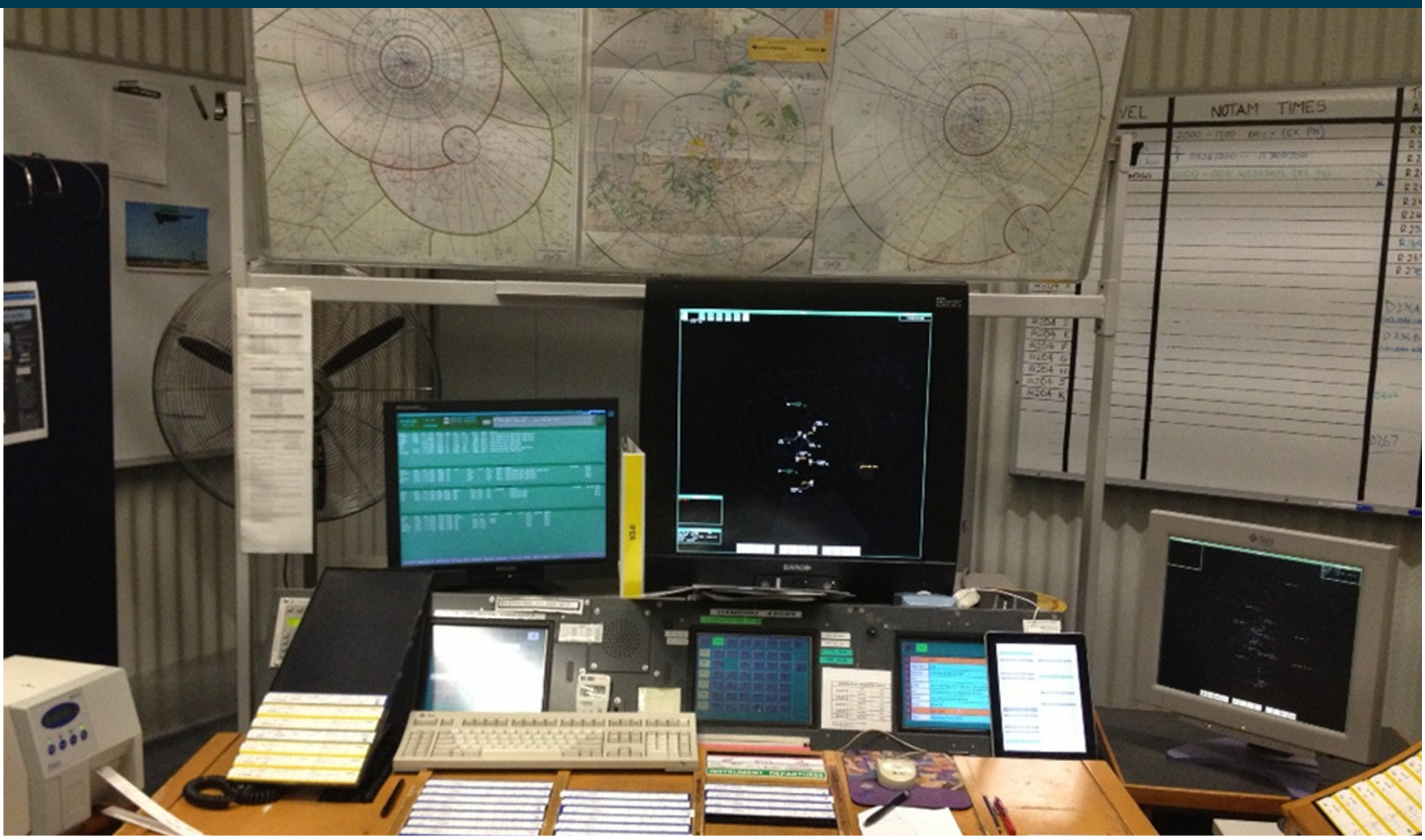
Australian Government

Australian Transport Safety Bureau

Loss of separation involving Boeing 717, VH-NXQ and Boeing 737, VH-VXM

near Darwin Airport, Northern Territory | 2 October 2012



Investigation

ATSB Transport Safety Report

Aviation Occurrence Investigation

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Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone: 1800 020 616, from overseas +61 2 6257 4150 (24 hours)
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117, from overseas +61 2 6247 3117
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

Addendum

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Safety summary

What happened

At 1345 Central Standard Time on 2 October 2012, a loss of separation (LOS) occurred between a descending Boeing 717 aircraft, registered VH-NXQ (NXQ), operating a scheduled passenger service from Alice Springs to Darwin, Northern Territory, and a climbing Boeing 737, registered VH-VXM (VXM), operating a scheduled passenger service from Darwin to Melbourne, Victoria. The LOS occurred about 14 NM (26 km) south of Darwin, and the aircraft were under the jurisdiction of Department of Defence air traffic control (ATC) at the time of the occurrence.

Prior to the LOS, a predicted conflict alert was activated within the Australian Defence Air Traffic System (ADATS). After a short delay, the Approach controller instructed VXM's flight crew to stop their climb at 9,000 ft. NXQ's flight crew advised the controller of conflicting traffic below them and the controller instructed them to maintain 10,000 ft. Separation between the aircraft reduced to about 900 ft vertically as NXQ passed directly overhead VXM on a crossing track. The required separation standards were either 1,000 ft vertical separation or 3 NM (5.6 km) radar separation.

What the ATSB found

The ATSB determined that an already-assigned transponder code was allocated to the 717 in ADATS, which resulted in the 717's call sign being incorrectly correlated in ADATS to an overflying aircraft that was in the general proximity of the 717. Manual processes to check the assigned transponder code with the code listed in ADATS were not conducted effectively. Due to local contextual factors and confirmation bias, the Darwin Approach controller and Approach Supervisor assumed that the radar return labelled as NXQ was correct, and they did not identify the error until after the conflict alert activated.

The ATSB identified safety issues relating to the Department of Defence's (DoD's) risk controls for ensuring transponder code changes were processed correctly, the expectancy in the Darwin approach environment about the relevance of radar returns with a limited data block, the risk assessment and review processes for the introduction of new equipment, and refresher training for compromised separation recovery actions.

What's been done as a result

The DoD issued a Safety Advisory to highlight to controllers the importance of the appropriate and timely actioning of all messages sent to the ADATS Problem Message Queue, for Planner controllers to confirm that correct transponder codes are allocated in the ADATS flight plan and to reinforce to controllers to take immediate action on all conflict alert and predicted conflict alert alarms. Following a September 2013 DoD review of the Comsoft Aeronautical Data Access System and its associated impact on the Planner role, Flight Data Operators have been introduced at a number of Defence air traffic control establishments to reduce workload in the Planner position.

The ATSB is not satisfied that the DoD has adequately addressed the safety issues regarding the provision of refresher training to air traffic controllers for the scanning of green radar returns and in compromised separation recovery requirements and techniques. As a result, the ATSB has made formal recommendations to the DoD to take further safety action on these issues.

Safety message

The ATSB reminds operational personnel such as controllers of the problems associated with confirmation bias when dealing with unusual situations and the importance of searching for anomalous indicators in such situations. The ATSB also reminds high-reliability organisations such as air traffic services providers that, even though they may have multiple levels of risk control in place to reduce safety risk, these controls need to be regularly evaluated to ensure that they are effective.

Contents

The occurrence

Introduction

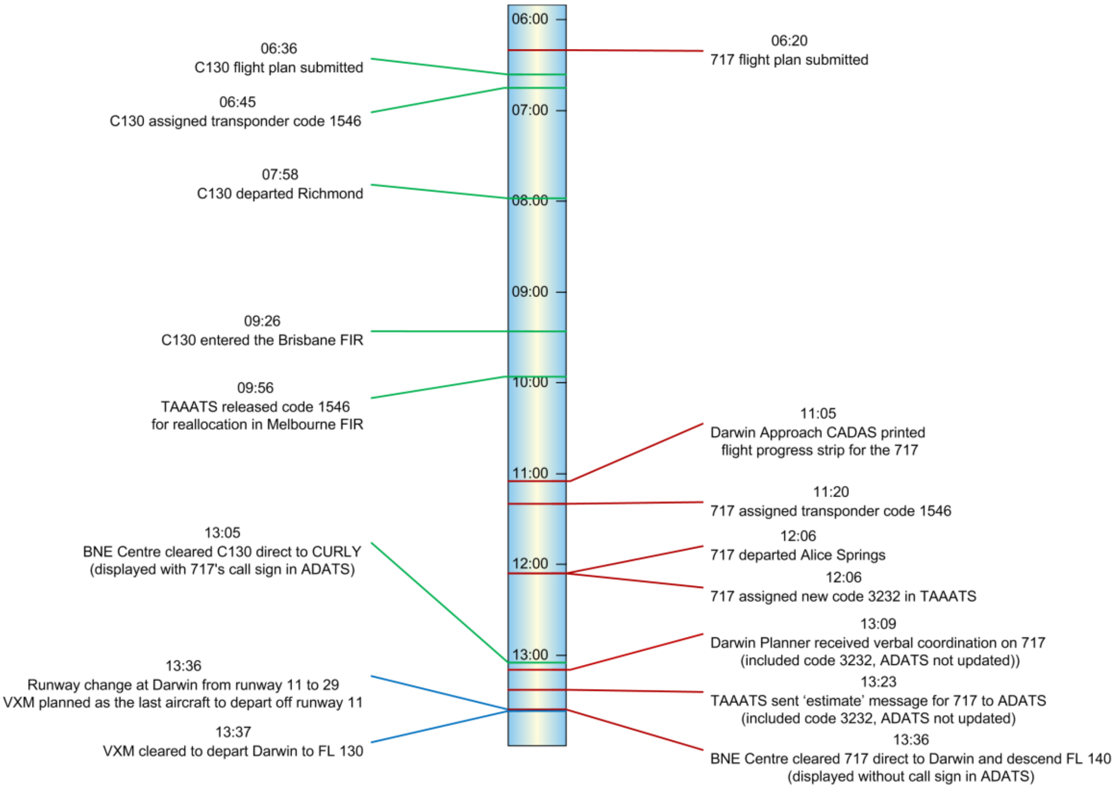
At 1344:43 Central Standard Time[1] on 2 October 2012, a loss of separation (LOS)[2] occurred 14.2 NM (26.3 km) south of Darwin, Northern Territory under the jurisdiction of Department of Defence (DoD) air traffic control (ATC). The two aircraft involved were:

- a Boeing Company 717-200 aircraft, registered VH-NXQ (NXQ), operating a scheduled passenger service from Alice Springs to Darwin, Northern Territory, which was descending towards Darwin
- a Boeing Company 737-838 aircraft, registered VH-VXM (VXM), operating a scheduled passenger service from Darwin to Melbourne, Victoria, which was climbing after take-off.

A key aspect of the occurrence was that Darwin ATC personnel misinterpreted another aircraft as the 717 on their radar display (see Transfer of the 717 to Darwin Approach). This other aircraft was a military C130 Hercules (C130), operating a flight from Richmond, New South Wales, to Dili, Timor-Leste.

The main events associated with the occurrence, prior to the transfer of control jurisdiction for the 717 to Darwin ATC, are summarised in Figure 1 and are explained in more detail in the sections that follow.

Figure 1: Summary of events prior to transfer of control jurisdiction for the Boeing 717



Source: ATSB

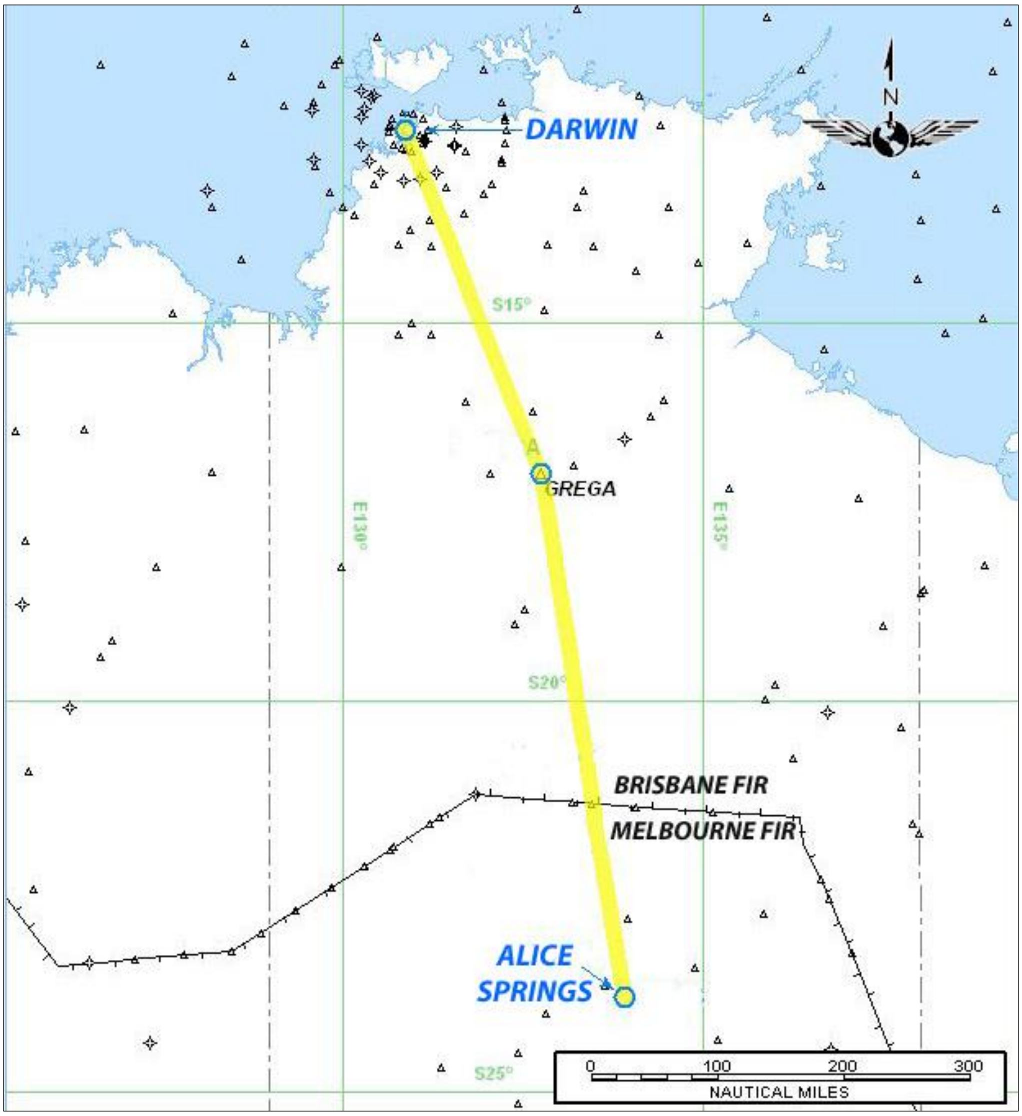
[1] Central Standard Time (CST) was Coordinated Universal Time (UTC) + 9.30 hours.

[2] 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).

Flight planning

At 0620 on 2 October 2012, a flight plan was submitted for the 717's flight from Alice Springs to Darwin. The flight was planned to commence within the civilian-controlled airspace within the Melbourne Flight Information Region (FIR)[3] before entering the Brisbane FIR (Figure 2). The aircraft was scheduled to depart at 1205. The flight plan was disseminated to the civilian air traffic services provider's computer system, The Australian Advanced Air Traffic System (TAAATS), and the DoD's ATC computer system, the Australian Defence Air Traffic System (ADATS).

Figure 2: 717 flight planned route

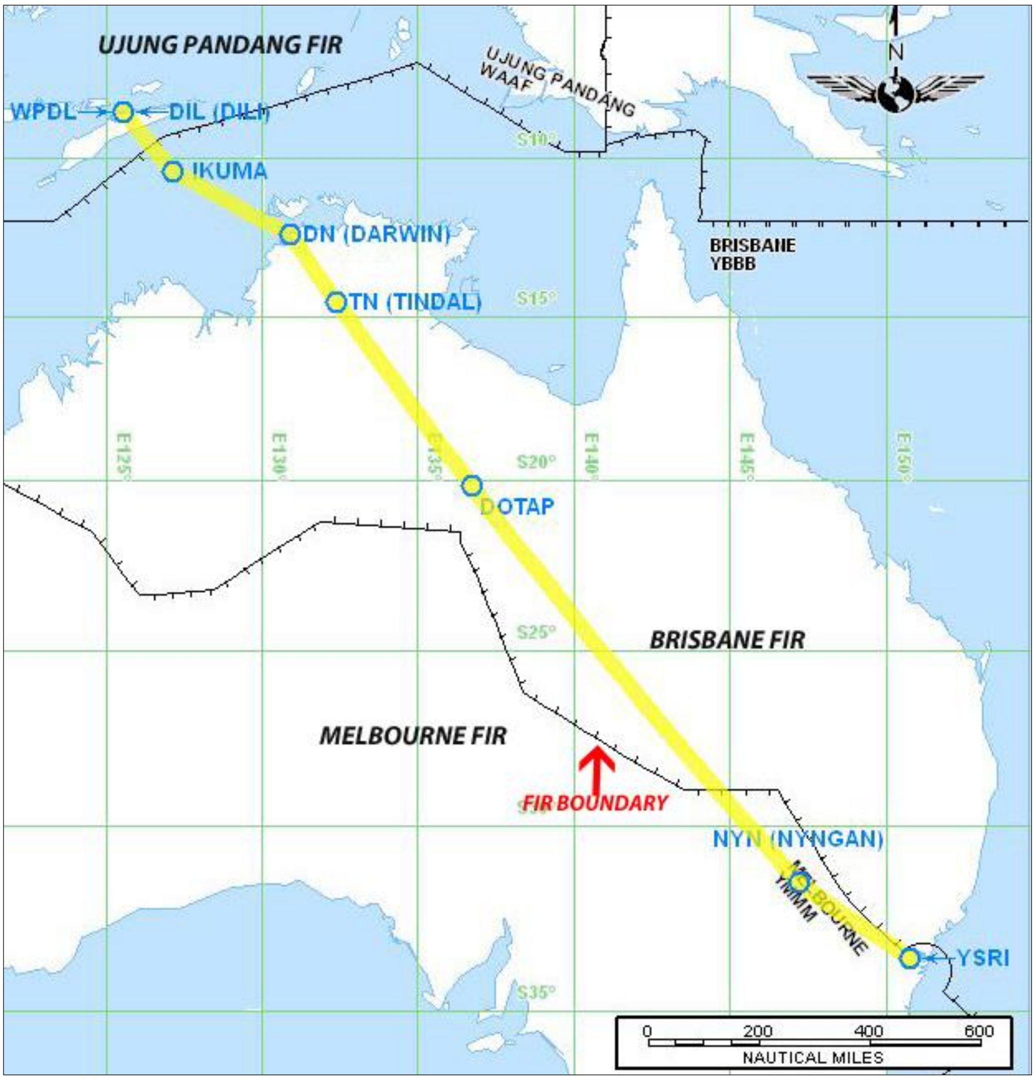


Source: Jeppesen. Image modified by the ATSB.

At 0636, a flight plan was submitted for the C130's flight from Richmond to Dili. The flight was planned to enter civilian-controlled airspace within the Melbourne FIR before transiting through the Brisbane FIR into the foreign controlled Ujung Pandang FIR (Figure 3). Within the Brisbane FIR, the flight was planned to transit at high level overhead Darwin under civil ATC jurisdiction (that is, the jurisdiction of controllers from Airservices Australia's Brisbane Centre). It was not planned to descend into Darwin military controlled airspace en route to its destination, and therefore Darwin ATC did not receive a copy of the C130's flight plan.

3 Airspace of defined dimensions within which flight information service and alerting service are provided.

Figure 3: C130 flight planned route



Source: Jeppesen. Image modified by the ATSB.

Transponder code assignment

At 0645 (45 minutes before the scheduled departure time), TAAATS automatically assigned the C130 a discrete Secondary Surveillance Radar (SSR) transponder[4] code[5] '1546' from the available bank of codes within the system. The C130 departed at 0758 and entered the airspace within the Melbourne FIR.

At 0926, the C130 transited into the Brisbane FIR. Although there was no radar coverage in that area and the aircraft was subject to procedural ATC services, the C130 remained assigned with and squawking[6] the transponder code '1546'. As the aircraft was no longer operating within the Melbourne FIR, 30 minutes later (at 0956), TAAATS automatically released code '1546' for reallocation to aircraft operating within the Melbourne FIR.

At 1105, the Comsoft Aeronautical Data Access System (CADAS) located in the Darwin ATC Approach room printed a paper flight progress strip (FPS) for the 717 for use by Darwin Approach

[4] A receiver/transmitter fitted to an aircraft which will generate a reply signal upon proper interrogation; the interrogation and reply being on different frequencies.

[5] The number assigned to a particular multiple-pulse reply signal transmitted by a transponder in Mode A or Mode C.

[6] Transmission of a four digit number sent out by the aircraft's transponder.

ATC. As the time was more than 45 minutes prior to the aircraft's scheduled departure, TAAATS had not allocated the aircraft a transponder code and therefore no code appeared on the FPS.

At 1120, TAAATS allocated the 717 a transponder code of '1546' (the code previously allocated to the C130) from the codes available for the Melbourne FIR. As part of that process, TAAATS generated a system 'change' message stating the assigned code. This message was disseminated within TAAATS and externally to ADATS and the CADAS in Darwin ATC.

At 1206, the 717 departed Alice Springs, squawking the assigned code '1546'. TAAATS automatically identified that the aircraft would enter the Brisbane FIR and that there was already an aircraft using the transponder code '1546' within that partition (that is, the C130). As a result, TAAATS allocated an amended transponder code of '3232' for the 717, and an automatic internal system message was generated to update the aircraft's flight plan details in TAAATS. That system message was not disseminated externally to ADATS or the CADAS in Darwin ATC. Civil ATC advised the 717 flight crew of the amended transponder code, and the crew selected transponder code '3232'.

Flights to Darwin

At about 1305, when the C130 was 199 NM (369 km) south-east of Darwin at flight level (FL)[7] 260, Brisbane Centre re-cleared the aircraft direct to position CURLY, which was located 150 NM (278 km) north-west of Darwin. With the amended tracking, the C130 would no longer fly overhead Darwin, but pass to the south-west (Figure 4).

At 1309:44, a Brisbane Centre controller provided verbal coordination to the Darwin Approach Planner (PLN) controller for three aircraft tracking to Darwin. The coordination was conducted in accordance with local ATC instructions and included an estimated arrival time for the 717 and the aircraft's assigned transponder code '3232'. The Brisbane Centre controller would not have been aware that there had been a transponder code change associated with the 717, and therefore did not advise the PLN controller that there had been a change. The PLN controller annotated the code '3232' on the printed FPS for the 717, but they did not verify that the code correlated to that assigned to the aircraft's flight plan in ADATS. They then provided the strip, and the strips for the other two aircraft, to the Darwin Approach (APR) controller.

The code assigned in ADATS for the 717 remained as '1546'. Consequently, the ADATS situation displays presented the radar return for the 717 labelled with the transponder code '3232' but no registration or call sign, while the C130 was incorrectly labelled with the 717's registration 'NXQ' (see Figure 6).

At 1323, TAAATS automatically provided a system 'estimate' message to both ADATS and CADAS in Darwin stating the time that the 717 would be at the boundary between civilian and Darwin ATC airspace. That message included the aircraft's assigned code '3232' as amended on departure. Due to an aspect of the message format (see *System messaging*), ADATS did not automatically process the message and it was transferred to the ADATS 'Problem Message Queue' for processing by the Darwin PLN controller. The PLN controller did not check the information contained in the message, including the transponder code, before they deleted it.

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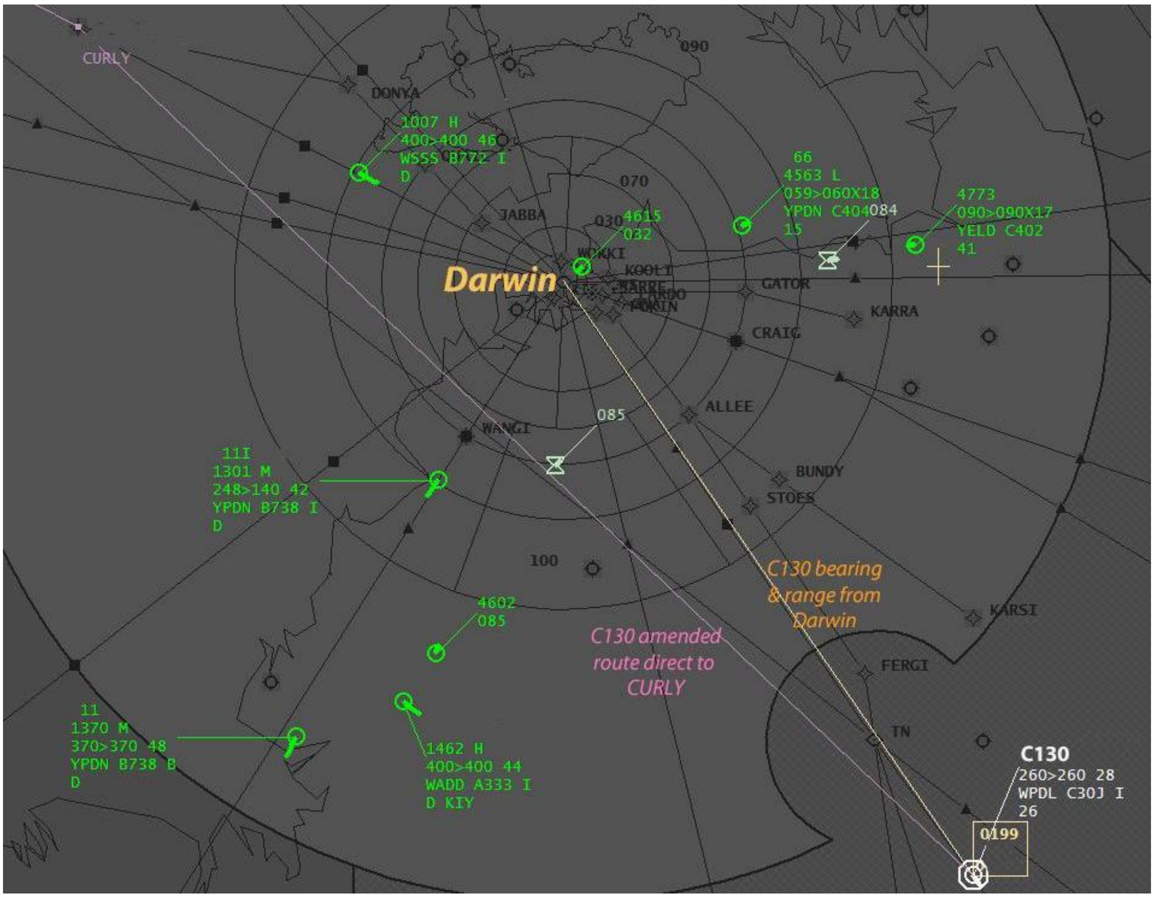
7 At altitudes above 10,000 ft in Australia, an aircraft's height above mean sea level is referred to as a flight level (FL). FL 260 equates to 26,000 ft.

Figure 4: C130 amended route at 1305:29 (TAAATS display)



Source: Airservices Australia. Image modified by the ATSB.

Change of duty runway

Initially the 717 and another Boeing 737, registered VH-YVA[8] (YVA), were planned to track for runway 11 at Darwin via a Standard Terminal Arrival Route (STAR), with YVA positioned about 3 minutes behind the 717. At about 1336, the Darwin Approach Supervisor (ASPR) received a phone call from the Darwin Tower Supervisor advising that there had been a variation in wind direction that favoured a change in operations from runway 11 to runway 29. The ASPR looked at the Approach long-range display, observed the aircraft labelled as 'NXQ' to the south of Darwin and told the Tower Supervisor that the 717 would be the first aircraft to land on runway 29, after the current sequence of aircraft departures from runway 11 was completed. VXM was to be the last departure off runway 11.

After instructing the PLN controller to advise Brisbane Centre of the runway change, the ASPR coordinated directly with Brisbane Centre for the 717 to be re-cleared direct to Darwin and YVA to track via a STAR for runway 29, in order to de-conflict the two inbound aircraft with VXM's departure track. At 1336:33 Brisbane Centre advised the 717's flight crew they were cleared direct to Darwin and to descend to FL 140.

The ASPR later reported that they had not considered the tracking and position of the radar return, labelled as NXQ, to be abnormal for the 717 as at that time of year weather diversions were becoming more frequent. They assumed that the 717's position, left of its flight-planned route, and its reduced groundspeed were related to the flight crew diverting around weather while under the jurisdiction of Brisbane Centre. The ASPR reported that they advised the APR controller

[8] YVA was operating a scheduled passenger service from Sydney, New South Wales, to Darwin.

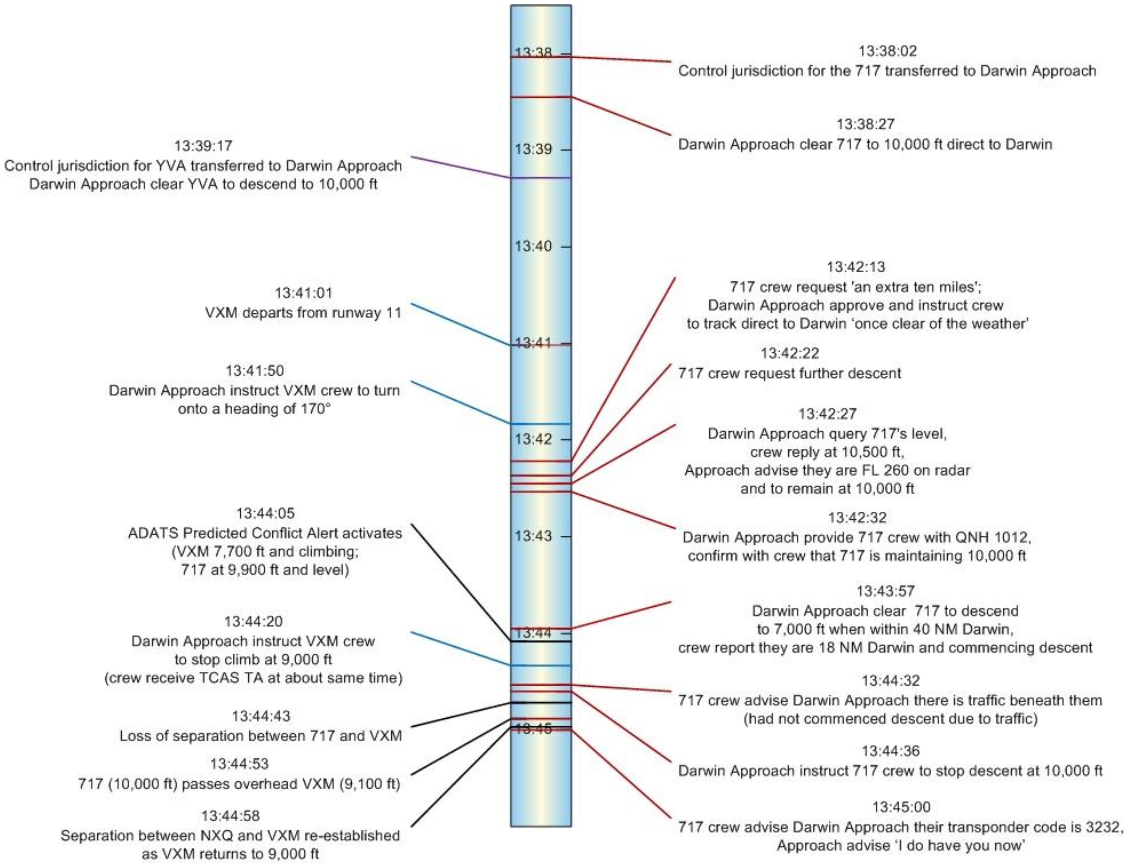
that the 717 appeared to be tracking around weather. They also told the APR controller that coordination had been completed for the 717 to track direct to Darwin and YVA to track via a STAR.

At 1337:27, the APR controller issued departure instructions to Darwin Tower for VXM, with clearance for the aircraft to climb to FL 130.

Transfer of the 717 to Darwin Approach

The main events after the transfer of control jurisdiction for the 717 to Darwin Approach are summarised in Figure 5 and are explained in more detail in the sections that follow.

Figure 5: Events following the transfer of the 717 to Darwin Approach



Source: ATSB

At 1338:02, the Brisbane Centre controller handed over control jurisdiction of the 717 to the Darwin APR controller. During the verbal radar handoff, the Brisbane Centre controller stated 'south east that is NXQ'. The handoff coordination was conducted by the Brisbane Centre controller in accordance with documented coordination requirements established with Darwin ATC. At that time, the 717 was 59 NM (109 km) to the south-east of Darwin descending through FL 292, and the C130 was 56 NM (104 km) to the south of Darwin maintaining FL 260 (Figure 6).

As the radar return for the 717 was outside the 45 NM (83 km) set range of the APR position's main situation data display (SDD), the APR controller referred to the supplementary long-range display to accept the transfer of control. The APR controller later reported that they observed the radar return labelled as 'NXQ' south of Darwin and assumed that the disparity between the 717's observed position and its expected position was due to the amended direct tracking instruction for runway 29 coordinated by the ASPR. After consultation with the ASPR, it was decided that YVA would be sequenced ahead of the 717, based on the perceived position of the 717 relative to an approach to runway 29.

Figure 6: APR long-range display at 1337:57 on 100 NM (185 km) range

Source: Department of Defence. Image modified by the ATSB.
Note: the range set on the APR situation data display at the time of the occurrence was 45 NM (83.3 km).

Loss of separation assurance

On first contact from the 717's flight crew at 1338:22, the APR controller cleared the 717's flight crew to descend to 10,000 ft and track direct to Darwin for an approach to runway 29. That instruction resulted in a loss of separation assurance (LOSA)[9] between the actual position of the 717 (56 NM south-east of Darwin) and VXM (issued climb to FL 130). Consistent with normal practice, the controller also advised the flight crew of the Darwin QNH.[10]

At 1339:17, the Brisbane Centre controller conducted a radar handoff of YVA, which was sequenced about 15 NM (27 km) behind the 717 for arrival into Darwin and cleared to descend to FL 140. On first contact with YVA's flight crew, the APR controller advised them to expect a visual approach to runway 29 and issued them clearance to descend to 10,000 ft.

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9 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.

10 Altimeter barometric pressure subscale setting to provide altimeter indication of height above mean sea level in that area.

At 1341:01, VXM departed off runway 11 on climb to FL 130. On first contact with the APR controller (at 1341:50), VXM's flight crew were issued with an instruction to turn on to a heading of 170° for 'separation with arrivals'.

717 descent to 10,000 ft

At 1342:13, as the 717 was descending through FL 124 and positioned 29 NM (54 km) to the south-east of Darwin, the crew requested 'an extra 10 miles'. The APR controller responded by clearing the 717 crew 10 NM (19 km) 'left of track' with an instruction of 'once clear of the weather track direct to Darwin'. The APR controller reported that they perceived the flight crew's request was to deviate around weather, as the aircraft labelled 'NXQ' was positioned left of the aircraft's expected track to Darwin. At that time, the C130 (mislabelled as 'NXQ') was 44 NM (82 km) to the south-south west of Darwin, tracking in a north-westerly direction, and maintaining FL 260.

The 717's flight crew read back 'one zero miles left and request further descent'. The 717 flight crew later reported that they requested the extra distance to assist with the aircraft's descent profile, and that they had not reported any adverse weather to ATC.

At 1342:27, in response to the flight crew's request for further descent, the APR controller queried the aircraft's flight level and the crew advised they were at 10,500 ft. The controller responded that the 717's displayed altitude was FL 260, and they requested the flight crew to maintain 10,000 ft and to recycle the aircraft's transponder. The controller later said that at this time they thought there was a problem with the altitude information provided by the aircraft's transponder. They also commented that they were not permitted to allow an aircraft to descend below 10,000 ft until it was within 40 NM (74 km) of the airport, but that it was not unusual for flight crew's to request such descent prior to reaching 40 NM.

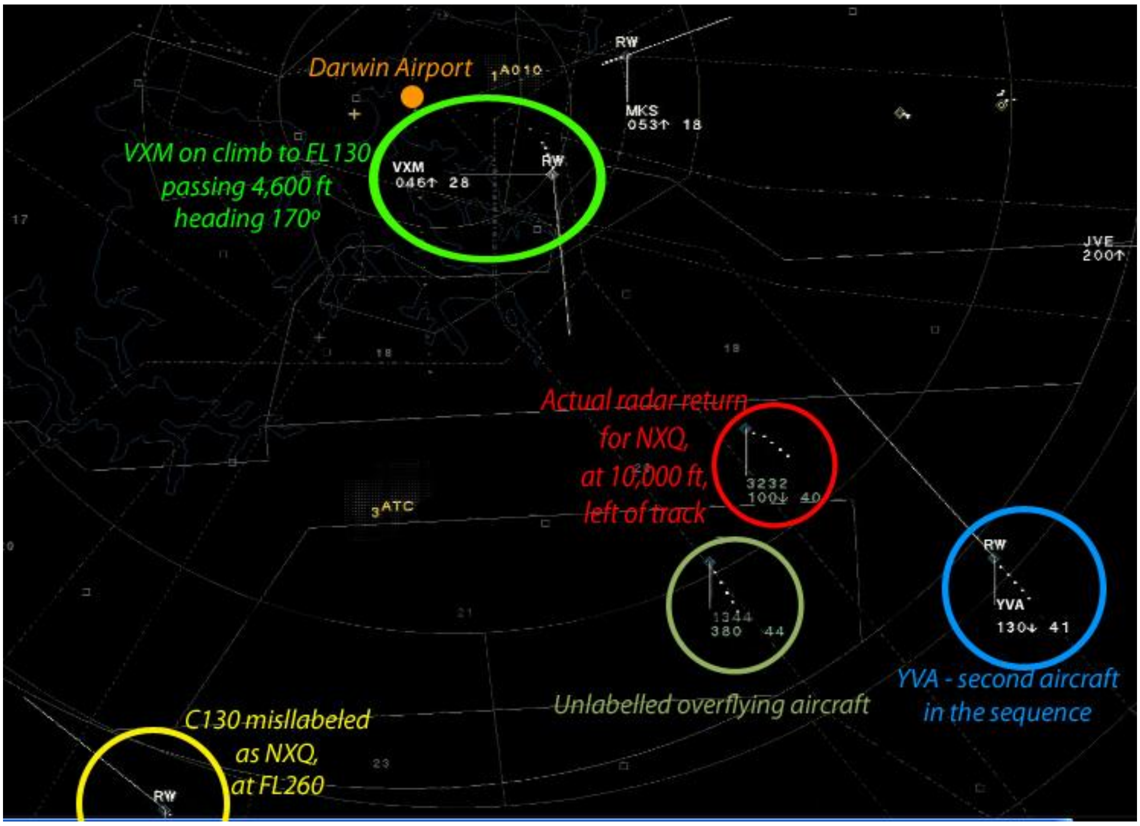
At this time (1343:02), the 717 (with no call sign in its label) was 23.2 NM (43 km) south-east of Darwin, maintaining 10,000 ft, with a groundspeed of 390 kt. In about the 717's 1 o'clock[11] position, at 15.7 NM (29 km), was VXM climbing through 4,600 ft with a groundspeed of 280 kt. YVA was 38 NM (70 km) to the south-east of Darwin, descending through FL 130 with a groundspeed of 410 kt. The C130 (mislabelled as NXQ) was 42.7 NM (79 km) south-south-west of Darwin, maintaining FL 260, with a groundspeed of 290 kt (Figure 7).

At 1343:32, the APR controller advised the flight crew that the amended QNH was 1012. At 1343:40, following acknowledgement of the amended Darwin QNH, the 717's flight crew advised the APR controller that 'if we were at two six DME[12] [26 NM] at flight level [pause] we would have had no chance of getting down'. The APR controller replied that they understood that would be problematic, but they were concerned that the aircraft still did not appear to have descended on radar. They then asked the crew if they were still maintaining 10,000 ft, which the crew confirmed.

11 The clock code is used to denote the direction of an aircraft or surface feature relative to the current heading of the observer's aircraft, expressed in terms of position on an analogue clock face. Twelve o'clock is ahead while an aircraft observed abeam to the left would be said to be at 9 o'clock.

12 Distance Measuring Equipment (DME) is a ground-based transponder station. A signal from an aircraft to the ground station is used to calculate its distance from the ground station.

Figure 7: Position of aircraft on the ADATS situation data display at 1343:02



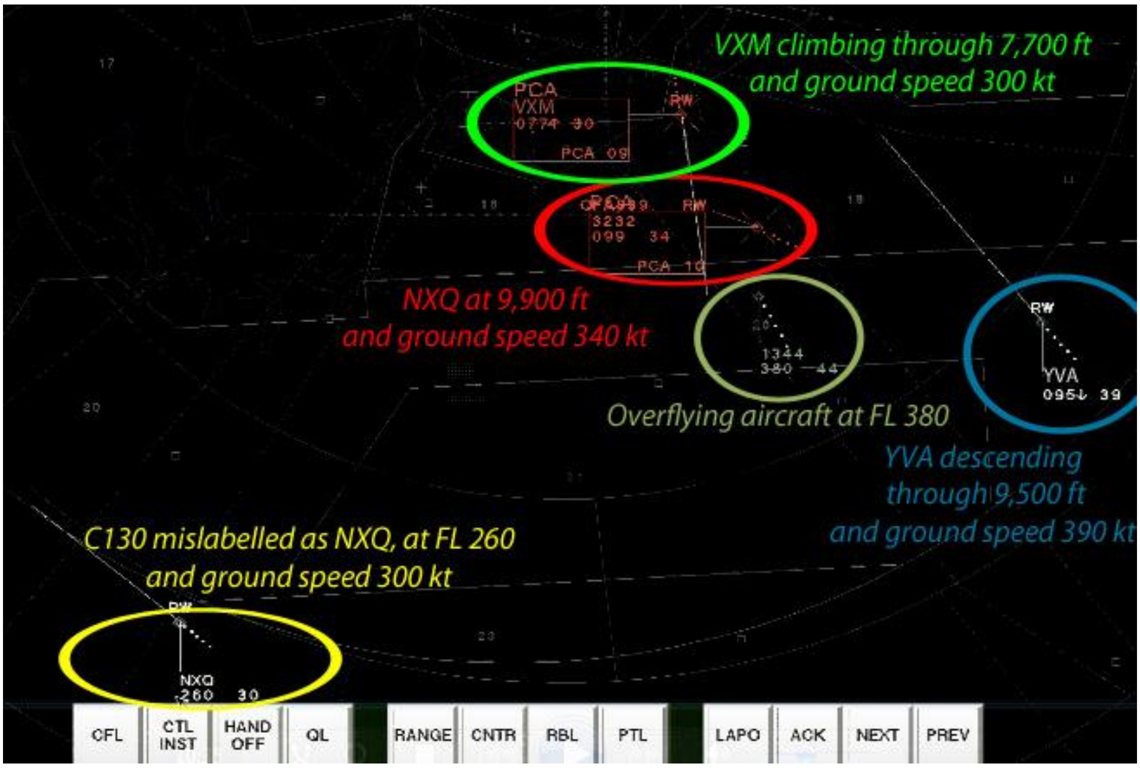
Source: Department of Defence. Image modified by the ATSB.

At 1343:57, the APR controller provided the 717 flight crew with a conditional clearance that, when the aircraft was within 40 NM (74 km) of Darwin, they were cleared to descend to 7,000 ft. The crew advised that they were 18 NM (33 km) from Darwin and leaving 10,000 ft on descent to 7,000 ft. The three controllers all later reported that, as soon as the 717 flight crew stated that they were at 18 NM, they knew something was wrong. At that time (1344:01), the 717 was 18.8 NM (34.8 km) to the south of Darwin, VXM was 11 NM (20 km) south of Darwin, climbing through 7,600 ft, the C130 was 42 NM (77 km) to the south-west of Darwin at FL 260 and YVA was 33 NM (60 km) south-south-east of Darwin, descending through 9,900 ft.

At 1344:05, the ADATS predicted conflict alert (PCA) function activated when there was 1,200 ft and 7.4 NM (13.7 km) between VXM and the 717, with VXM climbing through 7,700 ft and the 717 at 9,900 ft (Figure 8). At about this time the radar return labelled as NXQ was within the 45 NM (83 km) display range of the APR controller's main SDD.

The APR controller reported that they thought the PCA was spurious so they initially disregarded it. The ASPR reported that they were mentally processing the information from transmissions between the 717's flight crew and the APR controller regarding the aircraft's reported position when they saw the PCA activate between VXM and the radar return squawking code '3232'. In response to the APR controller stating that it was a spurious alert, the ASPR instructed the APR controller to stop VXM's climb at 9,000 ft. At 1344:20, the APR controller instructed VXM's flight crew to stop their climb at 9,000 ft, as the aircraft's radar displayed altitude was 8,300 ft. No safety alert was issued and no traffic information was passed.

Figure 8: Activation of the ADATS predicated conflict alert at 1344:05



Source: Department of Defence. Image modified by the ATSB.

The flight crew of VXM later reported that, after departure, they observed an aircraft on their Traffic Alert and Collision Avoidance System (TCAS)[13] about 10 NM (19 km) in their 10 o'clock position, about 2,000 ft above and descending. As VXM approached 8,700 ft, the flight crew received a TCAS Traffic Advisory (TA)[14] alert at the same time that the APR controller issued the revised altitude clearance of 9,000 ft. VXM's flight crew queried the amended altitude, which the APR controller confirmed. The flight crew confirmed the clearance and then entered 9,000 ft into the aircraft's flight management system.

The flight crew of the 717 later reported that they were about to commence their descent from 10,000 ft when they noted that there was proximity traffic on their TCAS display and they immediately acquired that traffic visually. The flight crew then received a TCAS TA alert, and they observed an aircraft in their 2 o'clock position and climbing. At 1344:32, the 717's flight crew informed the controller that there was traffic 1,000 ft beneath their aircraft. The controller instructed them to stop descent and maintain 10,000 ft. At that time, there was 3.6 NM (6.7 km) and 1,400 ft between the 717 and VXM as VXM was still at 8,600 ft on radar and the 717 maintained 10,000 ft.

Loss of separation

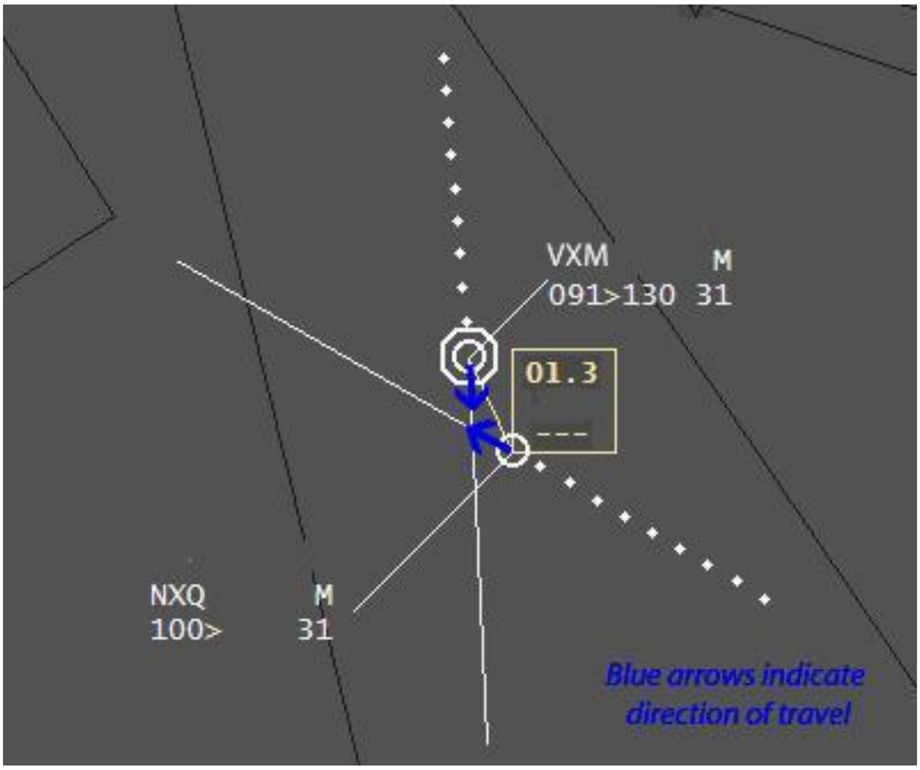
At 1344:43, VXM climbed to 9,100 ft, as the flight crew were unable to arrest the aircraft's climb with the limited notice provided by ATC. The 717 remained at 10,000 ft. The aircraft were 1.3 NM (2.4 km) and 900 ft apart, with VXM positioned 14.2 NM (26.3 km) south of Darwin (Figure 9). The groundspeeds of both aircraft were 310 kt. As the required separation standards were either

[13] Traffic alert and 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.

[14] Traffic alert and collision avoidance system Traffic Advisory (TA)-when a TA is issued, pilots are instructed to initiate a visual search for the traffic causing the TA.

1,000 ft vertical separation or 3 NM (5.6 km) radar separation, there was a LOS. At 1344:45, the ADATS PCA changed to a conflict alert (CA).

Figure 9: Loss of separation at 1344:43 (TAAATS data)



Source: Airservices Australia. Image modified by the ATSB.

As the LOS situation continued, the APR controller asked the 717's flight crew to advise their position, and the crew responded that they were directly above another aircraft. The controller then advised them that 'you've just popped up on our radar at that point' and that the 717's radar return was positioned 40 NM (74 km) from Darwin. At that time (1344:50), the 717 was 15 NM (27.8 km) south of Darwin and 0.6 NM (1.1 km) and 900 ft from VXM.

At 1344:53, the 717 passed directly overhead VXM on a crossing track with 900 ft between the aircraft. Shortly after (1344:58), the vertical separation standard was re-established as VXM had descended to 9,000 ft. At that time, the distance between the aircraft was 1.5 NM (2.8 km) and increasing. The ADATS CA transitioned back to a PCA at 1344:55 and the PCA deactivated at about 1345:05.

At 1345:00, the 717's flight crew advised that they were 15 NM (27.8 km) from Darwin and squawking their assigned transponder code of '3232'. The controller responded with 'roger I do have you now'. After the 717's flight crew informed the APR controller that their aircraft was squawking code '3232', the ASPR checked the FPS for the 717 and saw that it was annotated with that code. The ASPR then checked ADATS, which revealed a transponder code mismatch for the 717 and the overflying C130 aircraft. The ASPR then updated ADATS to correct the code allocation for the 717 in the system.

Context

Air traffic services in Australia

In Australia, the Flight Information Region (FIR) is divided into the Melbourne and Brisbane FIRs (Figure 3). Air traffic control (ATC) services within each FIR are provided by two air traffic services providers. The bulk of controlled airspace in each FIR is under the jurisdiction of Australia's civil air traffic services provider, Airservices Australia (Airservices). The Department of Defence (DoD) provides tower and approach control services at a number of Australian Defence Force bases with aerodrome facilities. Although their prime function is to provide a capability for controlling military aircraft, DoD controllers provide air traffic services at the 'Joint User' airports of Darwin and Townsville for all civil and military aircraft movements.[15]

At the time of the occurrence, DoD was responsible for the provision of air traffic services at Darwin. Darwin ATC comprised of Tower and Approach elements. Darwin Approach was responsible for the provision of air traffic services in the Darwin control area, within a 40 NM (74 km) radius of Darwin, up to and including FL 180, and the active Darwin restricted areas.

Australian Defence Air Traffic System

The Australian Defence Air Traffic System (ADATS) was the computer-based system used by the DoD, including Darwin ATC. ADATS and The Australian Advanced Air Traffic System (TAAATS), used by Airservices, operated independently of one another. There was limited communication between the two systems in the form of system messaging through the Aeronautical Fixed Telecommunications Network (AFTN).

Aircraft labels

In ADATS, aircraft with an active flight plan within that system were displayed as a white track and had a full data block label with the aircraft's call sign, the transponder altitude and a system-calculated groundspeed. The call sign was correlated to the aircraft's transponder code (and the call sign allocated to that code within ADATS).

Radar returns for aircraft without a flight plan in ADATS were displayed as a green track and had a limited data block label with the aircraft's transponder code, transponder altitude and a system calculated groundspeed. Such a track was known colloquially as a 'green code' and could be observed in the Darwin Approach cell numerous times each day for aircraft operating within the circuit area, low level operations outside of controlled airspace and over-flying aircraft.

Conflict alerting

The ADATS conflict alerting system was based on a predicted and/or actual reduction of the basic separation standards used in Approach airspace; 1,000 ft vertical separation and/or 3 NM (5.6 km) radar separation. When ADATS detected that the separation standards between two aircraft were likely to be infringed, based on radar derived information, the predicted conflict alert (PCA) function would activate. That resulted in an aural alert and the tracks and labels of the involved aircraft being displayed in red, with a box around the label and a cross over the radar symbol. If the conflict continued and the proximity between aircraft reduced to below the required horizontal and/or vertical separation standards, the alert would escalate to a conflict alert (CA), also with an aural component. As the ADATS conflict alerting system utilised radar derived data, both aircraft

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15 44 Wing is the Royal Australian Air Force (RAAF) wing responsible for providing ATC services to the DoD. It directly commands two squadrons, which in turn command 11 ATC flights located across the country at nine RAAF bases, HMAS Albatross (Naval Air Station) and Oakey Army Aviation Centre.

tracks coupled to an ADATS flight data record and those without a flight plan (green codes) were subject to conflict alert processing.

At Darwin, ADATS conflict alerting was enabled for the volume of military controlled airspace from 3,500 ft to FL 180 and then the civilian controlled airspace above up to and including FL 240.[16] The CA parameters were set at 2.8 NM (5.2 km) horizontally and 750 ft vertically. The PCA would activate 30 seconds prior to an aircraft infringing the 2.8 NM / 750 ft parameters. The ADATS conflict alerting function was activated for Darwin ATC at the time of the occurrence, with alerting for the circuit area airspace volume suppressed.

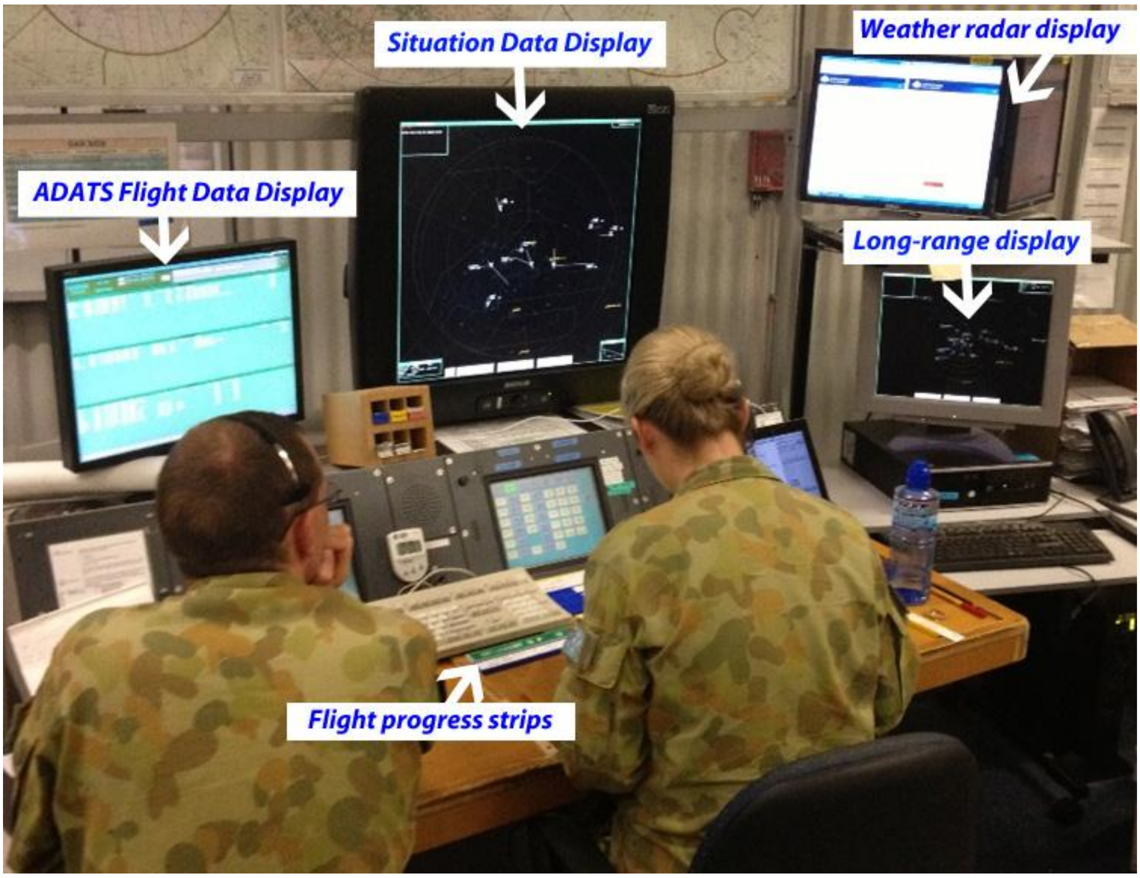
Darwin Approach

The Darwin Approach cell consisted of four positions: Approach Supervisor (ASPR), Approach (APR) East, APR West and Planner (PLN). At the time of the occurrence, the APR East and APR West positions were combined as the traffic levels and complexity did not meet the criteria required for split operation.

Darwin Approach control position

The APR West console consisted of the main ADATS situational data display (SDD), flight data display (FDD), long-range display, weather radar display, flight progress strip board, communications facilities, portable electronic device (for the display of airport approach and departure procedures and aircraft type information) and flight progress strip bay (Figure 10).

Figure 10: Darwin Approach Radar position console



Source: Department of Defence. Image modified by the ATSB.

16 The upper limit of Darwin Approach airspace was FL 180 but the ADATS conflict alerting upper limit was set at FL 240 to include the portion of airspace in which descending aircraft transferred to Darwin Approach by Brisbane Centre were operating.

The SDD was a square, flat, high-resolution Barco screen. The local standing instructions did not document the required default range to be displayed on the SDD. It was reported that the SDD displayed range was dependant on individual APR controller preferences, but normally controllers set their SDD at a range of 45 or 55 NM (83 or 102 km). On the day of the occurrence, the APR controller had their SDD set at a range of 45 NM.

The long-range display provided a view of the ADATS display data for the Darwin airspace at a range of 100 NM (185 km). It had not been part of the original console layout, but had been added later due to the unique circular shape of the Darwin airspace not providing a spare area on the SDD on which to have an auxiliary window set on an extended range. In addition, the SDD was set at a range that did not enable controllers to view aircraft outside of their airspace without a number of inputs to increase the range display. The long-range display was a low-resolution screen situated to the right of the APR controller at a height, distance and resolution that was inconsistent with that of the SDD. The DoD advised that the long-range display was intended to be used only as a situational awareness tool and APR controllers were not to provide radar control services using that display. Other DoD ATC units had an airspace design that enabled an auxiliary window to be shown on their SDDs, and they were not equipped with long-range displays.

A number of Darwin-based controllers reported that due to the low resolution and screen position, they found it difficult at times to see the details in aircraft labels on the long-range display. It was also reported that they found it more effective to increase the range of the SDD to view aircraft outside of their usual setting, as the targets and label details were more clearly defined. In addition, if controllers had aircraft under their jurisdiction that were operating outside of their usual SDD range, many but not all would increase the range on the SDD to ensure that those aircraft were visible. It was identified during the ATBS's investigation that some Darwin APR controllers were using the long-range display to accept aircraft.

Darwin Planner position

The Darwin Approach PLN position required that controller to perform a number of roles including ATC coordination, clearance delivery and flight data coordination.

The PLN position console consisted of communications facilities, flight progress strip bays and board and surveillance equipment of an ADATS SDD and a lower fidelity long-range display. The flight data equipment in the Darwin PLN position consisted of the ADATS FDD (Figure 11) and the Comsoft Aeronautical Data Access System (CADAS)[17] terminal with flight progress strip (FPS) printer (Figure 12).

The primary role of CADAS was to automate the transcription of FPSs. ADATS and CADAS operated independently, and a number of Darwin-based controllers reported that the two systems often operated with conflicting and incomplete information. The absence of integration between the two systems required the PLN controller to manually interact with both, which included completing, updating and correcting information on the CADAS strips and inputting and updating data in ADATS.

The PLN controller was also responsible for processing messages in the ADATS Problem Message Queue (PMQ). System messages sent via the AFTN that could not be automatically processed by ADATS would enter the PMQ.

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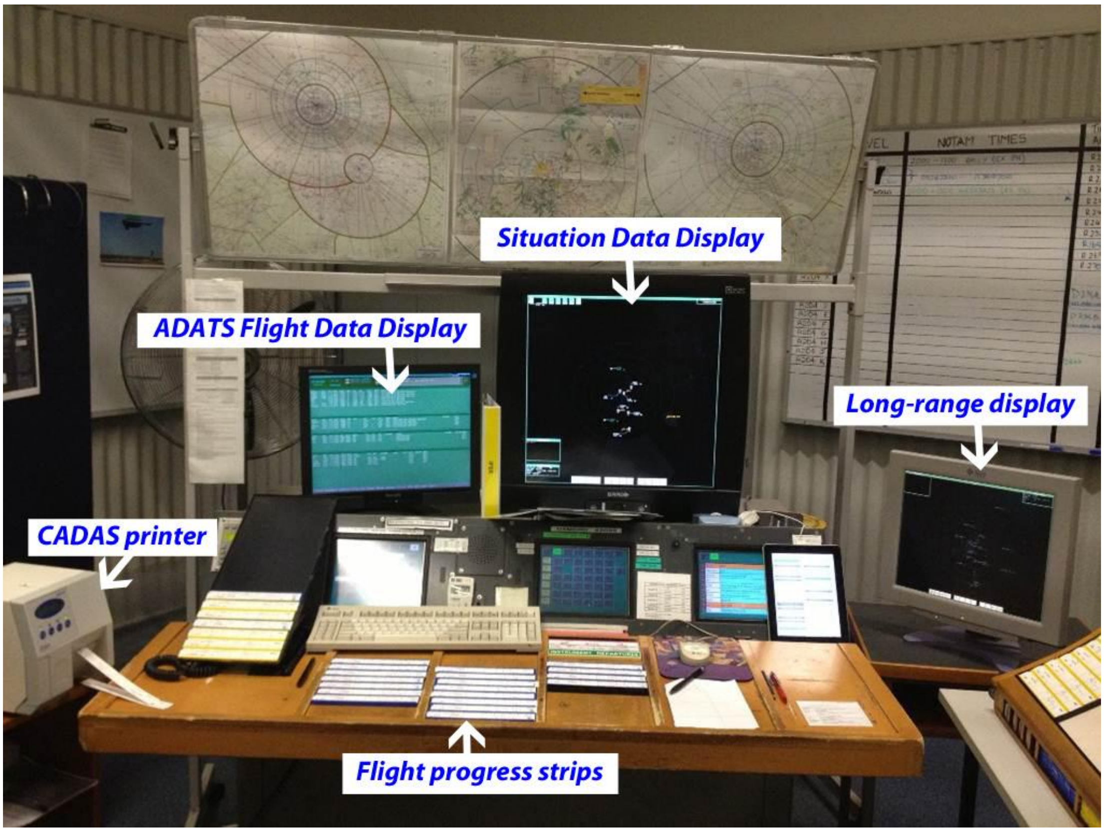
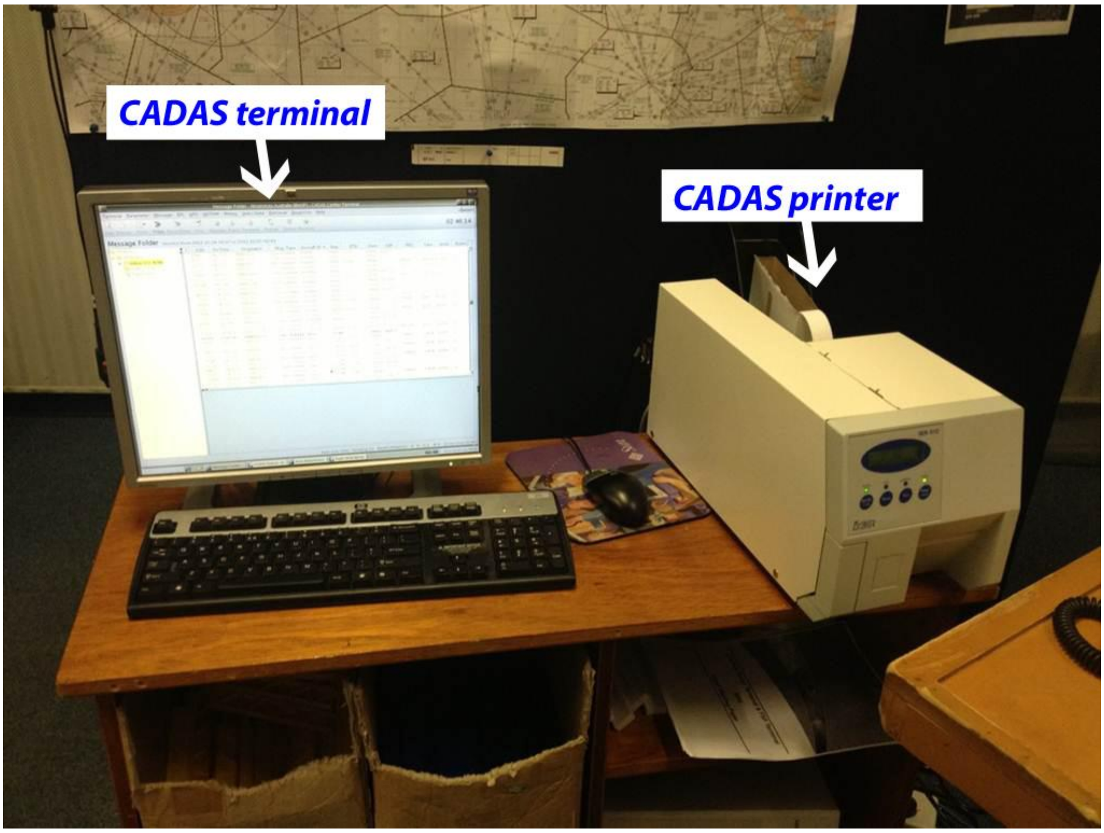
[17] A CADAS terminal and printer was also located in Darwin Tower. In addition, CADAS was in operation in other Defence ATC establishments.

Figure 11: Darwin Approach Planner position console



Source: Department of Defence. Image modified by the ATSB.

Figure 12: CADAS terminal and printer



Source: Department of Defence. Image modified by the ATSB.

Darwin Approach Supervisor role

The Darwin Approach Supervisor (ASPR) had a console located behind and within a few metres of the Approach and PLN position consoles which consisted of communications facilities and a screen displaying the airspace out to 150 NM (278 km) from Darwin.

A close level of supervision was expected to be provided by the ASPR position to the PLN and APR controllers. There was also an expectation that rated controllers were able to operate safely and the ASPR was available to them in a supporting role, to assist when required. The ASPR was required to answer the telephone in the Approach cell and the position was listed in the En Route Supplement Australia as the point of contact for pilots to arrange training flights outside of the circuit area, including instrument rating tests and practice instrument approaches, which required prior ATC approval. The Darwin ASPR position was documented as being staffed as a 'day shift' from 0730 to 1900 daily, with provisions for the position to be unstaffed, with a 5-minute recall under certain conditions, including traffic and controller experience considerations.

ATC system interactions

Secondary Surveillance Radar code assignment processes

TAAATS consisted of two interconnected network systems: one for the Brisbane FIR and one for the Melbourne FIR. The system had 162 Secondary Surveillance Radar (SSR) transponder codes, plus 18 spares, available for allocation to aircraft transiting from the Melbourne FIR to the Brisbane FIR. At 45 minutes before an aircraft's scheduled departure time, TAAATS automatically assigned the aircraft a discrete transponder code from the available bank of codes within the system.

When an aircraft left one of the FIRs and was not under surveillance coverage, a system variable set parameter (VSP) of 20 minutes was applied, after which the flight data record for that aircraft 'finished' in the system. After another 5 minutes, the aircraft's flight plan was 'cancelled' in TAAATS. The code was then 'frozen' for a further 5 minutes to prevent immediate re-assignment after cancellation of the flight plan.

After that period (a total of 30 minutes after the aircraft exited the FIR), the SSR code was released to the set of codes available for reallocation in that FIR. When the system allocated a free SSR code from those available to another aircraft, the oldest free code was assigned.

Control practices for verifying transponder-related information

Brisbane Centre controllers were required to identify an aircraft on radar prior to it entering Darwin airspace and to advise Darwin ATC in the event that it was not radar identified. Transfer of control responsibility was to be conducted by radar handoff and initiated by 10 NM (18.5 km) prior to the common boundary, which was by 50 NM (92.6 km) from Darwin.

The MATS[18] Supplementary Procedures (MATS Supp) for the Northern Territory (NT) documented the coordination requirements between Darwin ATC and Brisbane Centre. In the case of the arriving aircraft involved in this occurrence, Brisbane Centre was required to provide verbal coordination to the Darwin PLN controller when the aircraft were 70 NM (130 km) from Darwin. That coordination consisted of the aircraft's callsign, tracking point or STAR, estimate for Darwin and SSR code.

MATS documented the phraseology for a verbal radar hand-off between ATC units when the aircraft was within the receiving controller's air traffic surveillance system coverage. The transferring controller was required to use the phraseology 'THAT IS… (*callsign*)' and the receiving controller was to respond with 'ACCEPT… (*callsign*)'.

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[18] The Manual of Air Traffic Services (MATS) was a joint publication of Airservices and the DoD.

MATS required that controllers provide ATS surveillance system-derived position information to a pilot under a number of conditions, including when an identified aircraft's position differed significantly from its observed position, and when an identified aircraft was observed to have deviated from its previously approved or advised route. In addition, MATS documented procedures for controllers to use when the displayed pressure altitude-derived level information differed from the pilot-reported or known altitude by more than 200 ft. Controllers were to advise the pilot, request a check of the pressure setting and confirm the aircraft's current level. If the altitude display discrepancy then continued, the controller was to request the pilot to stop the transponder transmission of pressure altitude data, provided that there was no loss of position and identification information.

System messaging

TAAATS was designed to generate and send system messages to advise relevant ATC units of routinely required information and changes associated with a flight.

For an aircraft that departed from a location within the Melbourne FIR, the Melbourne FIR's TAAATS Flight Data Processor (FDP) assigned an SSR transponder code. That code was sent as a system 'change' message to all units that would have an ongoing responsibility for that aircraft. The change message included the aircraft's registration, departure point, destination and assigned transponder code.

If the aircraft was transiting from the Melbourne FIR to the Brisbane FIR, the Melbourne FDP provided the Brisbane FDP with a system 'estimate' message stating when the aircraft would enter the Brisbane FIR. The FIR boundary estimate message included the aircraft's call sign, assigned transponder code, departure point, location and time when the aircraft would enter the Brisbane FIR, and destination.

When the Brisbane FIR's FDP received an 'estimate' message from the Melbourne FDP, it would generate another change message. In the majority of cases, this second change message generated by the Brisbane FDP was a duplication of the original change message from the Melbourne FDP. Accordingly, TAAATS was designed to send the second change message to an internal TAAATS address that did not require action by controllers. This prevented addressees of the first change message from receiving two identical messages.

On 2 October 2012, the transponder code allocated to the 717 ('1546') was already in use within the Brisbane FIR by the C130. In such a situation, the Brisbane FDP issued a new transponder code for the 717 and the second change message generated by the Brisbane FDP included the new transponder code ('3232'). Consistent with the way the system was designed, this change message was sent to the internal TAAATS address, but no other addressees. TAAATS automatically changed the aircraft's assigned transponder code at that time, but ADATS did not.

For an aircraft operating to Darwin, TAAATS would generate an estimate message for the aircraft's arrival which included a waypoint or position on the aircraft's route that was on the boundary between civilian airspace and Darwin ATC airspace. On 2 October 2012, this estimate message included the transponder code that was assigned to the aircraft at that time (code '3232' in the case of the 717 for this second estimate message).

In most cases, the Darwin boundary estimate message would automatically be processed by ADATS. That would include automatically changing the transponder code allocated to the aircraft if the code was different to what had initially been allocated. However, in some cases the message format could not be automatically processed by ADATS, and ADATS sent such messages to its Problem Message Queue (PMQ).

DoD reported that the main reason why some estimate messages could not be automatically processed by ADATS was because the boundary point used in the estimate message was not specified in the ADATS flight plan, as ADATS would truncate the route segment. For some route structures, that truncation resulted in the boundary point being removed from the ADATS flight plan and the relative estimate messages not being automatically processed as there was then no boundary point for ADATS to process. DoD advised that this often happened with aircraft arriving to Darwin from the south-west, but aircraft arriving from the south-east (such as the 717) were normally processed by ADATS without a problem. DoD determined that in the case of the 717 on 2 October 2012, the Darwin boundary estimate message probably went to the PMQ as ADATS could not associate it with an existing flight plan with the transponder code of '3232'.

Situations where the same transponder code was allocated to two different aircraft operating in the same FIR, and the change in code was not automatically processed by ADATS, was reported to be a rare event. Airservices advised that a risk control in place for such a situation for Darwin ATC was to include the new code in the Darwin boundary estimate message generated by TAAATS, which included Darwin ATC as an addressee. In addition, Brisbane Centre was required to provide Darwin ATC with a voice-coordinated estimate for the aircraft, and this was also to include the current transponder code.

ADATS spurious conflict alert activations

The APR controller reported that spurious conflict detections at Darwin were common. Other controllers reported that although spurious alerts could occur they were not that common. In addition, they noted that when they did occur they were of known types. There were no formal hazard or incident reports associated with spurious ADATS conflict alert activations at Darwin prior to the occurrence.

The DoD advised that there were two explanations for the most common spurious alerts. Firstly, the ADATS alerting function parameters were set for a reduction in the separation standards between two instrument flight rules (IFR) aircraft and it was defined in the system to be applicable to all aircraft within a volume of airspace. In situations where separation standards of reduced distances were being applied, such as those that could be applied between IFR and visual flight rules (VFR) aircraft or during the appropriate application of visual separation, ADATS conflict alerts could activate in accordance with the larger standards defined in the system, even though no separation infringement may have actually occurred.

The second explanation was associated with system errors in correlating the data from different radar feeds. Darwin ADATS received radar data from two local radars. The Darwin terminal area radar was located at Darwin Airport and provided both primary and secondary radar surveillance data. The other local radar, located at Knuckey Lagoon to the east of Darwin Airport, provided SSR services only. It was commissioned in 2010 by Airservices and provided enhanced radar coverage for aircraft operating in upper level airspace under the jurisdiction of civilian Brisbane Centre controllers using TAAATS.[19]

An Airworthiness Bulletin issued by the Civil Aviation Safety Authority on 21 December 2010 stated that anomalous transponder behaviour had been detected by Airservices following the installation of new generation SSR interrogators at main airports in Australia. The information from some older aircraft transponders was resulting in the new SSR interrogators interpreting variances from the transponders as different code values. For the Darwin ADATS, utilising data from one of the new SSR interrogators and some aircraft operating in the airspace with older transponders, on occasion the system would receive data for and display two different radar returns, in the same position, for the one aircraft. That would result in an immediate CA activation in ADATS. Darwin controllers reported that the aircraft likely to produce this problem in Darwin were well known, and they did not include NXQ or VXM.

[19] The radar data used by TAAATS was derived from the Knuckey Lagoon radar and Tindal radar (located near Katherine, Northern Territory). Airservices advised that there were no faults associated with the Knuckey Lagoon radar at the time of the occurrence.

TAAATS conflict alerting information

The 717 was correctly labelled in TAAATS as the active SSR code in the FDR correlated with that assigned to the flight crew. The Brisbane Centre controller received a Short Term Conflict Alert (STCA) at about 1443:34, about 22 seconds before the activation of the ADATS PCA.

The system parameters for STCA activation were set for the en route partition at the Brisbane Centre controller's position. The alert activation parameters were 4.1 NM (7.6 km) and/or a controller warning time of 60 seconds. The Airservices Australia National ATS Procedures Manual (NAPM) stated that:

> Parameters for activation are not based on ATC separation standards as this would result in excessive and inappropriate responses to intended operational outcomes.

The NAPM contained procedures for civilian controllers to follow on receipt of a STCA. Controllers were required to assess the integrity of the alert and issue a safety alert if the STCA was valid and the aircraft were, or would be, in unsafe proximity. In the event that the alert was valid but the criteria for issuing a safety alert did not exist, controllers were to then issue traffic advice.

The STCA could be inhibited on a position by position basis by the Shift Manager or Supervisor if they determined that the number of false alerts was affecting the provision of a safe ATC service. Controllers could inhibit the STCA on an individual basis for aircraft involved in formation flights, aircraft operating in close proximity and responsibility for separation had been assigned to the pilots, or military aircraft involved in specific operations.

Although a STCA activated in TAAATS, due to VXM's coordinated level having been updated in the associated FDR, it would not be expected in this occurrence situation that the Brisbane Centre controller would question the separation applied between VXM and the 717. It appeared on radar, from the proximity and altitudes of the aircraft displayed, that vertical separation was being applied by the Darwin APR controller. In addition, it was Darwin ATC's separation responsibility and reasonable for the Brisbane Centre controller to presume that a separation standard was being applied as the two aircraft crossed tracks.

Compromised separation recovery

The Manual of Air Traffic Services (MATS) included guidance and procedures for controllers for the provision of safety alerts and avoiding action advice. MATS stated a requirement for controllers to 'remain vigilant for the development of Safety Alert situations'. A safety alert was to be issued when controllers became aware that an aircraft was in a situation that placed it in unsafe proximity to terrain, obstruction, active restricted or prohibited areas, or other aircraft, and

> the pilot has not advised that action is being taken to resolve the situation or that the other aircraft is in sight, issue a Safety Alert.

Avoiding action advice was to be issued

> to an identified aircraft, when you become aware that an aircraft is in a situation that, in the judgment of the controller, places it at risk of a collision with another aircraft.

MATS also documented a requirement for controllers to not assume that because another controller had responsibility for an aircraft that an unsafe situation had been observed and a safety alert or avoidance advice had been issued.

Following the loss of separation occurrence south of Williamtown, New South Wales on 1 February 2011 (ATSB investigation AO-2011-011)[20], the DoD undertook a number of safety actions to address the identified safety issue that DoD controllers had not received training in compromised separation recovery techniques. All DoD ATC units initiated directed controller briefings and lessons with oral testing in addition to written theory regarding the provisions of

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20 ATSB investigation AO-2011-011, Breakdown of separation near Williamtown, NSW. Available from www.atsb.gov.au.

MATS relating to safety alerts. Subsequently, it was reported that they also introduced regular (fortnightly on average) scenario-based questioning of controllers on safety alerting. In addition to the implementation of Compromised Separation Recovery Training (COMSERT) at the School of Air Traffic Control, the DoD also advised that the development of COMSERT training for all ATC units was in progress, with the objective to provide refresher training at each ATC operational location. When finalised, the training was to be available to all Australian Defence Force air traffic controllers.

Darwin-based controllers reported that shortly after the 2011 Williamtown occurrence, ATC personnel were given detailed briefs on that occurrence and the phraseology to be used in a compromised separation situation. In addition, the relevant MATS section on safety alerting had been printed off and adhered to the APR consoles. There had been no subsequent COMSERT refresher training provided to Darwin-based controllers. The DoD reported that at the time of the 2 October 2012 occurrence, COMSERT for Darwin-based controllers was integrated into the training and assessment syllabus and that COMSERT-specific simulator sequences had been recently designed. In terms of assessment, it advised that controllers annual knowledge-based exams included a range of COMSERT-related questions.

Personnel information

Darwin Approach controller

The Darwin APR controller had about 4 years' experience as a military controller, all of which was gained in Darwin. They reported that they had not received any recent ATC refresher training, including no recent simulator training.

Prior to 2 October 2012, the controller had the previous 3 days free of duty. They reported having a normal amount of sleep during the two nights prior to the occurrence and that they were fit for duty. They commenced their shift on the day of the occurrence at 1100 and, following a 1-hour break, they were plugged into the APR console from 1300.

The APR controller reported that the traffic level during the period leading up to the occurrence was at most moderate, although there was some complexity associated with the runway change. There were no operational distractions.

Darwin Planner controller

The Darwin Planner (PLN) controller had about 6 years' experience as a military controller, of which the last 2 years was gained in Darwin. They also held an APR rating for Darwin. They reported that they had not received any ATC refresher training within the last 2 years, including no recent simulator training.

Prior to 2 October 2012, the Darwin PLN controller had worked shifts on the previous 2 days. They reported having a normal amount of sleep during the two nights prior to the occurrence and that they were fit for duty. They commenced their shift on the day of the occurrence at 1300.

The PLN controller reported that their workload during the period leading up to the occurrence was moderate and 'not too busy', and that there were no operational distractions.

Darwin Approach Supervisor

The Darwin Approach Supervisor (ASPR) had graduated from the Department of Defence's School of Air Traffic Control in July 2008 and been posted to the Darwin Approach cell. They held all of the Darwin Approach ratings, including On-the-job Training Instructor (OJTI), and had been an APR controller for about 2 years and an ASPR for over 1 year at the time of the occurrence. They reported that they had not completed any refresher training in the previous 12-month period.

Prior to 1 October 2012, the ASPR had 10 days free of duty. They reported they had returned to Darwin late on 30 September and had a 'decent sleep' and that they were fit for duty when commencing their shift at 1300 on 1 October. No problems were reported with their sleep prior to their shift on 2 October, which they commenced at 1300.

At the time of the occurrence, the ASPR was providing close supervision of the APR controller, at the APR controller's request, as part of an assessment of their suitability for recommendation to become a training officer. The ASPR reported that traffic levels were light in the period leading up to the occurrence.

Related occurrences

Occurrence related to changes in a flight status

On 12 September 2012, a representative from Darwin ATC submitted an operational hazard report, in the Defence Aviation Hazard Reporting and Tracking System, regarding the displayed full data blocks for airborne aircraft under Darwin ATC jurisdiction terminating and reverting to the default limited data block display. The reporter stated that the hazard associated with such occurrences was that under routine operations, limited data block labels were displayed for aircraft not under Darwin ATC jurisdiction and '…are not subject to regular scan. In effect, they could be ignored'. The potential for the displayed label of an aircraft under control to change to a limited data block, at any time and without warning, was noted as a concern, particularly during periods of high controller workload.

The hazard report also stated that the uncommanded label change was due to the expiration of the aircraft's associated flight plan in ADATS, which could be attributed to a number of factors, including the incorrect amendment of the flight plan from the ADATS PMQ.

Occurrence related to limited checking of flight details[21]

On 14 March 2012, the pilot of a Piper PA-34 aircraft, registered VH-FEJ (FEJ), submitted a flight plan for a flight from Archerfield to Cairns via Townsville, Queensland. Prior to departure, ATC at Archerfield updated the flight plan from visual flight rules (VFR) to instrument flight rules (IFR) at the pilot's request.

The updated flight plan was transmitted via a change message to the various ATC agencies responsible for the aircraft. Townsville ATC, operated by the DoD, utilised CADAS printed FPSs and the FPS for FEJ was printed prior to the change message being processed. The strip therefore indicated that FEJ was a VFR flight.

On first contact with Townsville Approach, FEJ's pilot requested a runway 01 instrument landing system approach. The APR controller cleared the aircraft to track direct to the initial approach fix and, once the aircraft was within 36 NM (66.7 km), cleared the pilot of FEJ to descend to 4,000 ft.

Shortly after, the APR controller became concerned about FEJ maintaining visual meteorological conditions given the weather in the area, and queried the pilot on the aircraft's flight category. On being advised that FEJ was an IFR flight and in cloud, the APR controller immediately instructed the pilot to stop the descent at 5,500 ft. By the time the pilot was able to arrest the aircraft's descent, FEJ had reached 5,200 ft. Though FEJ did not descend below the lowest safe altitude on the aircraft's track, terrain clearance on track was not assured until FEJ climbed back to 5,500 ft. Shortly after, the pilot became visual and FEJ landed without further incident.

The DoD conducted an internal investigation into the incident and found that the PLN controller did not crosscheck an aircraft's flight rules category contained within a change message with those on the FPS. The APR controller did not compare the flight rules category on the FPS for FEJ with that displayed on the radar display, as the controller reported they expected the FPS details to be accurate. In addition, neither the PLN nor the APR controllers queried why FEJ was

[21] ATSB investigation AO-2012-042, ATC procedural error near Townsville, Qld. Available from www.atsb.gov.au.

arriving via an IFR level. However, the report noted that it was not unusual for VFR aircraft to request a practice instrument landing system approach at Townsville.

The DoD investigation stated that Townsville had previously had dedicated flight data positions but that they were removed in December 2009 and CADAS was introduced on 2010. As a result of this occurrence, Townsville-based DoD controllers were required to ensure that the FPS details correlated with the ADATS flight plan, and that the flight rules category and SSR code were correct, before passing the FPS to the APR controller.

Safety analysis

Introduction

The loss of separation (LOS) near Darwin on 2 October 2012 involved the Boeing 717 registered VH-NXQ (NXQ) passing overhead the Boeing 737 registered VH-VXM (VXM) on a crossing track with 900 ft separation between them; this was less than the 1,000 ft separation required. The crews of both aircraft had identified the other aircraft on their Traffic Alert and Collision Avoidance System (TCAS) displays and received a TCAS traffic advisory (TA) alert, and overall there was minimal risk of collision.

A key aspect of the occurrence was that a previously-assigned transponder code was allocated to the 717 in the Australian Defence Air Traffic System (ADATS), which resulted in the 717's radar return remaining without a call sign in the system and its call sign incorrectly correlated to an overflying aircraft that was in the general proximity of the 717. There were no reports of such a situation previously occurring in Australian airspace, and it would be a very low likelihood event.

High-reliability systems such as air traffic control (ATC) have many layers of risk controls to minimise the risk associated with operational hazards. The Department of Defence (DoD) had many risk controls in place to minimise the likelihood of an incorrect code allocation, minimise the likelihood such an event would lead to a LOS, and recover situations following the activation of a conflict alert. However, several of these risk controls were rendered ineffective in this case by many factors, including inherent weaknesses in the design of some of the controls.

This analysis discusses the relevant controller actions, local conditions and risk controls in terms of the allocation and management of transponder codes, identification of an incorrectly-coded aircraft, identification of limited data block radar returns and compromised separation recovery.

Allocation and management of transponder codes

ADATS limitations

The Australian Advanced Air Traffic System (TAAATS), Australia's civil ATC computer system, was designed to minimise the likelihood that two aircraft within the same Flight Information Region would be allocated the same transponder code. In the rare situation where that event did occur, Airservices had processes in place to ensure that a new code was allocated within TAAATS.

However, there were limitations in the interactions between TAAATS and ADATS. In most situations, the standard 'estimate' message sent by TAAATS for aircraft entering Darwin airspace was automatically processed by ADATS. If a new transponder code was allocated to the aircraft in TAAATS, the new code would appear in the estimate message and then be automatically allocated to the aircraft within ADATS.

In some cases, as occurred with the 717 on the day of the occurrence, the Darwin boundary estimate message was not automatically processed by ADATS as it could not associate it with an existing flight plan with the transponder code of '3232'. Not automatically processing estimate messages due to this and other reasons was a known integration problem that DoD had not been able to resolve. If the message was not automatically processed and the code had also changed, the old code continued to be associated with the aircraft in ADATS.

In cases where the estimate message was not automatically processed, the message was sent to the ADATS Problem Message Queue (PMQ) for the Darwin Approach Planner (PLN) to review and process. Darwin-based controllers reported that there were often multiple messages in the PMQ. An estimate message in the PMQ was in the same format regardless of the reason for it being sent to the PMQ, and in most cases an estimate message in the PMQ contained no amended information. If the transponder code changed, this change was not highlighted in the message format.

The DoD noted that it was problematic to include changes in flight plan details, such as a transponder code, in an estimate message, and that it would be more appropriate to notify such changes through a change message. TAAATS did generate a change message in this situation, but it was only sent internally within TAAATS. However, this change message was a routine message generated by the TAAATS Brisbane Flight Data processor on each flight that transitioned from the Melbourne Flight Information Region (FIR) to the Brisbane FIR, regardless of whether there was a change in the transponder code. In the vast majority of cases this change message contained no new information, and therefore TAAATS was configured to not send it to external units in order to avoid unnecessary message duplication. If this change message had been sent on this occasion, it is likely that ADATS would not have automatically processed the message, and there would have been both a change message and an estimate message for the same flight sent to the PMQ.

Manual checking of transponder codes

During the standard coordination process for an aircraft about to enter Darwin airspace, a Brisbane Centre controller would provide the Darwin Approach Planner (PLN) controller with the transponder code currently assigned in TAAATS. However, as most transponder code changes were automatically processed within TAAATS, the Brisbane Centre controller would not be aware if there had been a code change, and therefore could not directly advise the Darwin PLN controller of any such change through the verbal coordination process.

In such situations, the DoD's processes relied on the PLN controller manually checking the transponder code provided by Brisbane Centre with that assigned in the aircraft's flight plan in ADATS. In addition, the process relied on the PLN checking the details within any message listed in the PMQ.

The requirement for the PLN controller to check transponder codes was not specifically stated in the Darwin Approach local instructions. However, to be rated in the Darwin PLN position, a controller was required to complete a competency assessment and demonstrate skills and knowledge in a number of elements, such as the communication of accurate operational messages. The performance criteria included 'FPS [Flight progress Strip] and FDR updated to reflect current air traffic situation' and 'FPS and FDR included in controller's scan pattern and cross-referenced for accuracy'. After the initial rating, a controller's competency in the PLN role was required to be assessed on a 6-monthly basis.

The PLN controller during the LOS on 2 October 2012 reported that they did not crosscheck the 717's transponder code that was verbally advised by Brisbane Centre with the code assigned in ADATS. They also stated that they would normally only conduct that check when the workload was low, and at the time of the occurrence the workload was moderate and 'not too busy'.

The PLN controller said that they could not specifically recall being taught during their training for the Darwin PLN rating to crosscheck the allocation of transponder codes in ADATS with the coordinated codes, and they were not aware of the requirement to do so. They noted that problems had not been identified with their performance in this area during their initial rating check or subsequent 6-monthly checks, or when they were rated as an on-the-job instructor for the PLN position.

A sample of other Darwin-based controllers reported that they were aware of the requirement to crosscheck transponder codes, but some noted that this could not always be done when workload was high (see next section). Some controllers also reported that particular competencies in the PLN training guide were ambiguous, and though an instructor would ensure that a trainee had displayed and achieved the listed requirements prior to their proficiency assessment, individual interpretations of the competencies could result in controllers not meeting the intended requirements, such as crosschecking transponder codes.

As a result of a previous occurrence in Townsville in 2012 involving the crosschecking of information on the FPS with the information displayed by ADATS, local safety action within

Townsville formally required Planner controllers to check the flight category and transponder code were correct prior to passing the FPS to the Approach controller. This safety action had not been considered by the DoD at a broader level.

In summary, due to system limitations, transponder code changes were not always automatically processed by ADATS and detecting such changes relied on the PLN controller manually checking the transponder code provided by TAAATS with that assigned in ADATS. However, unprocessed code changes were not highlighted to controllers. In addition, they were relatively rare, and therefore not expected. Conditions of low salience and low expectancy are known to reduce the ability to detect problems (Wickens and McCarley 2008). Evidence also indicates that the requirement to manually check codes in Darwin was to some extent not consistently understood and reinforced, and the requirement was not always practicable in high workload situations, which could result in not conducting checks becoming more routine in other situations. Overall, there were significant limitations in the risk controls in place to ensure that transponder code changes were correctly updated in ADATS.

Planner position workload

The Comsoft Aeronautical Data Access System (CADAS) was implemented in Darwin towards the end of 2010. Prior to that, there was an additional position in the Darwin Approach room to manage the flight data function, staffed by non ATC-rated DoD personnel. That role also supported the Approach Supervisor (ASPR) position by performing some administration tasks, including answering the phone. Following the implementation of CADAS, the flight data position in the Approach room was terminated and the role assigned to the PLN position. The DoD’s ATC wing (44 Wing) advised that the removal of the flight data position was not initially intended as part of the CADAS implementation, but it occurred at the same time due to other requirements.

A number of controllers reported that the training associated with the implementation of CADAS at Darwin was minimal and had mainly consisted of a PowerPoint presentation, which was not viewed by all controllers. One controller reported that they were absent when CADAS was implemented and they were not provided with an opportunity to learn the new system properly on their return before being required to use it operationally.

Controllers reported that following the introduction of CADAS and the removal of the flight data position, there was a significant increase in workload at times for the PLN position as they had to do a lot more administrative tasks. As a result, they were often required to prioritise tasks and were not always able to complete tasks effectively. The changes also resulted in an increase in the workload for the ASPR position. It was reported that Darwin-based controllers had raised their concerns about the CADAS implementation and associated workload increases in the PLN role within the unit; however, the ATSB was unable to obtain any associated documentation or reports.

The DoD was unable to provide the ATSB with any documentation relative to the introduction of CADAS, and no risk assessment or post-implementation review material was available. Overall, the evidence indicates that during the combined implementation of CADAS and removal of flight data operators at Darwin, the DoD did not effectively identify or manage the risks associated with the increased workload for the Planner position. However, given the workload at the time of the occurrence was not high, it is unlikely that this issue was relevant to the LOS on 2 October 2014.

Identification of an incorrectly-labelled aircraft

Initial assumptions

The 717 was transferred to Darwin Approach at 1338:02. The Darwin APR controller and the ASPR did not identify that the incorrect aircraft was labelled as the 717 in ADATS until after the predicted conflict alert (PCA) activated at 1344:05. The controllers’ performance did not appear to be affected by factors such as workload, distraction or fatigue. Rather, it was consistent with normal cognitive processing tendencies.

The controllers' initial assumption that the radar return labelled and displayed as 'NXQ' was the 717 was not unreasonable given the context. The Brisbane Centre controller had already radar identified the aircraft and the PLN controller had provided them with a FPS for the aircraft. There was an aircraft on the situation displays with the 'NXQ' call sign, and it was at about the same distance and altitude as the 717 and on a similar bearing. As the C130 was not entering their airspace, the allocation of the 717's code to the C130 in ADATS did not provide any suggest ion to the controllers that they were now missing an aircraft under their jurisdiction.

In addition, the controllers had not previously experienced a situation where an aircraft had been assigned the label of another aircraft. In previous cases where an aircraft had a problem with transponder codes labelling, there would be have a limited data block radar return where the aircraft was expected, but not an aircraft being allocated an incorrect code.

It is a known phenomenon of human cognitive processing that when people are faced with an ambiguous situation, they will develop a theory to explain that situation (Reason and Hobbs 2003). People will seek information that confirms their hypotheses, but they rarely attempt to prove their hypotheses wrong, often disregarding or even failing to observe information that would contradict their ideas. This phenomenon is known as confirmation bias (Wickens and Hollands 2000, Kahneman 2011), and it was evident in the performance of the Darwin controllers.

The emergence of a disparity between the information displayed to Darwin ATC and the reports from the 717 flight crew provided subsequent indications that there were discrepancies between the controllers' interpretations and the information presented. In addition, the mislabelled radar return displayed groundspeeds of between 290 to 300 kt and maintained an altitude of flight level (FL) 260, which were inconsistent with the expected aircraft performance and descent profile for a Boeing 717.

Both the APR controller and ASPR noted that the 717 was further left than they expected, with a slower than normal groundspeed for a Boeing 717 aircraft and maintaining a flight level that was not coordinated by Brisbane Centre or reported by the flight crew. However, they assumed that this was associated with the aircraft diverting around weather, even though no weather diversions had been coordinated by Brisbane Centre for the 717 and no other flight crews had reported concerns about weather that day. The fact that both controllers shared the same understanding would have reinforced their assumptions.

The 717 flight crew's request at 1342:13 for 'an extra ten miles' was mistaken by the APR controller as a weather deviation request and resulted in the crew being issued with an instruction to report once clear of the weather. The controller did not realise that the crew's request related to the aircraft being too high on its descent profile. The flight crew acknowledged the clearance, but did not see a need to clarify that their request was because the controller had not facilitated timely clearance to enable the crew to proceed in accordance with the aircraft's descent profile. Unfortunately, the absence of a clarification further reinforced the APR controller's incorrect understanding of the situation.

Resolution of potential transponder discrepancies

At 1342:32, the APR controller was provided with salient information that there was a discrepancy between what was displayed on their situation displays and what was being reported by the crew. This discrepancy related to the aircraft's altitude: it was displayed as FL 260 but the crew reported that they were passing 10,500 ft.

The techniques applied by the Darwin APR controller in this occurrence, to resolve a discrepancy in transponder-derived information, which was perceived to be a transponder fault, were not effective. The options available to the APR controller included asking the 717 flight crew to 'squawk IDENT[22]' which would have provided a flashing radar return on the controller's main situation data display (SDD). In addition, the controller could have asked the flight crew to confirm their assigned code and crosschecked that with the associated flight plan in ADATS. Both of these options would have been effective in this case, but they would have required an understanding that the situation involved more than a problem with displayed altitude.

In hindsight, rather than focussing on a displayed altitude problem, a more useful approach to the situation would have been to start questioning what other information about the aircraft was potentially incorrect. However, as already noted, it is a normal human tendency to look to confirm hypotheses rather than disconfirm them.

At 1343:40, the APR controller was provided with additional cues that there was a problem with the displayed information for the 717. The 717 flight crew indicated they were at 26 NM from Darwin, however the transmission was not complete and it is possible the controller may have interpreted the '26' as referring to the flight level (260), which was unstated. The crew also stated 'if we were at 26 DME' rather than 'we are at 26 DME'. Nevertheless, the crew did indicate that they were too high for their current position.

In effect, the controllers did not realise that the situation was one of being uncertain of the aircraft's position rather than a displayed altitude problem until 1344:01, when the flight reported that they were at 18 NM (33 km) from Darwin, rather than the 42 NM (78 km) displayed by ADATS. It was at that time that the ASPR recognised that there was a disparity in the position information, while the APR controller also started to become aware that something was amiss at this time, but still did not recognise the actual position of 717 or the conflict with the climbing 737.

Use of the long-range display

On the day of the occurrence, the APR controller accepted control jurisdiction from Brisbane Centre for the 717 based on their view of the long-range display, which was consistent with their normal practice, but not in accordance with the DoD operational requirements. For the majority of the occurrence period, the mislabelled radar return for the 717 was displayed to the APR controller on the long-range display only, and they provided control instructions to the 717 flight crew based on the information from the low resolution 'long-looker'. The APR controller later reported that they had some difficulty reading the speed and altitude data of the radar return labelled as NXQ on the long-range display.

The Darwin APR position long-range display was a low resolution screen that was for situation awareness use only. Consequently, controllers were required to use the main SDD for operational control purposes, even though at times it required a number of inputs to increase the range of the SDD to view and monitor aircraft under their control jurisdiction. The investigation determined that some other APR controllers were also using the long-range display for operational control.

Regardless of whether the long-range display was being used as a situation awareness tool or for operational control, its distance from the APR controller and its low-resolution meant that the clarity of the display was sub-optimal. If the display was being used for operational control, it was also not located in an area whereby the display's information could fall into the controller's central visual field, even with a minor head movement. A much preferable option for a long-range display would be one that was located next to the SDD and was of a similar size and resolution to the SDD.

Despite the limitations of the long-range display, it is unlikely that the controller's use of the display contributed to them not recognising the incorrect aircraft was labelled as NXQ. As discussed

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22 All mode A, C, and S transponders include an 'IDENT' button, which activates a special thirteenth bit on the mode A reply known as IDENT, short for 'identify'. When radar equipment receives the IDENT bit, it results in the aircraft's blip 'blossoming' on the radar display. This can be used by the controller to locate the aircraft amongst others by requesting the IDENT function from the pilot.

above, this assumption was associated with contextual factors rather than difficulties in reading the label. The controller also reported that they had no difficulty reading the call signs of aircraft on the long-range display.

Identification of relevant limited data block radar returns

The three controllers in Darwin Approach did not identify that the 717's limited data block radar return was actually the 717, or that it was an aircraft in their jurisdiction airspace, until after the PCA activated. The track would have been detectable for several minutes, and it was relatively close to VXM, so it would have been in an area that was scanned during the relevant period. In addition, the mode C altitude information on the data block would have indicated to the controller that the aircraft was in their jurisdiction airspace. There were several other limited data block tracks on the Darwin Approach main SDD at the time, and these were not relevant to activities in the Approach jurisdiction airspace.

There are many factors that influence the extent to which a relevant target is identified, with a key factor being expectancy. It is a well-demonstrated phenomenon that people are more likely to detect targets they are expecting and less likely to detect targets they are not expecting (Wickens and McCarley 2008). This occurs even when the targets are salient, potentially important and in an area the person is looking at, a phenomenon known as 'inattentional blindness' (Chabris and Simon 2010).

In ADATS, limited data block radar returns were coloured green and full data block returns, representing aircraft with a valid flight plan associated with Darwin ATC and a linked transponder code, were coloured white. In general, white tracks represented aircraft that were relevant for Darwin control purposes, and were therefore usually the most important targets to scan. The use of colour is very effective for distinguishing between different types of targets and making it easier to search for relevant information (Wickens and McCarley 2008). The use of colour in ATC displays to distinguish between jurisdiction aircraft and other aircraft is now common and it is very effective in reducing controller workload. Although it has many advantages, a noted drawback is the potential for making it more difficult to identify relationships between an aircraft within jurisdiction airspace and aircraft from non-jurisdiction airspace (Xing 2006).

Although green radar returns were generally associated with aircraft operating outside of an APR controller's jurisdiction, the consideration of such returns, as part of the traffic picture, was integral in assuring separation with the aircraft known to approach and being provided with an ATC service. A green radar return may not only have represented an aircraft whose transponder code had not been correctly correlated in ADATS, but also an aircraft that unintentionally infringed controlled airspace without a clearance or an aircraft that experienced an in-flight emergency and was unable to communicate with ATC. While the ADATS conflict alerting system would notify controllers of conflictions between both known aircraft and green tracks, routine scanning could proactively identify potential problems before an alert activation.

The APR controller stated that Darwin controllers had constant exposure to multiple green returns for aircraft not under Darwin Approach jurisdiction, such as circuit traffic, high level over-flyers in Brisbane Centre's airspace and low-level aircraft operating outside of controlled airspace. These aircraft were rarely relevant for separation purposes, and the controller had become used to filtering these returns out and not scanning them in detail. They also reported that their training in Darwin had not emphasised the importance of scanning green tracks. Other Darwin controllers also reported that they did not routinely scan green tracks and had not received refresher training covering this issue.

It was reported that at other DoD ATC units, such as Williamtown and Amberley, controllers in those locations were more likely to scan green tracks as such aircraft were more likely to have an influence on separation tasks and there were a great number of instances of operational deviations from pilots resulting in violations of military controlled airspace. The three Darwin ATC Approach personnel on duty at the time of the occurrence had not worked as APR controllers at any other location. Consequently, they had limited experience with including green track radar returns as part of their scan of the display.

In summary, the expectancies of at least some Darwin controllers had developed to the extent that green tracks were not anticipated to provide relevant information relating to jurisdiction aircraft, and so they were not routinely scanned. From a human factors perspective, the best way of overcoming this limitation is to make potentially-relevant aircraft with limited data blocks easier to distinguish from other aircraft with limited data blocks. However, this type of solution is probably not practicable for ADATS. In the absence of a design change, changing controller expectancies through the development, training and reinforcement of appropriate scanning techniques is important.

Compromised separation recovery

Automated conflict detection and alerting systems form fundamental layers of defence against a potential collision, with on-board TCAS providing a potential final defence with its resolution advisory functionality. In this occurrence, the aircraft and ADATS conflict alerting systems functioned in accordance with their design parameters.

The ADATS PCA initiated about 15 seconds prior to the TCAS TA received by VXM's flight crew, and the three controllers in the Darwin Approach cell appeared to immediately detect the PCA. However, the APR controller did not initiate compromised separation recovery actions until prompted to do so by the ASPR, with the first action (an instruction to the crew of VXM) occurring 15 seconds after the PCA activated (and at about the same time as VXM's TCAS TA).

There were also limitations in the nature of the recovery actions, with no safety alert issued or traffic information passed to the flight crew of either aircraft and no sense of urgency conveyed by the controller in limiting VXM's climb. The 717's flight crew identified the traffic confliction, through TCAS and their own situation awareness, and proactively limited their aircraft's descent before being instructed to do so by ATC, which reduced the extent of the vertical separation standard infringement.

Despite a number of indications that the PCA activation related to a genuine confliction, the APR controller advised that they did not promptly respond because they thought it was a spurious alert. As such, they did not identify that compromised separation recovery actions were required. Any situation where a valid traffic conflict alarm is not responded to because it has been assessed incorrectly as a false or spurious alert is very concerning. Although routine exposure to spurious conflict alerts could potentially erode controllers' consideration of the validity of such alerts and adversely affect compromised separation recovery measures, the ATSB found no evidence that that had been occurring in Darwin ATC. Of particular note, neither of the other two controllers on duty at the time considered the alert to be spurious.

There have been anecdotal reports of false or nuisance alerts in United States ATC leading to a 'cry wolf' effect, or reduced trust and use of the alarm system. However, a study looking at response to conflict alerts did not find evidence of this problem (Wickens and others 2009). The study's authors noted that, based on their study and previous research in other industries, false alerts are usually not ignored if system users understand the false alerts to be acceptable in terms of system logic. The spurious alerts that typically occurred at Darwin appeared to be understandable in terms of system logic (that is, a larger separation standard being applied where a smaller one was relevant), or were of a particular type that was easily recognisable (that is, a radar reflection). Neither of these situations applied during the LOS between VXM and the 717.

Research has shown that response times to abnormal or emergency events can vary greatly when the events are unexpected. For example, a recent study examined air transport pilots' responses to expected and unexpected events during routine simulator training flights (Casner and others 2013). When an aerodynamic stall event was expected, the average response time was 1.3 seconds and there was little variation between the pilots. When a stall event was unexpected, the average response time was about 10 seconds, there was much more variability between the pilots' responses, and many of the pilots were unsure about what was happening.

To correctly respond to an emergency situation, a person needs to detect the problem, diagnose the problem, select appropriate response actions and then implement those actions. Delays can occur in any of these stages. In this case, all three controllers promptly detected the PCA, but the APR controller did not diagnose the situation effectively. The PCA occurred at about the same time that the 717 crew provided information about their position that conflicted with the information on the ADATS displays. This probably led to the APR controller having a significant level of confusion regarding the situation and what information was the most reliable. The absence of instructions or traffic information provided to the 717 crew was probably associated with this ongoing confusion and the delay in fully comprehending the situation.

Compromised separation recovery actions are important, emergency response actions that need to be implemented by controllers promptly and accurately. It is widely recognised that to ensure emergency response actions are conducted effectively, they need to be regularly practiced. Skill decay is more likely to occur when tasks are rarely performed (Arthur and others 1998), as is the case for compromised separation recovery actions during actual controlling. It is also more likely to occur for procedural tasks rather than hand-eye co-ordination tasks (Casner and others 2014, Wisher and others 1999), and for tasks that are only learned to a proficiency level rather than over-learned or practiced significantly after reaching a proficiency level (Arthur and others 1998). As noted by Casner and others (2013), emergency training also needs to be carefully designed so as to ensure that the nature and context of the abnormal events vary so that they are not predictable.

Up until 2011, Darwin-based controllers had been provided with limited practical training for compromised separation recovery, and they had not been provided with refresher training since 2011. As such, even if the APR controller had responded to the system alert and applied compromised separation recovery techniques, they may not have been as familiar with the appropriate techniques and phraseology as they may have been if provided with regular, practical refresher training in identifying and responding to compromised separation scenarios.

System reliability

At the time of this report, air traffic services were delivered by two different providers in Australia, using two different air traffic management computer systems with a limited level of integration. As a result, the DoD was required to have a series of risk controls in the form of controller training and defined processes and procedures to manage the known challenges presented by the limited integration between TAAATS and ADATS. Ultimately, there were weaknesses in some of these risk controls.

System limitation and reliability issues may be addressed in the future by the proposal by Airservices Australia and the DoD to develop and implement one air traffic management system that will be used by both in the provision of air traffic services. At the time of writing this report, a project to develop a joint operational concept and national solution to replace or enhance current Australian ATC systems had commenced. The OneSKY Australia project aimed to plan, develop and implement a new air traffic management platform, with the harmonisation of future civil and military air traffic management infrastructure and operations to achieve benefits and efficiencies for military and civilian airspace users as well as for the DoD and Airservices.

Findings

From the evidence available, the following findings are made with respect to the loss of separation between a Boeing 717 aircraft, registered VH-NXQ and a Boeing 737 aircraft, registered VH-VXM, near Darwin, Northern Territory on 2 October 2012. 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

- A previously-assigned transponder code was allocated to the Boeing 717 (VH-NXQ) in the Australian Defence Air Traffic System, which resulted in the 717's radar return having a limited data block label and its call sign being incorrectly correlated to an overflying C130 Hercules aircraft.
- The Darwin Planner controller did not crosscheck the coordinated transponder code for the Boeing 717 with the code assigned in the Australian Defence Air Traffic System (ADATS), which resulted in the incorrect code remaining allocated in ADATS.
- **The Australian Defence Air Traffic System (ADATS) did not automatically process all system messages generated by The Australian Advanced Air Traffic System. In cases where transponder code changes were not automatically processed, the risk controls in place were not able to effectively ensure that the changes were identified and manually processed. [Safety issue]**
- Due to local contextual factors and confirmation bias, the Darwin Approach controller and Approach Supervisor assumed that the radar return labelled as VH-NXQ in the Australian Defence Air Traffic System (ADATS) was correct, and they did not identify the problem with this assumption until after the ADATS predicted conflict alert activated.
- The limited data block radar return displayed for the Boeing 717 was not observed by Darwin Approach until about the time a predicted conflict alert activated in the Australian Defence Air Traffic System.
- **Darwin Approach controllers were routinely exposed to green (limited data block) radar returns that were generally inconsequential in that Approach control environment, leading to a high level of expectancy that such tracks were not relevant for aircraft separation purposes. Refresher training did not emphasise the importance of scanning the green radar returns. [Safety issue]**

Other factors that increased risk

- Following the predicted conflict alert, the Darwin Approach controller did not provide any instructions for 15 seconds and they did not provide a safety alert or traffic information to either flight crew.
- **The Department of Defence's risk assessment and review processes for the implementation of the Comsoft Aeronautical Data Access System and removal of the flight data position did not effectively identify or manage the risks associated with the resulting increased workload in the Darwin Approach environment, in particular with regard to the Planner position. [Safety issue]**

- **The Darwin Approach long-range display was a low resolution screen that presented air traffic control system information with reduced clarity and resulted in it having diminished effectiveness as a situation awareness tool. [Safety issue]**
- **The Department of Defence had not provided Darwin-based controllers with regular practical refresher training in identifying and responding to compromised separation scenarios. [Safety issue]**

Other key findings

- The allocation of Secondary Surveillance Radar transponder codes, and the associated messaging and coordination, was in accordance with defined processes and procedures.
- The aircraft involved were squawking their assigned transponder codes and there were no identified unserviceabilities with the transponders of those aircraft.
- The flight crew of the Boeing 717 aircraft registered VH-NXQ identified the traffic confliction and proactively limited their aircraft's descent before being instructed to do so by air traffic control, which reduced the extent of the vertical separation standard infringement.

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.

Risk controls for manual processing of transponder code changes

Number:	AO-2012-131-SI-01
Issue owner:	Department of Defence
Type of operation:	Aviation – Air traffic services
Who it affects:	All Darwin Approach Supervisor, Approach and Planner rated Joint Battlefield Airspace Controllers

Safety issue description:

The Australian Defence Air Traffic System (ADATS) did not automatically process all system messages generated by The Australian Advanced Air Traffic System. In cases where transponder code changes were not automatically processed, the risk controls in place were not able to effectively ensure that the changes were identified and manually processed.

Proactive safety action taken by Department of Defence

Action number: AO-2012-131-NSA-033

A Safety Advisory dated 18 March 2013 was distributed to Department of Defence (DoD) controllers on 19 March 2013. The document referenced the findings of the Directorate of Defence Aviation and Air Force Safety's investigation. The documented purpose of the Safety Advisory was to address three internal recommendations:

- 44 Wing should highlight to controllers the importance of the appropriate and timely actioning of all messages sent to the Australian Defence Air Traffic System (ADATS) Problem Message Queue (PMQ)
- 44 Wing should implement measures to ensure that all Planner controllers confirm that correct transponder codes are allocated in the ADATS flight plan
- 44 Wing should reinforce to controllers to take immediate action on all conflict alert (CA) and predicted conflict alert (PCA) alarms, and, only once confirmed that no conflict is present or that particular alarm confirmed as spurious, can a lesser action be taken.

One of the intents of the Safety Advisory was to provide awareness to controllers that the PMQ needed to be thoroughly checked prior to inadvertent deletion of important information.

In addressing the recommendation for the implementation of measures to ensure the correct allocation of transponder codes, the Safety Advisory advised controllers to 'consciously ask themselves what needs to be done with the information they receive during coordination between different agencies.'

The document also highlighted to controllers the importance of ADATS conflict alerts and instructed controllers that all PCA and CA alarms were to be considered legitimate and that:

> …all necessary control instructions to ensure separation between conflicting aircraft are to be issued in the interim until the alarm is proven to be something other than legitimate.

On 31 July 2014, the DoD also advised that 44 Wing would work with Airservices Australia to ascertain if the implementation of change messaging between the ADATS and The Australian Advanced Air Traffic System was feasible.

ATSB comment in response

The safety action taken by DoD required that individuals be more vigilant in their processing of Problem Message Queue (PMQ) traffic and coordinated details but did not address the influence of increased workload in the Planner position that could result in not all tasks, including the manual processing of messages from the PMQ, being completed in a timely manner. However, the introduction of Flight Data Operators (FDOs) at a number of Defence air traffic control establishments (see AO-2012-131-SI-03) may reduce workload in the Planner position and allow more time for the processing of PMQ traffic and coordinated details. As such this safety action, in conjunction with the provision of FDOs and the potential for modification of change messaging, should reduce the risk of this safety issue.

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.

Controller scan of green radar returns

Number:	AO-2012-131-SI-02
Issue owner:	Department of Defence
Type of operation:	Aviation – Air traffic services
Who it affects:	All Darwin Approach Supervisor, Approach and Planner rated Joint Battlefield Airspace Controllers

Safety issue description:

Darwin Approach controllers were routinely exposed to green (limited data block) radar returns that were generally inconsequential in that Approach control environment, leading to a high level of expectancy that such tracks were not relevant for aircraft separation purposes. Refresher training did not emphasise the importance of scanning the green radar returns.

Proactive safety action taken by Department of Defence

Action number: AO-2012-131-NSA-034

On 27 November 2013, the DoD advised the ATSB that in response to an internal recommendation for the Department of Defence's 44 Wing to review radar control training programmes to ensure that they include a requirement for controllers to scan green codes, the Department of Defence (DoD) documented that:

> The School of Air Traffic Control stated that they concentrate quite a lot of time towards scanning of green codes during the Initial Employment Training and the Approach training.
>
> Planner students are required to continuously scan all unidentified aircraft to expand on their situational awareness. The subject of violations of controller airspace is also touched on with emphasis on the crew resource management aspect of scanning and assisting the approach controller in monitoring airspace.
>
> During Approach training, unidentified aircraft are actively input in the scenario as violations of controlled airspace adding to the requirement of the controller scanning the radar picture. To ensure a non-standard solution, the exercises have multiple unidentified tracks outside of controlled airspace which never actually enter the airspace.

In addition, DoD documented that the majority of simulator-equipped air traffic control units had included green radar returns in their local training packages. The scenarios included unidentified radar returns that entered controlled airspace, with some requiring a traffic alert to be given and an 'alternate separation solution implemented'.

ATSB comment/action in response

The ATSB is not yet satisfied that the action taken by the Department of Defence has addressed the safety issue. Though the consideration of controller scanning of green radar returns has been covered in the initial and approach training syllabus of the School of Air Traffic Control, and included in the simulator scenarios of the air traffic units where there is such a capability, there is no evidence that there are provisions at those units to ensure that controllers complete the simulator-based refresher training. In this occurrence, the Darwin Approach cell personnel on duty reported that they had not completed any refresher training in at least a 12-month period, though Darwin was simulator-equipped.

ATSB safety recommendation to the Department of Defence

Action number: AO-2012-131-SR-041

Action status: Released

The Australian Transport Safety Bureau recommends that the Department of Defence takes further safety action to address the limited provision of regular simulator-based refresher training that emphasises the importance of scanning green radar returns.

Current status of the safety issue

Issue status: Not adequately addressed

Justification: The ATSB is not satisfied that there are provisions for Department of Defence air traffic controllers at simulator-equipped units to regularly complete simulator-based refresher training and, as such, there is no provision for controllers to be regularly exposed to training scenarios involving green radar returns.

CADAS risk assessment and review process

Number:	AO-2012-131-SI-03
Issue owner:	Department of Defence
Type of operation:	Aviation – Air traffic services
Who it affects:	All Darwin Approach Supervisor and Planner rated Joint Battlefield Airspace Controllers

Safety issue description:

The Department of Defence's risk assessment and review processes for the implementation of the Comsoft Aeronautical Data Access System and removal of the flight data position did not effectively identify or manage the risks associated with the resulting increased workload in the Darwin Approach environment, in particular with regard to the Planner position.

Proactive safety action taken by Department of Defence

Action number: AO-2012-131-NSA-035

On 31 July 2014, the Department of Defence (DoD) advised the ATSB that in September 2013 they conducted a review of the Comsoft Aeronautical Data Access System and its associated impact on the Planner role. A number of recommendations were made as a result of that review process. The DoD advised the ATSB that:

> The review has highlighted that the implementation of CADAS was lacking in overarching guidance from higher command. It also explained that the intention was for the Flight Data Operators (FDO) to continue providing a service while utilising the CADAS; it was purely coincidental that the FDO was

> removed by their parent command (41WG) [41 Wing] at the same time that the CADAS was installed. 44WG was left with no option but to include the duties of the then vacant FDO position within the PLN function.
>
> One of the recommendations from this review was to explore the feasibility of employing FDOs at a number of our busier bases. Late in 2013, 44WG [44 Wing] assessed that those bases would be Amberley, Darwin and Williamtown, with scope to include other bases in the future. FDO personnel were selected from within Air Force and a staggered posting rotation began on 13 Jan 14. Darwin currently has one dedicated FDO in location with a second arriving on 04 Aug 14.

Current status of the safety issue

Issue status: Adequately addressed.

Justification: The ATSB is satisfied that the safety action, when fully implemented, will reduce the risk associated with this safety issue.

Long-range display effectiveness

Number:	AO-2012-131-SI-04
Issue owner:	Department of Defence
Type of operation:	Aviation – Air traffic services
Who it affects:	All Darwin Approach rated Joint Battlefield Airspace Controllers

Safety issue description:

The Darwin Approach long-range display was a low resolution screen that presented air traffic control system information with reduced clarity and resulted in it having diminished effectiveness as a situation awareness tool.

Proactive safety action taken by Department of Defence

Action number: AO-2012-131-NSA-040

On 31 July 2014, the Department of Defence advised that:

> 44WG [44 Wing] agrees that the long-range display should not be used for the purpose of issuing control instructions, or for establishing separation standards. As described in the analysis there was some confusion amongst the controlling workforce as to the intended and appropriate use of the long-range display. In the interim, Darwin Flight has ensured that all controllers are aware of the operating limitations of the long-range display and this is detailed within the local Flight Standing Instructions.
>
> 44WG is considering one of two options regarding the use of the long-range display. Option one will be to incorporate a display that is ergonomically placed to ensure it is in a controller's central visual field and is also of a display quality that meets the requirements to utilise it for controlling purposes. Option two is to remove the current long-range display and to adjust NT MATS SUPP coordination procedures to allow for radar hand-offs that occur within the range set on the APR [Approach] controllers' SDD [situation data display].

Current status of the safety issue

Issue status: Adequately addressed.

Justification: The ATSB is satisfied that this safety action will, when fully implemented, satisfactorily address the safety issue.

Compromised separation recovery refresher training

Number:	AO-2012-131-SI-05
Issue owner:	Department of Defence
Type of operation:	Aviation – Air traffic services
Who it affects:	All Darwin-based Joint Battlefield Airspace Controllers

Safety issue description:

The Department of Defence had not provided Darwin-based controllers with regular practical refresher training in identifying and responding to compromised separation scenarios.

Response to safety issue and proactive safety action taken by Department of Defence

On 31 July 2014, the Department of Defence (DoD) advised the ATSB that:

> Even though 44WG [44 Wing] does not agree that effective compromised separation recovery procedures played a major part in this incident, we do agree that Compromised Separation Recovery Training (COMSERT) is an essential element of air traffic service provision. As part of the COMSERT discussion the ATSB report makes reference to a previous LOS [loss of separation] occurrence at Williamtown, in which the implementation of COMSERT is discussed. Immediately after the occurrence [at Williamtown], the frequency of COMSERT was increased in order to reach an acceptable standard of knowledge and skill amongst the controlling workforce. Once this had been achieved, the intent was always to include COMSERT in initial employment training (IET) and on the job training (OJT). This would result in COMSERT becoming part of our core business. Evidence recorded [in ATSB report AO-2011-011] indicates an increased focus on safety alerting in IET at the SATC [School of Air Traffic Control], as well as local Flight ground school and OJT. In addition, the 44WG core knowledge exam banks also include a range of COMSERT related questions which forms part of an individual controller annual currency requirement. Anecdotal evidence through telephone reporting of safety occurrences and ASORs over the last 18 months indicates that the use of safety alerting has increased and has become a standard feature during occurrences that warrant the alerting.
>
> While 44WG agrees with the ATSB that COMSERT is essential for the provision of a safe air traffic service, it does not agree that we need to increase the amount of refresher training provided. Taking into account the fact that COMSERT is part of core business; is assessed through IET and OJT; is catered for in annual theoretical exams; and safety reporting indicates an increased use of safety alerting, 44WG believes that it has already met the ATSB's intent of effective COMSERT training.

On 28 August 2014, following a request from the ATSB for further information, the DoD advised that:

> The SATC covers training regarding COMSERT during Basic Course and also during SPVR [Supervisor] and TRNGOFF [Training Officer] Courses. Emphasis has also been instilled on all the FLTs [Flights] to ensure that COMSERT is part of JBACs [Joint Battlefield Airspace Controllers] ongoing training and assessment. FLTs are currently training/assessing in a number of different ways including: simulator exercises (for those FLTs that have one[23]), power point presentations, annual exams, during proficiency checks, through training Guides, during morning quiz and through phraseology cards placed in the workplace. HQ44WG [Headquarters 44 Wing], with the assistance of a member from SRG's [Surveillance and Response Group's] Training Team, is in the process of standardising a COMSERT Training Package to be distributed to all FLTs. This package will include a film and an annual exam (100% accuracy required to pass) that is PMKeyS reportable on CAMPUS. This package is being designed in alignment with the AsA [Airservices] COMSERT Training Package that was forwarded to the Wing. (Note: PMKeyS is the Defence personnel management system and CAMPUS is our computer based training system).

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[23] Williamtown, Darwin and Townsville are the major DoD controlled civil airports and each has a simulator.

ATSB comment/action in response

The ATSB acknowledges the DoD's present efforts and those in recent years to implement training and assessment for compromised separation recovery actions. However, the ATSB is still concerned that all controllers are not being provided with regular simulator-based opportunities to practice the implementation of these actions, including at Darwin where a simulator is available.

ATSB safety recommendation to Department of Defence

Action number: AO-2012-131-SR-042

Action status: Released

The Australian Transport Safety Bureau recommends that the Department of Defence takes further safety action to address the provision of regular and practical simulator-based refresher Compromised Separation Recovery Training to all controllers.

Current status of the safety issue

Issue status: Not adequately addressed

Justification: The Department of Defence have not considered in their safety action that the effective application of compromised separation recovery actions requires regular skills-based refresher training, in addition to theoretical training components.

Other 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 relevant to this occurrence.

Spurious collision alerts

Proactive safety action taken by Department of Defence:

Though the ATSB could not determine the number or regularity of spurious ADATS conflict alerts at Darwin, the Department of Defence investigation report contained a recommendation that '44 Wing should implement measures to document, and seek rectification of, the spurious Collision Alerts being experienced by the Darwin ADATS.'

In response, 44 Wing reported that processes were already in existence for the reporting of any fault within ADATS, including spurious alarms. Those procedures included notification to the Technical Operational Monitoring maintenance position at each air traffic control unit of any faults, and the option for controllers to document information in the Tower or Approach occurrence logs if a fault had an adverse impact on aviation operations at the time. Further work would be undertaken to better present reported data for the purposes of data extraction when monitoring the trends of spurious conflict alerts in ADATS.

General details

Occurrence details

Date and time:	2 October 2012 – 2245 EST	
Occurrence category:	Incident	
Primary occurrence type:	Aircraft separation	
Location:	26.3 km south of Darwin Airport, Northern Territory	
	Latitude: 12° 36' 42" S	Longitude: 130° 59' 47" E

Aircraft 1 details

Manufacturer and model:	Boeing Company 717-200
Registration:	VH-NXQ
Serial number:	55097
Type of operation:	Scheduled passenger service
Damage:	None

Aircraft 2 details

Manufacturer and model:	Boeing Company 737-838
Registration:	VH-VXM
Serial number:	33483
Type of operation:	Scheduled passenger service
Damage:	None

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the involved Department of Defence air traffic controllers
- the Department of Defence
- Airservices Australia
- the operators of VH-NXQ and VH-VXM.

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Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, the 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 involved air traffic controllers, the Department of Defence, Airservices Australia and the aircraft operators.

Submissions were received from the Department of Defence and Airservices Australia. 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

Enquiries 1800 020 616
Notifications 1800 011 034
REPCON 1800 011 034
Web www.atsb.gov.au
Twitter @ATSBinfo
Email atsbinfo@atsb.gov.au

Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation

Loss of separation involving Boeing 717, VH-NXQ and Boeing 737, VH-VXM near Darwin Airport, Northern Territory
2 October 2012

AO-2012-131

Final – 2 October 2014