SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A340-642, G-VYOU
No & Type of Engines:	4 Rolls-Royce RB211 Trent 556A2-61 turbofan engines
Year of Manufacture:	2006
Date & Time (UTC):	12 December 2009 at 1657 hrs
Location:	London Heathrow Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 16 Passengers - 282
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	16,432 hours (of which 10,833 hours were on type) Last 90 days - 164 hours Last 28 days - 38 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

During pre-flight preparations, the estimated landing weight was used to calculate takeoff performance rather than the takeoff weight. The error was not detected and the aircraft took off using values for V_R and V_2 that were significantly lower than those required for the actual takeoff weight. The aircraft was slow to rotate and initial climb performance was degraded but the aircraft continued to destination without further incident.

Background information

The operator used a system whereby the aircraft's takeoff performance would be calculated off-aircraft. The relevant data would be entered into the Multi-function Control and Display Unit (MCDU) on board and a Takeoff Data Calculation (TODC) request would be sent via the Aircraft Communications Addressing and Reporting System (ACARS) to a central computer. The TODC receipt provided performance data that would be entered into the MCDU as part of the pre-flight initialisation of the Flight Management and Guidance System (FMGS).

History of the flight

During pre-flight preparations, there was a late change to the zero fuel weight (ZFW) and the crew requested a new flight plan. Subsequently, the loadsheet and performance procedures were conducted out of the

normal sequence. On receipt of the loadsheet, the crew used the expected landing weight of 236.0 tonnes in the TODC request instead of the actual takeoff weight of 322.5 tonnes. The error was not detected and the aircraft took off using a V_R of 143 kt and a V_2 of 151 kt instead of the correct values of 157 kt and 167 kt respectively. In addition, the thrust used during takeoff was reduced too much from full thrust and a '*FLEX*'[1] temperature of 74° was used instead of the correct value of 63°. Although the crew discussed the unusually high *FLEX* temperature, it did not prompt the pilots to check the TODC. Correct figures for ZFW and fuel on board were entered into the FMGS and so the aircraft-calculated gross weight was correct.

During the takeoff roll, the PF noticed that the acceleration was slightly lower than it should have been but did not consider it particularly abnormal. He described the rotation as "slightly sluggish and nose heavy" and noticed that after rotation the aircraft settled at a speed below V_{LS}[2], which prompted him to reduce the aircraft pitch attitude in order to accelerate. He also noted that the rate of climb was low at between 500 and 600 fpm. The flaps were retracted on schedule and the aircraft continued its climb. At no time was full takeoff thrust selected. Later in the climb, the crew looked again at the TODC and realised their error.

Standard Operating Procedures (SOPs)

The operator's SOPs required crews to calculate an estimated takeoff weight based on the final ZFW. The estimated takeoff weight would be used to make an initial TODC request but no data from this TODC would be entered into the FMGS. When the final loadsheet was received, the actual takeoff weight would be verified against the estimated value used for the TODC and, if the difference between the two takeoff weights was within prescribed limits, the TODC data would be deemed to be valid and would be entered into the FMGS.

The SOPs required the loadsheet procedures to be led by the commander and checked by the co-pilot, and the TODC procedures to be led by the co-pilot and checked by the commander. Nine independent crosschecks were built in to the procedures including a requirement for the actual takeoff weight to be written on the TODC printout alongside the takeoff weight used for the calculation to provide a gross error check.

The operator's assessment of the cause

The operator believed that time pressure on the crew was likely to have contributed to the events in this incident. The late change of ZFW disrupted the usual loadsheet and performance procedures, which were conducted out of sequence. Because of the late change, the crew decided not to calculate an estimated takeoff weight for an initial TODC request, preferring to wait for the loadsheet to use the actual value. The landing weight entered in the takeoff weight field of the TODC request would have been acceptable as a takeoff weight on the Airbus A340-300, which the crew also flew. The operator considered that this might have been why the crew was not alerted to the error. Because no TODC was requested using an estimated takeoff weight, no gross error check could be made against the loadsheet takeoff weight. Finally, the crosschecks that were conducted by the crew were ineffective.

Footnote

[1] *'FLEX'* (flexible thrust) is a term that refers to the reduced thrust that can be used during takeoff which still allows the aircraft to meet its takeoff performance requirements. A higher *FLEX* temperature corresponds to a greater reduction from full thrust.

[2] V_{LS} represents the lowest selectable speed providing an appropriate margin above the stall speed.

Airbus Green Dot crosscheck

Some operators, although not the operator in this report, use Airbus' '*Less Paper Cockpit (LPC)'* concept, which uses an Electronic Flight Bag (EFB) to compute takeoff performance. The EFB output includes a value for Green Dot speed, which is the speed giving the best lift-to-drag ratio in the clean configuration. Amongst other uses, Green Dot speed is used as the engine-out operating speed in the clean configuration. The FMGS also calculates Green Dot speed from the ZFW, the position of the centre of gravity at the ZFW, and the sector block fuel, which are entered separately into the FMGS by the crew.

One calculation is based on the takeoff weight entered into the EFB and the other is based on the ZFW entered separately into the FMGS. A discrepancy between the two values for Green Dot speed would indicate a data entry error and would provide a trigger for the crew to check all the data.

Action taken subsequently by the airline

As a result of this incident, the airline reiterated to its crews the correct procedure for entering data into the TODC page on the MCDU and the importance of the independent crosscheck. A review was initiated to consider the adequacy of current TODC and loadsheet procedures.

The TODC format was altered to print a warning should a weight less than the maximum landing weight be entered in the takeoff weight field of the TODC request. It was recognised that this would not capture an error where a takeoff weight was entered that was lower than the actual takeoff weight but above the maximum landing weight. Consequently, the effectiveness of this change was to be monitored and the trigger level increased above maximum landing weight if possible to reduce the magnitude of error that would pass this check. The operator considered that incorporating a Green Dot gross error check into their SOPs would provide a significant enhancement to their procedures. At the time of writing, the operator was awaiting a response from Airbus as to how this could be accomplished.

Previous incidents of a similar nature

The AAIB investigated an incident to Boeing 767, G-OOAN, where the ZFW was inadvertently used instead of the takeoff weight in a computer-based takeoff performance calculation. In 2008, the BEA[3] issued a report, '*Use of Erroneous Parameters at Takeoff'*, which concluded that errors relating to takeoff data are frequent, and time pressure and interruptions contribute to the errors. The AAIB also investigated a serious incident to Airbus A330, G-OJMC, which took off with incorrect takeoff speeds programmed into the FMGS. The report referred to a number of other performance-related incidents and noted that in many of them the crew perceived the abnormal acceleration and took action. However, it also noted that there was no independent check of the performance data once it had been entered into the aircraft's flight management system. The report made two recommendations, which are reproduced below.

Safety Recommendation 2009-080.

It is recommended that the European Aviation Safety Agency develop a specification for an aircraft takeoff monitoring system which provides a timely alert to flight crews when achieved takeoff performance is inadequate for given aircraft configurations and airfield conditions.

Foonote

[3] Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile, the French equivalent of the AAIB.

Safety Recommendation 2009-081.

It is recommended that the European Aviation Safety Agency establish a requirement for transport category aircraft to be equipped with a takeoff performance monitoring system which provides a timely alert to flight crews when achieved takeoff performance is inadequate for given aircraft configurations and airfield conditions.

Analysis

The loadsheet and TODC SOPs developed by the airline were robust and contained numerous crosschecks to ensure takeoff performance data was calculated correctly. Despite this, the crew used incorrect information to calculate takeoff performance and, even though the pilots noticed the high *FLEX* temperature, it did not prompt them to investigate whether they had made an error.

Adding more crosschecks to the SOPs would probably complicate the procedures with no guarantee that a recurrence of a similar event would be prevented. The pre-departure phase of a flight is a dynamic environment where time pressure and interruptions can create conditions where diligent crews can perform robust procedures incorrectly. This highlights the need for an independent check of takeoff performance and this report endorses the recommendations made in the report into the serious incident to G-OJMC.

At the time of writing, the AAIB had not received a detailed response from the EASA regarding the recommendations but their nature is such that it will probably be a considerable time before a solution is operational. In the meantime, the Green Dot gross error check should provide a way to highlight that an error has been made in time for it to be investigated before departure.