



Australian Government

Australian Transport Safety Bureau

Flight below lowest safe altitude involving Boeing 747, N416MC

15 km NNW Sydney Airport, New South Wales, 12 February 2017

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Addendum

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Flight below lowest safe altitude involving Boeing 747, N416MC

What happened

On 12 February 2017, a Boeing 747-47UF (freighter) aircraft, registered N416MC, operating from Honolulu, Hawaii, conducted an approach to Sydney Airport, New South Wales. On board the aircraft were two flight crew. The captain was the pilot monitoring (PM) and the first officer was the pilot flying (PF).¹

The aircraft was cleared by the approach controller for the runway 16R instrument landing system (ILS) approach.² The auto-pilot was engaged³ and the modes for localiser and approach (glideslope) were armed⁴ while the aircraft was flown at 2,200 ft on a heading of 200° to intercept the 16R ILS. The aircraft captured⁵ the localiser and the PF turned it left onto the 16R final approach course, while maintaining 2,200 ft, in order to intercept the glideslope from below.

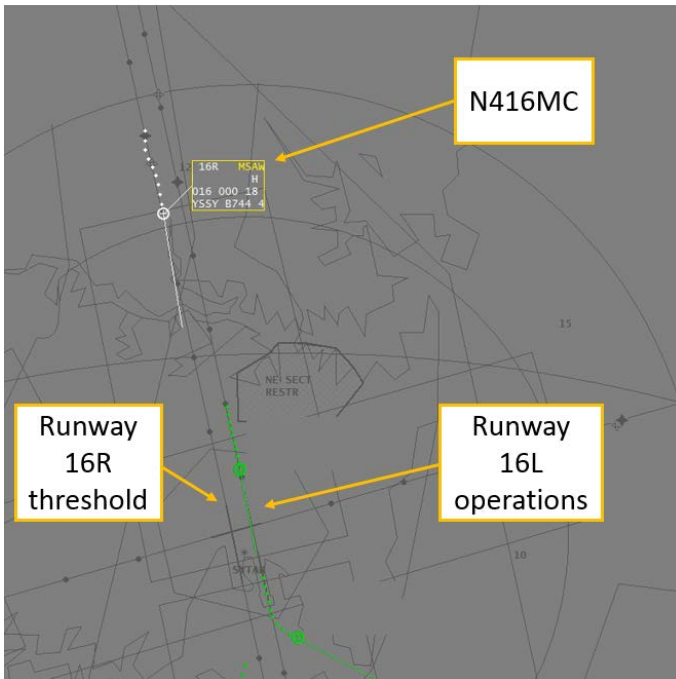
Shortly after the turn onto the final approach, the PF called 'glideslope captured' and the aircraft started to descend. However, the PM's primary flight display⁶ was still showing the aircraft below the glideslope. The PM crosschecked the PF's display and noticed the glideslope was captured, then checked their own display and noticed there was a failure flag displayed for the glideslope. The PM again crosschecked the PF's display, noticed there was a failure flag for the PF's glideslope, and instructed the PF to disconnect the auto-pilot and stop the descent.

As the aircraft descended through 2,100 ft, the approach controller requested confirmation that they were established on the glideslope. The PM responded that they had an interruption on glideslope and would maintain altitude until they could re-intercept. During the response, a minimum safe altitude warning (MSAW) alert appeared on the approach controller's radar for N416MC at an altitude of 1,800 ft. The approach controller immediately issued the instruction 'go-around, you are well below the glide-path, go-around'. The PM immediately acknowledged the instruction and the flight crew initiated the missed approach procedure.

The lowest point on the approach was 1,559 ft from flight data (1,600 ft on radar) at about 8.0 NM (14.8 km) from runway 16R (Figure 1). This resulted in the aircraft descending about 1,000 ft below the nominal 3° glideslope at the time of the incident. The aircraft was flown on the second approach with auto-pilot engaged. The localiser and glideslope captured and tracked the ILS with no anomalies detected.

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- ¹ Pilot Flying (PF) and Pilot Monitoring (PM): procedurally assigned roles with specifically assigned duties at specific stages of a flight. The PF does most of the flying, except in defined circumstances; such as planning for descent, approach and landing. The PM carries out support duties and monitors the PF's actions and the aircraft's flight path.
- ² The instrument landing system is a ground-based precision approach and landing aid. The main elements are (1) the localiser antenna, which provides centreline guidance; (2) the glideslope antenna, which provides a nominal 3° descent guidance; (3) the marker beacons (outer, middle and inner), which are used for altimetry checks and to indicate what stage of the approach has been reached; and (4) the approach lights (Distance Measuring Equipment (DME) and Global Navigation Satellite System (GNSS) may be used in lieu of marker beacons).
- ³ Engaged: A system mode or function that is actively performing its function.
- ⁴ Armed: A system mode or function that is set to become actively engaged at a later time, when certain conditions are met.
- ⁵ Captured: A system mode has become engaged.
- ⁶ An electronic flight display that presents the primary flight instruments, navigation instruments, and other information about the status of the flight in one integrated presentation.

Figure 1: Minimum safe altitude warning for N416MC

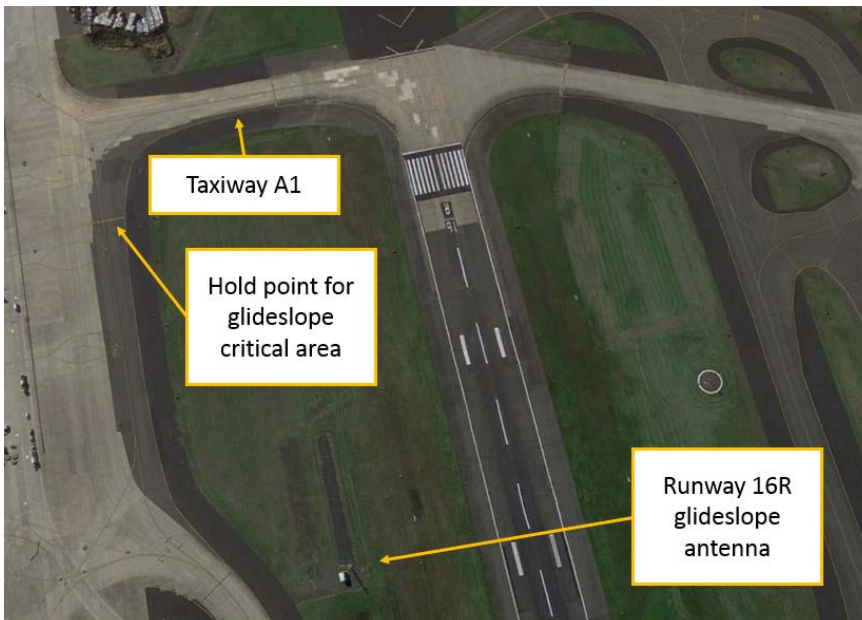


Source: Airservices, annotated by the ATSB

ILS signal interference

Disturbances to ILS localiser and glideslope courses are caused by fixed structures, such as buildings (static distortion), and moving vehicles or aircraft (dynamic distortion). The total ILS course distortion is determined by the root square summation of static and dynamic distortion and this is used to define critical areas⁷ near each localiser and glideslope antenna (Figure 2).

Figure 2: Runway 16R glideslope antenna and critical area hold point



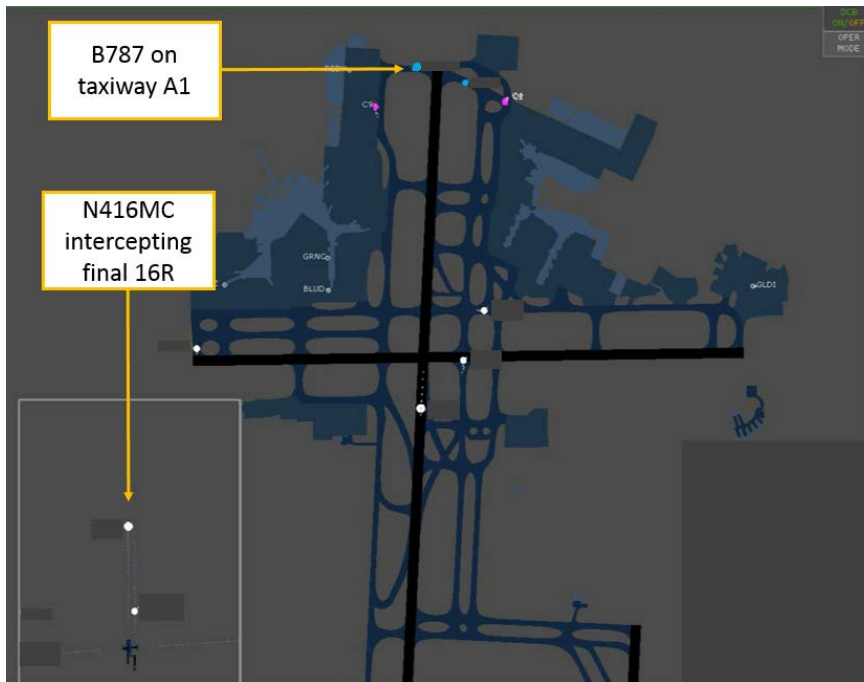
Source: Google earth, annotated by the ATSB

⁷ The critical area is a volume of airspace encompassing lateral and vertical dimensions based around the localiser and glideslope antennas to protect the ILS signal transmissions to airborne aircraft in poor weather.

The critical areas are protected for low visibility approaches. This is when the cloud ceiling is at or below 600 ft, or the visibility is 2000 m or less. In which case, no aircraft or vehicle is permitted to enter the critical areas when an arriving aircraft is within the outer marker, or 4 NM from the threshold if there is no outer marker.

At the time N416MC intercepted the runway 16R localiser, a Boeing 787 was holding on taxiway A1, within the runway 16R glideslope critical area (Figure 3). However, the weather conditions did not require air traffic control to activate the ILS critical area, and N416MC was instructed to go-around before reaching the outer marker.⁸

Figure 3: Infringement of the 16R glideslope critical area



Source: Airservices, annotated by the ATSB

Receiver characteristics

A moving receiver passing through a distorted ILS signal will produce a guidance error. The error produced will vary depending on the receiver characteristics, its antenna characteristics and the speed of the vehicle carrying the receiver as it passes through the distorted signal.

Similar incidents

Glideslope signal disturbances

- On 17 March 2017, a Boeing 747-400 attempted to intercept the runway 16R ILS in instrument meteorological conditions using the autopilot for a coupled approach.⁹ When the glideslope was captured, the indications began to oscillate and the autopilot chased the indications. A high rate of descent developed and a 'low on profile' call was made on the flight deck to stop the descent. The descent was stopped at about 1,500 ft, about 7 NM (13 km) from the threshold of runway 16R. An Airbus A380 was lined up for departure on runway 16R from taxiway A1 when the Boeing 747 was about 8 NM (14.8 km) from the threshold of runway 16R.
- On 23 March 2017, a Boeing 747-400 attempted to intercept the runway 16R ILS in instrument meteorological conditions using the autopilot for a coupled approach. Approaching 2,000 ft, the glideslope on the captain's primary flight display disappeared, followed by the glideslope on the first officer's primary flight display. The aircraft pitched nose down with an associated increased

⁸ Runway 16R outer marker is about 3.9 NM from the runway threshold.

⁹ Coupled approach: An approach flown by the auto-pilot.

rate of descent. The captain disengaged the auto-pilot and stopped the descent at about 1,500 ft and 8 NM (14.8 km) on final for 16R. A minimum safety altitude alert activated and the approach controller instructed the flight crew to conduct a missed approach. An Airbus A380 was holding on taxiway A1 at the time of the incident. A second approach was flown using the auto-pilot without incident. There were no aircraft in the glideslope critical area during the second approach.

Localiser signal disturbance

On 27 August 2015, a Boeing 787-800 attempted to conduct an autoland¹⁰ to runway 34L at Sydney Airport in visual meteorological conditions. The aircraft experienced a disturbance to the localiser signal at about 100 ft and the flight crew immediately disconnected the autopilot to complete the landing. The flight crew were aware the ILS critical area was not required to be protected at the time and had not notified air traffic control they were conducting an autoland. They were aware that disturbances to the ILS signals were possible and were prepared to intervene. An Airbus A330 departed directly in front of the 34L localiser antenna at the time of the incident.

Manufacturer comments

Boeing, the aircraft manufacturer, reported that they have no reason to believe that the 747 would behave any differently to their other aircraft types. The same antenna system is installed on the 757, 767 and 777. However, there are some differences in the antenna locations. The 747 and 777 receiver antennas are located on the main landing gear doors, while the 757 and 767 antennas are located in the nose of the aircraft. The glideslope incidents might relate to a varying signal strength, rather than a distorted beam.

Aeronautical Information Publication

If a pilot advises air traffic control that an 'autoland' or 'coupled approach' is to be flown, then air traffic control will either report 'ILS critical area not protected' or 'LVP¹¹ in force' if the critical area is protected.¹²

Airservices Australia comments

Airservices Australia, the air traffic services provider, reported that disturbance of the glideslope signal is less for aircraft at the taxiway A holding point (holding point for glideslope critical area) than it is for the same aircraft at the holding point on taxiway A1. Airservices Australia conducted a computer simulation which indicated that an Airbus A380 aircraft stationary at holding point A1 is unlikely to have caused the large ILS signal disturbance observed in this incident.

The simulations and radar recordings indicated the observed disturbance in each case occurred after the holding aircraft was provided with its line up clearance and while taxiing between the holding point and the runway. In this respect, there will always be significant interference to approaching aircraft outside 4 NM regardless of whether the holding point on taxiway A or A1 is used at the same time as runway 16R is used for arrivals.

Safety analysis

N416MC intercepted the final approach and the auto-pilot captured the ILS localiser and glideslope at the same time as a Boeing 787 (B787) was holding on taxiway A1, which lies within the critical area for the runway 16R glideslope. The presence of the 787 in the critical area likely resulted in N416MC receiving either a distorted glideslope beam or a beam of varying signal strength. This required flight crew intervention following a glideslope failure indication, which was detected by the captain crosschecking the two primary flight displays. At the time of the incident,

¹⁰ Landing of the aircraft by the autopilot for the operational purpose of landing when there are no visual cues for the pilot.

¹¹ Low visibility procedures

¹² Refer: Aeronautical Information Publication (AIP) Australia AD 1.1 – 2.

the glideslope critical area was not required to be protected, in accordance with the manual of air traffic services.

ATSB comment

It has been previously noted by regulators and manufacturers, that it is common practice for operators to conduct coupled approaches and autoland to satisfy maintenance, training or reliability program requirements. These approaches may be conducted in weather conditions which do not require protection of the ILS signal. There have been incidents reported in which the autopilot has responded to disturbances in the ILS signal when the aircraft was close to landing. Airservices Australia advise that ILS signals may be disturbed with the consequential effect on autoland performance when weather conditions do not require protection of the ILS critical area.

For more information on ILS signal distortion and determination of protected areas following the introduction of the Airbus A380 see [Assessment of ILS protection areas impact on large aircraft operations](#).

Findings

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

- The descent below the nominal 3° approach glideslope was probably the result of the aircraft auto-pilot capturing a distorted glideslope beam.
- The glideslope beam was probably distorted due to the presence of a Boeing 787 in the glideslope critical area, which was not required to be protected in the weather conditions which prevailed at the time of the incident.

Safety message

This incident highlights the importance of crosschecks on the flight deck and between air traffic control and the flight crew. After detecting unexpected indications on the flight deck, the flight crew intervened to stop the descent, which was then followed by an instruction from air traffic control to initiate a go-around.

The aircraft manufacturer and regulators have recommended that flight crew remain vigilant for ILS disturbances with resulting unexpected flight control movements and be prepared to immediately disconnect the autopilot, particularly during autoland operations.

General details

Occurrence details

Date and time:	12 February 2017 – 2152 EDT	
Occurrence category:	Incident	
Primary occurrence type:	Flight below minimum altitude	
Location:	15 km NNW from Sydney Airport, New South Wales	
	Latitude: 33° 48.87' S	Longitude: 151° 08.98' E

Aircraft details

Manufacturer and model:	The Boeing Company 747-47UF	
Registration:	N416MC	
Serial number:	32838	
Type of operation:	Air transport high capacity - Freight	
Persons on board:	Crew – 2	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

About the ATSB

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; and fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to operations involving the travelling public.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

About this report

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope, fact-gathering investigation was conducted in order to produce a short summary report, and allow for greater industry awareness of potential safety issues and possible safety actions.