C-FWGH

Investigation Synopsis

At 1539 hrs on 21 July 2017, a Boeing 737-800 took off from Belfast International Airport (BFS) with insufficient power to meet regulated performance requirements. The aircraft struck a supplementary runway approach light, which was 36 cm tall and 29 m beyond the end of the takeoff runway.

An outside air temperature (OAT) of -52°C had been entered into the Flight Management Computer (FMC) instead of the actual OAT of 16°C. This, together with the correctly calculated assumed temperature thrust reduction of 48°C, meant the aircraft engines were delivering only 60% of their maximum rated thrust. The low acceleration of the aircraft was not recognised by the crew until the aircraft was rapidly approaching the end of the runway. The aircraft rotated at the extreme end of the runway and climbed away at a very low rate. The crew did not apply full thrust until the aircraft was approximately 4 km from the end of the runway, at around 800 ft aal.

There was no damage to the aircraft, which continued its flight to Corfu, Greece without further incident. However, it was only the benign nature of the runway clearway and terrain elevation beyond, and the lack of obstacles in the climb-out path which allowed the aircraft to climb away without further collision after it struck the runway light. Had an engine failed at a critical moment during the takeoff, the consequences could have been catastrophic.

The investigation found the following causal factors for this serious incident:

An incorrect OAT was entered into the FMC, which caused the FMC to calculate an N1 setting for takeoff which was significantly below that required for the aircraft weight and environmental conditions.

The incorrect OAT was not identified subsequently by the operating crew.

The abnormal acceleration during the takeoff run was not identified until the aircraft was rapidly approaching the end of the runway, and no action was taken to either reject the takeoff or increase engine thrust.

The investigation found the following contributory factors for this serious incident:

The aircraft's FMC did not have the capability to alert the flight crew to the fact that they had entered the incorrect OAT into the FMC, although this capability existed in a later FMC software standard available at the time.

The Electronic Flight Bags (EFB) did not display N1 on their performance application (some applications do), which meant that the crew could not verify the FMC-calculated N1 against an independently-calculated value.

The crew were unlikely to detect the abnormally low acceleration because of normal limitations in human performance.

The investigation identified other examples of accidents or serious incidents where there was a gross failure of an aircraft to achieve its expected takeoff performance, and found that technical solutions to address this serious safety issue are now feasible.

Safety Recommendation 2017-016

Safety Recommendation 2017-016

It is recommended that the Federal Aviation Administration, mandate the use of Flight Management Computer software revision U12.0, or later revision incorporating the outside air temperature crosscheck, for operators of Boeing 737 Next Generation aircraft.

Date Safety Recommendation made: 20 September 2017

LATEST RESPONSE

Response received:

11 December 2017

In order to evaluate Safety Recommendation 17.100, we conducted research to ascertain the extent to which FMC software version U12 is already in use among 737 Next Generation (NG) operators, any reasons operators may have for continuing to use older software versions, and what actions may have already been taken to advise operators of the issue. In order to gather this information, we coordinated with the FAA Advanced Avionics & Airborne Software System Oversight Division and the individual Principal Avionics Inspectors (PAI) conducting oversight of various Boeing 737 NG operators.

Based on the research conducted, we do not concur with Safety Recommendation 17.100.

There are currently four FMC software versions in use among United States (US) Boeing 737 NG operators: U10.8A, U11, U12, and U13. U12 and U13 account for the vast majority (approximately 75%) of aircraft operating under part 121 in the US. Like any type of software, each FMC version may have specific hardware compatibilities, added functions and capabilities, fixes to bugs from previous versions, and bugs or deficiencies of its own. An operator's decision on which software version or versions to use is a programmatic one which typically includes these characteristics, as well as operational considerations such as fleet commonality, procedural changes, training, and resources. While some operators upgraded their entire NG fleets to U12 or U13, others are operating with mixed software versions, or made the conscious decision not to install U12 at all. The reasons vary from operator to operator.

For example, one part 121 major airline operates approximately 28 percent of its NG fleet with U11 software installed, due to compatibility issues with onboard equipment in use on those aircraft. In particular, the HGS5200 head-up displays in this fleet are not compatible with software later than U11; a mandate for the use of U12 would require retrofit of these and other onboard systems. While the remaining NG aircraft in this airline's fleet are compatible with U12, they chose not to install U12 in those aircraft, due to issues with the software "locking up." As a result, this operator continued to use older software until U13, which contained a fix for these issues, became available. The operator then installed U13 on all compatible aircraft in the fleet.

Another part 121 airline decided to operate U11 software across its fleet due to "service issues" with the U12 software. This operator plans to upgrade its fleet to a later version when these issues are addressed and the use of the updated version will be more beneficial for their operations.

As a result of this assessment, the FAA concludes that operators using older software are doing so based on a comparison of benefits and drawbacks. The FAA mandating use of U12 places a burden on the operator that outweighs any safety benefit gained.

Boeing took steps to address and publicize the erroneous OAT issue. At the time of the incident that precipitated Safety Recommendation 17.100, Boeing issued a Service Bulletin advising operators of the

potential hazard, and recommending installation of U12 software by January 2019. In December 2017, as a result of the AAIB recommendation, Boeing conducted a Safety Review Board which determined that the existing measures were adequate to address the hazard.

Safety Recommendation Status Closed

AAIB Assessment

Not Adequate

Feedback rationale

Safety Recommendation No 2017-016 was superseded by Safety Recommendation 2018-012 when the final report into the subject Serious Incident was published. (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 11 December 2017

The FAA has assigned this recommendation to its Flight Technologies and Procedures Division/Flight Operations Branch. To that end, the point of contact has conducted preliminary coordination with the FAA's Aircraft Evaluation Group (AEG) team responsible for Boeing 737 Next Generation aircraft. This coordination has revealed that there may be hardware compatibility, fleet compatibility, and cost implications for some 737 operators that are currently using pre-U 12.0 software revisions. These implications must be understood and considered before we can make a determination about the recommended mandate. The Flight Technologies and Procedures Division/Flight Operations Branch will coordinate further with AEG as well as the individual Certificate Management Offices to determine if and to what extent the various 737 operators would be burdened if the U12.0 software revision were to be mandated as recommended. We will provide a more updated response by December 17, 2018.

AAIB Assessment – Partially Adequate Open

(SRIS Reference: GB.SIA-2017-0016)

Safety Recommendation 2017-017			
Safety Recommendation 2017-017			
It is recommended that The Boeing Company promulgates to all 737 operators the information contained within this Special Bulletin and reminds them of previous similar occurrences reported in the Boeing 737 Flight Crew Operations Manual Bulletin dated December 2014.			
Date Safety Recommendation made: 20 September 2017			
LATEST RESPONSE			
Response received: 15 January 2018			
The Boeing Company recently completed its internal Safety Process which culminated with this event being presented at its Safety Review Board (SRB). The SRB consists of 737 Program Executive and Senior managers who have voting power to determine if an issue is considered Safety or not. (A single vote for safety is all that is needed to classify an issue as Safety, a unanimous decision is not required). A similar event had previously been presented to the Board where a determination of 'Safety' had been made. Mitigating action consisted of the release of the Service Bulletin. As such, no further action is anticipated resulting from the latest event under investigation.			
However, it was agreed that a Multi Operator Message should be sent to all 737 operators to remind operators of this issue, the associated Service Bulletin and the time remaining to install the U12 FMC update and BP15 Displays update.			
In addition, Boeing plans to discuss this issue and remind operators of the existing Flight Operations Technical Bulletin at the January Fleet Team Call.			
Safety Recommendation Status Open			
AAIB Assessment Partially Adequate			
Action Status			
Feedback rationale			
Although your proposal to remind B737 operators of this issue through a Multi-Operator Message meets the intention of our recommendation, to classify the recommendation as 'Adequate' and 'Closed' we would need confirmation of when the Multi-Operator Message will be, or was, sent.			
The AAIB has therefore classified the response to 2017-017 as 'Partially Adequate – Open' pending confirmation from you as to the status of the Multi-Operator Message.			
RESPONSE HISTORY			
N/A			
(SRIS Reference: GB.SIA-2017-0017)			

Safety Recommendation 2018-012

Safety Recommendation 2018-012

It is recommended that the Federal Aviation Administration mandate the use of Flight Management Computer OPS software revision U12.0, or later, and the Common Display System Block Point 15 update where this is required, to enable the outside air temperature crosscheck on all applicable Boeing 737 aircraft.

Date Safety Recommendation made: 14

14 November 2018

LATEST RESPONSE

Response received:

23 April 2019

To evaluate Safety Recommendation 18.175, the FAA conducted research to ascertain the relationship between Common Display System Block Point 15 (BP15) and Flight Management Computer OPS software revision U12.0 (OPS U12). The work was coordinated with the Transport Aircraft Seattle Aircraft Evaluation Group. Based on the research conducted, and the previous assessment of Safety Recommendation 17.100, the FAA does not concur with Safety Recommendation 18.175.

OPS U12.0 was released in December 2015, and BP15 was subsequently released in October 2016. While OPS U12 and BP15 pertain to two different onboard systems and BP15 is not a prerequisite for OPS U12 installation, the two software versions are co-dependent in that BP15 solves some compatibility issues between OPS U12 and previous Block Point versions. For example, the automated outside air temperature crosscheck feature included in UPS U12 is not compatible with previous Block Point versions and is, therefore, only available on those aircraft that also have BP15 installed. This relationship is what precipitated safety recommendation 18.175 to supersede the very similar 17.100.

Safety Recommendation 18.175 helps to underscore the many interdependency and compatibility considerations that must be taken by operators when considering software and hardware upgrades. The FAA maintains that an operator's decisions on when and how to install software updates are programmatic in nature and must be based upon many interrelated factors. For these reasons, and those stated in the previous response to Safety Recommendation 17.100, the FAA reiterates its assessment that the burden placed on operators by the recommended mandates would likely outweigh any safety benefit gained. The FAA further assesses that a simple manual reasonability crosscheck of takeoff settings and speeds prior to departure is still an effective safeguard against incorrect takeoff data.

The FAA considers it has effectively addressed this safety recommendation and considers its actions complete.

Safety Recommendation Status Closed

AAIB Assessment

Not Adequate

RESPONSE HISTORY

N/A

(SRIS Reference: GB.SIA-2018-0012)

Safety Reco	ommendation 2018-013			
l l	Safety Recommendation 2018-013			
	It is recommended that the I operators of Boeing 737 aircra value of N1 against an indepen	Boeing Commercial Airplanes give guidance to aft on how they might verify the FMC-calculated ndently-calculated value.		
Date Safety I	Recommendation made:	14 November 2018		
LATEST RES	SPONSE			
Response re	eceived:	13 February 2019		
Boeing agrees with this recommendation and has recently published guidance in the enclosure B) FOTB. This guidance is intended to reduce takeoff performance errors that are introduced either by dispatch and load planning, automated ground-based systems (such as weather data), or pilot data entry errors.				
This guidance is applicable for all Boeing airplane models including all models of the 737. Specific guidance as applicable for the safety recommendation (verification of the FMC calculated N1 value) is outlined on page 5 of the FOTB.				
Safety Recor	mmendation Status	Closed		
AAIB Assess	sment	Adequate		
RESPONSE	HISTORY			
N/A				
(SRIS Reference: GB.SIA-2018-0013)				

Safety Recommendation 2018-014

Safety Recommendation 2018-014

It is recommended that the European Aviation Safety Agency, in conjunction with the Federal Aviation Administration, sponsor the development of technical specifications and, subsequently, develop certification standards for a Takeoff Acceleration Monitoring System which will alert the crew of an aircraft to abnormally low acceleration during takeoff.

Date Safety Recommendation made: 14 November 2018

LATEST RESPONSE

Response received:

19 July 2024

On 30 August 2023, the European Union Aviation Safety Agency (EASA) published the Terms of Reference (ToR) for Rulemaking Task RMT.0741:

https://www.easa.europa.eu/en/document-library/terms-of-reference-and-rulemaking-group-compositions/tor-rmt0741

The objective of this RMT is to mitigate, using on-board design means of protection, the risk of large aeroplane accidents or incidents caused by the use of erroneous take-off performance parameters, and by erroneous take-off positions.

Taking into account design solutions that have been developed by industry to date, this objective should be achieved through the introduction of design requirements aiming at detecting and preventing these errors by providing a means of informing or alerting the flight crew in a timely manner. This should include the monitoring of real-time aeroplane performance during the take-off roll.

Design requirements will be considered to address new large aeroplane designs. An analysis and impact assessment will be conducted to assess the feasibility and the benefit of design requirements applicable to existing (already type certificated) large aeroplane designs.

In parallel, the European Organisation for Civil Aviation Equipment (EUROCAE) created Working Group WG-129 'Take-off Performance Monitoring System Strategy' that held a first meeting on 30 April 2024 with the participation of EASA. The WG is tasked with developing a minimum operational performance standard (MOPS) and/or a minimum aviation system performance standard (MASPS) in order to facilitate the introduction of a take-off performance monitoring system (TOPMS). A close relationship with RTCA is also ensured by EUROCAE.

In view of issuing a common standard. EASA will take into account the work done by this WG and ultimately consider any issued standard that could support the compliance demonstration with new EASA certification specifications.

A Notice of Proposed Amendment (NPA) is being drafted with a publication for consultation currently expected in Q4 2024.

Safety Recommendation Status Op	en
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AAIB Assessment

Partially Adequate

Action Status

Planned Action Ongoing Update Due 31 December 2024

Feedback rationale

The AAIB hopes that the work to develop a real-time takeoff performance monitoring system and associated performance standards is ultimately successful and notes that a previous AAIB Safety Recommendation, SR 2009-080, asked for a relevant specification to be developed. However, this investigation established that work to that end had been unsuccessful, and so SR 2018-014 recommended the development of a takeoff acceleration monitor, for which there is existing technology, as opposed to a real-time takeoff performance monitor, for which there is not.

However, a real-time takeoff performance monitoring system, if successfully implemented, would encompass the intent of SR 2018-014, i.e. it would capture abnormally low acceleration during takeoff. Therefore, EASA's response is classified as Partially Adequate and the AAIB requests that it is sent the consultation copy of the Notice of Proposed Amendment in Q4 2024. (EU Regulation 996/2010 article 18 refers).

RESPONSE HISTORY

Response received: 08 February 2019

The safety issue "Entry of aircraft performance data" was included in the Agency's safety risk portfolio commercial air transport fixed-wing in 2016 {link}.

To reduce the risks, EASA issued a Safety Information Bulletin {SIB)"Use of Erroneous Parameters at Takeoff' to alert operators and flightcrew to the safety issue and to recommend the implementation of operational mitigation measures (published in February 2016: https://ad .easa.europa .eu/ad/2016-02).

The effectiveness of the SIB 2016-02 is being evaluated with the support of the EASA Advisory Bodies composed of competent authorities and industry (consultation February/March 2019). The outcome will be used by EASA to decide whether additional means of mitigating the safety risk should be assessed; this may include the use of Takeoff Acceleration Monitoring System (TAMS).

EASA will liaise with FAA on this matter.

AAIB Assessment - Not Adequate Open

(SRIS Reference: GB.SIA-2018-0014)

Safety Recommendation 2018-015				
Safety Recommendation 2018-015				
It is recommended that the International Civil Aviation Organization note the conclusions of this report and introduce provisions addressing Takeoff Acceleration Monitoring Systems.				
Date Safety Recommendation made: 14 November 2018				
LATEST RESPONSE				
Response received:01 March 2019				
With respect to the above-mentioned safety recommendation, this subject will be referred to the Flight Operations Panel Working Group for consideration during their next meeting scheduled for the end of April 2019.				
I trust that the foregoing information meets the intent of the safety recommendation of the United Kingdom Air Accidents Branch.				
Safety Recommendation Status Open				
AAIB Assessment Partially Adequate				
RESPONSE HISTORY				
N/A				
(SRIS Reference: GB.SIA-2018-0015)				