
Airmiss incident between a Boeing 737-200 ZK-NAZ and Piper PA38-ZK-PAH at Wellington on 6 April 1992

Micro-summary: A near-miss incident between this Boeing 737-200 and Piper PA-38 Tomahawk

Event Date: 1992-04-06 at 0737 NZST

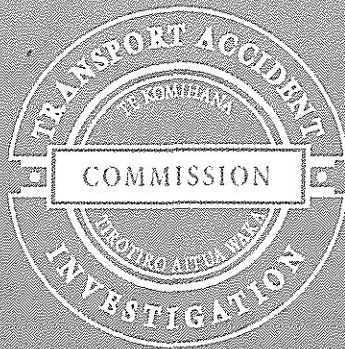
Investigative Body: Transport Accident Investigation Commission (TAIC), New Zealand

Investigative Body's Web Site: <http://www.taic.org.nz/>

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AIRCRAFT ACCIDENT REPORT

No. 92-010

AIRMISS INCIDENT

**Boeing 737-200 ZK-NAZ
and
Piper PA38 ZK-PAH
at Wellington**

on 6 April 1992

**Transport Accident Investigation Commission
Wellington - New Zealand**

TRANSPORT ACCIDENT INVESTIGATION COMMISSION

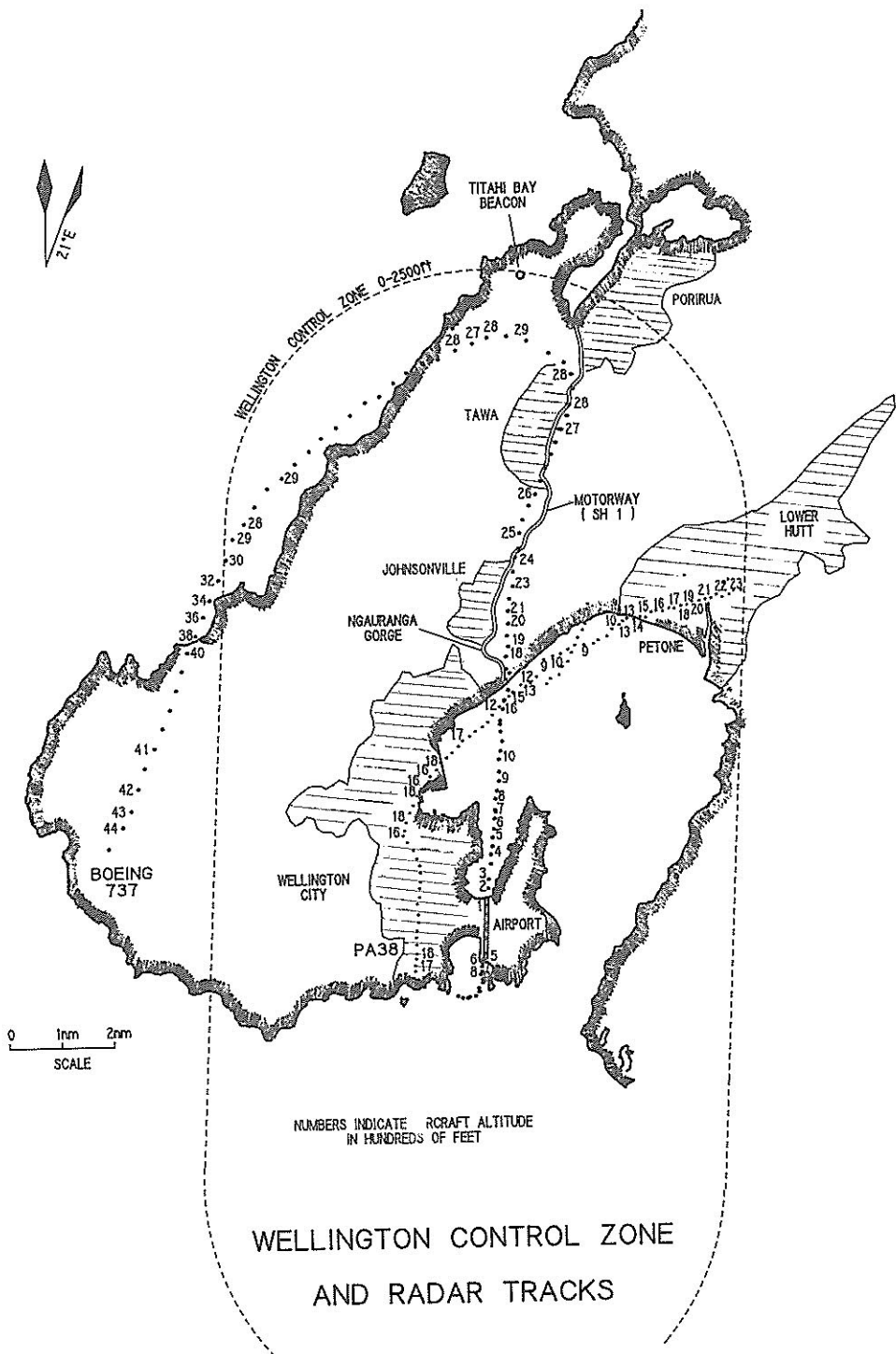
AIRCRAFT AIRMISS REPORT No. 92-010

Aircraft Type, Serial Number and Registration:	Boeing 737-200 S/N 20913 ZK-NAZ and Piper PA38-112 S/N 38-80-A0055 ZK-PAH
Number and Type of Engines:	B737: Two Pratt and Whitney JT8D-15 PA38: One Lycoming O-235-L2C
Year of Manufacture:	B737: 1975 PA38: 1980
Date and Time:	07 April 1992, 0757 hours NZST PA38: 1980
Location:	4 nm north of Wellington Airport
Type of Flight:	B737: Scheduled Air Transport PA38: Aerial Work
Persons on Board:	B737: Crew: 6 Passengers: 60 PA38: Crew: 2
Injuries:	B737: Crew: 6N Passengers: 60N PA38: Crew: 2N
Nature of Damage:	No damage to either aircraft
Pilot in Command's Licence:	B737: Air Transport Pilot Licence PA38: Commercial Pilot Licence Aeroplane
Pilot in Command's Age:	B737: 37 years PA38: 22 years
Pilot in Command's Total Flying Experience:	B737: 9000 hours PA38: 380 hours
Information Sources:	Transport Accident Investigation Commission field investigation
Investigator in Charge:	Mr D V Zotov

SYNOPSIS

The Transport Accident Investigation Commission was notified of this incident by an Air Safety Incident signal originated by the Wellington Aerodrome Control Tower at 0941 hours NZST on 6 April 1992.

An Air New Zealand B737 was on final approach to runway 16, at Wellington Airport when a Piper PA38 Tomahawk was cleared to cross from Wellington City to Petone, maintaining visual separation. The aircraft converged until a loss of separation occurred. Both aircraft were flying in visual meteorological conditions (VMC). The pilot of the Tomahawk attempted to take evasive action. The aircraft passed in opposite directions with about 350 m between them. None of the 68 persons on board the aircraft were injured.



1. FACTUAL INFORMATION

1.1 Background Information

1.1.1 Runway 16 was in use at Wellington International Airport.

1.1.2 Approach Control Radar was responsible for the separation and sequencing of arriving IFR (Instrument Flight Rules) traffic. The normal procedure was for the Approach Controller to sequence aircraft on to the ILS (Instrument Landing System) localiser or, for aircraft making a visual approach, until clear of other traffic; at which point he would transfer them to Tower for landing instructions.

1.1.3 In the Control Tower, two Controllers were responsible for traffic in the vicinity of the aerodrome. The Aerodrome Controller was responsible for aircraft movements both on the ground and in the air, while the second Controller handled aircraft route clearances. The Aerodrome Controller was also acting as Tower Coordinator, providing the link between Radar and Aerodrome Control. This position was separately manned when traffic density increased.

1.1.4 Each aircraft operating within the Wellington Control Zone (see Diagram 1) required an ATC clearance and aircraft operating under IFR were provided with separation from all other aircraft by Air Traffic Control (ATC).

1.1.5 Separation between controlled flights could be either vertical, horizontal, or visual. Vertical separation was normally 1000 feet between aircraft. Horizontal separation, under radar, required a minimum of 5 nm between each aircraft's return. Visual separation was available where (in general) each pilot reported that he had the potentially conflicting aircraft in sight, and agreed to maintain his own separation from it (see paragraph 1.10 for more detail).

1.1.6 The Tower radar at Wellington was out of service on 6 April 1992. This radar was intended to assist in sequencing arriving traffic by monitoring the distance of aircraft from touchdown. It was not intended for the general control of air traffic, and Aerodrome Controllers were not necessarily rated as Radar Controllers.

1.1.7 The two aircraft involved in this incident were an Air New Zealand Boeing 737, callsign NZ410, a scheduled service from Christchurch to Wellington; and a Piper Tomahawk operated by the Wellington Aero Club, callsign ZK-PAH, which was making reports on road traffic in and around Wellington for a local radio station. There were no other aircraft in the immediate vicinity.

1.1.8 The traffic patrol aircraft normally proceeded from Wellington via the coastal motorway to the Ngauranga Gorge intersection, thence to Petone and Lower Hutt. This route crossed the approach path to runway 16. Over the eight months that the patrol had been operating, the pilots had developed a system of starting the patrol at a height of about 1500 feet over Wellington City, descending en route to about 1000 feet at Ngauranga, then crossing to Petone. They believed that this procedure would place them comfortably below the ILS glidepath.

1.1.9 At 4 nm from touchdown on runway 16 the centreline of the glidepath was at 1309 feet and an aircraft flying at “half-scale deflection” below the glidepath would be at 1177 feet at this point.

1.1.10 The procedures used in determining the margins of safety on instrument approaches allowed a tolerance for pilot error of half-scale deflection in tracking the ILS glideslope. (Refer also to Section 2.2.5).

1.2 Significant Events

1.2.1 When in a position to join downwind for a right hand circuit, the Captain of NZ410 advised the Approach Controller that he was able to make a visual approach to Wellington. However, the Tomahawk was over Wellington City, so the Controller directed NZ410 towards the Titahi Bay NDB (non directional beacon), the normal commencement point for an ILS approach, before handing the aircraft over to Wellington Tower.

1.2.2 While NZ410 was on its downwind leg towards Titahi Bay, ZK-PAH had flown towards Ngauranga (see Diagram 1). NZ410 turned short of the Titahi Bay NDB, and joined the ILS approach path so that the ILS could be used to monitor the visual approach. Meanwhile ZK-PAH asked for and was given clearance to proceed to Petone.

1.2.3 The usual clearance for ZK-PAH was in the form “Pass behind (traffic)”. On this occasion however, the Controller advised that the B737 was on long final, and cleared the pilot of ZK-PAH to Petone, with the traffic in sight, to maintain his own visual separation. The reason for the difference in the clearances was the absence of the Tower radar: the Controller had no information on the relative range of the two aircraft and considered that it was inappropriate to instruct the PA38 to pass behind the B737. This view was supported by senior officers of the Airways Corporation, at the time of the occurrence.

1.2.4 The pilot of ZK-PAH could see only a light from the B737. Because the aircraft itself was not visible, and because he considered that “long final” implied a long way out, the pilot believed there was room for him to pass in front. To him the absence of the usual instruction to “pass behind” supported this view. Accordingly, he began to fly directly towards Petone.

1.2.5 The Controller could see the two aircraft converging, but was unable to determine whether they would pass safely. He therefore asked the B737 crew whether they could see the traffic “over the wharves”. The crew looked out to their right but saw nothing, then looked ahead again and saw an aircraft at the “half-past-eleven” position (just to the left of the nose) “performing a bunting manoeuvre”. The aircraft had passed beneath the level of the B737, to the left. There was no time for the crew of the B737 to take any avoiding action.

1.2.6 The pilot of the Tomahawk had one light of the B737 continuously in sight in the sharply curved section of the windscreen to the left of the Tomahawk’s centreline. Suddenly the airframe “sprang into view around the light”, and the pilot realised it was very close. He closed the throttle and pushed forward on the control column as an evasive manoeuvre, but the control inputs only started to become effective after the aircraft had passed

each other. When the Tomahawk was recovered from its dive, its altimeter showed 900 feet.

1.2.7 The Tomahawk pilot continued his patrol; the B737 was landed safely and the crew filed an airmiss report. The Captain considered that the other aircraft was 100 to 150 m ahead when seen; the horizontal crossing distance was about 100 m and the vertical separation 100 to 150 feet.

1.2.8 The airmiss occurred approximately 4 nm north of Wellington Airport, in VMC, latitude 41°15'S longitude 174°49'E, at 0737 hours NZST.

1.3 Personnel Information

1.3.1 The Tower Controller at Wellington Airport was appropriately rated and in current operating practice. The duty roster showed that he had not been involved in excessive duty times.

1.3.2 He had qualified as an Aerodrome Controller in 1989, and joined Wellington Unit on 1 January 1990.

1.3.3 The Manual of Air Traffic Services required all controllers to undergo an annual proficiency assessment. The last such assessment on file was dated 31 January 1991, when a satisfactory standard was achieved. A waiver extended the reexamination date to the end of April 1992.

1.3.4 The pilot of the PA38 held a Commercial Pilot Licence (Aeroplane) and a "C" Category Instructor Rating. His total flight time was 380 hours.

1.3.5 He was one of three pilots who regularly flew the morning traffic patrol. He had flown about 30 hours on such flights.

1.4 Aircraft Information

1.4.1 The Piper PA38 "Tomahawk" ZK-PAH, a two-seat, single engine, low wing training aircraft was examined after the incident. Its windscreen had been cleaned externally after the incident; the pilot advised that he had not cleaned it before the flight.

1.4.2 The perspex windscreen was a dark grey "smoked" colour. It was of wrap-around design. In the areas of sharpest curvature from front to sides, the moulding process had introduced close-spaced striations. The perspex was not noticeably crazed or scratched.

1.4.3 The interior of the windscreen was not conspicuously dirty, but there was some grime on it. It was covered with fine water-droplet marks, as though condensation had previously been wiped with a cloth.

1.4.4 In the region where the B737 would have been visible to a pilot sitting in the right hand seat, there were no obstructions to binocular vision.

1.4.5 It was standard practice for the pilot of the traffic patrol aircraft to fly from the right seat. This gave the traffic observer, seated on the left, an unobstructed view of the roads, which were on the aircraft's left when it flew the usual route.

1.4.6 The aircraft operator's standard procedure was for crews to use the landing light to enhance visibility only when the visibility was poor. The single light, mounted in the engine cowling, had a thin, unsupported filament. The operator advised that the service life of the landing light had been found to be short, hence the restriction on its use. The pilot advised that it was not in use at the time of the incident.

1.4.7 The aircraft was also fitted with white wingtip strobe lights and an under-belly flashing red anticollision light. When examined, these lights were serviceable, but the forward face of the anticollision light was so encrusted with exhaust deposits that it was unlikely to be visible from ahead, at any distance. From the aspect from which the aircraft was visible to the B737 crew, the anticollision light would have been obscured by the airframe.

1.4.8 Comparison of the intensity of the wingtip strobe lights against the predominantly white background of the city suggested that the lights might not have been very effective as attention-getters.

1.4.9 The upper surfaces of ZK-PAH were predominantly white.

1.4.10 Boeing 737-200 ZK-NAZ was a twinjet airliner. Its colour scheme was as follows:

Wings: Light grey on top and undersides; leading edges natural metal.

Fuselage: White top, light grey belly, the colours divided by narrow parallel lines of medium green and dark blue.

Engines: Natural metal.

Fin: Predominantly dark blue, with white Koru symbol.

1.4.11 It had landing lights mounted in the leading edge of each wing and incorporated in the same cluster were "turn-off lights" angled out at about 30°, the function of which was to illuminate the edge of the taxiway at night. These lights were selected "ON" on ZK-NAZ. When seen from one side, the landing light on the other side was masked by the fuselage.

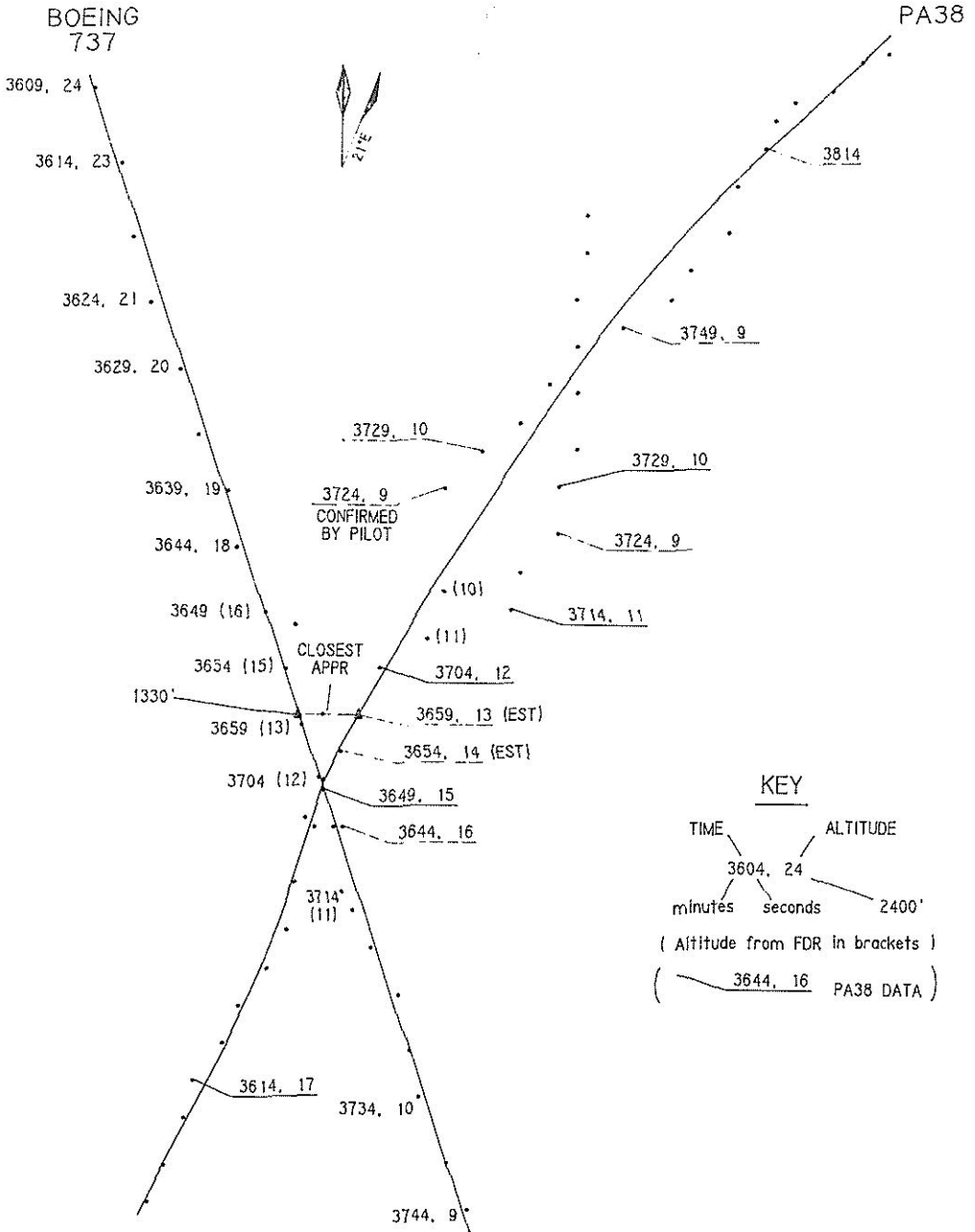
1.5 Meteorological Information

1.5.1 At the time of the incident, the visibility at Wellington Airport was reported to be 40 km, with one octa of cloud at 2500 feet amsl and seven octas at 3000 feet. There was no precipitation. The surface wind was from 170° magnetic at ten knots. The sea-level pressure was 1022 hPa.

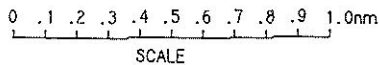
1.5.2 The Tomahawk pilot described the background, inland, as hazy and grey. The orographic effect of the southerly wind against the northern slopes of the harbour increased the depth of the cloud in that area. Also, the low elevation of the early morning sun presented a considerable depth of cloud through which light had to pass.

1.5.3 For the two days prior to this incident, southerly gales had blown at Wellington. These winds were laden with salt particles from the surrounding sea.

DIAGRAM 2



RADAR TRACKS AND DETAILS



1.6 Communications

1.6.1 Normal radio telephone communications were maintained between the Tower and each of the aircraft. ATC communication tapes were impounded for review, but proved to be blank over the relevant period. While the quality of the tapes had been checked daily, it was subsequently found that an intermittent fault had been causing short periods of non-recording, one of which coincided with the period of this incident.

1.7 Flight Data Recorder

1.7.1 The digital flight data recorder (DFDR) from ZK-NAZ was read out by the Australian Bureau of Air Safety Investigation. Clear outputs were obtained. Because the B737 crew had transmitted on RTF when they saw the Tomahawk, and the RTF keying was recorded on the DFDR, it was possible to ascertain the aircraft's position and height at the time of the incident. The radar altimeter showed that the aircraft had just crossed the coast at Ngauranga: the aircraft's altitude was 1350 feet amsl. It was also confirmed that the aircraft did not deviate from its flight path at the time of the incident and was near the centre line of the ILS glide path.

1.8 Radar Recording

1.8.1 Recording of the primary and secondary radar returns, as they would have been available at radar screens for Approach Controllers, were examined. A video recording of the information available provided a graphic illustration of the incident.

1.8.2 "Mode C" transponder altitude encoding was also displayed. This was available to the nearest 100 feet: it was only updated each time the aircraft passed through a hundred-foot layer. The encoded altitude was corrected for ambient pressure, but subject to a number of potential errors. However, the comparison between the B737 encoded altitude and DFDR records, and between the Tomahawk's encoded altitude and the pilot's reported altitude after the evasive action, showed that the errors were small. The encoded altitudes were used, without further correction, for analysis.

1.8.3 The radar positions displayed were "best estimates" by computer, from a number of radar heads. Occasionally this can lead to anomalies, such as the double-imaging of ZK-PAH after the incident. Another anomaly was the displacement of radar positions when two aircraft were in close proximity. The DFDR showed that the displacement of the B737 symbols at the time of closest passage of the Tomahawk was such an effect; accordingly interpolation of the relevant 15-second interval was used.

1.8.4 The radar tracks of the two aircraft are shown, superimposed on a map of Wellington, at Diagram 1, while an enlargement showing the details of the airmiss, is shown at Diagram 2.

1.9 Previous Airmisses at Wellington

1.9.1 On 24 February 1991, a B737 was established on the ILS for runway 16 at Wellington Airport. The crew reported that, at 1400 feet in broken cloud,

they sighted a light aircraft ahead of them, moving left to right, and turning to follow the approach path. Before the B737 could take avoiding action, the controller diverted the aircraft clear. The B737 crew estimated the miss distance was about 100 m.

1.9.2 The pilot of the light aircraft had been instructed to hold late downwind and report sighting a B737 on eight miles final. The pilot reported "late downwind and we have no contact", which the controller misheard as "we have contact" and instructed the pilot to "follow the Boeing number two". The pilot subsequently heard the controller clear an aircraft to taxi off the runway and, assuming he was now number one to land, joined left base for runway 16.

1.9.3 On 19 January 1992, a B737 was taking off from runway 34 at Wellington Airport. A Piper Cherokee, which had taken off earlier, was over Oriental Bay. The Cherokee pilot reported that he had the B737 in sight, and was cleared by the Tower to maintain visual separation and pass behind the B737. After the B737 became airborne the co-pilot could see the Cherokee through the Captain's window, moving in an easterly direction, eventually into Evans Bay. At 400 feet he told the Captain to make an immediate right turn to avoid the Cherokee, which appeared to be in the flight path of the B737. He then called the Tower to express concern. The Tower replied that the light aircraft had the B737 in sight.

1.10 Other Information

1.10.1 Civil Aviation Safety Order No 1 (CASO 1) stated, at Section 9:

"9.5.1 Except as provided for in subparagraph 9.5.8 of this Section, the responsibility for the separation of specified aircraft operating in specified airspace is vested in the ATC unit responsible for that airspace.

9.5.3 Separation shall be provided between all aircraft operating in accordance with IFR and all aircraft operating in accordance with VFR in . . . the Wellington . . . [control zone].

9.5.8 Separation is not provided by ATC between aircraft operating in accordance with IFR and gliders . . . or between aircraft providing their own separation by visual observation.

1.10.2 The Manual of Air Traffic Services stated at RAC 3-8:9-1:

"9 VISUAL SEPARATION

9.1 Separation by visual observation

9.1.1 In the vicinity of aerodromes, visual separation may be applied:

(a) When each aircraft is continuously visible to the Aerodrome Controller, and adequate separation can be provided by this Controller,

(b) Each aircraft is continuously visible to the pilot of the other aircraft concerned and the pilots report that they can maintain their own separation; or

- (c) When one aircraft is following another and the pilot of the succeeding aircraft reports that he has the other aircraft in sight and can maintain separation.”

1.10.3 ICAO Document 4444, Rules of the Air and Air Traffic Services, defined “in the vicinity of aerodromes” as meaning “in, entering or leaving the circuit”.

1.10.4 The circuit at Wellington Airport was defined in the Visual Chart Supplement of the Aeronautical Information Publication, Wellington International Aerodrome Chart. The left base leg of the circuit for runway 16 was 2.3 nm from the runway threshold.

1.10.5 The Manual of Air Traffic Services stated, at RAC 3-8 : 9-1:

“9.1.2 **In controlled airspace** except OCAs, visual separation may be applied and two controlled flights cleared to climb or descend through each others level, provided that:

- (a) **A specific request is made by a pilot;** and
- (b) Both flights remain in VMC; and
- (c) The pilots are in direct communication with the ATS unit on the same frequency, and **both concur** with the application of the procedure; and
- (d) There is no possibility of incorrect identification; and
- (e) **Each aircraft is continuously visible** to the pilot of the other aircraft and **both pilots report that they can maintain their own separation** until vertical separation is re-established, or, when the pilot of a succeeding aircraft reports that he has the other aircraft in sight and can maintain visual separation until vertical separation is re-established; and
- (f) Such clearances may be issued only during daylight hours.”
(Emphasis added).

The Air Transport Division advised that these provisos were added to the less restrictive ICAO provisions some 20 years previously, to prevent clearance by visual separation between light aircraft and airline traffic without the concurrence of the pilot of the airliner.

1.10.6 The word “following” was not defined in the Manual of Air Traffic Services, but the Airways Corporation advised that in their view one aircraft was following another if the Controller considered it was able to pass behind the other aircraft. The Controller’s use of visual separation as described in paragraph 9.1.1 (c) was in accordance with standard practice at Wellington, except that he should have used the words “pass behind”. To require visual separation to the standard required in paragraph 9.1.1 (b) would have been restrictive of light aircraft traffic at busy periods since the pilots of airliners on final approach were unlikely to agree to maintain their own separation from light aircraft traffic.

1.10.7 The Air Transport Division advised that “is following” means that the following aircraft is already behind the lateral axis of the leading aircraft.

1.10.8 The Manual of Air Traffic Services stated, at RAC 3-8 : 14-4:

“14.4 Geographical Separation”

14.4.1 Geographical Separation is established by:

- (a) Requiring an aircraft to proceed by visual reference to prominent geographical features or visual reporting points which are located within a sector laterally separated from a particular IFR track or procedure . . .

14.4.4 Separation between an aircraft maintaining visual reference to geographical features or reporting points and an IFR flight on final approach shall be achieved in the following manner:

- (a) Suitable landmarks for use as visual reporting points or holding points and prominent geographical features located outside the final approach area shall be selected and promulgated in local unit orders. Local operators shall be provided with a list of these points and a diagram of the final approach area together with advice on the way geographical separation will be applied.
- (b) Aircraft operating by visual reference shall normally be instructed to proceed to one side of the feature or reporting point away from the final approach area.”

1.10.9 The Air Transport Division (ATD) of the Ministry of Transport had only one officer who was experienced in Air Traffic Control, at the time of the airmiss. His primary responsibility was to draft Rules governing the Airways Corporation. There were no Rules in existence at the time of the incident. As Air Traffic Control had been part of the Ministry of Transport prior to formation of the Airways Corporation, no separate Regulations had been necessary prior to that event.

1.10.10 The ATD officer also assisted in audits of the Airways Corporation. These audits consisted of examination of the documentation to see if it provided for a satisfactory system of operation. No independent inspection of the actual operations of the Airways Corporation was undertaken.

1.10.11 The Swedavia McGregor Report on the Review of Civil Aviation Safety Regulations and the Resources, Structures and Functions of the New Zealand Ministry of Transport Civil Aviation Division stated, at Section 13.4:

“. . . Functional supervision is a necessary task of the safety authority, (including):

— Surveillance, by continuous monitoring of safety performance; . . .

13.4.1 Surveillance is the safety authority’s primary tool for actioning its responsibility to ensure that participants in the system perform according to the standards set.

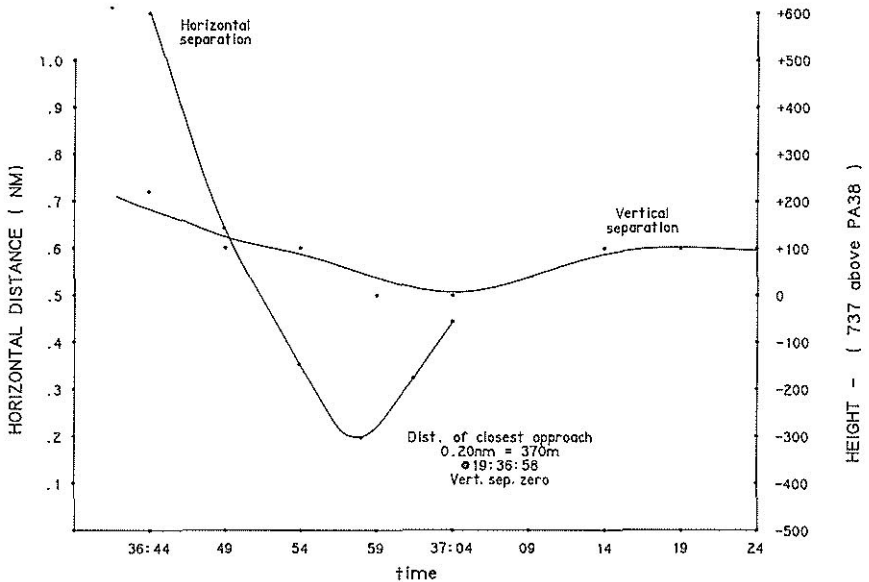
The safety authority must be confident an operator . . . is performing satisfactorily overall.

The methods used by the safety authority . . . include audits, inspections, spot checks . . .

Any sign that company personnel and procedures deviate from the provisions of the manuals is an indication that management does not have sufficient control of its operation. And this situation is unacceptable from a safety point of view.”

With specific reference to the Airways Corporation, the Report stated, at Section 13.7:

“13.7.1 . . . The role of the safety authority will be to . . . maintain supervision, so as to be satisfied that providers of . . . airways services live up to the prescribed standards . . . From time to time the safety authority may need to perform specific audits and inspections.”



MISS DISTANCE

DIAGRAM 3

2. ANALYSIS

2.1 Miss Distance

2.1.1 The PA38 crossed the B737's projected flight path at 1936:49; at that time the PA38 was 100 feet below the B737, which was at 1600 feet. The B737 was 0.6 nm from the cross-over point and this distance represented 8 seconds at the combined closing speed of the two aircraft. The point of closest approach was found to occur at 1936:58. The horizontal passing distance was recorded as 0.20 nm (370 m); the semi-spans of the B737 and PA38 totalled 20 m so the separation was about 350 m. Both aircraft were then at about the same height. A plot of vertical and horizontal separation against time is shown at Diagram 3.

2.1.2 The plot of vertical separation showed the B737 just above the Tomahawk at the point of closest approach, with the height difference subsequently diminishing to zero. The evasive manoeuvre performed by the Tomahawk, which commenced 15 seconds before the point of closest approach, from 1600 feet, reached its lowest point some 40 seconds later at 900 feet. It had little effect on the height difference between the two aircraft; whereas the Tomahawk started from virtually level flight, the B737 was descending at about 800 feet per minute throughout. Such an evasive manoeuvre would need to have been performed with vigour, achieving negative “g” and a near-vertical attitude, to have been successful.

2.1.3 The proximity of the aircraft at the time of the airmiss was unaffected by any avoiding action by either crew: the absence of collision was due to random chance.

2.2 *Pilot Judgement*

2.2.1 The Tomahawk pilot’s decision to cross in front of the B737 was induced by a number of factors:

- (a) He perceived the other aircraft as being a long way off, in relation to the closing airspeed.
- (b) He thought he would pass safely below the normal glidepath of arriving aircraft.
- (c) The absence of the normal instruction to “pass behind” led him to believe it was safe to pass in front.

2.2.2 The term “long final” was defined in the Aeronautical Information Publication, RAC 1-17 at paragraph 2 — Circuit Procedures, and meant “between 5 and 8 nm on final approach”. Since Ngauranga was on the extended centreline of the runway at 4.5 nm from touchdown, the information that the aircraft was on long final should not have suggested to the Tomahawk pilot that it was a long way from his aircraft.

2.2.3 It was not possible for the PA38 pilot to judge distance from a single light. However, the pilot’s assessment that the B737 was a long way off was coloured by his inability to see anything of the aircraft other than its landing lights. A number of factors contributed to the problem of perception:

- (a) Although the meteorological visibility was good, the target could be discriminated only if it contrasted with its background. The background at the time was a dark overcast, and the aircraft would have received little illumination, because the low altitude of the sun combined with the layer of cloud to produce a low level of illumination below the cloud. The B737’s colour scheme was inappropriate to contrast with a land and sky background.
- (b) The tinted perspex canopy of the Tomahawk may have further reduced the pilot’s ability to perceive a poorly illuminated target.
- (c) The Tomahawk’s windscreen probably had a layer of salt particles deposited on it as a result of the preceding gales. Internally, grime and droplet marks would also have impaired the pilot’s vision.

2.2.4 The distance at which it would have been safe for the Tomahawk to pass in front was related to the closing speed of the two aircraft. The B737's airspeed was of the order of 175 knots, and the Tomahawk's was of the order of 95 knots, at 30° to the Boeing's track. The combined closing speed was therefore about 260 knots. At this speed, the aircraft would have closed one nautical mile in 14 seconds. Even had the B737's airframe been visible to the Tomahawk pilot, the inability to estimate range with sufficient precision to assure a safe margin for him to cross ahead of the B737 would have militated against such a procedure.

2.2.5 At 4 nm from touchdown on runway 16, the centreline of the glidepath was at 1309 feet and an aircraft flying within expected tolerances could have been as low as 1177 feet. Even had the Tomahawk been at 1000 feet at this point, there would have been no safe margin of separation from aircraft making ILS approaches. A maximum height of 500 feet amsl would have been needed to provide a safe procedural crossing.

2.2.6 The pilot was not aware that the reason for the normal "pass behind" instruction not being given was that the Tower radar was unserviceable.

2.2.7 The loss of separation was due to the Tomahawk pilot's decision to pass ahead of the B737, a decision based on an inadequate appreciation of relative range and closing speed. This was compounded by his lack of knowledge of the reason for the changed format of the Controller's instruction.

2.3 System Deficiencies

2.3.1 CASO 1 imposed on the Airways Corporation a legal obligation to provide separation between IFR and VFR aircraft operating within the Wellington Control Zone, and the Manual of Air Traffic Services provided, in essence, that this separation could be provided by procedural, radar, geographic, or visual means. Where a clearance with visual separation by the pilots was given, the Corporation considered that it shifted its legal responsibility to the pilots concerned.

2.3.2 Visual separation was permissible at Wellington only in certain, tightly constrained circumstances:

- (a) Between aircraft in, leaving or joining the circuit
- (b) Between aircraft one of which was climbing or descending through the level of another, and with the concurrence of both pilots.

The circuit at Wellington was defined on the Aerodrome Chart: it extended downwind 2.3 nm beyond the threshold. An aircraft at 3 nm final might be said to be joining the circuit, but it would be stretching the point to claim that an aircraft at 8 nm was doing so: an aircraft on long final is only joining the circuit when it enters the defined circuit area.

2.3.3 Not only was the B737 on long final not "in the vicinity of the aerodrome" within the meaning of ICAO Doc. 4444, but ZK-PAH had left the circuit some minutes previously to perform its traffic survey, and was proceeding to the Hutt Valley. It, too, was not "in the vicinity of the aerodrome". The appropriate criteria were therefore those of RAC 3-9 : 9-1, at paragraph 9.1.2, which required the concurrence of both pilots.

2.3.4 Even were the aircraft “within the vicinity of the aerodrome”, the Manual of Air Traffic Services permitted visual separation where only one pilot had the other aircraft in sight when that pilot “is following” the other aircraft, ie. he was already behind the other. This Section could not have applied when one aircraft was ahead of, but might subsequently pass behind another.

2.3.5 It is essential that the ATC system be, to the greatest extent possible, tolerant of human error, since errors are inevitable. Such tolerance could be achieved in a number of ways:

- (a) By adopting wide safety margins, so that infringement resulting from error would be detected, and the error rectified, before an unsafe situation results.
- (b) By devising procedures that relied on simple observation rather than judgement: for example the Tomahawk pilot could have been instructed to hold at the wharves until the B737 had passed.
- (c) By having a second person monitoring, for example monitoring a procedural separation by radar.
- (d) By automation, as had been achieved in the Airways Modernisation Project.

2.3.6 The Manual of Air Traffic Services provided for monitoring of visual separation, in that one pilot in each aircraft must have had the other aircraft continuously in sight. The exemption from this requirement where one aircraft is following another is acceptable if the two aircraft are of similar performance or the leading aircraft is faster, as the closing speed would be low or non-existent, and a “wide tolerance” situation would exist.

2.3.7 The practice has developed whereby one of two aircraft closing head-on is said to be “following” the other if the Controller expects it to pass behind the other. That situation is neither independently monitored nor is there wide tolerance. It is not surprising therefore that a simple human error by one pilot resulted in a hazardous situation, on this occasion.

2.3.8 Another procedure which has developed over the years is, in effect a hybrid procedure: directing an aircraft to hold at a geographic point until able to follow another aircraft. This combination of geographic and visual separation is not in strict accordance with the Manual of Air Traffic Services: two separate clearances would be required. It carries the risk of misjudgement by the light aircraft pilot and, even if the instruction is to hold until the airline traffic had passed, there is the risk of misidentification as occurred in February 1991.

2.3.9 It is desirable that any proposed departure from the Manual should be reviewed and published in the Manual, prior to implementation. This would give an opportunity for any deficiencies to be disclosed in advance. Additionally, compliance with the Manual could then be examined by auditors, any discrepancies being readily apparent and remediable. A recommendation to this effect was made to the Airways Corporation.

2.3.10 The attempt to pass responsibility for safe separation from airline traffic to a single, light aircraft pilot, was not safe, and it was expressly prohibited by the Manual of Air Traffic Services. It did not discharge the legal

burden on the Corporation imposed by CASO 1. The Controller had a duty to ensure that the method of separation that he proposed was viable; at the very least, it had to comply with the Manual of Air Traffic Services. This departure from the Manual should have been detected and rectified before an airmis occurred, and at the latest after the incident in February 1991.

2.3.11 The previous airmisses had the following similarities with the present incident:

- (a) Each involved an airliner and a light aircraft
- (b) Each took place in the Wellington control zone
- (c) In each case the clearance by visual separation was issued to the pilot of the light aircraft, without the concurrence of the captain of the airliner
- (d) In each case the light aircraft was ahead of the lateral axis of the airliner at the time the clearance was given.

2.3.12 The responsibility for each of the three incidents described herein was attributed by the Corporation to one of the pilots involved. The Airways Corporation should not have been put in the difficult position of being a judge in its own cause. For this reason the Swedavia report not only recommended that, in general, surveillance of an operator by the Air Transport Division should include monitoring to ensure that the operator's staff complied with appropriate manuals, but also made specific reference to the need for such monitoring in the case of the Airways Corporation. Mere auditing of the Corporation's manuals was insufficient, and this airmis demonstrated the validity of the Swedavia comments on this subject.

2.3.13 Routine monitoring by the Air Transport Division might have discovered that Controllers were departing routinely from the provisions of the Manual in regard to visual separation, but even if it did not, special surveillance ought to have been instituted after the airmis in February 1991. Such surveillance should have detected the aberration and so averted the subsequent airmisses. It should not have been necessary to wait for a formal investigation, to discover and rectify such situations. Recommendations were made to the Director of Civil Aviation Safety for improved surveillance of the Airways Corporation.

2.3.14 Problems are created at Wellington Airport by the topography and mix of the types of air traffic, a combination not encountered at the other international airports. A strict application of the existing separation requirements would restrict light aircraft operations severely at busy periods. However, three near misses in little more than a year is a clear demonstration that the existing situation is unsafe. It may be necessary to adopt other forms of control (for example, by training controllers to use the tower radar for separation of traffic within the control zone, as is done in some overseas countries). Alternatively, it might be necessary to remove much of the light aircraft traffic from Wellington Airport, as has already been done at Auckland Airport.

3. FINDINGS

3.1 The pilots and Controller concerned with the airmiss were properly qualified and licensed.

3.2 The Controller's clearance to the Tomahawk pilot to maintain visual separation from the B737 was not in accordance with the *Manual of Air Traffic Services*.

3.3 The clearance to the Tomahawk to maintain visual separation was in accordance with a normal practice at Wellington.

3.4 The Tomahawk pilot's judgment that there was sufficient room for him to pass safely in front of the B737 was erroneous.

3.5 The visual separation was not monitored in any effective way.

3.6 The miss distance at the point of closest approach was about 350 m. The Tomahawk passed in front of the B737, about 100 feet below it.

3.7 The aircraft missed each other by random chance, because neither crew could take effective evasive action in the time available.

3.8 There had been similar occurrences three months and thirteen months previously.

3.9 No preventive action had been taken after the previous airmisses.

3.10 The Air Transport Division's surveillance of the Airways Corporation was restricted to the inspection of Manuals. The Swedavia Report recommends that surveillance extend to operations in accordance with the Manual.

3.11 In the absence of physical inspections there was no mechanism in place for the Air Transport Division to detect the departure by the Airways Corporation's Controllers from the requirements of the Air Traffic Services Manual.

3.12 This airmiss resulted from a system of ATC clearance with visual separation which was not in accordance with the *Manual of Air Traffic Services*, but was approved by the Airways Corporation. Had the prescribed procedures been followed, the pilot of the Tomahawk would not have had the opportunity to make an erroneous judgement that he could pass safely in front of the airliner on final approach. Contributing factors included inadequate surveillance of the Airways Corporation's operations by the Air Transport Division, and lack of specific review and preventive action following earlier airmiss incidents.

4. SAFETY RECOMMENDATIONS

4.1 The following recommendations were made to the Airways Corporation; the Corporation's responses are shown in italics.

- (a) Require controllers to desist from issuing clearances by visual separation where only one pilot had sighted the other aircraft, unless that pilot was behind the lateral axis of the other aircraft.

This recommendation is based on an erroneous interpretation of the provisions of MATS and is unnecessary to ensure safe separation. The adoption of this recommendation would create serious problems for aerodrome controllers and would be a major departure from overseas practices. We therefore decline to implement this recommendation.

- (b) Require controllers to comply strictly with provisions of the Manual of Air Traffic Services.

Controllers are already required to comply strictly with the provisions of MATS (see page 0-01 of MATS). Compliance with MATS and local unit orders is constantly monitored by supervisory staff and is regularly audited by the Corporation's ATS Standards Section and the Quality Assurance Team. It is therefore unnecessary to implement this recommendation.

- (c) Require that proposed new procedures, or changes to procedures, be reviewed and incorporated in the Manual of Air Traffic Services prior to implementation.

As we explain in the accompanying schedule, the implementation of this recommendation would be detrimental to safety and would seriously compromise the Corporation's flexibility of operations. We therefore decline to implement this recommendation.

- (d) Investigate system deficiencies disclosed by airmiss incidents having an element of pilot error, with a view to devising systems that are error-tolerant.

The Corporation's objective is to reduce system and personnel error to zero. We investigate all identifiable incidents and where necessary or desirable, put corrective measures in place. However, the Corporation does not have the authority, and indeed to a large extent the expertise, to investigate pilot infringements. That is the responsibility of the Civil Aviation Authority. We therefore decline to implement this recommendation.

We accept that human error will occur from time to time and that it is therefore necessary to design systems that are error tolerant. The Corporation is in the process of examining its airspace management processes to see if there are any improvements that can be made to help reduce air safety incidents in all categories.

4.2 It was recommended to the Director of Civil Aviation Safety that he address the departures from the procedures in the Manual of Air Traffic Services by:

Requiring the Airways Corporation to desist from giving clearances by visual separation where only one pilot had the other aircraft in sight, and the "following" aircraft was not behind the lateral axis of the other aircraft at the time, and

Requiring the Airways Corporation to ensure that its staff complied with the requirements of the Manual of Air Traffic Services.

It was also recommended that he:

Require the Airways Corporation to ensure that, before new procedures were implemented, they were incorporated in the Manual of Air Traffic Services, and

Institute regular inspection of the Airways Corporation's operations, as recommended by the Swedavia Report, and institute independent inspections of the Airways Corporation's operations where in the opinion of one of the pilots a collision was likely to have occurred if avoiding action had not been taken, irrespective of the cause attributed by the Airways Corporation.

12 November 1992

M F DUNPHY
Chief Commissioner