Serious Incident

Aircraft Type and Registration:	Boeing 737-8K5, G-FDZS
No & Type of Engines:	2 CFM56-7B27/3 turbofan engines
Year of Manufacture:	2009 (Serial no: 35147)
Date & Time (UTC):	4 March 2024 at 1104 hrs
Location:	On take off from Bristol Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 163
Injuries:	Crew - None Passengers - None
Nature of Damage:	None reported
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	47 years
Commander's Flying Experience:	14,500 hours (of which 4,500 were on type) Last 90 days - 220 hours Last 28 days - 81 hours
Information Source:	AAIB Field Investigation

Synopsis

When the crew began their takeoff, the autothrottle (A/T) disconnected when the Takeoff/Go-Around switch (TOGA) was selected. As a result, neither thrust lever advanced automatically towards the calculated N_1 takeoff setting. Despite attempting to re-engage it, the A/T remained in an inactive mode. The takeoff was conducted with 84.5% N_1 instead of 92.8% N_1, with the associated reduction in aircraft performance. The rotation occurred close to the end of the runway and the aircraft climb rate was initially very slow. The crew increased power on the engines towards the takeoff setting from 450 ft aal. The rest of the flight to Las Palmas was completed without incident although the A/T remained unavailable. The uncommanded disconnect was likely the result of the voltage being supplied to the autothrottle servo motor (ASM) being too low which was a known problem with the B737 A/T and the older revision of the ASM part fitted to G-FDZS.

The operator has taken a number of safety actions to address both the actions to be taken in the event of an uncommanded disconnection of the A/T at takeoff, and their monitoring of events through flight data monitoring.

History of the flight

The aircraft was prepared for a flight from Bristol Airport to Las Palmas, Gran Canaria with six crew and 163 passengers. The flight was a line training sector for a new captain who was sitting in the left seat, with a training captain, acting as aircraft commander, sitting in the right seat.

Having completed their pre-flight preparation, the aircraft left the stand at Bristol to taxi to Runway 09 at 1041 hrs. The A/T arm switch on the Mode Control Panel (MCP) had been set to ARM during the before start procedures in accordance with the operator's SOPs. The aircraft taxied onto Runway 09 at 1104 hrs and was cleared for takeoff shortly afterwards. The left seat pilot handed control of the aircraft to the right seat pilot who was to be PF for the sector. The PF advanced the thrust levers to 40% N_1 and paused for the engines to stabilize before pressing the TOGA which engages both the A/T in N_1 mode and the autopilot/flight director system (AFDS) in takeoff mode. At this point, the A/T disengaged with an associated warning and the A/T arm switch on the MCP was re-engaged by the PM almost immediately afterwards. At the same moment the PF advanced the thrust levers manually towards the required takeoff setting before releasing the thrust levers for the left seat occupant to control in accordance with the SOPs. Both pilots believed that the A/T was engaged, and they expected it to function as if in TOGA mode from this point.

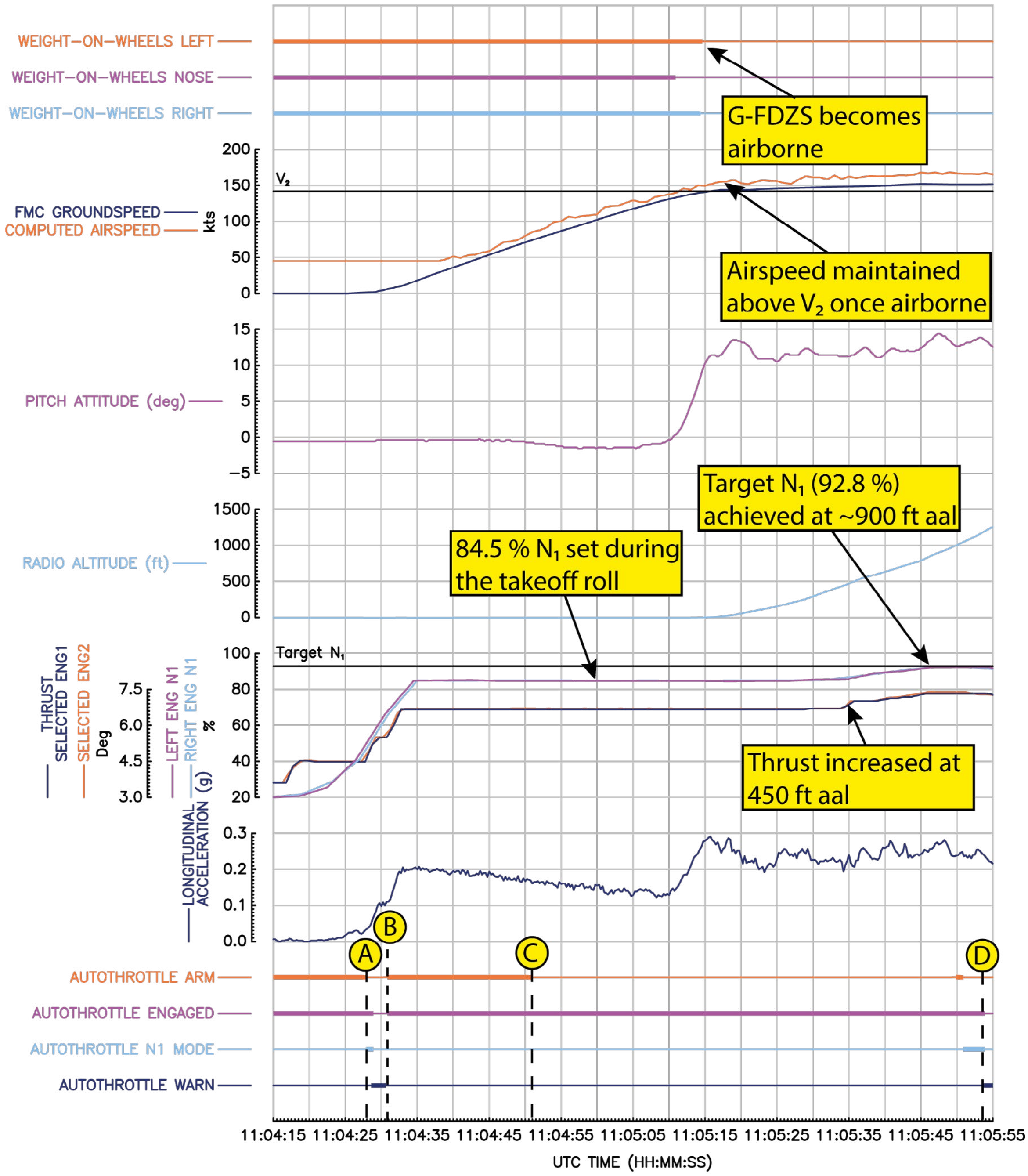
When the A/T arm switch was re-engaged on the MCP after initial A/T disengagement, it did not control the thrust lever servos as the pilots expected and instead entered an armed mode. As a result, the thrust levers did not advance to the required thrust setting and neither pilot moved them from the position the PF had set them to. Despite the SOP requiring that the thrust is set by 60 kt and checked as correct at 80 kt, the incorrect setting was missed by both pilots. This resulted in the aircraft takeoff being conducted with significantly less thrust than required, 84.5% N_1 was used instead of 92.8% N_1, with the associated reduction in aircraft performance.

The rotation point was 260 m from the end of the runway and the aircraft crossed the end of the runway at a height of approximately 10 ft. Both pilots had noted how close to the end of the runway they were. The flight to Las Palmas was uneventful apart from several attempts to re-engage the A/T and subsequent disengagements.

Recorded information

Flight recorders

G-FDZS was fitted with both an FDR and a CVR. The CVR fitted to G-FDZS was not removed from the aircraft as it continually overwrites itself, retaining only the last two hours of audio. As such, the recording of the takeoff would have been overwritten during the flight to Las Palmas. However, the FDR was removed and downloaded. Data from the FDR is shown in Figure 1.



(A) A/T transitions from ARM to N1 mode on TOGA selection, disconnects almost immediately with a warning
(B) A/T re-armed within five seconds but no active mode selected
(C) A/T transistions to ARM HOLD mode, as per design, at 84 kt
(D) A/T transitions from ARM to N1 mode, but disconnects with a warning almost immediately (2nd uncommanded disconnect)

Figure 1

FDR data for the takeoff

The data shows that 84.5% N_1 was set for the takeoff instead of 92.8% N_1 and, although the thrust setting was increased from 450 ft aal, the required takeoff thrust setting was not attained until passing approximately 900 ft aal. As a result, G-FDZS became airborne 260 m from the end of Runway 09 and the runway end was overflown at a height of approximately 10 ft.

Multipurpose Control and Display Unit (MCDU) Fault data

The MCDU allows maintenance personnel to interrogate the health of several aircraft subsystems, including the A/T, and to investigate any logged faults. The fault history for the A/T, (Figure 2), shows that 11 faults were logged for the incident flight to Las Palmas - LEG 02 - but no faults were logged on the return flight to the UK, or on the preceding day.

Figure 2

A/T fault history for the incident flight and the preceding day

Five of the 11 logged faults related to uncommanded A/T disconnections. The first of these fault records is shown in Figure 3, and occurred at 1104 hrs when, from the FDR data, G-FDZS was on the runway at the beginning of the takeoff roll.

Figure 3

Detailed fault record for the initial uncommanded A/T disconnection, showing the suspected cause as the rate monitor logic within ASM 1

The fault record indicates the suspected cause of the uncommanded A/T disconnection as the rate monitor logic within ASM 1, the A/T servo motor for the No 1 engine throttle lever. A further four uncommanded A/T disconnections occurred during the flight to Las Palmas, two during the initial climb to altitude and two during the cruise. A series of other fault messages were logged, after the initial A/T disconnection, as G-FDZS accelerated for takeoff. These were generated passing 90 kt airspeed and all related to the mis-set thrust, indicating that the correct takeoff thrust had not yet been set.

Flight data monitoring (FDM)

The AAIB has investigated numerous other takeoff performance events and made several safety recommendations. One of these safety recommendations, Safety Recommendation 2022-019, relates to the use of FDM data to identify takeoff events that may otherwise go unnoticed and unreported.

Safety Recommendation 2022-019

It is recommended that the UK Civil Aviation Authority encourage all UK Air Operator Certificate holders to implement into their flight data monitoring programme algorithms to detect the precursors relevant to the monitoring of takeoff performance detailed in the European Operators Flight Data Monitoring Document, Guidance for the implementation of flight data monitoring precursors.

Although this event was reported, the operator conducted a retrospective analysis using a simple statistical measure of other 737 takeoffs from Bristol and produced the plot shown in Figure 4. The X-axis represents the peak longitudinal acceleration at around 80 kt groundspeed and the Y-axis the number of takeoffs that are represented by each bar. The incident takeoff is shown by the red arrow in Figure 4, far to the left of the bulk of the data, whereas for a normal distribution of data 99.7% of all takeoffs would be expected to lie within the region marked by the two vertical red lines.

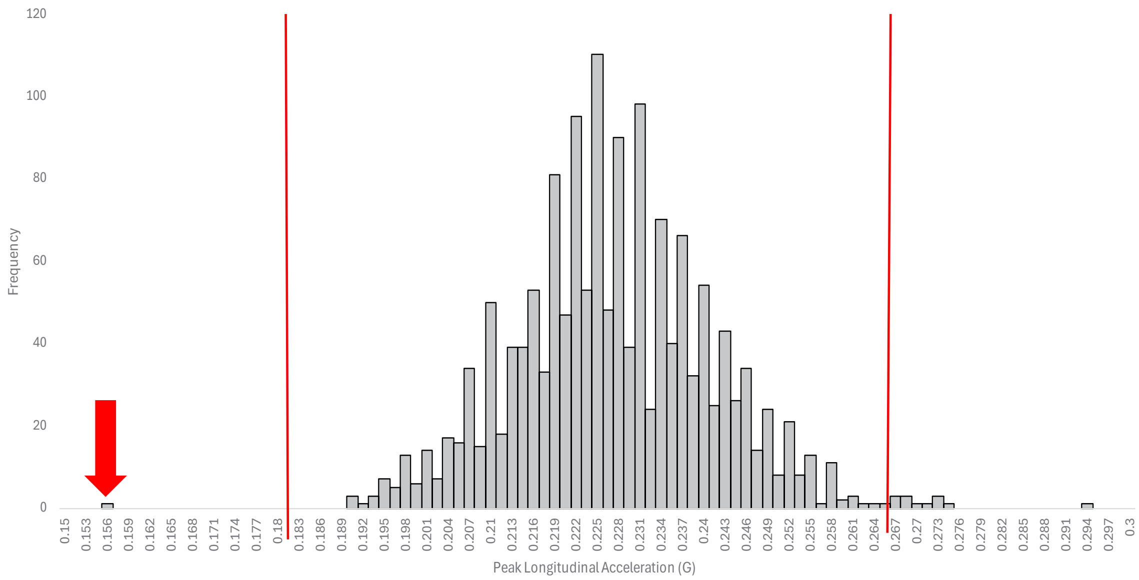


Figure 4

Histogram of 737 takeoffs at Bristol,
showing the normal spread of peak accelerations and the incident takeoff

Aircraft information

The Boeing 737-800 is a twin turbofan narrow body aircraft used mainly in short and medium haul flights. The B737-800 is part of B737 Next Generation[1] (B737NG) series of aircraft. G-FDZS is fitted with 189 passenger seats.

Arrangement of displays

The B737-800 has six LCD screens arranged with two screens in front of each pilot and the remaining two in the middle, one on top of the other (Figure 5). The engine gauges are displayed on the top screen of these two, in the middle on what is called the Upper Display Unit (Upper DU). The aircraft N_1 gauges are displayed at the top of the upper DU and are visible all the time. The Upper DU also displays the engine gas turbine temperature and the fuel flow for both engines as well as some warning lights and the fuel gauges.

Footnote

[1] This was the third generation derivative of the Boeing 737 and includes the B737-600,-700,-800 and -900

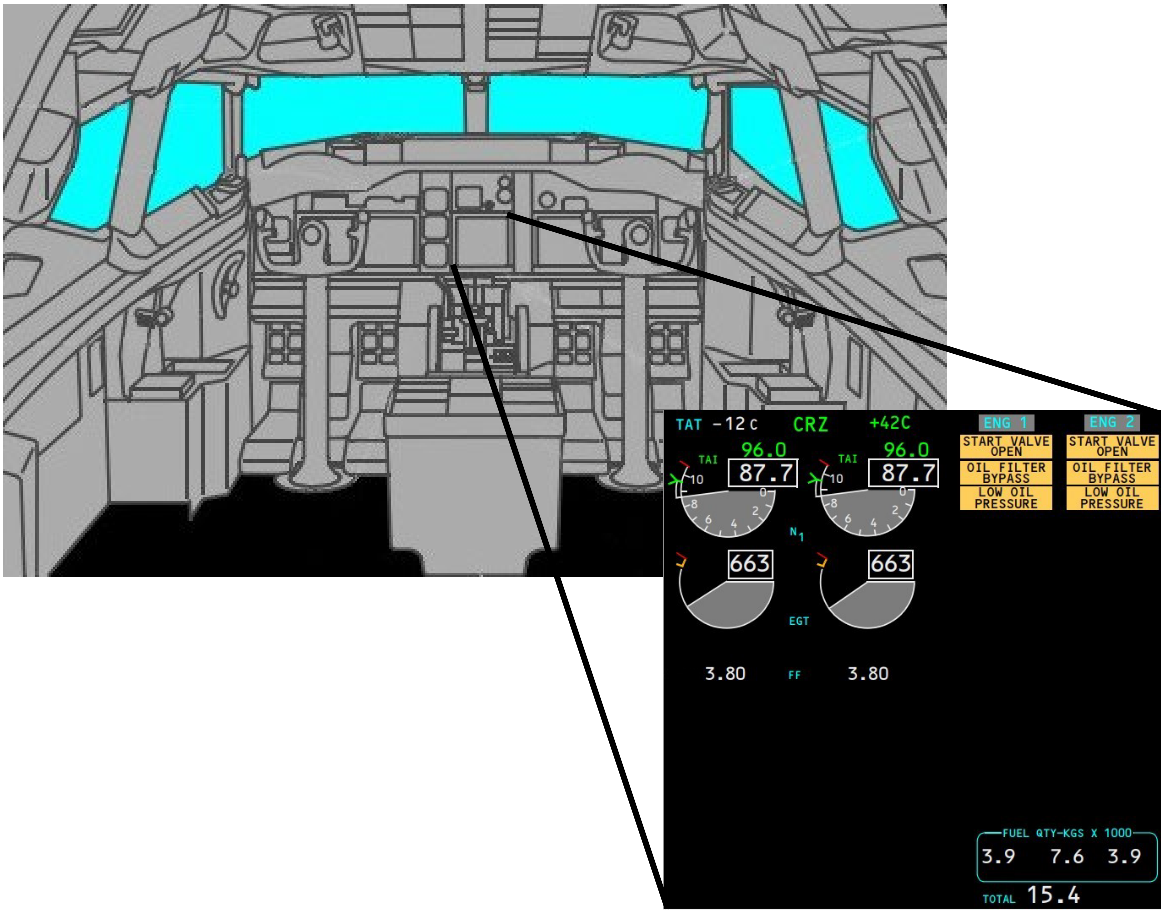


Figure 5

B737-800 screen arrangement with Upper DU location and display

N_1 Gauges

The N_1 gauges at the top of the Upper DU display a large amount of information to the pilots in both pictorial and digital formats (Figure 6). The actual N_1 is indicated on the gauge by the white needle with a grey shaded area behind it. The difference between the actual N_1 and that commanded by the thrust leaver position is showed with a white arc (not shown on the diagram). The reference N_1 is shown as a green bug. Both the actual N_1 and reference N_1 are also shown in digital figures. The maximum N_1 is indicated by an orange line and is the N_1 for full rated thrust, whilst the N_1 operating limit is indicated by a red line.

During takeoff the green bug and green reference digital reading should match the calculated N_1 to be used for takeoff. With the AT engaged and TOGA switch pressed, thrust levers should move toward the bug and the white needle and white digital readout of actual N_1 should then match the green bug and green digital figure.

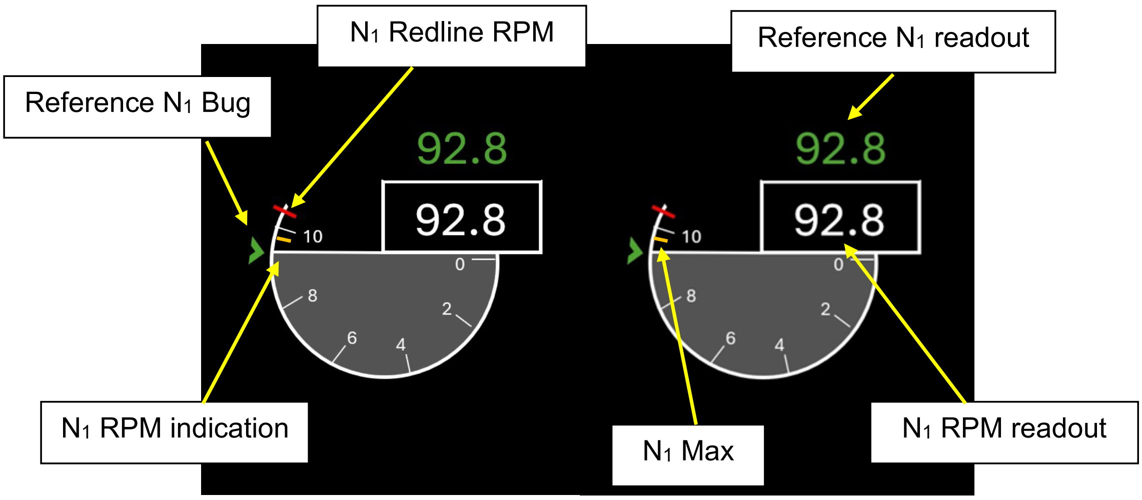


Figure 6

N_1 gauges G-FDZS

A/T system

The B737-800 A/T system provides for automatic thrust control during all phases of flight from takeoff to landing. The A/T moves each thrust lever with a separate servo motor to comply with the computed thrust requirements except when in either throttle hold (THR HLD) or ARM modes. The ASMs are supplied with two power sources via the flight control computer (FCC) one to power intern electronics (logic power) and one to power the internal motor (motor power). Motor power is only provided when a change of throttle position is required. The ASMs internal electronic control has a minimum power supply voltage level below which the motor part will not respond; leading to the FCC disengaging the A/T function. There needs to be a higher voltage restored for the motor to start responding to the FCC's demands for movement.

A/T modes on takeoff

The A/T is armed by selecting the switch on the mode control panel (MCP) to ARM. Although the A/T is armed, the ASM logic is powered but the separate motor remains unpowered as the FCC is yet to demand a change in throttle position. When the PF pushes the TOGA switch, the A/T will enter N_1 mode and the FCC will command the ASMs to move the thrust levers to the position required by the calculated FMC takeoff thrust at the same time providing power to the ASM motors. At 84 kt during the takeoff run, the A/T engages THR HLD mode. This mode removes power from the ASM motors, although the ASM logic is still powered, to ensure that there is no uncommanded movement of the throttles during the rest of the takeoff. The A/T remains in this mode until 800 ft above airfield elevation when the mode changes to ARM and a reduction to climb thrust at the FMC selected thrust reduction altitude can be made automatically by the AFDS with the A/T engaging in N_1 mode. Power is only restored to the ASM motors by the FCC when N_1 mode becomes active and a change in throttle position is commanded. The A/T will automatically disengage when a system fault is detected.

These modes are displayed to the pilots, as well as those of the AFDS, on the top section of the pilots primary flying display as flight mode annunciations.

Airfield information

Bristol Airport has a single runway orientated east/west. Runway 09, which was the one in use for the takeoff has an Accelerate/Stop Distance Available (ASDA)[2] and Takeoff Run Available (TORA)[3] of 2,011 m. The Takeoff Distance Available (TODA)[4] of 2,133 m. This gives a runway clearway[5] of 122 m. Beyond the end of runway 09 (ASDA/TORA) is 296 m until the airfield perimeter fence which includes the 122 m of clearway. On the other side of the perimeter fence is the A38 road.

Meteorology

The weather at Bristol airport was good with no cloud detected and visibility more than 10 km. The wind was south-easterly and gave between 5 and 15 kt headwind throughout the period that the aircraft was on the ground at Bristol.

Aircraft performance

The crew calculated the aircraft performance using an electronic flight bag tool provided by the manufacturer. The crew entered the passenger and baggage details to generate the aircraft weight and balance before entering the details of the weather at Bristol. The program then generated detailed performance such as flap setting, any derating (fixed or assumed temperature), as well as V speeds and the airborne procedure to be followed in the event of an engine failure.

The performance calculation done by the crew was correct, and the details were correctly entered into the flight management computer (FMC). This gave a flap setting of 15, a fixed derate to TO-2[6] with no assumed temperature reduction and speeds of V_1 136, V_R 136 and V_2 142.

The takeoff performance using the thrust that was actually set was to the extreme left of the normal distribution curve in post-incident analysis conducted by the operator (Figure 4) and the aircraft did not make the regulated performance requirements. The aircraft passed the upwind threshold of the runway at approximately 10 ft with both engines operating.

Footnote

2 Accelerate-stop distance available means the length of the takeoff run available plus the length of stopway, if such stopway is declared available by the State of the aerodrome and is capable of bearing the mass of the aeroplane under the prevailing operating conditions.
3 Takeoff run available means the length of runway that is declared available by the State of the aerodrome and suitable for the ground run of an aeroplane taking off.
4 Takeoff distance available in the case of aeroplanes means the length of the takeoff run available plus the length of the clearway, if provided.
5 Clearway means a defined rectangular area on the ground or water under the control of the appropriate authority, selected or prepared as a suitable area over which an aeroplane may make a portion of its initial climb to a specified height.
6 Fixed derate is a derated takeoff thrust and is a certified takeoff thrust rating lower than full rated takeoff thrust. TO-2 is a 20% reduction.

Unfactored calculations by the aircraft manufacturer indicated that with no increase in thrust, had an engine failed at V_1 and the crew decided to stop, the aircraft would probably have stopped on the runway as long as the crew had used maximum reverse thrust. Had the crew elected to continue or if the engine failed above V_1, calculations indicate that the aircraft would not have been able to climb away without the application of more power. Figure 7 shows some of this data on a graphic of Bristol Airport.

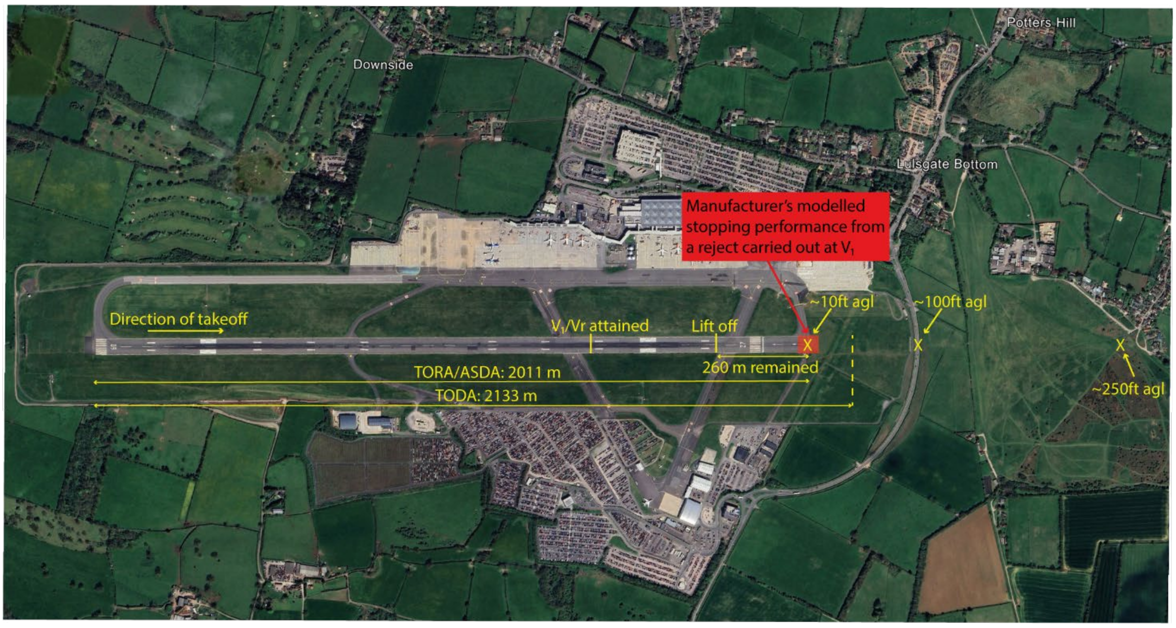


Figure 7

Graphic of G-FDZS's takeoff from Bristol Airport
© 2024 Google, Image © 2024 Airbus

Personnel

Both pilots had significant experience on the B737-800. The pilot in the left seat was a new commander under training for whom this was the eleventh flight sitting in that seat. He had completed a number of simulator sessions in the left seat as part of his command training course before beginning his training in the aircraft. The pilot in the right seat was a training captain and was the aircraft commander. He was qualified to operate in either seat and his recent flying had been split evenly between the two seats.

Changing seats can be challenging as the location of items shifts in the pilot's field of view and a pilot's mental scan pattern can be disturbed, with it requiring more mental effort to locate and read instruments and gauges. For the new captain sitting in the left seat this is also compounded by the unfamiliarity of a new role especially on departure with the added responsibilities including the need to taxi the aircraft.

The B737-Max displays are subtly different from those in the B737-800 with the engine gauges remaining identical but in a different position. The B737-Max has four large LCD screens in a row across the flight deck with the operators practise to have the engine instruments displayed on the inboard screen of the PM. Whilst this may seem a small movement, it requires an adaption in the visual scan for both pilots as they move from one type to the other.

B737-Max also requires a lower thrust setting on takeoff than the B737-800 with N_1 figures often in the eighties. A calculation using the actual passenger and baggage load for the incident flight, using a representative fuel figure for the B737-Max showed that an N_1 of 85% would have been required for a takeoff in the conditions of the day. This figure is close to that on the actual takeoff. Both pilots recent experience had been almost exclusively flying the B737-Max rather than the B737-800.

The takeoff is a dynamic part of the flight with both the PF and PM engaged in multiple tasks as the aircraft accelerates and gets airborne. Combined with the limitations in the human detection and processing systems, the crew are unlikely to detect that the aircraft is not accelerating as calculated until the visual picture alerts them to the rapidly approaching runway end. At this point evidence from many previous incidents also indicates that they are unlikely to select full thrust to improve their predicament.

Both crew members would have been expecting the A/T to function when it was re-engaged after the initial drop out and did not notice that it was not in an active mode. They did not fully appreciate that the A/T would only be in arm mode with the servo motors unpowered. Neither crew noted that the displayed N_1 did not match the reference N_1. The PF commented that he was busy with trying to align the aircraft with the centreline and probably did not glance at the gauges at the 80 kt check. It is likely that the PM glanced at the gauges and noted the green number without processing that the white number did not match it. Both crew members would have been expecting to see the thrust at the reference N_1 as that is the expected behaviour of the A/T.

Procedures

Before start procedures

As part of the before start procedures both pilots must complete independent calculations of the aircraft performance using the computer programme provided and the actual takeoff weight from the loadsheet. When both pilots have completed the calculation the left seat pilot calls out the data which is verified by the right seat pilot as identical to his calculation. The left seat pilot then enters the required acceleration altitudes (all engines and single engine) into the FMC before the right seat pilot enters the results of the performance calculation including any derate and/or assumed temperature. The left seat pilot then calls out the figures from the FMC (including the N_1 figure) which the right seat pilot verifies against his calculation. The left seat pilot then sets the A/T arm switch to ARM.

Takeoff procedures

G-FDZS has nosewheel steering only on the left side of the flightdeck and therefore must be taxied by the left seat pilot. Having taxied the aircraft onto the runway and lined up with the centreline, should the right seat pilot be PF, then control must be handed over at this point. The duties are then separated by PF/PM roles as in Table 1 once takeoff clearance is obtained:

Pilot Flying (PF)	Pilot Monitoring (PM)
Advance the thrust levers to approximately 40% N_1. Allow the engines to stabilize.	
Push the TO/GA switch.	
Verify that the correct takeoff thrust is set.	
	Monitor the engine instruments during the takeoff. Call out any abnormal indications. Adjust takeoff thrust before 60 knots as needed. * During strong headwinds, if the thrust levers do not advance to the planned takeoff thrust, manually advance the thrust levers before 60 knots. Call “THRUST SET”
After takeoff thrust is set, the captain’s hand must be on the thrust levers until N_1	
Monitor airspeed. Maintain light forward pressure on the control column.	Monitor airspeed and call out any abnormal indications.
Verify 80 knots and call “CHECK.”	Call “80 KNOTS.” **

Table 1

Takeoff procedures

* The manufacturers Flight Crew Training Manual (FCTM) states the PM should:

> *‘Ensure the target N_1 is set by 60 knots. Minor increases in thrust may be made immediately after 60 knots to reach the target N_1.’*

** The FCTM states the PM should:

> *'verify that takeoff thrust has been set and the throttle hold mode (THR HLD) is engaged. A momentary autothrottle overshoot of 4% N1 may occur but thrust should stabilize at +/- 2% N1, after THR HLD. Thrust should be adjusted by the PM, if required, to - 0% + 1% target N1. Once THR HLD annunciates, the autothrottle cannot change thrust lever position, but thrust levers can be positioned manually.'*

The FCTM also states that

> 'with any autothrottle malfunction, the autothrottle should then be disconnected and desired thrust set manually'.

Displayed thrust

The reference N_1 was set in the FMC at 92.8% as per the performance calculation completed before departure from the stand. This reference N_1 was displayed on the N_1 gauges as previously described. During the takeoff run, after the A/T had disengaged, the selected N_1 was 84.5%. A demonstration of what the N_1 gauges should have looked like compared to the actual N_1 used for takeoff is shown at Figure 8.

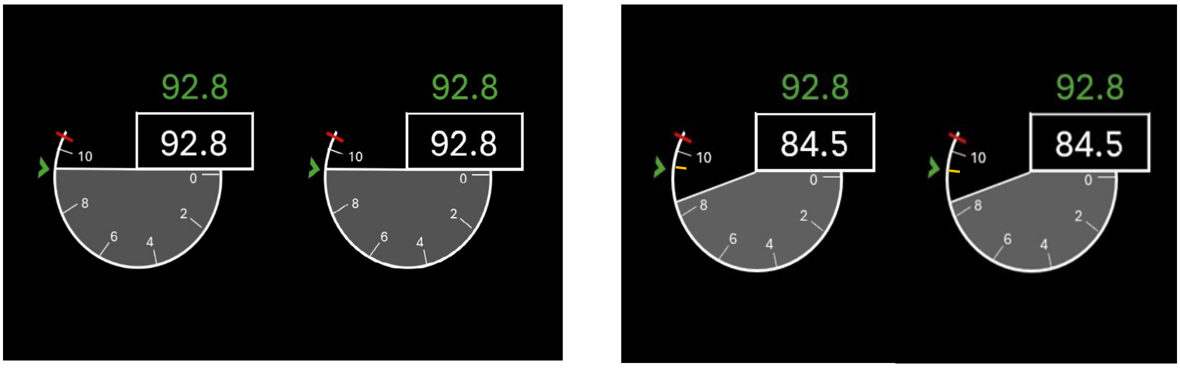


Figure 8

N_1 display as should have been (left) and with the N_1 used for takeoff showing (right)

Malfunction and emergency procedures

The manufacture produces a Quick Reference Handbook (QRH) which details the actions the crew need to take in the event of a malfunction or emergency. The QRH details the rejected takeoff manoeuvre and states that '*The captain has the sole responsibility for the decision to reject the takeoff.*' It goes on to list the reasons to reject the takeoff before 80 kt which includes '*system failure(s)*'. The manufacturer considered that the failure of the A/T to stay engaged in TOGA is a systems failure and should therefore resulted in a rejected takeoff.

The commander of G-FDZS was not sitting in the left seat and the left seat trainee captain was new to the role. In this configuration whilst the captain in the left seat could make the decision and carry out the reject actions, the training captain in the right seat, as aircraft commander, also had authority to decide and action a rejected takeoff. The training captain had received additional training for this scenario.

Other information

The manufacturer described the A/T system on the B737NG as having a long history of nuisance disconnects during takeoff mode engagements. When the fault history of the A/T is checked they often show fault messages for the autothrottle servo motor (ASM) for either throttle lever 1 or 2. Usually, subsequent functionality checks on the system find no faults as was the case with G-FDZS.

As a result of these reported uncommanded A/T disconnects the aircraft manufacturer together with the servo motor manufacturer analysed the possible cause. This analysis determined that it was likely that the voltage supplied to the servo motor dropped below that required and the motor remained stationary as a result. On occasion, such as occurred with G-FDZS, the voltage did not recover to a sufficient level for the servo motor logic electronics to start up again and so the A/T remained disconnected despite the crew attempting to re-engage it.

The original servo motor type had required remodelling due to an obsolescence issue, and this allowed adjustments to the characteristics of the new model during its development. These adjustments meant that the circuits in the ASM could restart at a lower voltage than the original model. These adjustments proved successful in significantly reducing the occurrence of uncommanded A/T disconnects. The newer model of ASM was introduced into the manufacturing line in 2017, but there was no requirement to retrofit the newer part to previously manufactured aircraft.

The manufacturer recommends that any operators of the B737NG who are affected by these disconnects should retrofit their aircraft with the newer model of ASM and associated FCC software. The manufacturer released a Fleet Team Digest in October 2021 detailing the issue and the available Service Bulletin (SB) for replacement. The Fleet Team Digest was revised in August 2022. At the time of this event G-FDZS was fitted with the earlier model of ASMs.

Analysis

During the takeoff at Bristol, the A/T disconnected uncommanded by the crew when the TOGA switch was pressed. Despite an attempt by the crew to select the A/T ON again, it did not engage in an active mode and therefore did not move the thrust levers to the takeoff N_1 setting as the crew expected. Despite the SOPs requiring both crew to check the N_1 setting at 80 kt, the thrust was not set as calculated and the takeoff was performed with a significantly reduced N_1. This resulted in the aircraft rotating close to the end of the runway and climbing at a very low rate until the crew started to increase the thrust at 450 ft aal.

Recognition of the issue

Previous investigations completed by the AAIB into takeoff performance errors have shown that the crews are very unlikely to notice any reduction in acceleration rates until the end of the runway becomes increasingly close to their position. Their actions at this point also rarely include the selection of full thrust in order to improve the acceleration and rate of climb of their aircraft. The performance of the crew of G-FDZS in this respect was therefore as expected from previous event analysis.

The crew also had some additional challenges in their performance in their familiarity with the seats in which they were sat as well as the change in position of the N_1 gauges from the aircraft they flew more regularly (B737-Max) to G-FDZS (B737-800). They were also more used to flying the B737-Max where the N_1 setting for takeoff was often close to that used on this takeoff. The SOPs for the aircraft type required both crews to check that the white digital readout of the N_1 set at 80 kts was the calculated N_1 for takeoff as shown as the green digital readout on the N_1 gauges. Both pilots missed the check, the PF as he was busy trying to straighten the aircraft on the takeoff roll, and the PM as he likely read only the green numbers without checking them against the white numbers below. The takeoff roll is a busy and dynamic phase of flight.

Response to the disconnect

The PM attempted to re-engage the A/T immediately but it had disconnected and although it seemed to have been successful, the A/T remained in an inactive mode with no control over the thrust lever servos and therefore no ability to move the thrust levers towards the target N_1. The manufacturer stated that such an uncommanded disconnect should be considered by the crews to be a systems failure and therefore fall into the reasons for a rejected takeoff. The reason for this is that it allows for the crews to consider the overall effect of a failure when the aircraft is stopped rather than during such a dynamic phase of flight. Such a rejection would have ensured that both crew members were fully aware of the fault, allowed them to consider a manual thrust takeoff and flight as well as consult with the operator and engineers as required.

Cause of the uncommanded disconnect

It is likely that the uncommanded disconnect of the A/T was caused by low voltage to the ASM when TOGA was selected. This issue is one widely known to the manufacturer. The aircraft manufacturer and ASM manufacturer investigated the nuisance disconnects on the 737NG and produced a new design of ASM which was more resistant to the problem and therefore less likely to have uncommanded disconnects. Whilst the fitment of the new design of ASM is not mandatory, the manufacturer does recommend that operators should retrofit their aircraft when they experience problems. G-FDZS was fitted with the original model of ASM on both throttles.

Conclusion

Having selected the TOGA switch to begin the takeoff roll at Bristol, the A/T disconnected. The crew reselected the A/T, but it did not re-engage in an active mode and did not control the throttles as the crew expected. Neither crew realised that the thrust was not set as required for takeoff but was significantly less than had been calculated during the pre-flight preparation. As a result, the aircraft performance was significantly compromised. The uncommanded disconnection was likely caused by low voltage being supplied to the ASM which caused it to disconnect from the throttles. The issue is a well known one for which a new model of ASM, and updated FCC Software incorporating changes to reduce the incidence of uncommanded disconnects.

The operator took action to raise awareness of the issue and what actions are expected as well as strengthening their FDM programme to better monitor the occurrences. The manufacturer encourages any operators who experience nuisance disconnects to replace the ASM with the newer model and ensure a later standard of FCC Software loaded.

Safety actions/Recommendations

The operator took the following safety actions:

Flight data Monitoring

- Event trigger created for A/T disconnection during takeoff. The event allows an understanding the historical and current level of nuisance A/T disconnects being experienced.
- Further refinement of the slow acceleration trigger using the statistical analysis.
- Event trigger created for a N_1 Reference and actual takeoff thrust delta. This is part of a layered approach to give visibility of potential events which do not meet the required takeoff thrust. This event compliments the slow acceleration FDM trigger.

Flight Ops

- A safety alert was published immediately after the event to raise awareness. The alert has been reissued to give clear guidance that A/T disconnect is a system failure and meets the definition for RTO.

Further work

- Recommendation for any further training to be considered.
- Reliability of ASM will be recommended for review.

Published: 5 December 2024.