Australian Government
Australian Transport Safety Bureau

Runway incursion involving Sling 2, VH-ZSD

Moorabbin Airport, Victoria, on 23 July 2020

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Addendum

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Safety summary

What happened

On the afternoon of 23 July 2020, five aircraft were operating in the runway 17 Left (L) circuit at Moorabbin Airport, Victoria. A Piper PA-28 aircraft, VH-TAX (TAX), was lined up in the displaced threshold area of runway 17L. A Sling 2 aircraft, VH-ZSD (ZSD), then on the base leg of the circuit approaching the occupied runway, passed above TAX and conducted a touch and go landing. The runway incursion by ZSD removed the required runway separation between the aircraft.

What the ATSB found

The ATSB found that the student pilot of ZSD sighted TAX but decided to conduct the touch and go landing due to an incorrect belief that the controller had provided a landing clearance. The ATSB identified that the student pilot's training had not been effective in conveying that a go-around must be initiated if the runway was occupied.

The investigation also found that the air traffic controller did not identify the developing conflict as ZSD approached runway 17L. Additionally, the controller did not recall the aircraft passing above TAX and conducting a touch and go landing, and remained unaware of the incident until after it was reported over an hour later.

What has been done as a result

Royal Victorian Aero Club, the flight training school operating ZSD, has made changes to its student training program including educational, procedural and recurring activities. The school updated instructor and student educational materials, procedural guidance and examination content.

Safety message

Runway incursions and other runway separation issues are one of the most significant risks to safe aviation operations and a key global safety priority. Airport operators and air navigation service providers are strongly encouraged to identify and mitigate risk areas, especially at locations with inexperienced pilots or unusual airport configurations, such as displaced thresholds. The Airservices-published safety bulletin *Preventing the risk of a runway incursion* and the runway safety article *Tips for flying at Moorabbin* provide relevant guidance.

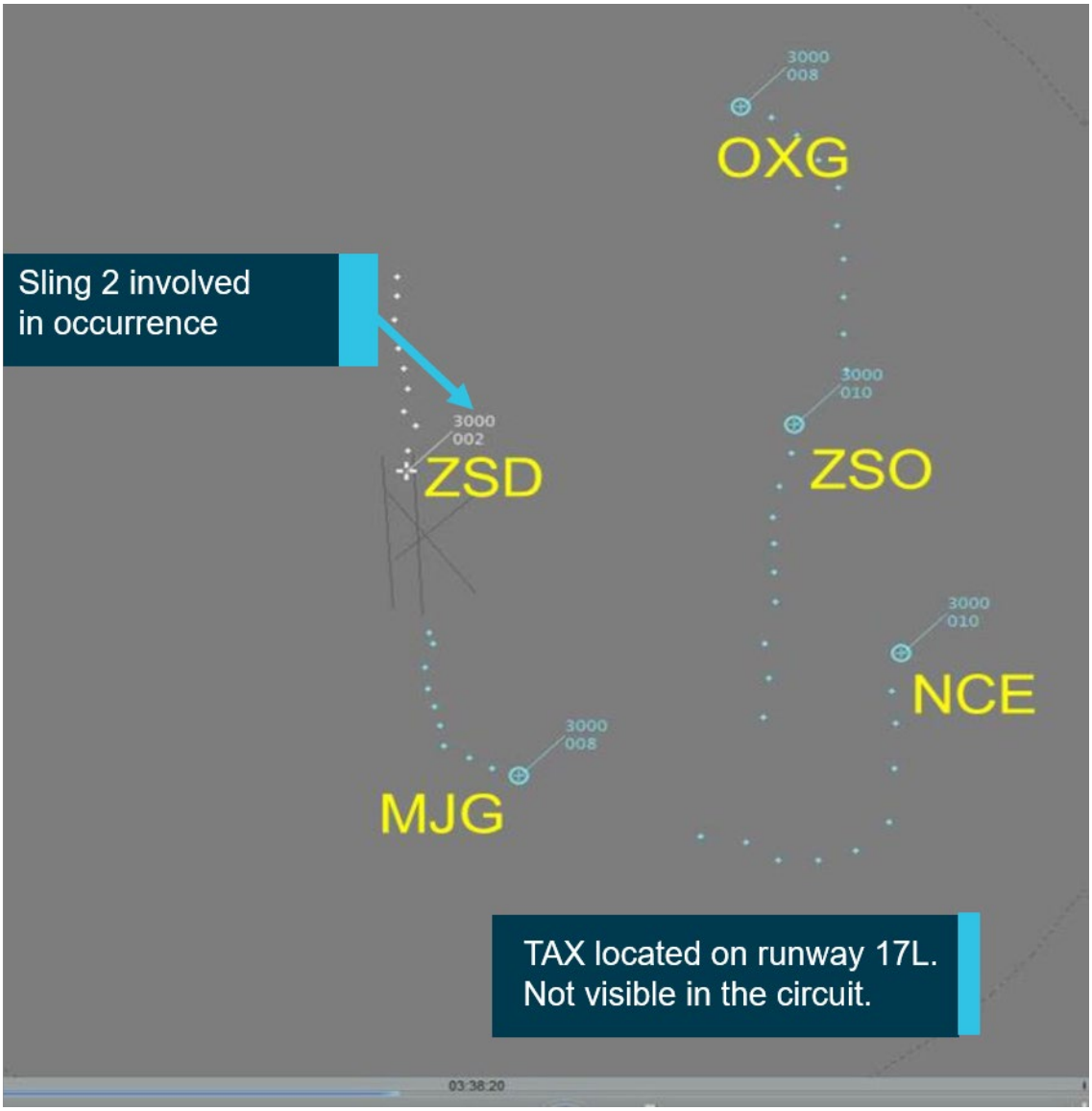
Pilots are strongly encouraged to identify potential conflicts or runway incursions that may develop during circuits early and to attend carefully to air traffic control communications. It is important that flight training schools reinforce training regarding occupied runways and go-arounds to students. Air traffic controllers are encouraged to monitor all aircraft and provide clear and unambiguous instructions to their flight crew to avoid runway incursions and related occurrences.

Contents

The occurrence

At about 1334 Eastern Standard Time[1] on 23 July 2020, five aircraft were operating in the runway 17 left (17L) circuit at Moorabbin Airport, Victoria (Figure 1). They included a Sling 2, registered VH-ZSD (ZSD), operated by the Royal Victorian Aero Club (RVAC) with a student pilot on a second, solo flight. The pilot conducted a touch and go landing on runway 17L a few minutes earlier.

Figure 1: Runway 17L circuit traffic situation display screen shortly before the occurrence

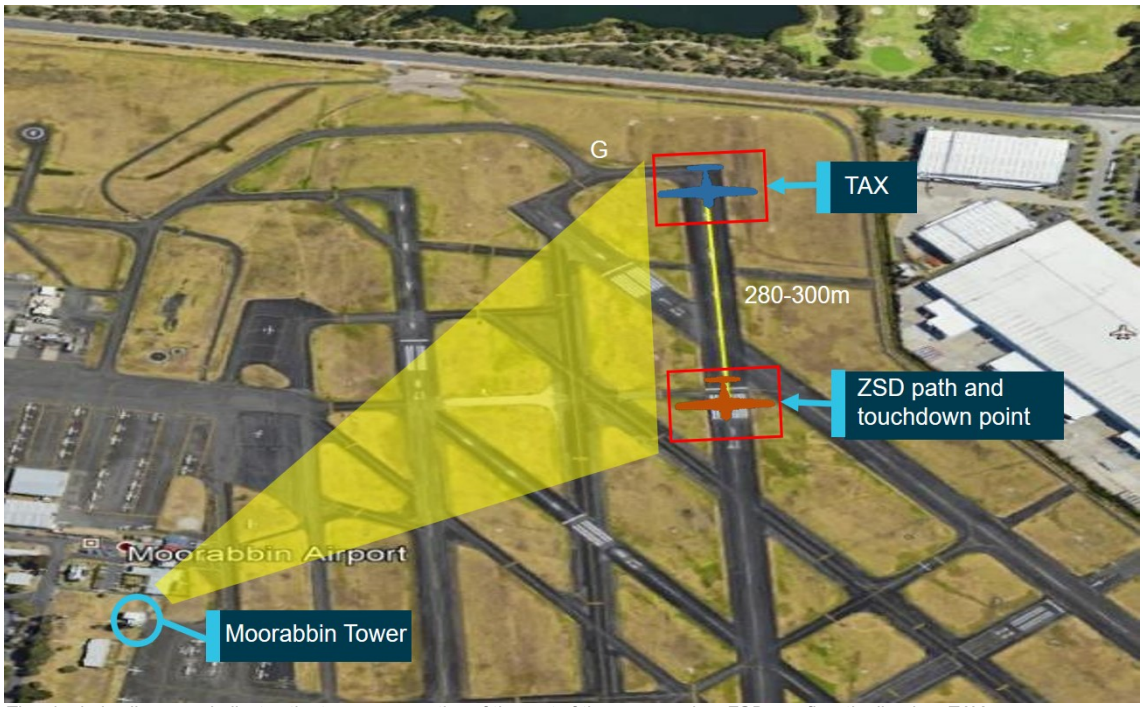


Source: Airservices Australia

In addition to the circuit traffic, a Piper PA-28, registered VH-TAX (TAX), operated by Moorabbin Flying Services, with an instructor and student pilot on board, was at the holding point of taxiway G for 17L (Figure 2). The aircraft was in the final stages of preparation for a local training flight.

[1] Eastern Standard Time (EST): Coordinated Universal Time (UTC) + 10 hours.

Figure 2: Overview of Moorabbin Airport showing key locations



The shaded yellow area indicates the tower perspective of the part of the runway when ZSD overflew the lined-up TAX.
Source: Airservices Australia, annotated by ATSB

At 1334:49, the Moorabbin Tower (tower) air traffic controller instructed the pilot of ZSD: 'Zulu Sierra follow Cessna late downwind'.[2] The pilot responded: 'Zulu Sierra Delta', and shortly after began preparing for a touch and go landing on runway 17L. The pilot of ZSD also mistakenly thought that the controller had issued a landing clearance. There was no further communication with the controller during that circuit.

At 1336:49, the controller instructed the pilot of TAX to line up on runway 17L. One minute later, TAX was still waiting in the lined-up position about 280 m behind the displaced threshold. The pilot of ZSD sighted TAX on the runway during the approach for landing. Just as the instructor was about to contact the tower to ask about the take-off clearance, ZSD passed above TAX and conducted a touch and go landing.[3]

The instructor was surprised by the unusual event of an aircraft overflying another but did not immediately report the runway incursion, deciding instead to focus on TAX and its flight, and deal with incident-related matters in the post-flight debrief. At 1338:43, the controller (unaware of the incident) issued a take-off clearance and shortly after, TAX departed for the training area.

The pilot of ZSD did not believe any incident had occurred and continued conducting circuits, landing shortly after 1349.

At about 1440, after TAX completed the training flight, the instructor reported the incident to the flight training school's head of operations and then phoned the tower. The tower supervisor was informed and, in turn, advised the incident controller.

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2 The Cessna was VH-MJG.

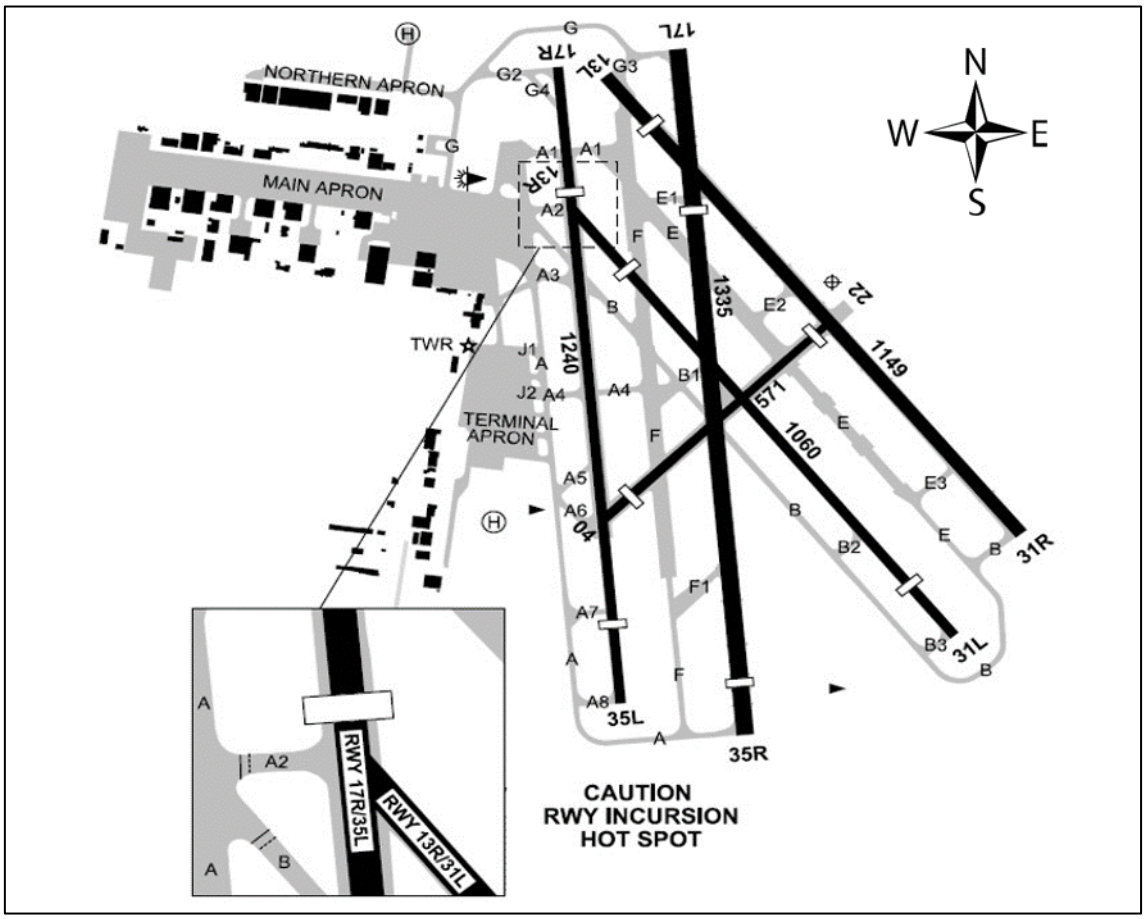
3 The pilot of TAX estimated ZSD passed 50-100 ft above their aircraft (data to verify the vertical separation was not available).

Context

Moorabbin Airport

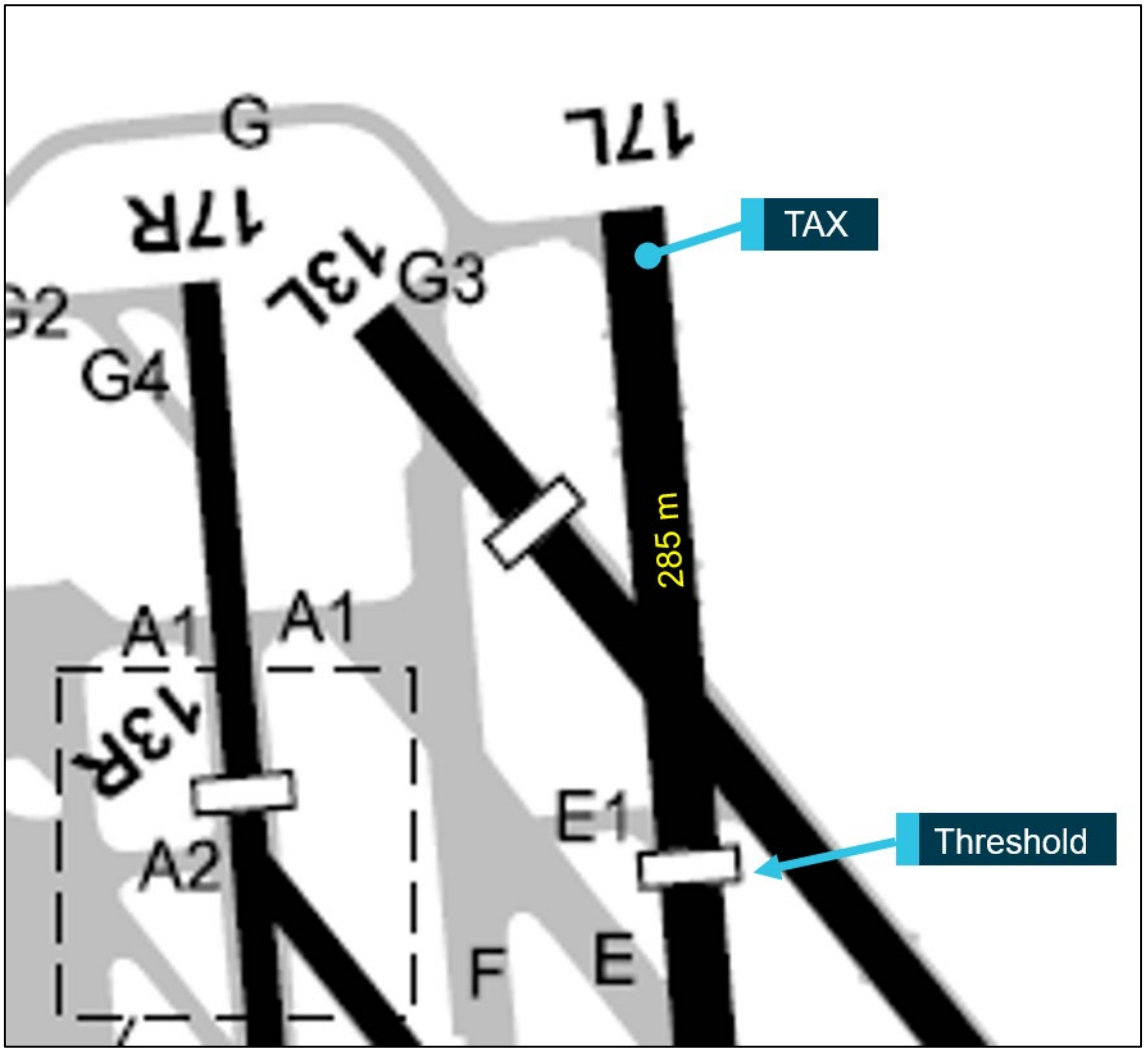
Moorabbin Airport has five runways (Figure 3) and the vast majority of operations at the airport involve training activities. Runway 17L is 1,335 m in length and has an unusually long (285 m) displaced threshold (Figure 4). The airport operates within Metro Class D airspace and Airservices Australia (Airservices) provides the air traffic services (see *Air traffic services* section).

Figure 3: Moorabbin Airport



Source: Airservices Australia

Figure 4: Runway 17L section showing the position of TAX behind the displaced threshold



Source: Airservices Australia annotated by ATSB

Air traffic services

Moorabbin Class D airspace

Moorabbin Airport's Class D terminal airspace is controlled by controllers situated in the Moorabbin control tower. The Class D airspace extended to the north and south-west from ground level to a 3 NM boundary.

Staffing

Airservices determines a minimum number of full time equivalent (FTE) staff (referred to as the mature requirement) to adequately staff a control tower. Moorabbin Tower's mature requirement at the time of the incident (and for a number of years prior) was 11 FTE, but actual FTE numbers had been higher. The staff in excess of the mature requirement (the surplus) were available to assist in the tower.

In 2019, an informal 'spotter' position was created to utilise surplus staff. There was no licensing requirement for a 'spotter' nor a job description or procedure for utilising the position, but it was included in the roster. In practice, the 'spotter' was an additional resource to assist controllers in performing their duties.

In the months before the incident, however, there were some changes to staffing levels. One change was the removal of the 'spotter' position from the roster due to Airservices' pandemic

management plan,[4] which introduced isolation rosters to mitigate virus spread by physically distancing controllers.

At the time of the incident on 23 July 2020, all three control positions in the tower were staffed. Four controllers were present: the operating Aerodrome Controller West (ADC-W), the outgoing controller handing over the ADC-W position, the Surface Movement Controller-Coordinator (SMC-COORD) and the Aerodrome Controller East (ADC-E). The ADC-E (the controller involved in this incident) controlled the runway and airspace in the eastern part of the airport area using radio frequency 118.1 MHz while the ADC-W performed those functions for the western part on 123.0 MHz.

According to the tower supervisor, a request to Airservices to reinstate the 'spotter' position was under consideration at the time with the intention to formally introduce the position when staffing numbers allowed. During the course of this investigation, a proposal to increase the mature requirement to 12.5 FTE was submitted to Airservices in November 2020. A reason given to support the proposal was that traffic levels and complexity at Moorabbin Airport were at a level where there was a risk of missing conflicts. At the time of publication of this report, the request was being considered with a view to allowing the SMC-COORD position to be de-combined during busy periods, but not to provide any additional resource for a formal or informal 'spotter' position.

Traffic movements

Under routine conditions, the training environment at Moorabbin Airport includes the workload demands of students learning to fly. In addition to this workload, the controller involved in this incident perceived that there had recently been a 20 to 25 per cent increase in movements at the airport. The tower supervisor also noted the increase in traffic over the previous 5 months and observed that traffic levels were quite saturated with the workload becoming challenging.

These perceptions were supported in part by objective data. Airservices Australia records indicated that monthly traffic movements at Moorabbin Airport had, on average, increased by 8.74 per cent between February and July 2020 (from 19,943 to 21,686 movements). A possible reason for the increase in movements was that pilots who could no longer fly for major airlines (due to the impact of the Coronavirus pandemic) and held an instructor rating, were working at flight training schools and this contributed to increased student flight training activities.

The instructors of both student pilots involved indicated that it had been busier for them over the past 15 months and that they had noticed reduced staffing in the tower. Overall, there appeared to have been an increase in the amount of traffic management work for controllers at Moorabbin Airport.

Traffic during the event

The incident controller assessed that traffic conditions at the time of the event were moderate to high. The airspace contained two aircraft with very similar callsigns, Zulu Sierra Delta (ZSD) and Zulu Sierra Oscar (ZSO). The presence of aircraft with similar callsigns operating in the same area and especially on the same frequency often gives rise to potential and actual flight safety incidents. This hazard is usually referred to as 'callsign confusion'.

At 1334:49, the controller instructed the pilot of ZSD: 'Zulu Sierra follow Cessna late downwind', without including 'Delta' to avoid potential confusion with ZSO (which was also in the circuit and conducted four landings before the occurrence and two subsequently). Two downwind calls were made by ZSO and November Charlie Echo (NCE), with the first call from ZSO coinciding with the approximate time that take-off clearance for TAX would have been expected for its immediate departure following Mike Juliet Golf (MJG). After the conflict occurred, the controller had a pause

[4] Coronavirus disease (COVID-19) was an infectious disease caused by a newly discovered coronavirus. The World Health Organization (WHO) first learned of this new virus on 31 December 2019. International and domestic responses to manage the pandemic included reducing aviation activity internationally and domestically.

in communications (prior to an instruction at 1340:09 'Zulu Sierra Delta follow Cessna late downwind') and only after the conflict, at 1340:30, emphasised the word 'Oscar' in an instruction ('Zulu Sierra Oscar cleared touch and go').[5]

Traffic control errors

In June 2020, Airservices conducted an operational safety study of Moorabbin Tower incidents from January 2013 to July 2018. The study provided an overview of the nature and frequency of Air Traffic Control (ATC) conflicts. The purpose of the study was to support operational managers in understanding the unit's safety performance based on results derived from submitted safety occurrence reports.

The study showed that 5 per cent of the total coded occurrences were ATC attributable with six occurrences (3 per cent of the total) resulting in the system entering an undesired state (incorrect presence of at least one aircraft on a runway). The occurrences related to ATC inducing tactical conflicts (occurrences that are pilot attributed) with the tactical planning-related failures being resolved prior to entering the undesired state. The study showed that ATC attributable errors do occur, albeit with a low level of incidence of ATC induced tactical conflicts.

Landing clearances

Airservices provide landing clearance requirements directly relevant to the airspace in which this incident occurred. The Airservices Aeronautical Information Publication En-route (AIP ENR) 1.1 states that a pilot in command must not land unless they receive specific clearance 'Cleared to land'.

AIP ENR 1.1 provides the following separation standards for Class D controlled airspace:

> A landing aircraft will not be permitted to cross the threshold of the runway on its final approach until:
>
> - a preceding departing aircraft using the same runway:
> - is airborne and
>   - has commenced a turn; or
>   - is beyond the point on the runway at which the landing aircraft could be expected to complete its landing roll and there is sufficient distance to manoeuvre safely in the event of a missed approach;
> - is at least 1,000 m from the runway threshold, and has commenced the take-off run, and
>   - in the opinion of the controller, no collision risk exists

Airservices has also published safety material to avoid runway incursion errors. Relevant publications include the safety bulletin *Preventing the risk of a runway incursion* and the runway safety article *Tips for flying at Moorabbin*.

The controller

The controller was working in the ADC-E position at Moorabbin tower. The controller was first rated in August 2003, achieved a rating for all tower positions in March 2007, and was qualified to conduct training and assessment in July 2010. There was also an endorsement to provide relief staffing at Avalon tower when needed. The controller successfully passed a renewal check in April 2020 and had been operating on an approved leave reduction program, of 4 days on, followed by 12 days off duty since early 2020. This level of recency, however, met Airservices' requirements.

There was no evidence to suggest any likelihood of reduced controller performance due to fatigue, distractions or general health. The weather conditions and visibility were also not considered to have influenced the controller's actions.

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[5] Pauses can represent confusion (for example about the sequence of events) and words are often emphasised to clearly distinguish similar callsigns. In this case, the controller emphasised the word 'Oscar' after the event.

Tools available

In addition to visual observations from the Moorabbin tower and using voice communications, controllers use other tools to assist with performing their duties.

The controller was using a traffic running sheet to record aircraft movement data and to assist in sequencing aircraft. The traffic running sheet provides a back-up memory prompt to the primary function of visual monitoring of traffic. The running sheet that the controller used contained many changes, corrections and annotations, reflecting the level of activity and traffic complexity, which increased the likelihood of making an error (see *Appendix – Traffic Running Sheet*). The sheet also indicated that the controller remained unaware of the incident between ZSD and TAX.

Moorabbin Tower also utilises a support tool called the Traffic Situation Air Display (Figure 5). This display provides awareness of aircraft higher than about 200 ft, which is higher than ZSD was operating at the time of the incident.

Flight progress strips (FPS)[6], a tool that has the same functional objective as traffic running sheets, are not used at Moorabbin Airport. According to Airservices, FPS are generally not required for visual flight rules (VFR) flights.

Figure 5: View and perspective from controller position towards runway 17L

Source: Airservices Australia annotated by ATSB

Air traffic communications

Table 1 provides the air traffic communications between the tower and ZSD and TAX in the lead up to the runway incursion. A large number of communications were also made between the controller and various other aircraft. Significant items are highlighted in the table.

[6] Controllers use fight progress strips to maintain situation awareness of ATC operations and traffic. Standard annotations (such as recording the departure runway/location) provide information to assist with the correct execution of the controller's plan and the early detection of any errors that may occur.

Table 1: Communications and events leading up to the time of the incident

Time	Communications and events	Notes
1334:46	'Zulu Sierra follow Cessna late downwind'	
1334:49	'Zulu Sierra Delta'	Pilot's response to instruction for turning downwind (Last radio call before incident).
1334:52	'Oscar X-Ray Golf is going around'	
1334:54	'Oscar X-Ray Golf'	
1335:15	'Moorabbin Tower November Charlie Echo is ready runway 17 Left circuits'	
1335:21	'November Charlie Echo line up'	
1335:23	'Line up November Charlie Echo'	
1335:42	'November Charlie Echo follow the Sling upwind. Cleared for takeoff'	
1335:45	'Copy traffic. Cleared for takeoff November Charlie Echo'	
1336:27	'Mike Juliet Golf follow the twin upwind cleared touch and go'	
1336:30	'Cleared touch and go Mike Juliet Golf'	
1336:33	'Oscar X-Ray Golf turning downwind touch and go'	
1336:36	'Oscar X-Ray Golf follow the Sling on base'	
1336:39	Oscar X-Ray Golf	
1336:41	'Moorabbin Tower Tango Alpha X-Ray is ready, one, runway 17 left for oblique crosswind departure to the training area'	
1336:49	'Tango Alpha X-Ray line up'	TAX given clearance to line up, ZSD is on base and sights TAX below
1336.51	'Lining up Tango Alpha X-Ray'	TAX gives radio call about lining up
1337:15	'Sierra Oscar follow the twin late downwind'	Tower talks to ZSO
1337:20	'Zulu Sierra Oscar follow the twin late downwind'	Tower talks to ZSO
1337:22	'Zulu Sierra Oscar'	
1337:44	'November Charlie Echo turning downwind touch and go'	
1337:48	'Charlie Echo follow the Sling mid downwind'	
1337:51	'November Charlie Echo'	
1337:51	ZSD does touch and go over the top of TAX	The incident
1338:41	'Tango Alpha X-Ray cleared for take-off'	TAX given clearance for take-off
1338:43	'Cleared for take-off Tango Alpha X-Ray'	TAX reads back the take-off clearance and departs for the training area
1340:09	'Zulu Sierra Delta follow Cessna late downwind'	Controller pause in communications
1340:30	'Zulu Sierra Oscar cleared touch and go'	Controller emphasises 'Oscar'

Student pilot information

The student pilot commenced training on 9 June 2020, with the first flying lesson on 23 June. Records showed a total flying experience of 18.5 hours to the last recorded flight (the occurrence

flight) on 23 July, all on the Sling 2 aircraft type. Of that total experience, 17 hours had been in the previous 30 days. The student was not required to, and did not, hold a flight crew licence.

The pilot was an international student and had completed the General English Language Proficiency (GELP) test on 14 July 2020. On 23 July, the pilot was operating a second session of solo circuits and stated 'feeling very nervous' because English was not their first language. The incident occurred during the final leg of the fourth circuit, prior to a full stop landing.

The training school records indicated that the student pilot had completed the required training (as per the lesson entry reports) approved by the school's instructors. The student was familiar with the runway configurations at Moorabbin, including the unusually long displaced threshold of runway 17L. The training school manual had a requirement about occupied runways and directed that students undertake specific training, including missed approaches/go-arounds.

> If for any reason, it is judged that an approach cannot be continued to a successful landing, a missed approach (go-around) will be conducted.

The operator's training manual also provided runway descriptions and airport markings (including displaced thresholds). This incident was the first time that the student pilot had experienced another aircraft on the runway when approaching to land. The pilot also expressed a belief that it was permitted to have another aircraft lined up on the runway when landing. The pilot also believed that a landing clearance had been issued, observed that TAX was stationary and thought that it would not take off until the tower issued a take-off clearance.

After the incident, the instructor debriefed the student pilot and explained the requirement to conduct a go around if an aircraft was lined up on the runway. The instructor did not think this had been specifically discussed with the student previously although it may have been covered otherwise in training (during theory classes or briefings). Following that debrief, the pilot reported having a correct understanding of what to do in the event of an occupied runway.

There was no evidence that fatigue risk, distractions or other personal health aspects were likely to have been present. The weather conditions and visibility were also not considered to have influenced the pilot's actions.

Monitoring regulations

The Civil Aviation Safety Authority (CASA) requirements for instructors monitoring students on their second solo flight are contained within Civil Aviation Safety Regulation (CASR) Part 61.112(3). These requirements state that a flight is suitably supervised if the instructor:

> (a) provides guidance to the person in relation to the flight,
>
> (b) during the flight is at the aerodrome from which the flight began and
>
> (c) can be contacted during the flight by radio or other electronic means.

CASR Part 142.340 details the required exposition content for operators conducting integrated and multi-crew flight training. This states that the exposition must contain a description of the procedures by which the operator conducts and manages the activities, including the supervision of instructors and persons participating in activities.

Additionally, the CASR Part 142 Technical Assessor handbook details how the above requirements are to be documented in an organisation's exposition. Section C3.1.1 (k) of the handbook 'Procedures for Conduct and Management of Training - Supervision of Student Pilot Solo Flight' outlined the documented expectations that are to be contained within an exposition with respect to the supervision of student pilots. While not a regulatory requirement, CASA inspectors are advised to check the following.

- The process should include provision for active monitoring of each solo flight by a flight instructor. As well as active monitoring, the supervising instructor should provide flight following, operational control and the rendering of assistance if necessary.

- For solo circuit operations, the applicant should ensure that a competent instructor is assigned to visually monitor circuit operations. The supervising instructor may be provided with two-way radio communication with circuit aircraft for the purpose of exercising operational control over solo flights, if necessary.
- For training area and navigation solo flight operations, an application should ensure that an instructor is assigned to monitor radio frequencies when possible, to provide assistance if necessary, and maintain a search and rescue watch.

Visual monitoring

The instructor usually monitored students by listening to the ATC frequency via radio from the RVAC operations room, as was the case at the time of the incident. There was no CASA requirement to visually monitor operations, and CASA advised that while the instructor needs to be available, it would not be appropriate to intervene in operations at a controlled airport such as Moorabbin. Hence, CASA considers the first knowledge a training school would have of such an incident at a controlled airport is similar to the way this incident unfolded, or the tower would inform the school by telephone.

In any case, from the operations room, the instructor was unable to visually monitor aircraft, as per the suggested guidance in the assessor handbook. The view was also partially obstructed by parked aircraft and the instructor was dividing attention between monitoring the radio and administrative work.

Safety analysis

Introduction

At 1337 on 23 July 2020, the PA-28 aircraft, VH-TAX (TAX), was lined up on the threshold of runway 17L at Moorabbin Airport, awaiting take-off clearance. The Sling 2 aircraft, VH-ZSD (ZSD) was on the base leg of the circuit and its student pilot believed (incorrectly) that a clearance for a touch and go landing had been provided. The student pilot saw the lined-up aircraft but continued the approach, passed above TAX about a minute later and conducted a touch and go landing.

The air traffic controller in the Moorabbin Tower (tower) managing the movements of the two aircraft did not identify the developing conflict as ZSD approached the runway or the aircraft passing above TAX and conducting a touch and go landing, and remained unaware of the incident until advised about an hour later.

Decision to continue the approach and landing

The student pilot's decision to continue the approach and conduct a touch and go landing on the occupied runway was based on an incorrect belief that a landing clearance had been provided, and a misconception that landing on a runway with another aircraft lined up was permitted. The belief that a clearance had been provided may have been influenced by the following factors:

- callsign confusion
- expectation bias
- cognitive tunnelling
- authority gradient and pilot inexperience.

As discussed, aircraft with similar callsigns operating in the same area and, especially, on the same frequency often gives rise to flight safety incidents. At the time of the incident, ZSD and ZSO were in the circuit at the same time and conducting touch and go landings on runway 17L. It is possible that the downwind calls made by ZSO prior to the event may have been mistakenly heard as a clearance by the student pilot of ZSD.

The student pilot misperceived the tower communications and assumed the expected clearance had been provided by the controller. There may have been an expectation to hear this clearance, where the student pilot filled in the gaps in the communication. Expectation bias can occur when an individual's expectations about an outcome influence perceptions of one's own or others' behavior.[7] The student pilot may have been experiencing this bias (expecting the landing clearance to be provided), which could explain why the pilot made the decision to conduct the touch and go, and later recalled hearing a clearance.

There may also have been a degree of cognitive tunnelling for the student pilot. It has long been established that cognitive tunnelling is an inattentional blindness where one becomes overly-focused on some variable other than the present environment.[8] It can occur under periods of high stress or workload, which student pilots experience due to high demands on their attentional resources in the training environment.

During this occurrence, the student pilot may have been so focussed on the landing and avoiding a collision with TAX on the runway, that attentional resources were not focussed on tower communications. Hence, the student pilot incorrectly assumed a verbal clearance by the tower had been provided.

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7 Williams and others 2012.

8 Mack and Rock 1998; Most 2010.

Finally, the student pilot's belief that the controller had provided a landing clearance and deciding to land on an occupied runway may also have been influenced by a steep authority gradient between the student and the controller, as well as the student's lack of experience.

> Authority gradient refers to the established and/or perceived command and decision-making power hierarchy in a team, crew or group situation and how balanced the distribution of this power is experienced within the team, crew or group (Hawkins 1993). A steep gradient occurs when a role appears dominant over another and leads to others being less likely to express concerns, question decisions or even clarify instructions.

As the student pilot was conducting a second solo flight and had English as a second language there may have been a steep authority gradient, which could explain why the student would not have clarified the (assumed) landing instruction.

The evidence shows the student pilot decided to continue the touch and go landing due to an incorrect belief that a clearance had been provided, and a misconception that landing on a runway with an aircraft lined up was permitted. Exact reason(s) for believing a clearance had been provided could not be established, but factors that may have contributed to that belief include callsign confusion, expectation bias, cognitive tunnelling, authority gradient and pilot inexperience, or a combination of these factors.

Occupied runway training

The student pilot of ZSD conducted the touch and go after seeing TAX lined up behind the runway threshold. According to the training instructions and AIP procedures, the approach should not have continued, as the runway was occupied, and a landing clearance had not been received. The instructor did not think this had been specifically discussed with the student previously although it may have been covered otherwise in training. The pilot later stated understanding what to do in future in the event of an occupied runway.

While the training documentation contained occupied runway requirements and Airservices' safety publications provide further guidance, interview evidence, as well as the student's actions, indicate that learning in this aspect had not been effective.

Unidentified conflict

The controller did not see ZSD approaching to conduct a touch and go landing with TAX lined up and, therefore, took no action to avoid the runway incursion. Normally, pilots report that they are on short final (for example, OXG and NCE in the circuit that day). However, the pilot of ZSD did not contact the tower when approaching for that touch and go landing. Based on the available evidence, the controller's ability to identify the conflict may have been influenced by the following factors:

- traffic density
- workload and communications
- callsign confusion.

Evidence from the interviews of the controller, the tower supervisor and the involved pilots; as well as the recorded traffic movement data, suggest that traffic movements increased in the months leading up to the time of the event. A controller's ability to detect a conflict can depend on the traffic load and more controllers miss more potential conflicts when traffic density is high, compared to when it is low.[9]

The changing traffic movements may also have affected the controller's workload level. The following research-based observation is relevant to this relationship with workload.

[9] Metzger and Parasuraman 2001.

> Workload reflects the interaction between a specific individual and the demands imposed by a particular task and represents the cost incurred by the human operator in achieving a particular level of performance. An individual has a finite set of mental resources they can assign to a set of tasks and will seek to perform at an optimum level of workload by balancing the demands of their tasks.[10]

Both the controller and the supervisor indicated that workload was influenced by traffic movements. Additionally, the number of communications leading up to the event and the many changes to the traffic running sheet suggest high workload. It is probable that an increased level of mental workload because of increased traffic density, resulted in the controller having less opportunity to identify the conflict. Airservices' safety study data referred to earlier also shows that ATC-attributable errors have occurred at Moorabbin Airport.

It is also possible that callsign confusion played a part in the controller not identifying the conflict. There was significant communication at the time, both ZSD and ZSO had similar communications with the tower while operating in the same area on the same frequency. At 1334:49, the controller also omitted 'Delta' in the instruction 'Zulu Sierra follow Cessna late downwind' giving potential for confusion between ZSD and ZSO. The first two phonetics of these callsigns (that is, ZS) were the same. Further, they had visually similar shapes that can be easily mixed up as they only differ by their last designator (for example, on a traffic running sheet). The controller's pauses are indicative of some level of confusion and only emphasising the phonetic 'Oscar' after the occurrence, suggests the controller may not have recognised the potential for confusion in time.

Overall, the evidence shows that the controller did not identify the conflict between ZSD and TAX, but the exact reason(s) could not be established. This may have occurred due to the high traffic density and resulting communications workload or the similar aircraft callsigns operating in the same circuit on the same frequency, or a combination of these factors. While it is possible some other factors may have had an influence (for example, runway confusion or not following standard operating procedures), there was no evidence to justify considering such factors.

Other considerations

As the informal 'spotter' position was no longer used, the controller was the only person that could have identified the developing conflict because, as explained, the student pilot's instructor could not have done so. Further, as the instructor in TAX (who had reasons to delay it) did not report the incident immediately, the corrective action taken to address the immediate operational risks by relieving the controller was delayed by more than an hour.

Single person controller operations where a position/sector is operated by one person are unsuitable during busy periods, as they can lead to high task loads, distraction, failure to detect threats and not recognising errors. Monitoring each other's actions (also known as the 'four-eye principle') reduces the likelihood of this error by increasing situation awareness. This was probably the main safety-related reason for rostering an informal 'spotter' in Moorabbin Tower.

Airservices' safety study provides an indicative level of risk that it can use to assess the level of acceptable risk for single person controller operations at Moorabbin, including situations involving student pilot errors or non-compliance with ATC instructions. The ATSB did not find any additional information, such as incident trend data or studies into optimal workload levels (for Moorabbin or similar towers) to make findings with respect to tower staffing levels.

[10] Orlady and Orlady 1999.

Findings

ATSB investigation report findings focus on safety factors (that is, events and conditions that increase risk). Safety factors include 'contributing factors' and 'other factors that increased risk' (that is, factors that did not meet the definition of a contributing factor for this occurrence but were still considered important to include in the report for the purpose of increasing awareness and enhancing safety). In addition 'other findings' may be included to provide important information about topics other than safety factors.

Safety issues are highlighted in bold to emphasise their importance. A safety issue is a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

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

From the evidence available, the following findings are made with respect to the runway incursion involving The Airplane Factory Sling 2, VH-ZSD at Moorabbin Airport, Victoria, on 23 July 2020.

Contributing factors

- While the Piper PA-28, VH-TAX, was in the lined-up position (behind the displaced threshold) on runway 17L, the Sling 2, VH-ZSD, passed overhead and conducted a touch and go landing.
- The student pilot of ZSD sighted TAX but decided to conduct the touch and go landing due to an incorrect belief that it was permitted to have another aircraft lined up on the runway when landing, and that the controller had provided a landing clearance.
- The student pilot's training had not been effective in conveying that a go-around must be initiated if the runway, including its displaced threshold, was occupied.
- The air traffic controller did not identify the runway incursion developing, see ZSD pass above TAX or its touch and go landing and remained unaware of the incident until advised about 1 hour later.

Safety actions

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues. The ATSB expects relevant organisations will address all safety issues an investigation identifies.

Depending on the level of risk of a safety issue, the extent of corrective action taken by the relevant organisation(s), or the desirability of directing a broad safety message to the aviation industry, the ATSB may issue a formal safety recommendation or safety advisory notice as part of the final report.

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

The initial public version of these safety issues and actions are provided separately on the ATSB website, to facilitate monitoring by interested parties. Where relevant, the safety issues and actions will be updated on the ATSB website as further information about safety action comes to hand.

Safety action not associated with an identified safety issue

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

Additional safety action by Royal Victorian Aero Club

The Royal Victorian Aero Club advised the ATSB that it has taken the following actions.

Flight crew and student education

- Briefings for circuits and circuit emergencies have been updated.
- Instructor training now includes being trained on checking essential knowledge for the lesson.
- New manuals have been provided to all instructors and have been signed as acknowledged.
- The pre solo exam and pre area solo exam have been updated to cover the scenario of runway occupied/no clearance provided.

Procedural actions

- The recreational pilot licence training manual has been updated to include essential knowledge to be checked before solo flights.
- Instructors were briefed and have acknowledged the updated manual.

Proactive action

- Solo flights have been reviewed, ensuring that instructors comply with the training manual including supervision requirements and checking essential knowledge.

General details

Occurrence details

Date and time:	23 July 2020 – 1340 EST	
Occurrence category:	Incident	
Primary occurrence type:	Runway incursion	
Location:	Moorabbin Airport	
	Latitude: 37º 58.55' S	Longitude: 145º 06.13' E

Aircraft 1 details

Manufacturer and model:	The Airplane Factory, Sling 2	
Registration:	VH-ZSD	
Operator:	Royal Victorian Aero Club	
Serial number:	257	
Type of operation:	Flying Training	
Departure:	Moorabbin, Victoria	
Destination:	Moorabbin, Victoria	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	None	

Aircraft 2 details

Manufacturer and model:	Piper Aircraft Corp PA-28-161	
Registration:	VH-TAX	
Operator:	J&J Aviation	
Serial number:	2842252	
Type of operation:	Flying Training	
Departure:	Moorabbin, Victoria	
Destination:	Moorabbin, Victoria	
Persons on board:	Crew – 2	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	None	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- Pilot and instructor for VH-ZSD
- the instructor of VH-TAX
- Airservices Australia
- The air traffic controller
- The tower supervisor
- Royal Victorian Aero Club
- Moorabbin Flying Services
- Bureau of Meteorology.

References

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Submissions

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the following directly involved parties:

- pilot and instructor for VH-ZSD
- the instructor of VH-TAX
- Airservices Australia
- the air traffic controller
- Royal Victorian Aero Club
- Moorabbin Flying Services
- Civil Aviation Safety Authority

Submissions were received from:

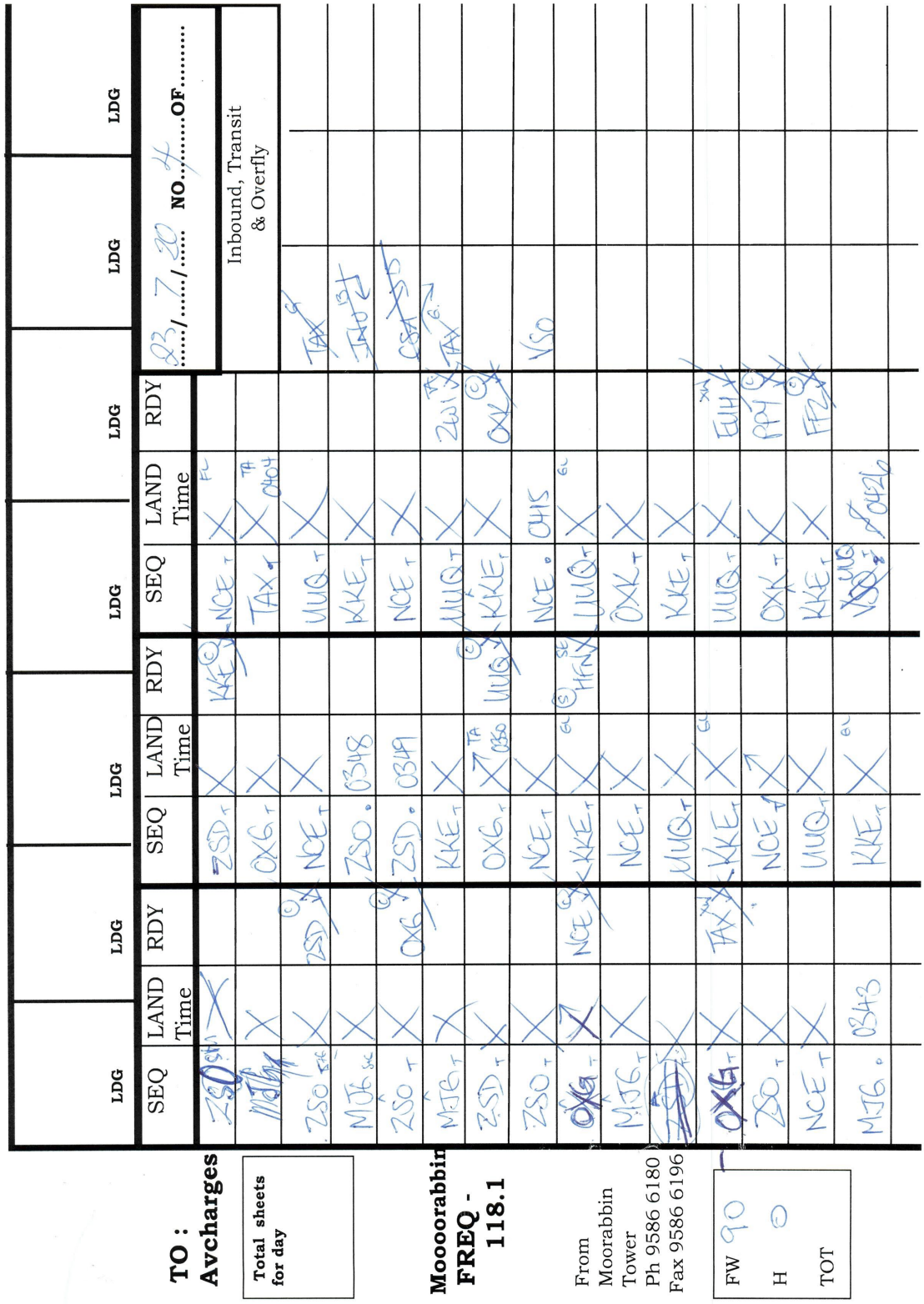
- Airservices Australia

- the air traffic controller
- Civil Aviation Safety Authority

The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

Appendices

Appendix – Traffic running sheet



Source: Airservices Australia

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.