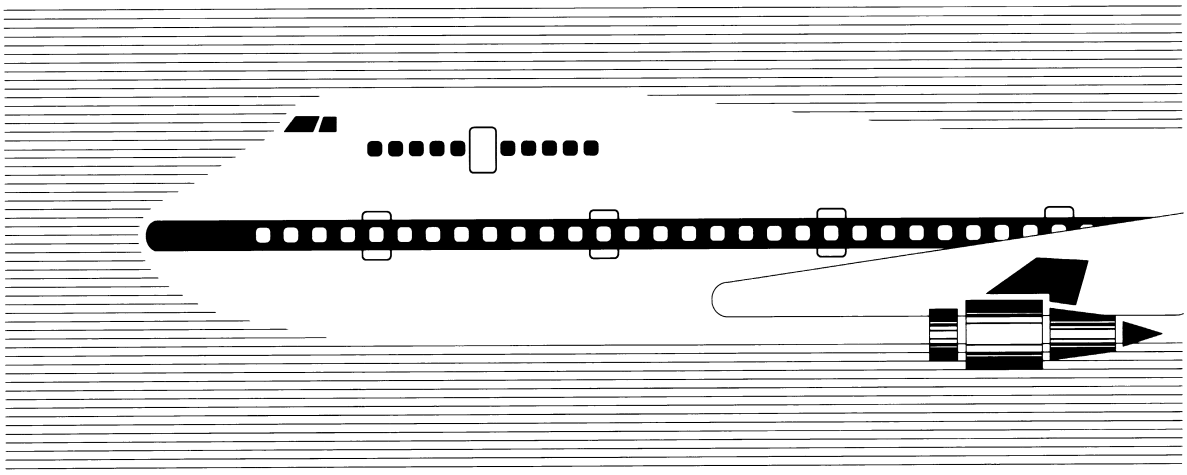
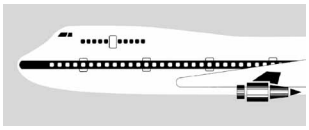
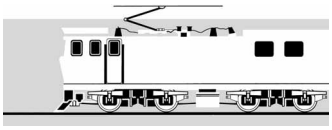


AVIATION OCCURRENCE REPORT

04-006 **Boeing 777, HL 7497, landed short of displaced threshold, Auckland International Airport** **16 November 2004**


TRANSPORT ACCIDENT INVESTIGATION COMMISSION
NEW ZEALAND

The Transport Accident Investigation Commission is an independent Crown entity established to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. Accordingly it is inappropriate that reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

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 04-006

Boeing 777-200

HL7597

landed short of displaced threshold

Auckland International Airport

16 November 2004

Abstract

On Tuesday 16 November 2004, HL7597 was a Boeing 777-200, operating as flight AAR 607 on a scheduled flight from Incheon, South Korea to Auckland with 200 passengers and 17 crew on board. As AAR 607 approached Auckland runway 23L, a work party was cleared onto the closed section of the runway for further work. However, the work party were concerned about the low approach of the landing aircraft, so elected to remain clear of the runway. Despite repeated air traffic control advice to the crew about the displaced threshold on runway 23L, AAR 607 landed short of the displaced threshold in an area where the runway workers could have been. No injury or damage resulted.

An unobstructed runway and the crew flying a *stepped approach,* which placed them below the normal glidepath for the displaced threshold, probably contributed to the crew's actions. Poor communication skills may have also been a factor.

The Transport Accident Investigation Commission (TAIC) did not receive notification of the serious incident until after the aircraft and crew had left New Zealand. As a result TAIC was unable to interview the crew immediately after the event and so could not accurately determine all the contributory factors to the incident.

Safety issues identified included:

- the benefit of flying constant angle approaches
- the presentation of instrument approach charts
- the effect on compliance and competency of crews having English as a second language
- the need to improve runway markings for displaced threshold operations
- the timely notification of serious incidents.

Safety recommendations were made to the operator, the aerodrome operator and the Director of Civil Aviation to address these issues.

Contents

Figures

Abbreviations

AAR 607	Asiana Airline flight 607
ACNZ	Airways Corporation of New Zealand
AFTN	aeronautical fixed communications network
AIAL	Auckland International Airport Limited
AIC	Aviation Information Circular
AIP	Aeronautical Information Publication
ATIS	automatic terminal information service
ATS	Air Traffic Service
C	celsius
CAA	Civil Aviation Authority of New Zealand
CFIT	controlled flight into terrain
DME	distance measuring equipment
ft	feet
ICAO	International Civil Aviation Organisation
ILS	instrument landing system
KAIB	Korea Aviation-accident Investigation Board
LIH ALS	light intensity high approach lighting system
LLZ	localiser
LOC	localizer (Jeppesen abbreviation)
m	metre(s)
MDA	minimum descent altitude
MHz	megahertz
NPA	non-precision approach
PAPI	precision approach path indicator
RCLL	runway centreline lighting
REIL	runway end identifier lighting
Rwy	runway
TAIC	Transport Accident Investigation Commission
UTC	coordinated universal time

Glossary

dew point	the temperature at which the air becomes saturated and condensation forms.
missed approach point	the position at which the pilot must have commenced the missed approach procedure if the required visual references have not been obtained.
non-precision approaches	instrument approach procedures that utilise lateral guidance but have no vertical guidance element.
NOTAM	a notice containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.
QNH	an altimeter sub-scale setting to obtain elevation when on the ground.
runway 23L	runway 23 left at Auckland International Airport, aligned on about 230º magnetic.
squawk	the setting of the aircraft's transponder code as instructed.

Data Summary

Aircraft registration:	HL7597
Type and serial number:	Boeing 777-200**,** 28686
Year of manufacture:	2001
Number and type of engines:	2 Pratt and Whitney 4090 turbofans
Operator:	Asiana Airlines Incorporated
Date and time:	16 November 2004, 1058[1]
Location:	Auckland International Airport latitude: 37° 00.48′ south longitude: 174° 47.5′ east
Type of flight:	scheduled air transport
Persons on board:	crew: 17 passengers: 200
Injuries:	crew: nil passengers: nil
Nature of damage:	nil
Captain's licence:	Airline Transport Pilot Licence
Captain's age:	46
Captain's total flying experience:	8499 hours (693 hours on type)
Investigator-in-charge:	I R M^{c}Clelland

Acknowledgement

The Commission acknowledges the assistance provided by the Korea Aviation-accident Investigation Board (KAIB).

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

1 Factual Information

1.1 History of the flight

1.1.1 On Tuesday 16 November 2004, HL7597, an Asiana Airlines Boeing 777-200, was on a scheduled service from Incheon, Republic of Korea (South Korea) to Auckland, New Zealand. On board were 200 passengers, 13 cabin crew and 4 pilots, comprising a primary and relief crew, each with a captain and first officer. The primary crew captain was the flying pilot for the flight. The flight had the designation of AAR 607 and the crew used the callsign Asiana 607.

1.1.2 The flight was scheduled to take between 11 and 12 hours. The primary crew flew the first 5 - 6 hour segment of the flight, after which the relief crew flew took over. With about an hour still to fly, the primary crew returned to the flight deck and prepared for the approach and landing at Auckland International Airport. The relief first officer remained on the flight deck to assist the primary crew for the arrival.

1.1.3 At 1020, the first officer changed radio telephone frequency to Auckland Control and advised "Auckland, Asiana 607 approaching *Dugan*[2] maintaining 390[3]." The controller replied "Asiana 607, Auckland Control good morning, squawk 4163"[4]. The first officer acknowledged the request and the crew set the required code. Shortly afterwards the controller advised "Asiana 607 identified [at] flight level 390. Cleared Harbour One Alpha Arrival for runway 23 left (23L)[5]. Auckland information *Hotel*, QNH 1011[6]". The first officer replied "Asiana 607, 390. Harbour One Alpha Arrival, 23L. Information *Hotel* 1011".

1.1.4 The "information *Hotel*" referred to by the controller and acknowledged by the first officer was the aerodrome information that was being broadcast on the automatic terminal information service (ATIS) at the time. The ATIS broadcast was as follows:

> Auckland information Hotel, issued at 2056[7] [0956 local]. Active runway mode, special operations refer flight guide or Jeppesen[8] Yellow Pages. Expect Zulu 23L approach. Runway conditions dry. Displaced threshold runway 23L. Landing distance available 2535 metres. NOTAM Bravo 3815. Surface wind 280 degrees 16 knots. Visibility 25 km. Present weather haze. Cloud, few 2300 feet, scattered 3000 feet. Temperature 20. Dew Point 14. QNH 1011. Reported 2000-foot wind, 280 degrees 20 knots. On first contact with Auckland Tower or Control, notify receipt of Hotel.

1.1.5 As AAR 607 continued towards Auckland, the controller instructed the crew to descend in stages to 11 000 feet (ft) and change frequency to the Auckland Terminal Radar controller. At 1042:02 the first officer changed frequency and reported "Auckland Control, Asiana 607 descend 11 000 [ft], *Hotel*." The Terminal controller replied "Asiana 607 descend to 6000 ft, maintain your current speed". The first officer acknowledged the instructions.

1.1.6 At 1042:20 the Terminal controller advised "Asiana 607 expect Zulu 23L approach"[9]. At 1042:38, with no response, the controller repeated the information and at 1042:40 the first officer replied "Zulu 23L approach, Asiana 607". At 1043:46 the Terminal controller instructed AAR 607 to change frequency to Auckland Arrivals.

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[2] DUGAN was a reporting point located 200 nautical miles (nm) from Auckland on a bearing of 319º magnetic and identified the New Zealand domestic boundary.
[3] Flight Level 390, or about 39 000 ft.
[4] Instruction for the crew to select the allocated code on the aircraft's transponder, thereby assisting in the identification of the aircraft on the controller's radar screen.
[5] Harbour One Alpha Arrival procedure required the aircraft to track from DUGAN to ANKIL reporting point (northeast of Auckland), from there to expect radar vectors for runway 23L and to descend as instructed.
[6] QNH, an altimeter subscale setting to obtain elevation when on the ground.
[7] UTC time reference.
[8] Jeppesen Sanderson Incorporated of the United States.
[9] The "Zulu 23 left approach" referred to the localiser DME (distance measuring equipment) instrument approach to be used when an inset or displaced threshold was in operation for runway 23L.

1.1.7 At 1045 ATIS information *Hotel* was replaced by information *India*. The information remained essentially the same but noted a deterioration in the conditions with "showers in the vicinity", scattered cloud at 2300 ft, a dew point of 13º C and a 2 knot reduction in the surface wind.

1.1.8 Between 1044 and 1050 the Arrivals controller gave AAR 607 instructions to position for the instrument approach for runway 23L. At 1052:17 the Arrivals controller instructed AAR 607 to turn "right heading 200, cleared Zulu approach runway 23L". At 1052:23 the first officer replied "Heading 200 [unreadable] cleared Zulu 23L approach, Asiana 607". The Arrivals controller responded "Asiana 607 correct… contact tower…".

1.1.9 At 1053:31 the first officer reported "Asiana 607 approaching runway 23L". The Tower controller responded "Asiana 607, Auckland Tower good morning, continue approach runway 23L, displaced threshold, number one". The first officer replied "continue approach 23L, number one".

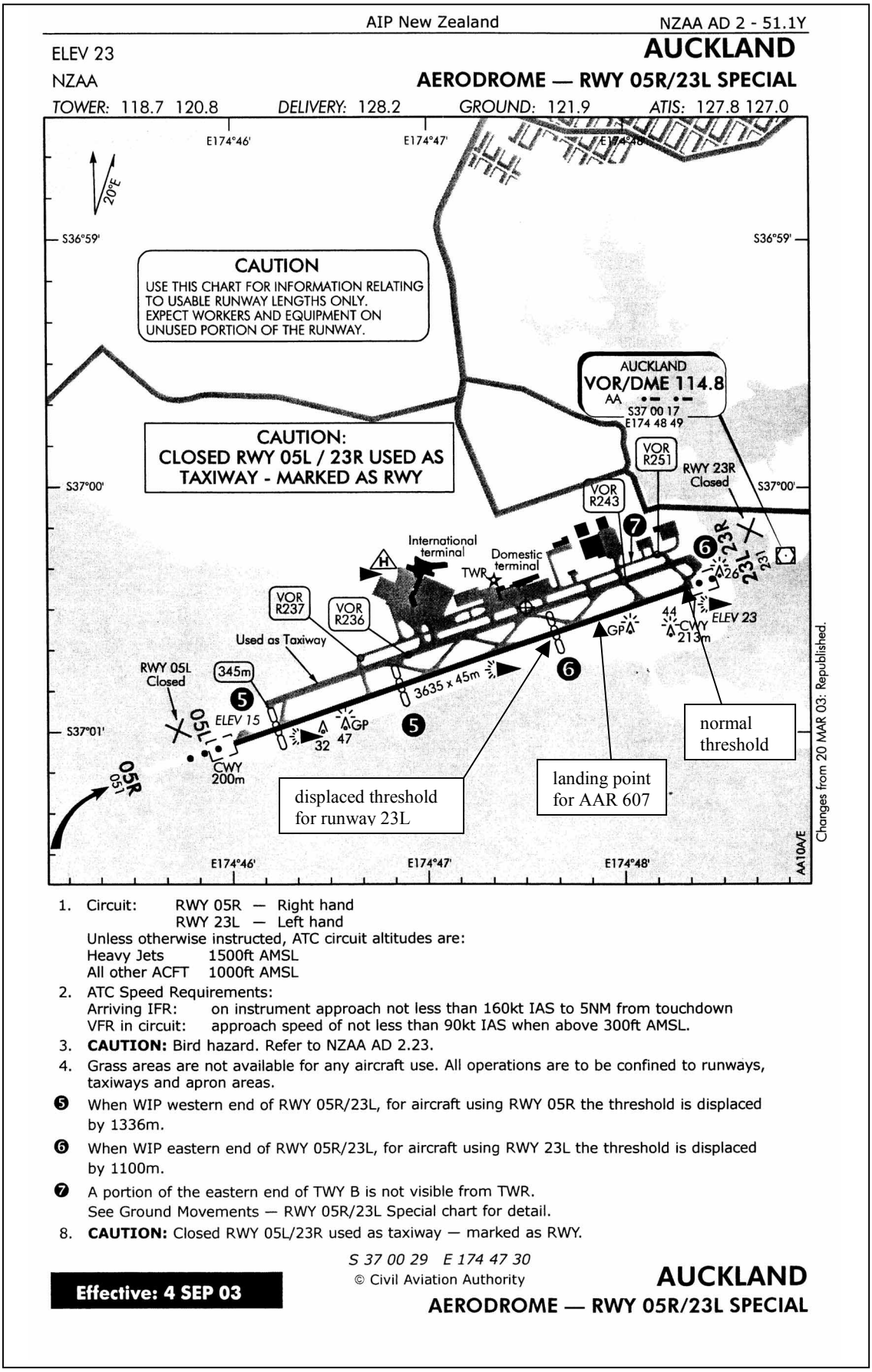
1.1.10 At 1053:49 the Tower controller called a preceding aircraft on short final, advising "[callsign] ... displaced threshold 23L, cleared to land". The pilot of the preceding aircraft acknowledged the landing instruction. At 1055:14, after the preceding aircraft had landed, the Tower controller cleared a Boeing 767-300 for take off from full length. Neither the Tower controller nor the Boeing 767-300 crew made any reference to departing from full length at this time.

1.1.11 At 1056:37, after the Boeing 767-300 had departed, the Auckland Ground controller, on a radio frequency separate from the tower frequency, cleared a runway work party back onto the runway to continue their work on the eastern closed section of runway. The Ground controller also advised the work party, "Asiana should be for the displaced threshold". The coordinator for the ground party replied "… works party moving on back for displaced threshold".

1.1.12 At 1056:59 the Tower controller instructed "Asiana 607, surface wind 290º 14 knots, displaced threshold runway 23L, cleared to land". The first officer replied "cleared to land 23L, Asiana 607". At 1057:49 the Tower controller reported he was able to see AAR 607 and, concerned about its angle of approach, transmitted "Asiana 607 confirming displaced threshold". The first officer replied "Asiana 607".

1.1.13 After being cleared onto the runway by the Ground controller, the work party coordinator saw AAR 607 approaching at below what he considered to be the expected approach path for the displaced threshold. He therefore decided to wait until AAR 607 had landed before allowing the work party onto the runway. The Tower controller continued to monitor the approach of AAR 607 and saw that the runway work party was remaining clear of the runway. There were no other obstructions on the runway.

1.1.14 At 1058 AAR 607 was observed to land abeam taxiway Bravo 3, about the normal landing position for full runway length operations (see Figure 1). The landing point was about 720 m past the full-length threshold, or about 380 m short of the displaced threshold, and about 750 m short of what was regarded as the landing point for displaced threshold operations. The crew of AAR 607 and the operator were not aware that there had been an incident until advised by TAIC some 10 days later.



1. Circuit: RWY 05R — Right hand
   RWY 23L — Left hand
   Unless otherwise instructed, ATC circuit altitudes are:
   Heavy Jets 1500ft AMSL
   All other ACFT 1000ft AMSL
2. ATC Speed Requirements:
   Arriving IFR: on instrument approach not less than 160kt IAS to 5NM from touchdown
   VFR in circuit: approach speed of not less than 90kt IAS when above 300ft AMSL.
3. **CAUTION:** Bird hazard. Refer to NZAA AD 2.23.
4. Grass areas are not available for any aircraft use. All operations are to be confined to runways, taxiways and apron areas.

❺ When WIP western end of RWY 05R/23L, for aircraft using RWY 05R the threshold is displaced by 1336m.

❻ When WIP eastern end of RWY 05R/23L, for aircraft using RWY 23L the threshold is displaced by 1100m.

❼ A portion of the eastern end of TWY B is not visible from TWR.
See Ground Movements — RWY 05R/23L Special chart for detail.

8. **CAUTION:** Closed RWY 05L/23R used as taxiway — marked as RWY.

S 37 00 29 E 174 47 30

Effective: 4 SEP 03

AUCKLAND
AERODROME — RWY 05R/23L SPECIAL

Figure 1
Auckland Aerodrome Chart, Runway 05R/23L Special
(courtesy of Airways New Zealand)

1.2 Injuries to persons

1.2.1 There were no injuries.

1.3 Damage to aircraft

1.3.1 There was no damage to the aircraft.

1.4 Personnel information

1.4.1 The flying captain was aged 46. He held a Korean Airline Transport Pilot Licence and had flown some 8500 hours, including about 693 hours on the Boeing 777. He had flown 220 hours in the last 90 days.

1.4.2 The captain's last annual proficiency check was completed on 20 July 2004. He was reported as having flown to Auckland on 11 occasions, the first on 12 November 2003 and the last before the incident was on 6 September 2004.

1.4.3 The first officer, aged 35, had a total flying experience of 3894 hours with 1637 hours on the Boeing 777. The relief first officer, aged 34, had a total flying experience of 2616 hours with 1650 hours on the Boeing 777.

1.4.4 The first officer and relief first officer had also flown to Auckland on 11 occasions, the first officer's last flight being 1 October 2004 and the relief first officer on 1 September 2004.

1.4.5 After completing the flight, the crew of AAR 607 remained in Auckland for 2 nights before flying the return leg to Incheon on Thursday 18 November.

1.5 Aircraft information

1.5.1 HL7597 was a Boeing Company 777-200 aeroplane, serial number 28686, manufactured in the United States in August 2001. It was capable of carrying 327 passengers and crew.

1.5.2 The aircraft was fitted with 2 Pratt and Whitney 4090 turbofan engines.

1.5.3 The aircraft was reported as serviceable with no defects that would restrict its operation. The aircraft returned to Incheon later the same day with another crew as scheduled.

1.6 Aids to navigation

1.6.1 Auckland Airport was equipped with a range of navigation aids for managing aircraft approaches and departures. For the approach of AAR 607 the Auckland controller used radar vectors to position the aircraft for the instrument approach to the runway in use, runway 23L.

1.6.2 For full runway length operations, the aerodrome was equipped with several instrument approach aids, the primary aid being the instrument landing system (ILS) for each of the main runways, 23L and 05R. The ILS provided a pilot with both tracking (heading) and glidepath information. Set for a 3º glidepath, the ILS for runway 23L gave a predicted 50 ft (15 m) threshold crossing height. A co-located DME (distance measuring equipment) provided distance information to the landing point.

1.6.3 HL7597 was fitted with the normal complement of navigation aids for a large aircraft.

1.7 Communication

1.7.1 There was normal radio transceiver communication between the crew of AAR 607 and ATS.

1.8 Aerodrome information

Normal operations

1.8.1 To assist in the transition from an instrument approach to visual flight for the landing, each runway at Auckland was equipped with a range of lighting systems. For the ILS approach to runway 23L there were 3 sequenced strobe lights, a light intensity high approach lighting system (LIH ALS), a runway end identifier lighting (REIL) system and a runway centreline lighting (RCLL) system. These systems provided runway lead-in, threshold and centreline guidance for a pilot.

1.8.2 To provide visual glidepath information, runway 23L was equipped with a precision approach path indicator (PAPI) lighting system. The PAPI consisted of 4 lamp units located to the left of the runway, each containing both red and white lights. The PAPI was set for a 3º glidepath to give a nominal 73 ft (22 m) threshold crossing height.[10] When on glidepath, a pilot would see 2 of the units illuminated red and 2 illuminated white. If flying above the glidepath the number of white illuminated units would increase and if below glidepath the number of red units would increase.

1.8.3 Runway 23L also had white painted markings defining the threshold and touchdown zone. The threshold markings were a series of broad stripes placed either side of the runway centreline, commencing 6 m in from the start of the runway. The touchdown zone markings consisted of pairs of slightly smaller stripes placed symmetrically either side of the runway centreline. The first pair was located 150 m in from the start of the threshold markings and then every 150 m after that for the length of the touchdown zone. Between the threshold and touchdown zone markings was a large number 23L, confirming the runway designation. The markings were in accordance with international standards.

Displaced threshold operations

1.8.4 In the mid 1990s a major works programme was started on the runway and taxiway facilities at Auckland International Airport. To facilitate work on the main runway Auckland International Airport Limited (AIAL) and Airways Corporation of New Zealand (ACNZ) developed procedures where the runway, or sections of it, could be closed to traffic. When work on either end of the runway was required, the remaining two-thirds or thereabouts would still be available for operations. Should the centre section or the full runway be closed, then the former taxiway would be utilised as a temporary runway. To facilitate this, the taxiway was widened to 45 m and marked and designated as runway 05L/23R.

1.8.5 ACNZ produced colour-coded charts for the various operating scenarios. The standard white charts were for normal full-length runway 05R/23L operations. Green coloured charts were to be used when runway 05R/23L was closed and runway 05L/23R became the alternative runway. Yellow coloured charts were to be used when displaced threshold operations were being conducted for either runway 05R or 23L. To emphasise the runway mode, the current ATIS would include the phrase "Active Runway Mode Special Operations, refer AIP [flight guide][11] or Jeppesen Yellow Pages".

1.8.6 Additional runway lighting systems were installed for main runway displaced threshold operations when runway 23L or 05R operated with a displaced threshold. Lighting systems installed included REIL, PAPI and displaced high-intensity threshold wing markers. The PAPI was set to 3º and positioned to give a displaced threshold crossing height of 73 ft.

1.8.7 To activate the lighting for displaced threshold operations for runway 23L, the Ground controller rotated a key in the control tower. This action turned on the displaced threshold PAPI, REIL and threshold wing marker lights. It also turned off the full-length PAPI, REIL and the 3 strobe lights, and the RCLL lights.

[10] The threshold crossing height was from a pilot's eye to the ground. For the Boeing 777-200 this would give a minimum wheel height above the threshold of 30.2 ft (9.9 m).
[11] AIP – Aeronautical Information Publication charts produced by ACNZ.

1.8.8 The key action also disabled the glidepath element of the ILS. Pilots were therefore required to fly a localiser/DME (LLZ/DME) instrument approach to the displaced threshold. This instrument approach was contained within the Yellow Pages of the approach charts for Auckland and was titled LLZ/DME RWY 23L ZULU 23L.

1.8.9 Prior to any work on the main runway being undertaken a NOTAM[12] was required to be issued and available to all aerodrome users. On 16 November 2004, NOTAM B3815/04 was current and the relevant information is summarised as follows:

> Runway 05R/23L, work in progress east of taxiway A3. Reduced length for take off and landing will apply. Full-length take off available to long haul international aircraft with 15 minutes prior notification. Full-length landing not available. Restrictions not activated when runway wet. Activation of restrictions will be by ATIS or radiotelephone. Auckland Arrival/Departure Chart (5) – runway 05R/23L displaced threshold information refers. Published Zulu and Vulcan Yellow Charts apply for displaced threshold. Runway 23L, threshold displaced 1100 m. PAPI available south side of runway giving 73 ft threshold crossing height. All landing aircraft use PAPI to avoid works area. Inset threshold marked by illuminated high intensity green wing markers both sides of runway. LIH ALS and LIL ALS and RCLL not available. Effective distance available runway 23L: landing distance available 2535 m. Men and equipment will be working on closed portion of runway.

1.8.10 On the day of the incident, work on the eastern end of runway 05R/23L was scheduled. For runway 23L operations this required the closing off of the first 1100 m of runway. In accordance with procedures Air Traffic Services (ATS) activated NOTAM B3815/04 by issuing ATIS information *Hotel* at 0956. The preceding ATIS, information *Golf* issued at 0850, advised normal runway operations and full runway length available.

1.9 Flight recorders

1.9.1 The aircraft was fitted with both cockpit voice and flight data recorders. However, the information from the recorders was not retrieved as it had been overwritten before the operator was advised a possible incident had occurred.

1.10 Organisational and management information

1.10.1 The operator advised that there was no specific check requirement for pilots to fly to Auckland. Pilots were required, however, to have received training in oceanic procedures and completed a training flight to either Sydney or Auckland before being approved for regular operations. The crew of AAR 607 were reported to have met this requirement.

1.10.2 The operator further advised that regular training sessions were held for pilots. On 7, 22 and 27 April 2004 and 6 May 2004 company pilots were given a briefing on Auckland runway work and the effect on operations. All Boeing 777 pilots were reported as having attended one of these briefings.

1.10.3 For en route navigation, instrument approaches and aerodrome information, the operator used maps and charts produced by Jeppesen but based on locally manufactured charts produced by a country's aeronautical authority. For Auckland, Jeppesen produced a series of charts, also colour-coded white, yellow and green, based on the AIP charts produced for the Civil Aviation Authority of New Zealand (CAA). The chart used by the crew of AAR 607 for approach to runway 23L was a Jeppesen chart titled "ZULU 23L LOC DME Rwy 23L", effective from 17 May 2001 and was current on the day of the incident (see Figure 2).

[12] A notice containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.

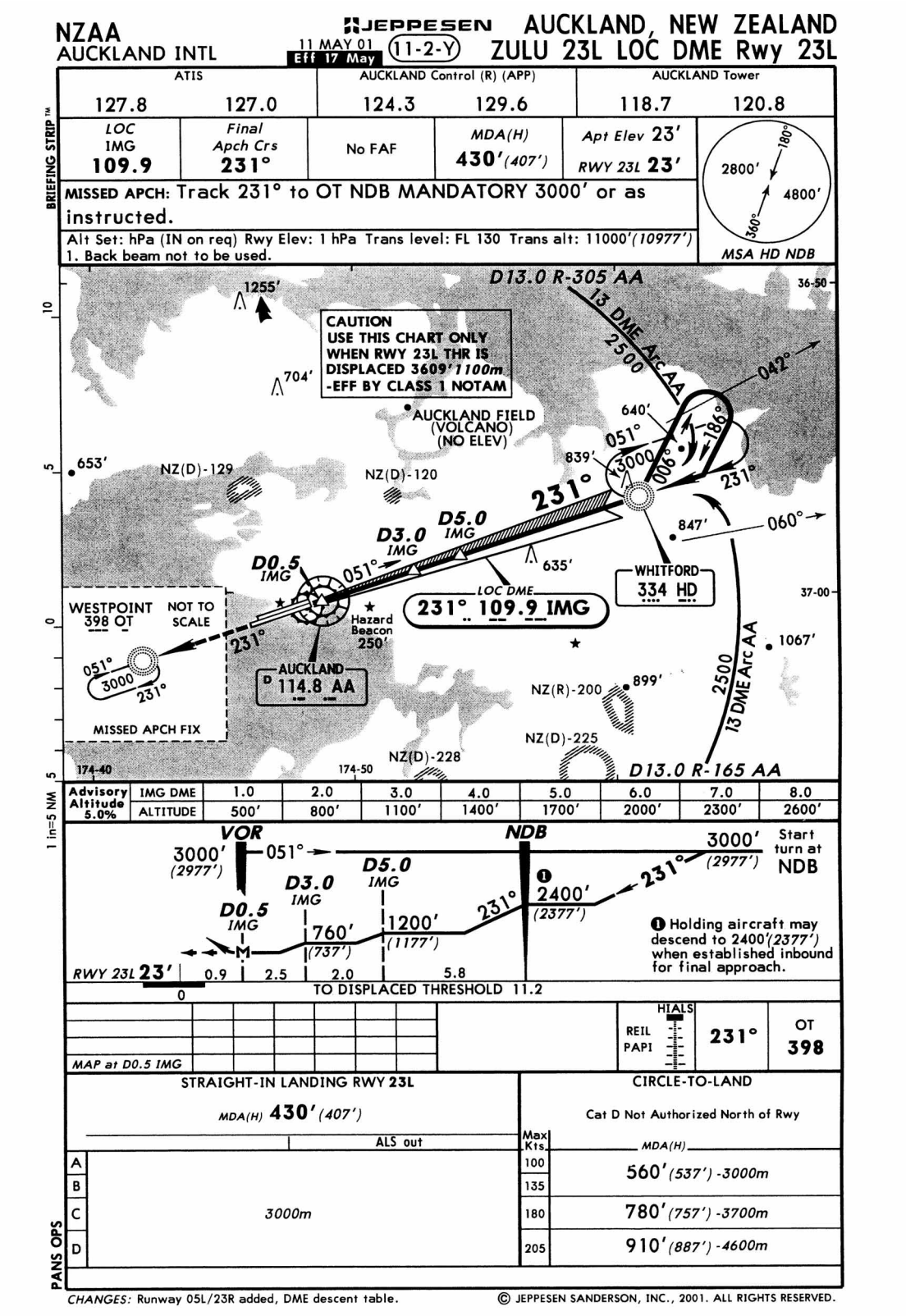


Figure 2
Jeppesen Auckland Approach Chart, ZULU 23L LOC DME Runway 23L
(Reproduced with permission of Jeppesen Sanderson, Inc)
NOT FOR NAVIGATIONAL USE

1.10.4 While the AIP and Jeppesen charts for the 23L ZULU approach contained the same factual information, they did differ in presentation. One obvious difference was that the descent profile for the AIP chart was depicted as a constant angle. DME altitude limits during the approach were written along the constant angle profile.[13] The Jeppesen chart approach profile was drawn in steps, with a descent after each DME altitude limit, followed by a level portion before the next DME limit was reached.

1.10.5 The operator advised that for non-precision approaches, or those approaches without a glideslope element, for example the localizer (LOC) approach, pilots were to fly a "*stepped approach*" method. A pilot would couple the LOC to the autopilot for automated heading or tracking control. The approach angle or glideslope was controlled by use of the aircraft's vertical navigation capability. After passing a DME altitude limit on the approach a pilot would set the next altitude limit and the aircraft would immediately start descending to that altitude. The new altitude would normally be reached before the next DME limit and so the aircraft would be flown level until it was passed. This procedure meant that the minimum descent altitude (MDA)[14] could be reached early, potentially allowing a pilot more time to obtain the required visual cues needed for landing. For the ZULU 23L LOC DME Rwy 23L approach the MDA was 430 ft (131 m) and the missed approach point[15] was 0.9 nautical miles (nm) from the displaced threshold.

1.10.6 The operator reported that on 16 November the crew of AAR 607 flew a *stepped approach* profile for the LOC DME runway 23L.[16] The operator further advised that the aircraft would have been flown on autopilot until the required visual cues were obtained. The autopilot would have then been disconnected and the aircraft landed manually.

1.11 Additional information

1.11.1 The operator later advised that the dispatcher responsible for the collation of flight information for the crew of AAR 607, including forecast route weather and NOTAM information, was new to the job. Further, during the preparation for the flight NOTAM B3815/04 was "mishandled" by the dispatcher and not included with the rest of the briefing package. The operator was developing new procedures to prevent any future mishandling of NOTAMs.

1.11.2 Studies undertaken by aviation organisations, including Flight Safety Foundation and International Civil Aviation Organisation (ICAO), into controlled flight into terrain (CFIT) accidents have identified that a large percentage of these accidents occurred in the final approach phase of flight, with a majority occurring on non-precision approaches (NPAs). NPAs that contained a distance measuring reference, for example a DME, were traditionally based on the *stepped approach* methodology to ensure the required obstacle clearance was maintained as the aircraft approached a runway.

1.11.3 The studies further identified that a constant angle approach, based on a specified datum or aiming point, for example 50 ft over the threshold, was preferable to a *stepped approach.* While this could result in the aircraft crossing some approach check heights above the minimum permitted, the constant angle approach had the advantage of providing a smoother stable flightpath to landing and helped avoid any undershooting tendency that might occur.

[13] On commencing the approach, the aircraft was not permitted to descend below specific altitudes until past the associated DME limit: for example, not below 1200 ft until past 5 DME, and not below 760 ft until past 3 DME.
[14] An altitude an aircraft may not descend below until the required visual references are obtained.
[15] That point at or before which the prescribed missed approach procedure must be initiated in order to ensure that the minimum obstacle clearance is not infringed.
[16] Once cleared for an instrument approach, it is up to the pilot to manage the aircraft during the approach and ensure the stated minima are not infringed. A constant angle or stepped profile is at the pilot's discretion.

1.11.4 ACNZ, in Aeronautical Information Circular (AIC) 3/04 titled *Non-precision Instrument Approach Procedures – Constant Angle Descent Profile:* effective 5 August 2004[17], refers to the CFIT studies and attributes many of the accidents to pilots flying a *stepped approach* profile. The AIC states that the "constant angle of descent technique is widely used as a method of reducing the potential of an accident during a non-precision approach (with distance reference) in that a vertical flight path, above segment minimum safe altitudes, is provided." All NPA approaches in New Zealand with a DME reference depicted the approach profile as a constant angle, for at least the final approach segment. ACNZ was also in the process of adding advisory altitudes based on a constant 3º glidepath.

1.11.5 Jeppesen advised in a bulletin issued 16 April 2004 that:

> Beginning 16 APR 04 revision, for countries that provide approach procedure profile (descent) information described above [profile descent information for non-precision approaches], Jeppesen will modify its approach charts to show the vertical approach path in the profile view (thick line) as a constant angle descent path.

A diagram of the proposed profile for 23L at Auckland is at Figure 3.

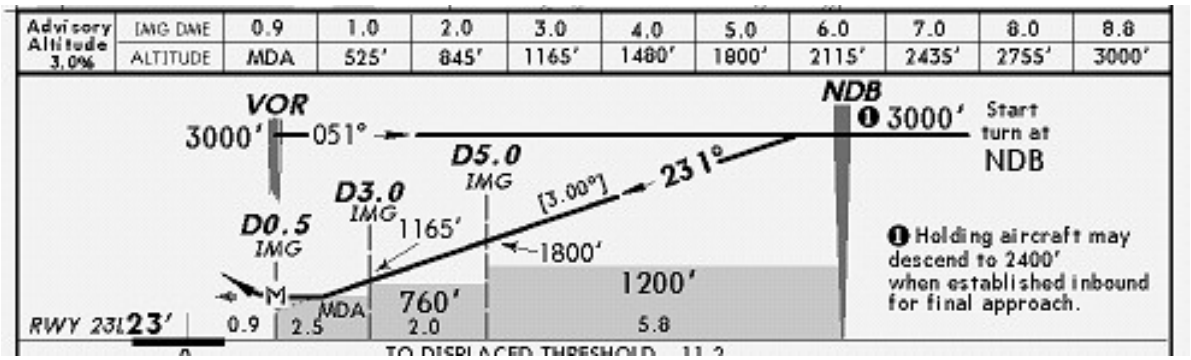


Figure 3
Proposed Jeppesen profile diagram for Localiser DME approach 23L
(Reproduced with permission of Jeppesen Sanderson, Inc)
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1.11.6 Both ICAO[18] and CAA[19] consider an aircraft landing short of a designated threshold to be a serious incident. Civil Aviation Rule Part 12.57, dated 30 April 1999, directs that CAA be notified of a serious incident "as soon as practicable" and full details supplied within 10 days.

1.11.7 On this occasion, ACNZ notified CAA of the incident by sending an aeronautical fixed telecommunications network (AFTN) message within 15 minutes of Asiana 607 landing. However, ACNZ accorded the incident a lower priority as they considered there was no possibility of an accident due to the vigilance of the ground party coordinator. Accordingly CAA did not immediately act on the low priority message, despite the message narrative identifying it as a likely serious incident.

1.11.8 TAIC became aware of the incident on 24 November from another source and after inquiries to CAA received notification on 25 November. By this time the aircraft and crew had departed New Zealand and any relevant cockpit voice recording had been overwritten. The TAIC investigator was unable to talk directly to the crew, but the KAIB interviewed the flight crew and dispatcher on his behalf.

[17] Replaced by AIC 2/05, effective 17 March 2005, which repeated the same information.
[18] ICAO Annex 13, Ninth edition July 2001, Attachment C, dated 1 November 2001, and confirmed by email correspondence 27 May 2005.
[19] Civil Aviation Rules Part 1, Definitions and Abbreviations, dated 25 November 2004.

2 Analysis

1.12 AAR 607 was a routine scheduled flight with an augmented flight crew. The crew were appropriately rested and had ample time to prepare for the approach and landing. The aircraft was serviceable and the weather was not a factor, with isolated showers and a light to moderate surface wind. The available runway length was more than sufficient for a Boeing 777 to land safely.

1.13 The absence from the crew's briefing package of NOTAM B3815/04 detailing work on the runway should not have limited their understanding of the approach and landing procedure. The 3 pilots on the flight deck during the approach and landing were familiar with Auckland, each having flown there on 11 occasions, with on average a little over 2 months since their last flight there. They were also equipped with the full range of charts to allow for any work being performed on the runway.

1.14 ATS informed the crew of the displaced threshold on 7 separate occasions, either directly or indirectly through reference to the ATIS or type of instrument approach to be flown, but AAR 607 still landed short. Why the crew did not recognise or register the presence of a displaced threshold could not be determined.

1.15 The crew first called Auckland Control some 24 minutes after ATIS information *Hotel* was issued. The crew should therefore have been aware of the aerodrome conditions, including the requirement to use the yellow copies of the approach and landing charts. Had the crew received the earlier information *Golf,* the requirement to repeat back to a controller that information *Hotel* was current should have corrected any early erroneous mindset that full runway length was available.

1.16 As AAR 607 continued towards Auckland the first officer confirmed to the Terminal controller that they had received ATIS information *Hotel*. Soon afterwards the Terminal controller advised the crew to expect the ZULU 23L approach, which the first officer acknowledged. At 1052:17 AAR 607 was cleared for the ZULU approach and first officer again correctly repeated back the clearance.

1.17 The Jeppesen instrument approach chart used for the approach clearly stated in a caution box on the chart that it was only to be used when the runway threshold was displaced by 1100 m. The chart was colour-coded yellow to reinforce the special conditions that applied, namely work on the runway and a displaced threshold.

1.18 On final approach the crew should have again been alerted to the displaced threshold on 4 occasions. The Tower controller specifically advised the crew of AAR 607 on 3 occasions and he also cleared a preceding aircraft to land with the displaced threshold, a conversation that would have been heard by the crew of AAR 607. Although the first officer was not required by aviation protocols to repeat back the advice on the displaced threshold, he did acknowledge the Tower controller's transmission on each occasion. The controller, therefore, could reasonably assume that the crew of AAR 607 knew of the displaced threshold.

1.19 Once becoming visual and electing to continue the landing, the crew of AAR 607 would have been able to use the available runway lighting systems to maintain or re-establish a 3º glidepath and land past the displaced threshold. The PAPI lights would have provided an accurate indication of the correct approach angle. That AAR 607 still landed short indicated that the captain probably ignored the glidepath and threshold lighting and was focused on landing as soon as possible.

1.20 By flying a *stepped approach*, the crew continuously placed themselves below the normal profile for the displaced threshold. Once past the last check altitude of 760 ft at 3 nm, the pilot was able to descend immediately to the MDA of 430 ft. With about 3 nm to fly to the displaced

threshold the pilot would have needed to apply significant power to arrest the descent and intercept the 3º glidepath to land safely.

1.21 Stable approaches are strongly recommended for jet transport aircraft, with targeted speeds and a steady rate of descent, requiring only minimal changes in power. By flying a *stepped approach* to touchdown, the crew was continually required to manoeuvre the aircraft along each step and therefore possibly devoting less attention to monitoring ATS instructions and other external sources of information, for example PAPI glidepath lighting.

1.22 The crew could have seen the runway environment as early as about 2300 ft on the approach as they descended below the cloud base. This would have placed the aircraft at about 11 nm from the runway. While the crew may have seen the Boeing 767 take off and depart, they would have been unlikely to see where it started its take off roll. Therefore, this should not have influenced the crew's expectation of where the displaced threshold was located. Also runway and approach lighting remained set for the displaced threshold while the Boeing 767 departed.

1.23 On final approach, the pilots of AAR 607 were presented with a view of a runway extending out into the harbour at the far end. This possibly provided a subconscious influence on the captain to land as soon as possible and complete the landing roll well before the end of the runway. Also the working party had not entered the runway area, and so visually there was nothing obstructing the initial portion of the runway. However, having flown to Auckland 11 times before, the crew should have been aware of the aerodrome layout.

1.24 The requirement to repeat back particular elements of an air traffic control clearance was an established international procedure to help ensure a pilot clearly understood instructions. While English was probably not the first language for the crew of AAR 607, the first officer's responses to ATS clearances and advice were correct and gave no outward indication that the crew was unaware that the first 1100 m of the runway was closed. Further, if there was any doubt about the intended landing point during the approach, any member of the crew should have been able to alert the others to the displaced threshold and the requirement to land past it.

1.25 While ATS controllers have a responsibility to assist pilots who are perhaps unfamiliar with an aerodrome and local procedures, they should not have to repeatedly ask if a pilot has understood an instruction. It is incumbent on operators to ensure that their crews are appropriately trained and can clearly communicate with controllers to ensure the safe conduct of a flight.

1.26 A Tower controller is able to cancel a landing clearance and instruct a pilot to overshoot if it is considered dangerous for the aircraft to continue its approach and landing. The Tower controller on duty for the approach of AAR 607 was able to see that the runway was clear and there was no danger to the aircraft or runway work party. He therefore elected not to intervene and allowed AAR 607 to continue to land. This decision was reasonable, for to direct AAR 607 to overshoot in the final stages of the approach may have added to any confusion.

1.27 The runway work party coordinator made an appropriate decision not to allow the work party to enter the runway area when he saw AAR 607 approaching. Potentially the aircraft could have landed on or among the workers with consequent serious results.

1.28 One of the requirements for work to be undertaken on the runway at Auckland was that full runway length be available for heavy weight aircraft take offs and for emergency operations. Workers and their equipment needed to be able to be moved clear of the runway at short notice. Any hazard markers used to identify runway work therefore also needed to be light and easily transportable. Only in the event of a complete runway closure could large semi-permanent hazard markers be used to identify a closed section or runway. The typical method of identifying a hazard was to use large Xs, either as illuminated structures at the runway threshold or painted on the runway surface. Large lighted Xs inset into the runway, that could be illuminated as required, provide one possible solution for temporary closures.

1.29 The notification of the incident, although in accordance with Civil Aviation Rules and normal procedures, did result in delays and vital information being lost. TAIC was not able to interview the crew in a timely manner or access the aircraft's recorders. The investigation was, therefore, unable to determine if this incident was an isolated breakdown in crew communication or an indication of a wider systemic issue.

1.30 Both CAA and TAIC need to be notified immediately should a serious incident like this occur in the future. While the AFTN is efficient in message transmission ATS, and particularly CAA who manage the notifications, need to ensure that potentially high priority serious incidents are acted upon without delay, thereby ensuring an investigation is started in a timely manner.

3 Findings

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

3.1 The aeroplane was serviceable and correctly crewed for the flight.

3.2 The pilots were appropriately qualified and should have been familiar with Auckland, all having flown there a number of times before.

3.3 There was no evidence of fatigue or major distractions for the crew.

3.4 NOTAM B3815/04, advising of the runway work, was received by the operator but not passed on to the crew.

3.5 The crew was alerted by ATS to displaced threshold operations on numerous occasions and acknowledged the advice.

3.6 The aircraft landed short of the displaced threshold in an area where workers were cleared to operate.

3.7 The work party coordinator was vigilant in identifying a potentially hazardous situation and keeping the workers clear of the runway.

3.8 The Tower controller's decision not to instruct AAR 607 to overshoot was reasonable given his knowledge that the full runway length was available.

3.9 The flying of a *stepped approach* profile prevented the crew from achieving a stable approach to touchdown and may have contributed to the aircraft landing short of the displaced threshold.

3.10 The crew ignored the available glidepath and threshold lighting systems and continued for a landing within the normal touchdown zone.

3.11 The crew displayed questionable competence in their compliance with the various controllers' instructions and approach guidance information, which may have been affected by English being their second language.

3.12 The incident was notified according to regulations, but valuable investigative information was lost when the aircraft and crew departed New Zealand before the investigation had commenced.

4 Safety Actions

4.1 ACNZ advised that Auckland-based controllers had been briefed on the incident and there was a heightened level of awareness of the potential for aircraft to land short of a displaced threshold. Further, controllers are fully aware that if they believe a situation is unsafe to immediately instruct the pilot to go-around.

4.2 Due to the distance and prospective from the tower it is difficult for a controller to assess if an aircraft is going to land short or is overflying the closed portion of the runway at low level before landing on the displaced threshold. Controllers will therefore continue to closely monitor carriers where pilots may not be fully familiar with Auckland runway operations.

5 Safety Recommendations

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

5.1 On 26 May 2005, the Commission recommended to the Chief Executive of Asiana Airlines that he:

5.1.1 direct that, where possible, the flying of *stepped approach* profiles be discontinued and replaced with constant angle approaches for non-precision instrument approaches. (059/05)

5.1.2 review training requirements, particularly English competency levels, for crews who fly to international destinations. (060/05)

5.2 On 15 June 2005, the General Manager Preventative Safety Team, Asiana Airlines replied and is summarised as follows:

5.2.1 The safety recommendations [059/05 and 060/05] are implemented.

5.2.2 After completing ground school requirements pilots will conduct VNAV (vertical navigation) approaches instead of using step down approaches. This will be included in revised aircraft Operations Manuals and is subject to Korean Civil Aviation Safety Authority (CASA) requirements. All Asiana Airlines B747, B777 and Airbus aircraft are well-equipped for VNAV operations.

5.2.3 Asiana Airlines are preparing for ICAO Language Proficiency Requirement scheduled for 5 March 2008. Flight crew are given structured training in English, including a 2-day course and recurrent training. This is supervised by CASA. Additional training is also available and planned. Only qualified pilots are cleared for international flights. The basic training stage for all cockpit crews will be completed on 30 June 2005.

5.3 On 13 May 2005, the Commission recommended to the Chief Executive of AIAL that he:

5.3.1 examine runway visual indications with the objective of providing additional visual reminders to pilots that a displaced threshold is in operation. (063/05)

5.4 On 3 June 2005, the Airfield Operation Manager for Auckland International Airport Limited replied in part:

5.4.1 Auckland International Airport Limited intends to implement the safety recommendation 063/05 and has already been looking for possible solutions. However, as there is no standard fix for this type of operation, it will not be something that can be implemented immediately. While we are unsure of the size of the task at this stage, it is likely to take at least 6 months, with perhaps a progressive roll out of different aspects in the interim.

5.5 On 17 June 2005, the Commission recommended to the Director of Civil Aviation that he:

5.5.1 complete a review of accident and incident notification procedures to ensure notifications, especially those requiring immediate action, are processed in a timely manner. (066/05)

5.6 On 27 June 2005, the Director of Civil Aviation replied:

5.6.1 The Director will accept this recommendation and the Manager Safety Investigation will review procedures to ensure information is correctly categorised and processed. In addition after normal working hours process[es] will be enhanced to detect serious incidents in a timely manner.

This review will be completed by 1 August 2005 and the new procedures will be implemented during September.

Approved on 30 June 2005 for publication

Hon W P Jeffries
Chief Commissioner

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Transport Accident Investigation Commission
P O Box 10-323, Wellington, New Zealand
Phone +64 4 473 3112 Fax +64 4 499 1510
E-mail: reports@taic.org.nz Website: www.taic.org.nz

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