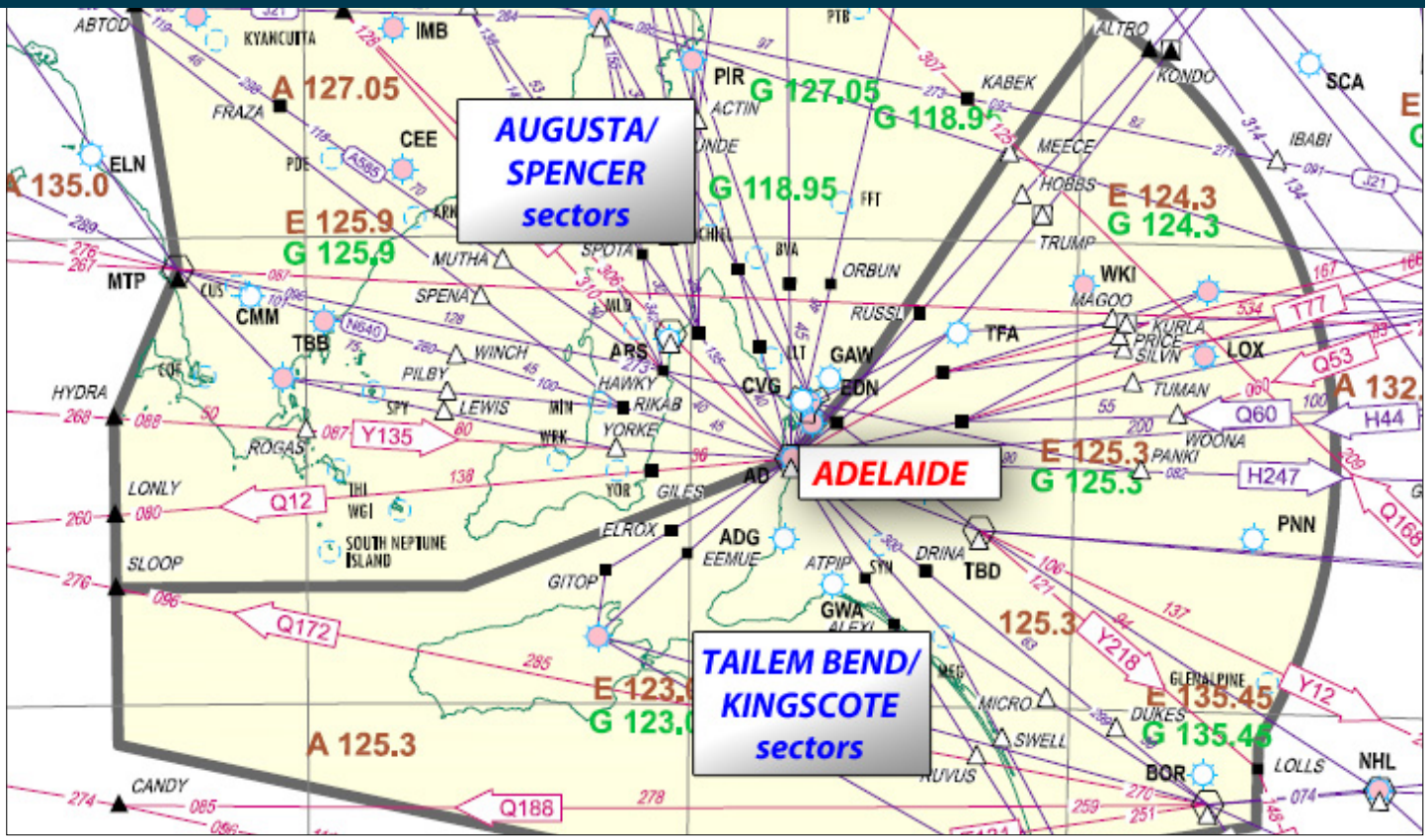
Australian Government
Australian Transport Safety Bureau

Loss of separation between Airbus A330 VH-EBO and Airbus A330 VH-EBS

near Adelaide, South Australia | 20 September 2013



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Addendum

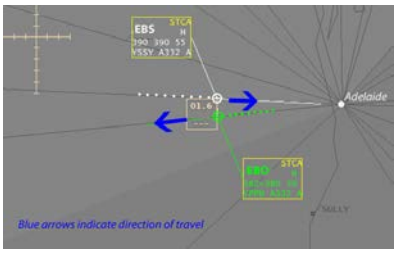
Page	Change	Date

Safety summary

What happened

On 20 September 2013, a loss of separation occurred about 17 km west of Adelaide, South Australia, between an Airbus A330 aircraft, registered VH-EBO (EBO) operating a scheduled passenger service from Sydney, New South Wales to Perth, Western Australia, and an Airbus A330 aircraft, registered VH-EBS (EBS), operating a scheduled passenger service from Perth to Sydney. Both aircraft were within radar surveillance coverage at the time of the occurrence and were equipped with a traffic collision avoidance system (TCAS).

Aircraft proximity at 1213:53



Source: Airservices Australia. Image modified by the ATSB.

What the ATSB found

The ATSB determined the en route air traffic controller did not adequately assess the traffic for potential conflicts before issuing a climb instruction to the EBO flight crew. The air traffic control computer system subsequently alerted the controller to the conflict and they promptly commenced compromised separation recovery actions. The flight crew of EBS responded to alerts generated by the aircraft's TCAS. The TCAS in EBO malfunctioned and did not provide the flight crew with traffic information or generate any safety alerts. The reason for the malfunction could not be determined and the equipment manufacturer considered it to be a unique event.

The ATSB identified a safety issue relating to the convergence of many published air routes overhead Adelaide, combined with the convergence point being positioned on the sector boundary of the Augusta and Tailem Bend sectors, which reduced the separation assurance provided by strategically separated one-way air routes and increased the potential requirement for controller intervention to assure separation.

What's been done as a result

Airservices Australia is undertaking a review of air routes and of the Australian airspace design that contributes to risk. There is also consideration to providing more flexible route structures using modern navigation technology to create traffic directional flows and remove convergence points.

In addition Airservices undertook pro-active safety action associated with safety alerting and traffic avoidance advice by air traffic services.

Safety message

This occurrence is a reminder of the potential for skill-based errors to occur when experienced personnel are performing their tasks and highlights the importance of controllers following their normal processes to ensure traffic is assessed prior to providing control instructions.

Contents

The occurrence

Introduction

At 1213:34 on 20 September 2013, a loss of separation[1] occurred about 9 NM (17 km) west of Adelaide, South Australia between:

- an Airbus A330 aircraft, registered VH-EBS (EBS), operating a scheduled passenger service from Perth, Western Australia to Sydney, New South Wales, and
- an Airbus A330 aircraft, registered VH-EBO (EBO), operating a scheduled passenger service from Sydney to Perth.

Both aircraft were flight planned on different tracks which converged overhead Adelaide.

Taking over control of the Augusta/Spencer airspace

At 1159:56 Eastern Standard Time,[2] following a handover/takeover, an air traffic controller in Airservices Australia's Barossa Group, based in the Melbourne Air Traffic Services Centre, accepted control jurisdiction for the Augusta (AUG) and Spencer (SPN) airspace sectors (Figure 1), which were permanently operated in a combined configuration. The AUG/SPN controller had previously been monitoring another controller who was conducting a familiarisation shift, following a period of leave, on the air traffic control (ATC) group's other two sectors (Tailem Bend (TBD) and Kingscote (KSC)), which were also permanently combined.

As sector traffic levels and controller workloads were relatively low, the AUG/SPN controller was preparing to also take over control jurisdiction for the TBD/KSC sectors on the one console. It was normal practice for all of the group's sectors to be combined at that time of day due to low traffic levels.

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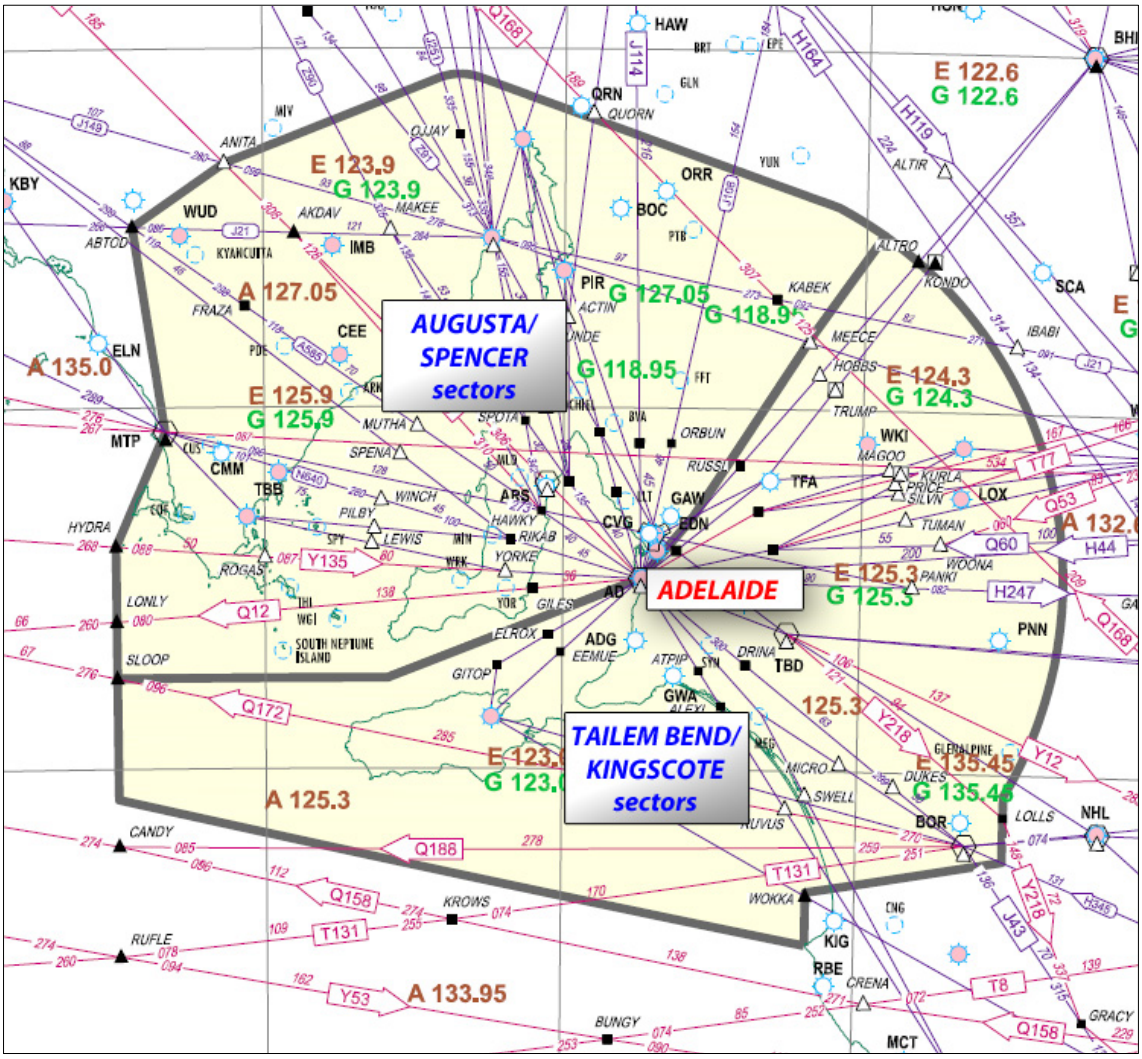
1 Controlled aircraft should be kept apart by at least a defined separation standard. If the relevant separation standard is infringed, this constitutes a loss of separation (LOS).

2 Eastern Standard Time (EST) was Coordinated Universal Time (UTC) + 10 hours.

Figure 1: Augusta/Spencer and Tailem Bend/Kingscote airspace sectors



Source: Airservices Australia. Image modified by the ATSB.

At the time the controller assumed control of the AUG/SPN sectors, EBS was within the AUG/SPN airspace at a position 140 NM (259 km) west of Adelaide, eastbound on the one-way route Y135[3] at flight level (FL)[4] 390. EBO was within the TBD/KSC airspace, 80 NM (147 km) east of Adelaide, westbound on the H44 route at FL 380. An eastbound Boeing 747 (747) positioned to the west of AUG/SPN (in the adjoining Forrest airspace sector) was operating on a flexible track at FL 370 (Figure 2). All three aircraft were operating at conforming flight levels[5].

The AUG/SPN controller reported that earlier, while monitoring the TBD/KSC controller's familiarisation period, they had observed EBO, EBS and the 747 and assessed that vertical separation was established between the three aircraft. By the time the AUG/SPN controller assumed jurisdiction of the sectors about 1 hour later, they no longer recalled that particular traffic situation. The handover of the AUG/SPN sectors by the previous controller had included EBO and EBS as relevant traffic.

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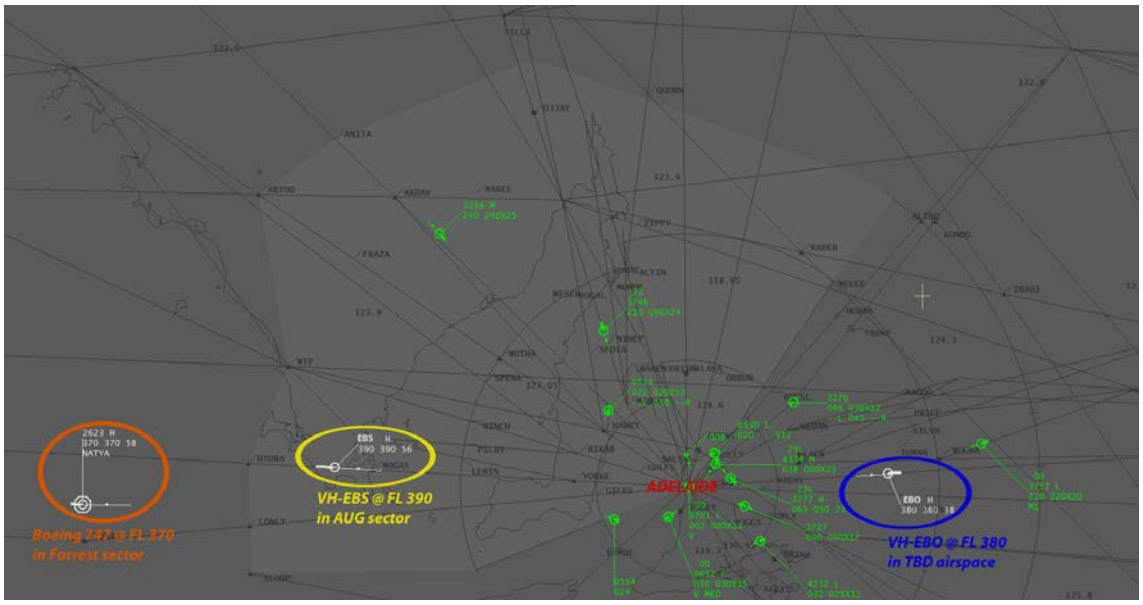
3 One-way air route Y135 joined at waypoint YORKE with the two-way air route J15 which then continued to Adelaide.

4 At altitudes above 10,000 ft in Australia, an aircraft's height above mean sea level is referred to as a flight level (FL). FL 390 equates to 39,000 ft.

5 Magnetic tracks 001^0 - 180^0 have one set of standard levels and 181^0 - 360^0 have another set of standard levels, designed to provide for vertical separation between aircraft on reciprocal flight paths.

Figure 2: Positions of aircraft at 1159:54



Source: Airservices Australia. Image modified by the ATSB.

The controller accepted jurisdiction for the track of the eastbound 747 at 1204:58 and spoke to the flight crew soon after. That aircraft was about 95 NM (176 km) west of EBS's position.

The AUG/SPN controller interacted with the track and/or label for EBS two times between assuming jurisdiction for the AUG/SPN sectors and the occurrence: at 1206:38, when they moved the label; and at 1210:04 when they designated[6] the track (immediately following the designation of EBO's track). The controller had no verbal interaction with EBS prior to the occurrence, nor was any verbal interaction required by the relevant policies and procedures.[7]

At 1209:58, the controller accepted jurisdiction of the track for EBO. At 1210:15, EBO's flight crew contacted the AUG/SPN controller as the aircraft approached entering the airspace. The controller observed that the ATC computer system's human machine interface prompts, which were displayed on their air situation display (ASD), provided a conflicting indication as to whether onwards coordination with the Forrest sector controller had been completed for EBO. Local instructions for the Barossa Group specified that voiceless coordination procedures applied between the AUG/SPN and TBD/KSC sectors but voice coordination was required with the Forrest sector.

To assure that this coordination had been carried out, the AUG/SPN controller called the Forrest controller via the internal coordination line at 1211:34 and was advised that coordination had already been completed. In addition, the Forrest controller advised that they had no vertical restrictions[8] for EBO. The AUG/SPN controller entered that information into the operational data line of EBO's label in the ATC computer system. They then interacted with tracks for other aircraft under their jurisdiction, including the eastbound 747 at FL 370, before moving their map on their ASD to the right, to display the TBD/KSC sectors. As traffic levels and associated controller workload were low, the AUG/SPN controller planned to also accept control jurisdiction for the TBD/KSC sectors and work all of the sectors combined on the one ATC console. In preparation, they were scanning traffic in the other two sectors.

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6 To designate a track in the air traffic control system, the en route controller moved the cursor on their air situation display, using their computer mouse, over the track and clicked the left mouse button. The action of designating a track provided a means of interacting with a track to aid with controller situation awareness for traffic planning and separation.

7 The previous AUG/SPN controller had accepted jurisdiction for the track for EBS at 1154:42, and the flight crew of EBS had contacted the previous AUG/SPN controller as the aircraft approached entering the airspace at 1157:52.

8 An aircraft's level may be changed, but the track may not be changed without further coordination.

Loss of separation assurance

The crew of EBO reported that that they had been cruising westbound at FL 380 when the aircraft's flight management system indicated that FL 400 was the optimum altitude. The captain checked their traffic collision avoidance system (TCAS)[9] display for traffic, in addition to a visual check, and noted no potential conflicts ahead. They subsequently requested climb to FL 400 at 1212:57[10]. At that time, the AUG/SPN controller still had their ASD off-centred to the right, as they were assessing pending traffic to the east. On receiving the request, the controller immediately restored the ASD to its default display setting and, about 3 seconds later, issued the climb instruction for EBO and updated the cleared flight level in the aircraft's label on the ASD. This resulted in a loss of separation assurance[11] between EBO and EBS as there was no assurance that the vertical separation standard of 1,000 ft would exist when the aircraft passed on their routes at a point where there could be less than the required radar separation standard distance laterally of 5 NM (9.3 km).

At the time the climb request was approved, EBO was west of Adelaide and westbound on the one-way air route Q12 (Figure 1). EBS was west of Adelaide, eastbound on the two-way route J15 from waypoint YORKE to Adelaide. On receipt of the level change clearance, EBO's flight crew reported leaving FL 380 and recorded data from the aircraft showed that it commenced climbing at 1213:08.

After assigning EBO climb, the controller then designated the track for EBO, followed by the 747 to the west. At that time (1213:10), there was 12 NM (22.2 km) between EBS and EBO (Figure 3).

The flight crew of EBS later reported that they had noticed the opposite direction traffic on their TCAS display when they were about 40 NM (74 km) from their position. The crew heard a flight crew on frequency request climb to FL 400: however, they thought that it could not be the aircraft on their TCAS display as it was too close in proximity to them.

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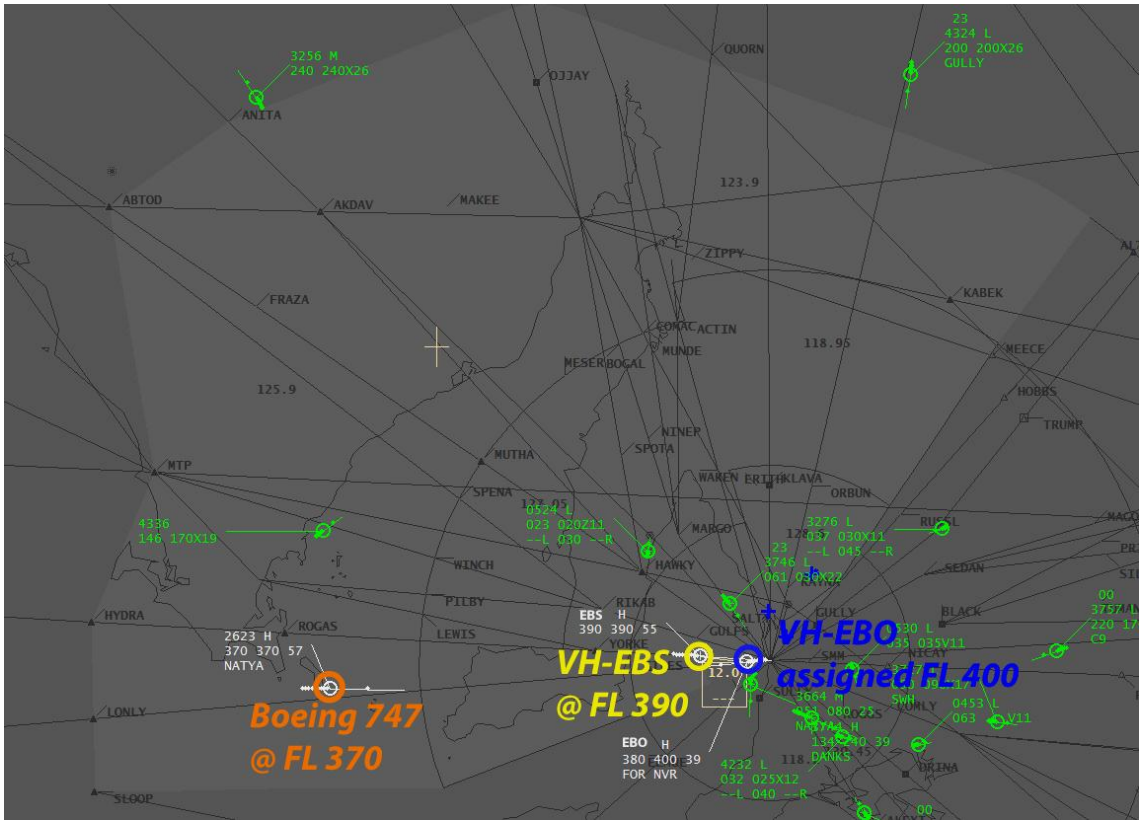
9 Traffic collision avoidance system (TCAS) is an aircraft collision avoidance system. It monitors the airspace around an aircraft for other aircraft equipped with a corresponding active transponder and gives warning of possible collision risks.

10 There were no verbal communications between the controller and anyone else amid the discussion with the Forrest controller at 1211:34 and the flight crew's request.

11 Loss of separation assurance describes a situation where a separation standard existed but planned separation was not provided or separation was inappropriately or inadequately planned.

Figure 3: Positions of aircraft at 1213:10



Source: Airservices Australia. Image modified by the ATSB.

Loss of separation

At 1213:25, the controller acknowledged an ATC system Short Term Conflict Alert (STCA) between EBO and EBS. The controller later reported that they instantly recognised the reason for the alert, which they immediately acknowledged. The STCA had activated before both the radar and vertical separation standards were infringed, alerting the controller to the imminent loss of separation between EBO and EBS.

At 1213:26, the controller commenced compromised separation recovery actions by instructing EBO's flight crew to maintain FL 380, which the crew acknowledged with advice that they were descending back to that level. The controller later reported that they had quickly identified that the routes of the aircraft were diverging and there was low likelihood of collision, but that a loss of separation had occurred.

Recorded data from EBS showed that, at 1213:27, the crew received a traffic advisory (TA)[12] from their aircraft's TCAS. At 1213:37 the TA changed to a resolution advisory (RA).[13] Both flight crew members noted the altitude of the approaching aircraft (EBO) increase on the TCAS display and they realised that the traffic in close proximity was climbing. The traffic was then sighted visually. The crew could see EBO was heading in the opposite direction and appeared to be on a diverging route. They also saw EBO climbing and diverging to the south on the TCAS display before receiving the TA and the RA.

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12 Traffic collision avoidance system: Traffic Advisory, when a TA is issued, pilots are instructed to initiate a visual search for the traffic causing the TA.

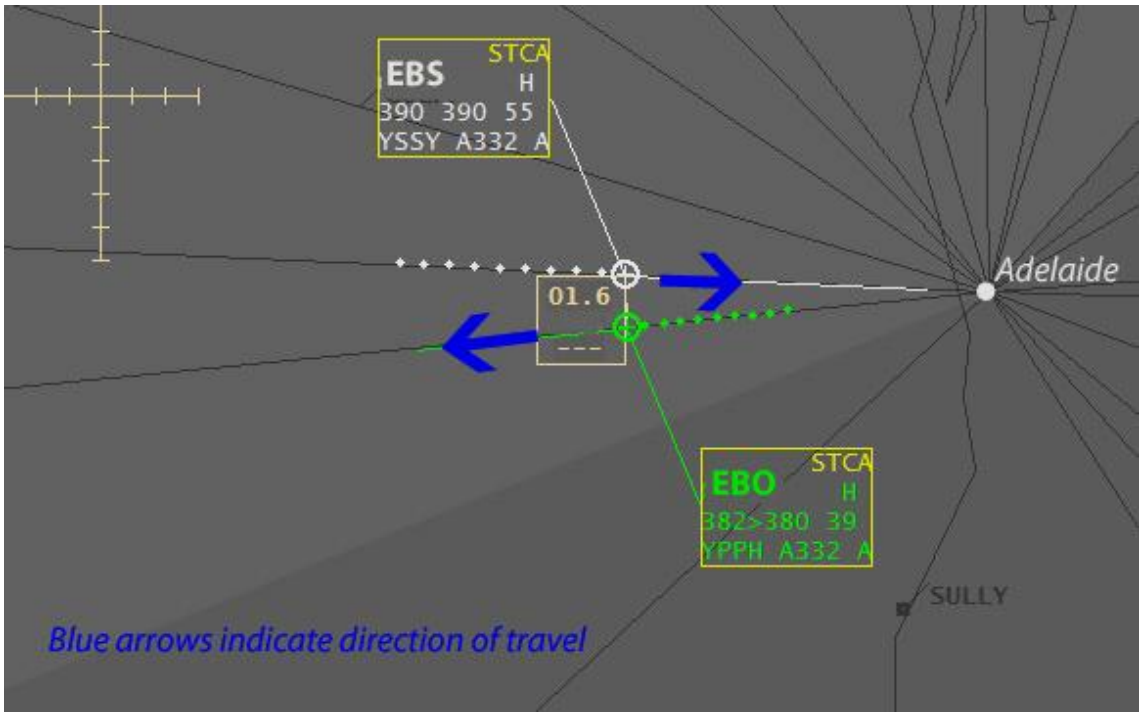
13 Traffic collision avoidance system: Resolution Advisory, when an RA is issued pilots are expected to respond immediately to the RA unless doing so would jeopardize the safe operation of the flight.

Recorded data from EBO showed that the aircraft reached a maximum altitude of 38,350 ft at 1213:37. The flight crew later reported that they did not see EBS on their TCAS display, nor did they receive a TA or RA.[14]

At 1213:44 the EBS flight crew advised the controller that they were responding to an RA and the aircraft started to climb. The controller responded with traffic advice of an aircraft passing below at FL 383. The EBS crew later reported that, on receipt of the RA, the captain assumed control of the aircraft and commenced a rate of climb of about 800–1,000 ft per minute. They recalled that the climb was achieved by a gentle manoeuvre, which would be unlikely to be detected by the passenger cabin as a collision avoidance action. Following the TCAS advice that EBS was clear of the conflict, the flight crew resumed FL 390 via a shallow descent.

Recorded data from the two aircraft showed that the minimum vertical separation was 650 ft at 1213:37, when the two aircraft were 4.1 NM (7.6 km) apart laterally. The minimum lateral separation was 1.6 NM (3 km) at 1213:51, when the aircraft were 870 ft apart vertically (Figure 4). At that time both the vertical and lateral separation were increasing as the aircraft were tracking to intercept separate one-way routes. The vertical and radar separation standards were re-established a short time later.

Figure 4: Aircraft positions at 1213:53



Source: Airservices Australia. Image modified by the ATSB.

Note: Data in this figure is provided from the ATC system with a different level of resolution compared to the data provided from the aircraft's recorders. The figures '55' and '39' refer to the ground speeds of the aircraft (divided by 10).

[14] The EBO flight crew advised the AUG/SPN controller that they had not received any TCAS indications at 1215:24.

Context

Airspace

The main objective of airspace management is to maintain the level of safety applicable to air traffic operations within a volume of airspace while maximising the efficient use of that airspace. Route structures and air traffic control (ATC) sectorisation need to accommodate major traffic flows while reducing airspace structure complexity and balancing ATC workload.

An air route is a specified route designed for channelling the flow of traffic as necessary for the provision of air traffic services. A legacy design feature of air routes, prior to the development and implementation of the Global Positioning System,[15] Area Navigation,[16] Performance Based Navigation (PBN)[17] and improved aircraft navigation capabilities, was the requirement to track via ground-based radio navigation aids.

Air navigation in continental airspace is transitioning from conventional ground-based radio navigation aids to PBN; in Australia the PBN implementation is based on Global Navigation Satellite Systems (GNSS). GNSS is also being used in oceanic regions to provide a PBN solution. From 4 February 2016 all aircraft operating in Australia under the Instrument Flight Rules will be required to be equipped with GNSS.

The air routes on which the aircraft involved in this occurrence were tracking at the time of the occurrence both converged over the Adelaide Very High Frequency Omni Directional Radio Range (VOR)[18] ground-based radio navigation aid. Most of the air routes that converged overhead the Adelaide VOR were one way routes. The ATC sectorisation of the high level Augusta (AUG) and Tailem Bend (TBD) sectors resulted in the boundary between the two pieces of airspace crossing overhead the Adelaide VOR, where a number of air routes converged (Figure 1).

The International Civil Aviation Organisation (ICAO) Doc 4444 – *Procedures for Air Navigation Services – Air Traffic Management* (PANS-ATM) – Fifteenth Edition 2007 specified 'the actual procedures to be applied by air traffic services units in providing the various air traffic services to air traffic'. The implementation of the procedures was the responsibility of Contracting States, of which Australia was a member. The document required that the scope of air traffic services (ATS) unit safety reviews include the ATS route structure to ensure that it provided adequate route spacing and that crossing points for ATS routes were located so as to reduce the need for controller intervention and for inter- and intra-unit coordination.

Controller information

The Augusta/Spencer (AUG/SPN) controller was initially rated as a controller in 2005, with all of their control experience based in the Barossa group. In recent years the controller had been working part-time. Although this provided some challenges for maintaining recency and proficiency, particularly in high workload periods, the controller reported that Airservices Australia had provided them rosters to minimise the potential for this problem.

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15 The Global Positioning System (GPS) is a space-based global navigation satellite system (GNSS) that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites.

16 A method of navigation which permits aircraft operation on any desired flight path within the coverage of ground or space-based navigation aids, or within the limits of the capability of self-contained aids, or a combination of these.

17 Area navigation based on performance requirements for aircraft operating along an air traffic services route, on an instrument approach procedure or in designated airspace.

18 A ground-based navigation aid that emits a signal that can be received by appropriately-equipped aircraft and represented as the aircraft's bearing (called a 'radial') to or from that aid.

Prior to 20 September 2013, the controller had the previous 3 days off duty. They reported normally obtaining about 6 hours sleep a night, and they had obtained 6 hours sleep on both of the nights prior to the occurrence, although on both nights the sleep had been disrupted. They reported not feeling tired on the morning of the occurrence. They commenced their shift on 20 September at 0700, and worked according to their normal pattern of about 60 minutes at the console and 30 minutes break.

The controller reported that workload on the Barossa Group of airspace sectors was relatively low at the time of the occurrence and that there were no operational distractions. This was supported by other controllers in the group. The controller also reported that they were under no time pressure to assume jurisdiction for the TBD/KSC sectors.

The AUG/SPN controller had completed compromised separation recovery refresher training, with a simulator component, within the previous 12-month period. The simulator based training was generic in nature and not sector or group specific.

Compromised separation recovery

Separation is considered to be compromised when separation standards have been infringed, or where separation assurance is absent to the extent that a breakdown of separation is imminent.

In accordance with the Manual of Air Traffic Services (MATS), controllers were required to issue safety alerts to pilots of aircraft as a priority when they became aware that aircraft were in a situation considered to be in unsafe proximity to other aircraft, unless a pilot had advised that action was being taken to resolve the situation or that the other aircraft was in sight.

ATC were required to issue avoiding action advice in critical situations if aware that there was a collision risk in all classes of airspace both within and outside ATS surveillance system coverage. Avoiding action advice would be prefixed with the term ‘AVOIDING ACTION’ and include instructions to the pilot for avoiding the other aircraft.

The phraseology to be used by ATC when providing safety alerts and avoiding action was contained in the Australian Aeronautical Information Publication.[19] At the time of the occurrence, there was no direct provision in the MATS safety alerting section to enable controllers to abbreviate safety alert and traffic avoidance advice phraseologies to ensure timely provision of advice. However, MATS did contain a general provision that there was no preclusion for controllers to exercise their best judgement and initiative when the safety of an aircraft may be considered in doubt.

Traffic collision avoidance system information

Introduction

A traffic collision avoidance system (TCAS) is designed to independently alert flight crews to possible conflicting traffic. It identifies a three-dimensional airspace around appropriately equipped aircraft based on the closure rate of other transponder-equipped traffic. If an evolving potential conflict meets defined vertical and horizontal parameters , TCAS generates a visual and aural alert.

The TCAS system comprises:

- TCAS computer
- ATC transponders (1 and 2)
- directional antennas (upper and lower)
- ATC/TCAS control unit.

[19] A package of documents that provides the operational information necessary for the safe and efficient conduct of national (civil) and international air navigation throughout Australia and its Territories.

One transponder is active while the other unit is on standby. The crew can switch between transponders (SYS 1 and SYS 2) using the ATC/TCAS control unit.

Although all air transport aircraft are required to have a TCAS, on rare occasions the system can fail or lose functionality during a flight. In such situations a flight crew is usually provided with a fault message, and the flight crew are required to advise ATC. In addition, under specific conditions, aircraft are able to be dispatched for short periods of time without a serviceable TCAS[20]. In such cases, the absence of a fully functional TCAS needs to be advised to ATC in the relevant flight plan or verbally as soon as the flight crew become aware of the unserviceability. Controllers advised that this information is normally available to them, but that it did not generally influence how they provided ATC services.

Reported problem

The crew of EBO reported that they did not receive any indications of the presence of EBS and did not receive a traffic advisory (TA) or resolution advisory (RA). Immediately after the event, the flight crew cycled the TCAS and tried both of the aircraft's transponder systems. About 5 minutes later, EBO passed both a 747 and Boeing 737 which the flight crew sighted visually but received no indications of those aircraft on their TCAS display. They also reported not being able to see other aircraft on their TCAS display during the rest of their flight in situations where the other aircraft's crews could see them, until reaching the Perth Terminal Area, where traffic returns were evident. They had been able to see other aircraft on departure from Sydney and there was no indication of a TCAS failure prior to the loss of separation event. The flight crew reported that prior to the event there had been no radio congestion.

Examination of TCAS system components from VH-EBO

Examination of quick access recorder (QAR)[21] data from EBO showed that no TA or RA was recorded. There had been no TCAS-related faults previously reported for EBO.

After the aircraft landed in Perth, a built-in test equipment (BITE) test was conducted on the TCAS system with no faults indicated. A minimum equipment list item was applied for the unserviceable TCAS system for the return flight to Sydney. A full system test was conducted in Sydney with a failure identified between ATC transponder 2 and the TCAS computer and directional antennas. The TCAS computer and ATC transponder 2 were replaced with spare units and a further system test carried out with nil faults detected.

The TCAS computer[22] and ATC transponder 2 were sent to the manufacturer in the US for testing in accordance with a test plan agreed to by the participants in the investigation. The testing was witnessed by an officer from the US National Transportation Safety Board (NTSB). The test plan included:

- a visual inspection of the units particularly the rear connector pins
- a check that the correct operational software was currently loaded
- a download of the TCAS computer (all BITE data, TCAS alert/warning logs etc.)
- a download of the transponder fault logs
- a review of the event logs

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[20] The relevant MEL (Minimum Equipment List) stated that "the TCAS function may be inoperative for flights between Australia and New Zealand and for flights in Australian Class A, C and D airspace provided that the system is deactivated." The repair interval was 72 hours excluding the day that the MEL was issued.

[21] The QAR is a type of flight data recorder that records a number of flight parameters. The QAR differs from a flight data recorder in that it is not required to meet the same crash protection standards and does not have a required minimum set of parameters. The parameters recorded by the QAR are selected by the operator to suit their operation and typically exceed the minimum number of parameters for a mandatory flight data recorder.

[22] The TCAS computer and ATC transponder were manufactured by Aviation Communication & Surveillance Systems (ACSS) with part numbers 7517900-10012 and 7517800-10100 respectively.

- environmental testing
- using simulated inputs, a check of the correct operation of the unit.

The testing did not identify any incorrect or anomalous findings. The analysis of the TCAS computer's Event log did not show any RAs or TAs corresponding to the incident. The Event log did record events while ground testing was performed after the incident. The analysis of the fault log from the transponder unit did not show any faults recorded at the time of the incident.

In summary, the failure of the TCAS system on EBO to detect EBS and produce an RA and TA was not explained and the equipment manufacturer considered it to be a unique event. The manufacturer was not aware of any other such events.

Safety analysis

Introduction

A loss of separation occurred when the Augusta/Spencer (AUG/SPN) controller cleared the flight crew of the westbound VH-EBO (EBO) to change levels from flight level (FL) 380 to 400 when VH-EBS (EBS) was eastbound at flight level 390. The minimum vertical separation between the two Airbus A330 aircraft was 650 ft, when the aircraft were 4.1 NM (7.6 km) apart laterally and the minimum lateral separation was 1.6 NM (3 km), when the aircraft were 870 ft apart vertically. The aircraft were on diverging air routes.

In high reliability systems, there are multiple risk controls in place to reduce the likelihood that safety-critical personnel will make an error. However, on rare occasions an error will still occur, and systems have additional risk controls in place to detect and recover from such errors, or mitigate the consequences of such errors. In this occurrence, one of these detection and recovery controls did not work effectively (that is, the traffic collision avoidance system (TCAS) on EBO). However, other risk controls were functioning effectively. These included the air traffic computer system's Short Term Conflict Alert (STCA) function, the functioning TCAS in VH-EBS (EBS), EBS's flight crew's visual acquirement of EBO and the use of one-way routes.

Controller actions

Receiving and responding to flight level change requests is a very familiar task for an experienced controller. The AUG/SPN controller reported that their normal practice for this task was to advise the crew to 'standby', assess the traffic for potential conflicts, and then either issue the instruction or not as required. People generally perform very familiar tasks at a skill-based or automatic level, with attentional checks on progress conducted at key points (Reason 1990). In this case the recent coordination of no vertical restrictions for EBO from the adjoining (Forrest) sector controller probably resulted in the controller omitting a key step in their normal sequence (conducting an assessment for traffic conflicts) and they promptly approved the flight level change.

Omitting a step in a task is one of the most common types of human error (Reason 2002) and errors of omission are often difficult to detect by the people who make them (Sarter and Harrison 2000). Many aspects of the task and its context can contribute to skill-based omissions (sometimes termed 'lapses'). In this case, in addition to the recent advice from the Forrest controller of no vertical restrictions, the controller had limited interaction with EBS prior to the occurrence, including no verbal communication. It is possible that the controller had not fully integrated the aircraft into their mental model of the jurisdiction traffic situation. They were more aware of the 747, which was in a similar location to EBS, and knew that there were no traffic conflicts between the 747 and EBO.

During the period immediately leading up to the level-change request, the controller's attention was focussed on assessing the traffic picture for the adjacent Tailem Bend (TBD) and Kingscote (KSC) sectors. However, there did not appear to be any concerns with workload, time pressure or distractions associated with the occurrence sequence.

Sleep is vital for recovery from fatigue, with both the quantity and quality of sleep being important. It is generally agreed that most people need at least 7–8 hours of sleep each day to achieve maximum levels of alertness and performance, although there are individual differences in the amount of sleep required. The controller reported that they normally obtained 6 hours sleep and had received that for the two previous nights, although with some disruptions. Some research has shown that having 5 hours or less sleep in the previous 24 hours can influence performance (Dawson and McCullough), and other research has indicated having less than 6 hours sleep can influence performance (Thomas and Ferguson 2010 and Williamson and others 2011). In this case it is possible that the controller may have been experiencing the effects of having disrupted

sleep, but there was insufficient evidence to conclude that they were experiencing fatigue at a level likely to influence performance.

Compromised separation recovery

The AUG/SPN controller had completed practical compromised separation recovery training in the previous 12 months. However, on this occasion they did not comply with the documented requirement to issue a 'safety alert' to the flight crews.

The controller later reported that their priority had been to issue the instruction to EBO to restore separation and they considered that the effectiveness of their compromised separation recovery actions may have been reduced if they used the full safety alerting phraseology, due to time limitations to effect change and the proximity of the aircraft. In addition, the controller considered that the term' safety alert' may not convey to pilots the time-sensitive or safety-critical nature of the information that needed to be conveyed.

Notwithstanding the omission of key words, the controller's response to the conflict alert was very prompt and it was effective in resolving the traffic conflict and re-establishing vertical separation. The controller's decision to abbreviate the phraseology can be considered appropriate with respect to time limitations and their assessment that the tracks of the aircraft were diverging at that time.

There is a risk that there may not be a common understanding in the aviation industry of the safety alerting phraseology contained within the Australian Aeronautical Information Publication and its associated urgency, or the application of procedures in compromised separation occurrences. However, there were no indications in this occurrence that the flight crews involved did not understand the situation, even with the omission of the term 'safety alert'.

Airspace and air route design

Strategic planning, design and review of the structure of airspace and air routes, and air traffic control (ATC) sectorisation, can provide an effective means of reducing risk associated with potential traffic conflicts. While adherence to conforming flight levels by flight crew and ATC provides strategic separation assurance between aircraft on reciprocal tracks, air route design and the consideration of conflict point distribution is an additional risk control.

The ATC sectorisation at the time of the occurrence resulted in the point of conflict of a number of air routes overhead the Adelaide Omni Directional Beacon (VOR) being positioned on the sector boundary between the high-level AUG and TBD sectors. Although this design did not contribute to the loss of separation in this occurrence, there was a potential increased risk associated with having two controllers (when AUG and TBD sectors were not combined) having to manage the traffic in their respective sectors in addition to having an awareness of traffic on the adjoining sector to ensure that they do not hand over to their colleague an aircraft that would conflict with their traffic.

There were a number of other locations within the Australian Flight Information Region where air routes converged overhead a location, such as Tindal, Northern Territory. However, the ATC sectorisation of the AUG and TBD sectors was unique as other points of air route convergence were not positioned on airspace sector boundaries but designed to wholly contain the convergence point within a single sector.

In times of increased workload and cognitive effort, controllers may become focused on assuring separation within their jurisdiction airspace, and the conflict point overhead Adelaide could become less of a priority, with some element of ambiguity regarding separation responsibility. In addition, with aircraft being transferred between the two sectors prior to the boundary, two aircraft within close proximity to Adelaide, and one another, may be on different ATC sector frequencies unless one controller proactively identifies the situation and coordinates a delayed hand-off.

Airspace design is complex and challenged by many different competing requirements and priorities. Air routes and aircraft tracks will often need to cross at some point. As such, there will always be some form of compromise in airspace design and ATC sectorisation. However, continual monitoring and regular evaluation is required to ensure that risks are identified and managed, and defences are effective.

TCAS malfunction

For flight crews and aircraft operators, TCAS is an integral defence in reduction of collision risk. It also provides a fundamental situation awareness tool to flight crews through the display of traffic in their proximity. EBO's flight crew reported that they did not observe EBS on their TCAS display and no TCAS advisories were annunciated, which indicated that the TCAS malfunctioned during the en route flight phase and so any testing of the system during the pre-flight checks would not have identified a problem at that time. In addition, TCAS are designed to provide the flight crew with an error message when there is a malfunction, but in this occurrence no message was generated to the flight crew to indicate that they had lost functionality prior to the occurrence. In an airspace sector with low traffic levels, there would have been no indications to the crew that the absence of traffic on their TCAS display was unusual.

As reported by EBO's flight crew, pilots routinely checked their TCAS display to determine if there was any potential conflicting traffic in their proximity, prior to submitting a request to ATC for a level change, which provides another defence against a potential loss of separation situation in addition to that provided by ATC. The malfunction of EBO's TCAS removed the effectiveness of that defence in this occurrence. However, this was a very rare occurrence and as EBO's transponder was functioning correctly, the aircraft remained an eligible and identifiable target for the defences provided by other aircraft's TCAS and the ATC computer system's conflict alerting function.

Findings

From the evidence available, the following findings are made with respect to the loss of separation between an Airbus A330, registered VH-EBO, and an Airbus A330, registered VH-EBS that occurred about 17 km west of Adelaide, South Australia on 20 September 2013. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (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 operating environment at a specific point in time.

Contributing factors

- At least partly due to some task-related factors specific to this occasion, the controller did not assess the traffic for potential conflicts before issuing the climb instruction to the flight crew of VH-EBO.

Other factors that increased risk

- The traffic collision avoidance system in the A330 aircraft registered VH-EBO malfunctioned and did not provide the flight crew with traffic information or generate any safety alerts.
- **The convergence of many published air routes overhead Adelaide, combined with the convergence point being positioned on the sector boundary of the Augusta and Tailem Bend sectors, reduced the separation assurance provided by strategically separated one-way air routes and increased the potential requirement for controller intervention to assure separation. [Safety issue]**

Other findings

- The reason for the malfunction of the traffic collision avoidance system in the A330 aircraft registered VH-EBO could not be determined and the equipment manufacturer considered it to be a unique event.

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

Convergent air routes and airspace sectorisation

Number:	AO-2013-161-SI-01
Issue owner:	Airservices Australia
Operation affected:	Aviation: Airspace management
Who it affects:	All Augusta and Tailem Bend en route controllers, and associated airspace users

Safety issue description:

The convergence of many published air routes overhead Adelaide, combined with the convergence point being positioned on the sector boundary of the Augusta and Tailem Bend sectors, reduced the separation assurance provided by strategically separated one-way air routes and increased the potential requirement for controller intervention to assure separation.

Proactive safety action taken by Airservices Australia

Action number: AO-2013-161-NSA-019

Airservices Australia (Airservices) reported on 1 September 2014 that:

> The Airservices SkySafe Taskforce – Airspace Stream is reviewing air routes in respect to the following criteria:
>
> - Identify elements of route structure and airspace usage which generate the highest risk;
> - Mitigate risks by reducing conflicting traffic streams, increasing systemisation and reducing the impact of human error;
> - Examine the effectiveness of existing protocols for the regular review of route structure and airspace usage, with specific attention to emerging risks presented by traffic growth
>
> The Taskforce is undertaking a review of the Australian airspace design that contributes to risk. Due to a legacy design feature requiring air routes to be from Navigation Aid to Navigation Aid, the Taskforce is considering that with the advent of GPS [Global Positioning System] and improved aircraft navigation capability the need to track via Navigation Aids may no longer remain in many cases.
>
> There is also consideration to providing more flexible route structures using modern navigation technology to create traffic directional flows and remove convergence points.

In addition, on 12 February 2015, Airservices reported that:

> Furthermore Airservices confirms that the initiatives identified as part of the Operation SkySafe Taskforce are on-going. Airservices has commenced a holistic review of the air route network to address the safety issue identified in the report; to consider the impact and opportunities arising from the ADS-B [Automatic Dependant Surveillance Broadcast] and GNSS [Global Navigation Satellite

> System] mandates; and the capabilities that may be delivered with the new oneSKY air traffic management system.

Current status of the safety issue

Issue status: Adequately addressed

Justification: The ATSB is satisfied that the safety action undertaken, and action in progress, will satisfactorily address the safety issue.

Additional safety action

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

Safety alerts and traffic avoidance advice

Although no safety issues were identified in respect of compromised separation recovery procedures or controller training, the following safety action was reported by Airservices Australia on 1 September 2014.

Documentation

The Manual of Air Traffic Services (MATS) Version 28, effective from 29 May 2014, amended the section previously titled 'Safety Alerts and Avoiding Advice' to 'Safety alerts and traffic avoidance advice', with clarifications on when safety alert and traffic avoidance advice phraseologies should be applied and that procedural air traffic control services[23] were not to issue avoiding action advice. The Australian Aeronautical Information Publication update to reflect the changes would be published on 5 March 2015. The MATS amendment also included the addition of a paragraph enabling controllers to abbreviate safety alert and traffic avoidance advice phraseologies, when required, to ensure timely provision of advice.

Controller training and standardisation

Airservices Australia issued a Standardisation Directive titled 'Assessment of Compromised Separation Phraseology', effective from 25 July 2014, requiring that air traffic control console reference materials be updated to display phraseology pertinent to the local environment and that controller rating paper and assessment debriefs include a 'verbal assessment of the assessee's conditioned and instinctive use of the phraseology in a desktop situation'. The Directive stated that:

> Notwithstanding the provisions of MATS 9.1.4.5 (Abbreviated phraseology) and 10.1.1.2.1 (Likely hazard), the response will be assessed for:
>
> - Use of key TRIGGER terms (e.g. 'Safety Alert', 'Avoiding Action')
> - Provision of instructions to RESOLVE the situation (e.g. Turn, Level Change)
> - Sense of URGENCY (e.g. Tone, Words Twice, use of 'Immediately')
> - CONFIRM that pilot has heard and understands
> - Provision of TRAFFIC information.

[23] Aircraft operating outside of air traffic control surveillance coverage are provided with procedural air traffic services.

General details

Occurrence details

Date and time:	20 September 2013 – 1214 EST	
Occurrence category:	Serious incident	
Primary occurrence type:	Loss of separation	
Location:	17 km west of Adelaide, South Australia	
	Latitude: 34° 56’ 52” S	Longitude: 138° 19’ 41” E

Aircraft 1 details

Manufacturer and model:	Airbus A330-202
Year of manufacture:	2010
Registration:	VH-EBO
Operator:	Qantas
Serial number:	1169
Type of operation:	Air transport high capacity
Damage:	None

Aircraft 2 details

Manufacturer and model:	Airbus A330-202
Year of manufacture:	2011
Registration:	VH-EBS
Operator:	Qantas
Serial number:	1258
Type of operation:	Air transport high capacity
Damage:	None

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- Airservices Australia
- involved air traffic controllers
- aircraft operator
- traffic collision avoidance system manufacturer
- Manual of Air Traffic Services
- Australian Aeronautical Information Publication
- Civil Aviation Safety Authority
- ICAO Doc 4444 – Air Traffic Management (PANS-ATM)
- National Transportation Safety Board (NTSB) – United States of America
- Bureau d'Enquêtes et d'Analyses (BEA) - France

References

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Reason, J 2002, 'Error management: Combating omission errors through task analysis and good reminders', *Quality and Safety in Health Care*, vol. 11, pp. 40–44.

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Sarter, NB & Alexander, HM 2000, 'Error types and related error detection mechanisms in the aviation domain: An analysis of aviation safety reporting system incident reports', *The International Journal of Aviation Psychology*, vol. 10, pp. 189- 206.

Williamson, A Lombardi, DA Folkard, S Stutts, J Courtney, TK & Connor, JL 2011, 'The link between fatigue and safety', *Accident Analysis and Prevention*, vol. 43, pp. 498-515.

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 Airservices Australia, the air traffic controller, the aircraft operator, the aircraft manufacturer, TCAS manufacturer, US National Transportation Safety Board (NTSB), the French Bureau d'Enquêtes et d'Analyses (BEA) and the Civil Aviation Safety Authority (CASA).

Submissions were received from Airservices Australia, the TCAS manufacturer, the NTSB, the BEA and CASA. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB 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 factors related to the transport safety matter being investigated.

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 it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation

Loss of separation between Airbus A330 VH-EBO and Airbus A330 VH-EBS near Adelaide, South Australia, 20 September 2013

AO-2013-161
Final – 5 March 2015