SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A320-214, G-EZTD	
No & Type of Engines:	2 CFM56-5B4/3 turbofan engines	
Year of Manufacture:	2009 (Serial no: 3909)	
Date & Time (UTC):	24 April 2019 at 2022 hrs	
Location:	Lisbon Airport, Portugal	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 6	Passengers - 175
Injuries:	Crew - None	Passengers - None
Nature of Damage:	None reported	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	27 years	
Commander's Flying Experience:	4,300 hours (of which 4,100 were on type) Last 90 days - 162 hours Last 28 days - 38 hours	
Information Source:	AAIB Field Investigation	

Synopsis

Under international protocols, this investigation was delegated to the AAIB by the Gabinete de Prevenção e Investigação de Acidentes com Aeronaves e de Acidentes Ferroviários (GPIAAF) in Portugal.

During pre-flight preparations, both pilots completed a takeoff performance calculation for a takeoff from the runway intersection with Taxiway U5. During subsequent re-planning, the crew thought they had recalculated performance information from Taxiway S1 but had, in fact, used S4 (runway full length). The aircraft took off from Taxiway U5 with performance calculated for the full runway length. The takeoff distance available from U5 was 1,395 m less than that used for the performance calculation, and the aircraft passed the upwind end of the runway at 100 ft aal. The operator had another identical event 14 days later.

Following this event, the operator acted to raise awareness of the issue with its crews and engaged with the aircraft manufacturer to review possible technical developments which might prevent a recurrence of these type of events.

One Safety Recommendation is made to mitigate the risk of further confusion relating to takeoff positions.

History of the flight

The aircraft was making the return flight to London Luton Airport from Lisbon Airport having arrived at Lisbon at 1940 hrs. The crew initially planned for a departure from the intersection of Taxiway U5 with Runway 21 (Figure 1) and both pilots completed the performance calculations from this intersection (Takeoff Run Available (TORA) 2,410 m). This intersection was referred to as '*PSNUTMP'* (temporary position U)[1] in the Electronic Flight Bag (EFB). The crew subsequently re-planned for a departure from Taxiway S1, but in recalculating the performance they both selected '*PSNSTMP' (*temporary position S). This position was the intersection of Taxiway S4 with the runway ie the full length of the runway. The crew did not cross check the TORA from PSNSTMP against the TORA from Taxiway S1, so the error was not identified by the crew before takeoff.

The aircraft departed from the Taxiway U5 intersection (TORA 2,410 m) at 2034 hrs using an engine thrust setting based on performance figures calculated for the full length of the runway (TORA 3,805 m) (Figure 2). With the reduced power setting, the commander commented subsequently that the takeoff "felt wrong", but Takeoff/Go-around (TOGA) thrust was not selected. The aircraft passed the upwind threshold of the runway at a height of approximately 100 ft. During the flight, the crew realised what had happened and reported it to the operator after landing.

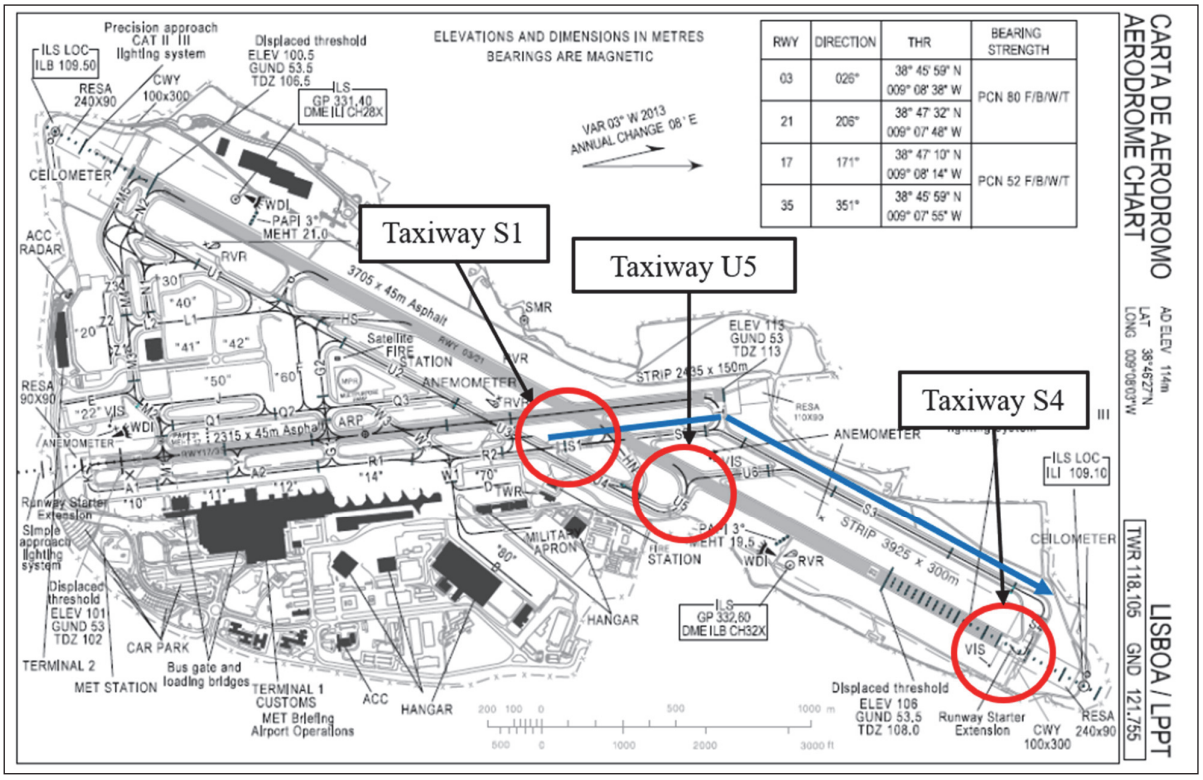

Figure 1

Plan of Lisbon airport showing Taxiways S1, U5 and S4
(chart not orientated north-up)

Footnote

[1] See later sections, *Airfield information* and *Electronic flight bag nomenclature*.

Figure 2

Image of Lisbon Airport showing the calculated and actual takeoff points

Recorded information

Data from the FDR and digital access recorder (DAR) were downloaded from the aircraft by the operator on arrival at Luton and copies were subsequently provided to the AAIB. The DAR is used to provide data for the operator's Flight Data Monitoring (FDM) programme. The 2-hour duration CVR recording was sent to the AAIB for download and analysis, but the duration of the flight from Lisbon meant that the takeoff portion of the flight had been overwritten by the time the aircraft landed.

Analysis of the FDR data for the event showed that the takeoff roll was about 1,860 m long, with the aircraft becoming airborne 400 m before the upwind runway threshold, which it overflew at 100 ft climbing at about 2,700 ft/min. The airspeed at lift off was 170 KIAS.

Airfield information

Lisbon Airport has two runways which are orientated 03/21 and 17/35 as shown in Figures 1 and 3. Runway 03/21 is the preferred runway for both takeoffs and landings, and the prevailing winds mean that Runway 03 is more commonly used. At the time of publication, Runway 17/35 was expected to close and become a taxiway.

For reasons described as "historic", runway takeoff points are referred to as '*Positions*' in the Aeronautical Information Publication[2] (AIP) entry for Lisbon Airport. It is typical for airports elsewhere to use the intersection of taxiways with a runway to describe takeoff points. Commercial chart companies use information from the AIP to generate their publications and takeoff performance data, and they therefore refer to Positions at Lisbon Airport. However, Positions are not generally used by Lisbon ATC when issuing clearances.

When Runway 21 is in use, the preferred takeoff point for all aircraft except heavy jets is 'Position U', which is the intersection of the runway with Taxiway U5. Pilots must advise ATC

Footnote

[2] Aeronautical Information Publication (AIP) is a publication issued by or with the authority of a State and containing aeronautical information of a lasting character essential to air navigation. (ICAO Annex 15 - Aeronautical Information Services.)

on start-up if they require the full length of the runway for takeoff. Full-length departures are from Holding Point S4, which is known as 'Position S'. Taxiway S begins abeam Runway 17, before crossing Runway 21 at Taxiway S1, and then turning north-east to run parallel to Runway 21 (marked on Figure 1 in blue). The taxiway ends at the threshold of Runway 21. There are therefore two points on Runway 21 where Taxiway S intersects the runway.

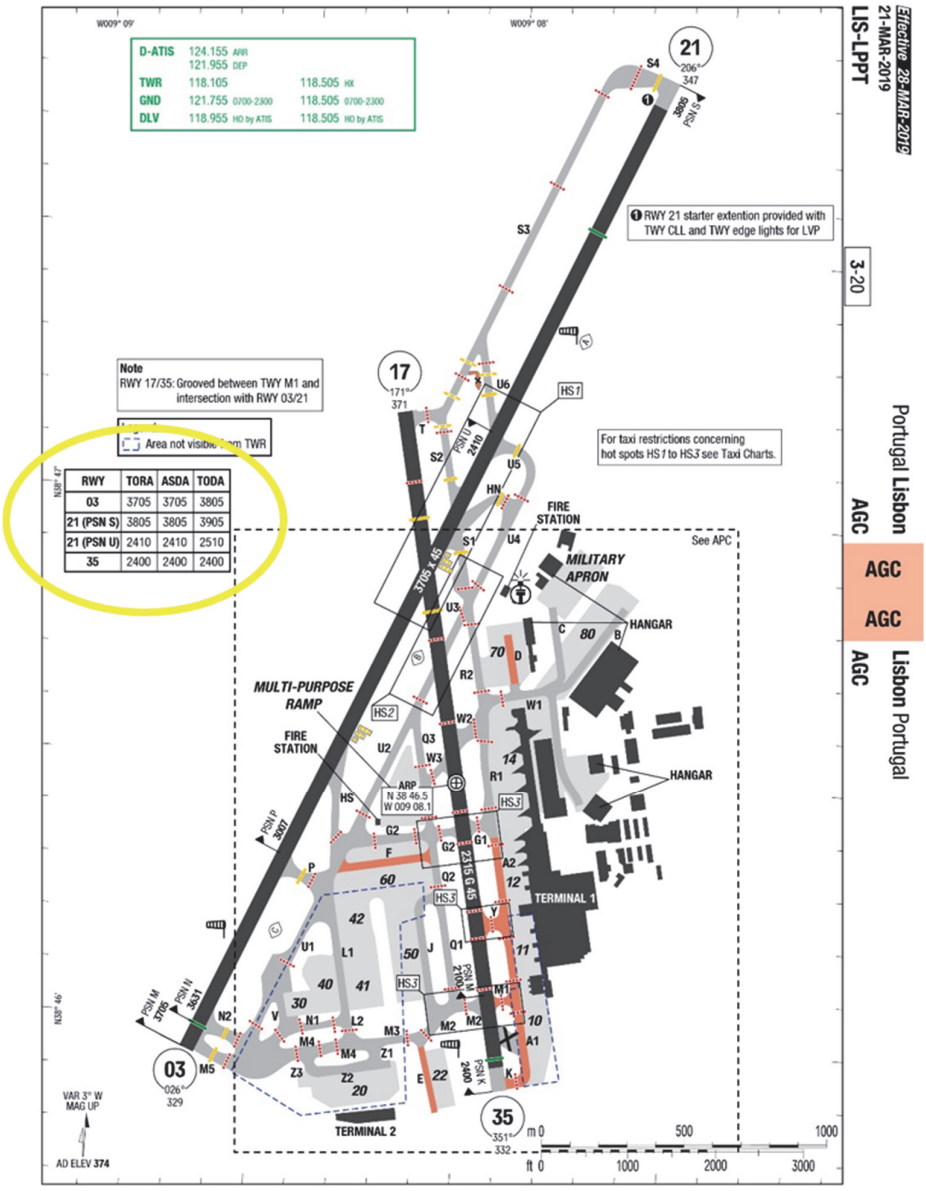

Figure 3

Lisbon aerodrome ground chart © LIDO

Operational procedures

The operator uses an EFB to calculate the weight and balance of the aircraft as well as takeoff performance. Both pilots have a tablet computer on which they complete the required calculations.

Electronic flight bag nomenclature

Data for the EFB performance software is supplied to the operator by a third party. Within the software the crew must initially select the runway for departure and then a point on that runway from where the takeoff will begin. Some runways may have multiple intersections available for departure and, in the case of Lisbon Runway 21, two positions are available, Position U and Position S. These are named in the software as PSNU and PSNS.

At the time of the incident, there was a NOTAM affecting the takeoff performance calculation (referring to an obstacle in the climb-out zone). This meant that the data supplier had inserted two further temporary selections for the two takeoff positions for Runway 21, which were labelled PSNUTMP and PSNSTMP as shown in Figure 4.

Figure 4

EFB dropdown menu showing the all the intersections available

The crew initially selected PSNUTMP for the performance calculation, ie intersection U5, but in discussing the likely takeoff point, they decided that they could use the S1 intersection if necessary, from which there was a lower TORA than from U5. They then performed the calculation from what they thought was the S1 intersection in the EFB selection: PSNSTMP.

Operator's procedures

The operator has detailed standard operating procedures (SOPs) for calculating performance information for takeoff, and each pilot must make the calculation independently before push back. Before completing the performance calculation, the pilots must agree which intersection they will use for the calculation, using the one most likely to be used for takeoff. Should the aircraft depart from a less limiting intersection, no further performance calculation is required. The length of the runway selected is shown on the EFB calculation as shown in Figure 5.

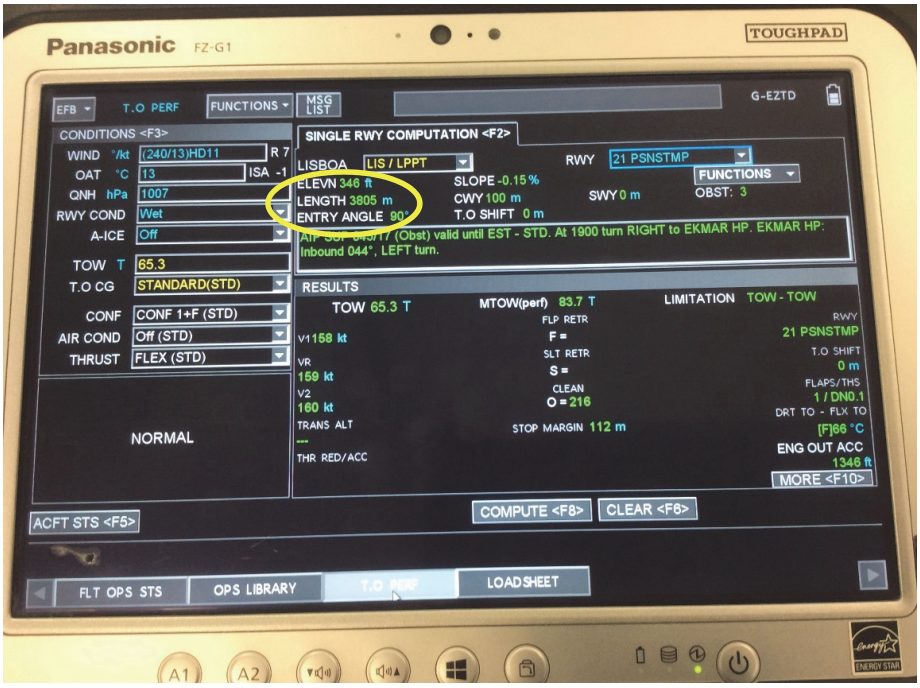

Figure 5

Performance calculation from the temporary Position S showing the distance display

Both pilots are required to cross-check the runway distances available from the chosen intersection against the lengths displayed on the aerodrome ground chart, as shown circled in yellow in Figure 3 for Lisbon.

Further event

The operator subsequently reported an identical event which occurred with another company aircraft 14 days later. This event involved A320-214, registration OE-IJL, which departed Lisbon at 1906 hrs on 7 May 2019 for a flight to Paris Charles de Gaulle Airport. In this event, the aircraft lifted off 350 m before the upwind runway threshold which it crossed at about 75 ft aal.

Further information

The AAIB has investigated numerous serious incidents where aircraft have taken off using performance information calculated from a different start point. Worldwide, similar events present a significant hazard to civil aviation despite SOPs containing measures designed to prevent them, such as cross-checks and independent calculations. Pilots performing cross-checks often fail to notice errors or differences when the figures are unexpected. Humans are poorly adapted physiologically to discriminate between slightly-different acceleration rates, and many years of training have made pilots reluctant to move the throttles once takeoff power is set[3]. In recognition of this, the AAIB has previously

Footnote

[3] AAIB report into a serious incident in Belfast Aldergrove Airport, Boeing 737, C-FWGH, took off with insufficient thrust for the environmental conditions and struck an obstacle after lift-off https://www.gov.uk/aaib-reports/aircraft-accident-report-aar-2-2018-c-fwgh-21july-2017 [accessed December 2019]

recommended that a technical barrier should be developed to capture the effects of an incorrect takeoff performance calculation when it occurs.

The CAA has been working closely with EASA, operators, manufacturers and the AAIB to drive forward developments in mitigation strategies for takeoff performance errors. The strategies include increasing awareness in crews and operators about the criticality of takeoff performance data, development of flight data monitoring flags to detect takeoff performance errors, and the possibility of technological barriers to trap the effects of errors that are made. A copy of a letter on takeoff performance safety sent by the CAA to the CAT industry in December 2018 is at Appendix A.

The aircraft manufacturer has developed a system aimed at protecting against incorrectly-calculated takeoff performance information for other types of aircraft within its fleet. This system performs a lift-off distance check and an aircraft position check before the aircraft begins its takeoff roll, and the manufacturer is in the process of extending the availability of this system to the A320 series of aircraft. The aircraft manufacturer indicated that the trial system would not have warned the crews of G-EZTD or OE-IJL against taking off because, at the start of the takeoff roll, the system-calculated value for runway remaining exceeded the forecast lift-off distance.

Analysis

During pre-flight preparation, both flight crew selected PSNSTMP in the EFB as the reference point for the takeoff performance calculation believing it to be where Taxiway S1 crossed Runway 21 whereas it was actually the reference point for the full length of the runway. The use of takeoff Positions gave rise to the situation where two points on Runway 21 could be construed by the crew as being 'Position S' within the EFB performance software.

The operator's SOPs required the crew to crosscheck the takeoff distance shown in the EFB against the equivalent distance shown on the aerodrome ground chart, but this crosscheck did not capture the error. Consequently, a lower thrust setting than required was used for the takeoff from S1 because it had been calculated for the full length of the runway (which had an additional 1,395 m available). After lifting off, the aircraft passed the upwind end of the runway at 100 ft aal.

Another aircraft from the same operator, although operating under a different AOC, had an identical serious incident 14 days later. In both cases the pilots were confused by the EFB intersection selections because they did not refer to taxiway names, and the selection PSNSTMP could be confused between two runway intersections, S1 or S4. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2020-003

It is recommended that ANA Aeroportos de Portugal discontinue the use of takeoff 'Positions' at Lisbon Airport to minimise confusion in relation to takeoff points.

Conclusion

Both aircraft took off using incorrect performance data for the intersection used. In each case, a selection error was made in the EFB which led the crew to believe that they had calculated performance information for a departure from S1 when in fact they had selected the full length of the runway. In both cases, the procedural barrier of cross-checking the runway distance against the aerodrome ground chart failed to prevent to error. Human performance limitations mean it is difficult for pilots to recognise and react to reduced performance (acceleration) once the takeoff has begun, so robust adherence to procedures is a key defence against such incidents occurring.

Safety action

As a result of these serious incidents the following safety action was taken:

- The aircraft operator issued a notice to its flight crew clarifying the takeoff positions available on Runway 21 at Lisbon Airport.
- A NOTAM was issued highlighting '*confusing runway holding point naming*' and reminding crews that 'Position S' referred to the full length of Runway 21 (Figure 6).
- The aircraft operator issued a description of the events and their causes to its flight crew to raise awareness of the risks of using the wrong intersection and distance for takeoff.
- The aircraft operator engaged with the aircraft manufacturer to review future developments that could offer extra protections against events such as those covered in this report.
- The airport authority undertook to rename taxiways so that Taxiway S intersected the runway at only one point; S4 (full length).

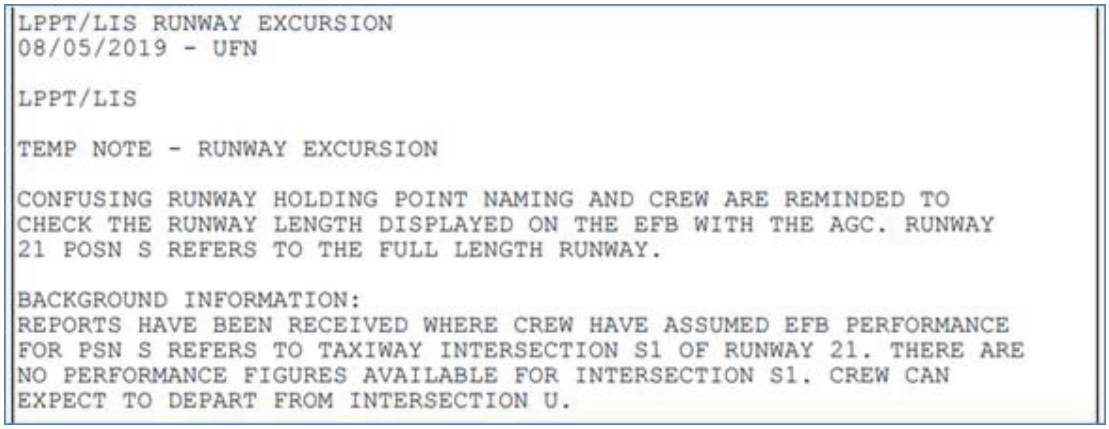

Figure 6

Crew NOTAM

Appendix A

Letter from the CAA to the Commercial Air Transport industry

Chief Executive's Office

10 December 2018

Incidents and errors affecting take-off performance safety: a global aviation issue

Sector: large commercial air transport aeroplane (CAT)

The UK Civil Aviation Authority (CAA) has been monitoring domestic and foreign take-off performance incidents and accidents very closely for some time. Whilst we have engaged with our industry to raise awareness of this risk, the CAA Board has determined that more needs to be done, especially in the area of devising technological barriers that will prevent further occurrences.

Significant incidents continue to occur globally and, in some cases, investigations have revealed that all safety margins were eroded. It is a widely held belief that not all incidents are reported and flight data monitoring programmes are, in many cases, not covering this area. Some recent examples relevant to take-off performance error include:

- Boeing 777 at London Heathrow – Full runway length data used for initial calculation, but flight crew accepted an intersection departure. The First officer recognised the different, but changed data to match the Captain's full-length date with no cross-check (Indian AAIB report issued Aug 2018)
- Boeing 737 at Belfast – Incorrect data entered in the assumed temperature field resulting in the take-off thrust being less than was required (UK AAIB Special Bulletin 20 Sep 2017)
- Airbus A320 at Luton – Intersection departure with full length data used. Crew were distracted by ensuring the different flap setting that was required was selected, but missed the runway length discrepancy (UK AAIB report published 14 Jan 2016)
- Airbus A320 at Malaga – incorrect runway data used for departure and the crew only noticed when they cross-checked calculations in the cruise (UK AAIB report published 12 Jan 2017)
- Airbus A320 at Belfast – System anomaly defaulted to wrong runway after change to input data and was not spotted by crew (UK AAIB investigation published 12 May 2016)

And:

- On Friday 12 October, an Air India Express B737-800 hit a low wall at the departure end of the runway in use. The images are quite alarming and it does not take an aviation expert to conclude that this could so easily have resulted in a much worse outcome. Whilst we must all respect the integrity of the investigation process, this incident must be a catalyst for more activity to be undertaken by all parties, including manufacturer (OEM), operator and regulator.

Whilst much of the focus to date has been on Human Factors and procedure design, which remain key areas for continued improvement, the UK CAA very much supports the development and implementation of technology-based solutions which could provide vital additional controls to the barriers currently in use and development.

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The UK CAA has been working closely with the European Aviation Safety Agency following the Agency's 2016 bulletin[1] and its associated 2018 survey on wrong take-off parameters, to develop appropriate mitigations. The UK CAA will continue to work with EASA in order to further elaborate on relevant actions as part of the European Plan for Aviation Safety (EPAS). In parallel to this work and given the four UK specific incidents above, the UK and its AAIB have established a working group to look in more depth at this issue. This has highlighted the following actions:

- Crew awareness – it is apparent that many crews don't understand the criticality of take-off performance data and the errors and traps with data processing and data entry. This is especially important as analysis has demonstrated that the only significant barriers in the chain are human-based, i.e. process and procedure.

- Operator awareness – Until recently, very few operators have been looking for take-off errors in their FDM programmes and safety reporting systems have not flagged up many issues as, unless the error is significant, crews rarely report an issue after the event. Experience has shown that operators that have had issues and educate crews then see an increase in safety reports about take-off performance errors.

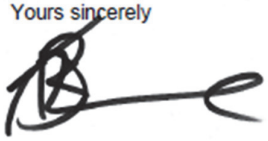
- Technological barriers – All the current barriers are human-based and what is required is a technological barrier, as late in the take-off process as possible to trap as many errors as possible. A recent EUROCAE project around take-off performance declared that a 100% effective take-off performance tool was unachievable. The group is, however, supporting a simple system that would trap gross errors by detecting insufficient acceleration during the take-off roll and alerting the crew during the 'slow speed' phase of the take-off to allow a safe stop to be made. A system is currently available on Airbus A380 aircraft and an Avionics manufacturer has trialled a simple retrofit solution based on EGPWS.

The UK CAA plans to keep the Take-Off Performance working group running for as long as necessary and in the meantime, will endeavour to increase crew and operator awareness. At the same time, the position of the UK CAA Board is to strongly encourage OEMs to develop and support a take-off performance alerting system and note that certain technology already exists.

The UK CAA would be encouraged by all stakeholders recognising the importance of this issue and agreeing to do more to prevent further incidents. We would like to understand your perspective on this issue and would welcome the establishment of a global task force to help develop proposals aimed at addressing this risk. If it is established by commercial industry, the UK CAA would be willing to join such a global take force, in order that we determine the next steps.

We look forward to receiving your response.

Yours sincerely



Richard Moriarty
CHIEF EXECUTIVE

[1] EASA SIB 2016-02

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