



No. 95-012

Boeing 737, NZ 450 and Hawker Siddeley 748, ZQA 719

Wellington Airport

2 July 1995

Abstract

On Sunday, 2 July 1995 at 1308 hours a loss of runway separation occurred at Wellington Airport, where a Boeing 737 landed before a HS 748 had become airborne from the runway ahead. It was recommended that controllers apply conservative judgement; that CAA develop educational material on go-around procedures; that ACNZ review the use of language in MATS.

Transport Accident Investigation Commission

Aircraft Incident Report No. 95-012

Aircraft types, and flight numbers:	Boeing 737, NZ 450 Hawker Siddeley 748, ZQA 719
Date and time:	2 July 1995, 1308 hours
Location:	Wellington Airport
Types of flights:	Scheduled Air Transport
Persons on board:	Not Reported
Injuries:	Nil
Pilots in Command licences:	Airline Transport Pilot Licence (Acroplane)
Pilots in Command total flying experience:	N/A
Information sources:	Transport Accident Investigation Commission field investigation
Investigator in Charge:	Mr J J Goddard

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

1. Factual Information

- 1.1 During the morning and early afternoon of Sunday 2 July 1995 the weather at Wellington was fine and settled. At Wellington Airport weather reports had progressively recorded scattered cloud at 2500 feet, rising to 3500 feet and then clearing completely, while the visibility rose from 40 to 60 km. The surface wind had varied from light and variable to a 10 knot easterly. At about midday it changed to a four knot northerly before becoming light and variable again. The 2000 foot wind remained a light easterly.
- 1.2 Wellington aerodrome traffic was moderately busy with a mixture of VFR light aircraft and scheduled airline arrivals and departures. In the ten minute period surrounding this incident Wellington Tower was providing air traffic control services to 15 different aircraft.
- 1.3 At 1302.26 hours a Hawker Siddeley 748 aircraft, callsign Ansett 719, on a scheduled flight to Nelson, requested taxi clearance and was cleared to the holding point for Runway 34. At 1306.00 hours Ansett 719 reported ready for take-off, and was instructed to hold; to expect take-off behind a Partenavia light twin aeroplane on short final.
- 1.4 ZK-ERA, the Partenavia, had made contact with Wellington Tower at 1258 hours on a VFR arrival, and had been sequenced to follow a Metroliner, itself following a Saab 340 on final approach for Runway 34. At 1306.27 hours ZK-ERA was given a conditional landing clearance while the Metroliner ahead was vacating the runway. The clearance included the instruction to "taxi right", which was duly acknowledged.
- 1.5 At 1304.29 hours a Boeing 737, callsign New Zealand 450, on a scheduled flight from Christchurch, reported to Wellington Tower on a visual approach. Wellington Tower advised that the Boeing 737 was number three in sequence, behind the Partenavia. At that stage the Boeing 737 was about 8 nm out on long final.
- 1.6 At 1306.36 hours the HS 748 was cleared to line up behind the Partenavia which was then on short final, and to be ready for an immediate take-off. The aircraft was accordingly lined up and held on the runway, waiting for the Partenavia to clear after landing.
- 1.7 At 1307.22 hours Wellington Tower instructed ZK-ERA to "expedite clear". The pilot of ZK-ERA responded "OK, request left clear", which Wellington Tower approved at 1307.27 hours. The aircraft was taxied left off the runway at taxiway W2.
- 1.8 Ansett 719 was "cleared immediate take-off" at 1307.33 hours, and promptly commenced its take-off roll. At that stage the Boeing 737 was about 1.1 nm from the runway threshold.
- 1.9 Ten seconds later, at 1307.43, Wellington Tower issued a conditional landing clearance to NZ 450: "748 departing, cleared to land".
- 1.10 NZ 450 crossed the runway threshold at about 1308.02 hours, and landed while the HS 748 was still accelerating on the runway before becoming airborne.
- 1.11 The exact time the HS 748 became airborne was not established because of radar limitations, but was probably about 1308.14. It crossed the departure end of the runway at 1308.26 hours.
- 1.12 The minimum runway separation standards had been revised by ACNZ with effect from 27 April 1995. These revised standards were introduced to increase runway utilisation by allowing reduced separation to be applied in some circumstances.

- 1.13 Before this revision the applicable minimum separation between landing and departing aircraft, as specified in MATS RAC 5-35 was:

"A landing aircraft shall not be permitted to cross the threshold of the runway on final approach until:

- A preceding departing aircraft has crossed the end of the runway-in-use, or started a turn."

- 1.14 After the revision the equivalent MATS RAC 5-39 included essentially the previous standard, but added:

"By day, a qualified landing clearance may be issued to permit an aircraft B to cross the runway threshold to land prior to a departing aircraft A crossing the other end of the runway in use or starting a turn provided aircraft A is airborne and allowance is made for:

- any difference in aircraft performance; and
- the possibility of aircraft A returning to the runway; and
- the possibility of aircraft B not landing."

- 1.15 The information promulgated for pilots in NZAIP PM OPS 34 was essentially the same as that for air traffic controllers in MATS.

- 1.16 The "qualified landing clearance" had been in effect for some years, and was specified in MATS RAC 4-13:

"An arriving aircraft may be issued with a qualified clearance to land before a preceding landing or departing aircraft has cleared the runway provided:

- it is during daylight hours; and
- visual meteorological conditions prevail; and
- there is reasonable assurance that the required separation will exist at the time the approaching aircraft crosses the threshold; and
- the pilot is advised of the preceding aircraft and will be able to keep it in sight until it is clear.

The following phraseology shall be used in the clearance:

'(aircraft type) *VACATING LEFT* (or *RIGHT*), *CLEARED TO LAND*' or
'(aircraft type) *DEPARTING. CLEARED TO LAND*'

It is the responsibility of the pilot of a landing aircraft to go around if runway separation criteria cannot be met."

- 1.17 The NZAIP PM, OPS 34/1, on the same topic, advised:

"At controlled aerodromes the aerodrome controller may issue a qualified landing clearance by day only, to an aircraft on final approach when it is obvious that a preceding landing or departing aircraft will be clear of the runway before the approaching aircraft crosses the threshold.

Examples of qualified landing clearances are as follows:

- '737 VACATING RUNWAY LEFT, CLEARED TO LAND'
- 'F27 DEPARTING, CLEARED TO LAND'

Note: It is the responsibility of the pilots of landing aircraft to 'go around' if they consider that the runway separation criteria detailed above cannot be met. Pilots are reminded of the possibility of wake turbulence when following another landing or departing aircraft and of the fact that it may persist to a varying degree depending on the direction and strength of the surface wind."

- 1.18 The Captain of the landing Boeing 737 had been aware of the aircraft ahead, both landing and waiting to depart. On short final he alerted his First Officer to the possibility of a go-around because the HS 748 had no take-off clearance. Shortly after that the take-off clearance was given and the HS 748 started its take-off. He elected to land because of the possibility of a conflict with the HS 748 if he made a go-around from his position at the time.
- 1.19 At the time of the incident Wellington Tower was manned by an Aerodrome Controller, a Surface Movements Controller/Co-ordinator and a Flight Data Assistant.
- 1.20 The Aerodrome Controller explained that he had expected the Partenavia to vacate the runway rapidly. He had cleared the HS 748 to line up behind, anticipating it being able to depart promptly. The Partenavia had taken longer to vacate the runway than he expected. When he was able to clear the HS 748 for an immediate take-off he thought that minimum runway separation between it and the Boeing 737 would be achieved. He had a brief discussion with the other controller in the Tower who concurred with his judgement.
- 1.21 When the HS 748 was part-way through its take-off roll the Aerodrome Controller realised that the Boeing 737 was in fact too close, but he decided that the safer option was for it to land rather than go around.
- 1.22 Both controllers thought that the lack of wind was a factor in the loss of runway separation. The Aerodrome Controller also thought that the Partenavia not vacating the runway as instructed, and the HS 748 not lifting off where he had anticipated had contributed to the incident.
- 1.23 The task of an Aerodrome Controller in sequencing aircraft so that runway separation standards are maintained between them relies on personal judgement based on experience. Parameters involved are visual assessments of distances and relative positions, likely speeds and elapsed times for typical manoeuvres. Some assistance may come from the use of local geographical features as references, and from Tower Radar, if available. The latter is of principal use in planning the sequence of aircraft while they are more remote from the runway, and is not a substitute for looking out at the traffic and runway. It is however able to provide information on the distance from the runway threshold of aircraft on final approach, which is more immediate and accurate than a visual estimate.
- 1.24 After the incident the Captain of the Boeing 737 advised that he had not seen any advisory material on the reduced runway separations. This was a result of his Airline internal publications system which issued a current AIP to the flight library of each aircraft, rather than to each pilot. The Airline Operations Management reviewed amendments to the AIP, and selected significant change material to be displayed as memos on crewroom notice boards, in advance of the effective date. A memo on the runway separations had been so displayed in March/April 1995, but the Captain's deployment at that time led to his not seeing it. The Airline's pilots did not normally see AIC's.

- 1.25 Before the introduction of the reduced runway separations, ACNZ devised and implemented a training programme for controllers, with tests on the separation standards required to be passed for validation of the controllers' ratings. It was emphasised that controllers should be conservative in applying the new minima, and that greater distances should be applied where environmental conditions or aircraft relative performance so required.
- 1.26 Training for pilots comprised the AIP amendment 95/5, which instituted the changes, and an explanatory "Planefacts" flier, distributed to subscribers, which amplified the AIP material. An AIC/GEN, B26/94, had been issued in December 1994 to advise of the proposed changes, and to seek submissions and comment.
- 1.27 No CAA or ACNZ publication gave pilots any guidance or instructions on procedures to follow to ensure a safe clearance between aircraft in a situation like this, where a higher performance aeroplane might go around from short final because the runway ahead was occupied by a lower performance aeroplane about to take off.

2. Analysis

- 2.1 The significant feature about this occurrence was that the Boeing 737 landed on the Wellington runway before the departing HS 748 became airborne. This represented a manifest loss of runway separation because the minimum standard was that the departing aircraft should be airborne before the landing aircraft crossed the runway threshold.
- 2.2 Radar evidence indicated that the time lapse between the Boeing 737 crossing the runway threshold and the HS 748 becoming airborne was about 10 to 12 seconds. Since a typical take-off ground roll of an HS 748 takes some 20 to 30 seconds, it might be inferred that about half of the required minimum separation, measured in time, was achieved.
- 2.3 It was not practicable to estimate the closest distance between the two aircraft from the radar data available, but it may have been of the order of 500 to 800 metres.
- 2.4 When the HS 748 was cleared to line up behind the landing Partenavia, to be ready for an immediate take-off, the controller probably had reasonable assurance that adequate separation was available from the approaching Boeing 737, provided that the take-off could proceed promptly. The three parameters he was estimating to assess the situation were the time the Partenavia would take to vacate the runway; the time the HS 748 would take to get airborne; and the speed of the approaching Boeing 737.
- 2.5 While it was becoming evident that the Partenavia was taking longer than his estimate to vacate the runway, the remaining margin of separation above the minimum between the Boeing 737 and the HS 748 had started to dwindle. The rate of attrition of this margin would have been faster than the normal for Wellington because of the calm wind conditions at the time. Wellington has an average wind speed of 14.8 knots. The effect of the calm wind would be an increased ground speed of the Boeing 737, as well as a longer take-off roll for the HS 748, in comparison with more typical wind conditions. The magnitude of the effect on each aircraft would have been of the order of 10 to 15% in speed or time. As a result the situation would have deteriorated more quickly than on a normal windy day, and would have created some potential for misjudgement by the controller.
- 2.6 The slower than expected clearance of the runway by the Partenavia may also have been due in part to the calm winds, resulting in a longer landing roll. While the pilot may have been less than expeditious in clearing the runway, the actual time taken was probably not much outside the normal range of times for a light twin aircraft to land and taxi clear.

- 2.7 The alternative course of action available to the controller before the event was to hold the HS 748 clear of the runway while the Partenavia taxied clear, then reassess the situation without it as a factor. While this may have enabled the controller to avert the particular loss of separation which occurred, it probably would not have simplified his job or reduced the pressure of busy traffic, because the next aircraft on approach may well have then become involved instead of the Partenavia.
- 2.8 The revised runway separation standards, introduced nine weeks before this incident, were intended to increase runway utilisation by allowing the controller to reduce the separation. In this case, between departing and arriving aircraft, the minimum was reduced from the whole length of the runway between the two aircraft, to the departing aircraft being airborne before the landing one crossed the threshold. This meant that at Wellington, with a departing aircraft of HS 748 performance, aircraft could be up to about 20 seconds closer together.
- 2.9 This reduced time separation was of obvious value to extra runway utilisation in busy traffic periods, but if an aerodrome controller was to achieve close to this minimum separation, his margins of buffer time around each movement would be reduced by a similar interval, requiring additional judgement, skill and precision. The Aerodrome Controller was likely to be working under increased stress as a result.
- 2.10 One outcome of the revised separation was that a loss of separation was not more likely to occur than previously, but when it did occur then residual separation between aircraft would probably be quite small, and therefore more critical to any consequent action taken by pilots or controller.
- 2.11 The three single-runway separation situations are between two departing aircraft; two arriving aircraft; or between an arriving and a departing aircraft. Consideration of these indicates that the latter situation is likely to be most critical because the aircraft are doing dissimilar manoeuvres, thus making controller judgement more difficult; and also because the required remedial action if separation is lost, of the landing aircraft going round, may well be more hazardous if undertaken when the two aircraft are close. This is because the aircraft going round may, if of higher performance, overtake the other without its pilots being able to see and avoid the aircraft ahead.
- 2.12 The application of the revised runway separation did require the Aerodrome Controller to make allowance for any difference in aircraft performance. While this allowance could not be quantified, in the circumstances of this incident with a landing Boeing 737 and a departing HS 748 and in calm conditions, a practical safe minimum to aim for was probably closer to the whole length of the runway between aircraft.
- 2.13 It was worthy of note that, in this incident, both the Captain of the Boeing 737 and the Aerodrome Controller independently decided that a go-around was a less safe option than the Boeing 737 landing before the HS 748 had taken off. These decisions were probably justified because by the time they were made the aircraft were evidently already too close to allow a comfortable go-around. Assuming an average speed differential of 30 knots, a go-around commenced at the runway threshold by the Boeing 737 would have resulted in it overtaking the HS 748 within 60 seconds, or about 1 NM north of the aerodrome.
- 2.14 It was concluded that with the new runway separation minima a loss of separation could develop, as in this instance, and not be clearly identified until a late stage where a required go-around as prescribed in the NZAIP and MATS was not the safest course of action. However both the Boeing 737 Captain and the Aerodrome Controller were able to make the appropriate decision for the landing to proceed.
- 2.15 Under the previous runway separation minima, it was probable that a loss of separation would have been apparent at an earlier stage where a go-around was less likely to conflict with the aircraft taking off, and a go-around was in those circumstances an appropriate standard procedure.

- 2.16 The emphasis in the ACNZ training programme for controllers, that the new minima should be applied conservatively, was evidently wise counsel. This incident demonstrated that in the particular situation of an arriving and a departing aircraft, especially where the arriving aircraft is of higher performance, the situation can become critical with little warning, and may not be resolved readily by a go-around.
- 2.17 The radar recording showed that when the Aerodrome Controller was clearing the HS 748 for take-off, the Boeing 737 was 1.1 nm from the runway threshold. This same information was available to him on the Tower Radar at that moment, and could have alerted him to the imminent loss of runway separation. Such information at that stage could have enabled a timely and safe decision to hold the HS 748 on the runway, and to instruct the Boeing 737 to go around. While the emphasis in aerodrome control must remain on the Aerodrome Controller looking out, the value of the tower radar in quantifying the aircraft's distance from the runway threshold is considerable. Its use could have helped prevent the late decision and critical situation which developed in this incident.
- 2.18 One anomalous corollary to this event is that if the Boeing 737 Captain had carried out a go-around, in spite of the good airmanship decision not to do so, and then perhaps overtaken the HS 748 in uncomfortable circumstances, this "loss of runway separation incident" would not have occurred; and the prescribed action to have been deemed taken to avert the situation. An ACNZ incident report may not have been generated at all, even if the event was perceived as less safe than what actually took place.
- 2.19 It is of concern that no CAA publication gave pilots any guidance on procedures to follow in a go-around situation like this, to ensure safe clearance between aircraft where involuntary overtaking may occur. Historically ab-initio pilot training has taught that aircraft going around from short final should be flown to the right, or to the non-traffic side of the runway ahead. This may be inappropriate, however, for heavy transport aircraft, or where the geographical location of a runway may require different action.
- 2.20 The circumstances which led to the Boeing 737 Captain not being aware of the reduced runway separations are worthy of note. The Airline had adopted a publications management system which was more amenable to quality control than an alternative of issuing each pilot with an AIP, to be individually and regularly reviewed and amended. The significant change memos displayed on crewroom notice boards had addressed the revised runway separations at the time, but the Captain's deployment then had led to his not seeing it. The Airline has since taken action to ensure that its pilots in similar circumstances review significant changes in the AIP.
- 2.21 In this incident, the Captain's decisions and actions may have been unchanged even if he had known about the reduced runway separations at the time. However, the aviation publishing authorities, CAA and ACNZ, should note that not all of the pilot information material which they publish reaches all pilots, as a result of some airline internal publications management systems.
- 2.22 The paragraph in MATS RAC 5-39 which introduced the revised minima (see 1.14) was written in an ambiguous way and was capable of being misinterpreted. In particular, the clause "provided aircraft A is airborne and" could apply equally to "a qualified landing clearance may be issued", or to "permit aircraft B to cross the runway threshold". While the intended meaning may have been properly taken in this instance, such ambiguity is out of place in this regulatory operating document.

2.23 After the incident ACNZ issued signal amendments to MATS as follows:

- number 102, to MATS RAC 4-13, which deleted the italic text "*it is the responsibility of the pilot of a landing aircraft to go around if runway separation criteria cannot be met*". (see 1.16.)
- number 103, to MATS RAC 5-39, which deleted the words "allowance is made for", and amended the last line of the paragraph to read "starting a turn provided, aircraft A is airborne and past the point on the runway which aircraft B could be expected to have completed a normal landing roll."

It also deleted the three bullet points associated with the paragraph. (see 1.14.)

2.24 The intention of amendment 102, above, was to reinforce controller action to require a go-around if the required separation would not be achieved. This intention is unfortunate because, as already discussed, a go-around may not necessarily be the safest course of action.

2.25 Amendment 103 effectively increases the runway separation minima between arriving and departing aircraft in a way which recognises some difference in aircraft performance, and should assist controllers in providing a buffer in this situation.

3. Findings

3.1 A loss of runway separation occurred between the landing Boeing 737 and the departing HS 748.

3.2 While the normal safety standards were breached, there was not a seriously heightened risk of collision.

3.3 The Aerodrome Controller was applying recently revised separation standards in a busy traffic situation.

3.4 Cumulative delays, and the effects of abnormally calm wind on the performance of the aircraft led the Aerodrome Controller to misjudge the situation.

3.5 Use of the Tower Radar could have assisted the Aerodrome Controller's judgement.

3.6 The Boeing 737 was landed before the HS 748 had become airborne.

3.7 The decision for the Boeing 737 to land rather than to go around was appropriate.

3.8 The reduced separation minima led to a late appreciation of the loss of separation.

3.9 The standard requirement to go around in this situation is not always the safest course of action.

3.10 No CAA guidance to pilots on procedures to follow in a late go-around was available.

3.11 The relevant runway separation minima have been amended to improve their application and safety.

4. Safety Recommendations

4.1 It was recommended to the Chief Executive of Airways Corporation of New Zealand that he:

Continue to counsel controllers to apply caution and conservative judgement to the specific situation of an arriving and a departing aircraft, especially where the arriving aircraft is of higher performance (012/96) and

Review the use of language in such documents as MATS to ensure that ambiguities do not occur. (013/96)

4.2 It was recommended to The Director of Civil Aviation that he:

Develop some educational material on go-around procedures where involuntary overtaking may occur, and promulgate this to pilots and controllers. (014/96)

21 February 1996

M F Dunphy
Chief Commissioner