SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A319 OE-LQE
No & Type of Engines:	2 CFM56-5B5-3 turbofan engines
Year of Manufacture:	2010
Date & Time (UTC):	30 September 2018 at 0540 hrs
Location:	London Gatwick Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 144
Injuries:	Crew - None Passengers - None
Nature of Damage:	None reported
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	10,908 hours (of which 8,156 were on type) Last 90 days - 203 hours Last 28 days - 65 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and the Operator's safety investigation report

Synopsis

The flight crew made an undetected error during the transposition of aircraft loading data from a paper form into their loadsheet calculation software application. As a result, the calculated aircraft all-up-weight (AUW) was 1,962 kg lighter than the actual aircraft weight. This incorrect AUW was used as the basis for takeoff performance calculations. The aircraft took off without difficulty and the flight crew reported the incident upon arrival at their destination. As a result, the airline conducted its own safety investigation into the circumstances and planned to review the way it used its Electronic Flight Bags.

History of the flight

As part of the cockpit preparation process, Pilot Monitoring (PM) was responsible for generating the aircraft loadsheet using his Electronic Flight Bag (EFB). He used the application's 'Detailed' mode to input passenger and cargo data from the Loading Form Certificate (LFC) (Figure 1) compiled by the Handling Agent. Pilot Flying (PF) later reviewed PM's data entries. A cross-check of the loadsheet output revealed approximately two tonnes discrepancy between the calculated Zero Fuel Weight (ZFW) and the flight plan's estimated ZFW. With such a significant difference, the crew re-checked their working but could not find any obvious errors and so used the existing loadsheet for their takeoff calculations.

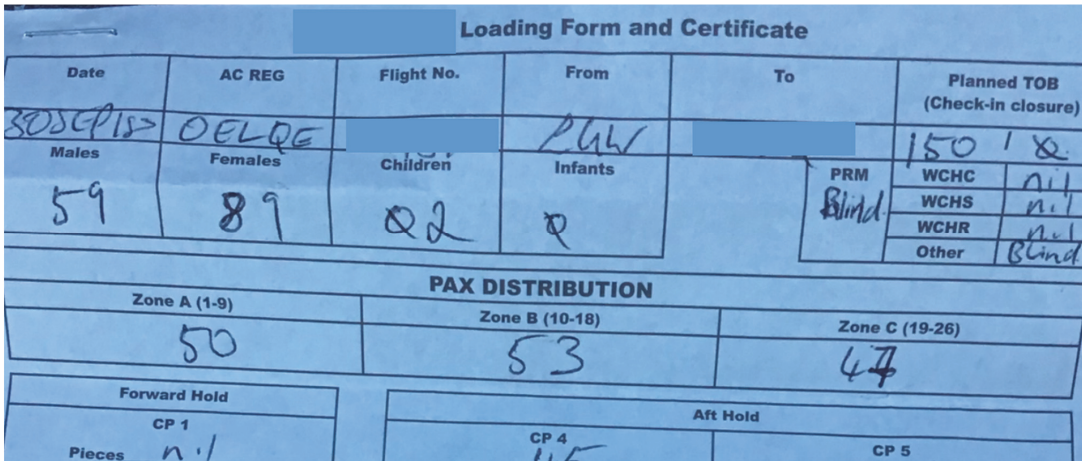

Figure 1

Loading Form Certificate passenger data boxes

Prior to departure, the Handling Agent notified the crew of a Last-Minute Change (LMC) to passenger and cargo numbers. The crew used the application's 'Reduced' mode to update the loadsheet to reflect the change, which reduced the calculated AUW by 384 kg. The new loadsheet did not invalidate the crew's previous takeoff calculations, which were already loaded into the aircraft's flight management system.

Having not fully resolved the ZFW discrepancy, the crew discussed the anomaly while at the runway Holding Point. The takeoff calculations had specified a reduced-thrust departure. The crew resolved that if they had any concerns regarding aircraft performance during the takeoff they would select TOGA thrust (see Aircraft Information paragraph below). The crew based their decision on the fact that the LMC reduced the AUW, and there was a '*central* [CG] *position and excess performance at* [Gatwick]*'*. The subsequent departure was uneventful.

Once established in the cruise, the crew re-checked their loading calculations. They discovered that the Males, Females and Children data fields in the loadsheet application had been incorrectly populated. They contained the passenger cabin zone distribution figures (Figure 2) rather than the correct gender/age data (Figure 3). The resulting incorrect gender/age profile meant that the total passenger weight was underestimated by 1,962 kg. The flight continued to destination without further incident, whereupon the commander reported the loadsheet error to the Company Duty Pilot.

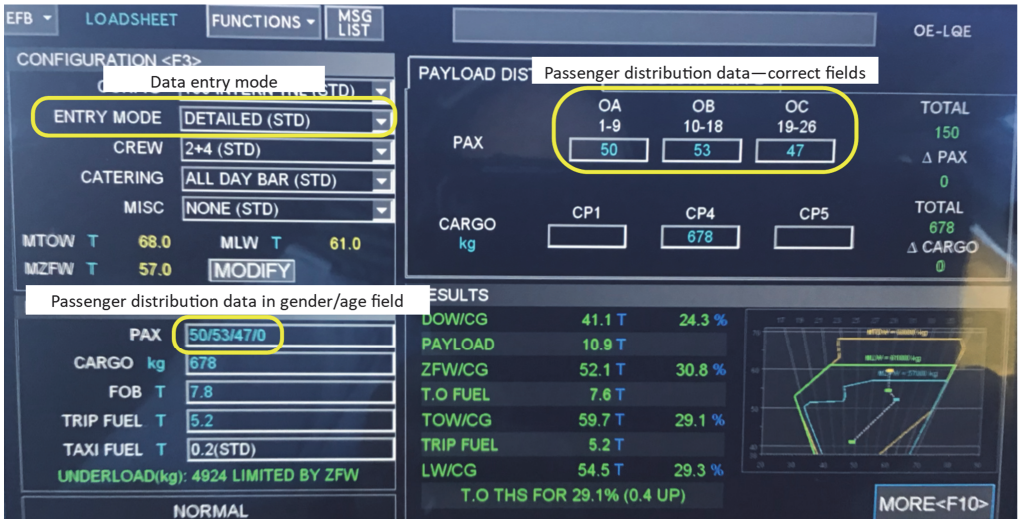

Figure 2

Software screenshot with passenger distribution data in gender/age data box

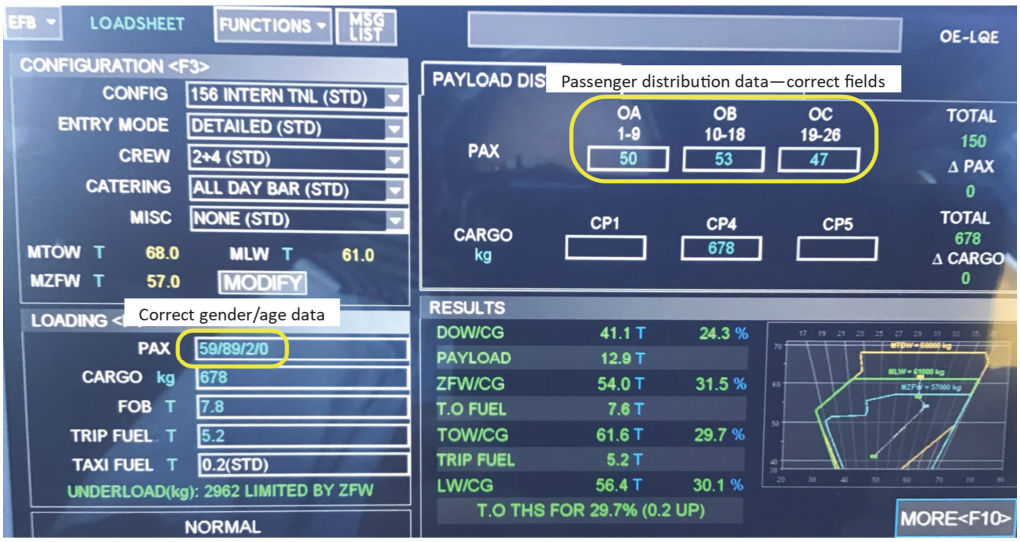

Figure 3

Software screenshot with correct gender/age data as per the LFC

Aircraft information

The Airbus A320 family of aircraft uses software to optimise takeoff parameters. Amongst other outputs, the software application calculates whether full-thrust is required for takeoff or whether it is possible to safely depart with a reduced setting. Reduced thrust departures are the norm for many commercial flights. The application uses an output parameter called the Flex Temperature (FT) to indicate to the pilots that a reduced thrust, 'Flex', takeoff is possible. The FT parameter is entered into the aircraft's flight management computer, which limits takeoff thrust when the thrust levers are advanced to the 'FLX/MCT' detent. Pilots can override the limit by pushing the thrust levers fully forwards to the Takeoff/Go-Around (TOGA) position, whereupon maximum engine thrust is commanded. The maximum allowable thrust reduction for a Flex takeoff is 25%.

Weight and balance

A loadsheet is the commander's legal proof that the aircraft has been loaded correctly. The document must demonstrate that the aircraft will remain within the prescribed CG and weight limits throughout the proposed flight. The application uses known aircraft parameters and variable load data, such as passenger and baggage quantities, when generating a loadsheet. Rather than requiring each passenger and bag to be individually weighed, regulations allow for the use of assumed weights for males, females, children, adults and checked baggage. The application uses these standard weights to calculate the aircraft's payload. If the passenger gender/age profile inputs are incorrect, the loadsheet outputs will be wrong. This is not an error that would be detected by routine flight data monitoring processes.

The Company's investigation noted that the design of the LFC and software application may have contributed to the initial data-entry error. Their report stated:

> *'Inspection of the LFC and EFB formats used for the W&B Data Insertion revealed that the layouts and labelling are not comparable, and do not, therefore support the user in this* [data entry] *task…'*

The crew commented that once they had entered Reduced mode to input LMC data, the passenger gender/age profile information was no longer visible (Figure 4). The commander considered that this was not helpful when trying to find the reason for the ZFW anomaly.

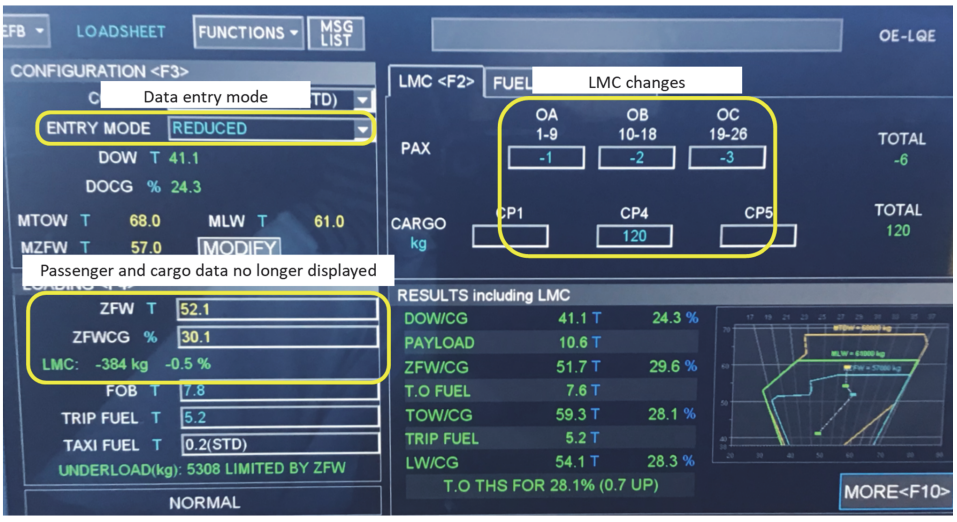

Figure 4

Loadsheet app in Reduced mode

Aircraft performance

The takeoff performance application takes loadsheet AUW and CG data and calculates the optimum takeoff speeds and thrust setting for the runway in use and the reported weather conditions. Correctly calculated takeoff parameters play an important role in the safety assurance for normal and rejected takeoff situations, as well as for safe obstacle clearance

on departure and acceptable one-engine inoperative performance. If the pilot-entered data is in error, the takeoff performance optimisation process will produce an invalid output, potentially impacting safety.

Human factors

The AAIB Formal report[1] into a serious incident, where a Boeing 737 (C-FWGH) took off with excessively reduced thrust, contains relevant lessons which can be read across to this event. Specifically, at Appendix B to the Report[2], a Human Factors expert discussed the challenges of cross-checking data entry in electronic systems and detecting abnormal aircraft acceleration.

Regarding identifying data entry errors in electronic systems, the report stated:

> *'The system feedback in relation to the error was quite opaque. Once the FMC page was changed the input was not visible…Once the initial error was made, failure to notice it was predictable and within normal human performance…'*

The parallels with this investigation are that the initial error was incorrect data entry and that, in Reduced mode, the application removed the erroneous data from view.

The pilots' stated intention was to select TOGA thrust if they perceived any performance-related problems during the departure. In the C-FWGH incident, takeoff thrust was inadvertently reduced to 60% of the maximum available, but the report concluded that even at such a low level of thrust the pilots could not be expected to reliably detect the resultant, abnormally low acceleration:

> *'Pilots experience different accelerations on almost every flight due to different runway lengths, loadings and weather, and so do not become accustomed to perceiving a single specific acceleration…it can be confidently concluded that direct vestibular and/or visual acceleration cues would not have alerted a crew to the abnormally low acceleration…'*

The C-FWGH report contained four Safety Recommendations, two of which were aimed at promoting the development of aircraft Takeoff Acceleration Monitoring Systems (TAMS). The intent was that TAMS would automatically detect and alert pilots to abnormally low aircraft acceleration during takeoff.

Organisational information

The Airline's Standard Operating Procedure (SOP) is to use a single EFB to generate the loadsheet. PF and PM transpose calculated loadsheet data into their individual EFBs and

Footnote

1 https://www.gov.uk/aaib-reports/aircraft-accident-report-aar-2-2018-c-fwgh-21july-2017 accessed 11 February 2019.

2 AAIB-commissioned report by Dr Steve Jarvis, "*Human Factors Report for serious incident to Boeing 737-86J, C-FWGH, Belfast, 21st July 2017*".

independently calculate takeoff performance before cross-checking their outputs. The AAIB is aware of at least three different operators who mandate independent calculation of loadsheet as well as takeoff performance data. Independent calculations can be a barrier against incorrect data entry leading to undetected errors but can add to pilot workload.

The Airline had planned an upgrade to their EFB systems in 2019. As part of that project they intended to conduct a thorough review of EFB SOPs and to investigate the potential for automatic data transfer from ground-based load control systems. Recommendations arising from related incidents and outcomes from the Company's participation in a UK CAA-led industry workshop review of EFB SOPs would help inform the process.

Analysis

This serious incident resulted from the error of inputting incorrect data into three fields on the loadsheet application. Once the mistake had been made, human performance limitations reduced the likelihood that the slip would be detected. The crew noticed a ZFW anomaly, but despite looking for an error they could not find one. The lack of commonality between LFC and EFB formats was considered by the operator to be an exacerbating factor, as was the lack of gender/age profile information in the loadsheet application's Reduced mode.

The undetected error led to the departure being flown with incorrect takeoff performance parameters. The crew's decision to use TOGA thrust if they had any performance concerns during takeoff might not have been a reliable risk control because the C-FWGH incident showed that pilots are unlikely to perceive when extra thrust is required.

The C-FWGH report highlighted the challenges of finding data entry errors and the limited ability of pilots to detect abnormally low aircraft acceleration. Procedural barriers, such as parallel EFB calculations, attempt to reduce the likelihood that these types of error occur. Technical barriers to capture the errors once made are still in their infancy.

Conclusion

A data entry error led to an aircraft taking off using incorrect takeoff parameters. The crew noted an anomaly but could not detect an associated error. They continued with a reduced thrust takeoff, agreeing to use TOGA thrust if they had concerns about aircraft performance during the takeoff. Experience has shown, however, that pilots often do not notice the low acceleration associated with insufficient takeoff thrust.