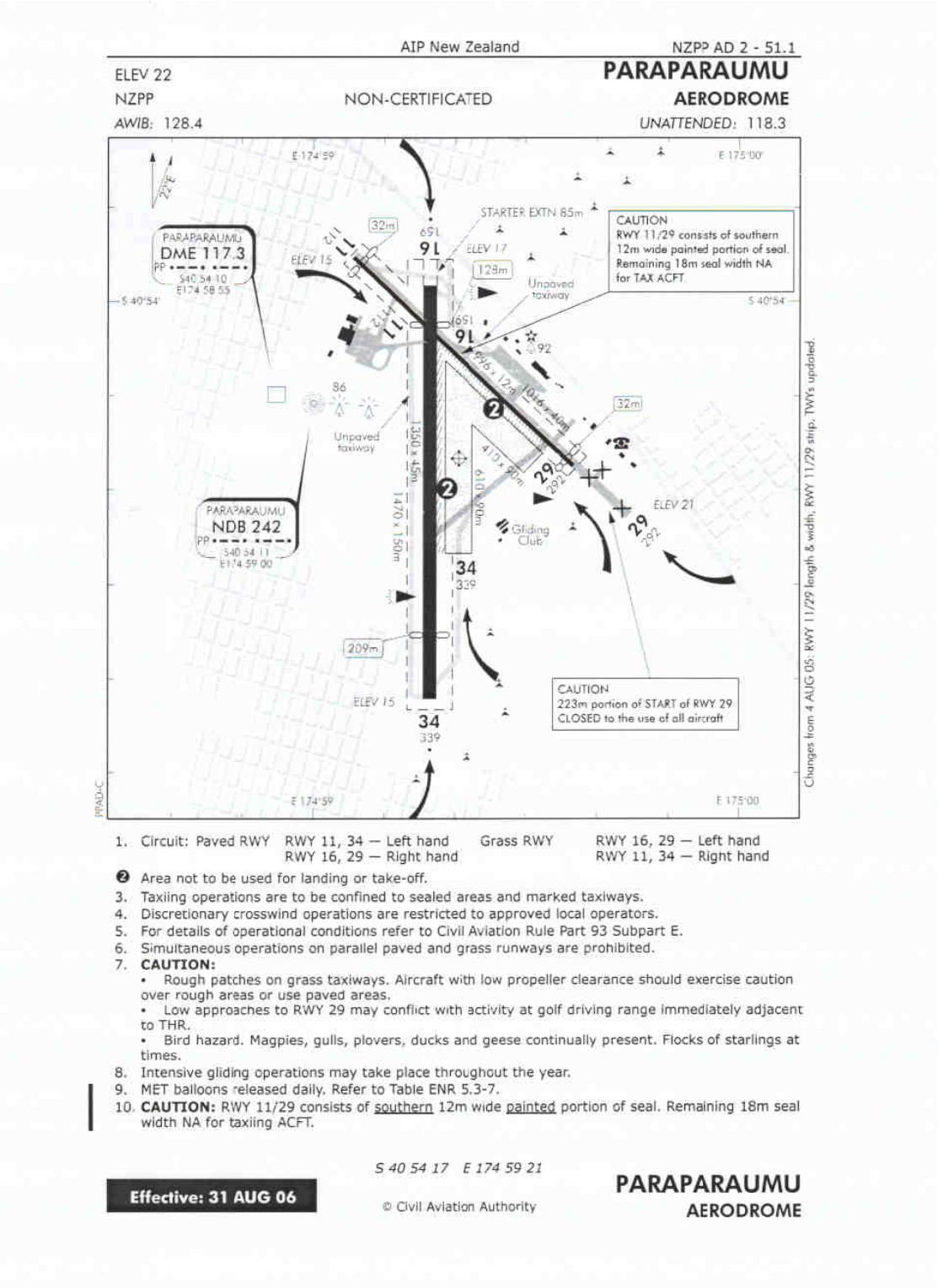
Meteorological information

1.2.10 Pilots flying at around the time of the accident and local witnesses reported the weather conditions were fine with a light northerly wind. The automated Meteorological Service of New Zealand (MetService) facility located on the Paraparaumu Aerodrome recorded the following information at about the time of the accident:

surface wind	360º Magnetic at 9 knots
visibility	35 km
cloud	2 – 3 oktas[12] at 3000 feet
temperature	19º Celsius
dew point	13º Celsius
QNH	1010 hectoPascals

[12] Cloud was measured in eighths or oktas. Total overcast would be 8 oktas.

1.2.11 The sun was calculated to have been on a bearing of 022º Magnetic from the 2 aircraft and at an elevation of 54º above the horizon, at the time of the accident.



1.2.12

Figure 3
Landing chart
(not to be used for navigation)

Aerodrome information

1.2.13 Paraparaumu Aerodrome was located near the coast and contained within the general boundary of the Paraparaumu township. The aerodrome had 2 paved runways and 2 parallel grass runways available for use.[13] These were 11/29 paved and grass, and 16/34 paved and grass. Runway 16/34 was longer and used more often than runway 11/29 (see Figure 3).

1.2.14 In order to provide traffic separation when parallel runways were in operation, the published circuit directions for the paved and grass runways were away from each other; for example, 34 seal was left-hand, while 34 grass was right-hand. The landing chart notes stated that "simultaneous operations on parallel paved and grass runways are prohibited". This was understood by the Civil Aviation Authority (CAA), the aerodrome operator and local aircraft operators to mean that 2 aircraft could not take off or land side by side. A stagger was required between aircraft taking off or landing to provide separation should an aircraft suddenly veer towards the adjacent runway.

1.2.15 Other notes on the landing chart also advised that aircraft were not to take off or land in the area between the seal and grass runways. A third note also referred pilots to Civil Aviation Rules (CARs) and local noise abatement procedures.[14] These procedures were in response to concerns about aircraft noise levels in the local area.

Aerodrome history

1.2.16 Originally Crown owned and operated, Paraparaumu Aerodrome was in 1949 the busiest commercial aerodrome in New Zealand. With the opening of Wellington International Airport in 1959 aircraft movements, take-offs and landings reduced significantly. This eventually resulted in the air traffic control (ATC) service being replaced by an aerodrome flight information service (AFIS) in 1973. AFIS officers provided pilots with aerodrome information and information on local weather conditions to facilitate the safe flow of aircraft operating in and around the aerodrome rather than controlling the traffic.

1.2.17 In uncontrolled airspace pilots transmitted their intentions on a common radio frequency. The AFIS operator would, during the hours of service, advise pilots of the runway in use and other aircraft of which the operator was aware that might pose a conflict. The AFIS operator would also report any breaches of safety to the regulator, thus encouraging an orderly flow of traffic. Outside the hours of service, pilots were encouraged to ensure that the same orderly flow continued by transmitting their position and intentions and coordinating with other pilots.

1.2.18 In 1992, the Crown formed Paraparaumu Airport Limited to manage the aerodrome, and in 1995 the aerodrome was sold to a private company, Kapiti Avion Holdings Limited. The AFIS remained in operation, with operators paying a landing fee to help cover the costs of the service. Around this time the aerodrome became non-certificated.[15] To hold certification, an aerodrome needed to adhere to standards and practices as detailed in CARs, including design and operating requirements, rescue and fire-fighting, and security. These standards did not apply to non-certificated aerodromes, where greater responsibility was placed on operators and pilots to ensure aircraft could safely operate into and out of the aerodromes.

[13] The landing charts referred to "paved" runways, but "seal" was the more commonly used term. Both words are used in this report.
[14] CAR Part 93 Subpart E, effective 31 August 2006.
[15] CAR Part 139.5, effective 18 January 2008, directed that aerodromes serving any aeroplane having a certified seating capacity of more than 30 passengers and engaged in regular air transport operations were to be certificated and comply with the requirement of the Rule.

1.2.19 In 1996, following discussions between the aerodrome owner and the CAA, the CAA initiated a safety assessment of Paraparaumu Aerodrome and the provision of air traffic services. The assessment, dated 22 November 1996, determined the following:

- 96% of the total movements at Paraparaumu were VFR (visual flight rules) light aircraft operating on the "see and be seen basis".
- More than 40% of these movements were gliders and their associated tugs.
- 45% of all movements occurred during the weekend.
- The provision of AFIS at Paraparaumu could not be justified based on the results of the cost benefit analysis, and that air traffic services could not be required on the grounds of safety alone.
- On the basis of current expected growth rates and the mix of aircraft flying into Paraparaumu this conclusion was not expected to change within the foreseeable future.
- Significant changes to the assumptions behind the econometric model did not affect the results of the analysis.
- Several safety recommendations were made with regard to procedures should AFIS be withdrawn from Paraparaumu.
- The provision of flight information services by a non-Airways Corporation of New Zealand air traffic services provider was relevant to some of the safety recommendations. This was an issue that was considered outside the scope of the assessment and should be addressed by the CAA.

1.2.20 The assessment identified numerous safety issues and made associated recommendations. Some of the safety issues identified were:

- The surrounding geography and strategic position of Paraparaumu aerodrome resulted in significant amount of traffic either overflying or passing west abeam Paraparaumu aerodrome. Transiting aircraft were provided with traffic and weather information to assist in the safe conduct of their flight.
- Although the established circuit patterns appeared to work well in segregating powered and non-powered (glider) aircraft, there were times the mixture of circuits might have safety concerns.
- Paraparaumu aerodrome circuit patterns were bi-directional. There was no "non-traffic side" with regard to overhead rejoins.[16]

1.2.21 In response to the safety concerns identified above, the assessment made the following recommendations for consideration by the Director of Civil Aviation:

- An aerodrome traffic zone be established to prevent itinerant aircraft overflying the aerodrome.
- A Paraparaumu overhead joining procedure be promulgated.
- Traffic management flow indicators and radiotelephone frequency indicator boxes should be promulgated on local charts.

1.2.22 The assessment discussed in further detail the density of traffic and the circuit patterns. The assessment predicted 46 273 movements for 1996, increasing to 50 558 in 1997. With 92% of the movements being operations under VFR, the annual totals were greatly affected by weather conditions. Weather conditions in 1996 did not favour VFR activity, so no significant increase in movement rates was predicted.

[16] The non-traffic side was the side of the runway opposite to the circuit direction.

1.2.23 Concerns about the circuit patterns focused primarily on possible conflict between light aircraft and gliders, particularly when crosswind training was taking place. The assessment also questioned the use of standard overhead rejoin patterns as described in aeronautical publications and whether they should be varied because there was "no non-traffic side when gliding is in progress".

1.2.24 The Paraparaumu Aerodrome file held by the CAA contained no documents more recent than the 1996 safety assessment, other than some internal emails that referred to a meeting between the CAA, the aerodrome operator and users, held on 15 May 1997. The emails suggested that the various parties at the meeting had not agreed on a number of issues, including the type of airspace to be established and joining procedures.

1.2.25 Following a Transport Accident Investigation Commission (Commission) request for further information, the CAA responded that no other documents relating to the safety assessment and any subsequent decisions could be found. The CAA advised that the current electronic document management system had not been introduced until 1997, and no back-loading of documents had been carried out. Therefore, any misplaced documents would be difficult to locate without considerable effort.

1.2.26 The CAA further advised that in reviewing the recommendations "the intent of all except one have been subsequently actioned". The exception was the recommendation to promulgate an overhead joining procedure. The reason for this could not be confirmed but was considered by the CAA to have been a decision by the then Director of Civil Aviation to allow the status quo to continue.

1.2.27 In 1997 the AFIS at Paraparaumu was dis-established and shortly afterwards a mandatory broadcast zone (MBZ) was established around the aerodrome. The MBZ extended to the foothills (2 km) to the east of the aerodrome, Otaki River (20 km) to the north, Kapiti Island (7 km) to the west and 6 km to the south. Pilots flying aircraft within the zone were required to call every 10 minutes on a common frequency of 118.3 MHz and report their position and intention. Further, as an extra safety measure, aircraft landing lights or anti-collision lights were to be used when fitted.[17]

1.2.28 In about 2000, an automated aerodrome and weather information broadcast (AWIB) facility was installed at Paraparaumu. The AWIB transmitted local weather information on a dedicated frequency, initially 128.3 MHZ but later changed to 125.2 MHz. The information was sourced from the MetService weather station on the aerodrome. The repetitive transmissions could also include additional information such as mowing in progress, gliding in progress, and left and right circuits in operation, to alert pilots to these activities.

1.2.29 At the time of the accident on 17 February 2008, only the weather information contained in paragraph 1.2.10 was being transmitted. There was no mowing activity, but gliding operations had commenced mid-morning. An oversight by the local gliding organisation meant that the AWIB had not been updated when gliding operations commenced.

1.2.30 In June 2006 the aerodrome owner sold all its shares to Paraparaumu Airport Holdings, subsequently Paraparaumu Airport Limited. The aerodrome manager advised that following the removal of the AFIS and up until the time of the accident, there had been infrequent informal meetings of aerodrome operators or users. These meetings mainly dealt with changes to local landing charts and aeronautical publications to remove references to the AFIS. No record of the most recent aerodrome user meeting could be located, nor a copy of the 1996 CAA safety assessment.

[17] Aeronautical Information Publication New Zealand, ENR 5.3 – 12, Mandatory Broadcast Zones.

1.2.31 The aerodrome manager said the aerodrome handled about 55 000 movements per year. This was considered an estimate as it was based on a sample of take-off and landing calls recorded on the aerodrome radio frequency monitor. By comparison the uncontrolled aerodromes of Taupo and Ardmore reported annual movements of about 33 000 and 183 000 respectively. The air traffic services provider, Airways Corporation of New Zealand (Airways New Zealand), reported that for the controlled aerodromes of Palmerston North and Queenstown, 88 817 and 49 015 movements respectively were recorded for 2007. These figures included international arrivals and departures, and a significant number of instrument flight rules (IFR) flights by ATR72 and Boeing 737 sized aircraft.

1.2.32 A review of the CAA incident and accident database for Paraparaumu showed that for the 15 years leading up to the time of the accident there had been 9 reported "near miss" incidents at Paraparaumu.[18] Of the 9 incidents, 6 had involved near misses with weather balloons that had been released from the MetService facility on the aerodrome. A 10th near miss had been reported outside the aerodrome environment near Levin. One of the reported near misses, on 5 September 2007, had involved an aircraft flying an overhead rejoin when the pilot observed a helicopter fly underneath the aircraft. The helicopter was reported to have been 200 feet below and 300 feet laterally displaced as the 2 aircraft crossed. This report was, however, not made to the CAA until 5 March 2008, about 2 weeks after the mid-air collision on 17 February 2008.

1.2.33 The database included a further 7 reported incidents at Paraparaumu that had involved some form of conflict between aircraft, for example an aircraft cutting in front of another, joining for the wrong runway or a reported loss of separation. Analysis of the incidents showed the rate of reported occurrences before and after the AFIS was disestablished in 1997 was about the same.

Airspace information

1.2.34 Paraparaumu Aerodrome was contained within the Paraparaumu MBZ and was classified as class G uncontrolled airspace. Pilots were not required to obtain a clearance to enter or operate within class G airspace. See section 1.5 for separation instructions and requirements in uncontrolled airspace.

1.2.35 The MBZ extended from the surface to 2000 feet and a pilot was required to make radio broadcasts at intervals not exceeding 10 minutes, stating aircraft call sign, position and altitude, and intention.[19] Broadcasts were also to be made at the following occasions:

- at entry,
- when joining the aerodrome traffic circuit, and
- before entering a runway for take-off.

1.2.36 Pilots were also required to maintain a listening watch on the radio frequency and use their aircraft landing lights or anti-collision lights when fitted.[20]

Communications

1.2.37 All communications were on the local aerodrome and training area frequency of 118.3 MHz. A recording facility located in the disused control tower recorded all radiotelephone transmissions on the day of the accident. These were available to the investigation and the relevant transmissions are contained in section 1.1 of this report. The transmissions from both aircraft were clear and of a good volume.

[18] A near miss was assumed to be when a collision was narrowly avoided.
[19] As directed in CAR Part 91.135, effective 22 November 2007.
[20] CAR Part 91.135, effective 22 November 2007.

Aids to navigation

1.2.38 Airways New Zealand radar facilities recorded portions of the flights of both aircraft, including the aeroplane returning to Paraparaumu Aerodrome from the training area, and the helicopter as it positioned in the downwind leg for the 180º autorotation. The recording showed the flight paths of the 2 aircraft converging and meeting at 1112:10 (see Figure 4.)

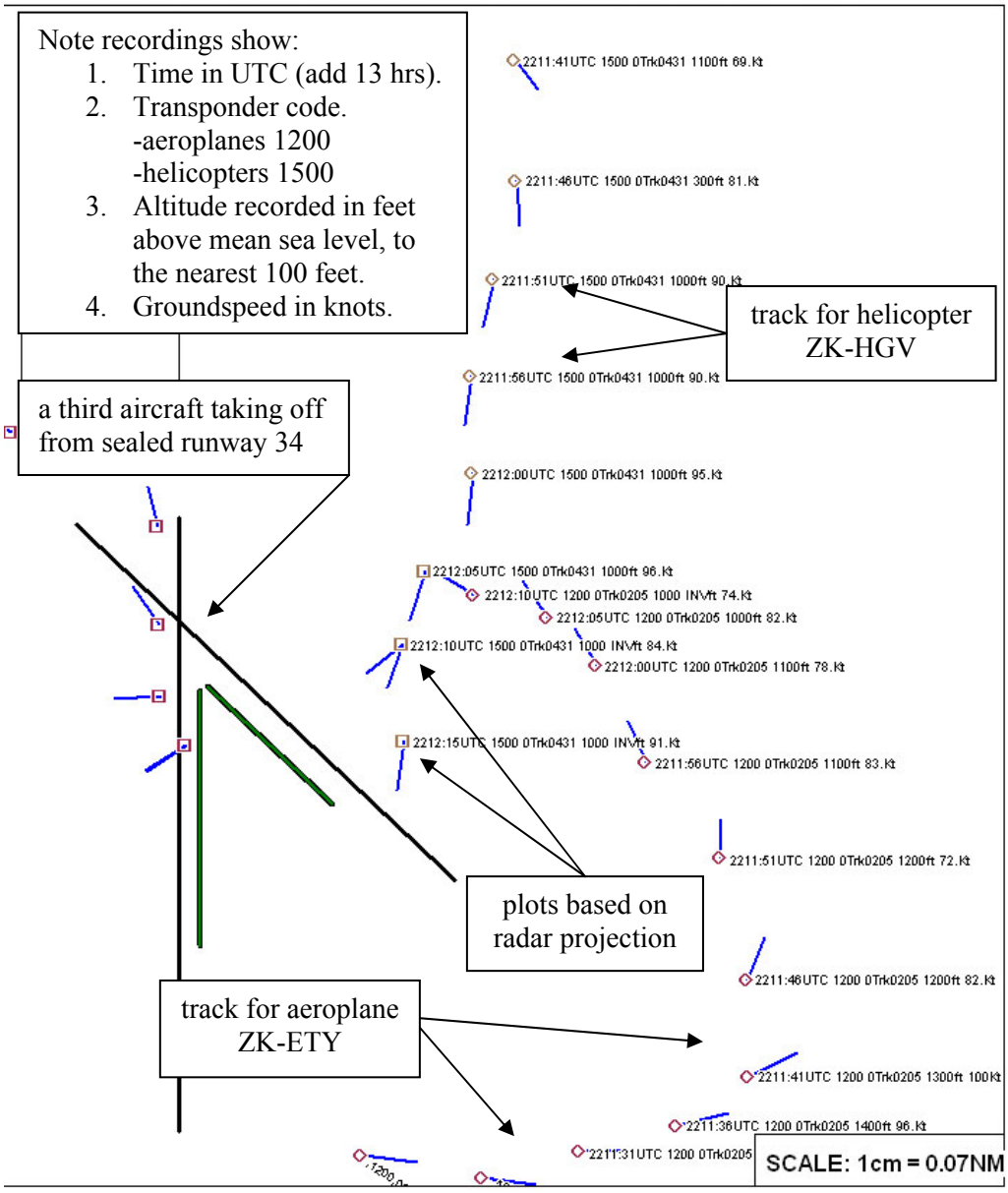


Figure 4
Radar plot

(Note: The radar plot is based on information received from several sources, updated every 5 seconds, processed and displayed in a pictorial manner. Airways advised that in general radar positional error was less than 0.25 nautical miles (465 m), but in this case the tracking displacement was estimated to be no more than 0.04 nautical miles (75 m). However, it should be noted that due to the close proximity of transponders in the 2 aircraft, mutual garbling of replies may have caused data errors and this was probably the reason for some positional variations as the 2 aircraft approached each other and for the helicopter reporting an incorrect altitude (300 feet) at time 2211:46.)

1.3 Personnel information

1.3.1 The helicopter pilot was aged 19. He held a current class 1 medical certificate, issued on 30 May 2007 and valid until 30 May 2008.[21] He had started flying training with the helicopter operator in September 2007 and was undertaking a course of instruction towards obtaining his private pilot licence (helicopter) and eventually his commercial pilot licence (helicopter). At the time of the accident he had flown 76 hours. All but 2.1 hours were on the Robinson R22 helicopter.

1.3.2 The helicopter pilot was reported to have had a good night's rest and on the morning of the accident was observed to be alert and well prepared for his flight test. He was not known to be suffering from any medical condition that may have contributed to the accident.

1.3.3 The aeroplane pilot was aged 17. He lived locally and had started his flying training with the aeroplane operator in April 2007. He held a current class 2 medical certificate, issued on 13 August 2007 and valid until 13 August 2012. The certificate contained no restrictions and he was not known to have any medical conditions that would have affected the conduct of the flight.

1.3.4 At the time of the accident the aeroplane pilot had flown 25 hours, including nearly 24 hours on the Cessna 152 type aircraft. After going solo for the first time on 16 January 2008, he flew a further 8 flights in the circuit, 4 dual and 4 solo, before advancing to other exercises. On 30 January he completed an instructional flight involving "overhead rejoins". This was followed by a solo consolidation flight of the same exercise 2 days later. The next exercise was practice forced landings without power followed by an exercise on steep turns on 16 February. The accident flight was the aeroplane pilot's eighth solo flight, and his third solo flight away from the circuit.

1.3.5 On the morning of 17 February the aeroplane pilot, in conjunction with the duty instructor, agreed he was fit to go flying. The instructor commented that he thought the aeroplane pilot was "cheerful" and "thoroughly aware of the exercise he was to complete and altitude he was to fly at". He was described by others who knew him as quiet, responsible and not prone to excessive or antisocial behaviour.

1.3.6 The flight examiner was aged 30. He had started flying training in 1996 at age 18 and held a commercial pilot licence (helicopter). He had obtained his category A instructor rating in August 2005 and was a CAA-approved flight examiner. He also held a class 1 medical certificate valid until 19 July 2008. The certificate included an endorsement that spectacles were to be available when flying.

1.3.7 A review of the flight examiner's logbook showed he had flown 2674 hours on helicopters. He was employed by another helicopter operator as a commercial and rescue pilot based in Palmerston North and undertook instructional or flight test duties for a commercial flight test organisation on his scheduled days off. He was familiar with Paraparaumu, having previously been based there as a flying instructor. The logbook recorded that since December 2006 the flight examiner had flown 35 instructional flights or flight tests, all on the R22 helicopter. He had flown 12.3 hours in the preceding 2 weeks and 3.7 hours in the week immediately prior to the accident. He had had a rest day on Thursday 14 February and had flown one flight on each of the following 2 days for a total of 1.6 hours.

1.3.8 On 17 February 2008, the flight examiner had travelled by car from Palmerston North to complete the flight test. He was reported to have been well rested and in good health before commencing the flight.

[21] Student pilots and private pilot licence holders were required to hold at least valid class 2 medical certificates before they were permitted to fly solo or exercise the privileges of their licence. Commercial pilot licence holders were required to hold valid class 1 medical certificate.

1.3.9 CARs permitted both the helicopter student and the flight examiner to log the flight as pilot-in-command.[22] The helicopter student was the flying pilot and controlling the aircraft. He was therefore effectively the pilot-in-command for the purposes of the flight test. However, the Rules directed that the flight examiner must be the pilot-in-command when this was necessary in the interests of safety.[23] According to the CAA and 2 New Zealand flight test organisations, the practical application of this was that should a flight examiner identify a dangerous situation, they would assume command over a student. A potential mid-air collision would be such a situation.

Medical and pathological information

1.3.10 Post-mortem examinations of the 3 pilots showed they sustained extensive injuries that were not survivable. Toxicology tests for any performance-impairing substances were negative and identified nothing that would have been contributory to the accident.

1.4 Aircraft information

ZK-ETY (the aeroplane)

1.4.1 ZK-ETY was a Cessna Aircraft Company 152 aeroplane, serial number 15285023. The aeroplane was manufactured in the United States in 1981 and imported into New Zealand shortly thereafter. It was a light aeroplane of all-metal construction, with a high wing and a fixed tricycle landing gear. It was powered by a single Lycoming O-235-L2C piston engine, serial number RL-14229-15.

1.4.2 The aeroplane was privately owned but leased to the Aero Club, which also operated 4 other aircraft of the same type. It had seating for 2 and dual controls were fitted to permit flight instruction. A pilot or student pilot would normally fly the aircraft from the left seat, as was the case on 17 February 2008.

1.4.3 The aeroplane had been issued with a standard category Certificate of Airworthiness, which was non-terminating provided the aircraft was maintained and operated in accordance with the relevant operating limitations and manuals. A review of the aircraft documents recorded it had been maintained in accordance with the approved Cessna 152 maintenance schedule.

1.4.4 In July 2007, the engine from the aeroplane was removed for overhaul, and re-installed on 27 August 2007. An engine ground run and test flight were then satisfactorily completed.

1.4.5 On 6 December 2007 the aeroplane was subjected to an annual review of airworthiness (ARA). The ARA identified no defects and the aeroplane was returned to service.

1.4.6 At the time of the accident, the aeroplane had accumulated 9779 flight hours. The most recent scheduled inspection was a 200-hour check completed on 25 January 2008. The aeroplane had 61 hours to run to the next scheduled inspection, a 100-hour check due at 9840 hours. Additional planned maintenance included an oil and filter change every 50 hours. The next change was due at 9790 hours.

1.4.7 On 9 February 2008, the aeroplane was hired for a cross-country flight to Masterton and return. One of the 2 pilots who hired the aeroplane reported that on approaching to land at Masterton they were unable to lower the electrically operated flap. The aeroplane was eventually landed and the pilots called the operator to report the problem. The pilots agreed that they would again try lowering flap before returning to Paraparaumu. This was successful and the aeroplane was flown back to Paraparaumu without incident.

[22] CAR Part 61.31 and 61.107.
[23] CAR Part 61.27.

1.4.8 Back at Paraparaumu the aeroplane was inspected but the fault could not be reproduced. The aeroplane was flown a further 5 times before the accident flight. The Commission spoke to each of the pilots who flew the aeroplane and no problems were reported with the flaps or aeroplane generally. At the time of the accident there were no reported faults with the aeroplane that may have contributed to the accident.

ZK-HGV (the helicopter)

1.4.9 ZK-HGV was a Robinson Helicopter Company R22 Beta II helicopter, serial number 3735. The helicopter was manufactured in the United States in November 2004 and imported by the helicopter operator soon after. It was a light 2-bladed helicopter powered by a single Lycoming O-360-J2A piston engine, serial number L-39701-36A.

1.4.10 The helicopter had seating for 2 and was primarily used for flight training by the helicopter operator. The helicopter was flown from the right seat and it was fitted with a second set of flight controls for an instructor sitting in the left seat.

1.4.11 The helicopter had been issued with a standard category Certificate of Airworthiness, which was non-terminating, provided the helicopter was operated and maintained in accordance with the manufacturer's instructions and operator's maintenance manual. A review of the records for the helicopter indicated it had been maintained in accordance with the prescribed documents and had accumulated 1269.3 flight hours at the time of the accident.

1.4.12 The most recent inspection, a 50-hour check, had been performed on 7 February 2008, and the helicopter had 29 hours to run to the next scheduled inspection. The most recent ARA had been completed on 4 October 2007. At the time of the accident there were no recorded or reported unserviceabilities for the helicopter that might have contributed to the accident.

1.5 Additional information

1.6 Review of mid-air collisions

1.6.1 The CAA reported that there had been 12 mid-air collisions in the previous 20 years, including the accident at Paraparaumu on 17 February 2008.[24] Six of the collisions had resulted in fatalities, with a total of 20 people killed. Six of the collisions had involved some form of formation flying or pre-planned close-proximity activity, air-to-air filming for example. All the mid-air collisions had occurred in visual meteorological conditions with the pilots operating under VFR.

1.6.2 None of the 12 mid-air collisions had occurred in controlled airspace. Five of the collisions had occured in or near an aerodrome or circuit environment. The Paraparaumu accident was the only mid-air collision to involve aircraft operating in a circuit that were not part of a formation.

1.6.3 A review of mid-air collisions in the United States by the Federal Aviation Administration (FAA) found that all mid-air collisions had occurred in visual meteorological conditions where bad weather was not considered a factor.[25] The review found that "inadequate visual lookout – failure to see and avoid" remained the most common causal factor. About 88% of pilots involved in mid-air accidents never saw the opposing aircraft in time to take evasive action. Pilot experience was not considered a safeguard, as a third of the pilots involved had more than 3000 flying hours experience.

[24] Collisions involving military aircraft not included.
[25] FAA Aviation News, Characteristics of U.S. Midairs, May/June 2001.

1.6.4 The failure to see and avoid was not strongly related to high closing speeds between converging aircraft. In most cases the closing speeds were low as one aircraft usually struck the second from the rear, from above or from a quartering angle, rather than head-on. This stemmed from most mid-air collisions occurring in areas of high traffic density, particularly near uncontrolled aerodromes. The high traffic congestion also explained why student pilots were involved in 36.5% of mid-air collisions, as they spent a significant portion of their training in the aerodrome circuit, or vacating and later rejoining. The high percentage of student involvement also suggested that "instructional pilots may be distracted with instruction and not properly monitoring the flight".

1.6.5 The above analysis was supported by data from the National Transportation Safety Board of the United States (NTSB), which showed that 77% of mid-air collisions involved arrival at, departure from or flight over an aerodrome. 61% of the midair collisions involved aircraft in the circuit.

1.6.6 Following 3 mid-air collisions at major general aviation aerodromes in Australia in early 2002, the Australian Transport Safety Bureau (ATSB) conducted a review of mid-air collisions that had occurred in the period 1961 to 2003.[26] The objectives of the review were to identify common characteristics and contributing factors, assess whether the mid-air collision rate had changed in recent years, and compare the results with other countries. The review made no safety recommendations.

1.6.7 The review identified 37 mid-air collisions involving general aviation aircraft, with an average of about one collision per year since 1968. Most (78%) mid-air collisions had occurred in or near the circuit area, reflecting the higher traffic density identified by the FAA. About 41% of the mid-air collisions had occurred at the 5 major general aviation aerodromes, but the rate had decreased since the introduction of "General Aviation Aerodrome Procedures" in 1980.

1.6.8 The ATSB review identified no dominant causal factor. Most of the collisions had involved one aircraft colliding with another from behind, or both aircraft converging from a similar direction. The review determined that the characteristics and contributing factors of mid-air collisions were similar to those observed in the United States, France and Canada.

Civil aviation procedures and rules

1.6.9 Aerodromes by their nature and purpose have a greater concentration of aircraft and therefore a higher potential for mid-air collisions. To assist in the orderly flow of traffic within an aerodrome, the CAA published standard procedures to be followed by pilots. For example, the standard aerodrome traffic circuit direction was left-hand, unless specifically stated otherwise. This meant that all turns made in the circuit area would be to the left. Also, unless stated otherwise, the downwind circuit[27] height was 1000 feet above the aerodrome. This was the case for runway 34 seal at Paraparaumu. The runway 34 grass circuit height was also 1000 feet above the aerodrome, but the circuit direction was right-hand.

1.6.10 Circuit heights both higher and lower than 1000 feet, depending on local circumstances, could be approved to assist in traffic separation or perhaps reduce local noise levels. Local Paraparaumu operators advised that until 2006 an unofficial grass circuit height of 800 feet had been used to help provide additional traffic separation. This ceased when updated noise-abatement procedures came into effect.[28] The new abatement procedures were in response to complaints from residents living near the aerodrome.

[26] ATSB Research Report B2003/0114, Review of Midair Collisions Involving General Aviation Aircraft in Australia between 1961 and 2003, May 2004.
[27] That portion of the circuit where an aircraft flies downwind parallel to the runway before turning base leg and then onto final approach to land.
[28] CAR Part 93 Subpart E, effective 31 August 2006.

Joining procedure

1.6.11 At controlled aerodromes, ATC instructions could be complemented by published arrival and departure procedures. Some uncontrolled aerodromes, for example Ardmore and Milford, also had published arrival and departure procedures. For other uncontrolled aerodromes the CAA promoted the use of a standard overhead joining procedure for pilots to follow when joining the circuit. The CAA's Aeronautical Information Publication (AIP) described the circuit and standard overhead joining procedure that should be flown at unattended aerodromes and when a pilot was unfamiliar with an aerodrome or needed to identify and fit in with circuit traffic.[29] The CAA also distributed additional material in the form of posters and articles describing the standard joining procedure and right of way (see Figure 5).[30]

1.6.12 The standard joining procedure is summarised as follows:

- Approach the aerodrome by descending or climbing to not less than 1500 feet above aerodrome elevation. If a circuit height other than 1000 feet is specified, join at not less than 500 feet above circuit height.
- Pass overhead the aerodrome in order to observe wind, circuit traffic and any ground signals displayed. Continue to circuit the aerodrome at 1500 feet until satisfied all required information has been obtained.
- Make all subsequent turns in the direction of the traffic circuit.
- Descend on the non-traffic side to circuit height.
- Turn 90º across wind and pass sufficiently close to the upwind end of the runway to ensure that aircraft taking off can pass safely underneath.
- Turn to join the downwind leg of the traffic circuit at a point that ensures adequate spacing with any aircraft in the circuit ahead or behind.

1.6.13 Broadcasts advising other traffic of location, altitude and intentions were to be made at specified points during the join. The first broadcast was to be 5 to 10 nautical miles from the aerodrome, followed by a broadcast overhead informing which runway was to be used, and finally downwind with landing intentions. This helped pilots to build a mental picture of where other aircraft were and alerted those established in the circuit to the joining aircraft's presence.

1.6.14 Alternatively, pilots could join the circuit directly into the downwind, base leg or long final provided that:

- if radiotelephone equipped, joining intentions were advised to traffic; and
- the runway-in-use and aerodrome traffic were properly ascertained; and
- priority was given to aircraft already established in the circuit or established in the standard overhead circuit joining pattern; and
- when entering or flying within the circuit, all turns were to be made in the direction appropriate to the runway-in-use.

[29] AIP New Zealand AD 1.5 Aerodrome Operations, effective 2 September 2004. (The section was updated on 14 February 2008, but contained no changes to the joining procedure.)
[30] Aerodrome Joining Procedures, CAA Vector, Issue 7, 1997. Right-of-Way at Unattended Aerodromes, CAA Vector, November/December 2006.

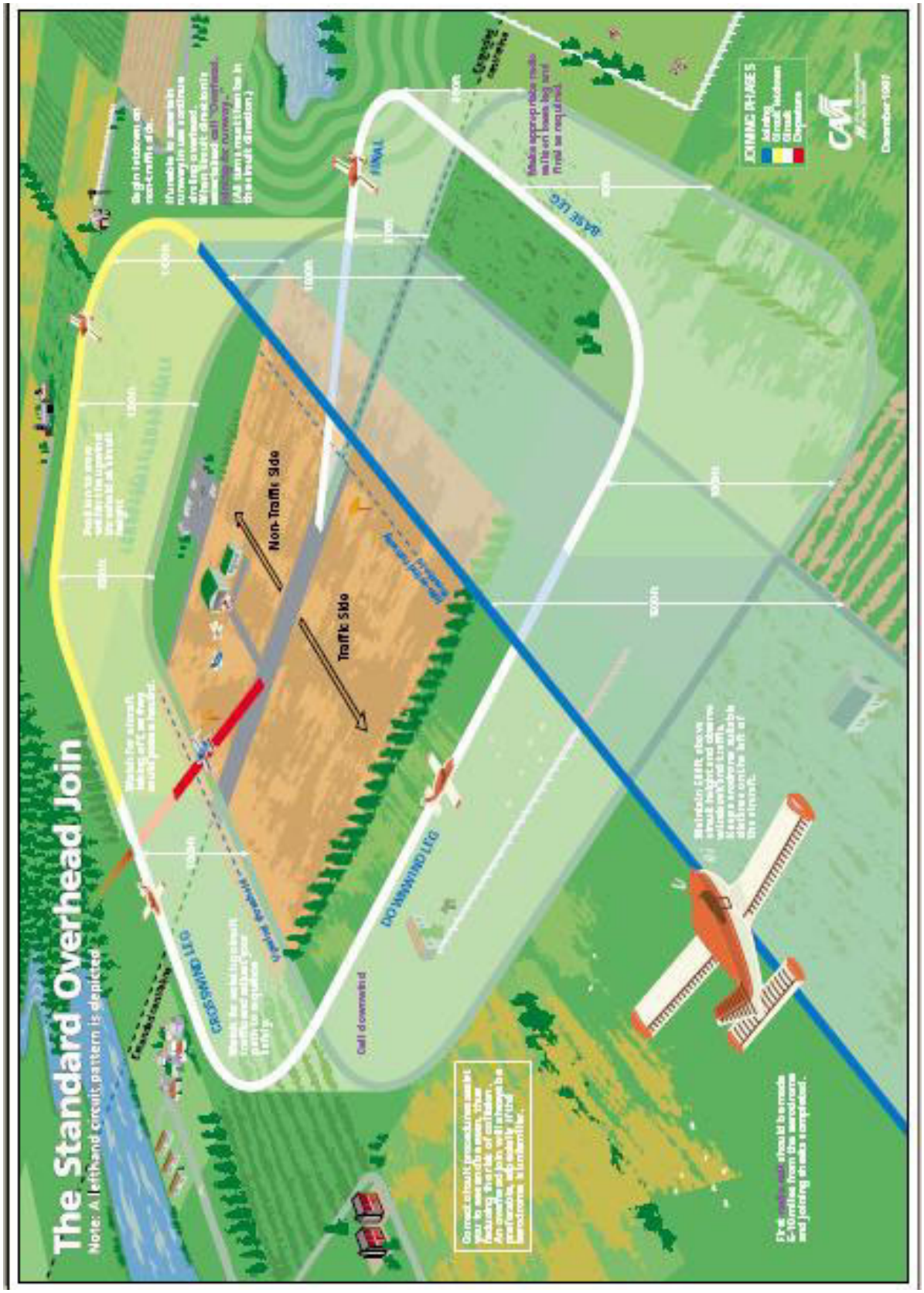


Figure 5
Standard overhead joining procedure
(Courtesy of the CAA)

(Note: The diagram is a representative model only and the actual pattern flown may vary owing to weather and aerodrome conditions, other traffic and aircraft performance.)

1.6.15 The AIP also described runway selection and in particular simultaneous circuits at unattended aerodromes.[31] The section stated that the aircraft that first formed an aerodrome traffic circuit had priority and other aircraft needed to conform to this pattern. However, CAA advised that the reference was meant to be apply to the simultaneous use of crossing runways, not for parallel runway operations such as at Paraparaumu, and it was therefore not applicable to the accident scenario.

1.6.16 In 1999, the CAA published an article in its bimonthly magazine titled "Joining Overhead?".[32] The article discussed the use of the standard overhead join at unattended aerodromes with opposite-direction circuits, and cautioned that with 2 active traffic sides, "letting down on to the active side of another circuit may create a risk of a head-on collision with an aircraft already established on the opposite-direction circuit". With specific reference to Paraparaumu Aerodrome, the article stated that joining overhead might be undesirable owing to intensive gliding operations throughout the year.

1.6.17 Other aerodromes with opposite-direction circuits mentioned in the article included Masterton, Ardmore, Dannevirke, North Shore and Wanganui. The article also stated that the helicopter circuit height was usually several hundred feet lower, "normally an adequate vertical separation".

Aircraft separation rules

1.6.18 As described above, aircraft joining an aerodrome were required to give way to aircraft already established in the circuit or joining ahead. CARs also specified additional operating and separation requirements for pilots operating on or near an aerodrome. Pilots were required to comply with published aerodrome procedures or instructions and observe other traffic for the purpose of avoiding a collision.

1.6.19 CAR *General Operating and Flight Rules* Part 91.127 detailed various rules regarding the use of aerodromes and stated among other things that no person could operate an aircraft at an aerodrome unless that person complied with any limitations and operational conditions notified by the aerodrome operator. Also, no pilot could operate an aircraft in an aerodrome traffic circuit unless it could be manoeuvred clear of any obstacle, and did not conflict with the aerodrome traffic circuit or instrument approach procedure of any other aerodrome.

1.6.20 While the latter part of the last sentence might concern conflict with the traffic circuit and instrument approach procedures of other aerodromes, CAR 91.223 stated that pilots must observe other aerodrome traffic for the purpose of avoiding a collision.[33] It further stated that a pilot was to conform with or avoid the aerodrome traffic circuit formed by other aircraft. It also directed pilots to perform the published left-hand or right-hand circuit.

1.6.21 CAR Part 91.227 stated that no pilot should operate an aircraft so close to another aircraft as to create a collision hazard.

1.6.22 CAR 91.229 described "right of way rules" for pilots to adhere to. Rules that could be applicable to the circumstances of the accident are summarised as follows:

- Pilots, when weather conditions permit, shall maintain a visual lookout so as to see and avoid other aircraft.

- Pilot of an aircraft that has right of way, shall maintain heading and speed, but shall not be relieved from the responsibility of taking such action that will best avert collision.

[31] AIP New Zealand AD1.5, section 3.1.4, effective 14 February 2008.
[32] Joining Overhead?, CAA Vector, Issue 5, July/August 1999.
[33] CAR 91.223 Operating on and in vicinity of an aerodrome, effective 22 November 2007.

- Pilot of an aircraft that is obliged to give way to another aircraft, shall avoid passing over, under, or in front of the other aircraft, unless passing well clear of the aircraft, taking into account the effect of wake turbulence.

- The pilot of an aircraft that is converging at about the same altitude with another power driven heavier-than-air aircraft that is to its right, shall give way.[34]

Non-certificated aerodromes and emergency rules

1.6.23 The CAA and Ministry of Transport confirmed that the Director of Civil Aviation, and in turn the staff of the CAA, were limited in their participation in activities on non-certificated aerodromes. Safe aviation practices were actively promoted through visits by CAA aviation safety advisers. Otherwise local procedures were prescribed through the development of CARs. The CAA was responsible for drafting any proposed rules for approval by the Minister of Transport.

1.6.24 The Ministry advised that in relation to VFR activity at uncontrolled aerodromes, there was no general authority for the Director of Civil Aviation to prescribe procedures. The Director did have powers to determine circuit direction (CAR 93.353) and under CAR Part 91 operating rules for operations on or in the vicinity of aerodromes.

1.6.25 CAR Part 93, Special Aerodrome Traffic Rules and Noise Abatement Procedures, provided for additional rules or exceptions. These rules were promulgated by the ordinary rule-making procedure under section 28 of the Civil Aviation Act 1990. They therefore resulted from the rule-making powers of the Minister of Transport, not the Director of Civil Aviation. The noise-abatement procedures for Paraparaumu were an example.

1.6.26 The Ministry advised that the Civil Aviation Act 1990[35] permitted the Director to enact emergency rules where it was considered "necessary to alleviate or minimise any risk of the death of or a serious injury to any person, or of damage to any property". However, the Act prevented the making of emergency rules "unless it is impracticable in the circumstances of the particular case for the Minister to make ordinary rules".

1.6.27 In summary the Ministry commented that "the Minister has the power to make ordinary rules which could apply to uncontrolled aerodromes. The Director does not appear to have the power to impose particular procedures at uncontrolled aerodromes".

See and avoid

1.6.28 "See and avoid" is the primary means by which pilots operating under VFR maintain a safe operating distance from other aircraft and hazards. It is also currently the final defence against a mid-air collision for any aircraft operating in visual meteorological conditions. A pilot must of course first see the potentially conflicting traffic in sufficient time to take avoiding action.

1.6.29 The sighting of other aircraft requires an effective visual scan outside the cockpit, supported by good radiotelephone use. This helps pilots build a mental picture of their surroundings and is a part of what is often referred to as good situational awareness. Radio calls alert other pilots to the presence of aircraft and by transmitting a position and intentions can enable a pilot to determine the potential for conflict. A pilot's lookout scan should also be directed towards the other aircraft's reported position to determine whether there is any possibility of conflict.

[34] CAR 91.229, effective 22 November 2007.
[35] Civil Aviation Act 1990, section 31, Power of Director to make emergency rules.

1.6.30 However, the "see and avoid" principle is not infallible, as shown by the statistic that in the majority of mid-air collisions pilots never saw the conflicting aircraft. The following paragraphs summarise some of the numerous articles on the limitations of "see and avoid". The articles referred to are listed in the footnote below.[36]

1.6.31 For pilots to see other traffic, they need to be looking outside the aircraft. However, the amount of time spent looking for other aircraft will reflect the assumed priority given by the pilot and can be dependent upon workload. The aerodrome circuit is an area of increased traffic density and therefore of increased threat. It is also an area of high workload, so a pilot's systematic scan can be disrupted by essential tasks, for example checking engine gauges and the aircraft position relative to the runway, and making a switch selection. The amount of time spent completing these routine tasks will be reduced as a pilot gains experience and confidence.

1.6.32 A human's field of vision is about 190º, but this starts to contract after about age 35. The quality of vision varies across the visual field and is best in the centre, covering an arc of about 2º. Hence the need for pilots to scan across the horizon to increase detection probability. However, when scanning for an object, the eye jumps from one focal point to another in a series of fixations called "saccades". This can cause gaps in the visual field, particularly at longer distances.

1.6.33 Another gap in the visual field is the "blind spot". An opposing aircraft can be hidden behind aircraft obstructions, for example a door frame or wing. The pilot therefore has to move their head around as much as possible to increase the field of view and look around any obstructions. A second type of blind spot is where the optic nerve exits the eyeball and is generally compensated for by binocular vision – the use of 2 eyes. However, when the field of vision is obstructed by some means, for example a cockpit window or door frame, any small object can remain hidden from view in the other eye's blind spot (see Figure 6).

1.6.34 As a pilot scans the horizon trying to locate another aircraft, without a visual cue the eye will automatically focus at a relatively short distance, about 56 cm. The effect is called "empty field myopia" and reduces the chances of identifying a distant object. This can be compounded by a dirty windscreen, where a pilot's focus may automatically drop to an insect on the windscreen and an aircraft in the distance becomes blurred and invisible.

1.6.35 An object can also be too small to be seen – it is below the eye's visual acuity level. Studies involving aircraft identification determined that an object must cover about 12 minutes of arc, 0.2º, to be reasonably recognised as another aircraft.[37]

1.6.36 Another challenge for a pilot in locating a conflicting aircraft can be its general conspicuity; that is its contrast with the environment or background, and includes aircraft size and colour. The size and profile of an aircraft are relevant and will be less when it is approaching directly towards a pilot than if it were side-on or turning at an oblique angle. The contrast between the colour of an aircraft and its background may vary owing to atmospheric effects, for example the angle of the sun, haze, broken light or shadows. The terrain behind an aircraft, for example changes in vegetation or hills, can also act to camouflage an aircraft in some conditions.

[36] FAA Advisory Circular 90-48C, Pilots' Role In Collision Avoidance, 18 March 1983.
ATSB Research Report, Limitations of the See-and Avoid Principle, 1 April 1991.
Aviation, Space, and Environmental Medicine Vol 75, No 4, Midair Collisions: Limitations of the See-and-Avoid Concept in Civil Aviation, April 2005.
ISASI Forum, The Physical Limitations of the "See and Avoid" Concept for Separation of Air Traffic, Captain Peter T. Popp, U.S Air Force, September 1995.

[37] NTSB 1993.

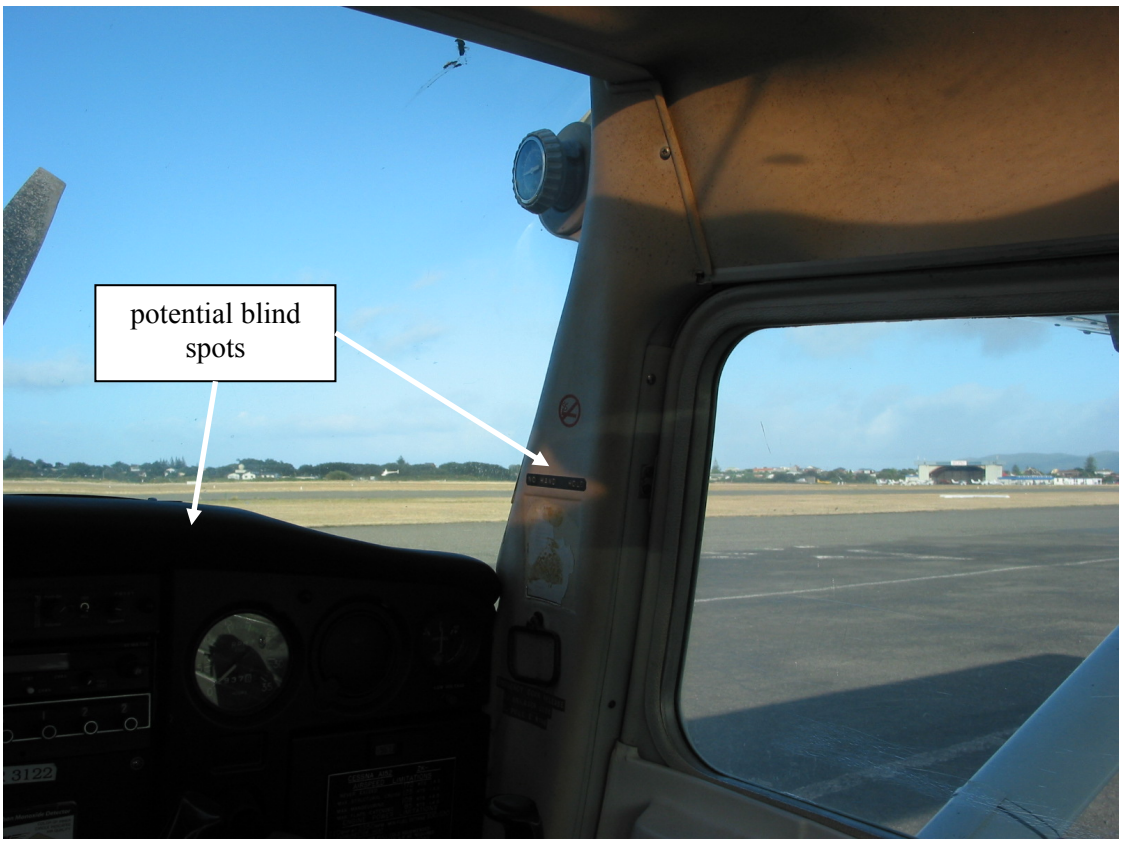


Figure 6
Cessna 152 blind spots

1.6.37 Following the accident a partial reconstruction of the flight paths of the 2 aircraft was flown to determine the conspicuity of the 2 aircraft. The reconstruction used the same types of aircraft and was flown at about the same time of day, with similar weather conditions and the sun on about the same bearing from the 2 aircraft. For additional safety, a positive vertical separation between the 2 aircraft was added and an early break-away briefed. The only other significant difference was that the R22 helicopter had a white paint scheme, unlike the red of ZK-HGV.

1.6.38 The partial reconstruction confirmed the challenges in sighting the opposing aircraft at distances greater than about 2 km to 3 km apart – despite knowing the general location of the other aircraft. The local terrain, especially the hills to the south of the aerodrome, added to the difficulty in locating the opposing aircraft. The different paint scheme made little difference in sighting the R22, with the darkness of the cabin dominating the visible profile of the helicopter. Cameras on board both aircraft recorded the flights and views from each aircraft (see Figures 7 and 8).

1.6.39 The human eye is better at detecting contrast and movement. An aircraft that is on a steady collision course will maintain a constant relative bearing and therefore not appear to move in the pilot's field of vision. Although getting progressively bigger, the lack of relative movement of a closing aircraft can fail to attract a pilot's attention sufficiently early for the pilot to initiate a response.

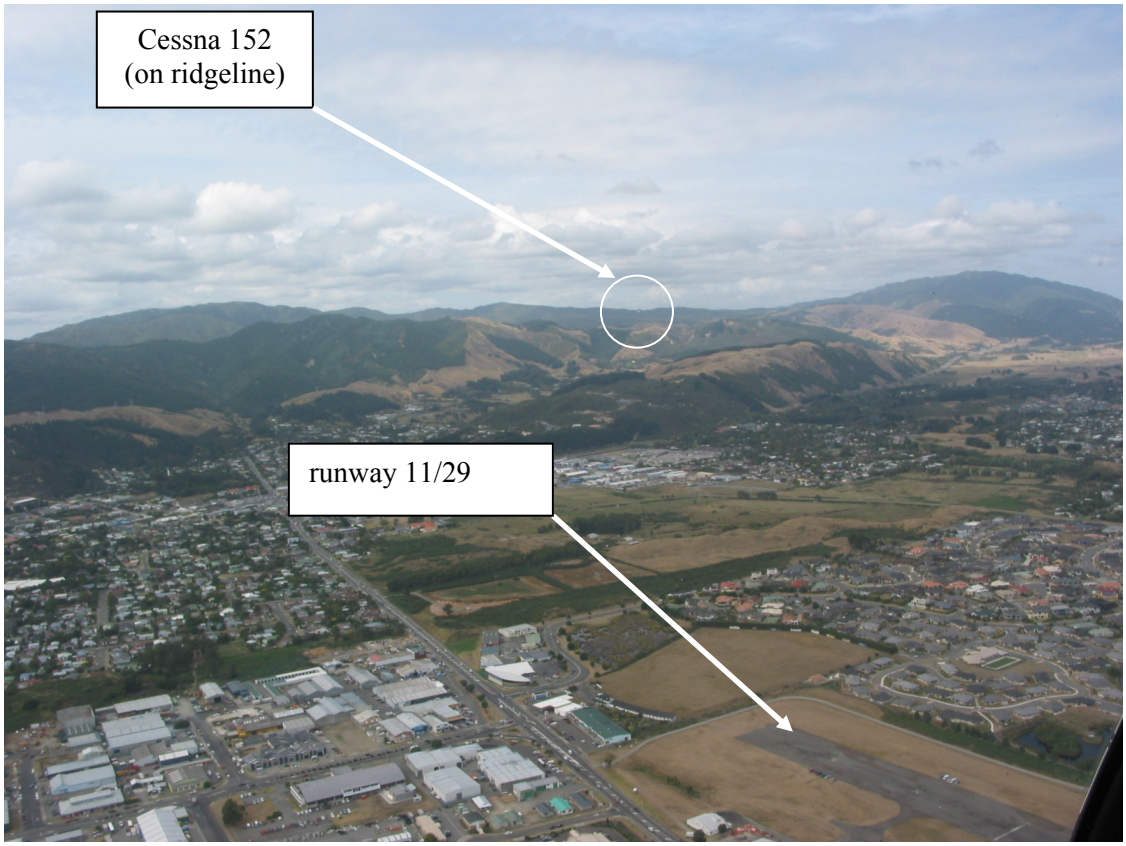


Figure 7
View from Robinson R22 looking south

Figure 8
View from Cessna 152 looking north

1.6.40 Once an object has been detected, a pilot needs to identify the object, determine if it is a threat and initiate avoiding action if required. Research has determined that the time required for a pilot to recognise an approaching aircraft and take evasive action is 12.5 seconds. The time commenced once an object had been detected and was broken down as follows:

Reaction Table	Specific Time	Cumulative Time
See object	0.1 seconds	0.1 seconds
Recognise aircraft	1.0 seconds	1.1 seconds
Recognise collision likely	5.0 seconds	6.1 seconds

1.6.41 The reaction time may also increase for older pilots, those with less than optimal vision, and less experienced pilots who have to complete each step consciously in the see and avoid process.

1.6.42 Using a closing speed of 200 knots, a pilot would need to see an opposing aircraft when it was nearly 1300 m away to ensure action was taken in sufficient time to avoid a collision. A Cessna C152 and a Robinson R22 were calculated to subtend an angle of less than 0.5º at this distance.

1.6.43 In 2006, the CAA published an article in its bimonthly magazine titled "See and Be Seen, How to avoid a mid-air collision".[38] The article discussed the challenges of see and avoid, and the benefits of an effective scan. It gave 2 examples of scanning techniques that could be employed. The summary included the following points:

- Keep the windscreen, windows and coaming clean and clear of obstructions.
- When cleaning windows, wipe in a vertical motion to reduce false horizons.
- Minimize head down time by having charts folded properly.
- Navigational lights and anti-collision beacons should be used at all times.
- Make accurate position reports and listen to other position reports to paint a situational picture.
- Scan constantly – 90% outside the aircraft, 10% inside the aircraft.

The magazine was issued free to all civil aviation document holders, including pilots and engineers, and organisations such as flying schools and aero clubs.

[38] CAA Vector magazine, November/December 2006.

Pilot licensing

1.6.44 Following the accident, questions were raised by some media about the age of the pilots involved in the accident, and comparisons made with New Zealand motor vehicle statistics. The following 10 paragraphs provide a summary of information on driver and pilot licensing.

1.6.45 The International Civil Aviation Organization (ICAO) set international standards and recommended practices for civil aviation activities, including pilot licensing.[39] No age limit was set for student pilots other than they were to be supervised by authorised flight instructors. Private pilot licence holders were not to be less than 17 years of age, commercial pilots 18 years, and airline transport pilots 21 years.

1.6.46 States were permitted to set their own standards, but any variation to the international standard was to be recorded by ICAO. The majority of countries, including New Zealand, Australia, Canada and the joint European group, which included the United Kingdom, France and Germany, complied with ICAO pilot licensing standards. The United States also complied with the standards except a minimum age of 23 years was required for the issue of an airline pilot licence. These countries also set an age limit of between 14 years and 16 years for student pilots, depending on the activity being undertaken.[40]

Accident statistics

1.6.47 In a review of motor vehicle accident statistics for New Zealand in 2006, the Ministry of Transport found young drivers (those aged 15 to 24) were involved in a statistically high percentage of road accidents, and were considered to be at fault in over 76% of those accidents.[41] In comparing age group and gender, male drivers aged 15 to 19 were approximately 7 times more likely to have an accident (per 100 million kilometres driven) than male drivers aged 45 to 49. By comparison, young female drivers were 6 times more likely to have an accident than the older age group.

1.6.48 Drivers aged 15 to 19 made up 7% of the licensed car drivers[42], but accounted for 155 of all minor injury accidents, 15% of all serious injury accidents and 14% of drivers involved in fatal accidents. Similar statistics applied to drivers aged 20 to 24, making up 9% of licence holders but accounting for between 12% and 14% of minor injury, serious injury and fatal accidents.

1.6.49 The review found that alcohol, drugs and speed were the major contributing factors for drivers involved in fatal accidents. Among drivers aged 15 to 24, 43% of fatal accidents involved driving too fast for the conditions. Alcohol or drugs were implicated in 31% of fatal accidents and loss of control was 25%. Inattention or attention diverted, inexperience and failing to keep left were each cited in 12% of fatal accidents. Subsequent monthly overviews of statistics produced similar results.

1.6.50 In a report prepared for the Automobile Association of America in June 2006, researchers determined that "young drivers, particularly 16 and 17-year olds, have been a significant road safety and health concern for decades in Canada and the United States because of their high risk of collision involvement".[43] The report grouped the causal factors into 2 categories: firstly, age-related factors, such as exuberance, risk-taking behaviour, peer pressure and sensation and thrill seeking; and secondly, experience-related factors such as psychomotor skills, perception of hazards, judgement and decision-making.

[39] ICAO Annex 1, Personnel Licensing, Tenth Edition, effective July 2006.
[40] The United States set a minimum age of 14 years for glider and balloon student pilots, and 16 years for powered aircraft student pilots.
[41] Ministry of Transport Crash Fact Sheet 2007 – Young Drivers, Crash Statistics For The Year Ended 31 December 2006.
[42] Including full, restricted and learner licenses.

1.6.51 The report found that graduated driver licensing systems helped to reduce collisions involving young drivers. Driver restrictions, such as no passengers were effective, but such restrictions needed to be better targeted and complemented by stronger education and higher entry ages. The report found that collision-involved teens were more likely to:

- have important skill deficiencies (for example, anticipating hazards),
- commit unintentional driving errors (for example, missing a stop sign),
- have a lower degree of safety mindedness (for example adjusting speed for the conditions),
- commit road code and aggressive violations,
- have more tickets and convictions,
- engage in risky behaviour (for example, using a cell phone while driving), and
- engage in health-compromising behaviours (for example, smoking and drinking alcohol).

1.6.52 The role of age and flight experience as factors in aviation accidents, particularly in New Zealand, has been researched by Professor David O'Hare, Department of Psychology, University of Otago. In an article titled "Safety is more than Accident Prevention: Risk Factors for Crashes and Injuries in General Aviation"[44], O'Hare refers to a study by C.F. Booze that "reported a clear increase in accident risk as a function of age with the older age groups 4 times more likely to be involved in accidents than the younger age groups".[45] While questions were raised about the validity of the statement, the United Kingdom Civil Aviation Authority identified "an over-involvement of older pilots (age 37+) in a series of general aviation accidents in 1987".

1.6.53 In 2005, the CAA conducted a review of aeroplane accidents that had occurred in New Zealand between 1995 and 2004.[46] The review found that pilots with between 200 and 2000 flight hours were more likely to have accidents than other pilots, with the most common type of fatal or serious injury accident being uncontrolled flight into terrain. This was followed by controlled flight into terrain.

1.6.54 The review determined in part that:

> The data showed that the risk of a pilot being involved in an accident increased with age, with the highest risk occurring in the 55 to 64 age bracket. Those pilots who gained their licence at an older age were more likely to be involved in an accident than those who gained their licence at a younger age. The longer the pilot had held their licence the less chance they had of having an accident.
>
> Pilots who blatantly disregard the rules (regardless of experience and age) present the greatest risk for having a fatal accident.

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[43] Reducing the Crash Risk for Young Drivers, prepared for Automobile Association of America by Traffic Injury Research Foundation, June 2006.
[44] Human performance in general aviation, Aldershot: Ashgate (1999)
[45] Booze, C.F. (1977). Epidemiologic investigation of occupation, age, and exposure in general aviation accidents. *Aviation, Space, and Environmental Medicine, 48,* 1081 – 1091.
[46] New Zealand Fixed Wing Aviation Accidents, A review of all reported New Zealand registered aeroplane accidents from 1995 to 2004, prepared by Anthony Wackrow, CAA, 2005.

Organisational information

Kapiti Districts Aero Club

1.6.55 Kapiti Districts Aero Club was formed in 1983 and was a member of the Royal New Zealand Aero Club. The Club had a membership of 270 as at 1 January 2008.

1.6.56 The Club had 2 distinct arms or operations. Firstly the Aero Club side was based on the traditional objectives of supporting recreational flying, pilot training and some commercial operations. The Club instructors carried out a range of instructional duties ranging from ab-initio flying training to commercial pilot training on aeroplanes. Instrument and multi-engine ratings were also conducted as well as biennial flight reviews for current licence holders. The Club held an air operators certificate and conducted some air transport CAR Part 135 operations including aerial photography, charter and scenic flights.[47]

1.6.57 The second arm was the Kapiti Air Academy, formed in 2002 and accredited by the New Zealand Qualifications Authority. The Academy offered one-year, full-time courses for training pilots to commercial licence standard. Follow-on courses were available for multi-engine instrument rating and category C instructor qualification.

1.6.58 To support both operations the Club had 8 full-time flying instructors, including 4 category B and 2 category C instructors. One of the category B instructors was the operations manager and chief flying instructor. Helicopter training was undertaken by a category B helicopter flying instructor. The Club had 5 part-time instructors, comprising 2 category C instructors, 2 category B instructors and one category A flying instructor. The category A instructor was an approved flight examiner.

1.6.59 Discussions with the Club's management and full-time instructors confirmed that student pilots were taught to fly the standard overhead joining procedure when returning to the aerodrome. The procedure was part of the CAA's syllabus of training for private pilot licence applicants and students needed to be competent in flying it.[48] The management and instructors also advised that students were briefed on the local hazards associated with joining and operating in the circuit, including the opposing circuit direction used by helicopters and the often non-standard rejoins flown by gliders, and the need to give way to other traffic. Discussions with several students supported the above comments. During the investigation some 12 pilots from the aeroplane operator, including flying instructors and students, were interviewed.

HELiPRO (Paraparaumu)

1.6.60 The HELiPRO Paraparaumu operation, located on the opposite side of the aerodrome to the aeroplane operator, was created in 2005 when the parent company purchased a local aeroplane training company that had been operating at Paraparaumu since 1976. The purchase enabled the operator to conduct combined helicopter and aeroplane training from the same facility on the aerodrome. A local "base manager" oversaw Paraparaumu operations for the parent company.

1.6.61 The helicopter operator performed flight training up to and including commercial and instructor standard for both helicopter and aeroplane. Specialist training was also performed and included such exercises as single- and multi-engine instrument ratings, sling loading, winching and fire-fighting. To facilitate the training 15 aeroplanes and 4 helicopters, including C152 and R22 types of aircraft, were based at Paraparaumu. Some commercial aeroplane and helicopter flights were also performed.

[47] CAR Part 135 Air Transport Operations – Helicopters and Small Aeroplanes.
[48] CAA Advisory Circular AC61-3, Revision 8, effective 9 May 2007 and CAA Flight Test Standards Guide Private Pilot Licence Issue, effective May 2006.

1.6.62 At the time of the accident there were 2 helicopter instructors on staff, comprising one category B instructor and one category C instructor. There were also 10 aeroplane instructors, comprising 5 category B instructors and 5 category C instructors. The helicopter operator had a contract with Flight Testing New Zealand to provide flight test examiners for licence renewals and non-professional licences. A second external organisation provided examiners for professional licence applicants.

1.6.63 The helicopter operator held CAA certification for Part 141 (Aviation Training Organisation) and Part 135 (Air Operations – Helicopters and Small Aeroplanes) operations. The operator was also accredited by the New Zealand Qualifications Authority.

1.6.64 Discussions with the helicopter operator's management, instructors and students confirmed all were aware of the challenges associated with aeroplanes, helicopters and gliders operating on the aerodrome, and in particular the parallel runway operation. Concern was expressed at the lapse in regular or semi-regular aerodrome user meetings, which had been replaced by irregular one-on-one operator meetings – typically between respective chief flying instructors. During the investigation, some 16 aeroplane and helicopter pilots from the helicopter operator, including instructors and students, were interviewed.

Aerodrome developments

1.6.65 At the time of writing the report, the Commission became aware that an airline planned to commence scheduled air transport operations at Paraparaumu, possibly late 2009, using aircraft with a seating capacity of greater than 30 passengers. This would require the aerodrome to become certificated. Future development plans for the aerodrome included the decommissioning of cross-runways 11/29, with the exception of a short emergency runway.

2 Analysis

2.1 The accident involved 2 aircraft operating under VFR, and undertaking a normal training flight and a check flight, with the pilots following standard procedures at the time of the collision. The pilots in the helicopter were operating in an established right-hand grass runway circuit. The pilot of the aeroplane was flying a well recognised and recommended joining procedure for the parallel left-hand sealed runway circuit. However, because the grass circuit was being used, there was no non-traffic side as would normally be the case at most aerodromes around New Zealand. This was where the collision occurred.

2.2 The weather was suitable for the flights, with the visibility sufficiently good that it would not have obscured the aircraft as they flew about the aerodrome. The sun was also high enough that it should not have impaired the vision of the pilots and their ability to sight each other.

2.3 The 2 aircraft were determined to be serviceable with no evidence of any fault leading up to the accident. All 3 pilots were in good health and fatigue was not considered a factor.

2.4 The 2 aircraft collided at 90º to each other at 1000 feet above the aerodrome. The collision occurred as the aeroplane was turning left to cross the upwind end of the runways and join the downwind leg for the sealed runway, and the helicopter was midway along a close downwind leg for the grass runway. The engine of the aeroplane struck the helicopter in line with its main rotor blades. One blade struck and immediately removed the engine's exhaust, with the engine also breaking away from its mountings and falling through the roof of a house. The second blade then struck the fuselage of the aeroplane. Both main rotor blades immediately separated from the mast as they struck the aeroplane. The high revving sound heard by some witnesses was likely to have been the helicopter engine over-speeding once the main rotor blades had detached.

2.5 The aeroplane flaps were found in the fully retracted position, in contradiction to the flap position lever which was set to 10º. The flaps were physically jammed and unlikely to have moved during the accident sequence. By contrast, the flap lever was loose and may have been knocked or more likely pulled partially down as the engine separated and the engine and flight controls became distorted. The flaps would normally not be lowered until late downwind or around base turn.

2.6 The location of Paraparaumu Aerodrome, near a large metropolitan population and on a major transit route for aircraft flying north and south, meant that it became a centre for a wide range of aircraft undertaking an equally wide range of flying tasks. Microlight and home-built aircraft, flight training aeroplanes and helicopters, private and commercial aeroplanes, helicopters and gliders all used the aerodrome either as a transit stop or as a base for their flying activities. Pilots needed to be aware of the differences in performance capabilities and requirements for the various types to ensure adequate separation was maintained at all times.

2.7 Larger or faster aircraft flew larger circuit patterns when compared with small aeroplanes and helicopters. Powered aircraft were able to follow established tracks or procedures, while glider pilots needed to be more flexible in the selection of their flight paths. Gliders required a tow to get airborne and could therefore occupy a runway for a longer period of time while they were hooked up and towed airborne. When returning to the aerodrome from the hills to the east, glider pilots often approached the runway from many directions, depending on their height and lift available. They were also constrained to a continuous descent path and that meant their flight paths could be less predictable for other pilots. After landing, a glider needed to be moved clear of the landing vector and could again occupy a runway or adjacent area for a greater period of time compared with powered aircraft.

2.8 The establishment of the parallel grass runways was one means of separating 2 significantly different types of circuit traffic – powered and non-powered. Powered aircraft were able to undertake circuit training without being delayed while a glider was manoeuvred clear of the runway. Glider pilots were able to join downwind, or on base leg if getting low, without having to cross in front of powered aircraft on final approach. While the flying activity had reduced over the years, the arrival of semi-intensive helicopter training added to the mix of operations and variations to the types of circuit, rejoin and landing that were flown.

2.9 Despite the establishment of parallel runway operations, near misses continued to occur. Most of these involved the release of weather balloons that floated up past aircraft flying overhead the aerodrome. However, improved communications and general awareness of the scheduled balloon release times had resulted in a significant decrease in this type of incident. Other near misses, as was typical for parallel runway operations, involved aircraft crossing or closing with the approach path for the adjacent runway as they turned onto final approach. The note on the landing chart regarding simultaneous operations should have alerted pilots to be aware of aircraft in the adjacent circuit and to sequence with them as they turned base leg and on to final approach. Of direct relevance to this accident was the reported near miss between a helicopter and an aircraft flying an overhead rejoin in 2007. This incident was, however, not reported to the CAA until after the accident and was therefore of little benefit in initiating any action that might have helped to prevent a mid-air collision.

2.10 The potential for a mid-air collision was clearly identified in a CAA safety assessment report completed in 1996. The assessment focused on conflict between powered aircraft and gliders, and the lack of a “non-traffic side”. While the decrease in glider operations may have eased the situation, the arrival of more intensive helicopter training meant that the airspace above the aerodrome became more congested. It was, nevertheless, appropriate that the helicopters utilise the grass runway circuit. The helicopters, with their slower speed, rapid changes in height when flying autorotations, and the need to use the grassed area for hovering exercises, were incompatible with the aeroplane circuit.

2.11 That no formal changes to the circuit and joining procedure were made as recommended in the 1996 safety assessment meant that the potential for a mid-air collision continued unmitigated, and likely increased with the basing of a helicopter training organisation. The unofficial use of an 800-foot circuit height for the grass runway was an attempt by the local operators to provide additional separation between the grass and sealed circuits. However, the unofficial or ad hoc nature of the local procedure had the potential in some circumstances to increase the risk of a collision, for example when itinerant aircraft joined overhead the aerodrome unaware of the different circuit heights. The lower circuit height also generated increased complaints about aircraft noise levels, so in 2006 the Minister of Transport prescribed additional noise abatement procedures through CARs. Further, the non-approved and non-standard circuit height of 800 feet was discontinued and the circuit height returned to the standard 1000 feet.

2.12 Why dedicated recommended or preferred joining procedures were not developed for Paraparaumu, either following the 1996 safety review or when the amended noise-abatement procedures were promulgated in 2006, could not be identified because of the lack of relevant documentation and change in staff in the following years. The CAA advised that the current processes, particularly its document management system, were more robust and provided an electronic document trail from the recommendations made in any aeronautical study through to the outcome of the Director's consideration of the recommendations and to tracking of subsequent actions. However, despite this assurance, many of the parties directly involved in the accident expressed dismay at the previous lack of action by the CAA in addressing an obvious safety issue.

2.13 Paraparaumu Aerodrome, while a busy aerodrome at times, did not warrant the continuing presence and cost of ATC or an aerodrome flight service. While there was a mix of aircraft types, as was typical for many unattended aerodromes around New Zealand, there was no medium or heavy VFR or IFR traffic that required additional coordination with circuit traffic or ATC. That the reported incidence of near misses continued to occur at about the same rate after the AFIS was disestablished showed that an ATC or AFIS presence was no guarantee of preventing mid-air accidents. But with no external control or oversight, operators and pilots needed to take a greater role in managing their separation from other aircraft and ensuring a safe and orderly flow of traffic around the circuits.

2.14 One advantage in having an air traffic service at Paraparaumu Aerodrome was that an organisation independent of the aerodrome owner and users present to monitor aerodrome operations and to feed information directly to the regulator – the CAA. With the disestablishment of the AFIS and the aerodrome becoming non-certificated, aerodrome-specific regulatory requirements under the civil aviation rules ceased to apply to the aerodrome owner. However, obligations arising from non-aerodrome-specific legislation, such as the Health and Safety in Employment Act 1992, continued to apply. This required the aerodrome owner, for example, to take all practical steps to ensure that people operating within, or visiting the aerodrome, were not exposed to harm, This could have included the coordinated development of procedures for the safe operation of aircraft using the aerodrome.

2.15 While CAA aviation safety staff still participated to some degree, the gradual decline in organised and regular user meetings showed that aerodrome operations had become less coordinated. The aerodrome operator through its aerodrome manager should have taken a leading role in ensuring the effective safe management of aerodrome operations, regular user meetings being one possible means of coordinating activities and addressing safety concerns. The Director, through his aviation safety advisers and others, also needed to have a greater level of interaction with aerodrome and aircraft operators, thereby helping achieve a CAA objective of directing safety efforts where they are needed most but noting its limitations as the regulator. A safety recommendation is made to this effect.

2.16 The establishment of the MBZ and adherence to its associated procedures should have helped pilots gain a better awareness of traffic in the area and alert them to potential conflict. The evidence indicted that it was virtually certain both aircraft had their anti-collision lights on as required by the MBZ procedures. The pilots of both aircraft also followed standard radiotelephone procedures and made their radio calls at the required locations and transmitted the required information. The radio calls were clear and should have been able to be heard by anyone listening on the same frequency.

2.17 At 1110:10 when the helicopter pilot transmitted "rolling grass 34, extending upwind leg", the aeroplane would still have been to the north of the aerodrome positioning on the western side of runway 34. The aeroplane pilot may not necessarily have been able to see the helicopter, but the call should have alerted him that there was a helicopter operating in the grass circuit and it posed a potential conflict somewhere to the east of the runway as the 2 aircraft crossed paths. He therefore needed to locate the helicopter and plan his rejoin around it.

2.18 The next call at 1111:20 by the aeroplane pilot reporting "overhead the field 1500 feet, commencing standard overhead rejoin 34 seal", occurred as the helicopter was early into its crosswind turn. From the radar recordings, the helicopter pilot and flight examiner would not have been able to see the aeroplane as it would have been behind them at this time. Nevertheless, the call should have alerted the 2 pilots that there was now an aeroplane descending to 1000 feet somewhere on the eastern side of the runways, and in an area they would shortly be entering.

2.19 The last radio call at 1111:58 by the helicopter pilot reported they were "close downwind grass 34, practise 180 autorotation to the centre grass 1000 feet". The 2 aircraft would have been less than one kilometre apart with the helicopter almost directly ahead of the aeroplane. This call put the helicopter at the altitude to which the aeroplane was descending and in the same area. This call should have again alerted the aeroplane pilot that there was now a helicopter in close proximity that he needed to promptly locate and avoid.

2.20 The 3 pilots were all familiar with Paraparaumu Aerodrome and the parallel runway operation. The pilots in the helicopter should have understood what was meant by a standard overhead rejoin and the general flight path an aeroplane would have followed when flying the procedure to runway 34 seal. Equally the aeroplane pilot should have understood what was meant by an autorotation, as this was taught to local students early in their training. He should certainly have known where the helicopter was when the helicopter pilot transmitted that the helicopter was "close downwind grass 34…1000 feet".

2.21 That the pilots of each aircraft did not respond to the other's calls, by either challenging them over the radio or manoeuvring their aircraft away, suggests that they were focused primarily on flying their aircraft. This may have been due to fixation on their respective tasks, task overload, or a combination of both.

2.22 The aeroplane pilot was the least experienced of the 3 pilots and would have been concentrating on flying the rejoin procedure as accurately as possible. This was shown by the radar plot, which confirmed the aeroplane pilot had followed the standard joining pattern, and had commenced his initial descent from 1500 feet once on the "non-traffic side" for the sealed runway. In the few seconds leading up to the collision he would have been concentrating on levelling the aircraft at 1000 feet and possibly adjusting his power settings. His attention may also have been drawn by the radio calls from the other aeroplanes, including the aeroplane about to join at the start of the downwind leg for the same runway and the need to ensure separation from that aircraft and position most likely behind it.

2.23 The helicopter pilot was flying a check flight and would have been under pressure to fly the helicopter as competently and accurately as possible. The 180º autorotation was a demanding exercise that needed to be accurately flown and he would have been focusing on positioning the helicopter for this manoeuvre when the aeroplane pilot called overhead. The radar plot showed that the helicopter was being manoeuvred closer to the grass runway as the 2 aircraft approached each other. Therefore, the helicopter pilot seated in the right seat would very likely have been looking down to his right, towards the landing area and away from the aeroplane as it approached from the forward left of the helicopter.

2.24 The flight examiner was the most experienced of the 3 pilots and was not flying the helicopter at the time of the accident. He was therefore potentially the person best able to establish an accurate mental picture of the situation and recognise early that the 2 aircraft were going to conflict. As the 2 aircraft converged it is likely that he would have been looking to his right across the cabin and away from the aeroplane, monitoring the helicopter pilot and deciding when he could safely close the throttle and initiate the 180º autorotation.

2.25 The separation rules that applied to this accident directed that the joining aircraft, the aeroplane, was to give way to aircraft joining ahead or established in the circuit. This would normally mean the same circuit for which an aircraft was joining. However, local pilots were aware that as the joining aircraft they needed to be aware of and give way to all circuit traffic operating of both the sealed and grass runways. The aeroplane pilot very likely had the same understanding.

2.26 While there were other aircraft in the sealed runway circuit, at the time of the accident the helicopter was the only aircraft in the grass circuit and consequently had the right of way for that circuit. Therefore, the helicopter pilots may have relaxed their lookout scan and assumed that provided they made the required radio calls there was no need to maintain a full lookout. Nevertheless, both pilots had a responsibility to ensure the safe operation of the helicopter, and by inference monitor other traffic.

2.27 Not withstanding the requirement to give way to aircraft already established in a circuit pattern, all pilots were required to maintain a visual lookout so as to see and avoid other aircraft. Further, regardless of having the right of way, a pilot was responsible of taking such action as to be able to avoid a collision. This of course required a pilot to be able to see the conflicting aircraft first.

2.28 Using the formula that an object needed to cover at least 0.2º of arc before it could be recognisable as an aircraft, the aeroplane, with a wing span of 33 feet (10 m), could have been detectable at a distance of about 3.1 km. For the helicopter, with a rotor diameter of 22 feet (7 m), detection range would have been about 2.1 km. However, in a head-on situation the wings and the rotor blades provide little visual reference and detection is more reliant on the frontal cross-section of an aircraft. For an object 2 m wide, slightly more than the cabin width for an R22 and Cessna 152, detection could be expected to occur at around 575 m. Having recognised an object as an aircraft and using the reaction time table described in paragraph 1.5.39, a pilot had 11.4 seconds to recognise collision was likely and take avoiding action.

2.29 The accident on 17 February 2008 was not a head-on collision; rather the 2 aircraft collided at 90º. However, the flight paths flown by the 2 aircraft as they approached each other, in particular the left turn flown by the aeroplane, meant that the cross-section or size of the opposing aircraft would have been larger than the 2 m, but not by much. At an estimated closing speed of between 70 and 90 knots, the 2 aircraft would have travelled between 410 m and 530 m in 11.4 seconds. With a calculated detection range of 575 m, the pilots of the 2 aircraft would have had little time to locate the opposing aircraft before a collision became inevitable. This reinforces the need for pilots to use radio transmissions to support their visual scans and detect potentially conflicting aircraft early.

2.30 Sighting of another aircraft can be aided by movement and contrast. Aircraft anti-collision lights provide a sudden burst of light designed to attract attention. Landing lights can also provide a bright contrast. However, on 17 February 2008, their effectiveness would have been reduced by the brightness of the day. Further, while there was good visibility about the aerodrome, the aeroplane would have been flying against a background of hills with shadows and broken colours, as it descended to 1000 feet on the eastern side of the runway. As highlighted in Figure 7, it would have been difficult for the pilots in the helicopter to locate the aeroplane ahead of them as they turned downwind.

2.31 For the aeroplane pilot, the helicopter would have been low in the windscreen of the aeroplane, either on the horizon or slightly below it, as the aeroplane was descended and was levelled at 1000 feet. The helicopter could also have appeared nearly stationary in the windscreen, with the lack of relevant movement making it harder to detect. The aeroplane pilot, sitting in the left seat and turning left, may have had a blind spot in his scan, with the engine cowling obscuring the approaching helicopter. The aeroplane pilot should have been aware of this and either manoeuvred himself or the aircraft around to check that the area into which he was flying was clear of other aircraft.

2.32 The standard overhead joining procedure promoted by the CAA was an effective and normally safe means of joining an aerodrome. It was also part of the pilot training syllabus and pilots needed to be competent in flying it. However, it should not have been the standard method of joining the circuit at Paraparaumu, especially when parallel runway operations were taking place with similar downwind circuit heights. This was recognised by the CAA in 1996 when it was recommended that local joining procedures be promulgated to segregate the traffic for the 2 circuits, and again in 1999 when it published an article in its bimonthly magazine making reference to the undesirability of standard overhead rejoins at Paraparaumu.

2.33 Despite their little experience, new pilots could have been instructed to use alternative joining procedures as was done at other aerodromes, for example Ardmore and Taupo. With an AWIB transmitting the local weather conditions and runway in use, pilots did not need to fly overhead to obtain this information. A pilot could, therefore, have held to the north or south of the aerodrome, located other traffic, then joined downwind or straight in. The standard overhead join could have been taught at other aerodromes or remained a dual-only exercise when there was an instructor on board and no conflicting traffic. See section 4. Safety Actions.

2.34 Although technical aids, for example the traffic collision avoidance system commonly known as TCAS, could reduce the risk of a mid-air collision, they were impractical in a training environment where emphasis needed to be placed on good lookout and listening skills. Further, the cost of installing such equipment could make it prohibitive for owners of small aircraft, including microlights and other home-built aircraft. Further, to be fully effective the equipment needed to be installed on all aircraft.

2.35 As discussed in paragraph 2.14, the Commission believed that under the Health and Safety in Employment Act 1992, all persons, particularly commercial operators, had a responsibility to take all practicable steps to ensure people in the vicinity were not exposed to harm. CAA aviation safety staff, as part of their job description, promoted safe aviation practices through regular aerodrome visits. However, for non-certificated aerodromes, the CAA was only able to direct operations through the use of Rules approved by the Minister. Should a dangerous situation develop, the Director of Civil Aviation could enact emergency rules if there was no other means of minimising risk of death, serious injury or damage. For Paraparaumu all parties were aware of the potential for a mid-air collision, especially involving an overhead rejoin and parallel runway operations, but the risk had continued unaddressed for years and become accepted as part of the everyday operation. This should not have been allowed to continue for as long as it did.

2.36 At 19 and 17 years of age, the helicopter pilot and the aeroplane pilot were in the age group that was over-represented in motor vehicle accidents in New Zealand. The 2 pilots had recently taken up flying and had accumulated 76 hours and 25 hours of flying time respectively. Both were considered competent and responsible students and were progressing at the expected rate for trainee helicopter and aeroplane pilots. They displayed none of the high-risk or antisocial behaviours that the studies identified were prevalent in motor vehicle accidents.

2.37 The combination of low hours and age was possibly significant in terms of the pilots' psychomotor skills and decision-making abilities. Hence the need to follow standardised procedures, which form a basis on which a pilot can gain experience and competence to develop the skills necessary for sound decision-making in more demanding and unusual circumstances. The overhead join was one such procedure. While the 2 student pilots may have been working to near capacity, the same factors could have applied to any student pilot with the same flying experience regardless of age, including the flight examiner, an A category instructor, who started his flying training at age 18.

2.38 New Zealand's age limitations for pilot licensing were in line with international practices. In reviewing the circumstances of the accident, there was no evidence found to suggest that the minimum age for student pilots should be raised. The rigid structure of pilot training, a competency-based system with its dual then solo, exercise-by-exercise programme, and the individual authorisation and close supervision by instructors, meant that a student displaying inappropriate behaviour was able to be identified early in their flying training.

2.39 The collision occurred over a built-up area with aircraft wreckage impacting on private homes and industrial buildings. While no people on the ground were injured, the risk of that happening in this accident was significant. The CAA and aerodrome owner had enacted local procedures, including a minimum circuit height of 1000 feet and avoiding flying over residential areas below 500 feet, to help reduce the level of aircraft noise over the local area. This also had the effect of ensuring pilots were flying at a higher altitude: that if a mechanical problem did occur there was sufficient height to land safely.

2.40 There are a number of aerodromes around New Zealand that are located within city boundaries or close to densely populated areas. There have been 12 mid-air collisions in the past 20 years and 2 have occurred over densely populated areas.[49] None of the mid-air collisions resulted in injuries or fatalities on the ground. This shows that the frequency of people on the ground being injured from mid-air collisions has been low, in fact non-existent in New Zealand. But the consequences of aircraft accidents of any type around densely populated areas have been shown to be high in other countries, typically larger aircraft landing short or overrunning runways. Future planners and regulators of building activities close to aerodromes will need to evaluate this risk, as will regulators of the aerodromes themselves. Otherwise, left unchecked the risk to the country as a whole could grow to unacceptably high levels.

[49] A mid-air collision over Central Auckland in November 1993 and the accident at Paraparaumu.

3 Findings

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

3.1 The pilots were fit for flying and were either appropriately licensed or undergoing an approved course of instruction.

3.2 The Cessna 152 aeroplane and Robinson R22 helicopter were airworthy and the weather was suitable for flying.

3.3 The pilots of both aircraft were concentrating on following the recommended route and procedures for their respective flights, but took no obvious action to locate or avoid each other.

3.4 The aeroplane collided at close to 90º with the left side of the helicopter, rendering both aircraft uncontrollable. The resultant impact with the ground was not survivable for the occupants of the helicopter and unlikely to be survivable for the aeroplane occupant.

3.5 Research showed that the age of the student pilots involved was not likely to have been a contributing factor to the accident, but pilot inexperience and/or preoccupation with the task of conducting, or in the case of the flight examiner monitoring the flights, was likely to have contributed to the pilots of either aircraft not having full situational awareness.

3.6 The design of the aerodrome circuit pattern, with counter-rotating circuit directions around parallel runways, together with the standard overhead joining procedure, was flawed in that it created the potential for 2 aircraft in different circuits to be at the same height at the same place.

3.7 The potential for a mid-air collision had been specifically identified in a 1996 safety assessment. The CAA, the aerodrome owners and the operators all had an opportunity to mitigate the increasing risk, with operations on the aerodrome becoming more complex and less coordinated, but with the exemption of the temporary lowering of the grass circuit height, none took that opportunity.

3.8 The relative speeds involved, difficulty in visually detecting other aircraft under certain conditions, and the natural limitations of human performance mean that the concept of "see and be-avoid" cannot be relied on as the only defence for preventing mid-air collisions. As well as radio communications, aerodrome circuit design and other technologies should be considered by regulators and aerodrome operators to lessen the risk.

3.9 The Director of Civil Aviation was limited by the current legislation in his ability to regulate operations around non-certificated aerodromes. However, the CAA could have had more influence on safety matters at Paraparaumu through a more interactive and cooperative approach with aerodrome and aircraft operators.

4 Safety Actions

4.1 In the week following the accident, an aerodrome user group meeting was held, attended by a CAA aviation safety officer. At the time of writing the report a further 2 meetings had been held, with the agreement that standard overhead rejoins would be discouraged, especially when opposed circuits were in operation. Further, changes to local procedures were to be investigated with the objective of providing greater separation for the various circuit patterns.

4.2 On 11 March 2008, the CAA completed an initial review of the accident to determine if any safety measures could be implemented immediately to mitigate the risk of mid-air collisions at Paraparaumu Aerodrome. The review determined that the cooperation of local aerodrome users and the owner was required as the Authority had limited control and ability to influence aerodrome activities as the aerodrome was non-certificated.

4.3 The review recommended, among other things, having the AWIB broadcast amended to discourage overhead rejoins, amending the circuit height of helicopters and completing a risk assessment evaluation using a recently developed "Aerodrome Airspace Collision Risk Model".

4.4 Following the accident, the aerodrome operator commissioned a risk review of aerodrome operations. The review was completed late in 2008 and identified several safety concerns and provided a list of recommended changes for discussion with various parties, including the CAA and local operators. Some of the recommendations were:

- close sealed runway 11/29
- close grass runway 11/29 to all but gliders and emergency use
- discourage overhead rejoins
- amend the aerodrome landing chart to provide more information to pilots
- promote regular and effective aerodrome user meetings
- extend the MBZ to cover the instrument approach areas
- introduce transponder mandatory airspace below 5500 feet
- introduce transit lanes for aircraft passing overhead.

4.5 At the time of writing the report all of the above recommendations had been enacted or were in the process of been acted upon. Further, on 21 April 2009 the aerodrome became certificated under CAR Part 139. The aerodrome operator also advised that it had appointed a new full-time aerodrome manger and quality assurance manager.

4.6 In July 2008 the CAA published an article titled "Joining the **Circuit** at an **Uncontrolled** Aerodrome" in the Authority's bimonthly safety magazine, Vector.[50] The article aimed to be a general reminder to pilots about unattended aerodrome joining procedures and circuit etiquette.

4.7 On 20 November 2008, the CAA issued amendments to the AIP charts for Paraparaumu Aerodrome. The changes included notes advising pilots to "be aware that helicopters will be much closer to the aerodrome during autorotation practice than during a normal circuit" and that radio calls should be made on finals when performing autorotations.

4.8 The landing chart note that advised that simultaneous operations on parallel paved and grass were prohibited, was expanded to include the term "side by side" to better describe "simultaneous", and adding aircraft could not depart or land at the same time on parallel runways. The amendments also included new VFR preferred arrival and departure procedures for the 4 runways, including both seal and grass runways.

[50] CAA Vector, Issue July / August 2008.

5 Safety Recommendations

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

5.1 On 17 August 2009 the Commission recommended to the Director of Civil Aviation that he take action to address the following safety issues, including:

5.1.1 The need for CAA staff to monitor aerodrome operations, particularly at non-certificated aerodromes, to ensure safety efforts are best directed to promote the coordinated safe management of flying activities. (026/09)

5.1.2 The need to encourage good aviation practice to help ensure pilots know how to perform an effective visual scan and how to actively listen to radio calls. (027/09)

5.1.3 The need to review the operations at other aerodromes around New Zealand that have opposing circuits, to assess and minimise the potential for a mid-air collision. (028/09)

5.2 On 11 September 2009 the Director of Civil Aviation replied:

5.2.1 As advised in previous correspondence, as Director of Civil Aviation I have limited regulatory powers with respect to non-certificated aerodromes.

Within the resources available to it, the CAA directs its attention to those aerodromes were risk is assessed as being highest – in this case to certificated aerodromes and non-certificated aerodromes engaged in regular passenger transport operations using 19-seat or more aircraft.

The CAA does not have the resources available to it to monitor all aerodromes 'equally'. However, CAA staff (e.g., aviation safety advisers, etc), actively engage with aerodrome users and others to identify risks and associated mitigations.

Consequently, I accept the recommendation in principle, with the caveat that the CAA's actions and engagement are driven by:

- Assessment of risk; and
- Targeting resources to areas of highest risk.

This is the CAA's current practice, which will continue. (026/09)

5.2.2 The CAA has a programme of activities designed to encourage good aviation practice. Articles have been produced in *Vector* on visual scanning, and active listening (see and be seen). Articles will be re-run in future editions of *Vector*. Consideration will also be given to using the *AvKiwi* seminar series to address the issue.

Consequently, I accept the recommendation, noting that CAA has already undertaken 'safety promotion' activities on this topic, and will continue to do so in the future as part of its ongoing safety promotion programme.

You can find evidence of the actions taken by CAA on the CAA's web-site and previous editions of *Vector*. (027/09)

5.2.3 As for recommendation 026/09, the CAA is constrained by 3 issues: (1) the extent of the Director's regulatory powers; (2) the resources available to it; and (3) the nature and extent of the risk being targeted.

As Director, I cannot mandate specific actions for individual aerodromes on the issue at the core of the recommendation. However, the *Aeronautical Information Publication Bulletin Volume 1 AD 1.5* clearly provides advice on the issue of Standard Overhead Circuit Joining procedures.

Consequently, I do not accept the recommendation as written.

I will undertake to make aerodrome operators aware of the TAIC recommendation, and their responsibilities with respect to the formation of aerodrome user groups/safety committees.

I will also undertake to make aerodrome operators aware of the risks associated with a 'mix' of operational activities, and their need to develop appropriate local procedures to minimise the risk of mid-air collisions.

CAA Aviation Safety Advisers (ASA's) currently work with a number of aerodromes. CAA will look to increase the activity and focus of ASA's as part of its work programme to address the underlying issue identified in the investigation report. (028/09).

Approved on 20 August 2009 for publication

Hon W P Jeffries
Chief Commissioner

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06-008	Piper PA23-250-E Aztec ZK-PIW, , landing gear collapse, Ardmore Aerodrome, 21 December 2006

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