Inquiry 11-007: Descent below instrument approach minima,
Christchurch International Airport, 29 October 2011

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.

Final Report

Aviation inquiry 11-007
Descent below instrument approach minima
Christchurch International Airport
29 October 2011

Approved for publication: June 2014

Transport Accident Investigation Commission

About the Transport Accident Investigation Commission

The Transport Accident Investigation Commission (Commission) is an independent Crown entity responsible for inquiring into maritime, aviation and rail accidents and incidents for New Zealand, and co-ordinating and co-operating with other accident investigation organisations overseas. The principal purpose of its inquiries is to determine the circumstances and causes of the occurrences with a view to avoiding similar occurrences in the future. Its purpose is not to ascribe blame to any person or agency or to pursue (or to assist an agency to pursue) criminal, civil or regulatory action against a person or agency. The Commission carries out its purpose by informing members of the transport sector, both domestically and internationally, of the lessons that can be learnt from transport accidents and incidents.

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Important notes

Nature of the final report

This final report has not been prepared for the purpose of supporting any criminal, civil or regulatory action against any person or agency. The Transport Accident Investigation Commission Act 1990 makes this final report inadmissible as evidence in any proceedings with the exception of a Coroner's inquest.

Ownership of report

Citations and referencing

Information derived from interviews during the Commission's inquiry into the occurrence is not cited in this final report. Documents that would normally be accessible to industry participants only and not discoverable under the Official Information Act 1980 have been referenced as footnotes only. Other documents referred to during the Commission's inquiry that are publicly available are cited.

Photographs, diagrams, pictures

Unless otherwise specified, photographs, diagrams and pictures included in this final report are provided by, and owned by, the Commission.

Boeing 737 – ZK-NGH
(Photograph courtesy of Jonathan Rankin)

Location of incident

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Abbreviations

ATIS	automatic terminal information service
CAA	Civil Aviation Authority
CAT	category
DME	distance measuring equipment
ILS	instrument landing system
m	metre(s)

Glossary

altitude	the vertical distance between an aircraft and mean sea level
decision altitude	a specified altitude in a precision approach (including an instrument landing system approach) at which a missed approach must be initiated if the required visual reference to continue the approach has not been established
height	the vertical distance between an aircraft and a datum, normally the surface of Earth
monitored approach	a shared approach where the pilot not flying monitors the instruments (head down) while the pilot flying monitors the approach and acquisition of visual references (head up)
precision approach	an instrument approach that in addition to providing directional or lateral information includes vertical or glide path information
route check	an assessment of a pilot's performance flying a regular route
stable approach	for the Boeing 737 the operator directed that the following criteria be met to continue the approach: • landing gear selected down by 1500 feet above aerodrome elevation • landing configuration established and landing checklist completed by 1000 feet • aircraft established on the correct glide path • airspeed not more than 10 knots above, or five knots below, target • sink rate no greater than 1000 feet per minute • thrust setting appropriate for the configuration (not idle)
threshold	the start or end of a runway
"visual"	"the pilot has visual contact with the ground or runway environment, as applicable"

Data summary

Aircraft particulars

Aircraft registration:	ZK-NGH
Type and serial number:	Boeing 737-319, 25607
Number and type of engines:	two CFM56-3C-1
Year of manufacture:	1999
Operator:	Air New Zealand
Type of flight:	scheduled passenger
Date and time	29 October 2011, 0810[1]
Location of incident	Christchurch International Airport latitude: 43° 29.4' south longitude: 172° 32.1' east
Injuries	nil
Damage	nil

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

1. Executive summary

1.1. On Saturday 29 October 2011, an Air New Zealand Boeing 737 (the aeroplane) was on a flight from Auckland to Christchurch with six crew and 128 passengers on board. The captain was the "pilot flying" and the first officer was the "pilot monitoring". A check captain was also on the flight deck. He was conducting an annual route check on the captain.

1.2. When the flight departed Auckland the forecast weather conditions for Christchurch were favourable for a successful landing. However, the weather conditions at Christchurch deteriorated en route, with low cloud and fog restricting visibility on the approach path to the runway.

1.3. The aeroplane made a standard instrument approach to the runway from the south. The procedure allowed the aeroplane to descend to 200 feet above the ground, which was called the decision height. At this point the captain had to decide if he had the required visual reference to continue the approach (for example, he could see the runway approach lights). If he did have visual reference, he was permitted to continue descending to land. If he did not have the required visual reference, it was mandatory to initiate a "missed approach" and "go around" for another attempt.

1.4. The aeroplane was still in cloud/fog when it reached a height of 200 feet, but the captain did not initiate a missed approach. Both the first officer and the check captain were about to intervene when the runway approach lights became visible at a height of about 100 feet. The captain then landed the aeroplane.

1.5. A pilot not initiating a missed approach when they do not have the required visual reference at decision height is a safety issue. Before reaching the decision height, the captain had failed to respond to two other procedural check calls, and these two failures went unchallenged by the first officer, which is another safety issue.

1.6. The Transport Accident Investigation Commission (Commission) determined that the captain did not comply fully with the procedures and perform the mandatory missed approach because he was under stress brought on by a combination of factors comprising:

- the Canterbury earthquakes and their aftershocks
- personal health issues
- anxiety associated with the route check flight.

1.7. The Commission also determined that the captain's failure to respond on two occasions should have been picked up and challenged by the first officer before the aeroplane reached the decision height.

1.8. The report discusses the role of a check captain and how this could affect crew interaction on the flight deck.

1.9. Air New Zealand (the operator) has used this incident to reinforce to its pilots the need to follow standard operating procedures and initiated a range of other safety actions. A recommendation was made to the Director of the Civil Aviation to highlight to other operators the need to follow procedures and to appropriately manage those situations where the normal crew dynamics may be disrupted by the inclusion of additional personnel, for example during a check flight.

1.10. Some key lessons arising from this investigation were:

- good crew communication and interaction and sharing a clear understanding of the intentions for each stage of the flight are essential elements of flight safety
- adherence to standard operating procedures by all crew members is essential for ensuring safe aircraft operations.

2. Conduct of the inquiry

2.1. The incident occurred on Saturday 29 October 2011 and the crew filed an internal occurrence notification later that same day. The Commission was alerted to the incident by the operator on the Monday. After making preliminary enquiries, the Commission opened an inquiry shortly after, under section 13(1) of the Transport Accident Investigation Commission Act 1990, to determine its circumstances and causes. An investigator in charge was assigned to investigate the incident.

2.2. Airways Corporation of New Zealand was contacted on the Monday afternoon and requested to secure any radar and radio recordings related to the instrument approach at Christchurch. The Commission's investigator in charge travelled to Auckland on Wednesday 2 November 2011 and interviewed:

- the captain
- the first officer
- the check captain
- Air New Zealand safety personnel.

2.3. The Commission's investigator also obtained a number of records and documents, including:

- the captain's medical and training records
- relevant Civil Aviation Authority (CAA) records
- the operator's procedures for conducting instrument approaches.

2.4. The Commission engaged an industrial psychologist, Mr Keith McGregor, to help the Commission gain a better understanding of the human and organisational factors that might have contributed to the incident[2]. On 28 June 2013 the industrial psychologist interviewed the captain in the presence of the investigator in charge and a support person for the captain.

2.5. On 16 December 2013, Commissioners approved a draft final report for distribution to interested persons[3] for comment. The draft report was distributed on 23 January 2014 with the submissions requested by 13 February 2014.

2.6. Submissions were received from the three pilots involved, the operator and the Civil Aviation Authority. These were considered by the Commission on 15 April 2014 and some changes were made to the report where appropriate.

2.7. On 27 May 2014, Commissioners met with the psychologist who had interviewed the captain. Following those discussions the report was further amended and the Commissioners approved a second draft report. The relevant section of the amended draft was sent to the two interested persons concerned for further comment. Both persons declined to add anything further.

2.8. The Commissioners approved the final report for publication on 23 June 2014.

[2] Keith McGregor BSc (Psychology), Registered Psychologist.
[3] Interested persons include those persons identified under s14(5) of the Transport Accident Investigation Commission Act 1990.

3. Factual information

3.1. History of the flight

3.1.1. On Saturday 29 October 2011, Flight NZ501[4] was a scheduled passenger service flight from Auckland to Christchurch operated by Air New Zealand. The aeroplane allocated for the flight was ZK-NGH, a Boeing 737. On the flight deck were a captain and first officer, and a check captain who was conducting the captain's annual route check.[5]

3.1.2. At about 0620 on the morning of the flight, the captain was joined by the first officer and check captain for the flight briefing. The captain was to be the "pilot flying", with the first officer performing the duties of "pilot monitoring". The check captain would sit in the crew seat, between but behind the two pilots. The check captain said that he briefed the crew that it was a route check for the captain and that he would be in the background observing a normal day at work. Because of the captain's experience he did not elaborate further.[6] The briefing package provided by the operator included actual weather for Christchurch and forecast weather for the flight.

3.1.3. The Christchurch weather conditions at 0500 were a surface wind of 030° true at four knots, visibility 5000 metres (m) in mist, and broken cloud layers at 300 feet and 700 feet above ground. For temporary periods[7] the visibility had reduced to 1500 m in mist. The flight was due to land at Christchurch at 0820. The Christchurch weather forecast for that time was a light north-east wind, drizzle and a broken cloud base at 2000 feet above the aerodrome. For temporary periods up until 0800, the visibility was forecast to reduce to 200 m in fog. The forecast for after 0800 was for a broken cloud base at 1200 feet for temporary periods. The prevailing and forecast weather conditions required the flight to carry additional fuel to allow for 30 minutes of holding above Christchurch and a return to Auckland if unable to land.

3.1.4. The flight departed Auckland almost on schedule at 0700 with 128 passengers and six crew on board. The flight south proceeded uneventfully. At 0731 the crew received an amended weather update for Christchurch, which forecast the wind to be 050° true at eight knots, unlimited visibility and a broken cloud base at 800 feet. For temporary periods between 0700 and 0900 the visibility was expected to reduce to 1500 m in mist and the cloud base expected to be broken at 200 feet.

3.1.5. At 0742, shortly before commencing the descent, the crew obtained the latest Christchurch weather information being transmitted on the automatic terminal information service (ATIS). The ATIS report included: runway surface condition as wet; surface wind of 020° magnetic at six knots; visibility of six kilometres reducing to 2000 m; drizzle; cloud, overcast at 300 feet; temperature 9° Celsius; and dew point 9° Celsius.

3.1.6. The captain briefed the first officer for the standard arrival route to runway 02[8], followed by the instrument landing system/distance measuring equipment (ILS/DME) category I (CAT I) approach (see Figure 1). For the Boeing 737 this permitted a descent to a decision height of 200 feet above the runway threshold[9]. The minimum visibility required to land was 800 m. The arrival procedure and ILS/DME approach were to be flown using the autopilot. The approach briefing also included the missed approach procedure to be followed should the crew not sight the runway by the decision height during the approach, or for any other reason. The approach was to be flown in accordance with the operator's standard "monitored approach" procedure, which meant the captain was flying and would look outside the cockpit

[4] Radio call-sign "New Zealand 501".
[5] The check captain, while a member of the crew, was not part of the operating crew.
[6] The operator's guidelines stated that "You should not generally contribute to the operation except in emergency/abnormal situations when full assistance should be offered."
[7] Infrequent changes expected to last less than an hour.
[8] Runway designation is referenced to magnetic bearing and rounded to the nearest 10°. For example, 017° is rounded to 020 and called runway 02, and 197° is rounded to 200 and called runway 20.
[9] For clarity the height above the runway threshold is used throughout the report.

approaching the decision height, while the first officer had his head down monitoring the instruments.

3.1.7. The aeroplane was following an ATR[10] that was also completing an ILS/DME approach. At 0808, after intercepting the inbound track for the ILS, the first officer changed radio frequency to Christchurch tower and reported "New Zealand 501 established ILS". The tower controller acknowledged the transmission and instructed the flight to continue the approach following the ATR. The controller advised, "The cloud has descended to the ground now – the viz [visibility] reducing to approximately 800 m and expect a late landing clearance for me to get the ATR in sight off the runway before I can clear you to land." The first officer acknowledged the transmission.

3.1.8. At 1000 feet above the runway threshold an automated voice call on the flight deck stated, "One thousand"[11]. The operator's procedure required the pilot flying to respond with either "Stable", which meant the aeroplane was stable in the instrument approach, or "Go around", in which case the missed-approach procedure was to be initiated. The captain made no response to the 1000-feet call, although the check captain believed he heard him "grunt". This was not verified by the captain or first officer.. The first officer said that the captain's lack of a response was not unexpected[12], and because the aeroplane was stable on the instrument approach, he did not challenge the captain. The operator's standard calls during an instrument approach, at the time of the occurrence, are detailed in Appendix 1.

3.1.9. At 0809:18, the crew of the ATR reported landing and "rolling through to Alpha 4" (see Figure 2). The controller instructed the ATR to report clear of the runway. At 0809:38 the ATR crew reported clear of the runway. The controller asked them to expedite the taxi as he needed to sight the ATR before he could clear the following aeroplane to land. By this time the aeroplane was about one and a half nautical miles from the runway threshold.

3.1.10. At 0809:54, the controller advised the crew to expect a late landing clearance as he had yet to sight the ATR. The first officer acknowledged the call. At 0810:02, the controller sighted the ATR as it turned off Alpha 4 onto the main taxiway and cleared the aeroplane to land.

3.1.11. At 100 feet above decision height (300 feet above the runway threshold) the aeroplane generated a second automated call "Plus hundred". This call should have been acknowledged by the captain saying, "Confirmed". The captain later said he thought he had responded to the automated call but could not remember what he said. Neither the first officer nor the check captain heard the captain respond. The first officer later said that he was about to prompt the check captain for a response when the aeroplane reached the decision altitude and the third automated voice call of "Minimums" was made.

3.1.12. The operator's procedures required the captain to respond to the "Minimums" call with either "Continue", in the event that he had sight of the runway, or "Go around" if he did not have sight of the runway. The captain did not make either call. The captain later said that as they were approaching decision altitude he was looking down at the instruments. When the "Minimums" call was made he looked up and was confused [surprised] that he was unable to see the runway or the environs.

3.1.13. The first officer repeated the "Minimums" call. He then looked across at the captain to check if he was still actively flying. The captain appeared okay, so the first officer then looked forward, expecting to see the runway ahead, but all he could see was cloud. The first officer later said he was again about to prompt the captain when the runway approach lights became visible. The aeroplane was estimated to be about 100 feet above the runway at this time. The captain disconnected the autopilot and landed the aeroplane without any word. The check captain later said that he also was about to challenge the captain's intentions and was trying

[10] Aerospatiale-Alenia ATR 72 aeroplane.
[11] The "One thousand" feet call is normally automated but could be made by the pilot monitoring.
[12] The first officer had not flown with the captain before but was aware of his reputation for not being overly communicative.

to locate his microphone 'press-to-talk' switch when the runway approach lights became visible.

3.1.14. The controller was unable to see the aeroplane until it had taxied clear of the runway at Alpha 4. After the aeroplane had been taxied in and shut down, the check captain advised the captain that he had failed the check flight and was stood down.

3.1.15. The next two aeroplanes to make an approach, four and seven minutes later respectively, conducted the missed approach procedure.

3.2. Instrument approach information

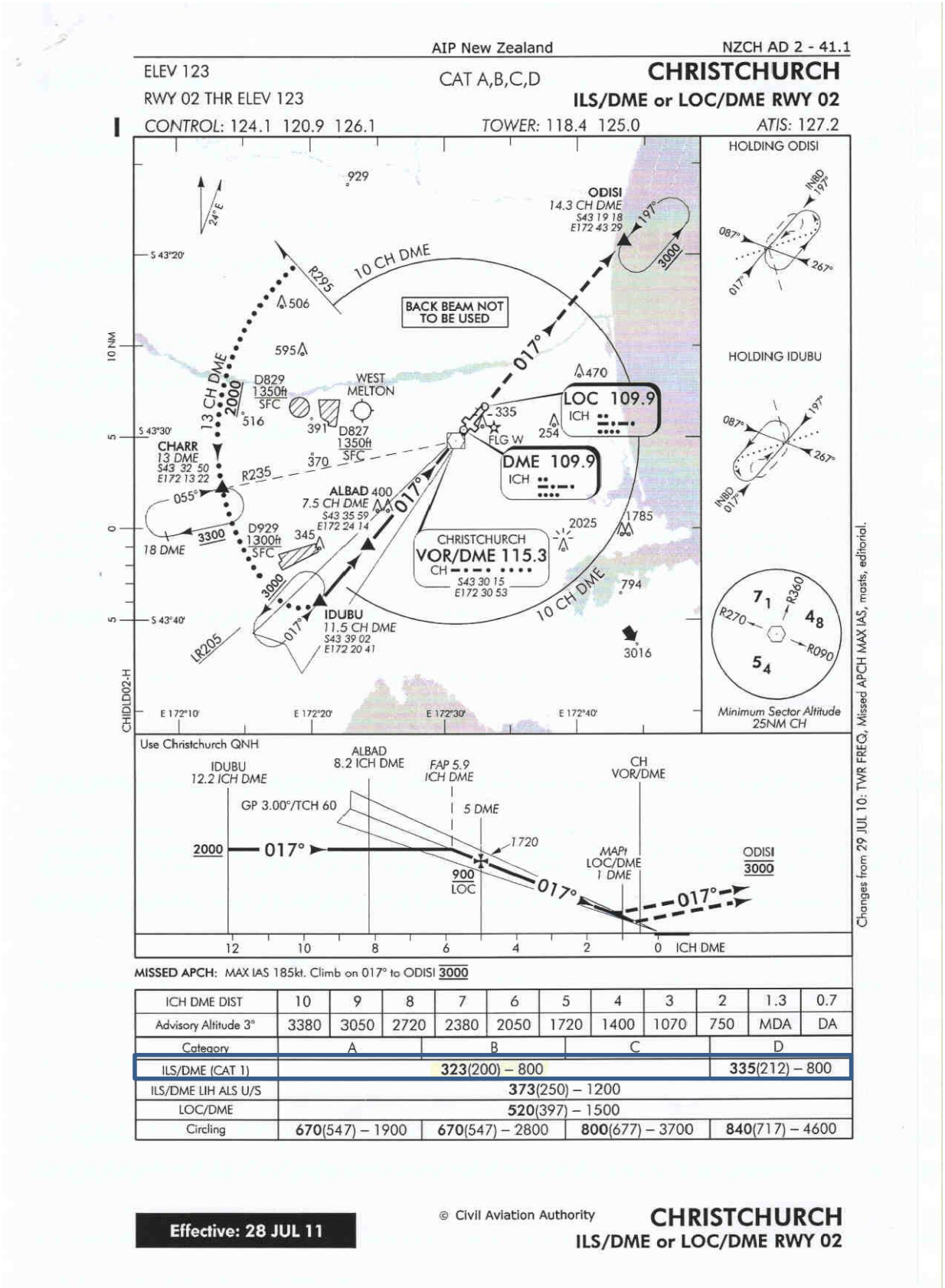
3.2.1. Christchurch International Airport is 123 feet above mean sea level. The main international airports around New Zealand have precision ILS approach capabilities. The two main runways[13] at Christchurch are equipped with ILS/DME approaches – both CAT I capable[14]. The ILS/DME CAT I approach for runway 02 has a commencement height of not below 2000 feet and an inbound track of 017° magnetic.

3.2.2. The ILS glide-path slope was set at the standard 3°, which meant an aircraft following the glide slope would have a rate of descent of about 600 feet per minute. The CAT I ILS approach meant that the decision height was 200 feet above the threshold of the runway.

3.2.3. Descent below the decision height was only permitted when an aircraft was in a position to make a normal approach and landing, which meant that the forward visibility had to be above the minimum, and the approach lighting, the threshold lights or markings, or runway lights or markings were visible to the pilots (Civil Aviation Rules, 2013)[15].

3.2.4. The runway 02 ILS/DME CAT I approach at Christchurch could be flown manually by the pilot or with the autopilot engaged. However, the landing had to be performed manually unless the pilot had sufficient visual reference to be able to safely monitor the approach and landing.

[13] Approaching from direction 020° magnetic or from reciprocal direction 200° magnetic (02/20).
[14] CAT I approaches had a decision height of 200 feet, with CAT II 100 feet and CAT III typically 50 feet. CAT IIIB approaches were approved for auto-land operations; they did not have a decision height but did have a minimum runway visibility requirement.
[15] See Civil Aviation Rule 91.413 for a full list of requirements.



ICH DME DIST	10	9	8	7	6	5	4	3	2	1.3	0.7
Advisory Altitude 3°	3380	3050	2720	2380	2050	1720	1400	1070	750	MDA	DA
Category	A			B			C		D		
ILS/DME (CAT 1)	**323**(200) – 800								**335**(212) – 800		
ILS/DME LIH ALS U/S	**373**(250) – 1200										
LOC/DME	**520**(397) – 1500										
Circling	**670**(547) – 1900			**670**(547) – 2800			**800**(677) – 3700		**840**(717) – 4600		

Figure 1
ILS/DME approach runway 02 Christchurch
(not to be used for navigation)

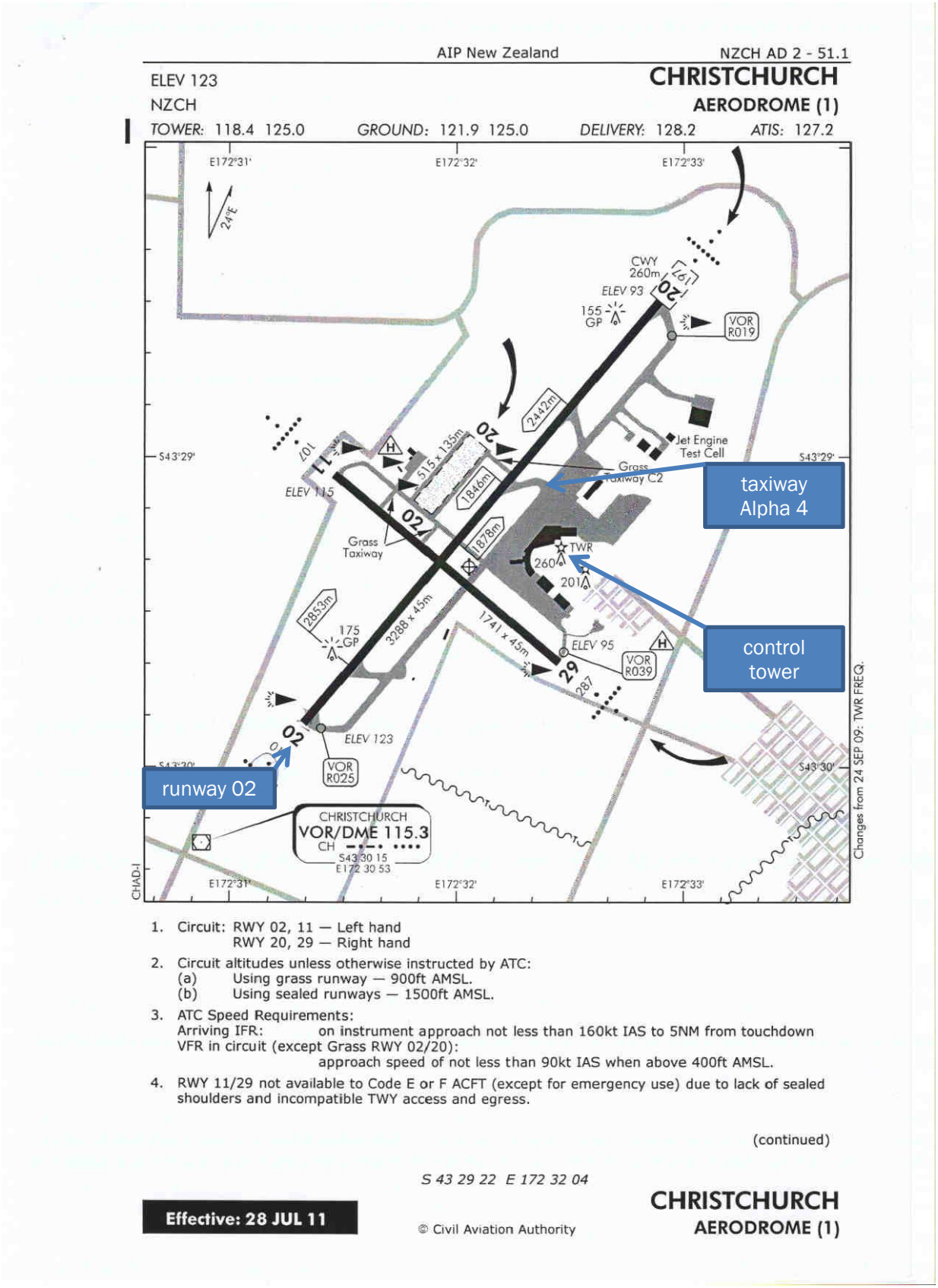


Figure 2
Christchurch Aerodrome chart
(not to be used for navigation)

3.3. Personnel information

3.3.1. The captain was aged 68. He had been with the operator for 47 years. He had obtained his first captaincy qualification in 1974 and moved to international operations in 1989, eventually becoming a Boeing 747-400 captain.

3.3.2. In 2003 the captain transferred to the Boeing 737 fleet[16] of aeroplanes as a captain. This was because of age restrictions imposed by the United States Federal Aviation Administration on captains of commercial aircraft flying within or into that country[17].

3.3.3. At the time of the incident the captain held an airline transport pilot licence and a current medical certificate with the endorsement that trifocal spectacles were to be worn when flying, which he said he was doing at the time of the incident. He had flown about 23 875 hours in total, including 7210 hours on the Boeing 737. In the four days prior to the incident the captain had:

- 25 October — Day off
- 26 October — Day off
- 27 October — Flew for 3.1 hours
- 28 October — Spent the day undergoing classroom emergency procedures refresher training and assessment
- 29 October — Day of incident.

3.3.4. The first officer was aged 43. He had joined the operator in 2007 directly onto the Boeing 737-300. He had a total flying time of 8420 hours, including 2320 hours on the Boeing 737. He held an airline transport pilot licence and a current medical certificate. His most recent line, simulator and instrument checks had been completed in July 2011.

3.3.5. The first officer had not worked the day before the incident and considered himself to be well rested with no personal issues that might have affected him on the day. He had not met the captain prior to the pre-flight briefing.

3.3.6. The check captain was aged 49. He had joined the operator in 1995 and been a flight examiner since 2006. He had accumulated a total of 17 200 flying hours, including 9200 hours on the Boeing 737. He held an airline transport pilot licence, a current medical certificate and a category D instructor qualification. He had worked the two days preceding the incident but said he was well rested and in good health.

3.3.7. All three pilots said that they had had about eight hours' sleep the preceding night and that fatigue had not been a factor. They were all familiar with Christchurch and the ILS/DME approach procedure.

[16] Air New Zealand operated the Boeing 737-200 series of aeroplanes from 1978 until 2001. The Boeing 737-300 first entered service in 1998.
[17] Commonly referred to as the "Age 60" rule, this rule came into effect in 1960. See paragraph 4.2.23.

4. Analysis

4.1. Introduction

4.1.1. When an aeroplane is on an instrument approach to a runway, it is a serious safety issue when the pilot continues with the descent below the minimum (decision) height without having the required visual references. Decision heights are calculated with safety margins to allow specific aircraft types to initiate safe missed approaches in the event of runway lights or markings not becoming visible. If a decision height is not heeded, safety margins are rapidly eroded and there is a real risk of the aeroplane landing with enough force to damage the landing gear. The consequences could be worse if the aeroplane were not aligned correctly with the runway at the time.

4.1.2. In this case the runway approach lights became visible at an estimated height of 100 feet, and the captain was able to land the aeroplane. Both the first officer and the check captain were just about to prompt the captain for a decision when the runway lights became visible. At a standard rate of descent and standard approach speed, there were only about another five seconds available for either the first officer or the captain to react and arrest the rate of descent to avoid striking the ground before initiating a missed approach, or to avoid a heavy landing.

4.1.3. The following analysis discusses a number of reasons for the captain not initiating a missed approach at the crucial time that he was supposed to. It also discusses two other safety issues:

- that there was no intervention from the first officer in response to the captain not making the required calls before reaching the decision height.
- that the operator was aware of performance issues with the captain and had not adequately dealt with those issues.

4.1.4. The investigation also considered whether age-related factors were possible contributors to the incident. However, there was no evidence to support that pilot age was a factor contributing to the incident (See Appendix 2 for more detail.)

4.2. Human performance

Standard operating procedures

Safety issue – The captain and first officer did not adhere to company standard operating procedures for a "monitored approach" to the runway in poor meteorological conditions, which eroded safety margins built in to the procedures and compromised the safety of the flight.

4.2.1. The operator's normal practice for making an approach under instrument flight conditions was to follow the "monitored approach" procedure, which was described as follows:

> The monitored approach is a fully monitored approach with the captain always being the [pilot flying] and the [first officer] the [pilot monitoring]. The monitored approach allows the captain the flexibility to assess the conditions and general conduct of the approach. This maximises the chances of obtaining the required visual cues at decision altitude.
>
> The [first officer's] duties are to monitor instruments and [flight mode annunciators] and advise the captain of any deviation from what is expected during the approach. The captain's role is to make any necessary decisions required during the approach and to scan for the required visual cues as the aircraft approaches decision height.

> From 1500 [feet radar altimeter] or the [final approach fix] (whichever occurs first) the [first officer] will be head down. The [first officer] remains head down until either the autopilot is disconnected after touchdown or a go-around is commenced[18].

4.2.2. The flight proceeded uneventfully until the final stages of the instrument approach at Christchurch. At 1000 feet above the runway threshold the approach was "stable", which according to the operator's procedures meant the following criteria had been met:

> the landing gear had been selected down by 1500 feet above aerodrome elevation
>
> the landing configuration was established and landing checklist completed by 1000 feet
>
> the aeroplane was established on the correct glide path
>
> the airspeed was not more than 10 knots above, or 5 knots below, target
>
> the sink rate was no greater than 1000 feet per minute
>
> the thrust setting was appropriate for the configuration (not idle).

4.2.3. The captain was required to respond to the automated 1000-feet call with the word "stable". He did not make that call, and the first officer did not challenge or prompt him for a response. The check captain believed he heard the captain "grunt". Both later said that the captain's lack of, or non-standard, response was "not unexpected". Neither was concerned at that point because they were aware that the aeroplane was on a stable approach. The first officer, however, should have prompted the captain, because the operator's procedures required the captain's lack of response to be challenged. This was the first breakdown in crew communication in that non-compliance with standard operating procedures went unchallenged.

4.2.4. The second breakdown in communication was the captain not acknowledging the next automated "Plus hundred" call at 100 feet above decision height and the first officer again not challenging or prompting him for a response . The purpose of this call was to prompt the captain to look outside the cockpit in preparation for deciding whether he had the required visual reference when the aeroplane reached decision height. The captain should have responded by saying, "Confirmed", which would have been confirmation for the first officer (who had his head down monitoring the instruments) that the captain was aware of the aeroplane's situation and was still actively assessing the approach and external conditions. This second example of not following standard operating procedures was more serious than the first, because by that time the aeroplane was close to the decision height.

4.2.5. The aeroplane reached the decision height about nine seconds later, at which time the final automated voice call announced, "Minimums". The captain was supposed to respond with either "Continue" if he had the required visual reference or "Go around" if he did not. Again the captain did not respond.

4.2.6. The first officer did not know if the captain was visual with the runway environment, or even if the captain was still in control of the aeroplane. The first officer therefore repeated the "Minimums" call then had to turn towards the captain to check on him before looking forward to see if they were actually visual. As he was about to react to the lack of visual cues, the runway started to appear.

4.2.7. Instead of looking out of the cockpit when the "Plus hundred" call was generated, the captain was looking down at the flight instruments. He should have been looking alternately inside and outside the aeroplane, assessing the conditions and trying to obtain visual reference with the runway as early as possible. When the decision height was reached and he looked up for the first time, he saw only cloud. This surprised him and he was unable to react as required

[18] The procedure was based on a fully automated approach and landing. Where the autopilot was to be disconnected before landing, it was assumed the first officer would look up at this time. Once visual the pilot monitoring would call the existing rate of descent to show the flight path was continuing to be monitored.

and commence an immediate missed approach. The possible reasons for this are discussed in the following section.

Human factors

4.2.8. The captain was resident in Christchurch and during the course of his interviews he made reference to some personal health issues and the 2010 and 2011 Canterbury earthquakes, in particular the effects of the aftershocks. The captain said that his health and the aftershocks had added to the stress under which he was operating at the time of the incident. The Commission's consulting medical advisor[19] reviewed the captain's medical records, including general practitioner and CAA records. The medical records were unremarkable, contained no stress related issues and nothing else was evident that might have affected his ability to fly an aircraft.

4.2.9. The captain also offered that he might have succumbed to a phenomenon commonly referred to as continuation bias (also sometimes referred to as target fixation). Continuation bias is a natural inclination to achieve a target or a goal because they either want to or simply assume they can. If the inclination is strong enough in an individual, they will press on even though changing circumstances might make achieving the goal difficult or unlikely.

4.2.10. Bias is an inclination, predisposition or prejudice towards an object, action or emotion (Concise Oxford Dictionary). There are many types of bias, including the cognitive biases of "confirmation bias" and "continuation bias". SKYbrary[20] defines plan continuation bias as the "unconscious cognitive bias to continue with the original plan in spite of [usually, adverse changes in] conditions."

4.2.11. There are numerous examples of pilots having continued with a flight plan or goal despite adverse changes in conditions, sometimes with tragic results. The operator published an article in its 2010/2011 Summer issue of Koru Safe, their safety magazine, titled "The Drive to Arrive – Why Professional Pilots Get Press-on-it is". The article discussed the failure to initiate a go-around as a major factor in runway excursions, citing numerous international examples involving airliners.

4.2.12. In New Zealand the January/February 2011 issue of the CAA's Vector magazine outlined two examples of pilots continuing with their original plans despite changing conditions and information that did not match their expectations (CAA, 2011). The article identified "confirmation bias" and "frequency bias" as contributing to the accidents. Confirmation bias is the tendency to favour or accept information that supports a pilot's expectation, and ignore or downgrade information that may be contrary to that expectation. An example of frequency bias is when a pilot lands at the same aerodrome without any issues, so expects the same outcome each time.

4.2.13. For this incident at Christchurch, the weather conditions and forecast information provided to the crew in the pre-flight briefing indicated that the weather conditions for their expected time of arrival at Christchurch were marginal, warranting the need to take on extra fuel to reach an alternate aerodrome. The updated ATIS weather information obtained at 0731 before beginning the descent showed that the weather conditions had deteriorated, with temporary periods of fog predicted up until 0900. The visibility was expected to reduce to 1500 m in mist and the cloud base expected to be broken at 200 feet. With this forecast there was still a possibility they would have visual contact with the ground before reaching decision height.

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[20] SKYbrary is an electronic repository of aviation safety material initiated by EUROCONTROL (the European Organisation for the Safety of Air Navigation) and supported by international organisations such as the International Civil Aviation Organization, Flight Safety Foundation, United Kingdom Flight Safety Committee, European Strategic Safety Initiative and International Federation of Airworthiness. It can be found at: http://www.skybrary.aero.

4.2.14. The ATIS information also reported that the temperature and dew point were both 9° Celsius, which indicated that low cloud or fog could form at any time. When the crew changed to the tower frequency the controller advised that the cloud was on the ground and visibility had reduced to 800 m. To emphasise the deteriorating conditions, the controller also advised on three occasions that he was having difficulty seeing the ATR that was ahead of the Boeing ("expect a late landing clearance"). The crew were receiving information that should have alerted them that the chances of making a successful landing were diminishing. The significance of this information could have been offset by the knowledge that the ATR aeroplane only two minutes ahead had made a successful landing. Either way, the reported information should have prompted a discussion in the cockpit to consider the possibility of a missed approach.

4.2.15. The captain's communication style could have been described as minimalistic – not wishing to promote interactive communication. He had a reported reputation within the company for saying little on the flight deck, and the first officer was aware of that reputation. The captain's communication style and his reputation could well have contributed to the observed breakdown in the communication loop during the approach to Christchurch. It could also explain why the first officer was unwilling to challenge the lack of response to the 1000-feet call..

4.2.16. Operating procedures included the requirement for the flight crew to cross-check and confirm the situation at certain points. One purpose of the procedures was to prevent human errors resulting in accidents or incidents. If the captain had developed a mind-set that he would become visual at decision height, this mind-set needed to be broken and the most effective means would have been for the pilots to have followed normal procedures. The first officer should have intervened when the captain deviated from or omitted part of the established procedures. However, as mentioned above, the crew communication loop had been undermined early in the approach.

Psychologist review

4.2.17. The Commission engaged an industrial psychologist to explore the human factors element of this incident. The psychologist interviewed the captain on 28 June 2013, some 20 months after the incident. The parties involved were aware that the elapsed time would affect recollections of the incident, but the focus of the interview was on enduring human performance traits that would be present and not the specific events of the day.

4.2.18. The psychologist who interviewed the captain placed less emphasis on the phenomenon of continuation bias and more on stress as a contributing factor. He said that typically a number of environmental and human factors will contribute to the occurrence of continuation bias. For example, the information required to enable timely, evidence-based decisions is usually ambiguous or missing. In this case, however, information about the weather and how it was changing was available. The psychologist said that pilots can develop the perception of being under pressure to act that becomes increasingly intense as action is delayed, and that in such cases there is usually an increased sense of psychological threat as it becomes apparent that the desired goal may not be achieved. It is this latter aspect that can have the greatest negative impact, as the brain's typical response to a perceived threat is to activate the primitive "fight, flight or freeze" response. Once activated, the stress reflex can cause a narrowed focus of attention and reduce the capacity of working memory, which limits the ability of a pilot to think clearly.

4.2.19. The psychologist considered the captain was operating under a relatively high level of stress during the check flight, which was limiting his ability to perceive and react appropriately to tasks other than the immediate control of the aeroplane. The captain appeared to have handled the major earthquakes of 2010 and 2011 well, but said that the ongoing aftershocks along with personal health issues were a source of stress for him.[21] The psychologist acknowledged that these could have been a factor, but when reviewing his longer history he

[21] The operator had provided support for Christchurch-based staff, including counselling if requested. This offer was not taken up by the captain.

thought it more likely that the captain's natural tendency to worry, exacerbated by his activities on the previous day (undergoing classroom emergency procedures refresher training and assessment) and the fact that he was undergoing a route check, were reasons for his not reacting appropriately during the instrument approach.

4.2.20. Both the check captain and the first officer agreed that this was just a routine check flight that did not affect the flight deck dynamics. However, the psychologist's opinion was that from this captain's perspective, the check flight changed the normal dynamics on the flight deck. From his perspective the check captain was there to assess his performance, and this placed additional "evaluative stress" on the captain, who did not enjoy such exercises. This may have been in part as a result of a previous experience involving the same check captain. During his interview with the psychologist the captain mentioned a previous check flight with the same check captain. He said that he "did not find it a relaxing experience". Evaluative stress differs from operational stress in that the focus of the individual is on *how* they are doing rather than *what* they are doing. This can introduce a layer of internal mental monitoring (continual self-assessment) that can in extreme cases cause mental blanks and acute anxiety to actively interfere with the primary task. Similarities can be seen in other activities such as public speaking ('stage fright') and job interviews where the performance of normally competent and effective individuals can be severely affected by mental blanks and acute anxiety.

4.2.21. Check flights were not new to the captain. According to the operator's records he had undergone 47 previous route checks and 94 simulator proficiency checks over his 47 years with the company. So how did this route check differ from the previous 47? There are four factors that probably added to the stress the captain was under at the time:

- his dislike for having his performance evaluated
- his past experience involving the same check captain, which from the captain's perspective was a negative experience
- the particular circumstances of this approach and landing in marginal weather conditions
- the other stressors he mentioned regarding his health and his response to the aftershocks to the Christchurch earthquakes.

4.2.22. Another factor considered was the captain's age. He was aged 68 at the time of the incident. The subject of pilot skill deterioration with increased age has been studied internationally at considerable length, but thus far results have been varied and largely inconclusive. A summary of the information reviewed is contained in Appendix 2. In this case there was no evidence to support the possibility that the captain's age was a factor affecting his performance during the approach to landing

Findings

1 The captain did not make the appropriate response to two automated calls prior to the aeroplane reaching the point (decision height) at which the flight crew needed to decide whether to continue and land, or initiate a missed approach, and the first officer did not challenge the captain for an appropriate response on either occasion.

2 The captain compromised the safety of the flight by not initiating a missed approach when the aeroplane reached the decision height and the meteorological conditions were not suitable to land.

3 The only appropriate decision was for the captain to commence a missed approach. He did not make that decision probably because he was operating under a level of stress, where anxiety was interfering with his cognitive functioning.

4 There was no evidence to suggest that the pilot's age was a factor affecting his performance on the flight.

4.3. Operator's management of crew performance

Managing the cockpit

4.3.1. Good communication between a captain and first officer is critical to safe flight operations. Both need to be fully aware of what the plan is and what checks are going to be made at certain points along the way. The standard operating procedures together with the various checklists help to form and verify that plan. The dynamics of the cockpit are affected by the make-up of the flight crew, including their personalities and any actual or perceived authority gradient. The concept of crew resource management is taught to overcome and "smooth" the dynamics so that any deviations from the plan can be challenged, confirmed or otherwise, regardless of seniority or personality. Adding a check captain to the usual two-pilot cockpit has the potential to alter those dynamics, and it is important that this situation be managed.

4.3.2. In this case the first officer should have challenged the captain on two occasions for not making the correct response to the automatic calls generated by the aeroplane systems. The first officer was aware that the captain was being assessed, but he said that this was not an issue as far as he was concerned. However, the psychologist was of the opinion that any first officer faced with the captain's uncommunicative style, in a similar situation could have found themselves having to determine the boundaries of their involvement. Stepping in too early to take corrective action or waiting too long for the captain to respond to a call may have been resented by the captain or seen by the check captain as interfering with the check process. In other words, because the two pilots were meant to act as a team, the first officer's performance could be perceived as affecting the assessment of the captain's performance.

4.3.3. A common dilemma for check pilots is how far they let a situation develop to enable key lessons to be demonstrated before it becomes unsafe. Therefore, emphasis needs to be placed on the briefing before the commencement of the flight. The check captain said that at the pre-flight briefing he told the crew that it was a route check for the captain and that he was there to observe. Because of the captain's experience he felt he did not need to elaborate further.

4.3.4. All parties need to have a clear understanding of their individual roles and how they will interact. For example, a check pilot may state that they will not intervene unless there is a direct threat to safety. In this case the first officer would not have been expecting intervention by the check captain when the captain missed making the 1000-feet and plus-100-feet calls. It would have been clear to him that any intervention needed to come from himself, as required by the company procedures.

Performance management

Safety issue – The operator was aware of the captain's tendency over a period of at least three years to not always follow standard communication procedures. The informal method the company used to address the issue did not result in any measurable improvement.

4.3.5. Files held on the captain by the CAA and the operator indicated that the captain had generally performed well in his regular assessments. His training records for the previous 15 years contained several comments such as "above average check" and "cockpit management is to a high standard". However, there was some critical comment regarding the use of non-standard communications.

4.3.6. The records showed that in November 2008 the captain had performed poorly in a simulator ride because of a lack of knowledge of some drills, and required further training. In the three years preceding this incident the captain had had three company operational occurrence reports filed against him. The reports had been submitted by a ground staff person and related to the use of non-standard communications during push-back operations[22]. The captain recalled that he had received informal verbal follow-up action from the Boeing 737 fleet manager or the manager's representative regarding each of the reports. On each occasion, the captain had agreed with the operator to try to use standard phraseology.

[22] The use of a tug or other vehicle to push an aeroplane back from the terminal gate prior to engine start.

However, when interviewed following the incident he said that he continued to believe that much of the phraseology was unnecessary. The operator later commented that the same ground staff person had made similar reports concerning other pilots.

4.3.7. In addition the Commission received anecdotal evidence from Air New Zealand pilots and other employees that the captain had a reputation for saying little to other pilots whilst flying, and abbreviating or omitting items from checklists. The first officer, who had not flown with the captain before, made reference to this in explaining why he did not challenge the captain for failing to respond to the 1000-feet call – "The captain's lack of response was not unexpected".

4.3.8. The operator advised that any time there was a reported non-adherence to procedures, a "Just Culture" investigation was launched with the objective of understanding the behaviour behind the occurrence. Air New Zealand said the emphasis was on promoting an open reporting system through the just and fair treatment of employees following an incident. Disciplinary action could be taken in the event of "reckless behaviour". One outcome of such an investigation was focused training for the individual concerned and potential lessons learnt for other pilots.

4.3.9. The process described by the operator was not followed when dealing with reports against this captain. The lack of formal action by the company in this case had two possible effects. Firstly, it could have showed a tacit acceptance of the captain's tendency to not conform with standard communication procedures. Secondly, the captain himself could have believed that he did not have to make any constructive efforts to change the way he operated.

4.3.10. The captain, on each occasion on which he was reported, acknowledged his error but continued with his normal way of operating. The operator had a responsibility to ensure that its pilots were complying with its procedures. Standardisation is essential for safe airline operations. This is especially so where there are a large number of pilots, and where first officers rarely team up with the same captains. The operator's standard procedures and regular crew resource management training are designed with this in mind

4.3.11. As a result of the incident the operator developed a performance management plan for the captain, but he retired before it could be put into action.

Findings

5 The presence of the check captain on the flight deck and its effect on crew dynamics and communications had not been thoroughly discussed during the pre-flight briefing, which had the potential to blur the boundaries of individual involvement in the flight deck operations.

6 The operator had not followed its own procedures for managing the previously identified performance issues with the captain. This resulted in his continuing with non-conforming practices, virtually unchallenged.

5. Findings

5.1. The captain did not make the appropriate response to two automated calls prior to the aeroplane reaching the point (decision height) at which the flight crew needed to decide whether to continue and land, or initiate a missed approach, and the first officer did not challenge the captain for an appropriate response on either occasion.

5.2. The captain compromised the safety of the flight by not initiating a missed approach when the aeroplane reached the decision height and the meteorological conditions were not suitable to land.

5.3. The only appropriate decision was for the captain to commence a missed approach. He did not make that decision probably because he was operating under a level of stress, where anxiety was interfering with his cognitive functioning

5.4. There was no evidence to suggest that the pilot's age was a factor affecting his performance on the flight.

5.5. The presence of the check captain on the flight deck and its effect on crew dynamics and communications had not been thoroughly discussed during the pre-flight briefing, which had the potential to blur the boundaries of individual involvement in the flight deck operations.

5.6. The operator had not followed its own procedures for managing the previously identified performance issues with the captain. This resulted in his continuing with non-conforming practices, virtually unchallenged.

6. Key lessons

6.1. Good crew communication and interaction and sharing a clear understanding of the intentions for each stage of the flight are essential elements of flight safety.

6.2. Adherence to standard operating procedures by all crew members is essential for ensuring safe aircraft operations.

7. Safety actions

7.1. General

7.1.1. The Commission classifies safety actions by 2 types:

(a) safety actions taken by the regulator or an operator to address safety issues identified by the Commission during an inquiry that would otherwise result in the Commission issuing a recommendation

(b) safety actions taken by the regulator or an operator to address other safety issues that would not normally result in the Commission issuing a recommendation.

7.2. Safety actions addressing safety issues identified during an inquiry

7.2.1. At the time of the incident the operator was in the process of amending the calls and responses to be made during an instrument approach. From 3 June 2013, at the 1000-feet call the pilot monitoring was required to call either "One thousand – stable" or "One thousand – unstable", depending on the condition. The pilot flying was required to respond with either "Confirmed" or "Go around" as appropriate. The objectives of the changes were to ensure that both pilots were aware of the condition of the aeroplane and to elicit more interactive communication with a positive action to either continue the approach or go-around.

7.2.2. Air New Zealand safety staff advised that notices had been issued to all pilots stressing the importance of making the appropriate calls during an instrument approach.

7.2.3. Air New Zealand is using the lessons from this incident as part of its crew resource management training and other refresher training.

7.2.4. Air New Zealand installed new press-to-talk switches for personnel sitting in the jump seat, allowing easier and quicker access to the crew intercom.

8. Recommendations

8.1. General

The Commission may issue, or give notice of, recommendations to any person or organisation that it considers the most appropriate to address the identified safety issues, depending on whether these safety issues are applicable to a single operator only or to the wider transport sector.

8.2. Recommendation

8.2.1. Adding a check captain to the usual crew could potentially alter the flight-deck dynamics and could create uncertainty around communication protocols unless this situation is carefully managed at the pre-flight and en-route flight briefings.

8.2.2. In this case the presence of the check captain on the flight deck and the effect this could have on crew dynamics and communications had not been thoroughly discussed during the pre-flight briefing. This had the potential to contribute to the first officer not prompting the captain for the responses required by standard operating procedures.

8.2.3. The pilot check process is common to most airline operations.

8.2.4. The Commission recommends that the Director of Civil Aviation:

> Note that the pilot check process can interfere with safe flight operations if not properly managed, and raise this potential safety issue with industry in the most appropriate manner. (015/14)

8.2.5. On 23 June 2014, the CAA advised that the recommendation was accepted, and would take appropriate action to implement it.

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Appendix 1: Instrument approach – standard calls

Instrument Approach

Condition/Location	Call (PM)	Response (PF)
Crossing all applicable NDBs	"___ [name of beacon] ___ [minimum charted altitude] feet"	"Confirmed"
First positive inward movement of localiser	"Localiser active"	"Confirmed"
First positive movement of glideslope	"Glideslope active"	"Confirmed"
Glideslope intercept	"Glideslope intercept at ___ [distance] DME" or "Glideslope intercept at ___ [name of navaid]" or "Glideslope intercept at ___ [distance] FMC distance"	"Confirmed"
OM, navaid, distance	"Outer marker ___ [charted altitude]" or "___ [name of navaid] ___ [charted altitude]" or " [distance] DME ___ [charted altitude]"	"Confirmed"
1,000 ft AAL (and stable) (and unstable)	"One thousand" (stable") "One thousand. Unstable")	"Stable" or("Confirmed" or) "Go-around"
100 ft above DA/MDA	"Plus hundred"	"Confirmed"
DA/MDA	"Minimums"	"Continue" or "Go-around"
MAP	"Missed approach point"	"Continue" or "Go-around"

Note: The bracketed calls at 1000 feet are the changes made 3 June 2013

Appendix 2: Age-related information

In 1960, the United States Federal Aviation Administration introduced the "Age 60" rule to address two age-related concerns – sudden in-flight incapacitation and pilot skill deterioration. The rule was considered a temporary measure until more accurate individual assessments and predications were available (Halaby, 1962).

In 1967, a study of accident records in the United States found that the accident rate for pilots over 60 was "essentially comparable, and in some cases superior, to that of the younger pilot group" (Mohler et al, 1967).

A 10-year study followed a group of 3306 commercial pilots who in 1987 were aged between 45 and 54 years (Li et al, 2003). The study found that the accident risk "remained fairly stable as the pilots aged from their late forties to their late fifties. Flight experience, as measured by total flight time at baseline, showed a significant protective effect against the risk of crash involvement". The study noted a progressive deterioration with age for cognitive functions such as sensory, perceptual and psychomotor skills, while most flight-related tasks such as decision-making, tracking, take-off and landing did not differ significantly.

A more recent study involved 72 instrument-rated pilots[23] using a simulator to fly multiple instrument approaches, including a holding pattern[24] (Kennedy et al, 2010). Over 3 trials the fog levels were varied and pilots needed to decide whether to land or not. The study found no support for its hypotheses of age or experience being a predictor of performance regarding accuracy in flying the entry to a holding pattern. However, when "compared to younger pilots, older pilots made less accurate Land/No Land decisions. In particular, older pilots were more likely to land under conditions in which it was too foggy to see the runway".

In summary, there is no conclusive evidence that older pilots generally are at greater risk of having an accident. There is evidence that cognitive function may decline with age, likely owing to a decrease in working memory, but there are many other human factors that can also affect pilot performance.

On 13 December 2007, the United States Federal Aviation Authority amended the Code of Federal Regulations to allow a pilot in charge of an international flight to be aged up to 65, provided they are paired with a pilot aged under 60. On domestic flights both pilots can continue flying to age 65. All pilots need to have first-class medical certificates valid for six-month periods.

The international Civil Aviation Organisation (ICAO) has adopted as a standard an age limit of 65 for captains when operating with a two-person crew, and then the other pilot must be less than age 60 (ICAO Annex 1, Chapter 2).

[23] Pilots qualified to fly with sole reference to instruments.
[24] A race track type pattern before commencing an instrument approach procedure.

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