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ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2009-011
Final

Weight and balance event, VH-QPJ
Sydney Aerodrome, New South Wales
6 March 2009

Abstract

On 6 March 2009, an Airbus A330-303 aircraft, registered VH-QPJ, was being loaded for dispatch on a scheduled international passenger service between Sydney, New South Wales and Hong Kong. Operational changes prior to the aircraft's dispatch required an adjustment of the planned load, with the load controller electing to offload a pallet of freight originally scheduled for that flight, and substituting it with a lighter pallet in the load management system.

Following the pallet substitution in that system, the load controller did not amend the loading instructions that had been previously issued to the ramp staff loading the aircraft. That resulted in the ramp staff being unaware of the changed loading requirement and the loading proceeded as initially planned.

The discrepancy between the actual aircraft load and operator's load management system was not detected during the completion of the load controller's 'Final Distribution Check' prior to issuing the final load sheet to the flight crew. That resulted in the aircraft exceeding the structural maximum taxi weight by 384 kg and the maximum structural take-off weight by about 884 kg. It also resulted in the flight crew entering inaccurate centre of gravity and zero fuel weight data into a number of the aircraft's systems.

Due to a delay in the notification of the loading error to the operator's relevant departments, the aircraft operated another 10 sectors before maintenance inspections for an overweight taxi were completed.

As a result of this occurrence, the operator implemented several changes to the process for managing load control activities. Those changes included: implementing a procedure to ensure the immediate notification of loading-related incidents and changes to the operating procedures in load control, including the introduction of a read and sign process for important ramp and load control communications; the appointment of a load control standards officer; and the conduct of a training needs analysis for load control officers.

FACTUAL INFORMATION

Flight preparation and dispatch

On 6 March 2009, an Airbus A330-303 (A330) aircraft, registered VH-QPJ (QPJ), was being loaded for dispatch on a scheduled international passenger service between Sydney, New South Wales and Hong Kong. Load planning for the flight was performed by a load controller, using a computerised and proprietary 'Flight Management' (FM) system[1]. About 1 hour and 20 minutes prior to the aircraft's scheduled departure time, the FM system indicated an uplift of additional fuel in response to operational requirements and that consequently, if all of the predicted freight/cargo was loaded, the flight would exceed the aircraft's maximum structural take-off weight[2] and

1 FM. An automated load control system that interfaced with a number of the operator's other systems during the processing of weight and balance activities.

2 233,000 kg.

maximum taxi weight (MTW)[3]. A timeline of relevant loading events is at Appendix A.

To ensure that the aircraft's weight did not exceed those limits, the load controller liaised with the operator's relevant department and identified a number of pallets for possible removal. A number of different combinations were evaluated to achieve the optimum aircraft loading.

During that period, the load controller used the FM system to check that the pallets and containers would 'lock down'[4] in their assigned position in the aircraft's cargo hold. There was no FM system software functionality to check that lock down, without selecting 'Approve Distribution' for the load sheet. That approval highlighted any pallets or containers that would not lock down in their assigned position, and also enabled the automatic (pre-scheduled) distribution of the Graphical Load Instruction Report (GLR).

The GLR was produced by the FM Event Scheduler, and was issued automatically 60 minutes prior to the aircraft's scheduled departure time. Automated distribution of the GLR included to a printer in load control and to a printer/fax that was used by ramp-loading staff. Any subsequent distribution of the GLR was initiated manually; such as when revisions were made to the aircraft's load, and necessitated the reissue of the report.

About 16 minutes after the automated dispatch of the GLR to the load control and ramp printers, the load controller finalised the selection of the pallet for offload, substituting it with a lighter pallet of freight and the FM system predicted that the take-off weight was 232,264 kg.

The load controller recalled that, at about that time, a colleague delivered the GLR to the controller's desk. The controller did not realise that the GLR referred to the aircraft's earlier loading configuration and that a revised version of the GLR had not been produced and issued to the ramp staff. When the load controller finalised the fuel uplift in the FM system, the event scheduler transmitted the provisional load sheet to the flight crew via the printer at the aircraft's departure gate.

To ensure that the aircraft was loaded in accordance with the GLR, the loading supervisor at the ramp was required to call the load controller and readback the as-loaded configuration for the aircraft. That readback included confirmation of the location of all of the pallets/containers in the hold and their weights. In turn, the load controller was required to verify the accuracy of the readback against the loading information in the FM system. The readbacks typically took the form of a series of partial readbacks as the loading of an aircraft progressed, and then a final readback once pallet/container loading was finalised, and any last minute items had been loaded.

On this occasion, the first partial readback included the pallet that should have been offloaded.

Following the final readback, the load controller completed the 'Final Distribution' check[5], but did not detect that there was a discrepancy between the information provided by the loading supervisor during the readback and the information contained in the FM system. The final load sheet was issued to the flight crew after the completion of the final distribution check, and delivered to the cockpit via a company datalink system.

Post-flight events

During unloading in Hong Kong, the (un)loading staff noticed that there was a discrepancy between the Offload Instruction Report (OIR) and one of the aircraft's pallets and noted that discrepancy on the OIR. The ramp-handling agent in Hong Kong was informed of the discrepancy via an OIR handover form, which was provided to the cargo terminal officer. Neither the loading supervisor nor the ramp-handling agent completed an 'Aircraft Irregular Load Report' (AILR) or reported the incident to the operator's airport manager as required by the operator's Ramp Services Manual.

The FM system indicated that the mis-loaded pallet was still in Sydney and needed to be transported to Hong Kong. Because the pallet

3 233,900 kg.

4 The process of securing the pallets and containers to the floor of the aircraft's hold, so that they do not move during flight.

5 Completed after the load controller receives the final ramp clearance, indicating that loading on the aircraft is complete.

could not be located, checks were initiated and it was established that the pallet had travelled to Hong Kong the previous day.

In response to the loading anomaly, a supervisor in the Regionalised Load Control (RLC) - Sydney office provided an email notification to the RLC manager advising of the incident, and notified the shift supervisor of the load controller's next shift that the load controller would need to fill out a report. The load control supervisor made copies of the relevant documents and placed them on the manager's desk. An internal load control investigation was commenced by the operator on 9 March 2009.

The operator's safety department became aware of the incident on 12 March 2009 and notified the operator's engineering department to facilitate any aircraft inspections/checks before further flight (see subsequent discussion titled *Inspection requirements*).

Load control submitted an AILR on 16 March 2009.

Load controller information

The load controller had been performing load control functions with the company for 14 years and was approved by the Civil Aviation Safety Authority to carry out duties involved in the control and supervision of aircraft loading for the operator's aircraft types, including the A330. The load controller was approved to use the FM system for loading activities, and completed certification training on that system in April 2007. That certification was valid for 3 years.

The load controller's shift commenced at about 1200, 3 hours prior to the aircraft's scheduled departure. During that shift, the controller was scheduled to perform load control functions for 11 flights, of which QPJ was the third flight for dispatch. Consequently, a number of competing tasks impacted on the controller's attention during the period leading up to the aircraft's departure.

In an effort to reduce the load controller's workload, a load control supervisor took over the dispatch of the controller's second scheduled flight, when the application of a Minimum Equipment List[6] item necessitated late-notice load sheet changes. The supervisor also assisted the load controller to reposition the freight for QPJ's departure to Hong Kong.

The load controller recalled being well-rested prior to commencing duty.

Aircraft information

Loading in excess of the load sheet total weight

The carriage of a heavier pallet than indicated in the FM system resulted in an additional 1,620 kg of freight being carried. The effect was that the aircraft exceeded its maximum take-off weight (MTOW)[7] by 884 kg and its MTW by 384 kg. In addition, the accuracy of the load sheet centre of gravity (c.g) information was adversely affected.

Inspection requirements

The operator's records indicated that the MTW was exceeded by less than 0.2%. The aircraft manufacturer required an overweight taxiing maintenance inspection if the aircraft was taxied at a weight exceeding between 2% and 4% of the MTW (4,678 to 9,356 kg), or if the MTW was exceeded and the taxi involved any high speed turns, sharp radius turns, heavy braking, taxiing over rough pavement, sharp turns with brake, or movement with deflated tyres.

There was no requirement for a maintenance inspection for exceeding the maximum structural take-off weight.

No damage was detected during the overweight taxi checks and the aircraft was returned to service.

Organisational and management information

Readback and final load distribution checks

The operator's Weight and Balance Manual specified the procedures to be followed during

6 An approved document that contains the conditions under which a specified aircraft may operate with particular items of equipment inoperative at the time of dispatch.

7 For this flight, the MTOW was not performance-limited and was the aircraft's maximum structural take-off weight.

aircraft loading. That included the procedure for completing the ramp readback, and the requirement for the load controller to record the details of any progressive ramp readbacks on their copy of the GLR.

The Weight and Balance Manual was supplemented by a number of procedures in the Aircraft Loading Manual and the Ramp Services Manual.

The final FM load distribution check included the verification by the load controller of the information received during the ramp readback(s), and that it was consistent with the information contained in the FM system. That verification was required to be completed for all positions before the final load sheet was sent to the aircraft.

Reporting requirements

The operator stipulated various reporting requirements in the case of loading incidents. In particular, the operator's Weight and Balance Manual specified the policy for safety reporting. That placed reporting responsibility with load control officers for occurrences and breakdowns in procedure that may contribute, or had contributed to the unsafe operation of an aircraft, and nominated the AILR and Safety Observation Report for submitting occurrence notifications.

The operator's Ramp Services Manual included standard operating procedures for application by ramp personnel and stipulated that the (un)loading supervisor was responsible for ensuring that an AILR was completed in relation to any unloading irregularities.

The operator's Airport Safety Management System (ASMS) included a document that defined the AILR and incident review process. A workflow in the ASMS indicated that, among other relevant tasks, an arriving port incident notification would be submitted to the operator's safety department.

The ASMS also included the operator's requirements for the immediate reporting of major aircraft irregular load occurrences and for an immediate call-out procedure. That included in the case of an aircraft departure that exceeded any structural or operational weight and/or a load sheet weight discrepancy greater than the allowable last-minute changes for that aircraft type.[8]

Although a number of loading personnel were aware that the aircraft had exceeded a structural limit, they assumed that an AILR notification would have been submitted by the receiving port.

Regional load control – audit activities

The operator's Weight and Balance Manual included the requirement for the regular audit and review of the operation of each RLC. RLC self-audits were required once every 3 months, and quality assurance reviews were to be carried out by senior management personnel[9] every 6 months. Quality assurance reviews were more comprehensive, and included the:

- review of at least two flight departure files from each port that was handled by the RLC, and by a variety of load control officers
- review of those flights' readback recordings
- observation of the loading activities in support of at least two flights.

An examination of the operator's records showed the conduct of Sydney RLC self-audits at the required intervals. No quality assurance review was recorded for Sydney RLC since May 2007.

The operator reported that a compliance audit of the Sydney RLC was conducted by the Airports Division in February 2008, which included a review of the RLC's flight files.

Additional information

Flight operations

The load sheet listed the aircraft's zero fuel weight (ZFW) and c.g position, which was entered into the multipurpose control and display unit (MCDU) by the flight crew. The entry of an incorrect ZFW adversely affected the accuracy of data presented

8 For the A330-300 series, the weight limit for last-minute changes was 730 kg.

9 Quality assurance reviews were to be carried out by the System Delivery Manager Weight and Balance, Quality Assurance Manager Weight and Balance or their delegates.

by, derived from and relied upon by several of the aircraft's systems. Those included:

- the system display of the aircraft's gross weight (GW) and c.g
- the flight management system predictions and speeds
- slight effects to the flight guidance system and to the flight control primary computer (PRIM) control laws
- the calculation of the aircraft's wings-level, 1 g[10] stall speed (VS1g) that was used by the PRIM
- the accuracy of characteristic speeds[11] that were displayed to the crew on their primary flight displays
- the automatic regulation during flight by the fuel control and monitoring computer (FCMC) of the aircraft's optimum c.g by transferring fuel between tanks.

During flight, the flight envelope computer (FE) computes a backup GW with aerodynamic data or from fuel-used data, a backup c.g with aerodynamic data and the position of the trimmable horizontal stabiliser. In the event that the FCMC and FE-computed centres of gravity differed by more than a specified threshold, the PRIM used 30% c.g for flight control laws. The FE-computed c.g triggered warnings to the crew of excessive aft c.g, and was independent of the FCMC.

The other critical speeds to the safe operation of the aircraft and to the operation of the aircraft's automatic flight envelope protection systems were derived from aerodynamic data and as such, would not have been affected by the entry of an inaccurate ZFW.

The load sheet also provided the crew with the 'stabiliser trim' setting for takeoff. The correct setting of the stabiliser trim provided for consistent rotation characteristics during takeoff and for a trimmed[12] aircraft at the initial climb speed of V_2 + 10 kts.

The load sheet that was provided to the crew indicated a take-off c.g of 28.3% of the aircraft's mean aerodynamic chord (MAC)[13] and a stabiliser trim setting of 3.4 'UP'. The investigation calculated that the actual c.g was about 26.8 % MAC and that the corresponding stabiliser trim setting was 4.1 UP.

The operator reported that the aircraft was operated below the relevant maximum take-off weight performance limit during the flight and that consequently, complied with the required take-off performance criteria. In addition, the operator calculated that the additional weight carried would have increased the total fuel burn for the flight by about 1,200 kg, and that that the aircraft's c.g remained within the manufacturer's approved limits for the duration of the flight.

Review of other occurrences

The Australian Transport Safety Bureau occurrence database was reviewed for load control incidents during the period 1 January 2008 to 2 August 2010. That review identified 28 incidents involving the operator's aircraft, 13 of which involved a discrepancy between the FM system-predicted and actual aircraft loading, with the last reported occurrence on 8 July 2010.

ANALYSIS

The final load sheet that was provided to the flight crew depicted the information contained in the Flight Management (FM) system, and indicated that the aircraft was loaded within the relevant limits. However, that load sheet did not correctly depict the actual aircraft loading, which exceeded the aircraft's published structural maximum taxi weight (MTW) and take-off weight (MTOW). In addition, the load sheet provided the crew with an incorrect take-off stabiliser trim setting.

10 1 g is the nominal value for vertical acceleration that is recorded when the aircraft is on the ground. In flight, vertical acceleration values are affected by any flight manoeuvring loads and turbulence.

11 Those speeds included the flap and slat retraction speeds (F and S, respectively), the minimum selectable speed (VLS) and the speed for the best lift drag ratio – known as the green dot (GD) speed.

12 A condition where the sum of all residual moments about an aircraft's c.g in hands-off flight is zero.

13 MAC describes the straight line joining the leading and trailing edges of an aerofoil section of an imaginary wing of constant section, having the same force vectors under all conditions as those of the actual wing.

Although on this occasion, the size of the discrepancy between the FM system-calculated and actual take-off weights was relatively minor, and did not affect the aircraft's compliance with relevant take-off performance criteria, a discrepancy between the FM system and actual aircraft loading had the potential to affect the safety of flight.

The aircraft exceeded its MTW/MTOW because of the discrepancy between the final data contained in the FM system and the Graphical Load Instruction Report (GLR) that had been used to load the aircraft. Although the load controller subsequently identified a pallet substitution that reduced the MTW/MTOW to within limits and affected that change in the FM system, the lack of an amended GLR meant that there was no mechanism for the load controller to communicate that intention to the ramp staff. The delivery of the automatically-distributed GLR at the load controller's workstation could have contributed to the load controller not identifying that the GLR had not been reissued.

The automatic distribution of the GLR occurred when the load controller selected the 'Approve Distribution' function to check that the pallets and containers would lock down. Approving the load sheet distribution while the FM system was predicting the aircraft would significantly exceed its MTW/MTOW increased the probability of the aircraft being loaded incorrectly.

The final FM load distribution check was ineffective because the load controller did not follow the operator's procedure as stipulated in the Weight and Balance Manual. Having already verified that the aircraft's loading was in accordance with the information contained in the GLR, the load controller may have been less vigilant when completing the final load distribution check, anticipating that the data from the GLR would match the information in the FM system.

The circumstances of this incident indicated a significant breakdown in the operator's internal reporting procedures, which impacted on the immediate notification of the exceedance of the aircraft's structural MTW and consequently, the assessment and conduct of any required maintenance inspections.

Although the (un)loading supervisor in Hong Kong detected there was a discrepancy between the aircraft's load and the Offload Instruction Report, they did not submit an Aircraft Irregular Load Report (AILR), as required by the Ramp Services Manual. The incorrect assumption by a number of load control staff that the receiving port would have submitted an AILR meant that, although load control staff were aware of the aircraft having exceeded its structural limits, no notification was provided to the operator's safety and maintenance departments. That precluded those departments from addressing any consequences from the overweight operation, and presented a risk to the ongoing airworthiness of the aircraft.

The lack of quality assurance reviews of the Regionalised Load Control centre at the stipulated periodicity denied the operator the opportunity to identify and rectify any discrepancies in the readback procedures and any departures from approved operating procedures. The investigation could not discount that, had those quality assurance reviews been carried out, this occurrence might have been avoided.

FINDINGS

Context

From the evidence available, the following findings are made with respect to the weight and balance event that occurred at Sydney Aerodrome, New South Wales on 6 March 2009 and involved Airbus A330-303 aircraft, registered VH-QPJ. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The load controller selected the 'Approve Distribution' flight management function before the load distribution for the flight was finalised.
- The load controller had not finalised the load distribution for the flight when the Flight Management Event Scheduler automatically issued a Graphical Load Instruction Report that predicted that the aircraft would significantly exceed its maximum taxi and take-off weights.
- The load controller did not reissue the Graphical Load Instruction Report on finalisation of the aircraft's load distribution.
- The load controller did not identify a discrepancy between the Graphical Load Instruction Report and the loading information

contained in the Flight Management system when completing the final distribution check.

Other safety factors

- The entry of incorrect weight and balance data into the aircraft's systems adversely affected the accuracy of the data and/or functions provided by those systems and had the potential to affect the safety of flight.
- A significant breakdown in the operator's internal reporting procedures contributed to the delayed notification of the maximum taxi weight exceedance, and in the assessment of the need for any checks/inspections before further flight to assure the aircraft's ongoing airworthiness.

Other key findings

- There had been no quality assurance review of the Regional Load Control centre in the 22 months preceding the incident.

SAFETY ACTION

Any safety issues identified during the conduct of an investigation are listed in the Findings and Safety Actions sections of the report. However, whereas an investigation may not identify any particular safety issues, relevant organisation(s) may proactively initiate safety action in order to further reduce their safety risk.

Aircraft operator

Although no safety issues were identified during this investigation, the following proactive safety action was taken by the aircraft operator in response to this occurrence:

- A 'read and sign' process was established for all important ramp and load control communications.
- A load control standards officer was appointed.
- An immediate load control notification procedure was implemented.
- A quote from the Flight Management software manufacturer was requested for the provision of additional functionality to enable load controllers to 'check locks'.
- An external consultancy was engaged by the operator to conduct a review of human factors issues related to load control and the use of the Flight Management software. That review identified eight high priority issues. Seven of those issues were categorised using the company's risk criteria by a combined operator/consultant team as 'low risk' and one was categorised as 'very low risk'. The issues were communicated to the software manufacturer and the operator implemented local procedures and training to mitigate the identified risks.
- A notice was distributed for 'read and sign' by load controllers that stipulated the correct use of the 'Approve Distribution' function.
- A training needs analysis was undertaken of the load control operator competencies.

Australian Transport Safety Bureau

In response to this and a number of other aircraft loading occurrences, the Australian Transport Safety Bureau (ATSB) conducted a research project to understand the safety risk associated with aircraft loading incidents, including with breakdowns in load sheet procedures. Research report AR-2010-044 *Aircraft loading occurrences July 2003 to June 2010* is available for download at www.atsb.gov.au

SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included the:

- operator of VH-QPJ (QPJ)
- load controller
- Civil Aviation Safety Authority (CASA).

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the aircraft operator, the load controller and CASA.

Submissions were received from the operator of QPJ. The submission was reviewed and, where considered appropriate, the text of the report was amended accordingly.

APPENDIX A: TIMELINE OF SIGNIFICANT EVENTS