Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT

Aviation Occurrence Investigation 200700231

Final

Runway incursion - Port Macquarie Airport
5 January 2007
Bombardier Inc. DHC-8-315, VH-TQZ
Piper Aircraft Corp. PA-28R-201, VH-TBB

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Figure 1 courtesy of Google Earth.

Abstract

On 5 January 2007, a Piper PA-28R-201 Arrow, registered VH-TBB, was approaching Port Macquarie Airport, NSW, in class G airspace under the visual flight rules from the south. The aircraft had descended from 2,500 ft above mean sea level and was approaching to join the circuit on left crosswind for runway 03. At about the same time, a de Havilland Dash 8 aircraft, registered VH-TQZ, and a Piper PA-31 Mojave, registered VH-PGW, both operating under the instrument flight rules, were preparing to depart from the airport. The airspace surrounding Port Macquarie Airport was designated as a common traffic advisory frequency (CTAF) (R), where the carriage and use of very high frequency radio was required.

On short final for runway 03, the pilot of the Arrow reported seeing the Dash 8 enter the runway. He immediately broadcast his position and prepared to initiate a missed approach. The crew of the Dash 8 saw the approaching Arrow at the same time as the Arrow pilot's broadcast. They advised that they would vacate the runway without delay, vacating via taxiway B1 as the Mojave pilot manoeuvred his aircraft to assist the Dash 8's runway departure. The pilot of the Arrow continued his approach and landed.

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

Sequence of events

On 5 January 2007, at approximately 1250 Eastern Standard Time[1], a Piper PA-28R-201 Arrow, registered VH-TBB, was approaching Port Macquarie Airport, NSW, in class G airspace under the visual flight rules (VFR) from the south. The weather conditions were good, with light winds. The aircraft had descended from 2,500 ft above mean sea level (AMSL) and was approaching to join the circuit on left crosswind for runway 03. At about the same time, a de Havilland Dash 8 aircraft, registered VH-TQZ, and a Piper PA-31 Mojave, registered VH-PGW, both operating under the instrument flight rules (IFR), were preparing to depart from the airport. The airspace surrounding Port Macquarie Airport was designated as a common traffic advisory frequency (CTAF) (R), where the carriage and use of very high frequency (VHF) radio was required.

Transmissions on the Port Macquarie CTAF were recorded and an examination of those recordings was used to confirm the transmissions made by the pilots of each of the aircraft. The pilot of the Arrow transmitted inbound broadcasts on the Port Macquarie CTAF at 20 NM, 15 NM and 10 NM, and then broadcast as he joined the circuit on crosswind, flew downwind and on the base leg of the circuit. The crew of the Dash 8 reported that they started to taxi from the apron via taxiway A, intending to enter and backtrack runway 03 (Figure 1). They transmitted a 13 second combined taxi and entering the runway broadcast on the CTAF, about 40 seconds after the pilot of the Arrow had broadcast his base position.

Figure 1: Aerial photograph of Port Macquarie Airport

Nine seconds after the crew of the Dash 8 made their combined broadcast, the pilot of the Mojave made an 8 second combined taxi and entering the runway broadcast

1 The 24 hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

as he was taxiing along taxiway B1 towards runway 03. The pilot of the Arrow reported seeing the Dash 8 stationary on the apron as he flew on the downwind leg of the circuit and assumed that the aircraft would remain clear of the runway for his landing. On short final approach for runway 03, the pilot of the Arrow reported seeing the Dash 8 enter the runway. He broadcast his position immediately after the pilot of the Mojave stopped transmitting and prepared to initiate a missed approach. The crew of the Dash 8 saw the approaching Arrow at the same time as hearing the Arrow pilot's broadcast. They advised that they would vacate the runway without delay, via taxiway B1. The Mojave pilot manoeuvred his aircraft to assist the Dash 8 crew to vacate the runway. The pilot of the Arrow continued his approach and landed.

Neither the crew of the Dash 8, nor the pilot of the Mojave reported hearing any of the Arrow pilot's transmissions prior to the transmission he made on short final approach to runway 03. However, the pilot of the Arrow reported hearing the transmissions from both the taxiing aircraft.

Communication procedures at Port Macquarie Airport

Radio communication procedures at non-towered aerodromes were based on broadcasts to all aircraft in the vicinity rather than pilot-to-pilot dialogue. A description of the procedures was contained in the Aeronautical Information Publication (AIP)[2] . The recommended radio broadcasts for arriving traffic were:

- inbound before 10 NM
- entering the circuit
- entering downwind or entering midfield on crosswind
- turning base
- turning final
- clear of the runway.

The recommended broadcasts for departing traffic were:

- before taxiing
- before entering the runway (with intentions).

Information about CTAF procedures in the AIP advised that all recommended broadcasts be made unless operational considerations precluded them[3], and that direct pilot-to-pilot dialogue should be avoided whenever possible. All traffic movement transmissions on the CTAF were considered as broadcasts and as such did not require acknowledgement.

2 AIP En Route, 1.1, sections 21.1.13 and 56, valid 23 November 2006.

3 AIP En Route 1.1., section 56.5, valid 16 March 2006.

The AIP also stated that:

> Pilots of higher performance aircraft, or pilots operating at busy aerodromes are encouraged to monitor/broadcast on the CTAF earlier to allow sufficient time to gain sufficient awareness on the traffic[4].

Port Macquarie Airport is busy at times, with a diverse range of operations, including recreational flying, parachuting, flying training and airline operations. The airport was equipped with an aerodrome frequency response unit (AFRU) that automatically transmitted a voice identification of the airfield's name in response to any transmission greater than 2 seconds duration, if there had been no other transmissions within the preceding 5 minutes. That response was designed to confirm that a pilot was transmitting on the correct frequency. Furthermore, the AFRU transmitted a 'beep' following a pilot's transmission, if within the previous 5 minutes any other transmissions had been made on the CTAF. The recorded radio transmissions indicated that the crew of the Dash 8 should have heard a 'beep' after their combined taxi and entering runway broadcast, which would have indicated that someone else had also broadcast on the CTAF within the preceding 5 minutes.

Dash 8 Operating procedures

The crew of the Dash 8 operated in accordance with the instrument flight rules (IFR), which, in addition to other radio communication obligations, required the crew to report to Air Traffic Services (ATS) at the Brisbane Centre as they commenced taxiing. As workload was high during the period of starting engines and conducting a series of checklists before and during taxi, the flight crew reported that radio reception was switched off for those critical phases of flight preparation to reduce the potential for distraction. The crew normally monitored both the aircraft's VHF radios immediately before and during taxiing, with one radio tuned to the Brisbane Centre frequency to report taxiing and obtain traffic information. The other radio was normally tuned to the Port Macquarie CTAF.

The crew also reported that they had monitored the aircraft's traffic alert and collision avoidance system (TCAS) display before entering the runway, but had not seen any indication that there was any aircraft in the circuit with an operating transponder. Although there was no requirement for aircraft operating in class G airspace to be transponder-equipped, all airborne aircraft that had transponders were required to use them with Mode C (altitude) selected. Recorded radar data from Brisbane Centre showed that the Arrow's transponder was operating in Mode C and capable of interrogation by the Dash 8's TCAS.

Changes to non-towered aerodrome communication procedures

On 24 November 2005, changes were implemented to the way that pilots operated in the vicinity of all Australian non-towered aerodromes. Those changes resulted from a Government-initiated process of airspace reform and the programme was managed by the then National Airspace System Implementation Group (NASIG) of the Department of Transport and Regional Services. The procedures were known as Characteristic 29 of the National Airspace System, Stage 2c (NAS 2c).

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4 AIP En Route 1.4., section 4.2.3, valid 16 March 2006.

An education process preceded the implementation of NAS 2c and consisted of industry briefings for pilot groups and the production of educational material, explaining the changes. That material was mailed to all licensed pilots. The NASIG material described the changes as intended to:

> …bring Australia in line with best international practice while at the same time standardising and simplifying procedures…

The changes were expected to closely align procedures and communications at non-towered aerodromes with those used in the United States. One of those procedures was the change from the use of radio communication to achieve pilot-arranged separation, to a system of standardised broadcasts designed to provide alerted see-and-avoid traffic awareness.

Following introduction of the changes, the Office of Airspace Management (OAM), Aviation and Airports Division of the Department of Transport and Regional Services[5], contracted an experienced aviation consultancy organisation to conduct a Post-Implementation Review (PIR) of the procedures. The PIR in its final report identified that a response to a radio broadcast could provide a degree of assurance that the transmission had been received and accepted, thereby closing the communication loop. In the example specifically given it stated:

> This could involve aircraft in the vicinity of an RPT [Regular Public Transport] aircraft responding with calls on position and intention following the making of an inbound call by an RPT aircraft.

Accordingly, the report recommended that responses to inbound broadcasts be strongly recommended rather than discouraged as in the present situation, particularly during the bedding-in process. One of the nine recommendations made in that report was that:

> CASA should emphasise the need to acknowledge inbound and taxiing calls so that there is no doubt that there is other traffic operating in the area, and to provide accurate position information to facilitate accurate situational awareness and alerted see and avoid.

On 25 January 2007, the Civil Aviation Safety Authority (CASA) responded to the report recommendations and advised the OAM that:

> …these recommendations represent significant variations to current CTAF procedures and do not seem well aligned to the principles underlying NAS. Noting that change itself represents safety risk, CASA would want to see a more safety case based backing than currently provided. Amongst other things this should involve consultation with industry to verify that the alleged risks (and suggested solutions) are agreed by industry.

The OAM also obtained a number of submissions from the industry on the PIR. Those submissions were provided to CASA.

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5 The Office of Airspace Management was originally established in the Aviation and Airports Division of the then Department of Transport and Regional Services, but is now contained within CASA as the Office of Airspace Regulation.

Following its review of the draft of this investigation report, CASA advised the ATSB that:

> As part of the response to the NAS 2c PIR recommendations, CASA has undertaken a review of radio calls at CTAFs and circuit joining procedures. One of the reviewed radio requirements related to mandatory radio calls at all CTAFs, where the PIR recommended that the mandatory (legislated) calls should include calls:
>
> prior to entering the runway for departure;
>
> prior to 10NM or 8 minutes inbound from the aerodrome,
>
> either entering downwind or turning base: and
>
> if conducting a straight-in approach, on final at 5NM.
>
> Related to the PIR recommendation on mandatory radio calls are two other PIR recommendations
>
> The first relates to the need for pilots to acknowledge inbound and taxiing calls so there is no doubt that there is other traffic operating in the area, and to provide accurate position information to facilitate situational awareness and alerted see and avoid.
>
> The second related PIR recommendation is that pilots intending to carry out a [live-side downwind] entry should first overfly the aerodrome above circuit height to better establish the position of other aircraft.
>
> CASA is currently seeking industry views on this matter.

ANALYSIS

At non-towered aerodromes, the disciplined use of radio to obtain traffic information to alert pilots and crews to each others' whereabouts and avoid traffic conflict assisted visual separation. The change associated with the National Airspace System 2c (NAS 2c) led to the predominant use of radio broadcasts in class G airspace to establish situational awareness about other traffic movements. The system replaced the previous pilot behaviour of pilot-to-pilot radio dialogue to achieve self-separation, and necessitated a greater need to listen carefully to the standard common traffic advisory frequency (CTAF) broadcasts of all other traffic.

The pilot of the Arrow made all the recommended broadcasts on the CTAF approaching the airport, but it was not until his 'short final' broadcast that the crew of the Dash 8 were alerted to the Arrow's presence. As the Dash 8 was already on the runway, a traffic conflict developed, necessitating either the Arrow pilot to initiate a missed approach, or the crew of the Dash 8 to vacate the runway.

The investigation was unable to determine why the crew of the Dash 8 and the pilot of the Mojave had not heard any of the Arrow pilot's transmissions until the broadcast made on short final approach. However, the crew of the taxiing Dash 8 made their taxi broadcast 40 seconds after the Arrow pilot's base broadcast finished, and it is likely that the crew of the Dash 8 started monitoring the CTAF after that broadcast. Similarly, the pilot of the Mojave made his taxi broadcast shortly after the Dash 8 crew's taxi broadcast and may not have been monitoring the CTAF at the time when the pilot of the Arrow made the base broadcast. The two taxiing broadcasts from the Dash 8 and the Mojave aircraft probably took up most of the period when the pilot of the Arrow would normally have been broadcasting that he was turning final in accordance with Aeronautical Information Publication (AIP) procedures. The 'beep' transmission from the aerodrome frequency response unit (AFRU) after the Dash 8 crew had completed their combined taxi and entering the runway broadcast should have indicated to the crew that another transmission had been completed within the previous 5 minutes, indicating a greater probability of other aircraft in the vicinity.

The AIP recommended two radio broadcasts before departure; a taxi broadcast and a broadcast before entering the runway. The two broadcasts would provide better situational awareness to circuit traffic than only one combined broadcast. However, there was no legislated obligation to make separate broadcasts. As there was only a short distance between the parking area on the apron and entering the runway via taxiway A at Port Macquarie Airport, there was little time to transmit the taxi and the runway entry broadcasts, and that proximity created less opportunity to use separate transmissions for those broadcasts. Any difference from common broadcast procedures may reduce the effectiveness of those broadcasts as tools to alert other pilots, because other pilots would expect to hear two broadcasts before runway entry.

The short taxiing distance to the runway resulted not only in a concentration of cockpit activity for the Dash 8 crew, but also could have significantly reduced the time when an effective listening watch on the CTAF could be made. In a traffic environment where pilot-to-pilot dialogue is discouraged in favour of sequential position information, monitoring the CTAF for a period of time that is shorter than the intervals between the recommended position broadcasts can result in an incomplete awareness of circuit traffic. The normal sequence of actions for start-up

and taxi in the Dash 8 included periods when radio reception was selected off, and the period for taxi before runway entry was short, despite advice in the AIP for higher performance aircraft at a busy aerodrome to monitor/broadcast on the CTAF earlier to allow sufficient time to gain sufficient awareness of the traffic. As a result, the Dash 8 crew had insufficient CTAF listening time to ensure that they had heard at least one of the sequence of position broadcasts from the Arrow pilot before the Dash 8's runway entry. There was also the possibility that the Dash 8 crew had been distracted from CTAF broadcasts while simultaneously monitoring both the Brisbane Centre frequency and the CTAF.

The lack of response to radio broadcasts within a CTAF, while reducing frequency congestion, removes the opportunity for acknowledgement between pilots that would close the communication loop between them. Assurance that both pilots have been made aware of each other by using broadcasts can only be gained if both pilots have been monitoring the radio frequency for sufficient time to hear at least one broadcast in another aircraft's sequence of broadcasts.

Although the orientation of taxiway A faced the circuit, the crew of the Dash 8 had not seen the Arrow until it was on short final approach. The pilot of the Arrow saw the Dash 8 enter the runway, contrary to his expectation, and broadcast his position while preparing to take avoiding action. It was likely that the Dash 8 crew would have seen the Arrow on short final, irrespective of the Arrow pilot's radio broadcast, but as they had entered the runway, a traffic conflict already existed.

There was no requirement for aircraft operating in class G airspace to be equipped with an operating transponder. The traffic alert and collision avoidance system (TCAS) on an aircraft on the ground may not always indicate nearby airborne aircraft. The use of TCAS on the ground for traffic information at non-towered aerodromes may not always provide a correct or full appreciation of the actual traffic situation, as highlighted in this case where the Arrow's transponder was responding in Mode C, yet was not observed on the TCAS visual display by the Dash 8 flight crew. The primary means of separation in non-controlled terminal airspace in visual meteorological conditions is visual acquisition and separation, supported by radio alerting. Although TCAS display indications often can assist, they provide no assurance of an indication of all nearby aircraft, unlike the anticipated assurance from a mandatory radio alerting system.

Any one of the separate acquisition systems described above could enhance the opportunity for the pilot of one aircraft to become aware of another in time to take avoiding action. In this incident, separation was assured by the Arrow pilot's visual acquisition, reinforced by radio alerting. In contrast, alerting from a radio broadcast or from a TCAS display indication did not enhance the Dash 8 crew's visual acquisition of the Arrow, and they were then wholly reliant on unalerted see-and-avoid to become aware of the Arrow. The limitations of unalerted see and avoid are well known; the then Bureau of Air Safety Investigation (BASI) 1991 research report, '*Limitations of the See-and-Avoid principle'*[6] concluded (page 23) that:

> Unalerted see-and-avoid has a limited place as a last resort means of traffic separation at low closing speeds but is not sufficiently reliable to warrant a greater role in the air traffic system.

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6 Limitations of the See-and-Avoid Principle (April 1991) Bureau of Air Safety Investigation, accessible from http://www.atsb.gov.au/publications/2005/pdf/See_and_Avoid.pdf

FINDINGS

From the evidence available, the following findings are made with respect to the runway incursion[7] event between the Piper Arrow and the Dash 8 at Port Macquarie Airport on 5 January 2007 and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The Dash 8 taxied onto the runway unaware of another aircraft on final approach for the same runway.
- The procedures used by the Dash 8 crew did not ensure an effective active listening watch on the Common Traffic Advisory Frequency to ensure that they had received radio notification from all other circuit aircraft before entering the runway. *[Safety issue]*
- The Dash 8's traffic alert and collision avoidance system (TCAS) display did not indicate the presence of the Arrow when the Dash 8 entered the runway, despite the Arrow's transponder operating normally with Mode C selected.
- The Dash 8 crew's visual lookout prior to entering the runway did not detect the Arrow on final approach.
- Frequency congestion occurred as the Dash 8 entered the runway, reducing the opportunity for the Arrow pilot to broadcast his position and intentions.

Other safety factors

- Combining a taxi broadcast and a runway entry broadcast into one combined transmission may reduce the broadcasts' effectiveness in alerting other pilots to an aircraft's actions.

Other key findings

- The Arrow pilot, aware of the Dash 8, maintained adequate separation throughout.
- The transponder in the Arrow was operating with Mode C selected.
- The different responses provided by an aerodrome frequency response unit (AFRU) can give an indication to all aircraft of the likelihood of other aircraft in the vicinity.

7 Runway incursion – The Transport Safety Investigation Regulations 2003, regulation 2.2 definition of a runway incursion is that it 'means any intrusion of an aircraft, vehicle, person, animal or object on the ground within a runway strip or helicopter landing site that creates a collision hazard or results in a reduction of safety for aircraft.'

SAFETY ACTION

The safety issue identified during this investigation is listed in the Findings section 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.

Safety Issue

The procedures used by the Dash 8 crew did not ensure an effective active listening watch on the CTAF frequency to ensure that they had received radio notification from all other circuit aircraft before entering the runway.

Operator's Safety Action

As a result of this occurrence, the aircraft operator advised the Australian Transport Safety Bureau that it issued a Safety Alert Notice on 21 April 2008 to all of its flight crew, on the Aerodrome frequency Response Unit (AFRU) and Common Traffic Advisory Frequency (CTAF) operations. A part of the Notice advises:

> Crews are encouraged that if a "beep back" occurs and no contact can be established with the proximate traffic, be it via the radio, TCAS or visual acquisition, then try and establish a means of communication to verify if any potential conflict exists prior to entering the runway.