BY MARK LACAGNINA

The 737 stalled after the autothrottles disengaged without notice.

IDLE

Neither pilot was aware that the autothrottle system had disengaged with the thrust levers at idle during an instrument landing system (ILS) approach to Bournemouth (Hampshire, England) Airport. The Boeing 737-300 initially decelerated according to the flight crew's expectations. However, after final flap extension, the commander noticed that indicated airspeed had dropped 10 kt lower than the target speed. He was moving the thrust levers forward to initiate a go-around when the stall-warning system activated.

The flight crew's subsequent actions to avoid the impending stall were inadequate, said the U.K. Air Accidents Investigation Branch (AAIB) in its final report on the serious incident.

As airspeed had decreased, the autopilot had increasingly trimmed the 737 nose-up to maintain the glideslope. The aircraft pitched up further as thrust from the underwing-mounted engines increased as the commander advanced the thrust levers.

The combination of the nose-up trim and the application of maximum thrust "overwhelmed" the elevator, the report said, but neither pilot considered retrimming the stabilizer. Both pilots were pushing their control columns against the stops when the aircraft finally stalled and descended in a steep nose-up attitude. The commander was able to recover from the upset only after reducing thrust to the go-around setting, which restored elevator authority.

None of the 132 passengers or five crewmembers was injured, and there was no damage. The AAIB's investigation of the Sept. 23, 2007, incident led to recommendations to ensure that flight crews are effectively alerted to the disengagement of an autoflight system and to clarify procedures for recovering from an impending stall.

Night Instrument Conditions

The aircraft was en route on a scheduled flight from Faro, Portugal. The commander, 56, had 11,280 flight hours, including 420 hours in type. He had served as a 757/767 first officer for the operator before upgrading as a 737 commander in 2006.[1] The first officer, 30, had 3,170 flight hours, including 845 hours in type. He had flown

APPROACH

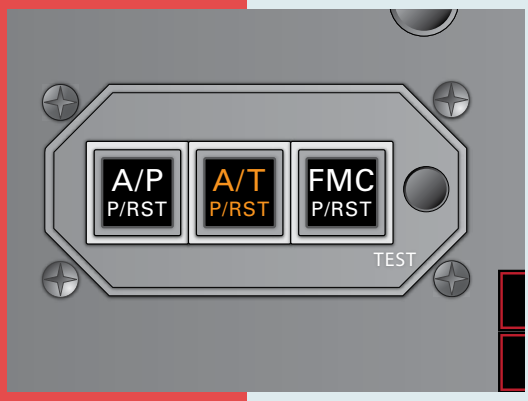
twin-turboprop regional aircraft before being employed by the operator in 2006.

"Before departing Faro, the crew discussed the weather at Bournemouth, uplifted additional fuel to permit two approaches and decided on a full-flap (flap 40) landing," the report said.

Night instrument meteorological conditions prevailed at Bournemouth, which is on the southern coast of England. Surface winds were from 220 degrees at 14 kt, visibility was 4,000 m (2 1/2 mi) in light rain, and the ceiling was overcast at 400 ft. Cleared to conduct the ILS approach to Runway 26, the crew calculated a landing reference speed (VREF) of 129 kt and decided to add six knots for the final approach.

As the autopilot captured the glideslope at 2,500 ft, the first officer, the pilot flying, asked the commander to extend the landing gear, select flap 15 and begin the landing checklist. He also selected a lower speed on the mode control panel (MCP). The autothrottle system moved the thrust levers to idle to reduce airspeed to the selected value. About 20 seconds later, the autothrottles disengaged. "The disengagement was neither commanded nor recognized by the crew, and the thrust levers remained at idle throughout the approach," the report said.

The autothrottle (A/T) annunciator flashes so often during approach that it may be perceived as a nuisance message.



Susan Reed

Indicated airspeed initially decreased normally at about one knot per second. "As the speed decreased below 150 kt, flap 25 was selected," the report said. "The autopilot tracked the glideslope accurately, gradually increasing the pitch of the aircraft to minimize glideslope deviation and adjusting the stabilizer angle to keep the aircraft in trim."

The report said that the approach was stable and that there was no sign the crew was "rushing the approach." However, the pilots momentarily became distracted when the first officer increased the illumination of his map light to read a placard showing the flap limit speeds before asking the commander to select flap 40. About this time, airspeed began to decrease rapidly.

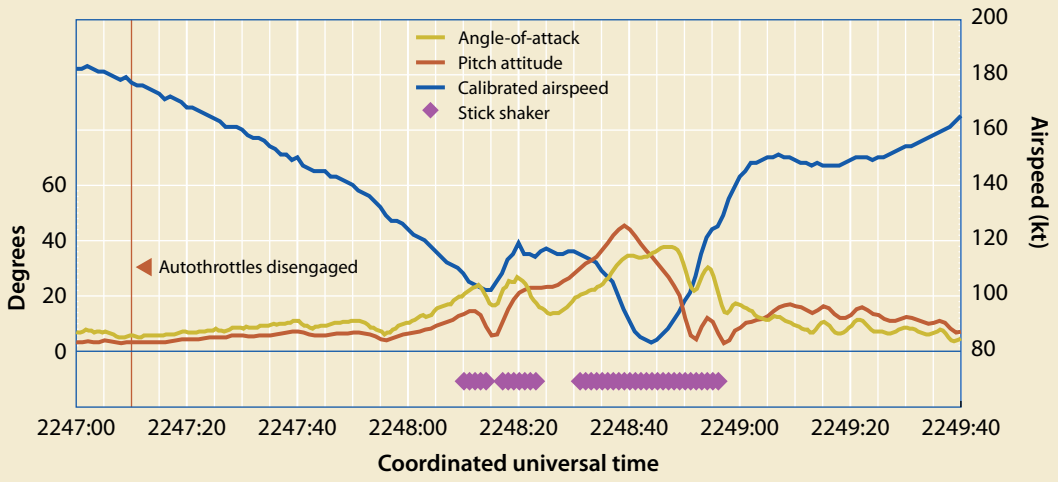
'I Have Control'

After selecting flap 40, the commander also selected 135 kt — the planned VREF plus 6 kt final approach speed — on the MCP and completed the landing checklist. "The commander stowed the checklist on top of the instrument panel, and when he looked down he saw an IAS [indicated airspeed] of 125 kt," the report said. "He called 'speed.' The [first officer] made a small forward movement with the thrust levers, and the commander called, 'I have control.'"

The aircraft was descending through 1,540 ft with a 12-degree nose-up pitch attitude and airspeed slowing below 110 kt when the commander moved the thrust levers full forward. As he did so, the stick shaker activated to warn of an impending stall (Figure 1, page 30). The commander engaged the autopilot's control wheel steering mode and moved his control column forward, reducing the pitch attitude to 5 degrees nose-up. "The stick shaker operation stopped, and the minimum airspeed was 101 kt," the report said. "A small, apparently unintended application of right aileron induced a right roll."

As engine low-pressure rotor speed (N_1) increased though 81 percent, the takeoff/go-around (TOGA) mode activated. "The autopilot

Selected Plots From QAR Data



QAR = quick access recorder

Source: U.K. Air Accidents Investigation Branch

Figure 1

disengaged, the pitch attitude started to increase again, and the stick shaker reactivated," the report said. "A corrective roll input was made to bring the aircraft wings-level, and although the control column was positioned fully forward, the nose-up pitch increased to 22 degrees."

N_1 increased to nearly 98 percent, which is above the rated go-around thrust setting of 94 percent. The pitch attitude stabilized briefly at 22 degrees, and the stick shaker ceased as airspeed increased to 118 kt. However, the pitch attitude again began to increase when the crew selected flap 15, the go-around setting.

"A small continuous left rudder input started a left roll," the report said. "As the flaps reached flap 15, the pitch angle was increasing through 27 degrees and the left roll was increasing through 7 degrees. The stick shaker reactivated, full nose-down elevator was still being applied, and the airspeed began to decay."

'Full Forward Stick'

The first officer called "high pitch," and the commander replied, "I have full forward stick." The first officer also held his control column full forward. "Both pilots reported [during post-incident interviews] that they had no pitch control authority," the report said.

Calibrated airspeed (CAS) decreased below 107 kt as the pitch attitude reached 36 degrees and the left bank increased beyond 13 degrees. The TOGA mode disengaged. A right rudder control input brought the wings level before the 737 stalled with a nose-up pitch attitude of 44 degrees.

"With no change in elevator position, the pitch rate reversed from positive to negative although angle-of-attack continued to increase as the aircraft started to descend," the report said. "Despite reducing pitch, the airspeed continued to decrease for a further five seconds to a minimum recorded CAS of 82 kt when the pitch was 33 degrees nose-up."

The commander regained control after reducing N_1 to 86 percent. Pitch attitude decreased rapidly to 5 degrees nose-up, and airspeed increased to 147 kt. "The commander initially leveled the aircraft at 3,000 ft before climbing to 4,000 ft and self-positioning for a second approach," the report said. The commander remained as pilot flying during the second approach, which was conducted without further incident with the autopilot and autothrottles engaged. The 737 was landed at 2301 local time.

After taxiing to a stand and shutting down the engines, the commander told the operator's base engineer that there had been an incident and that, although he believed the aircraft was serviceable, the operator likely would want to

review the recorded flight data. "No defects were entered in the technical log," the report said. "The engineer assured the commander that the operational flight data monitoring (OFDM) information was sent from the aircraft by an automatic mobile telephone-based data link."

Questions Unanswered

The next morning, the commander advised the operator's safety department of the incident and completed an air safety report (ASR). The AAIB report said that the ASR "contained limited information" and "did not depict the event accurately." Not realizing the seriousness of the incident, the operator did not file a mandatory occurrence report with the U.K. Civil Aviation Authority.

The OFDM analyst who read the ASR was not a pilot and flagged the event for further review by a pilot representative. An OFDM pilot representative was on duty in the safety department that day but was too busy with other tasks to review the incident aircraft's flight data. The report said that the seriousness of the incident was not identified and appropriate action was not taken until the next pilot representative came on duty again at the OFDM office 11 days later.

"[The aircraft] was not subjected to an engineering examination to ensure its continued airworthiness and remained in service throughout this period," the report said. Data recorded by the cockpit voice recorder and flight data recorder during the incident were overwritten, and the AAIB's incident investigation was limited to interviews and analysis of the flight data captured by the quick access recorder (QAR) for the OFDM program.

The investigation did not resolve why the autothrottle system disengaged during the approach. Manual disengagement is achieved by selecting the autothrottle switch on the glareshield panel to "OFF" or by pressing a push-button on either thrust lever. The QAR data indicated that neither of these actions had been taken.

The uncommanded disengagement of the autothrottle system could have resulted from detection of an internal fault by built-in test equipment. "Due to the delay in notification of the incident, the aircraft had completed more than 10 flights, and therefore the fault history information from the incident had been overwritten," the report said. Post-incident tests of the autothrottle system revealed no faults that could cause an uncommanded disengagement.

Why the pilots did not see the flashing red light on the instrument panel that warns of autothrottle disengagement also was unanswered. The annunciator is a small rectangular pushbutton lens in the upper center of the instrument panel. Labeled "A/T P/RST" —"autothrottle, push to reset" — the annunciator also generates a flashing amber caution light when airspeed is 10 kt above or 5 kt below the selected speed or decreases to "alpha floor," or 1.3 times the stalling speed.

"The autothrottle warning … flashes amber routinely for extended periods during the approach phase of flight," the report said. "It is likely that flight crews are subconsciously filtering out what is perceived as a nuisance message."

Investigators identified "a number of other events" that involved uncommanded and unrecognized autothrottle system disengagements in 737s. "Consequently, the efficacy of the autothrottle warning became of interest during the investigation," the report said, noting that the 737 did not have, and was not required to have, an aural indication of autothrottle disengagement.

As a result, AAIB recommended that Boeing and the U.S. Federal Aviation Administration review the effectiveness of the autothrottle system disengagement warnings in 300-, 400- and 500-series 737s and improve them if necessary. AAIB also called on the European Aviation Safety Agency to review Certification Standard 25 for transport category airplanes to "ensure that the disengagement of autoflight controls, including autothrottle, is suitably alerted to flight crews."

The incident investigation revealed that the flight crew did not apply nose-down trim to regain elevator authority. The flight crew training manual (FCTM) and the quick reference handbook (QRH) for the 737-300 both say that the first action in response to a stall warning or a stall is to apply full thrust. However, only the FCTM advises that the aircraft's nose will pitch up as the engines accelerate and that the stabilizer must be trimmed nose-down to assist in pitch control. "The [QRH] drill does not mention the use of pitch trim," the report said.

Based on this finding, AAIB called on Boeing to "clarify the wording of the approach-to-stall recovery [in the QRH] to ensure that pilots are aware that trimming forward may be required to enhance pitch control authority."

This article is based on AAIB Aircraft Accident Report 3/2009, "Report on the Serious Incident to Boeing 737-3Q8, Registration G-THOF, on Approach to Runway 26, Bournemouth Airport, Hampshire, on 23 September 2007."

Note

1. The operator was Thomsonfly, which became Thomson Airways in 2008.