

**ACCIDENT**

<b>Aircraft Type and Registration:</b>	Boeing 737-33A, G-ZAPZ
<b>No &amp; Type of Engines:</b>	2 CFM56-3C1 turbofan engines
<b>Year of Manufacture:</b>	1991 (Serial no: 25401)
<b>Date &amp; Time (UTC):</b>	14 April 2012 at 1008 hrs
<b>Location:</b>	Chambery Airport, France
<b>Type of Flight:</b>	Commercial Air Transport (Passenger)
<b>Persons on Board:</b>	Crew - 5                      Passengers - 131
<b>Injuries:</b>	Crew - None                      Passengers - None
<b>Nature of Damage:</b>	Damage to rear fuselage skin, frames and drain mast
<b>Commander's Licence:</b>	Airline Transport Pilot's Licence
<b>Commander's Age:</b>	34 years
<b>Commander's Flying Experience:</b>	3,950 hours (of which 1,417 were on type) Last 90 days - 75 hours Last 28 days - 25 hours
<b>Information Source:</b>	AAIB Field Investigation

**Synopsis**

An onboard hand-held Electronic Flight Bag (EFB) computer was used to calculate the aircraft's takeoff performance. The commander omitted to enter the aircraft's takeoff weight into the performance calculation software, which defaulted to the previous flight's takeoff weight. The crew did not cross-check the data and incorrect speeds and thrust were calculated and subsequently used for the takeoff. As a consequence, the airspeed at rotation was too low and the pitch angle was sufficient to strike the tail on the runway. A broken spring within the aircraft's elevator feel and centering unit caused reduced resistance in the flight controls in pitch, contributing to the excessive pitch attitude achieved during rotation.

The investigation also revealed wider issues relating to the general design and use of EFB computers to calculate performance data. Two Safety Recommendations are made.

**History of the flight**

The crew reported for duty at 0625 hrs at London Stansted Airport and were scheduled to position the aircraft, without passengers, to Chambery Airport in France. They were then scheduled to return, with passengers, to London Gatwick Airport.

No problems were identified during the pre-flight preparations, although engineering assistance was required to resolve an issue starting the No 1 engine.

This resulted in the aircraft departing 25 minutes late, at 0735 hrs. An EFB computer was used to calculate the takeoff performance data. Once this was completed, the EFB was placed in the standby mode. The flight to Chambéry was uneventful and the aircraft landed at 0915 hrs, 15 minutes behind schedule.

The return flight to Gatwick was scheduled to depart at 1000 hrs. The pre-flight preparations proceeded normally and the pilots reported no distractions other than those normally experienced during a turnaround. The co-pilot, who was the non-handling pilot for this flight, completed the manual load sheet whilst the commander programmed the route into the Flight Management Computer (FMC). The commander reported that he then cross-checked the load sheet information and, having ensured it was correct, entered the Zero Fuel Weight (ZFW) into the FMC. The FMC then calculated the Takeoff Weight (TOW) using the fuel weight automatically retained in the system. The commander read back the FMC calculated TOW to the co-pilot, who cross-checked it against the load sheet data and confirmed that they agreed.

Having loaded the ZFW into the FMC and cross-checked the TOW, the commander used the EFB computer to calculate the takeoff performance data. This involved waking up the EFB from the standby mode, then entering the airfield, weather and aircraft data, which included the flap position for takeoff. A specific flap setting could be entered, or the computer could be used to provide an optimum setting. The commander stated that he normally entered Flap 5 for the takeoff performance calculation. However, at airports where performance was considered to be more critical, he would set the performance computer to select the optimum setting. As the runway at Chambéry is relatively short, the commander chose the optimum flap position calculated by the performance

computer. This gave a selection of Flap 1 which, under the circumstances, he did not consider unusual. Similarly, the computed takeoff speeds did not seem unusual to the commander, particularly as they were predicated on a flap setting he did not normally use.

The computed figures, based on the data entered on the EFB, allowed for a reduced thrust takeoff. The calculated assumed temperature to be set to achieve this did not seem unreasonable at the time, although the commander stated that, in hindsight, he considered it to be too high for the airfield and the prevailing conditions.

Both pilots stated that they would normally cross-check the performance figures once they had been calculated on the EFB. However, on this occasion, and for reasons the pilots could not recall, this was not done. The commander wrote the speeds he had computed using the EFB on the flight paperwork and then entered them into the FMC, overwriting the FMC generated speeds. The commander stated that this was standard practice and on this occasion he did not take note of any difference between the two sets of speeds. The rest of the pre-flight preparation was completed and the aircraft took off from Runway 36 at Chambéry at 1008 hrs, on schedule, with 131 passengers onboard. The pilots reported the weather at the time was good, with a light wind from the east, good visibility and dry conditions. The ATIS reported a temperature of 8°C and a QNH of 999 hPa.

On takeoff both pilots felt a slight judder, which they considered was due to turbulence from the preceding aircraft. Early in the climb they received a call on the intercom from the rear cabin station informing them that the cabin crew to the rear of the aircraft had also felt a judder. This call was intended for the cabin purser at the front of the cabin, but was mistakenly made to the flight deck. The pilots reassured the

cabin crew member, still believing the judder was due to turbulence. Their opinion was reinforced by the absence of any abnormal flight deck indications or calls from ATC at Chambery to the contrary.

The remainder of the flight went without incident and the aircraft landed at Gatwick at 1130 hrs. The aircraft was taxied to stand and, after shutting down, the pilots were informed by ground personnel that the underside of the rear fuselage had sustained damage consistent with a tailstrike. This prompted the crew to reconsider the cause of the judder felt at takeoff and they reviewed the takeoff performance data. This revealed that the commander had omitted to enter the aircraft's TOW into the EFB computer at Chambery, with the result that the computer had reverted to the previous TOW data retained from Stansted to calculate the takeoff performance figures.

### Performance figures

The performance figures used for the two sectors flown are shown in Table 1.

	Stansted to Chambery	Chambery to Gatwick
Load	610 kg	10,894 kg
ZFW	36,491 kg	46,750 kg
Take off fuel	9,800 kg	6,150 kg
TOW	46,291 kg	46,300 kg (correct value 52,900 kg)
Flap setting	Flap 5	Flap 1 (correct value Flap 1)
Assumed temperature	58°C	47°C (correct value 30°C)
Resultant $N_1$	84.5%	88.6% (correct value 92.8%)
Speeds	$V_1$ 119 kt	$V_1$ 118 kt (correct value 129 kt)
	$V_R$ 123 kt	$V_R$ 127 kt (correct value 139 kt)
	$V_2$ 135 kt	$V_2$ 140 kt (correct value 149 kt)

**Table 1**

Performance figures for Stansted and Chambery sectors

### Aircraft damage

Damage to the aircraft was confined to deep longitudinal scoring of the rear fuselage skin, over a length of 1.9 m, from just forward of fuselage station BS927 to just aft of BS987 (Figure 1). The lateral extent of the damage was limited to the two lowermost fuselage stringers. The damaged area was within the pressurised section of the fuselage, beneath the aft end of the rear baggage hold. On the 737-300 variant of the aircraft this area is not protected by a tail bumper.

The fuselage skin had been fully abraded at stations BS927 and BS947, resulting in slight scoring of the supporting fuselage frames at these positions. This damage created a small leak path for pressurised cabin air to escape to atmosphere, although the rate of leakage was small and insufficient to affect cabin pressurisation during the flight to Gatwick.



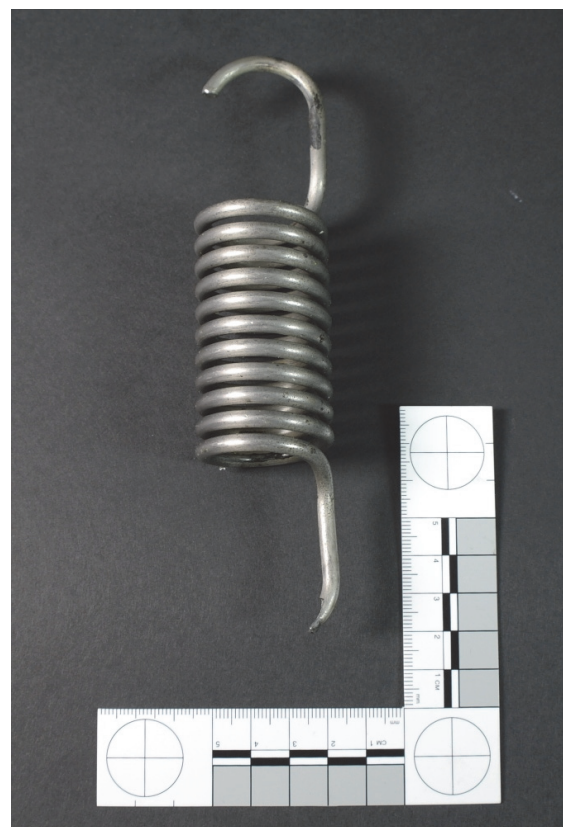
**Figure 1**

Damage to the lower fuselage skin and drain mast

In addition to the fuselage skin damage, the rear heated drain mast had been abraded and bent outboard due to contact with the runway.

#### **Post-event maintenance actions**

During the initial investigation it was reported to the AAIB that the pitch forces on G-ZAPZ were particularly light. No aircraft technical log entry regarding this had been made prior to the accident, but shortly after the aircraft was repaired and returned to service an entry was made by a flight crew member reporting that the elevator feel force was “light”. The operator carried out the ‘Low Control Forces’ troubleshooting actions from Chapter 27-31-00 of the aircraft maintenance manual, which revealed that a spring had broken within the aircraft’s elevator feel and centering unit. The unit was removed from the aircraft and sent to the AAIB for further investigation. During strip inspection, the outer main spring within the unit was found to have fractured (Figure 2). The



**Figure 2**

Broken outer main spring from the elevator feel and centering unit

elevator feel and centering unit was last inspected during the aircraft's 1C check, performed on 1 June 2011.

An analysis performed by the aircraft manufacturer showed that a broken outer main spring would reduce the control column pull force during aircraft rotation from approximately 30 lb.f, with intact springs, to approximately 20 lb.f.

### **Recorded information**

The aircraft was fitted with a Flight Data Recorder (FDR) and a 30-minute CVR. Due to the length of the flight between Chambery and Gatwick, relevant information on the CVR was overwritten. The FDR recorded just over 26 hours of operation and flight data was also recovered from the operator's Flight Data Monitoring (FDM) programme.

Just prior to takeoff, the recorded aircraft mass was 116,560 lb (52,870 kg). Takeoff commenced at 10:10:13 hrs with  $N_1$  on both engines increasing to 88.5% (Figure 3). At a computed airspeed (CAS) of 126 kt, the control column was pulled back to command a pitch-up attitude, the pitch attitude increased and the nosewheel left the ground. Approximately four seconds later, the pitch attitude increased through 10.8°, the threshold for a tailstrike with the landing gear compressed, and increased further as the mainwheels left the ground. The average pitch rate, calculated from the time of rotation to 10° pitch attitude, was 2.3° per second, within that recommended in the Flight Crew Training Manual.

At approximately the time the pitch attitude passed 10.8°, the recorded control wheel position increased to 21°, signifying a commanded right roll, which led to a corresponding aileron deflection. Spoiler positions

were not recorded, but assessment by the aircraft manufacturer was that this may have contributed to a loss of lift as this roll demand would have been sufficient to raise the roll spoilers on the right wing.

After lift-off the aircraft continued to accelerate, with the correct  $V_2$  of 149 kt being achieved at a radio altitude of 30 ft.

### **Aircraft manufacturer's performance assessment**

Flight data and accident details were forwarded to the aircraft manufacturer to review. They concluded that the primary contributory factor to the tailstrike was the aircraft being rotated too early during the takeoff.

### **Operator's Electronic Flight Bag**

#### *Overview*

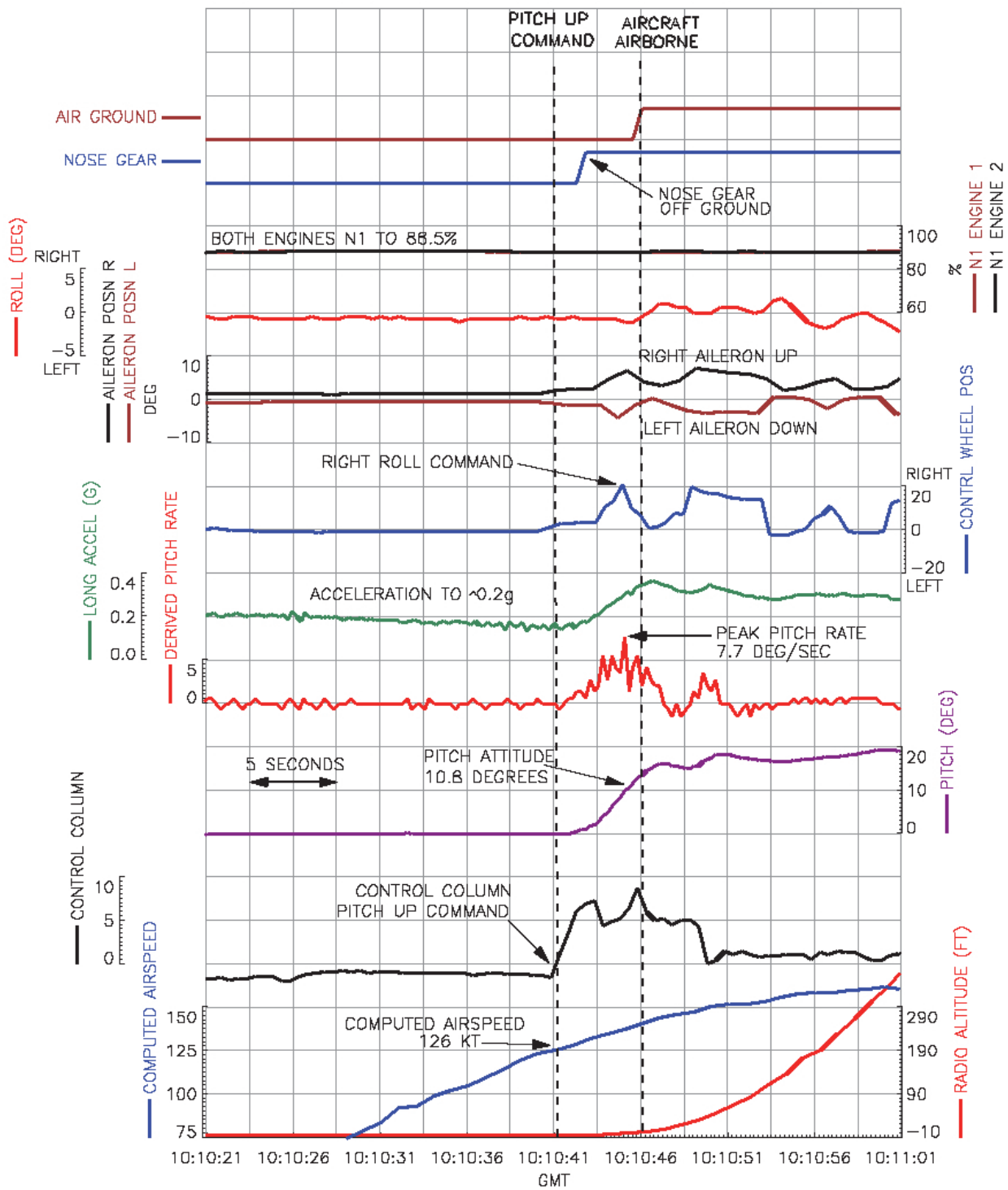
The EFB software<sup>1</sup>, referred to as 'the Guru' by the operator, was installed on a touchscreen hand-held computer. Data entry was achieved using an on-screen keyboard, touchscreen and stylus. The operator was involved in the early development of this EFB with the software supplier in 2004, and used it on their Boeing 737, 757 and 767 fleets. The EFB software supplier indicated that this EFB was used by operators in 13 countries.

The operator used the EFB for takeoff and landing performance calculations. To calculate takeoff performance, data is entered into the 'Input' tab (Figure 4) and the takeoff runway selected in the 'Airport' tab. The EFB software then calculates the takeoff performance and displays it, with other relevant information, on the 'Takeoff' tab (Figure 5). During this process some error checking is automatically performed by the software on the input data (eg QNH range, takeoff mass limits), which is flagged if inappropriate.

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#### **Footnote**

<sup>1</sup> Guru UI version V2 build 2426, Install awc1204.



**Figure 3**  
G-ZAPZ Chambery Takeoff FDR Parameters

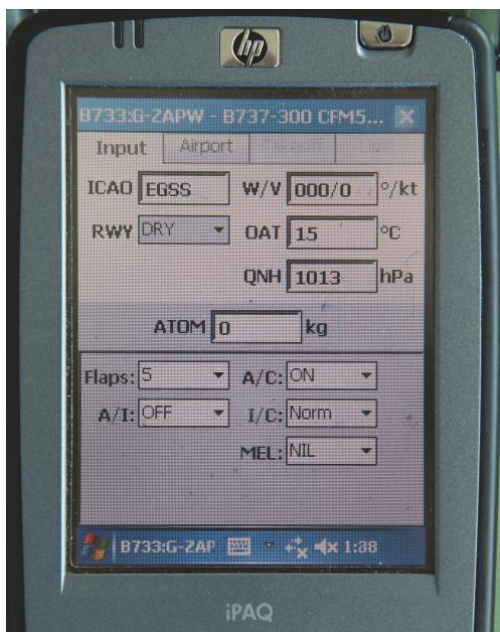


Figure 4

EFB takeoff input screen after software restart

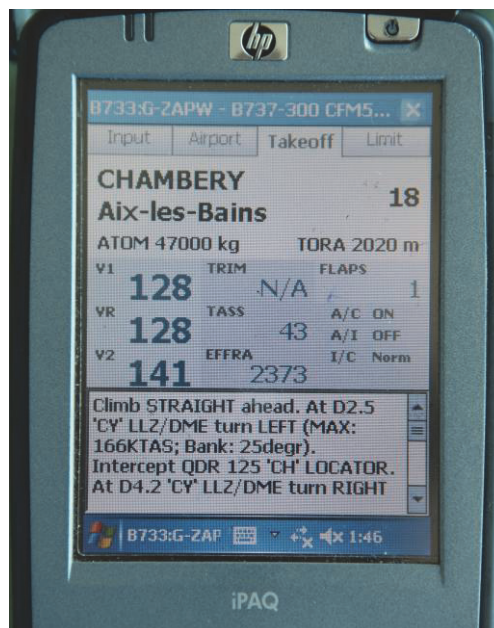


Figure 5

Example takeoff performance calculation showing takeoff speeds and emergency turn information

#### Hardware and software operation

Once a performance calculation has been completed, the Guru program can be shut down or the EFB can be set to a standby mode. The standby mode essentially switches the screen off, but maintains any active software running. Recovery from standby mode is nearly instantaneous and, of significance, any previously calculated takeoff and landing data is retained. The operator indicated that, in the event of any last-minute operational changes (for example, a runway change), retaining the information in the EFB in this way allowed the flight crew to recalculate performance quickly without having to re-enter data fields.

Restarting the Guru program after shutdown takes approximately 36 seconds and results in the 'Input' data fields being reset to a standard data set (Figure 4). It also resets the 'Takeoff' and 'Limit' tabs to prevent data calculated (V speeds etc) from previous sectors being accessed.

The operator's Operations Manual, Part B, Section 4.1 referred to the loss of stored data when the Guru program is shut down:

*'All information entered in Guru will automatically be stored in memory when closing the current section or moving to the next tab. However, if the main Guru window is closed and the program is shut down, the previously calculated information will not be displayed when Guru is restarted. This is for flight safety reasons, as only actual and up-to-date information shall be entered.'*

The Operations Manual did not state that the Guru program must be shut down between uses and pilots routinely left the EFB in the standby mode with the Guru program still active.

## Keyboards

In reviewing the EFB as part of the investigation, issues relating to the device keyboard were identified which, whilst not causal to this accident, were relevant to the overall EFB design approval.

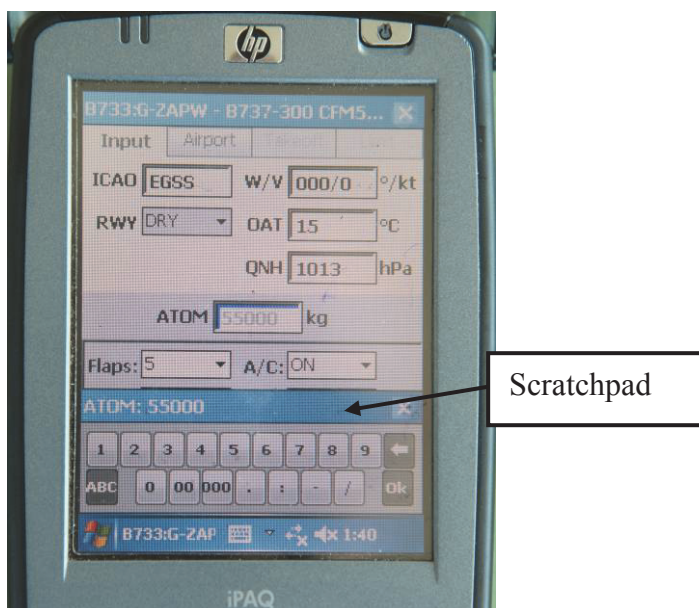
Data entry for the EFB software can be by one of three on-screen keyboard options. Two of these are bespoke keyboards created by the EFB software supplier; the third is the device's own intrinsic keyboard which is part of its operating system. Examples are shown in Figures 6 and 7.

Both the EFB software supplier's keyboards have a 'scratchpad' which allows the user to see what is being entered even if the keyboard obscures the field being completed (Figure 6). To guard against data lying unknowingly hidden behind the open keyboard, their keyboards must be closed before different tabs can be accessed. If either of the EFB manufacturer's keyboards are selected, the device's intrinsic keyboard

can still be opened, but cannot be used to enter data into any of the EFB fields.

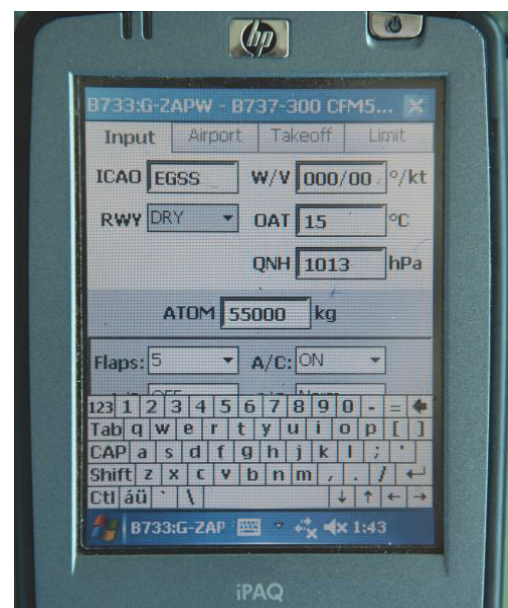
The device's intrinsic keyboard (Figure 7) has smaller key sizes (the number boxes are approximately 4 mm x 4 mm) than the EFB manufacturer's version. There is also no scratch pad facility, so should the keyboard cover the field being used, the numbers selected cannot be seen as they populate the field. In addition, the keyboard does not have to be hidden when moving between tabs, potentially allowing information to be hidden from view. For example, if the intrinsic keyboard was left open, the emergency turn information at the bottom of the screen shown in Figure 5 was hidden.

The EFB software supplier indicated that, for these reasons, the EFB is set to one of their bespoke keyboards by default. However, the operator preferred to use the device's intrinsic keyboard and this was the keyboard selected for use across their fleets at the time of this accident.



**Figure 6**

EFB software supplier's keyboard



**Figure 7**

Device's intrinsic keyboard



## Standard Operating Procedures (SOPs)

The calculation of takeoff performance data formed part of the operator's pre-departure checks, procedures for which appeared in the Operations Manual Part B, Section 2.14 and Section 2.17. The operator stated that all its pilots were trained on the use of the EFB and were checked on its use during LPC/OPC and line checks. However, the investigation revealed a lack of clarity in the way the procedures were laid out and on details of how information should be checked.

As a result of this accident the operator issued NOTAC OMB B733 02/2012, containing revised procedures. These included the requirement to shut down and restart the Guru program prior to conducting takeoff performance calculations. In addition, it instructed that the calculated  $V_2$  should be compared against simple tabulated values of  $V_2$  obtained by comparing flap position against aircraft weight. This was on the basis that  $V_2$  changes little with other variable conditions, such as weather and runway used, and can therefore be used as a gross error check.

## EFB approval

In October 2004, the JAA issued Temporary Guidance Leaflet (TGL) No 36 '*Approval of Electronic Flight Bags (EFBs)*' which provided guidelines to cover airworthiness and operational criteria for the approval of EFBs. Under the TGL 36 guidelines, EFBs are categorised according to their hardware and software functionality and as a consequence, not all EFB categories require airworthiness approval. The operator's EFB software is classified as a Type B application, running on Class 1 hardware, which required operational but not airworthiness approval. Class 1 hardware devices are generally Commercial-Off-The-Shelf (COTS) computers and with the improvement in tablet and mobile telephone computing power over recent years, the options

for Class 1 hardware to host EFBs have increased significantly.

Section 7 of TGL 36 details the 'Operational Approval' process with guidelines for operators on how to demonstrate to a regulatory authority the suitability of the EFB and the operational procedures that accompany it. This is demonstrated in a report, usually submitted to their National Airworthiness Authority (NAA) (in this case the UK CAA), who review this and then permit the use of the EFB system<sup>2</sup> if it is acceptable. Within this section are a number of generic requirements for 'Human-Machine Interface Assessment' along with requirements for flight crew operating procedures and training. Appendix D also details guidelines for input devices, which includes:

*'In choosing and designing input devices such as keyboards or cursor-control devices, applicants should consider the type of entry to be made and flight deck environmental factors, such as turbulence, that could affect the usability of that input device.'*

The guidelines for the 'Final Operational Report (Operational Compliance Summary)' require a summary of activities undertaken by the operator during the approval phase. However, the guidelines do not include specific software testing intended to identify potential sources of input errors, such as data fields not clearing after each flight.

## CAA EFB operational approval

The CAA granted the operator permission to use the EFB after an operational evaluation. This evaluation

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### Footnote

<sup>2</sup> An EFB system refers to the complete EFB operation including risk assessments, human-machine interface, flight crew operating procedures and training, EFB administration and quality assurance.

used TGL 36 as a baseline, plus the CAA's own bespoke 'Operators EFB Checklist'. This checklist added some detail to that in TGL 36 but did not list any requirements for management of retained performance data from previous flights, or specify which of the three keyboard options should be used. Inconsistencies in the operator's SOPs also suggested these would have benefited from closer scrutiny.

### Previous occurrences and studies

There have been a number of previous incidents and accidents resulting from incorrect calculation of takeoff performance. The outcome of such events can be: a perceived 'sluggish' takeoff, tailstrike, runway overrun, reduced obstacle clearance, degraded climb performance or, in the worst case, a catastrophic takeoff accident. As it is often the case that takeoff underperformance is subtle, it is possible that events have also occurred but have not been noticed.

On 14 October 2004, a Boeing 747 freighter, registered 9G-MKJ, crashed on takeoff from Halifax International Airport, fatally injuring the crew. The accident was investigated by TSB Canada whose report<sup>3</sup> concluded:

1. *The Bradley<sup>4</sup> take-off weight was likely used to generate the Halifax take-off performance data, which resulted in incorrect V speeds and thrust setting being transcribed to the take-off data card.*
2. *The incorrect V speeds and thrust setting were too low to enable the aircraft to takeoff safely for the actual weight of the aircraft.'*

#### Footnote

<sup>3</sup> Transportation Safety Board of Canada Aviation Investigation report No A04H004.

<sup>4</sup> Reference to 'Bradley' refers to Bradley International Airport in the USA; the takeoff runway on the sector prior to the takeoff from Halifax.

Analysis of the FDR data revealed that the data for the Halifax takeoff (V speeds, thrust derate) was nearly identical to that of the Bradley takeoff. In addition, the report identified that the EFB used for takeoff performance calculation retained '*all the previous settings, data, and information from the last use*' and that it was possible the Bradley takeoff weight retained in the EFB was used for the takeoff performance calculation.

After this report was issued, in August 2006, the JAA issued Safety Information Communication (SIC) No 7 titled 'Information on findings and recommendations relating to the use of an Electronic Flight Bag (EFB)'. This SIC was published as advice to operators in addition to TGL 36, with a view to reducing the chances of flight crews inadvertently using performance data retained in an EFB. The SIC made two recommendations to operators to modify their EFB software; one of these was to prevent:

*'(ii) Any field in the performance application which is used to derive operational performance for a critical phase of flight from remaining populated after the EFB is shut down.'*

Where a software modification was not achievable, the SIC recommended that robust crew procedures were put in place to ensure independent calculations, cross-checking and gross error-checking, coupled with provision of suitable training.

After an A340-500, registered A6-ERG, suffered a tailstrike and runway overrun in 2009, the ATSB produced a Safety Report titled 'Take-off performance calculation and entry errors: A global perspective'<sup>5</sup>.

#### Footnote

<sup>5</sup> ASTB Transport Safety Report. Aviation Research and Analysis report AR-2009-052.

This report highlighted 31 global accidents and incidents over 20 years where takeoff performance parameter calculation and data entry led to a variety of consequences ranging from a perceived sluggish takeoff, to tailstrikes, to destruction of the aircraft. The report concluded that the errors appear to occur irrespective of airline or aircraft type and that there are a number of sources to the errors. While a number of errors are captured, due to the large number of methods in calculating and entering takeoff performance data, there was no single solution available. In addition it concluded:

*'While it is likely that these errors will continue to take place, as humans are fallible, it is imperative that the aviation industry continues to explore solutions to firstly minimise the opportunities for take-off performance parameter errors from occurring and secondly, maximise the chance that any errors that do occur are detected and/or do not lead to negative consequences.'*

In June 2012, a NASA study<sup>6</sup> was concluded which extended that of the ATSB and a BEA commissioned study from 2008<sup>7</sup>. The study listed possible vulnerabilities from case studies and error reducing/trapping strategies. In addition, it proposed that:

*'more accidents are likely to occur unless existing measures to prevent and catch these errors are improved and new measures are developed.'*

Technical solutions have been studied, including Takeoff Performance Monitoring Systems (TPMS). Such systems operate during the takeoff roll and attempt to identify any underperformance in aircraft acceleration relative to runway position and highlight this to the pilots. The AAIB has previously made Safety Recommendations concerning TPMS in the report on an accident to G-OJMC (AAIB Bulletin 11/2009 refers).

### **EASA work**

On 12 March 2012, the EASA issued Notice of Proposed Amendment (NPA) No 2012-02, with a view to integrating TGL 36 into the structure of the Agency's rules and also enhance and update the content. The outcome of this NPA is Acceptable Means of Compliance (AMC) 20-25<sup>8</sup>. The NPA referenced the 9G-MKJ (Halifax) accident but did not include any reference to the recommendations in JAA SIC No 7.

The proposed 'Operational Approval Process' section of this AMC differs from TGL 36 in that, amongst other things, it specifically requires any Type B EFB performance application be evaluated by the EASA. In addition, with a view to standardising the way such EFBs are approved, it states:

*'The competent authority at national level should then base the granting of the operational approval on the results of the operational evaluation conducted by the Agency.'*

The AMC does not detail any equivalent detailed checklists such as those used by the UK CAA for an operational evaluation, nor do the EASA publish any. At the time of this report, AMC 20-25 was due for final release in early 2013.

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### **Footnote**

<sup>6</sup> NASA (2012) *Performance Data Errors in Air Carrier Operations: Causes and Countermeasures*. NASA/TM-2012-216007

<sup>7</sup> Laboratory of Applied Anthropology (2008). *Use of Erroneous Parameters at Takeoff*, DOC AA 556/2008

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### **Footnote**

<sup>8</sup> AMC 20-25 Airworthiness and operational consideration for the approval of Electronic flight Bags (EFBs).

## FAA and Transport Canada

The FAA and Transport Canada provide an ‘Advisory Circular’ for EFBs<sup>9</sup> and both provide checklists for the operational approval of a new EFB. In addition to the Advisory Circular, the FAA provides the ‘Electronic Flight Bag Authorization for Use’<sup>10</sup> document which contains detailed criteria for assessing an operator’s request to use an EFB.

## Safety actions by the operator

The Operator stated that since this accident, it has improved the Operations Manual guidance on the use of the Guru program, adding more robust procedures. It has embarked on a training programme to provide refresher training for all crews on aircraft performance and has also upgraded the aircraft FMC programs.

The operator initially requested a ‘clear’ button to be added to their EFB screen to allow flight crews to clear all data fields. After discussion with the Guru software supplier, it was agreed that after the application is started, instead of populating fields with ISA data, these will be blanked. In addition, if the four-digit ICAO airport identifier is changed to signify a new airport, data fields will be blanked.

As the current EFB hardware is becoming difficult to source, the operator is also researching different hardware platforms with their EFB software supplier.

## Analysis

### *Aircraft performance*

When the EFB was woken from the standby mode, the Guru program retained the TOW from the takeoff at Stansted. The commander omitted to enter the aircraft’s TOW at Chambéry and neither he nor the co-pilot cross-checked the EFB computed data. Consequently, the erroneous TOW data was not identified and incorrect performance data was computed by the EFB, based on a figure around 6,600 kg lower than the actual TOW. The takeoff speeds were therefore correspondingly lower and the assumed temperature for the reduced thrust takeoff was higher than it should have been.

The aircraft rotation commenced at 126 kt, 13 kt below the required airspeed for the aircraft’s TOW. As a result of the early rotation, the aircraft pitched up but did not take off immediately and, with an increasing pitch attitude, the tail struck the runway. Despite the lower than required rotation speed and thrust derate, the aircraft continued to accelerate during the rotation and lift off, achieving  $V_2$  at a radio altitude of 30 ft.

It is considered that the reduction in pitch forces due to the broken outer main spring within the elevator feel and centering unit contributed to the excessive pitch attitude whilst attempting to get airborne.

### *Operator’s EFB*

An important contributory factor to this accident was that when the EFB was set to standby mode, the Guru program retained data from the previous flight. To improve the EFB robustness, the operator and EFB software supplier intend to modify the software to help reduce the chance of the EFB software contributing to performance calculation errors.

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## Footnote

<sup>9</sup> FAA Advisory Circular No AC 120-76B, Transport Canada Advisory Circular AC 700-020.

<sup>10</sup> FAA Flight Standards Information Management System (FSIMS) 8900.1 Volume 4, Chapter 15.

Retaining takeoff performance data after calculation can be useful when last-minute changes are necessary. If flight crews are required to re-enter the takeoff data, especially at a point where workload pressure is likely to be high, this provides an additional opportunity to introduce errors. The retention of performance data is therefore only appropriate if adequate software and operational safeguards are in place.

At the time of the accident the operator was using a keyboard setting not intended for use by the EFB software supplier. An appropriate keyboard was available, but the software still allowed the use of the device's own intrinsic keyboard. Whilst it was not a factor in this accident, use of the intrinsic keyboard increased the potential for incorrect data being entered into the EFB and for information to be missed due to screen obscuration by the on-screen keyboard. The size of this keyboard was such that accurate use of the stylus was required to select the correct figures. This questions the use of the device whilst airborne in turbulent conditions for calculating data such as landing performance.

In developing the software, the supplier of the operator's EFB used the appropriate guidance material available at the time. However, neither this, nor the approval process specifically addressed the issues highlighted above. In order to reduce the risk of human factors errors occurring when using EFBs for calculating performance data, the following Safety Recommendation is made:

#### **Safety Recommendation 2012-035**

It is recommended that the Civil Aviation Authority update their criteria for the operational approval of Electronic Flight Bags (EFBs) to ensure operators have procedures in place for the use of any 'standby modes' and on-screen keyboards, and to prevent the inadvertent use of outdated EFB performance data.

#### *EFB evaluation and approval*

Although currently integrating TGL 36 into the structure of the agency's rules, the EASA does not provide operational approval for each EFB; this is the responsibility of the National Airworthiness Authorities. NPA 2012-02 proposes that all EFBs capable of performance and mass and balance calculations be evaluated by the EASA to ensure an EASA-wide evaluation consistency, from which NAAs can base their decision to permit EFB use.

Both this accident, and that to 9G-MKF in Halifax, used the takeoff weight from the previous sector for performance calculations. The EFB in this accident, however, differs in that it does erase calculated takeoff data after it is shut down. Guidance in both TGL 36 and the proposed AMC 20-25 is for generic robustness, but there is no specific reference to detailed testing or recommendations such as those contained in JAA SIC No 7. The following Safety Recommendation is therefore made:

#### **Safety Recommendation 2012-036**

It is recommended that the European Aviation Safety Agency establish a set of detailed guidelines for the operational evaluation and approval of Electronic Flight Bags. These should be more specific than the proposed Acceptable Means of Compliance (AMC) 20-25 and include information such as provided in the Federal Aviation Authority document '*Electronic Flight Bag Authorization for Use*' and Joint Aviation Authorities Safety Information Communication No 7.

#### *SOPs*

Deficiencies identified in the EFB were exacerbated by those identified in the operator's SOPs. The operator was sufficiently small that the relevant managers

believed all pilots knew what was expected of them despite these shortcomings. Both pilots stated they were aware of the need to check the EFB performance calculations. The problem came in identifying exactly what was expected and in this the SOPs were, in parts, out of date, insufficiently comprehensive and lacking in clarity. The operator acknowledged this and will be carrying out a review of the relevant SOPs as part of a larger review of their Operations Manual.

### **Summary**

The use of computers in the calculation of performance requirements has brought about improvements in the accuracy and ease with which they can be made. There

remains, however, a continued vulnerability to the use of incorrect data in making these calculations, a solution to which remains outstanding. This accident serves to demonstrate that, given these circumstances, the existence of and adherence to robust procedures, and appropriately designed software and hardware, are essential.

This event once again emphasises the need for technical solutions for takeoff performance monitoring, to cater for those occasions where current safeguards have failed, and reiterates previous Safety Recommendations made by the AAIB on this issue.