

Australian Government Australian Transport Safety Bureau

Mid-air collision involving SIAI Marchetti S-211s, VH-DZJ and VH-DQJ

25 km west of Tyabb Airport, Victoria, on 19 November 2023

ATSB Transport Safety Report

Aviation Occurrence Investigation AO-2023-057 Preliminary – 17 January 2024 Released in accordance with section 25 of the Transport Safety Investigation Act 2003

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Postal address:	GPO Box 321, Canberra, ACT 2601
Office:	12 Moore Street, Canberra, ACT 2601
Telephone:	1800 020 616, from overseas +61 2 6257 2463
	Accident and incident notification: 1800 011 034 (24 hours)
Email:	atsbinfo@atsb.gov.au
Website:	www.atsb.gov.au

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Addendum

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Preliminary report

This preliminary report details factual information established in the investigation's early evidence collection phase, and has been prepared to provide timely information to the industry and public. Preliminary reports contain no analysis or findings, which will be detailed in the investigation's final report. The information contained in this preliminary report is released in accordance with section 25 of the *Transport Safety Investigation Act 2003*.

The occurrence

On 19 November 2023, the crews of 2 SIAI Marchetti S-211s, operated by Jetworks Aviation and registered VH-DQJ and VH-DZJ, prepared to conduct a formation flight from Essendon Airport, Victoria. The flight operated using the callsign 'Viper Formation' and intended to undertake in-flight filming of both aircraft over Port Phillip Bay. VH-DQJ was the formation leader, operating as 'Viper 1', with a pilot and safety pilot (see section titled *Pilot details*) on board. VH-DZJ was operating as 'Viper 2' with a pilot and camera operator on board.

Prior to commencing the flight, the crews conducted a brief of the planned manoeuvres. The first of the manoeuvres involved Viper 1 flying inverted, straight and level, while Viper 2, flying upright, moved to the right line abreast position for filming (Figure 1). From that position, Viper 2 would move as required for the filming while maintaining separation from Viper 1. The crews planned to conduct this manoeuvre with Viper 2 starting in the right echelon position (panel A in Figure 1) before moving rearward to allow Viper 1 sufficient room to roll inverted (panel B in Figure 1). After Viper 1 rolled inverted, Viper 2 was to move forward and climb or descend as needed to reach the line abreast position at the same altitude, for filming (panel C in Figure 1). During the manoeuvring, the pilots would communicate on a discrete radio frequency.





Source: Kovozavody Prostejov, modified and annotated by the ATSB

The crews completed the brief and, at 1324 local time, the aircraft departed Essendon towards Port Phillip Bay. About 6 minutes later, while the aircraft were operating at about 3,000 ft above mean sea level and at a speed of about 200 kts, the crews began manoeuvring for the planned sequence. Viper 2 moved rearward (panel A in Figure 2) and Viper 1 rolled inverted (panel B in Figure 2). From a low right echelon position, Viper 2 moved forward and climbed toward the line abreast position while also moving laterally closer to Viper 1 (panel C in Figure 2). The rate of closure between the aircraft increased and before Viper 2 could stabilise in the line abreast position, the pilot banked away and moved out of the formation (panel D in Figure 2). Viper 1 then rolled upright.



Figure 2: Recorded images from Viper 1 of first manoeuvre

Note: For ease of interpretation some images have been inverted to present all footage in an upright orientation. Source: Recorded video from VH-DQJ, modified and annotated by the ATSB

Viper 2 rejoined the formation in the right echelon position (panel A in Figure 3) and shortly after, Viper 1 rolled inverted for a second attempt (panel B in Figure 3). On this occasion, instead of moving toward the line abreast and level position, the pilot of Viper 2 manoeuvred to pass below (panel C in Figure 3) and to the left of Viper 1 (panel D in Figure 3).



Figure 3: Recorded images from Viper 1 of second manoeuvre

Note: For ease of interpretation some images have been inverted to present all footage in an upright orientation. Source: Recorded video from VH-DQJ, modified and annotated by the ATSB

The safety pilot in Viper 1 observed Viper 2 pass beneath and alerted the pilot of Viper 1 to the manoeuvre. The pilot of Viper 1 then rolled upright and contacted the pilot of Viper 2 to discuss the manoeuvre. The pilot of Viper 2 advised that passing underneath Viper 1 provided a good filming opportunity and requested to repeat the manoeuvre. After discussing the manoeuvre, the pilots decided to attempt the previous manoeuvre again, and Viper 2 moved to the right echelon position to recommence the manoeuvre.

As with the previous attempt, Viper 2 moved rearward to allow Viper 1 to roll inverted. As Viper 1 stabilised in the inverted attitude (panel A in Figure 4), Viper 2 began manoeuvring to pass beneath Viper 1 (panel B in Figure 4). Viper 1 then stabilised in the inverted attitude and as Viper 2 approached, the vertical separation between the 2 aircraft reduced. Viper 2 passed beneath and began to pitch up and bank away from Viper 1 (panel C in Figure 4). At 1333, as Viper 2 climbed and banked left, the right wings of each aircraft collided (panel D in Figure 4).



Figure 4: Recorded images from Viper 1 of third manoeuvre and collision

Note: For ease of interpretation the images have been inverted to present all footage in an upright orientation. The occupants of Viper 2 have been obscured in panel D. Source: Recorded video from VH-DQJ, modified and annotated by the ATSB

After the collision and with the right wing severely damaged (Figure 5), Viper 2 continued to climb and began rolling right, passing above and behind Viper 1. Viper 2 rolled to an inverted attitude and quickly assumed a near vertical, nose-down flight path toward the water and commenced a slow right roll until impacting the water at high speed. Both occupants were fatally injured.



Figure 5: Recorded image from Viper 1 showing the collision damage to Viper 2

Note: For ease of interpretation the image has been inverted to present an upright orientation. Source: Recorded video from VH-DQJ, annotated by the ATSB The occupants of Viper 1 felt the collision but did not observe it. The collision deflected Viper 1 right 35 degrees from the level inverted attitude to an angle of left bank of about 145 degrees from upright and slightly nose down. The pilot rolled the aircraft upright, checked the control response and assessed that the aircraft was controllable. The pilot then attempted to contact the pilot of Viper 2, but no response was received.

The pilot of Viper 1 turned the aircraft back towards the location of the collision where the safety pilot observed a splash mark and debris from Viper 2 on the water's surface. The pilot of Viper 1 contacted air traffic control to advise of the mid-air collision and broadcast a 'mayday'.¹ Viper 1 then orbited the location of the splash mark to assist air traffic control (ATC) in marking the location for search and rescue purposes (Figure 6).



Figure 6: Recorded flight path of VH-DQJ

Note: As is normal procedure for formation flights, only the formation leader (VH-DQJ) had the transponder active. Surveillance data was only recorded for that aircraft. Source: Airservices Australia and ATSB

The pilot of Viper 1 then turned northeast and conducted controllability checks of the aircraft in both the cruise and landing configurations. The pilot considered a diversion to the briefed alternate airport of Moorabbin but elected to return to Essendon as the aircraft was assessed to be fully controllable and not significantly damaged. At 1349, the aircraft landed at Essendon without further incident.

Context

Aircraft details

The SIAI Marchetti S-211 (Figure 7) was a mid-wing aircraft designed for military flying training duties and fitted with full dual controls and 2 tandem configured ejection seats. The ejection seats

¹ MAYDAY: an internationally recognised radio call announcing a distress condition where an aircraft or its occupants are being threatened by serious and/or imminent danger and the flight crew require immediate assistance. A mayday call can also made on behalf of one aircraft by another.

were deactivated in VH-DQJ and VH-DZJ. The aircraft was powered by a Pratt and Whitney Canada JT15D-4C turbofan engine mounted in the aircraft fuselage mid-section directly behind the cockpit. Fuel system limitations restricted inverted manoeuvres to periods not exceeding 30 seconds.

Figure 7: VH-DQJ (left) and VH-DZJ (right)



Source: ATSB and Phil Vabre

VH-DQJ and VH-DZJ were built in Italy in 1985 and delivered to the Republic of Singapore Air Force (RSAF) where they operated in the military flight training role. From 1996 until 2009, when the S-211 fleet was retired from RSAF service, the aircraft were based at Royal Australian Air Force Base Pearce, Western Australia. Following retirement from military service, several RSAF S-211s, including VH-DQJ and VH-DZJ, were sold to civilian operators.

In 2011, both aircraft were entered onto the Australian Civil Aircraft Register and issued with special certificates of airworthiness (CoA) in the Limited category. The special CoA was subject to several conditions, including limitations on the operation of these aircraft to:

- aerobatic flights
- exhibiting an ex-military aircraft
- aerobatic training
- adventure style operations²
- mock combat
- any operations in support of the above purposes.

The carriage of passengers in these aircraft was permitted. However, the person operating the aircraft had to ensure that each person carried was made aware of the following details before boarding the aircraft and (if paying for carriage) prior to payment being made:

- the design, manufacture, and airworthiness of the aircraft are not required to meet any standard recognised by the Civil Aviation Safety Authority (CASA)
- the aircraft is not required by CASA to be operated to the level of safety normally associated with a commercial passenger flight
- that persons fly in the aircraft at their own risk.

Pilots operating the S-211 were required to undertake flight training and flight reviews for the aircraft type in accordance with Civil Aviation Safety Regulations.³ They were also required to hold a single engine aeroplane class rating and applicable design feature endorsements.

At the time of the accident, VH-DQJ had completed about 6,363 hours in service and had a maintenance release valid until 10 November 2024 or 6,458 hours in service. The aircraft was certified for day visual flight rules flight only. VH-DZJ had completed about 5,595 hours in service

² Adventure style operations are those allowing paying passengers to be carried for experience flights in ex-military aircraft.

³ Civil Aviation Safety Regulations 61.062: Prescription of types of aircraft for additional limitations on class ratings, and 61.747: Limitations on exercise of privileges of class ratings in certain aircraft--flight review

and had a maintenance release valid until 28 July 2024 or 5,678 hours in service. The aircraft was certified for instrument flight rules operations.

Pilot details

Viper 1 (VH-DQJ) pilot

The pilot of Viper 1 held an Air Transport Pilot Licence (Aeroplane) along with the required ratings, endorsements, and type training to operate the S-211 as pilot in command. In addition, the pilot held flight activity ratings and instructor training approvals for formation flying, formation aerobatics, low-level aerobatics (minimum height of 500 ft above ground level (AGL)) and spinning. The pilot also held several type ratings in transport category turbine engine aircraft.

The pilot had recorded over 20,700 hours of flying time before the accident flight of which 10.8 hours was in the S-211. The pilot's flying experience included military service operating aircraft of similar performance and handling to the S-211 and formation aerobatics displays. The pilot also had significant experience in civil formation aerobatic displays.

The pilot held a Class 2 medical certificate valid until 21 August 2024 with a restriction that required the pilot to fly with a safety pilot.

Viper 1 (VH-DQJ) safety pilot

The safety pilot in Viper 1 held an Air Transport Pilot Licence (Aeroplane) along with the required ratings and endorsements to operate the S-211 but had not completed flight training in the aircraft type.

The safety pilot also held flight activity endorsements for formation flying, formation aerobatics, spinning and type ratings in several transport category turbine engine aircraft.

The safety pilot had recorded a total of 12,276 hours before the accident flight, including a previous flight in the S-211. The safety pilot's experience also included military service operating aircraft of similar performance and handling to the S-211 and formation aerobatic displays.

The safety pilot held a Class 1 medical certificate valid until 22 February 2024.

Viper 2 (VH-DZJ)

The pilot of Viper 2 held a Commercial Pilot Licence (Aeroplane) along with the required ratings, endorsements, and type training to operate the S-211 as pilot in command. In addition, the pilot held formation flying, formation aerobatics, low-level aerobatics (minimum height of 500 ft AGL) and spinning flight activity endorsements.

The pilot had recorded a total of 1,542 hours before the accident flight including 489 hours on the S-211 aircraft type.

The pilot held a Class 1 medical certificate valid until 28 February 2024.

Meteorology

The flights and filming manoeuvres were conducted in clear and smooth flying conditions.

At 1330, 3 minutes before the collision, the Bureau of Meteorology (BoM) weather station at South Channel Island, 12 km southwest of the collision location, recorded the wind as 11 kt from 201° magnetic.

Recorded data

Neither aircraft was fitted with a flight data recorder or cockpit voice recorder, nor were they required for the type of aircraft and operation.

The camera operator in Viper 2 carried a hand-held camera for filming. Several video cameras were also mounted within the cockpit of both aircraft. The hand-held camera and mounted

cameras from Viper 2 were unable to be located during recovery operations or in the recovered wreckage.

There were 4 cameras fitted to Viper 1, of which 3 recorded video and audio during the flight (Figure 8), including the collision. The cameras were mounted on each side of the front seat headrest, looking left and right, on the glareshield looking forward and one mounted on the instrument panel facing the control column. The camera facing the control column stopped recording before departure while the cameras facing forward and left stopped filming during the return flight to Essendon. The right facing camera stopped filming after the flight as the crew exited the aircraft.

Figure 8: The recorded views of the cameras fitted to VH-DQJ



Source: Recorded video from VH-DQJ, annotated by the ATSB

Recorded surveillance and communications audio data was provided by Airservices Australia. The discrete radio frequency used by the crews during the manoeuvres was not recorded.

Wreckage

VH-DQJ

VH-DQJ sustained minor damage in the collision. Several impact marks and paint transfers from VH-DZJ were present on the upper surface of the right wing (Figure 9) and the landing light cover was shattered. There was no significant wing structure damage identified.

Figure 9: VH-DQJ collision damage (left) and overlay representation of the right wing of VH-DZJ (right)



Source: ATSB

VH-DZJ

Witnesses observed VH-DZJ impact the water in a near-vertical, nose down attitude at high speed. The aircraft was extensively damaged and came to rest on the floor of Port Phillip Bay at a depth of 24 m.

The wreckage was located the day after the accident and, on 25 November, Victoria Police recovered most of the fuselage including the engine. The wing structures and most of the empennage were unable to be located and were not recovered. In the following days, the police conducted further diving operations to retrieve other aircraft debris and associated items.

The ATSB examination of the recovered wreckage identified no pre-impact faults, although the scope of the examination was limited by the extensive damage to the aircraft. Damage to the engine was consistent with the engine operating at the time of the collision with water.

Examination of the recorded imagery also identified no pre-impact faults. The imagery showed that as the aircraft collided, the outer right wing structure of VH-DZJ immediately failed, with deformation to the forward wing spar and separation of the lower wing skin (Figure 10). The right aileron control system also appeared to be significantly damaged.

Figure 10: Recorded images showing VH-DZJ during the collision (top) and immediately after (bottom)



Note: For ease of interpretation the images have been inverted to present the footage in an upright orientation. The occupants of VH-DZJ have been obscured. Source: Recorded video from VH-DQJ, modified and annotated by the ATSB

Further investigation

The investigation is continuing and will include:

- examination of maintenance records
- consideration of formation flying procedures and practices
- examination of pilot records and training
- further analysis of recorded video and audio
- examination of aircraft and flight crew requirements when a safety pilot is required by medical restriction
- a review of the category of operation
- analysis of air traffic control surveillance and audio data.

A final report will be released at the conclusion of the investigation. Should a critical safety issue be identified during the course of the investigation, the ATSB will immediately notify relevant parties so appropriate and timely safety action can be taken.

Acknowledgements

The ATSB acknowledges the significant assistance provided by Victoria Police during the on-site phase of this investigation.

General details

Occurrence details

Date and time:	19 November 2023 – 1333 Eastern Daylight Time	
Occurrence class:	Accident	
Occurrence categories:	Collision, loss of control, collision with terrain, diversion / return	
Location:	25 km west of Tyabb, Victoria	
	Latitude: 38.2274°S	Longitude: 144.8864°E

Aircraft details – VH-DQJ

Manufacturer and model:	SIAI MARCHETTI SRL S-211	
Registration:	VH-DQJ	
Operator:	Jetworks Aviation	
Serial number:	025/02-015	
Departure:	Essendon, Victoria	
Destination:	Essendon, Victoria	
Persons on board:	Crew – 2	Passengers – Nil
Injuries:	Crew – Nil	Passengers – Nil
Aircraft damage:	Minor	

Aircraft details – VH-DZJ

Manufacturer and model:	SIAI MARCHETTI SRL S-211	
Registration:	VH-DZJ	
Operator:	Jetworks Aviation	
Serial number:	005/02-002	
Departure:	Essendon, Victoria	
Destination:	Essendon, Victoria	
Persons on board:	Crew – 1	Passengers – 1
Injuries:	Crew – 1 (fatal)	Passengers – 1 (fatal)
Aircraft damage:	Destroyed	

Australian Transport Safety Bureau

About the ATSB

The ATSB is an independent Commonwealth Government statutory agency. It is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers.

The ATSB's purpose is to improve the safety of, and public confidence in, aviation, rail and marine transport through:

- independent investigation of transport accidents and other safety occurrences
- safety data recording, analysis and research
- fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia, as well as participating in overseas investigations involving Australian-registered aircraft and ships. It prioritises investigations that have the potential to deliver the greatest public benefit through improvements to transport safety.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, international agreements.

Purpose of safety investigations

The objective of a safety investigation is to enhance transport safety. This is done through:

- identifying safety issues and facilitating safety action to address those issues
- providing information about occurrences and their associated safety factors to facilitate learning within the transport industry.

It is not a function of the ATSB to apportion blame or provide a means for determining 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. The ATSB does not investigate for the purpose of taking administrative, regulatory or criminal action.

Terminology

An explanation of terminology used in ATSB investigation reports is available on the ATSB website. This includes terms such as occurrence, contributing factor, other factor that increased risk, and safety issue.