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Australian Transport Safety Bureau

Aircraft separation issues involving Embraer ERJ 190, VH-ZPJ, and GippsAero GA-8, VH-XGA

near Mildura Airport, Victoria, 31 May 2016

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Addendum

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What happened

On 31 May 2016 at 1018 Eastern Standard Time (EST), Virgin Australia Airlines flight VA1615, an Embraer ERJ 190 aircraft, registered VH-ZPJ (ZPJ), departed Melbourne Airport on a scheduled passenger service to Mildura Airport, Victoria. On board the aircraft were 2 flight crew, three cabin crew and 81 passengers. The aircraft captain was the pilot flying (PF) and the first officer was the pilot monitoring (PM).[1]

About 40 NM from Mildura and just prior to ZPJ leaving controlled airspace, air traffic control (ATC) passed the flight crew traffic information about two aircraft operating above 10,000 ft to the west of Mildura Airport. In addition, there was also a public transport flight inbound to Mildura from Broken Hill and a light twin-engine aircraft inbound to Mildura on a converging track to ZPJ. The PM on board ZPJ contacted the light twin-engine aircraft and confirmed they would arrive at Mildura after ZPJ. The estimated arrival time for the public transport flight at Mildura was also later than the estimate for ZPJ, and consequently the flight crew on board ZPJ did not consider any of the traffic passed to them by ATC would conflict with their own arrival.

The aircraft operating to the west of Mildura were a GippsAero GA10 aircraft, registered VH-XGY (XGY), conducting spin testing supported by a Gippsland Aeronautics GA-8 'chase plane', registered VH-XGA (XGA), from the same company.

ZPJ joined the Mildura Airport circuit on the crosswind leg for a left visual circuit to land on runway 09.

On the base leg of the circuit, the flight crew on board ZPJ heard their traffic collision alert system (TCAS) announce a traffic advisory (TA) aural alert (see *TCAS limitations on approach*). They glanced at their TCAS display to check the relative position of the traffic, which indicated it was to their right (position 1 in Figure 1). The flight crew looked out the right window of the flight deck and identified the traffic to their right and high against the skyline. The traffic appeared to them to be stationary in the windscreen relative to their own aircraft and with a high closure rate (from TCAS data the aircraft were 1.25 NM apart at the time of the TA alert).[2]

The PM on board ZPJ contacted the other traffic on the radio and requested their intentions. The other traffic was XGA, which was leading XGY back to Mildura Airport for a straight-in approach to runway 09. When the pilot of XGA responded that they were tracking for a straight-in approach to runway 09, the PM assessed they were on a collision course on their present track. They also recognised that there would be a potential risk of collision if both aircraft performed a go-around to the south of the main runway. Therefore the PM responded to the pilot of XGA to immediately turn and remain south of the airport. The pilot of XGA identified ZPJ ahead of them on approach to runway 09 and responded that they would discontinue their approach and manoeuvre to the south of the airport.[3]

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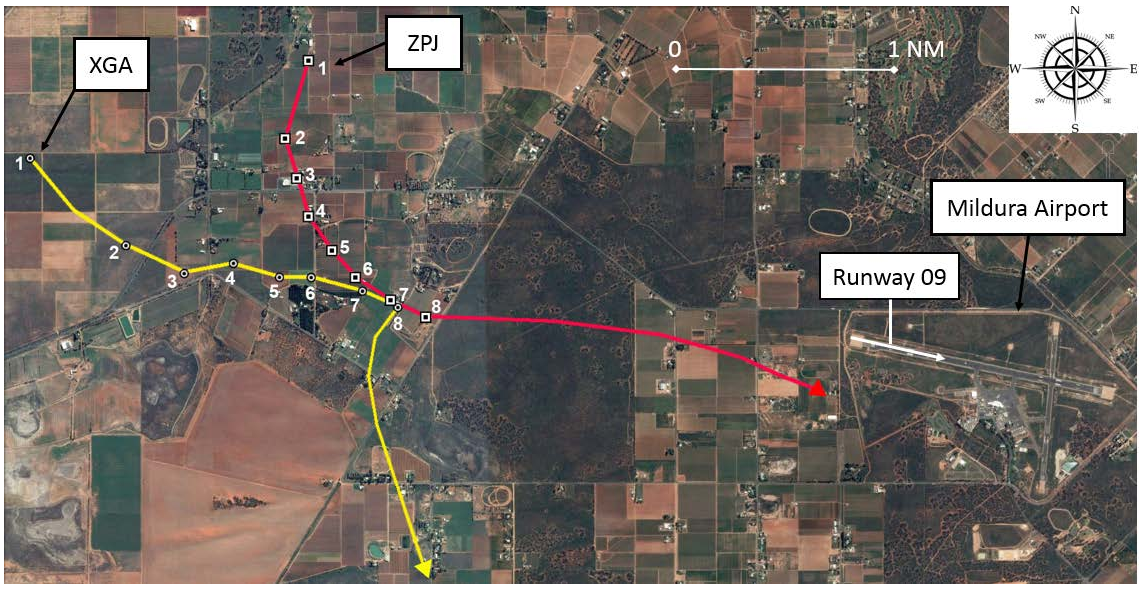
1 Pilot Flying (PF) and Pilot Monitoring (PM): procedurally assigned roles with specifically assigned duties at specific stages of a flight. The PF does most of the flying, except in defined circumstances; such as planning for descent, approach and landing. The PM carries out support duties and monitors the PF's actions and the aircraft's flight path.

2 Traffic that is closing, but appears stationary in the windscreen, is indicative of a collision course. In this case, the ERJ 190 will also appear stationary in the windscreen of XGA.

3 Traffic in the circuit have 'right-of-way' over traffic tracking for a straight-in approach.

The PF on board ZPJ decided to discontinue their approach to land on runway 09, as they were too late for their turn onto final and therefore not in a stabilised condition.[4] However, the PM indicated to the PF that they could not execute a go-around manoeuvre because there was another aircraft joining the circuit on crosswind (the light twin-engine aircraft). The PF decided that continuing the approach to land was not an option and therefore executed the go-around to the south of runway 09, maintained separation from the other traffic on crosswind and then landed from the subsequent circuit. During the go-around manoeuvre, the aircraft's TCAS detected XGA pass about 200 ft above and 0.125 NM behind ZPJ (position 7 & 8 in Figure 1).

Figure 1: Traffic conflict between ERJ 190 (VH-ZPJ) and GA-8 (VH-XGA)



Source: Google earth, annotated by ATSB based on Virgin Australia Airlines TCAS data (numbers indicate the relative positions of the conflict aircraft at the same time)

Airspace

Class E airspace

A Class E controlled airspace corridor extends from Melbourne to overhead Mildura Airport with a lower limit of FL 125.[5] In Class E airspace, instrument flight rules (IFR) traffic, such as ZPJ, require a clearance. Visual flight rules (VFR) traffic, such as XGA and XGY, do not require a clearance, but should monitor the Class E airspace air traffic service frequency. In Class E airspace, IFR flights are separated from other IFR flights and receive traffic information on VFR flights as far as practicable. ZPJ left Class E airspace on descent to Mildura about 37 NM from Mildura Airport, at which point ZPJ entered Class G airspace for the remainder of the flight.

Class G airspace

Class G airspace is non-controlled airspace. IFR and VFR traffic are permitted without a clearance and there is no separation service provided by ATC. Mildura Airport is a non-controlled aerodrome with a discrete common traffic advisory frequency (CTAF), which is a different frequency from the surrounding Class G airspace area frequency. About 10 NM to the north-west of Mildura Airport is Wentworth Aerodrome. Wentworth uses the same CTAF as Mildura.

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4 Stabilised approach criteria is used for identifying the need for a go-around or missed approach. For the ERJ 190 this included being established on runway centreline with wings level by 500 ft above ground level.

5 Flight level: 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 125 equates to 12,500 ft.

Radio broadcasts at non-controlled aerodromes

The following Table 1 indicates the non-controlled aerodrome radio broadcast requirements for inbound aircraft in accordance with the aeronautical information publication (AIP).

Table 1: Summary of broadcasts required for inbound aircraft at non-controlled aerodromes

Situation	Remark
Inbound to the aerodrome	Broadcast 10 NM from the aerodrome, or earlier, commensurate with aeroplane performance and pilot workload, with an estimated time of arrival (ETA) for the aerodrome.
Ready to join the circuit	Broadcast immediately before joining the circuit.
Intention to make a straight-in approach	Broadcast on final approach at not less than 3 NM from the threshold.

Incident flight radio broadcasts

During the spin testing of XGY, XGY was classified as 'lead' aircraft and XGA as 'in-trail'. The pilot of XGA set one of their two radio frequencies to their company frequency, for communication with XGY, and the other to area frequency, for communication with other traffic if required. While operating on the area frequency, the pilot of XGA heard a broadcast from ZPJ that they were inbound to Mildura from Melbourne, and a broadcast from another public transport aircraft inbound to Mildura from Broken Hill. On completion of the spin testing, XGA assumed the lead from XGY at about 10,000 ft and 11–12 NM from Mildura Airport. Shortly after the lead change, the pilot of XGA changed from area frequency to the Mildura CTAF.

The pilot of XGA made a 10 NM broadcast on CTAF, which included their position, altitude and intentions for a 5 NM straight in approach for final approach to runway 09. They received an immediate response from the public transport aircraft tracking from Broken Hill, who provided an estimated time of arrival for their 5 NM final approach position for runway 09. The pilot of XGA responded with a revised estimate for their arrival on the ground at Mildura Airport, which was the same time as the other aircraft's estimate for their 5 NM final position. At the end of this exchange, XGA, with XGY in-trail, was about 7 NM from Mildura Airport tracking to the north-east to intercept a 5 NM final position, at 140–150 kt airspeed, descending at about 2,000 ft per minute. The pilot of XGA heard no radio broadcasts from ZPJ on CTAF and assumed they had already landed.

XGA made a right turn onto final approach for runway 09 at about 3,200 ft, 4.5 NM[6] from the runway threshold. Shortly after the turn, the pilot of XGA heard a broadcast requesting their intentions from ZPJ. Following the initial exchange of broadcasts with ZPJ, the pilot of XGA visually identified ZPJ about 2 NM ahead on approach to runway 09. They recognised that ZPJ had right-of-way and made a broadcast that they were 'breaking off' their approach to runway 09 and turning south.

The PM duties on board ZPJ included managing the radio communications with other traffic. During the approach to join the circuit, and subsequently while flying the circuit, the captain was preoccupied with PF duties and did not comprehend all the radio broadcasts. However, the PM made several CTAF broadcasts, which started at 42 NM from Mildura at 01:06:35. The last broadcast before entering the Mildura circuit was just prior to ZPJ crossing overhead runway 09 to join crosswind at 01:15:27. The next CTAF broadcast made by ZPJ was at 01:18:16, after they turned base. The flight crew received a TA at 01:18:31 and subsequently made a broadcast to challenge the intentions of XGA at 01:18:43.

[6] This position is based upon TCAS data from VH-ZPJ and is indicative only.

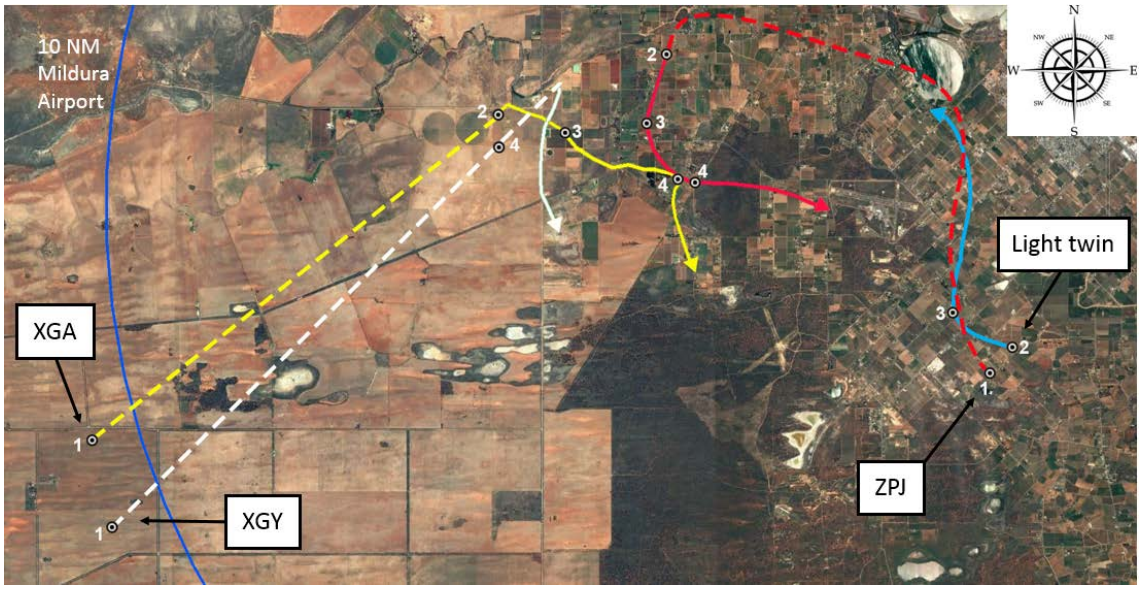
Incident aircraft geometry

The following Table 2 indicates the positions of ZPJ and the conflict aircraft XGA. Figure 2 depicts the geometry of traffic in the vicinity with numbering in accordance with Table 2. The positions of the aircraft are based upon TCAS data from ZPJ.

Table 2: Aircraft geometry

Time	Event	VH-ZPJ	VH-XGA
1:15:27 (1)	ZPJ CTAF broadcast – joining circuit	2,237 ft, 2.5 NM SE Mildura Airport	11,130 ft, 10.5 NM WSW Mildura Airport
1:18:16 (2)	CTAF broadcast ZPJ – after turning base	1,009 ft, Base runway 09	3,209 ft, 4.5 NM final runway 09
1:18:31 (3)	Aural TA annunciation	733 ft, Base runway 09	1,300 ft, 3.5 NM final runway 09
1:18:59 (4)	Closest point of approach	442 ft, 2.0 NM W runway 09	642 ft, 2.1 NM W runway 09

Figure 2: Aircraft geometry from Table 2



Source: Google earth, annotated by ATSB based on Virgin Australia Airlines TCAS data.

TCAS limitations on approach

The traffic alert and collision avoidance system (TCAS) II, will display traffic to the flight crew as: *other traffic*, *proximate traffic*, *traffic advisory*,[7] or *resolution advisory*.[8] However, only traffic advisories and resolution advisories trigger an aural alert to the flight crew.

The collision avoidance system logic is based on the concepts of sensitivity level (SL), threshold time (tau) for issuing a traffic alert or resolution advisory, and protected volume of airspace around the TCAS equipped aircraft. The higher the SL, the greater the volume of protected airspace. As SL reduces, the volume of protected airspace reduces and TCAS functions may become inhibited.

Tau is an approximation of the time, in seconds, to the closest point of approach of another aircraft. This forms the basis for the alerting functions and therefore the volume of protected airspace. Therefore, a reduction in the TCAS SL reduces the volume of protected airspace by reducing the value of tau.

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7 An indication given by TCAS to a flight crew when an aircraft has entered, or is projected to enter, the protected volume of airspace around their own aircraft.

8 An indication given by TCAS II to a flight crew that a vertical manoeuvre should, or in some cases should not, be performed to attain or maintain safe separation from another aircraft.

Below 1,000 +/-100 ft above ground level, the TCAS SL reduces from SL3 to SL2. For the ERJ 190 this equates to 900 ft when on descent and 1,100 ft when on climb. From SL3 to SL2 the tau reduces from 25 seconds to 20 seconds and resolution advisories are inhibited. Below 500 +/-100 ft above ground level, TCAS aural alerts are inhibited. For the ERJ 190 this equates to 400 ft when on descent and 600 ft when on climb. Close to the ground, the windshear and ground proximity warning system alerts have a higher alert priority.

The PM on board ZPJ commented that during the visual circuit they changed the focus of their scan from inside the cockpit to outside the cockpit. They suspect that XGA was probably displayed as other traffic on their TCAS before they received the TA alert. However, there are no company procedures specific to the use of TCAS at non-controlled aerodromes. Company procedures emphasise the importance of flight crew maintaining a 'constant lookout when operating within a CTAF', and use positive altitude separation or alternatively coordinate a track deviation with conflict aircraft.[9]

Limitations with visual sighting

Three limitations to sighting other traffic, of interest to this incident, are:

- alerted search versus unalerted search
- lack of relative motion on collision course
- effects of complex backgrounds

Alerted search versus unalerted search

Traffic alerts may come from radio calls or TCAS at a non-controlled aerodrome. Knowing where to look has been shown to improve visual detection of other traffic. The PF on board ZPJ was alerted to the potential conflict by TCAS, and then visually identified XGA. The pilot of XGA was alerted to the potential conflict following ZPJ's radio broadcast on the base circuit leg, and then visually identified ZPJ.

Lack of relative motion on collision course

The PF on board ZPJ commented that when they visually sighted XGA, the aircraft appeared to be stationary in the windscreen, which indicated a potential collision course. In this case ZPJ would also appear stationary to the pilot of XGA. Lack of relative motion against a background reduces the probability of visual detection.

Effects of complex backgrounds

When the PF on board ZPJ visually identified XGA, XGA was above the horizon (higher altitude relative to ZPJ) and against a background of sky. For the pilot of XGA, ZPJ was lower and against a background of terrain. The pilot of XGA was therefore required to detect the contrast between the aircraft and terrain to detect ZPJ. A terrain background may create a complex background and reduce the probability of visual detection.

Safety analysis

The AIP directs pilots to the minimum required radio broadcasts when operating at non-controlled aerodromes and the pilots of ZPJ and XGA complied with these requirements. However, it is likely that the pilot of XGA was not on the Mildura CTAF when the PM on board ZPJ made a broadcast that they were joining the Mildura circuit. When the pilot of XGA switched to the Mildura CTAF they were initially occupied with communicating with another public transport aircraft inbound from the north and considered this aircraft to be their only potential conflict. It could not be determined why the flight crew on board ZPJ did not comprehend the presence of a potential conflict from this

[9] Aircraft not equipped with transponders may be operated in non-controlled airspace, in which case they will not be detected by TCAS.

radio traffic. However, the flight crew of ZPJ had previously dismissed these two aircraft (XGA and XGY) as a potential conflict for their arrival.

After ZPJ turned onto the base leg for runway 09, the PM made a base radio broadcast. It could not be determined why the pilot of XGA did not comprehend the presence of a potential conflict from this broadcast. However, the investigation could not rule out the possibility that other aircraft operating at Mildura or Wentworth made broadcasts which interfered with one or several of the broadcasts made by ZPJ or XGA.

Shortly after the base leg radio broadcast from the PM in ZPJ, the flight crew were alerted to the presence of XGA by a TCAS TA aural alert. At this time ZPJ was below 900 ft and therefore TCAS resolution advisory was inhibited. However, the TCAS visual display of the relative position of XGA cued their visual search and facilitated a quick identification. XGA appeared to the flight crew on board ZPJ as stationary against a background of sky. Therefore, to the pilot of XGA, ZPJ was probably against a more complex background with no relative motion, contributing to the difficulty for the pilot of XGA to detect ZPJ before they were alerted by the radio call by ZPJ.

The radio broadcast from the PM on board ZPJ directed to the 'traffic inbound to Mildura from the west' alerted the pilot of XGA to the presence of other traffic and cued them to search for the conflict. The PM on board ZPJ then directed the pilot of XGA to 'turn immediately away to the south' to avoid a potential collision either during their turn onto final approach or in the event that both aircraft attempted a simultaneous go-around manoeuvre on the south side of runway 09.

After receiving an acknowledgement from the pilot of XGA, the flight crew on board ZPJ turned their attention to the execution of their go-around manoeuvre as their turn onto the final leg of the circuit was late due to their preoccupation with monitoring XGA. However, during their turn to join the upwind circuit leg for runway 09 on the south side of the runway, XGA continued to converge to a closest point of 0.125 NM behind and about 200 ft above ZPJ before making an abrupt turn to the south. This was the result of the intention of the pilot flying XGA to join the upwind leg of the circuit to the south of runway 09, before they realised that ZPJ was also conducting a go-around from their approach.

Findings

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

- The pilot of XGA was probably not monitoring Mildura CTAF when the PM on board ZPJ broadcast joining the Mildura circuit.
- The flight crew of ZPJ did not detect the broadcast from XGA that they were intending to join a straight in approach to runway 09.
- After a separation strategy was agreed, XGA continued to close on ZPJ to a closest point of approach of 0.125 NM behind and 200 ft above ZPJ when ZPJ started their go-around.
- Both aircraft made the required broadcasts on the CTAF.
- The flight crew on board ZPJ were cued to the conflict by their TCAS traffic advisory alert.
- The pilot on board XGA was cued to the conflict by the radio broadcast from ZPJ.

Safety message

Despite compliance with the radio broadcast requirements, a traffic conflict occurred in an environment with limited manoeuvring options for a high capacity public transport aircraft. This incident highlights the importance of an alerted search to the successful identification of potential conflict traffic. Further information is available from ATSB Research report: *Limitations of the See-and-Avoid Principle*.

The ATSB SafetyWatch highlights the broad safety concerns that come out of our investigation findings and from the occurrence data reported to us by industry. One of the safety concerns relates to *safety around non-controlled aerodromes*.

General details

Occurrence details

Date and time:	31 May 2016 – 1130 EST	
Occurrence category:	Incident	
Primary occurrence type:	Aircraft separation - issues	
Location:	Near Mildura Airport, Victoria	
	Latitude: 34° 13.75' S	Longitude: 142° 5.13' E

Aircraft details – VH-ZPJ

Manufacturer and model:	Embraer-Empresa Brasileira De Aeronautica – ERJ 190	
Registration:	VH-ZPJ	
Operator:	Virgin Australia Airlines PTY LTD	
Serial number:	19000209	
Type of operation:	Air Transport High Capacity - passenger	
Persons on board:	Crew – 5	Passengers – 78
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

Aircraft details – VH-XGA

Manufacturer and model:	Gippsland Aeronautics – GA-8	
Registration:	VH-XGA	
Serial number:	GA8-96-03	
Type of operation:	Private – test and ferry	
Persons on board:	Crew – 2	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

About the ATSB

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; and 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 operations involving the travelling public.

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.

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

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.

About this report

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope, fact-gathering investigation was conducted in order to produce a short summary report, and allow for greater industry awareness of potential safety issues and possible safety actions.