Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation – AO-2007-002
Final

Breakdown of separation
157 km east of Darwin, NT
19 April 2007
VH-AZJ
Piper Aircraft Corporation PA-31
VH-TFF
Cessna Aircraft Company C210N

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Abstract

On 19 April 2007, the Darwin radar (DNR) airspace was being operated as a non-radar procedural sector due to the removal of the Australian Defence Air Traffic System (ADATS) radar data from the civil Australian Advanced Air Traffic System (TAAATS). That change in arrangements was necessary because of ongoing technical problems with the integration of the ADF data into the civil radar system.

At about 0909 Central Standard Time, the DNR controller identified that an instrument flight rules (IFR) Cessna Aircraft Company C210N, tracking from Darwin to Gove, NT at an altitude of 9,000 ft, was in conflict with an IFR Piper Aircraft Corporation PA31-350 that was tracking from Bathurst Island to Jabiru and that a breakdown of separation standards had occurred. The controller re-established the required separation.

The investigation identified that the safety management system employed by Airservices Australia did not require the conduct of an independent review of the locally-conducted hazard assessment process that was utilised to manage the controller's loss of radar surveillance capabilities. This was considered to be a safety issue.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. ATSB investigations are independent of regulatory, operator or other external organisations.

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 enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, 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 proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au.

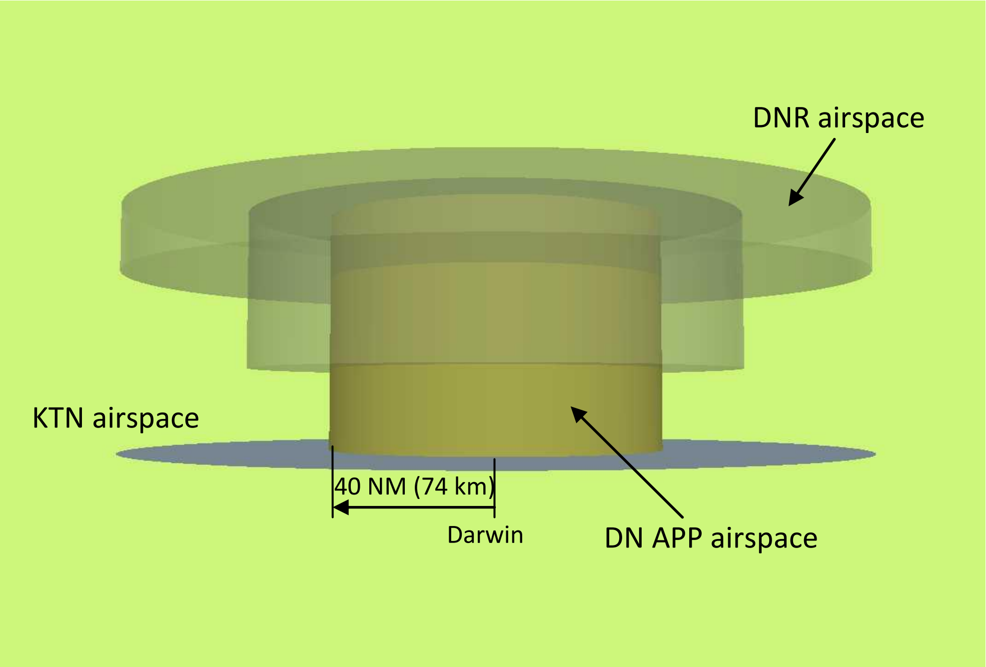
FACTUAL INFORMATION

History of the flight

On 19 April 2007 at about 0833 Central Standard Time[1], an instrument flight rules (IFR) Cessna Aircraft Company C210N (210), registered VH-TFF, departed Darwin Airport for Gove, NT on climb to an altitude of 9,000 ft above mean sea level (AMSL).

The airspace in the vicinity of Darwin was separated into a number of different areas of responsibility. The Darwin radar (DNR) controller was responsible for a sector of upper level airspace beyond 40 NM (74 km) of Darwin. The Darwin Approach (DN APP) controller was responsible for the controlled airspace within 40 NM (74 km) of Darwin, and the Katherine (KTN) sector controller was responsible for the lower level airspace outside that controlled airspace (Figure 1).

Figure 1: Controller airspace responsibilities



Due to unreliable position information and ongoing technical problems with the radar surveillance data being delivered from the Australian Defence Air Traffic System (ADATS) at Darwin to the Australian Advanced Air Traffic System (TAAATS), the DNR airspace at the time of the occurrence was being operated by the controller as a non-radar, procedural sector. The TAAATS system normally sourced ADATS radar data from both the Tindal and Darwin radar sensors. Previous Australian Defence Force (ADF) radar outages were generally managed by the DNR and KTN controllers with the provision of radar data from either the

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1 The 24-hour clock is used in this report to describe the local time of day, Central Standard Time (CST), as particular events occurred. Central Standard Time was Coordinated Universal Time (UTC) + 9 hours and 30 minutes.

Darwin or Tindal radar sensor on the affected controller's air situation display (ASD).

At about 0834, the KTN sector controller advised the DNR controller that an IFR Piper Aircraft Corporation PA31-350 (Chieftain), registered VH-AZJ, was taxiing at Bathurst Island for a flight direct to Jabiru. The DNR controller advised the KTN controller to clear the Chieftain to climb to and maintain 9,000 ft, and to have the pilot contact DN APP on departure from Bathurst Island. The DNR controller would assume responsibility for the Chieftain when it vacated the DN APP airspace.

A short time later, the KTN controller obtained approval from the DN APP controller for the pilot of the Chieftain to transit through the DN APP airspace prior to entering the DNR airspace. No operational restrictions were placed on the departure from Bathurst Island and the DN APP controller indicated his concurrence with the transit clearance of 9,000 ft.

The Chieftain departed Bathurst Island at about 0837 on climb to 9,000 ft. At that level, the flight-planned route of the Chieftain was in potential conflict with most departure routes to the north and east of Darwin. The DN APP controller used a 3 NM radar standard for separation during the period that the Chieftain and the 210 transited DN APP airspace. The pilot of the 210 transferred to the DNR radio frequency at 0850:30 and, about 7 minutes later, the pilot of the Chieftain also transferred to that frequency. At that time, the aircraft were about 24 NM (45 km) apart.

The two aircraft tracks were about 18 NM (33 km) apart at the point that they entered the DNR airspace.

The Chieftain's track intercepted that of the 210 at an angle of 22 degrees, at a position about 77 NM (143 km) to the east of Darwin and within Class E airspace[2]. That was 37 NM (69 km) after the pilot of the 210 transferred from the DN APP controller's radio frequency to that of the DNR controller.

The separation standard applicable in this case was specified in the Manual of Air Traffic Services (MATS) and required the provision of 1,000 ft vertical separation between the two aircraft prior to the time that they would be operating within a prescribed lateral separation area of conflict[3] (see discussion at *Separation responsibility and assurance*). That separation was not achieved.

At about 0909, when the DNR controller cleared the Chieftain to leave the control area on descent, he realised that there was no separation standard between the 210 and the Chieftain. A traffic alert was issued to the pilot of the 210, advising that

2 The Australian Flight Information Region (FIR) was divided into a number of different classes of airspace, depending on the level of service provided by Air Traffic Services (ATS) and on the requirements affecting pilots. Class E airspace required controllers to provide a full separation service for IFR aircraft from other IFR aircraft.

3 The entry and exit points for the area of conflict were determined by plotting the navigational tolerances applicable to the aids being used by the aircraft and then applying a 1 NM buffer to the possible location of each aircraft. An area of conflict existed when the plotted possible location for one aircraft overlapped that of the other affected aircraft.

the Chieftain was at a distance of 4 NM (about 7.5 km) to the pilot's eight o'clock[4], at 9,000 ft. There was a breakdown of separation (BOS).

The action by the DNR and KTN controllers to pass traffic information and re-establish the separation standard was in accordance with the MATS. Despite the traffic alert by the DNR controller, the pilots of the 210 and the Chieftain did not sight each other while in the prescribed lateral area of conflict.

Separation was re-established at about 0911, when the pilot of the Chieftain reported descending through 8,000 ft.

The investigation was unable to establish what standard was used by the DN APP controller to separate the aircraft when the Chieftain crossed the airspace boundary into the DNR airspace. The DN APP controller reported that a radar standard[5] was probably used, as the aircraft were so far apart that only the Chieftain would have appeared on his ASD.

The DNR controller commented that, with the track crossing point being at 77 NM (143 km) from Darwin, or 37 NM (69 km) to the east of the DN APP airspace boundary, the DN APP controller would not have been expected to identify the need for a procedural separation standard.

Controller information

The DNR controller held Area Radar and Procedural Control ratings[6], with radar and procedural endorsements[7] for the KTN and TRT (Territory) sectors. However, he had not experienced long periods of operation of the DNR airspace as a procedural sector.

The rostered hours worked, and comments by the controller, suggested that fatigue was not a factor. The controller reported that distraction was not a factor, and that there were no personal issues with the potential to have degraded his work performance.

The DNR controller considered the amount and complexity of the traffic at the time of the occurrence to be 'five out of seven', with seven being the maximum. An examination of the recorded radar data showed that, at that time, there were seven flight plan tracks with their associated information labels being managed by the DNR controller (including the two aircraft that came into conflict). There were also additional traffic conflictions reported by the controller to the south between a departing aircraft and two arriving aircraft, one of which was an inbound medical priority flight.

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4 Pilots and controllers used the 12 hours of the clock to quickly and unambiguously describe the location of objects. The front or nose of the aircraft was represented by '12 o'clock', moving clockwise to the rear or tail of the aircraft, which was '6 o'clock', and so on.

5 Except as otherwise prescribed in the Manual of Air Traffic Services, the required horizontal radar separation is 5 NM.

6 A rating confirmed the completion by a controller of general training and of the ability to provide a radar or procedural service. The rating was not usable without a valid endorsement.

7 An endorsement was airspace or task specific, and indicated that the controller was trained to, and could operate at, the required standard relevant to that airspace or task.

The controller advised that the potential for a confliction between the Chieftain and the 210 was recognised at the time the Chieftain taxied at Bathurst Island, but was forgotten due to more immediate separation priorities. It was not until the Chieftain was cleared to leave the control area on descent that the lack of a separation standard between the two aircraft was recognised.

Airspace and equipment information

The airspace to the east and north-east of Darwin that was managed by the DN APP controller was designated ‘Class C’[8]; having a stepped increasing lowest level with increasing distance from Darwin, and an upper level of flight level (FL) 180 (18,000 ft). Between 30 and 40 NM (about 56 to 74 km), the lowest level of that airspace was 7,500 ft and; between 40 and 50 NM (about 74 to 93 km), the lowest level was 9,500 ft. Beyond 40 NM (74 km) from Darwin, ‘Class E’ airspace extended from 8,500 ft up to the lowest level of the overlaying ‘Class C’ airspace, and was managed by the DNR controller.

The airspace below DNR airspace was managed by the KTN controller.

DNR airspace

The structure of the DNR airspace, its air routes and supporting traffic management procedures were originally developed by the ADF to meet its radar surveillance objectives, and were handed over to Airservices Australia (Airservices) in November 2006. Airservices reviewed the airspace structure and implemented a number of changes including; Standard Terminal Arrival Routes (STARs) to facilitate the separation of arriving and departing traffic, and a number of radar-based coordination, traffic management and contingency requirements, which were specified in the Northern Territory MATS SUPPS[9].

The Airservices investigation into this occurrence found that the structure of the DNR airspace was operationally predicated on the availability of continuous radar coverage via TAAATS, and on its representation on the relevant controller’s ASD. Airservices controllers reported that since Airservices assumed responsibility for the DNR sector, the controllers were not provided with simulator training consistent with the application of a procedural environment in the DNR airspace. Those claims were supported by training records.

The DNR control position was located in the Airservices Brisbane Centre Operations room. In addition to managing the DNR airspace, the DNR controller was also responsible for the TRT sector, which included the management of air traffic transiting Indonesian airspace via Darwin.

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8 Controlled airspace in which separation was provided to IFR aircraft from IFR, Visual Flight Rules (VFR) and Special VFR aircraft. Other separation provisions applied to VFR and Special VFR aircraft in that airspace.

9 MATS SUPPS. Locally agreed operational procedures, practices and interactions as determined jointly by the ADF and Airservices for those items that were not covered by the MATS.

Radar equipment

Australian Defence Air Traffic System (ADATS) radar surveillance equipment was located at Darwin and Tindal Airports and offered some radar data overlap. ADATS was not required to operate to the civil standards as specified in *Civil Aviation Safety Regulation (CASR) Part 171 Aeronautical Telecommunication and Radio Navigation Services*.

There was no Airservices radar surveillance equipment capable of providing radar coverage within 250 NM (463 km) of Darwin. However, the ADF and Airservices had an agreement to enable ADATS radar surveillance data to be integrated in the civil TAAATS. The data sharing agreement specified that the data would be provided by the ADF on an 'as is' basis, with no minimum quality, serviceability or reliability requirements specified. In that case, the Darwin and Tindal ADATS data, which was fed to the Brisbane Operations Centre for integration into TAAATS, was not required to satisfy the availability, reliability, accuracy, integrity and recovery time interface parameters of *CASR Part 171*.

Throughout 2006, quality checking of the ADATS radar data that was being provided to the TAAATS radar system revealed data integrity errors that made the inclusion of that data in the TAAATS system unacceptable. In response, TAAATS replaced the normally displayed affected aircraft's actual radar track and position (RDP) with a computer-generated, flight data processor (FDP) track and position that relied on the aircraft's flight plan track and position estimates. Although normally of limited duration before returning to RDP, the FDP-derived data was only as accurate as the aircraft pilot's adherence to the flight plan, and any updated information entered into TAAATS by the controller during the course of the flight. Airservices determined that the frequent reliance on FDP-derived data represented a significant safety issue with respect to controller situational awareness (see discussion *Separation responsibility and assurance*).

On 1 March 2007, Airservices removed the Tindal ADATS radar data input from TAAATS. That had the effect of removing the previously available overlap of Tindal and Darwin ADATS radar data, and the Darwin ADATS data then started to be rejected by the TAAATS data integrity checking process. The short-term replacement of RDP radar tracks and positions with FDP tracks continued, and there was no improvement in the integrity of the TAAATS data.

As a consequence, on 13 March 2007, Airservices removed the Darwin ADATS radar data input from TAAATS, meaning that radar separation was no longer available on the DNR sector, and that DNR controllers were reliant on the application of procedural separation. As a safety measure, the ADF ADATS radar data was still processed by Airservices, but its display was limited to an ASD screen in the Brisbane Operations Centre room that was located adjacent to the active control positions. A local Airservices instruction restricted the use of the ADF data to emergency situations.

During the recognition and resolution of this BOS, the DNR controller used that ASD screen to provide the traffic alert to the pilot of the 210.

Organisational information

The MATS was a joint Airservices/ADF document and was based on a combination of the requirements of the civil *Manual of Standards (MOS) Part 172 Air Traffic*

Services and other Airservices and ADF documentation. The requirements and obligations detailed in the MATS reflected the provisions and regulations of the *Air Navigation Act 1920*, the *Air Services Act 1995*, and Defence Instructions. Additions to the instructions in MATS were possible by affected Business Units using MATS SUPPS and, at field level, by Local Instructions.

Separation standards

Aircraft separation in a controlled environment relied on the promulgation of defined standards to prevent collisions. The MATS defined a separation standard as:

> A prescribed means to ensure separation between aircraft using longitudinal, lateral, vertical and visual standards.

Separation options included the use of radar, which relied on the determination of an affected aircraft's position via radar, and procedural separation, which was reliant on the application of procedural control. Procedural control related to the provision of air traffic services (ATS) without the need for information from an ATS surveillance system.

The continued availability of the Tindal and Darwin ADATS radars for use by ADF controllers meant that there was no interruption to the provision of radar separation in the DN APP airspace. However, the removal of the Tindal and Darwin ADATS radar data input from TAAATS required the application by Airservices DNR controllers of procedural separation standards in that airspace. In addition, the management of the DNR airspace was modified by the publication of a number of temporary local instructions (TLIs) and Notices to Airman (NOTAMs) [10] by Airservices, and via relevant ADF orders and instructions.

MATS supplements

The Northern Territory MATS SUPP section 6[11] specified that, when DN APP was receiving radar surveillance data and DNR was not, then:

> [DN APP shall] Provide procedural separation between aircraft departing and arriving at or below FL130.

and that the:

> TOPS[12] [Group] (KTN or DNR sectors) [was] to nominate restrictions for aircraft transferred to DN APP.

ADF orders and instructions

On 29 March 2007, Royal Australian Air Force (RAAF) 44 Wing (44 WG) Detachment Darwin published Flying Order 03/2007, which amended the

10 A notice that was distributed by all means to advise of the establishment, condition or change in any aeronautical facility, service, procedure or hazard.

11 Effective 23 November 2006.

12 Within TAAATS, the Australian airspace was divided into a number of 'Groups'. The TOPS Group comprised the Northern and Western airspaces, and involved large areas of non-radar airspace. Other groups included the REEF, OUTBACK and OCEAN Groups.

separation requirements that were specified in the Northern Territory MATS SUPP. The Flying Order was only applicable and available to military controllers, and stated that:

> This instruction applies to operations from Darwin and that these [sic] procedures expand on, and some procedures supersede, the requirements of Northern Territory MATS SUPP[13].

and that:

> A procedural standard is required between IFR aircraft entering Class C or E airspace. If a procedural standard is not available DN APP is to provide a radar standard and accept separation responsibility until a procedural standard exists.

Procedural separation

The options for the provision of procedural separation included the application of the MATS-defined longitudinal time and distance standards, lateral separation standards or vertical separation standards. The standard applied by a controller was dependant on the actual traffic situation, the available navigation aids and on aircraft performance. The separation option applied by a controller was to take into account the safety of the affected aircraft and the likely efficiency and operational advantage of the relevant standard.

Lateral separation area of conflict

The MATS defined lateral separation as the:

> Separation between the navigation tolerances of aircraft in the horizontal plane expressed in terms of [the] distance or angular displacement between tracks.

Any area in which the navigation tolerances of selected aircraft tracks overlapped was termed an area of conflict. Controllers based the determination of a lateral separation area of conflict on the probable positions of each aircraft, taking into account:

- the last positive fix or position of the aircraft
- the tolerances of the navigational aids being used
- pilot tracking tolerances
- the addition of safety buffers.

In this occurrence, the last positive fixes for the Chieftain and 210 that were available to the DNR controller were determined by the location of their departure aerodromes and the departure time notified by each pilot. Based on those fixes, the application of the relevant navigation aids and pilot tolerances, and appropriate safety buffers, the calculated area of conflict was as depicted in Figure 2.

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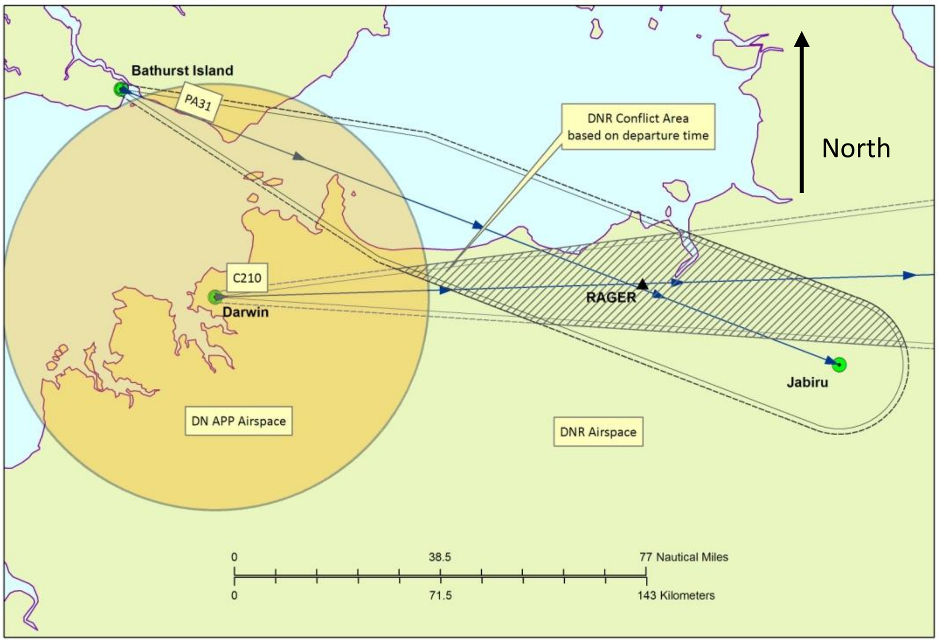
13 There was no indication in the order of which portion of the SUPP had been expanded upon or superseded.

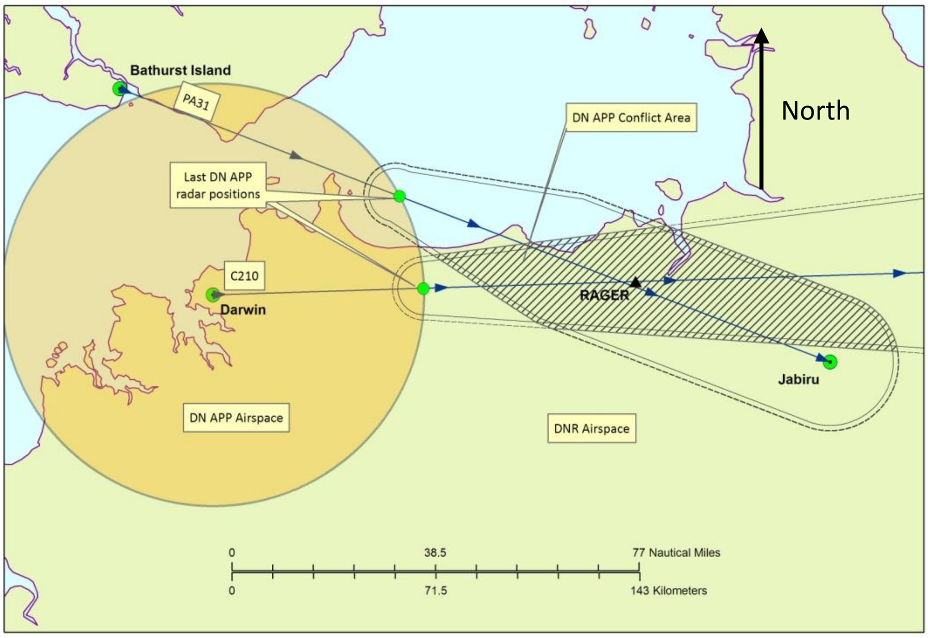
Figure 2: Calculated DNR controller-based lateral separation area of conflict (hatched area)



The calculated DNR area of conflict (Figure 2, hatched area) commenced about 6 NM (11 km) west of the eastern boundary of the DN APP airspace, in that controller's area of responsibility.

Radar surveillance data was available to the DN APP controller, meaning that the aircraft's last positive fixes for the calculation of procedural lateral separation by the DN APP controller were their last observed radar positions on the boundary of the DN APP airspace. Based on the information available to the DN APP controller, the calculated area of conflict was as depicted in Figure 3. That area commenced about 2 NM (approaching 4 km) to the east of the eastern boundary of the DN APP airspace.

Figure 3: Calculated DN APP controller-based lateral separation area of conflict (hatched area)



In this occurrence, neither the DNR nor the DN APP controllers plotted the lateral separation area of conflict for the two aircraft.

Separation assurance

Separation assurance was described by the MATS[14] in terms of the tactical and strategic environments. Broadly relating to controller separation activities as compared with organisational responsibility, tactical and strategic separation assurance were described as follows:

> Tactical separation assurance places greater emphasis on traffic planning and conflict avoidance rather than conflict resolution and requires that controllers:
>
> a. be proactive in applying separation standards to avoid rather than resolve conflicts;
>
> b. plan traffic to guarantee rather than achieve separation;
>
> c. execute the plan so as to guarantee separation; and
>
> d. monitor the situation to ensure that plan and execution are effective.

and:

> Strategic separation assurance is the designing of airspace, air routes, air traffic management plans and air traffic control practices, to reduce the likelihood that aircraft will come into conflict, particularly where traffic frequency congestion or system performance, amongst other considerations, may impair control actions.

14 MATS for ATS 10-10-300.

In December 2003, in response to an internal safety report, Airservices published an information circular[15] that included the discussion of a number of options for application by controllers in order to assure separation. The circular remained current and available to controllers at the time of this occurrence, and highlighted the capability for the 'system component'[16] to support controllers. Components of that system included:

- documented procedures
- one-way route structures
- the segregation of arrival and departure procedures
- the application of defined levels to ensure vertical separation between arriving and departing traffic, or between crossing routes
- traffic management practices; which were described as those practices that:

  > ...support a controller's ability to manage his or her workload so that conflict recognition and resolution can happen proactively rather than reactively and include:
  >
  > – Active operations supervision.
  >
  > – Controller initiated traffic management, including metering.

Management of controller workload

In addition to assisting controllers to ensure traffic separation, Airservices circular NIC 33/2003 noted that a number of its system components had the potential to reduce controller workload. Specifically, that included the promulgation of one-way route structures such as STARs, the segregation of arrival and departure procedures, and traffic management practices.

One-way route structures - STARs

A STAR was a published IFR arrival route that linked enroute airways systems to a fix that was at or near a pilot's destination aerodrome. STAR charts were published in the Aeronautical Information Publication (AIP) and provided pilots with a navigational reference for the arrival phase of their flight. *AIP ENR 1.5 - Holding, Approach and Departure Procedures* stated that STARs satisfied the following requirements:

> a. noise abatement procedures tracks;
>
> b. airspace segregation for ATC purposes;
>
> c. maximum traffic handling capacity; and
>
> d. reduction in pilot/controller workload and air/ground communication requirements.

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15 Airservices Australia; *National Information Circular; NIC 33/2003*; effective - 08122003 until 07032004.

16 Typically including communications and surveillance capabilities.

The availability of STARs at Darwin was cancelled by a Notice to Airmen (NOTAM CO723/07) on 13 April 2007. No alternative traffic management initiatives were introduced at Darwin that offered the airspace segregation, traffic capacity or controller/pilot workload advantages of the cancelled STARs. The effect was that, instead of the previously published five inbound routes that were segregated from the major departure routes, there was no limit to the number of routes available to pilots for entry to, and exit from, the DNR airspace.

Traffic management practices

Neither the revised RAAF 44 WG Flying Order 03/2007, nor any Airservices TLIs for application at Darwin, provided any specific airspace segregation or workload reduction requirements. Traffic management was addressed in those supplementary instructions by the inclusion of a 3-minute spacing requirement between successive departures from Darwin. That spacing did not equate to any MATS time/distance separation standard.

Safety and quality management

A number of Civil Aviation Safety Regulations (CASRs)[17] that affected the operation of civilian airports and their Air Traffic Services (ATS) required the establishment and operation of a safety management system (SMS). The requirements of an SMS were detailed in the relevant MOS and in advisory circulars (ACs) as required. The Civil Aviation Safety Authority (CASA) stated that an SMS should be both proactive and reactive, and provide a means to anticipate and prevent, or to reduce risks, and that that was the essential benefit of safety working in partnership with quality management.

Airservices had established an SMS in respect of the requirements of CASR Parts 171 and 172.

Safety assessment process

The Airservices approach to safety assessment was predicated on: [18]

- a systematic risk assessment by operational and technical management that identified hazards, assessed risk, and responded with appropriate control measures
- the reduction of the risk to the travelling public as a result of the services being provided in the National Airspace System (NAS) being reduced to, and remaining as low as reasonably possible (ALARP)[19]

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[17] CASR Part 139 prescribed the aerodrome requirements, including fire-fighting services, at those aerodromes that were used in air transport operations; CASR Part 171 outlined the tele-communication requirements for equipment used by air traffic services & the requirements affecting radio navigation equipment; and CASR Part 172 specified the regulatory framework affecting the provision of air traffic services.

[18] AA-REC-SAF-0105; Issue 11, Effective 01 March 2007; page 4 section 1.2.

[19] The residual risk was assessed as being ALARP when it could be demonstrated that all justifiable risk reduction measures were taken, and that the reduction of that residual risk was either

- safety assessors having appropriate knowledge and experience, and including representatives from all affected areas (internal and external).

The importance of communication and consultation with, and the involvement of stakeholders, were stressed at each step of the Airservices risk management process. Stakeholders were those parties who were potentially impacted by a particular change, and who had a role in controlling the identified risks.

The Airservices Australia National Operating document AA-NOS-SAF-0104 encapsulated the Airservices approach to safety assessment. Included was a staged safety assessment process for application to all changes to operational or technical activities that had the potential to affect the safe operation of the airways system or services.

Initially, a Safety Case Assessment and Reporting Determination (SCARD)[20] was required in consideration of the technical/equipment (CASR Part 171) and ATS (CASR Part 172) implications of the proposed change. The SCARD process evaluated the overall magnitude of the proposed change, including in terms of:

- the number of external service users and/or stakeholders affected, including the interfaces between those parties
- whether the change enhanced an existing functionality, provided a different functionality, removed a functionality or reduced the level of service
- any training required (both internal and external) as a result of the proposed change
- the complexity of the transition from the existing system
- the number and severity of any hazards related to the change.

A SCARD outcome of ‘minor’ was reviewed by the SCARD team’s business unit or project manager. SCARD outcomes of ‘moderate’ or ‘major’ were reviewed by the Airservices Safety Unit. Irrespective, there was the potential for the SCARD to identify the need for a more in-depth hazard identification process than that undertaken as part of the SCARD.

If required as a result of a SCARD outcome of ‘moderate’ or ‘major’, or at management discretion, the next stage of the safety assessment process was the commencement of a Safety Plan early in the change life cycle. In addition, a Safety Assessment Report was to outline the necessary safety management arrangements to ensure the safety of the proposed change.

The last stage of the safety assessment process was the as required conduct of a Post Implementation Review (PIR) of the identified safety aspects of a proposed change.[21] Post implementation reviews were to be scheduled in accordance with the

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unjustified in respect of its practicality, or that the required resources were likely disproportionate to any additional risk reduction achieved.

20 SCARD – a process that was developed by Airservices to assist users to initially evaluate a proposed change. The aim of a SCARD was to determine the type of safety assessment and reporting that was required in support of the proposed change. In addition, the magnitude of the change and its associated potential hazards/risks were identified.

21 A PIR was required for changes that were classified by the SCARD process to be ‘moderate’ or ‘major’.

safety assessment's review schedule or, if not specifically stated, not later than 12 months from the change becoming operational.

Removal of the ADATS radar data from TAAATS

In accordance with the requirements of AA-NOS-SAF-0104, the decision to remove the Tindal ADATS radar surveillance information from TAAATS required the completion of SCARDs in respect of the requirements of CASR Parts 171 and 172. The Tindal radar data was removed from TAAATS on 1 March 2007 and, on 2 March 2007, a CASR Part 172 (ATS-related) SCARD was completed by the TOPS ATC specialists. That SCARD found that the removal of the Tindal radar was a 'minor' change, with the effect that no further SMS activities were required. Local operational unit management sign-off occurred on 5 March 2007.

There was no evidence of the conduct of a SCARD in respect of the requirements of CASR Part 171 (technical/equipment).

No SCARD(s) were completed in support of the removal on 13 March 2007 of the Darwin ADATS radar data from TAATS, the operation of DNR airspace without radar surveillance data, or for the removal of the Darwin STARs.

Hazard identification process

The Airservices document AA-REC-SAF-0105[22] outlined the Safety Risk Assessment process for application during the concept, design, implementation and operations phases of any project, and had application in the SCARD initial assessment process, and any subsequent in-depth hazard identification and risk management processes. Broadly reflecting the requirements of AS/NZS 4360:2004 *Risk Management*, the Airservices document highlighted the benefits of the inclusion of a full cross section of stakeholders in any safety risk assessment. In the case of the removal of the ADATS data from TAAATS, the ADF air traffic control service officers and radar technicians, and the aircraft operators who normally fly within the DNR airspace, were not involved in that process.

The Airservices intent for any safety risk assessment was to compile a list of credible hazards that could present a safety risk. Risk treatments were developed in response to each hazard with the aim of reducing the residual risk to ALARP, before ranking those risks as follows:

- Class A, which were unacceptable and required additional treatment.
- Class B, which required additional risk reduction unless the associated cost was grossly disproportional to the benefits gained. General Manager authorisation was necessary for acceptance by Airservices of that level of residual risk.
- Class C, requiring further risk reduction action unless the cost of that investment was disproportionate to the potential benefits. Relevant Group Manager (ATC, ARFF and so on) approval was required for the acceptance of that residual risk.
- Class D, which represented an acceptable level of residual risk to the relevant authority.

[22] Issue 11, effective 11 March 2007.

Pursuant to management sign-off, Classes B and C risks were considered by Airservices to be ALARP (or tolerable).

At the time of the occurrence, Airservices Hazard Register 564 included 17 hazards/risks to the safety or continuity of operations relating to the loss of the Tindal ADATS data. Of those, 10 required management endorsement as an ‘acceptable’ level of residual risk. In addition, ATC Business Group Hazard Register 201 (TOPS Operational Risk Assessment), Hazard 36, was listed as a Class C hazard that related to a failure of the Darwin and Tindal ADATS radars and the resulting increased controller workload. On 29 May 2007, that hazard was reviewed by Airservices and reaffirmed as a Class C residual risk. No additional mitigation activities were identified by that review.

The ATS-related CASR Part 172 SCARD for the removal of the Tindal ADATS data from TAAATS did not record the Class B and Class C hazards that were registered within the existing Airservices databases.

There was no hazard noted on the Hazard Register in respect of the potential for the development by controllers of differing lateral separation areas affecting an aircraft as a result of:

- the application by ADF controllers of that aircraft’s last known radar position
- Airservices controllers relying on the pilot of that aircraft’s flight plan, departure times, position reports, and so on.

Additional information

Situational awareness

In its 2003 Systematic Review of Breakdown of Separation Occurrences, Airservices classified the controller errors and violations in 160 BOS occurrences from the period January 2000 to April 2003. That classification reflected the controller performance components and sub-elements of the Airservices Australia Performance Assessment Handbook that were necessary for the completion of the ATC task. One of those task components was the need for a controller to maintain situational awareness (SA).

In regard to the provision of air traffic services, SA was defined in the MATS as:[23]

> The perception and integration of external data inputs, the comprehension of their impact on the air situation, and the consideration of their effect on the provision of an effective air traffic management service.

The Airservices performance assessment model listed three stages in the development of a controller’s SA:

- the controller perceived the relevant information, termed the ‘scanning’ stage;
- that information was then integrated into a 3-D ‘traffic picture’, the integration/comprehension’ phase; and

[23] Part 10, section 1 (effective 31 August 2006).

- that traffic picture was 'projected' in time by the controller to create a dynamic understanding of future events. That ability allowed the controller to plan for and manage those future events.

The maintenance of complete, accurate and up-to-the-minute SA was considered to be essential for anyone who was in control of complex, dynamic systems and in high-risk situations, such as air traffic controllers and pilots.[24] Not unsurprisingly, the lack of, or inadequate SA, has consistently been identified as one of the primary factors in accidents attributed to human error.[25]

The 2003 BOS review identified that, if the initial phases in the development of a controller's SA resulted in an accurate traffic picture, then it was more likely that appropriate controller decisions would result. However, it was noted that a controller's SA can be adversely affected by a lack of coordination between controllers, such as not obtaining a 'heads-up' from an adjoining sector controller. In addition, the report observed that, in the absence of that traffic picture, the controller was '...totally dependent on system defences.'

When available, an ASD provided the primary source of information to assist in the development/maintenance of a controller's SA. Using their ASD, controllers gathered information on the displayed traffic from a variety of sources in order to determine an appropriate traffic management response.

Other factors that were identified by the 2003 BOS review as affecting a controller's SA included: the means and timing of any traffic coordination, the distraction of the controller by non-separation tasks, increasing controller workload, and any tendency for the controller's attention to become 'tunnelled' to a single task.

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24 Hopkins, V. David (1995). *Human factors in air traffic control*. London: Taylor & Francis Ltd.

25 The 2003 BOS Review found that the loss of SA was evident in 67 % of control tower breakdowns, 80% of breakdowns in Terminal Control Areas and in 92% of cases in enroute sectors.

ANALYSIS

The pilots of the two aircraft that were involved in the breakdown of separation (BOS) complied with all air traffic control (ATC) instructions and other requirements affecting their flights. As a result, this analysis will examine the development of the BOS in relation to the provision of the ATC service to those pilots.

Controller workload

The initial consideration by Airservices Australia (Airservices) of the structure of the Darwin Radar (DNR) airspace included the requirement for continuous radar coverage to be available on the DNR controller's air situation display (ASD). That radar coverage was reliant on the anticipated successful integration of Australian Defence Air Traffic System (ADATS) radar data into the Australian Advanced Air Traffic System (TAAATS). However, the unreliability of that integration ultimately lead to the unavailability of the ADATS data to Airservices' TAAATS system and its users; specifically, the DNR controller. In response, Airservices decided to apply procedural separation in the planned-for DNR radar airspace. The unavailability of radar data to the DNR controller removed a system defence, upon which the structure of that airspace was operationally predicated, and increased the DNR controller's workload for a given amount of traffic.

In addition, the removal of the standard terminal arrival routes (STAR), and lack of any other traffic management strategies in their place, reduced the DNR controller's maximum traffic handling capacity and further increased his workload. Moreover, the complexity and amount of the traffic preceding the occurrence, including the resolution of a number of potential conflicts, would have also exacerbated the controller's workload.

As a consequence, although the subsequent Chieftain/210 confliction risk was identified by the DNR controller when the Chieftain taxied at Bathurst Island, separation assurance was not established at that time, or subsequently, due to controller's other priorities, and the traffic complexity and workload being experienced by the controller at the time. Each had the potential to adversely affect the controller's situational awareness, decreasing the likelihood that the controller would take action to address the unresolved conflict.

Separation responsibility and assurance

The availability of radar information for use in the DNR airspace, as was anticipated by Airservices when establishing that airspace, would have simplified the coordination requirements between the Darwin Approach (DN APP) and DNR controllers. Both controllers would have had access to common, radar-derived information, and separation planning and assurance would have been possible based on common positional information. Had that been the case, it was more likely that both controllers would have shared a heightened awareness of the developing conflict between the Chieftain and 210.

However, the availability of ADATS-derived traffic information to the DN APP controller contrasted with the need for the DNR controller to rely on the display of aircraft positions that were based on flight plan information, as updated from time to time by pilot or controller-reported departure times and position reports. Those disparate data sources meant that each controller applied different techniques to determine the lateral separation areas of conflict, if and when establishing procedural separation for application in the DNR airspace. The potential for that to occur was not identified by the Airservices hazard identification process and, in this occurrence, resulted in two areas that commenced about 8 NM (15 km) apart, and that were each within the other controller's area of responsibility.

Any confusion would have added to the DNR controller's already high workload.

In addition, the differing data sources would have increased the risk of the controllers' situational awareness being adversely affected. Moreover, the risk of a differing dynamic understanding, and therefore awareness of future events by the DN APP controller to that of the DNR controller, was increased by the 'without restriction' clearance for the pilot of the taxiing Chieftain to leave and re-enter DNR airspace.

In any case, the Royal Australian Air Force (RAAF) 44 Wing (44WG) document Flying Order 03/2007 indicated that, depending on circumstances, the DN APP controller retained the responsibility for maintaining separation between aircraft entering Classes C and E airspace until a procedural standard was established. That ought to have influenced the controller to more effectively coordinate with the DNR controller. The lack of effective coordination by the DN APP and DNR controllers would have adversely affected their situational awareness, with the result that vertical separation was not established between the Chieftain and 210 prior to the BOS.

Safety management activities

The lack of Civil Aviation Safety Regulation (CASR) Part 171-related safety case assessment and reporting determinations (SCARDs) in respect of the removal of the Tindal, Darwin, or both radar's data from TAAATS, and of CASR Part 172 SCARDs in respect of the removal of the Darwin or both radars was not compliant with the requirements of the Airservices' safety management system (SMS). In addition, external stakeholders were not involved in the risk identification and assessment process following the removal of the radar data, increasing the risk that any associated hazards would not be fully identified and understood. The involvement of those stakeholders might also have influenced the Airservices risk management strategies pursuant to the removal of the ADATS data from TAAATS, such as arrival and departure route limitations and considering ADF control of the DNR airspace.

In this case, the lack of the requirement in the Airservices SMS for an independent review of the local hazard assessment process resulted in the acceptance by Airservices of a number of risks, and in the non-compliance of that hazard assessment with the Airservices SMS being undetected. An independent review of the locally-conducted SCARD hazard assessment by management might have:

- identified additional traffic management strategies to address the application of procedural separation in airspace that had previously been identified by Airservices as requiring continuous radar coverage
- addressed the issue of increased controller workload

- reiterated the need for all hazard assessments to comply with the SMS process.

FINDINGS

From the evidence available, the following findings are made with respect to the breakdown of separation that occurred 157 km east of Darwin, NT on 19 April 2007 and involved Piper Aircraft Corporation PA-31, registered VH-AZJ, and Cessna Aircraft Company C210N, registered VH-TFF. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- Separation assurance was not established when the Chieftain taxied at Bathurst Island, or subsequently.
- The high workload being experienced by the Darwin radar (DNR) controller, and diminished situational awareness, decreased the likelihood that the controller would identify the separation requirement.

Other safety factors

- Procedural separation was being used to provide air traffic services in an airspace structure that was predicated on the availability of continuous radar surveillance.
- The removal of the standard terminal arrival routes (STAR), and lack of any other traffic management strategies in their place, resulted in a reduced maximum traffic handling capacity and increased workload for the DNR controllers.
- The safety assessment process in support of the decision to remove the Australian Defence Air Traffic System (ADATS) data from the Australian Advanced Air Traffic System (TAAATS) did not comply with the requirements of the Airservices Australia (Airservices) safety management system (SMS).
- The potential for the determination by the Darwin Approach (DN APP) and DNR controllers of different lateral separation areas of conflict affecting the same aircraft was not identified during the safety assessment process.
- The Airservices SMS did not require an independent review of the locally-conducted hazard assessment process. *(Safety Issue)*

Other key findings

- The recovery action by the controllers was in accordance with the Manual of Air Traffic Services (MATS).

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety 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 responsible organisations for the safety issues identified during this investigation were given 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.

Airservices Australia and the Civil Aviation Safety Authority

Independent review of the locally-conducted hazard assessment process

Safety issue

The Airservices Australia safety management system (SMS) did not require an independent review of the locally-conducted hazard assessment process.

Response from Airservices Australia

Airservices Australia (Airservices) advised that, as part of its hazard assessment process:

> Workshops were facilitated in Brisbane by Canberra based Safety Management staff, giving a level of independence to the hazard identification and risk assessment process. In addition, the Tops risk register was also considered by Safety Management as it was a contributor to the overall picture of the level of risk. Notwithstanding the above, Airservices has a model of using independent risk specialists from Safety and Environment as facilitators for significant risk activities, thus providing a level of oversight and expertise.

ATSB assessment of the Airservices response

The ATSB acknowledges the technical imperatives for the decision by Airservices to remove the military radar information from The Australian Advanced Air Traffic System (TAAATS), and that a number of safety activities were undertaken following removal of the radar data. However, the lack of an independent review of the locally-conducted hazard assessment process, and the implications for the overall SMS, remained of concern. The ATSB will continue to monitor the application of the Airservices SMS within the context of future relevant investigations.

Response from the Civil Aviation Safety Authority

The Civil Aviation Safety Authority (CASA) advised that:

> The [Civil Aviation Safety Regulation] CASR Part 172 audit implications of this report have been drawn to the attention of the CASA air traffic services specialist surveillance staff for future reference.

ATSB assessment of the CASA response

The ATSB appreciates the commitment by CASA to highlight the audit implications from this investigation of the requirements of CASR Part 172 with its air traffic services surveillance staff. The ATSB considers that action by CASA, when applied to its future audits, to be a positive step towards ensuring an effective Airservices SMS.

APPENDIX A: SOURCES AND SUBMISSIONS

Sources of information

The sources of information during the investigation included:

- the involved air traffic controllers and managers
- recorded radio transmissions
- Airservices Australia (Airservices)
- the Civil Aviation Safety Authority (CASA)
- Australian Defence Force (ADF) documentation
- Civil aviation regulatory documentation.

References

The following references were accessed during the investigation:

- Manual of Air Traffic Services (MATS)
- *Darwin Airport radar evaluation report,* Darwin July 2007. Edition 1, 14 July 2007.

Submissions

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

A draft of this report was provided to CASA, Airservices, the ADF, the involved air traffic controllers, and the aircraft operators and pilots. Submissions were received from CASA and Airservices. The submissions were reviewed and, where considered appropriate, the text of the draft report was amended accordingly.