Australian Government
Australian Transport Safety Bureau

Operational non-compliance involving Boeing 777-3D7, HS-TKD

15 km south of Melbourne Airport, Victoria | 24 July 2011

Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
AO-2011-086
Final

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ATSB TRANSPORT SAFETY REPORT

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SAFETY SUMMARY

What happened

At 2019 Eastern Standard Time on 24 July 2011, a Thai Airways International Boeing Company 777-3D7 aircraft, registered HS-TKD, was conducting a runway 34 VOR approach to Melbourne Airport, Victoria. During the approach, the tower controller observed that the aircraft was lower than required and asked the flight crew to check their altitude. The tower controller subsequently instructed the crew to conduct a go-around. However, while the crew did arrest the aircraft's descent, there was a delay of about 50 seconds before they initiated the go-around and commenced a climb to the required altitude.

What the ATSB found

The ATSB established that the pilot in command may not have fully understood some aspects of the aircraft's automated flight control systems and probably experienced 'automation surprise' when the aircraft pitched up to capture the VOR approach path. As a result, the remainder of the approach was conducted using the autopilot's flight level change mode. In that mode the aircraft's rate of descent is unrestricted and therefore may be significantly higher than that required for an instrument approach. In addition, the flight crew inadvertently selected a lower than stipulated descent altitude, resulting in descent below the specified segment minimum safe altitude for that stage of the approach and the approach not being managed in accordance with the prescribed procedure.

What has been done as a result

In response to this occurrence, Thai Airways International issued a notice to flight crews that emphasized the importance of constant angle non-precision approaches and adherence to the segment minimum safe altitudes. Other actions included a review of the training in support of non-precision approaches and the provision of additional information relating to the use of the aircraft's autopilot flight director system.

Safety message

This occurrence highlights the risks inherent in the conduct of non-precision approaches and reinforces the need for flight crews to closely monitor the aircraft's flight path to ensure it complies with the prescribed procedure.

Modern air transport aircraft are equipped with ever increasing levels of automation that, when used appropriately, can greatly reduce flight crew workload. While flight crews retain the option of flying the aircraft manually, the use of automation is generally preferred and often provides increased levels of safety and efficiency. To effectively manage the aircraft and flight path, however, flight crews need to maintain a thorough understanding of the relevant automatic flight systems. Worldwide, errors associated with the use and management of automatic flight systems have been identified as causal factors in more than 20% of approach and landing accidents.

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Acknowledgements

Figure 1: Modified from the original document, Airservices Australia
Figure 2: The Boeing Company
Appendix A: Airservices Australia

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau 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; 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 fare-paying passenger operations.

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.

Purpose of safety investigations

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. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

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.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes appropriate, or to raise general awareness of important safety information in the industry. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: the ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

FACTUAL INFORMATION

Sequence of events

On 24 July 2011, a Thai Airways International Boeing Company 777-3D7 (777) aircraft, registered HS-TKD, was approaching Melbourne Airport, Victoria after a flight from Bangkok, Thailand. The first officer was the flying pilot.

At 2013 Eastern Standard Time[1], the aircraft was cleared by the approach controller to descend to 3,000 ft above mean sea level (AMSL) for a Melbourne runway 34 very high frequency omnidirectional radio range (VOR)[2] approach (Appendix A). Weather reports indicated that visual meteorological conditions[3] existed at that time and visibility was reduced to about 8 km due to rain showers. The wind was reported to be from the north at about 20 km/h.

At 2015, the aircraft was on descent with the autopilot, lateral navigation (LNAV) and vertical navigation (VNAV) modes engaged. VNAV speed (SPD) mode was selected on the aircraft's autopilot flight director system (AFDS) at that time with target values of 230 kts and 3,000 ft set in the mode control panel (MCP). In that mode, the auto-flight system acted to maintain the selected airspeed of 230 kts and limit the descent to not below 3,000 ft.

At 2015:47 and at an altitude of about 3,300 ft, the AFDS automatically changed mode from VNAV SPD to VNAV path (PTH) to ensure compliance with runway 34 VOR initial approach altitude constraint of 3,000 ft. As the flight management computer (FMC)-calculated flight path altitude at that time was 3,440 ft, the auto-flight system commanded a pitch-up change to achieve level flight and intercept the approach path profile.

A short time later, the flight crew changed the MCP target airspeed and altitude to 210 kts and 2,000 ft respectively. At 2016:05, the crew selected flight level change (FLCH) mode with the intent of ensuring that the descent continued. The crew then selected the wing flaps to position 1 and changed the target speed and altitude values on the MCP to 190 kts and 3,000 ft respectively. At 2016:46, the aircraft captured the MCP altitude of 3,000 ft and the pitch mode automatically changed from FLCH to altitude (ALT) mode to maintain the selected altitude.

At 2017:04, the flight crew changed the MCP target altitude to 970 ft[4], selected FLCH mode and the aircraft commenced descent. To maintain the target airspeed of 190 kts, the autothrottle reduced engine thrust to flight idle. The aircraft

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1 Eastern Standard Time (EST) was Coordinated Universal Time (UTC) +10 hours.

2 A ground-based navigation aid that emits a signal that can be received by appropriately-equipped aircraft and represented as the aircraft's bearing (called a 'radial') to or from that aid.

3 Visual Meteorological Conditions is an aviation flight category in which visual flight rules (VFR) flight is permitted — that is, conditions in which pilots have sufficient visibility to fly the aircraft maintaining visual separation from terrain and other aircraft.

4 The minimum descent altitude (MDA) for the approach was 760 ft. However, a Notice to Airmen (NOTAM) current at the time raised the MDA to 920 ft because of crane operations beneath the approach path. The operator advised that 'the pilots added approximately 50 feet to the MDA due to [a] CANPA [constant angle non-precision approach] requirement'.

subsequently intercepted the final approach track and at 2018:31, the flight crew contacted the tower controller and reported that the airfield was in sight.

The tower controller then cleared the aircraft for a visual approach, provided the aircraft was '... established on PAPI[5] and inside the circling area[6]'. At 2018:48, with the aircraft at 8.5 DME[7] (about 7 NM (13 km) to the runway threshold) and at an altitude of 1,284 ft, the flight crew disconnected the aircraft's autopilot.

At 2018:56, the tower controller observed both visually and by radar that the aircraft was low on the approach and asked the flight crew to 'check altitude'. Four seconds later the controller instructed the crew to 'climb go-around carry out missed approach runway 34', to which the flight crew responded 'climbing'. The aircraft's lowest altitude before the go-around of 984 ft was recorded a few seconds later, when the aircraft was 6.4 NM (12 km) from the runway threshold.

At 2019:26, and with the aircraft's altitude still low at 1,167 ft, the tower controller asked the flight crew to confirm that they were going around. The flight crew replied 'we are climbing Thai 461 we are maintaining 1,200 copy'. The controller again instructed the crew to carry out a missed approach, to which they replied 'on visual approach'. The tower controller then responded 'negative, missed approach runway 34, climb to 4,000 ft'. At 2019:50 the flight crew reported that they were climbing to 4,000 ft.

The subsequent runway 34 VOR approach was conducted by the captain using both LNAV and VNAV modes.

The aircraft's track and some of the key events associated with the first approach are depicted in Figure 1. A sequence of events table listing the active AFDS modes and various altitudes during the occurrence is at Appendix B.

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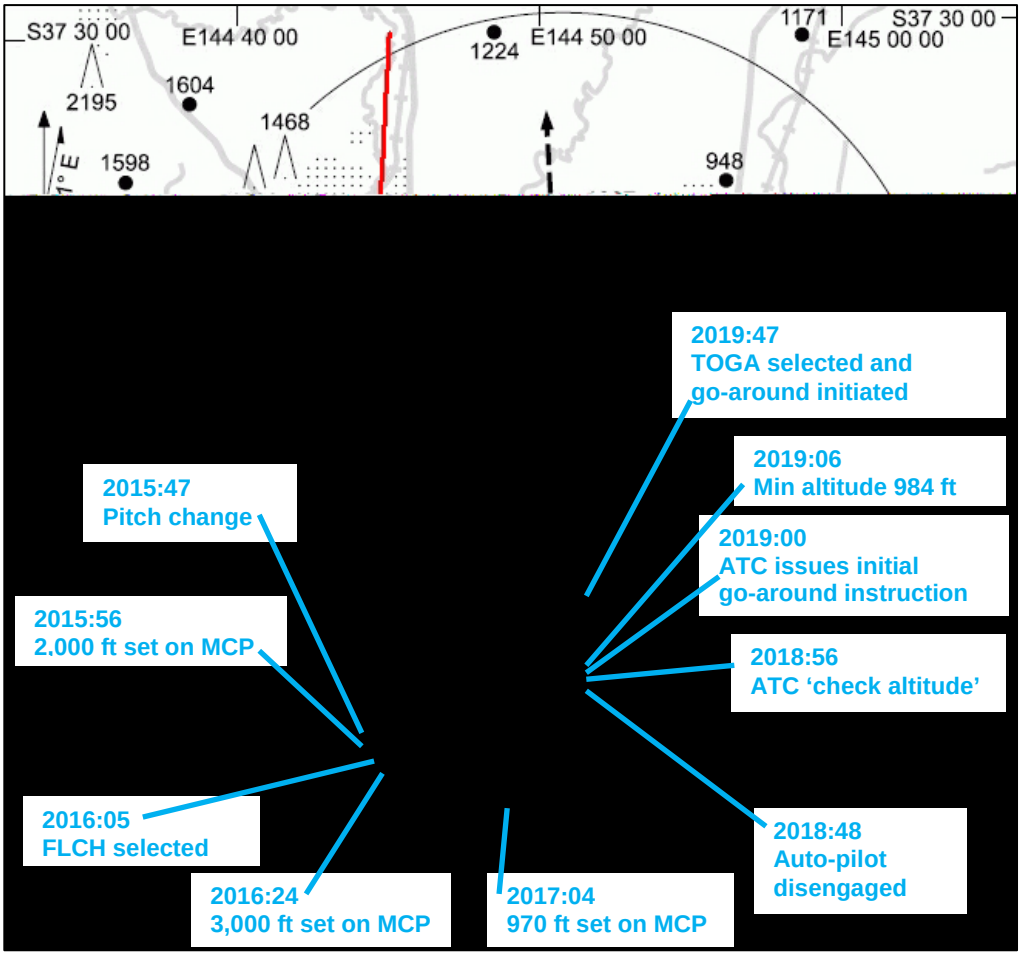
5 Precision Approach Path Indicator. Is a ground based, visual approach indicating system that uses a colour discriminating system used by pilots to identify the correct glidepath to the runway.

6 In this case, given that the runway threshold was located at 1.5 NM DME, the aircraft would have been within the applicable circling area after passing 6.8 NM DME.

7 Distance Measuring Equipment (DME) is a ground-based transponder station. A signal from an aircraft to the ground station is used to calculate its distance in nautical miles (NM) from the ground station.

Figure 1: Recorded track of the aircraft (in red) and key events (in blue)



Flight crew information

The captain reported that an approach briefing was conducted about 30 minutes prior to commencing descent. The briefing included confirmation that the VNAV profile in the aircraft's database agreed with the profile depicted on the approach chart.

The captain recalled that he did not anticipate the aircraft pitching up as it approached 3,000 ft and that he instructed the first officer to engage FLCH mode in response to that pitch up and to continue the descent to the selected MCP altitude. The captain thought that the pitch up may have indicated a fault with the VNAV function and was unsure if VNAV would resume its normal function if reselected. On that basis, the descent was continued using the FLCH mode.

The captain stated that, during the turn onto final approach and while he was attending to radio calls, the aircraft flew through a rain shower that impaired his ability to sight the runway. The captain attributed the steeper than usual descent during the turn onto final to a combination of high workload, a strong headwind and the use of FLCH mode.

The captain recalled that, as the aircraft lined up on final approach, the PAPI was indicating 'four reds' and that they were 'really low' (relative to the standard 3° approach path). The captain told the first officer to stop the descent and to climb

APPENDIX B: SEQUENCE OF EVENTS TABLE

Time (EST)	Event	AFDS Pitch mode	Aircraft ALT ft (3°app)	SMSA ft	MCP altitude
2013:13	Aircraft cleared for runway 34 VOR approach	VNAV SPD	6,000	3,000	3,000
2015:47	Pitch-up as the AFDS changes from VNAV-SPD to VNAV-PTH	VNAV PTH	3,300	3,000	3,000
2015:56	Flight crew set 2,000 ft on the MCP		3,300	3,000	2,000
2016:05	Flight crew select FLCH	FLCH	3,250	3,000	2,000
2016:24	Flight crew set 3,000 ft on the MCP	FLCH	3,300	3,000	3,000
2016:46	Aircraft captures the MCP altitude of 3,000 ft	ALT	3,000	3,000	3,000
2017:04	Flight crew set 970 ft on the MCP	FLCH	2,900	1,950	970
2018:12	Aircraft inbound at 9.7 DME	FLCH	2,100 (3,000)	1,950	970
2018:31	Flight crew advise that they have the airfield in sight	FLCH	1,700 (2,800)	1,950	970
2018:48	Aircraft's autopilot disconnected	FLCH	1,300 (2,500)	1,950	970
2018:56	Flight crew told to 'check altitude'	ALT	1,100 (2,500)	1,950	970
2019:00	Flight crew instructed to go-around and to carry out missed approach runway 34. Crew responds 'copied'	ALT	1,000 (2,450)	1,950	970
2019:26	Go-around instruction re-issued to flight crew, who respond that they are maintaining 1,200 ft	ALT	1,100 (2,200)	1,950	970
2019:35	Flight crew instructed to carry out a missed approach. The crew's reply is inaudible	ALT	1,150 (2,100)	920	4,000
2019:47	The tower controller responds, 'Negative, missed approach runway 34 climb to 4,000 ft' Flight crew acknowledges that they are climbing to 4,000 ft	TOGA	1,200 (1,900)	920	4,000

Altitudes in red are below the segment minimum safe altitude (SMSA). Altitudes shown in parentheses are the approximate recommended altitude for the aircraft to be on a standard 3° approach path.

APPENDIX C: SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included the:

- operator and flight crew of the aircraft
- aircraft manufacturer
- Airservices Australia (Airservices).

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the operator and flight crew of the aircraft, the aircraft manufacturer, the Department of Civil Aviation Thailand, the Civil Aviation Safety Authority (CASA) and Airservices. Submissions were received from the aircraft operator and CASA and where considered appropriate, the text of the draft report was amended accordingly.

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