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ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2009-013
Final

Avionics system event Sydney Airport, NSW 7 April 2009 VH-VYL, Boeing 737-800

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Abstract

On 7 April 2009, at about 1210 Eastern Standard Time, the flight crew of a Boeing 737-800 aircraft, registered VH-VYL, received an enhanced ground proximity warning system alert during an approach to land at Sydney Airport, NSW. At the same time, the autopilot disconnected and the engine thrust levers moved towards idle. The handling pilot corrected the engine thrust levers immediately and conducted an uneventful landing.

The investigation determined that spurious data from the left radio altimeter (RA) provided an indicated altitude of minus 7 ft, resulting in the autopilot disconnecting and the thrust lever movement.

An examination found that the left RA receive antenna displayed rubbing wear adjacent to the attachment screw inserts. A bonding check of the antenna indicated that the antenna's resistance was outside the aircraft manufacturer's limits. The antenna was replaced and the aircraft was returned to service.

Three months after the occurrence, a further RA warning flag event was experienced by another crew in this aircraft. As a result of that event, the left and right RA transceivers were removed and tested with internal faults found on the left unit.

FACTUAL INFORMATION

The information presented below, including any analysis of that information, was prepared principally from information supplied to the Bureau.

Sequence of events

On 7 April 2009, at about 1210 Eastern Standard Time[1] the flight crew of a Boeing 737-800 aircraft, registered VH-VYL, received an enhanced ground proximity warning system alert while passing through 129 ft above ground level during an autoland[2] approach and landing at Sydney Airport, NSW. At the same time, the left radio altimeter (RA) display reduced in altitude to minus 7 ft, the autopilot disconnected and the engine thrust levers moved toward the idle position. The pilot in command, who was the handling pilot, immediately re-positioned the thrust levers and conducted an uneventful landing.

1 The 24-hour clock is used in this report to describe the local time of day Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

2 Autoland – A hands-off approach and landing using the aircraft's flight control system. Includes the capability to be used in the absence of pilot visual cues.

RA system

The RA system measured the aircraft's height from the ground during low altitude flight, approach and landing. The system was duplicated into the number 1 (left) and number 2 (right) systems, with each comprised of; a transceiver (transmitter/receiver) unit, a transmit antenna and a receive antenna. A frequency-modulated, continuous wave radio signal was transmitted towards the ground by the system and reflected back to the aircraft, with the signal's return travel time used to derive the aircraft's altitude.

A subsequent engineering examination of the aircraft's autopilot system built-in test equipment (BITE) identified spurious left RA inputs. A review of the aircraft's digital flight data recorder (DFDR) information confirmed a coincident, momentary reduction in the left RA altitude reading from about 130 ft to minus 7 ft, followed by an increase to 63 ft within 4 seconds. The autopilot disconnected and the autothrottle commenced moving the thrust levers towards idle.

The DFDR data indicated that control of the aircraft and the descent profile were not affected (Appendix A).

A bonding check[3] was carried out on the left RA system, which revealed that the receiver antenna's resistance was 1.1665 ohms. That value was above the aircraft manufacturer's maximum allowable limit of 0.001 ohms. No other RA defects were found.

The aircraft operator replaced the left RA receive and transmit antennas and, following subsequent system testing, the aircraft was returned to service.

The aircraft manufacturer was notified of the observed high resistance found with the left RA. The manufacturer advised that the high resistance should not impact on the RA system's operation; however, the manufacturer considered that such high resistance could make the system more susceptible to problems in a high electrostatic environment. Such an environment was not experienced at the time of the incident.

3 A check to determine the level of electrical resistance between the aircraft's skin and the antenna contact surface and attachment screws.

In July 2009, about 3 months after the incident, the aircraft operator reported another RA flag alert event on the aircraft. As a result of that event, the aircraft's two transceiver units were removed by the operator and sent to the manufacturer of the transceivers for examination and testing.

Replacement transceiver units were installed in the aircraft to allow its continued operation. At the time of writing this report, there had been no similar RA-related faults experienced by the aircraft.

RA transceivers testing

The transceiver manufacturer tested the aircraft's left and right transceiver units. Those tests revealed that, although the right unit contained stored failures on its non-volatile memory, the failures were not confirmed within the unit's internal flag codes. That indicated the faults were external to the transceiver unit. The unit itself was subsequently tested with no faults found, and considered by the manufacturer to be serviceable.

The left transceiver also contained a number of stored failures on its non-volatile memory. Those failures were consistent with various recorded internal fault flag codes (including power and transmitter faults). During testing, the unit was found to be operating outside the design limits for its transmitter frequency and receiver sensitivity ranges. Further fault finding revealed that the unit's power supply card and interconnect assembly were predisposed to failure during cold temperature cycling. These defective components were replaced, with the unit subsequently passing bench testing and being returned to service.

A review of the aircraft operator's maintenance records revealed an increase in failure rate and in the unscheduled removal of transceiver units within their fleet. The nature of the failures varied, and did not show a trend towards the failure observed in this occurrence.

RA fault history

The aircraft had a previous history of left RA faults. A review of the aircraft's maintenance records indicated that, during the period November 2008 to April 2009, there were more than 20 left RA-related maintenance entries.

Rectification action in response to those faults included numerous system BITE checks, interchanging the left and right transceivers, full system operational testing, replacement of the left transceiver, a bonding resistance check and, following this occurrence, the replacement of the left receive and transmit antennas.

After the replacement of the antennas, there were no further RA faults reported on the aircraft until the event in July 2009. The operator has not reported any RA faults since the replacement of the transceivers.

A broader examination of the maintenance history for the aircraft operator's fleet of 38 Boeing 737-800 aircraft revealed that, over the previous 12 months, the operator had removed and replaced 24 RA antennas. The replacements (including for this event) were as a result of 11 antennas having failed bonding checks, and 12 antennas exhibiting RA system faults or alerts.

RA antenna examination

The aircraft's left and right RA receive and transmit antennas were examined by the Australian Transport Safety Bureau. Wear was found on both antenna contact surfaces, adjacent to the attachment screw inserts. The left receive antenna showed the highest level of wear (Figure 1).

Similar event

The Australian Transport Safety Bureau (ATSB) considered possible similarities between this incident and the accident involving Turkish Airlines B737-800, registered TC-JGE, at Schiphol airport, Amsterdam, 25 February 2009. The ATSB immediately contacted the lead investigating body of that accident, the Dutch Safety Board (DSB). The DSB's preliminary report of the accident indicated that the flight crew of TC-JGE were slow to respond to a radio altimeter malfunction that resulted in the autopilot prematurely reducing power.

Flight crew response

The PIC of VH-VYL attributed his quick response to the event as being the result of; (a) the utilisation of the head-up display guidance system fitted to the aircraft, (b) the high level of simulator training provided by the operator, which incorporated

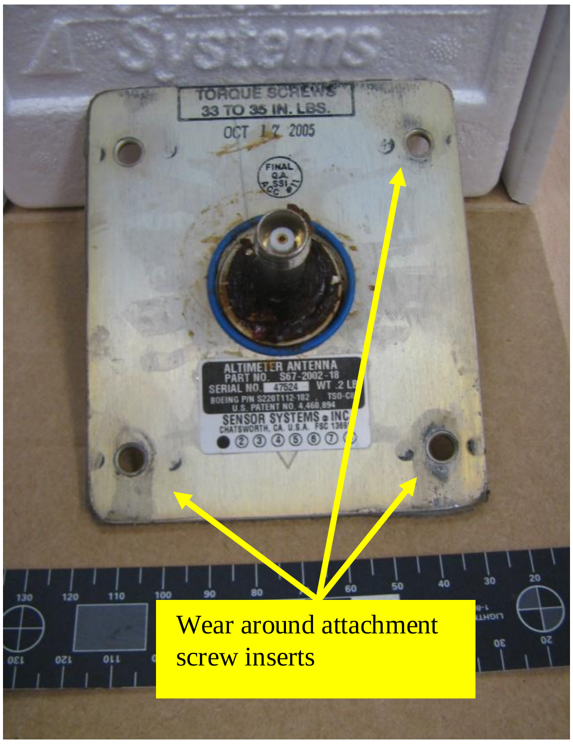

Figure 1: Left receive antenna

avionics system failures including dual radio altimeter (RA) failure, and (c) the operator's proactive attitude towards transferring information relevant to flight crews.

That knowledge transfer included distribution of a flight operations memo, dated 5 March 2009, that highlighted the Turkish Airlines accident and reminded crews to carefully monitor primary flight instruments during automatic flight modes.

ANALYSIS

The activation of the enhanced ground proximity warning system alert, the disconnection of the autopilot and the movement of the thrust levers towards the idle position, were the result of a spurious signal of minus 7 ft from the left radio altimeter (RA) system.

Examination of the aircraft following this event revealed that the only defect within the RA system was a high resistance of the left RA receive antenna. The aircraft manufacturer, however, did not consider that high resistance in an RA antenna would affect the operation of the RA system.

The surface wear adjacent to the attachment screw inserts on the left receive and transmit antennas was consistant with surface rubbing resulting from movement between the antenna and the aircraft's skin. The effect of the wear on the operation of the RA systems could not be determined. However, the possibility for the wear to have contributed to the antenna's increased resistance could not be discounted.

The internal component faults found on the left transceiver during its examination by the transceiver manufacturer, contributed to the spurious outputs from the left RA system. However, their potential to have contributed to the trend of increased transceiver unserviceability that was being experienced by the aircraft operator was less likley.

The left transceiver unit had not been fitted to the aircraft for the duration of the aircraft's ongoing left RA system fault history. Therefore, the performance of the left RA must have been influenced by a number of other faults prior to this event. It was possible that the replacement of the majority of the left RA system's components during the ongoing fault analysis and attempted rectifiction had masked any underlying problem, or individually rectified them.

The lack of any similar left RA-related faults after the replacement of the tranceiver indicated that the aircraft's ongoing problems were a result of a combination of a number of individual faults over time, and of an underlying problem with the tranceiver leading up to this event.

FINDINGS

From the evidence available, the following findings are made with respect to the avionics system event involving Boeing 737-800 aircraft, registered VH-VYL that occurred at Sydney Airport, NSW on 7 April 2009 and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- Spurious radio altitude system outputs led to undesirable effects on the aircraft's autopilot and autothrust systems.
- The left radio altimeter transceiver contained internal faults that adversely affected its operation.

Other safety factors

- The left radio altimeter receive antenna had a resistance value above the aircraft manufacturer's allowable limit.

SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included the:

- operator of VH-VYL
- transceiver manufacturer
- aircraft manufacturer.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, the 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 aircraft operator and the Civil Aviation Safety Authority.

Submissions were received from the aircraft operator. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly

APPENDIX A: GRAPHICAL REPRESENTATION OF DFDR DATA