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Inadvertent thrust lever asymmetry during the take-off roll involving an Airbus A320, VH-JQX

Sydney Airport, New South Wales | 6 February 2012

Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
AO-2012-022
Final

Australian Government

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ATSB TRANSPORT SAFETY REPORT

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SAFETY SUMMARY

What happened

On 6 February 2012, the flight crew of an Airbus A320-232, registered VH-JQX, commenced takeoff from runway 16R at Sydney Airport, New South Wales. The flight crew consisted of a training captain and a captain under training, who was occupying the left seat and conducting the duties of the captain.

During the takeoff, one of the thrust levers was inadvertently moved forward of the required detent, which resulted in a thrust setting reversion to manual mode. The training captain identified the issue and initially made the required standard calls to the captain under training to indicate the issue with the thrust lever.

The training captain then made a call to indicate that the takeoff should continue, with maximum thrust selected, and the captain under training began rotating the aircraft below the required rotation speed. At about that time the training captain increased the thrust levers to the maximum thrust setting. After noting the aircraft's airspeed was below the required rotation speed, the captain under training discontinued the rotation until a suitable airspeed was achieved prior to commencing the climb.

What the ATSB found

The ATSB found that the captain under training misunderstood the command from the training captain, which led to the early rotation. The training captain recognised the thrust lever asymmetry situation, however the captain under training did not, and this resulted in a miscommunication that was not resolved effectively between the crew.

In addition, the captain under training was transitioning from another aircraft type to the A320 and the manual thrust mode on the A320 was consistent with his experience of a normal takeoff on the previous aircraft type. This created a level of confusion for the captain under training and made it more difficult for him to recognise the thrust lever asymmetry situation. A situation where one thrust lever is in the detent and the other is not is indicated to the crew on the flight mode annunciator panel and is only displayed above 100 ft.

What has been done as a result

Jetstar have advised that they have incorporated a module into simulator training for all pilots covering incorrect thrust settings at takeoff. They have also released a communication to pilots on the responsibilities of the pilot in command during operational events.

Safety message

This incident highlights the importance of good flight crew communication to ensure a shared understanding of the aircraft's system status.

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Front cover photo: © Airbus
Figure 1: Airservices Australia

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes appropriate, or to raise general awareness of important safety information in the industry. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: the ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

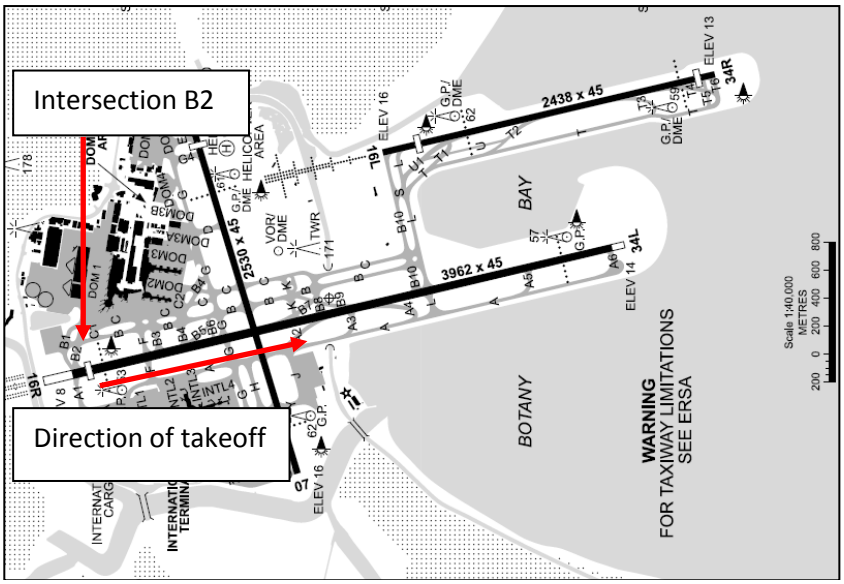
Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

FACTUAL INFORMATION

At about 0813 Eastern Daylight-saving Time[1] on 6 February 2012, the flight crew of an Airbus A320-232 (A320) aircraft, registered VH-JQX and operating as Jetstar Flight 745, commenced takeoff on runway 16R at Sydney Airport, New South Wales. The flight was a regular public transport flight from Sydney to Launceston, Tasmania. The flight crew consisted of a captain under training, who was the pilot flying (PF) and a training captain, who was pilot not flying (PNF).

The preparation for the takeoff was commenced while the aircraft was at the gate and was reported by the flight crew to be normal. The flight crew calculated the V speeds[2], with V_R calculated as 150 kts, which was the same as the V_1 speed of 150 kts, and the flex temperature[3] was calculated as 62^0. The aircraft was taxied to the intersection of taxiway Bravo 2 (B2) and runway 16R before positioning on runway 16R for takeoff (Figure 1).

Figure 1: Sydney airport



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1 Eastern Daylight-saving Time was Coordinated Universal Time (UTC) + 11 hours.

2 V speeds are used for takeoff as follows:

- V_1: the critical engine failure speed or decision speed. Engine failure below this speed shall result in a rejected takeoff; above this speed the take-off run should be continued.
- V_R: the speed at which the aircraft rotation is initiated by the pilot.
- V_2: the minimum speed at which a transport category aircraft complies with those handling criteria associated with climb, following an engine failure. It is the take-off safety speed and is normally obtained by factoring the minimum control (airborne) speed to provide a safe margin.

3 An assumed temperature or FLEX temperature for Airbus aircraft, used in the aircraft's FMGS to allow a reduced thrust takeoff, which reduces the amount of thrust the engines deliver, thereby reducing wear on the engines.

The PF advanced the thrust levers to the FLX/MCT detent, as the takeoff was being conducted as a reduced thrust takeoff and used a FLEX temperature to calculate the required thrust setting. After setting the thrust, the PF called 'MAN FLEX 62, SRS, runway, autothrust blue' from the flight mode annunciator (FMA), which indicated that autothrust was engaged in FLX mode, with a FLEX temperature of 62, SRS mode[4] was engaged, runway heading was set and autothrust was armed (Figure 2). This was a standard call from the PF at the commencement of the takeoff.

Figure 2: FMA display at takeoff with an example flex temperature entered

Information from the aircraft's quick access recorder (QAR) showed that just after the thrust was set, the right thrust lever was moved slightly forward of the MCT/FLX detent, by approximately 2°. This resulted in the aircraft reverting to manual thrust mode and the FMA displayed a change from 'MAN FLEX 62' to display 'MAN THR' (Figure 3).

Figure 3: FMA display at takeoff with manual thrust

The training captain, in scanning his FMA, saw the 'MAN THR' annunciation and stated 'man thrust'. The training captain continued his scan and noticed the right thrust lever sitting just forward of the detent, creating a thrust lever asymmetry.

At 80 kts, the training captain called 'man thrust, 80 kts, thrust not set', in order to indicate to the PF that there was a problem with the thrust. The expected call at 80 kts is 'thrust set'. The PF reported that he was assessing the situation during the takeoff and felt the aircraft was accelerating normally, with the thrust appropriately set. He reported being confused by the calls from the training captain as he kept reading the 'MAN THR' annunciation and felt this was correct, despite earlier calling 'MAN FLEX 62'.

The training captain reported he was waiting for the PF to issue a command to continue the flight, by calling 'go'. As he did not hear this command, he called for the PF to 'go' before briefly pausing and saying 'TOGA'[5] to indicate the PF should select maximum thrust, given the thrust lever asymmetry situation.

At this point, which was about 130 kts, the PF rotated the aircraft, after mistaking the 'Go...TOGA' call for 'rotate'. The PF reported that he thought he had missed the V_1 call, which immediately preceded the rotation call, and rotated before he

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[4] A managed vertical mode that is used during takeoff. The aircraft's flight directors use SRS to provide accurate pitch guidance information on the primary flight display.

[5] Takeoff – Go-Around thrust, which equates to maximum thrust.

realised that the aircraft was still 20 kts below the required rotation speed. Upon realising this, the PF slowed the rate of rotation of the aircraft to allow it to accelerate to the required rotation speed and avoid a tailstrike. The normal pitch attitude at takeoff is 11-13°, which is based on a normal rotation rate at the correct rotation speed for the aircraft's weight and configuration.

The training captain reported being surprised by the rotation and moved the thrust levers to the TO/GA position, as the PF had taken his hand off the thrust levers at V_1, in accordance with the standard operating procedure.

After accelerating to the required climb speed, the aircraft climbed normally and continued to Launceston without further incident.

Pilot information

Training Captain

The training captain held an Air Transport Pilot (Aeroplane) Licence (ATPL(A)) that was issued in 2003 and had accumulated a total aeronautical experience of about 9,343 flying hours, with about 4,957 hours on the A320. He held a valid Class 1 Medical Certificate.

Captain under training

The captain under training held an ATPL(A) that was issued in 1994 and had accumulated a total aeronautical experience of about 14,317 flying hours, with about 120 hours on the A320. He held a valid Class 1 Medical Certificate. Prior to transitioning to the A320, the captain under training had accumulated about 7000 hours flying the Boeing 767 (B767).

The captain under training was transitioning from the role of first officer on the B767 for an affiliated airline, to an A320 captain with the operator. He had obtained his A320 endorsement in October 2011 and was close to the completion of his line training, meaning he was about to be checked to line with no further training flights required. He was reported by the training captain to have been flying to a good standard and progressing well, with no obvious problems identified during his line training.

Additional information

Previous experience

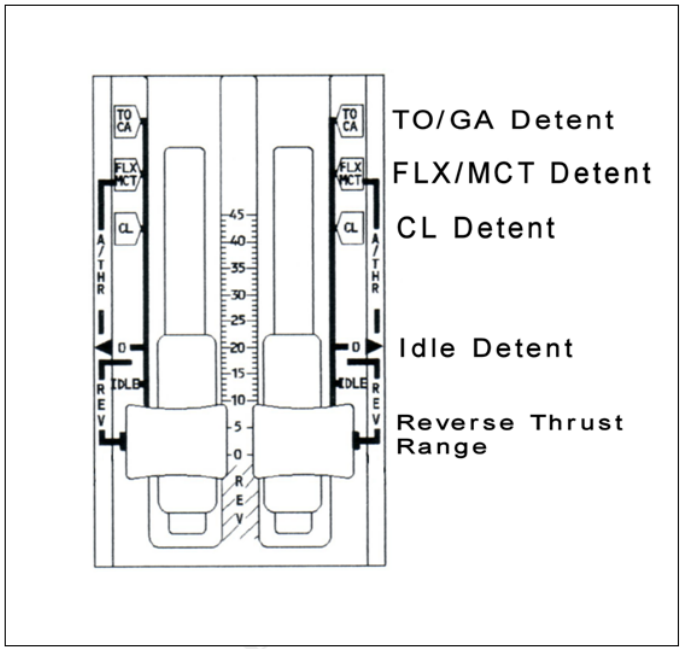
The PF had extensive previous experience on the B767, which he had flown for a number of years as a first officer. The B767, in contrast to the A320, had thrust levers that the crew moved to select a specified intermediate thrust setting before pressing a switch which then moved the thrust levers automatically to a position that would achieve the planned takeoff thrust. Unlike the A320, the B767 did not have detents for the thrust levers to be positioned in. The B767 also had a 'Thrust Hold' mode, which was reported to be equivalent to the manual thrust mode on the A320.

The PF reported that when he was viewing the 'MAN THR' annunciation on the FMA, he kept thinking that was normal for the takeoff and did not present a problem, despite the calls from the training captain that the thrust was not set. He also reported checking the engine indications and believed they were also normal.

Aircraft information

The A320 has five detents for the throttle levers (Figure 3). If the auto thrust is armed, it changes to being activated when the thrust levers are set between the IDLE and climb (CL) detents. As the takeoff was a flex temperature takeoff, the auto thrust was armed, but not yet activated, as the thrust levers were in the FLX/MCT detent, which is beyond the CL detent.

Figure 3: Thrust lever overview showing detents



The A320 flight crew operating manual (FCOM) outlines the condition required for the thrust lever asymmetry message "LVR ASYM" to be displayed on the FMA as '...one thrust lever in CL or MCT/FLX detent and the other one is not in this detent...'. Further advice from the aircraft manufacturer stated that this message is inhibited if the asymmetry situation occurs below 100 ft (in this case during the take-off roll).

The FCOM also detailed the conditions for 'MAN FLX [temp]' to be displayed as '...A/THR is armed, at least one thrust lever is in MCT/FLX detent with FLX TO [takeoff] temp set at XX°. The other thrust lever is at or below the MCT/FLX detent...'.

The FCOM did not provide an annunciation for when one thrust lever is set above the MCT/FLX detent. The necessary condition to display 'MAN THR' is '...A/THR is armed, and the most advanced thrust lever is above CL detent (two engines operative)...'. According to the FCOM, 'MAN THR' will be displayed on the FMA in white text in an amber box.

Human factors

The PF reported that he was confused by the calls from the training captain indicating that the thrust was not set. He reported that he was looking at the FMA display of 'MAN THR' and, as this message made sense to him for the phase of flight and acceleration of the aircraft, he did not understand why the training captain was calling 'thrust not set'.

The training captain reported that he was expecting the PF to make a call to 'go' as the aircraft was accelerating normally. He became concerned at the lack of reaction from the PF to his calls of 'thrust not set', and decided to call 'Go...TOGA' with a pause in between to break the two commands. The PF reported that it was unusual to hear the training captain issue a command and as such, when he heard this command he heard it as 'rotate', which was an expected command given the training captain's support role as PNF. The PF reported that when he heard what he thought was 'rotate', he thought he must have become distracted with the thrust calls from the training captain and missed the expected V_1 call.

The training captain stated that the use of the term 'go' was standard phraseology during takeoff, while 'TOGA' was not, although he felt the use of the terms together was justified given that their individual meaning was well understood amongst A320 flight crew. The training captain felt that, in hindsight, he should have resolved the situation earlier in the takeoff roll, either by moving the lever to the correct position, or communicating the situation more clearly.

ANALYSIS

Takeoff

The first indication for the training captain that the takeoff was not normal was the annunciation of 'MAN THR' on the flight mode annunciator (FMA), which occurred after the pilot flying (PF) called the 'MAN FLX 62' annunciation. The PF reported seeing and calling the 'MAN FLX 62' annunciation after he set the thrust levers in the MCT/FLX detent. It was after this point that the PF inadvertently moved the right thrust lever forward of the MCT/FLX detent, resulting in the 'MAN THR' annunciation that both flight crew recalled seeing during the takeoff.

The training captain, who was the pilot not flying (PNF), was aware of the thrust lever asymmetry and was prompting the PF, through the use of standard phraseology, to identify the problem behind the repeated calls regarding the thrust. He felt that by giving the '80 kts, thrust not set' call, the PF would realise there was a problem with the thrust levers and resolve the situation.

However the PF reported that he became confused about the repeated calls as his scan of the FMA and engine indications did not show any problems with the engine thrust. He also reported that, while he kept looking at the 'MAN THR' annunciation, he did not recognise that this meant the thrust mode had changed, despite having called the previous 'MAN FLX 62' annunciation. This was likely due to his previous experience of seeing thrust hold during takeoff on the B767, which was reported to equate to manual thrust on the A320. It is probable that the PF, in part, translated the 'MAN THR' annunciation to thrust hold and therefore did not completely comprehend the change in mode, or why it may have changed.

The PNF, while using standard phraseology, did not effectively communicate his understanding of the thrust lever asymmetry situation to the PF. In part this was due to the training environment that they were operating in, and that this situation was an opportunity for the training captain to assess the PF's actions in a non-normal event.

When the training captain realised the PF was not likely to respond to the lever asymmetry, he called 'Go...TOGA' in order to signal his intention that the flight should continue but also that the PF should select TO/GA thrust to resolve the thrust lever asymmetry situation. The PF likely misunderstood or misheard that command as 'rotate'. Given the position of the aircraft in the takeoff roll, it was not unreasonable for the PF to expect or believe that 'rotate' was commanded and that, given he thought that he missed the V1 call, which was the same speed as Vr, it could have confirmed that the next logical sequence to action was to rotate.

The rotation commenced approximately 20 kts below the required rotation speed. Very soon after he initiated rotation, the PF realised the speed was below V_R and subsequently slowed the rate of rotation to allow the aircraft to accelerate to the required rotate speed. This action also avoided a tailstrike that would likely have occurred had the rotation continued to the usual 11-13° pitch angle. The recognition and reaction of the PF prevented any damage occurring to the aircraft or runway and resulted in the aircraft being established on a normal flight profile.

Aircraft systems

The takeoff was planned as a flex temperature takeoff and, as such, the thrust levers were initially placed in the MCT/FLX detent, which was in accordance with the procedure for this type of takeoff. When the right thrust lever was inadvertently moved forward, the system reverted to manual thrust mode, however the aircraft was still accelerating and the engine indications reportedly showed the thrust was set as the PF expected.

The PNF called for TO/GA thrust, not because he felt they did not have enough thrust, but in order to highlight the asymmetric situation to the PF. The PNF subsequently moved the thrust levers to the TO/GA position just after the PF rotated. As the rotation was below the required speed the selection of TO/GA thrust assisted the aircraft to accelerate and become established on a normal climb profile after rotation.

The lack of FMA annunciation for the thrust lever asymmetry in this event, due to the aircraft being below 100 ft, meant the PF did not easily recognise this scenario during the takeoff. He was aware that the lever asymmetry message would show in some conditions, but had not comprehended that there could be an asymmetry condition and no message would be displayed.

The training captain identified the asymmetry through his scan of the flight deck following the manual thrust annunciation on the FMA. It was likely that as PNF, the training captain was better placed to identify the condition as the PF was dividing his attention between the runway and the primary flight instruments. While the ‘MAN THR’ indication is shown in white text with an amber box around it, this does not appear to have provided a trigger to the PF that the mode had changed.

FINDINGS

From the evidence available, the following findings are made with respect to the inadvertent thrust lever asymmetry involving Airbus A320-232 aircraft, registered VH-JQX, at Sydney Airport, New South Wales on 6 February 2012 and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- After the thrust levers were placed in the MCT/FLX detent, the right lever was inadvertently moved forward of the detent, which caused the autothrust system to revert to manual thrust mode.
- The training captain recognised the thrust lever asymmetry situation, however the pilot flying did not, and this resulted in a miscommunication that was not resolved effectively between the crew.

Other safety factor

- The pilot flying misunderstood a command from the training captain and rotated the aircraft at a speed that was approximately 20 kts below the required rotation speed, which had the potential to result in a tailstrike.

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this 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.

All of the relevant organisations identified during this investigation were given a draft report and invited to provide submissions. Although no safety issues were identified during this investigation, the following proactive safety action was advised by the aircraft operator.

Jetstar

Simulator training

The operator advised that, in response to this occurrence, they have incorporated a 'thrust mishandling/abnormal event prior to V1' into their 'Captain Simulator' qualification. They have also incorporated a module into their simulator cyclic training regarding incorrect thrust setting on takeoff.

Communications

The operator advised that, in response to this occurrence, they have issued a communication to flight crew regarding 'Command of Flight' requirements for the pilot in command in circumstances where an operational event occurs during a flight.

APPENDIX A: SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included the:

- flight crew
- aircraft operator
- aircraft's quick access data recorder
- 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 flight crew, the aircraft operator, CASA, the French Bureau d'Enquétes et d'Analyses pour la sécurité de l'aviation civile (BEA) and the aircraft manufacturer. Submissions were received from the flight crew, the aircraft operator and the aircraft manufacturer. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

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Investigation

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