

INCIDENT

Aircraft Type and Registration:	Airbus A320-214, G-EZTE	
No & Type of Engines:	2 CFM CFM56-5B4/3 turbofan engines	
Year of Manufacture:	2009 (Serial no: 3913)	
Date & Time (UTC):	7 January 2015 at 1523 hrs	
Location:	On approach to Paphos Airport, Cyprus	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 6	Passengers - 157
Injuries:	Crew - None	Passengers - None
Nature of Damage:	None	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	39 years	
Commander's Flying Experience:	4,500 hours (of which 4,200 were on type) Last 90 days - 173 hours Last 28 days - 94 hours	
Information Source:	Air Safety Report and investigation report submitted by the operator, and further enquiries by the AAIB	

Synopsis

During a visual approach to Runway 29 at Paphos, Cyprus, the airspeed reduced below the target speed and the ALPHA FLOOR autothrust (A/THR) protection activated. The flight crew took recovery action and, during the subsequent go-around, a TCAS RA was generated as the aircraft came into potential conflict with an aircraft at a higher altitude.

History of the flight

The commander and co-pilot were operating a scheduled flight from London Luton Airport to Paphos, Cyprus. The forecast weather conditions at Paphos were clear, with a wind from the north-west. After reviewing the flight planning paperwork, the co-pilot was designated as the pilot flying (PF) for the sector.

En route, the crew checked the latest weather information for Paphos Airport (elevation 41 ft amsl), which showed that conditions could be suitable for a visual approach to Runway 29. The 1430 hrs Paphos METAR reported: surface wind from 310° at 19 kt, with gusts to 29 kt, visibility more than 10 km, few cumulonimbus clouds at 2,500 ft, few towering cumulus clouds at 3,500 ft and scattered cloud at 5,000 ft, temperature 10°C and QNH 1010 hPa. The crew planned for both an instrument and a visual approach, to cover the two options.

During the approach briefing, which was conducted before the descent started, the crew consulted the Operations Manuals (OM) to review the visual approach procedures. The commander then sketched out a plan of how these procedures would apply to an approach at Paphos in the prevailing conditions. The briefing included a discussion of threat and error management. A number of potential threats at Paphos were identified, including the effects of the wind on the timing for the downwind leg and the crosswind on final approach. A modification was made to the information on the navigation display, at the co-pilot's suggestion, with the creation of a 4 nm range ring centred on the Runway 29 threshold. This was to depict the protected area for a circling approach, a technique that the co-pilot had been shown on his last simulator check but was not a standard operating procedure (SOP).

During the descent, the flight crew made visual contact with Paphos Airport and requested a visual approach from Paphos ATC. This was approved, with an initial cleared altitude of 4,000 ft amsl. Accordingly, the co-pilot flew a left-hand circuit pattern, joining the downwind leg at that altitude. The TRK/FPA (track/flight path angle) pushbutton was then pressed to select the flight path vector (FPV) ('the bird') on the PFD (Primary Flight Display), which also replaced the FD bars with the flight path director (FPD). The airspeed was reduced and Flap 2 was selected.

On receiving clearance from ATC, a further descent was initiated to the circuit altitude of 1,500 ft amsl, using the Thrust Idle (THR IDLE) and Open Descent (OP DES)¹ modes, with the autopilot engaged. Both crew considered that the aircraft was now above the desired profile. The landing gear was selected DOWN and the aircraft passed abeam the Runway 29 threshold at an altitude of 3,500 ft amsl. About 42 seconds later, while still within the 4 nm range ring, the co-pilot disconnected the autopilot and started the base turn, with the aircraft descending through an altitude of 3,100 ft amsl at an airspeed of 165 kt. The associated SOP call '*autopilot OFF*' and instruction '*flight directors OFF*' were omitted and the FPD remained ON². At the same time, ATC issued revised go-around instructions, advising the aircraft to maintain runway heading and level at an altitude of 2,000 ft amsl, in such an event. This was acknowledged by the commander.

As the aircraft turned onto base leg, the co-pilot announced "speed decaying". The commander, whose attention was directed outside the aircraft to provide position information during the base turn, thought this was the intention and asked the co-pilot if he required Flap 3. On receiving the latter's confirmation, Flap 3 was selected. The aircraft descended through 2,860 ft amsl, with a speed of V_{LS} ³ +5 kt, a high angle of attack and a pitch attitude of 12° nose-up. The speed continued to decay and at V_{LS} -2 kt the FD automatically disengaged⁴.

Footnote

¹ With OP DES engaged, autopilot pitch control maintained the target speed. Further description on this mode is provided under 'Aircraft information'.

² The commander commented that, with the FPV (the bird) active and the FPD replacing the FD bars on the PFD, the FPD symbol would have been less obvious than the FD bars.

³ Lowest selectable speed. The aircraft manufacturer states: '*VLS represents the lowest selectable speed providing an appropriate margin to the stall speed.*'

⁴ A feature of the speed protection system.

Concerned about the reduction in airspeed, the co-pilot focused his attention on the airspeed indication. In the turn, the pitch attitude increased and the rate of descent decreased, leading to a further reduction in airspeed. ALPHA FLOOR⁵ then activated and Takeoff/Go-Around (TOGA) thrust was set automatically by the A/THR. The co-pilot announced "ALPHA FLOOR" and after a few seconds, realising he was losing his situational awareness, handed control to the commander. At that point, the aircraft had a nose-up pitch attitude of 10.5° and was climbing through an altitude of 2,900 ft amsl.

The commander, whose attention had been redirected outside the aircraft and had been "startled" by the co-pilot's announcement, turned the aircraft away from the coastline and terrain, announcing "GO-AROUND, FLAP". TOGA thrust was selected on the thrust levers, to match the lever position with thrust, the co-pilot selected Flap 2 and an initial nose-down pitch input was followed by a nose-up pitch input. As the aircraft continued to climb, the Speed Reference System engaged (target speed V_{APP}) and the FD bars re-appeared. The speed increased, the flaps were retracted to Flap 1, A/THR was selected OFF and the thrust levers were moved out of the TOGA detent, to regain control of the thrust. Meanwhile, the landing gear remained DOWN.

As the aircraft climbed through 3,900 ft amsl, a TCAS RA "LEVEL OFF, LEVEL OFF" aural alert was triggered. The aircraft was levelled, then descended and passing 3,860 ft amsl the TCAS alert "CLEAR OF CONFLICT" was announced. The aircraft continued to descend to 3,380 ft, with the FD remaining ON, at which point ATC cleared the aircraft to climb to an altitude of 4,000 ft. Having levelled at 4,000 ft amsl, the autopilot and A/THR were re-engaged. Thereafter, an uneventful ILS approach and landing on Runway 29 was carried out.

The minimum speed recorded during the ALPHA FLOOR event was $V_{LS} -7$ kt.

Aircraft information

Warning and protection systems

The aircraft's Flight Augmentation Computer (FAC) computes the aircraft energy level and issues an aural 'low-energy' alert, 'SPEED SPEED SPEED', repeated every five seconds, to warn the pilot when the aircraft's 'energy level' becomes low. It is available with Flap 2, 3 and FULL, when the aircraft is below a height of 2,000 ft on the radio altimeter. During aircraft deceleration, the low energy alert is normally triggered before ALPHA FLOOR is activated.

A speed protection function is provided in some flight modes when FD orders are not followed by the flight crew. With the FD engaged (no AP) in OP DES mode and the speed at or below $V_{LS} -2$ kt, the FD bars disappear and the A/THR, if active, engages in SPEED mode. Thrust is increased to recover the speed target and a triple click aural warning sounds.

ALPHA FLOOR is a protection which becomes active with a high angle of attack, commanding TOGA thrust, regardless of thrust lever position. It is available throughout the flight, from

Footnote

⁵ A description of ALPHA FLOOR is provided under 'Aircraft information'.

lift-off until the aircraft has descended to a height of 100 ft RA on final approach. When ALPHA FLOOR activates, TOGA thrust is locked until it is disconnected by the flight crew. The Flight Crew Training Manual (FCTM) recommends that the flight crew cancel the mode by disconnecting the A/THR, using the 'instinctive' disconnect pushbutton on either thrust lever, as soon as a safe speed has been achieved.

Traffic Collision Avoidance System

When a RA is detected, the TCAS issues one of a number of aural alert messages and an associated visual command on the Primary Flight Display (PFD) vertical speed scale. The required initial crew actions are to select the autopilot OFF, if engaged, and both Flight Directors OFF. Then, the aircraft's pitch attitude should be adjusted smoothly, as required, to achieve a rate of climb/descent in the green band on the vertical speed scale and/or avoid the red band.

Automation modes

The active A/THR mode is displayed on the FMA at the top of the PFD. When the autopilot/flight director (AP/FD) is off and the A/THR is engaged, the A/THR is in SPEED/MACH mode (MANAGED OR SELECTED) and the thrust is varied to maintain the target speed. When the A/THR and AP/FD are both engaged, the A/THR modes '*are selected automatically in conjunction with the AP/FD modes*'. In THRUST mode, the A/THR maintains a fixed thrust, either CLB OR IDLE.

OP DES is an AP/FD 'vertical' mode. Speed, MANAGED OR SELECTED, is maintained with the autopilot pitch mode and the A/THR maintains IDLE thrust. When the autopilot is disconnected, the flight directors provide pitch commands for the PF to maintain the target speed/Mach number, and the A/THR continues to command IDLE thrust. When the flight directors are selected OFF, the A/THR reverts to speed mode, varying the thrust to maintain the target speed/Mach number.

Visual approach guidance

The operator's Operations Manual (OM), Part B, provides procedures for flying a visual approach. It states:

'Method

- *The autopilot is not used,*
- *Both FDs are off,*
- *FPV is recommended,*
- *A/THR use is recommended with managed speed'*

It is suggested that the FMS flight plan may include the downwind leg as a useful indication of aircraft position but notes that visual references must be used. A diagram of the circuit pattern is also provided, basing the timings and positional guidance on a circuit height of 1,500 ft aal.

In the section entitled 'Use of the flight management and guidance system', the following information is provided: 'When flying a visual approach the Flight Directors should be deselected'. The normal sequence of actions during a visual approach, with associated standard calls, are: 'autopilot OFF, flight directors OFF, and 'Bird'⁶ ON'.

Flight Crew Operating Manual

The Flight Crew Operating Manual (FCOM) also provides guidance on flying a visual circuit (see Figure 1).

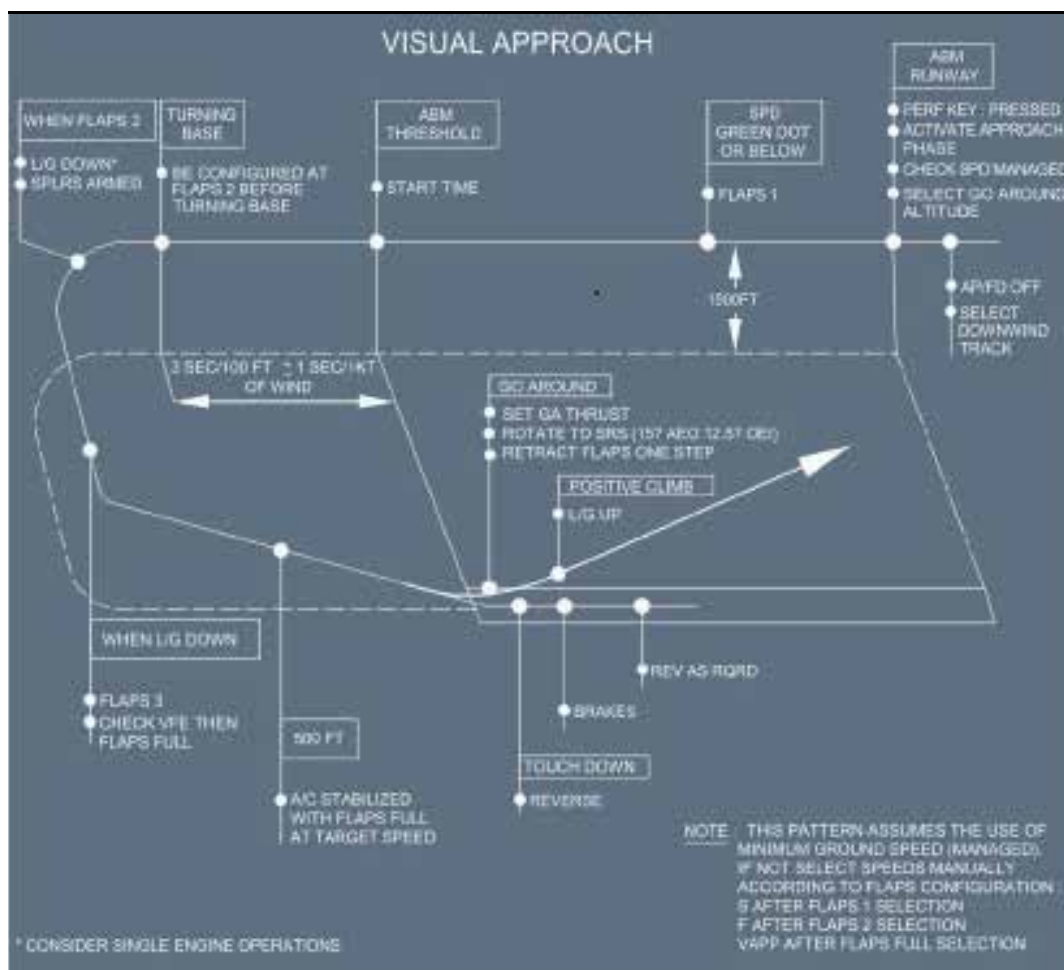


Figure 1

Visual approach pattern

Flight Crew Training Manual (FCTM)

The aircraft manufacturer's FCTM includes a section entitled 'Preventing Identified Risks', the purpose of which is to increase awareness and management of some of the risks likely to be encountered by flight crew. One of the risks highlighted is ALPHA FLOOR activation

Footnote

⁶ Flight Path Vector.

with no subsequent disconnection of autothrust, with TOGA thrust being maintained and the possibility of an overspeed. However, the FCTM does not include information about the risk associated with disconnection of the autopilot, without deselecting the flight directors, when operating in OP DES mode, and the A/THR continuing to command IDLE thrust.

Flight crew information

The co-pilot had 2,800 hours of experience on Airbus A320 series aircraft, and both he and the commander had carried out the operator's previous recurrent simulator programme, which included specific training on the automation modes and more complicated circling manoeuvres. The simulator programme, active at the time of the incident, included a specific element of A/THR awareness training, in which the risks associated with OP DES mode were highlighted. The co-pilot had completed this training.

Recorded flight data

As a result of the TCAS RA 'LEVEL OFF, LEVEL OFF' aural alert, a TCAS download was performed by the operator and supplied to the AAIB. This indicated that a minimum vertical separation of 1,000 ft was maintained.

Previous similar events

In December 2013, the French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) published a Serious Incident Report entitled '*Aircraft Airbus A320-214 registered F-HEPE, 3 April 2012 at 12 56 hrs, Deviation below manoeuvring airspeed on final, go-around, triggering of ALPHA FLOOR protection.*'⁷

The investigation reported on an incident which occurred during visual manoeuvring, as part of an RNAV Visual Approach, while an aircraft was turning onto final approach. The autopilot was disconnected but the flight directors remained engaged in OP DES mode, with the A/THR in IDLE thrust. The PF made an aft sidestick input during the turn, contrary to the flight director indication, and the speed reduced to $V_{APP} - 16$ kt. ALPHA FLOOR activated and the low speed situation was recovered. The report found that:

'Both pilots indicated that they thought that the A/THR would adjust the thrust to maintain speed. The PF's pitch-up input without intervention from the PNF showed that the crew had not identified the risk associated with not following the FD in OPEN DESCENT mode.'

In the report it was also noted that, on 8 April 2012,

'a similar event occurred on the same approach with the Airbus A320 registered F-GKXO and a different crew from the same airline. During this second event, the crew reacted as soon as the SPEED, SPEED, SPEED alarm sounded: the crew adjusted the thrust and continued the approach without the ALPHA FLOOR protection mode engaging.'

Footnote

⁷ <http://www.bea.aero/docspa/2012/f-pe120403.en/pdf/f-pe120403.en.pdf> [accessed 10 March 2015]

As a result of this investigation, the BEA made the following Safety Recommendation:

'EASA⁸, in partnership with national civil aviation authorities, ensure that training and recurrent training programmes include instruction on the risks associated with the use of OPEN DESCENT mode on approach. [Recommendation FRAN-2013-86]'

In response to this Safety Recommendation, on 10 June 2014 EASA issued Safety Information Bulletin (SIB) No: 2014-17, *Aeroplane Mode Awareness During Final Approach*, to encourage operators and training organisations to provide training to:

'enhance pilots' understanding of automated flight modes, with particular emphasis on: vertical modes commanding the thrust to idle and speed/energy protections....'

Since the two events reported on by the BEA, Airbus has introduced a revision to the FCOM, providing guidance on the procedure for flying an RNAV Visual Approach.

Discussion

The flight crew briefed thoroughly before the approach and had a plan they both understood. The visual circuit for Runway 29 involved a left-hand pattern. Therefore, the co-pilot, who was PF, would not be able to see the runway, from the downwind position and would have to rely on the commander for information on the visual aspect. However, the detail in the briefing suggested that, in practice, the co-pilot relied more on timing and the map display than the visual aspect. In addition, the briefing and proposed plan did not prepare the crew for the delayed clearance to descend to the circuit altitude.

The aircraft was in OP DES mode when the co-pilot initiated the base turn, while at an altitude of 3,100 ft amsl (3,059 ft aal) and just inside 4 nm from the Runway 29 threshold. From this position there were 7 track miles (nm) to the threshold, leaving the aircraft above the desired profile. The 4 nm range ring, which had been drawn on the navigation display and intended to be the limit for a circling approach, may have been misinterpreted as a limit for the visual approach, thereby constraining the circuit pattern. As the turn started, the co-pilot disconnected the autopilot but at that moment the commander was responding to a radio call from ATC, concerning revised go-around instructions. This was a possible distraction, diverting the commander's attention from monitoring the flight path and inhibiting the co-pilot from immediately announcing the autopilot disconnect SOP calls. Thus, the action to select the FD OFF was overlooked.

The co-pilot was aware that the speed was decaying but made an inappropriate aft stick input, suggesting that his situational awareness was reduced, possibly as a result of an increasing workload.

Footnote

⁸ European Aviation Safety Agency.

The activation of the ALPHA FLOOR protection mode and handover of control by the co-pilot startled the commander, who had to evaluate the unexpected situation and take corrective action. The aircraft was already above the revised go-around altitude of 2,000 ft and TOGA thrust had activated. While regaining the required airspeed and climbing, the aircraft approached another aircraft. A TCAS RA was generated and complied with, maintaining a minimum vertical separation of 1,000 ft.

Automation modes

On the A320 series, when the autopilot is disconnected in OP DES mode, the FD remains engaged in thrust mode, commanding IDLE thrust, and provides pitch commands for the PF to maintain the target speed. Thrust will not increase when the pitch commands are not followed and there is a decay in speed, until the low speed protections activate. To revert to SPEED mode and resume variable thrust, the flight director must be switched OFF. Flight crew are accustomed to the speed protections afforded by the A/THR system and the two events reported on by the BEA demonstrate that, if misunderstood, there can be an expectation that the A/THR will vary the thrust to maintain the target speed.

EASA's SIB No: 2014-17, *Aeroplane Mode Awareness During Final Approach*, encourages operators and training organisations to provide training to:

'enhance pilots' understanding of automated flight modes, with particular emphasis on: vertical modes commanding the thrust to idle and speed/energy protections....'

The crew had received the associated specific training on the automation modes and the co-pilot had recently undergone training in autothrust awareness, in which the risks associated with OP DES mode were highlighted. However, although the crew knew of the potential risks associated with the mode, a breakdown in procedures and lack of appropriate reaction to the reducing airspeed led to a high angle of attack and activation of ALPHA FLOOR.

Safety action

Following a review of the circumstances of this event the operator provided a programme of additional ground and simulator training for the commander and co-pilot. This training addressed non-technical skills, including threat and error management, technical aspects of the flight guidance systems and handling of the aircraft after activation of flight envelope protection systems.

The operator had earlier introduced a specific program of automated flight mode awareness simulator training, before this event. Since the occurrence, an additional procedure has been introduced, which requires the PF to announce the active A/THR mode whenever flight directors are selected OFF.