

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A321-251NX, G-UZMI
No & Type of Engines:	2 CFM International SA LEAP-1A32 turbofan engines
Year of Manufacture:	2020 (Serial no: 9422)
Date & Time (UTC):	3 January 2021 at 1450 hrs
Location:	Bristol Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 7 Passengers - 58
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	40 years
Commander's Flying Experience:	9,271 hours (of which 9,082 were on type) Last 90 days - 50 hours Last 28 days - 33 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and information from the operator

Synopsis

During the boarding process, the crew recognised that the passenger distribution was incorrect for their aircraft type. The commander subsequently filed a safety report that initiated an investigation by the operator. It was found that the previous sector might have been flown with the aircraft CG out of operating limits, and issues were identified with data transfer between the aircraft management and departure control systems.

Although it was subsequently found that the aircraft had not flown outside certified limits, the operator implemented safety actions to strengthen its procedures and prevent recurrence.

History of the flight*Bristol to Edinburgh sector*

At approximately 1450 hrs on 3 January 2021, the aircraft was on stand at Bristol Airport being prepared for a sector to Edinburgh. The aircraft originally allocated, an Airbus A320, had been replaced with an A321-NEO due to a technical issue. The aircraft commander and co-pilot originally rostered to fly were not qualified on the A321-NEO, so a crew qualified on type was called from standby and assumed responsibility for the operation.

The commander started the boarding process and prepared the aircraft for departure. The Turnaround Coordinator (TCO) handed the Loading Form and Certificate (LFC)¹, which included Last Minute Changes (LMCs), to the Cabin Manager (CM) who passed it to the flight crew. The co-pilot entered the load figures into the Electronic Flight Bag (EFB) load sheet application and noted that the load computation indicated that the CG was towards the forward limit of the operating envelope, but within computed operational limits. The flight to Edinburgh continued as normal.

Edinburgh to Bristol sector

At approximately 1650 hrs, during the boarding process at Edinburgh, the aircraft CM received the LFC from the TCO and passed it to the flight crew. The CM commented to the commander that the passengers were not seated as indicated by the LFC, so the commander requested a manual zone count of the passengers. It was found that the passenger distribution on the LFC was not correct and appeared to be based on row boundaries for seating zones on the A320 and not the A321-NEO. The flight crew entered the figures from the manual count into the EFB and found that the CG was forward of the permitted operating envelope. The commander instructed the CM to move passengers to the correct seating positions to resolve the issue, ensuring the aircraft operated within the allowable CG envelope for departure. The LFC was annotated with the new data. The commander left the flight deck and spoke with the TCO to discuss the issue. They agreed there appeared to be an IT system issue following the aircraft change such that the original LFC did not reflect the correct seating zone adjustments for the A321-NEO. With the issue identified and apparently resolved, the sector to Bristol, and subsequent two sectors, were flown without incident. On return to base, the commander filed an air safety report on the loading issue experienced at Edinburgh.

Investigation by operator

Initial analysis

Following receipt of the commander's air safety report the operator conducted an investigation and found that, unknown to the crew, the sector from Bristol to Edinburgh had been flown outside of the operational CG envelope² (Figure 1). It was concluded that following the change of aircraft type on the day of operation, the aircraft type and registration had been updated on the aircraft management system, but that change had not been identified by the departure control system responsible for generating the information recorded on the LFCs. When the TCO arrived for duty, he was advised by the operations centre that the flight had been changed from an A320 to an A321-NEO. He prepared the LFC with the correct type and registration details. On arrival at the gate, he extracted the load details from the departure control system to complete the

Footnote

¹ The Loading Form and Certificate shows the breakdown and distribution of the passengers, baggage, and freight on the aircraft. This allows the flight crew to calculate accurate performance figures and to ensure the aircraft is operating within centre of gravity limitations.

² The 'certified flight envelope' is mandated in the Original Equipment Manufacturer's Aircraft Flight Manual. However, this is further restricted by the operator to account for operational variations and errors such as fuel density, moving aircraft parts, dry operating weight, cabin movement, cabin distribution and baggage distribution. The result is the 'operational envelope'.

LFC but, unknown to him, the type change had not registered. Consequently, the flight was closed with the passenger distribution reflecting the seating configuration for an A320 and not an A321-NEO.



Figure 1

EFB CG data produced in the operator's investigation using correct A321-NEO seating configuration for the Bristol to Edinburgh sector (reproduced with permission)

For the sector from Edinburgh, it was found that the ground handling agent had noted that an aircraft type change had been recorded in the aircraft management system. However, the TCO was directed to deal with an aircraft returning to another stand with a technical issue so did not review the departure control system. Rather, at the point of close-out of the flight, the load details were passed over the radio by the gate staff to the TCO to complete the LFC. While this was in accordance with procedures, the opportunity to detect the information in the system being in error was reduced. The investigation commented that:

'This clearly contributed to why the issue was not already noticed. Trust was put in the fact that there was no reason to think the departure control system would not update the bays in line with the type change.'

Comments from aircraft manufacturer

The operator reviewed the Flight Data Monitoring information for the relevant sector and found that no certified aircraft limitations had been exceeded and that there was no impact on the controllability of the aircraft. However, as the investigation continued, the aircraft was grounded pending a review of the incident by the manufacturer. Following their analysis of

the Flight Data Recorder, Post-Flight Report and load sheets, the manufacturer concluded that the flight was conducted within certified limits and that the aircraft could be returned to service.

Further investigation by the operator

Further investigation by the operator revealed that the discrepancy in information displayed between the aircraft management system and the departure control system was due to code errors in the Batch Interaction Layer (BIL) operating outside of the original design specification. The BIL provides the channel for data transfer between elements that make up the system. An internal validation process runs in the background, comparing the aircraft management system to the departure control system to identify and update any changes. This process runs every five minutes. However, due to the Covid-19 environment, there had been a high number of changes to the operator's schedule and the validation process was taking longer than normal to run. Therefore, changes made outside the five-minute window were not detected automatically by the system.

The operator's procedures allowed manual updates to the departure control system to be made after the change of aircraft type had registered in the aircraft management system. Investigation revealed that in this case the aircraft type had been changed manually, but this change occurred after passengers had started the boarding process at Bristol. It was determined that the process did not consider this scenario and consequently the system had no mechanism to prevent the change of type being manually updated when boarding of the aircraft had started. Additionally, the system did not provide an alert to either the gate staff or the TCO. The aircraft registration data in the departure control system is not directly linked to the aircraft type data such that they can be changed separately. A type change registered in the system would prompt the seating algorithm to alter the bay figures, but the registration could match the previous aircraft causing confusion. The various elements of the IT system architecture do not 'talk' directly to each other but operate through a variety of interfaces such as the BIL, which makes errors and inaccuracies more likely.

The investigation concluded that:

'The manual update within the [departure control system] from an A320 to an A321 triggered a seating algorithm to run which changed some seat allocations and in turn adjusted the passenger bay split information to match the new seating allocation and the bay split for an A321. There were no gate alerts for seating changes as those with seat changes had already been processed and so the passengers sat in their original seats. The dispatcher then unknowingly obtains these inaccurate figures from the system to populate the loading form which is passed to the pilots to complete their calculations.'

Operator's Covid-19 aircraft biosecurity measures

The operator's Covid-19 biosecurity measures required the TCO to pass the LFC to the CM and not directly to the flight crew as had been the procedure before the measures were implemented.

Discussion

This serious incident was caused by a combination of operating factors in a complex system interacting in a manner which had neither been designed nor predicted. If passenger and cargo distribution on an aircraft leads to an undetected out of trim condition, the potential outcome could be unexpected handling qualities or control limitations.

The final weight and balance calculation is completed by the operating crew based on the loading data presented to them by ground personnel. If that information is incorrect, unless further evidence is available to indicate an anomaly, this final safety barrier is compromised as was the case at Bristol Airport.

Prior to the Covid-19 pandemic, the TCO would hand the LFC to the flight crew, providing an opportunity for them to query any LMCs directly. However, the operator's biosecurity measures required interactions with the flight deck to be minimised, so the LFC was delivered to the CM in the cabin. As the TCO was not on the flight deck, the crew were more likely to accept changes presented to them without discussion and complete their tasks as defined in their SOPs. However, as the CM checked the LFC before handing it to the commander at Edinburgh, the error was identified and trapped. This resulted in the commander filing the safety report which triggered the operator's investigation, which ultimately led to the cause of the error being detected.

Safety action

In response to this serious incident, the following safety action was taken:

The operator:

- Introduced a procedure where an aircraft is changed, requiring the Network Control team in the Integrated Control Centre (ICC) to conduct a manual check between the IT systems used for planning and loading to ensure the correct aircraft type and registration are displayed in all systems.
- Introduced a requirement for the Chief Pilot, in coordination with the ICC, to notify the duty pilot of any aircraft type changes. The duty pilot will discuss the potential risk with the operating crew.
- Requires a manual bay count to be completed before departure for every flight to ensure the weight and balance calculations are accurate.
- Published a poster to all stations to highlight the requirements for data checks following an aircraft change to ensure that information extracted from the system is correct.
- Initiated a further investigation into their IT systems to determine how operational changes are managed and communicated between the relevant parts of the system in order for a permanent solution to be established.