Runway Incursion Analysis

Safety Performance Analysis, Safety and Assurance
December 2017

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Purpose and methodology

- This document provides the trend and key contributing factors of Runway Incursion (RI) occurrences.
- RI occurrences data recorded in CIRRIS for the period of 1 July 2013 to 30 November 2017 (four (4) years and five (5) months) were analysed to generate occurrence trending information.
- The occurrence details of RI occurrences for the period of 1 December 2016 to 30 November 2017 (12 months) were analysed to identify the key contributing factors involved in RI occurrences.

Executive summary

The long-term trend of ATS and pilot attributed RI occurrences remained consistent

Pilot attributed occurrences are on average 9.5 times higher than ATS attributed occurrences per month

Decreasing trend at Metro D and capital-city aerodromes, Sunshine Coast is driving up the trend at Class D aerodromes

Very low number of very serious or major RI occurrences

Moorabbin, Bankstown and Jandakot constitute half of the occurrences (both ATS and pilot attributed)

Top contributing factors:

- ATS attributed occurrences: communication and situational awareness
- Pilot attributed occurrences: non-compliance with ATC clearances/instructions and non-compliance with AIP

Key definitions

ICAO Runway Incursion Severity Rating

A : A very serious occurrence in which a collision was narrowly avoided

B : A major occurrence in which separation decreases and there is a significant potential for collision, which may result in a time critical corrective / evasive response to avoid a collision

C : A minor occurrence characterised by ample time and/or distance to avoid a collision

D : Occurrence that meets the definition of runway incursion such as incorrect presence of a single vehicle/person/aircraft on the protected area of a surface designated for the landing and take-off of aircraft but with no immediate safety consequences

E : Insufficient information, inconclusive or conflicting evidence precludes severity assessment

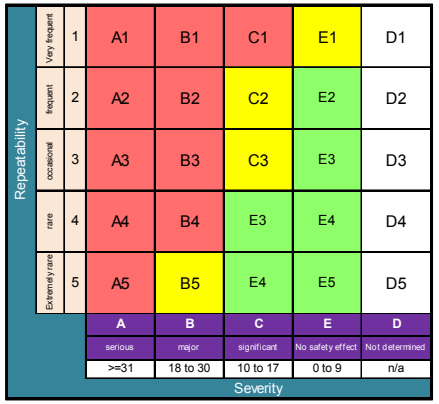
Safety Severity Index (SSI)

SSI NAME	DESCRIPTION	LEVEL OF CONTROL
SSI 1	Errors which were either not captured at all or were identified by airborne system defences such as Ground Proximity Warning Systems or Aircraft Collision Advisory Systems.	Providence
SSI 2	Airservices ATS errors which are detected by pilots or other industry participants such as Foreign or Military ANSPs.	Pilot/other industry participants
SSI 3	Airservices ATS errors which were identified and rectified by Airservices ATS but not in an effective or efficient manner.	ATS but not effectively
SSI 4	Errors are identified and rectified in an appropriate manner by the Airservices ATS system.	ATS

Risk Analysis Tool (RAT)

Airservices applies the Eurocontrol Risk Analysis Tool (RAT) for consistent identification of risk elements in ATS attributed LOS and RI occurrences.

Risk in the RAT methodology is calculated taking into account severity and repeatability, and can be categorized into three regions of ‘risk to be mitigated’, ‘risk to be monitored’ and ‘no further action’.



Risk to be mitigated

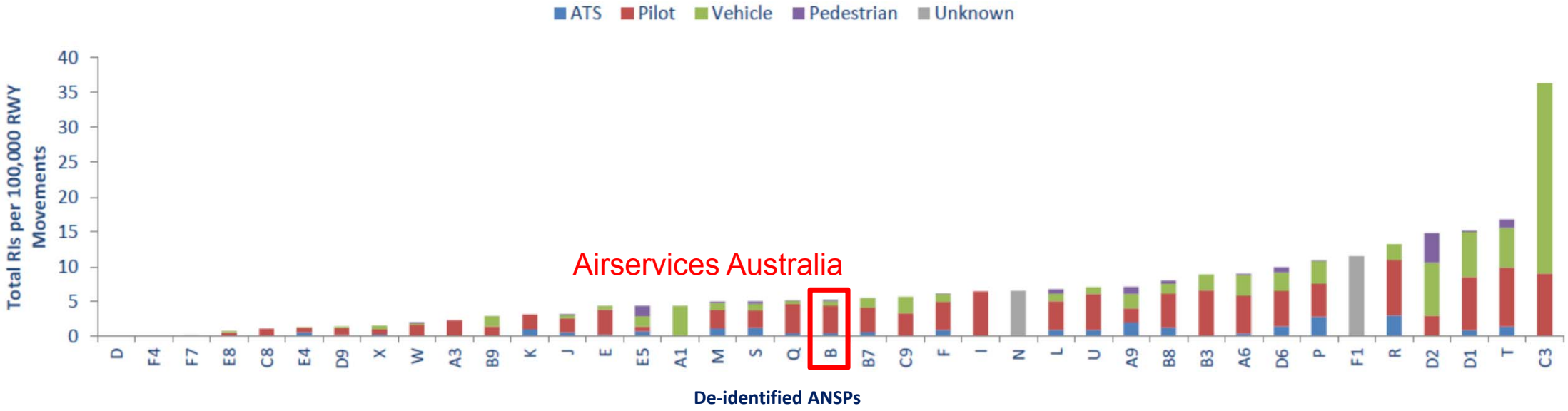
Risk to be monitored

No further action

International benchmarking (CANSO 2016)

- Airservices Runway Incursion (RI) rate benchmarking result in 2016 is similar to previous years' results.
- When compared to the eight ANSPs with similar movements and flight hours, Airservices has a lower RI rate than half of these ANSPs.

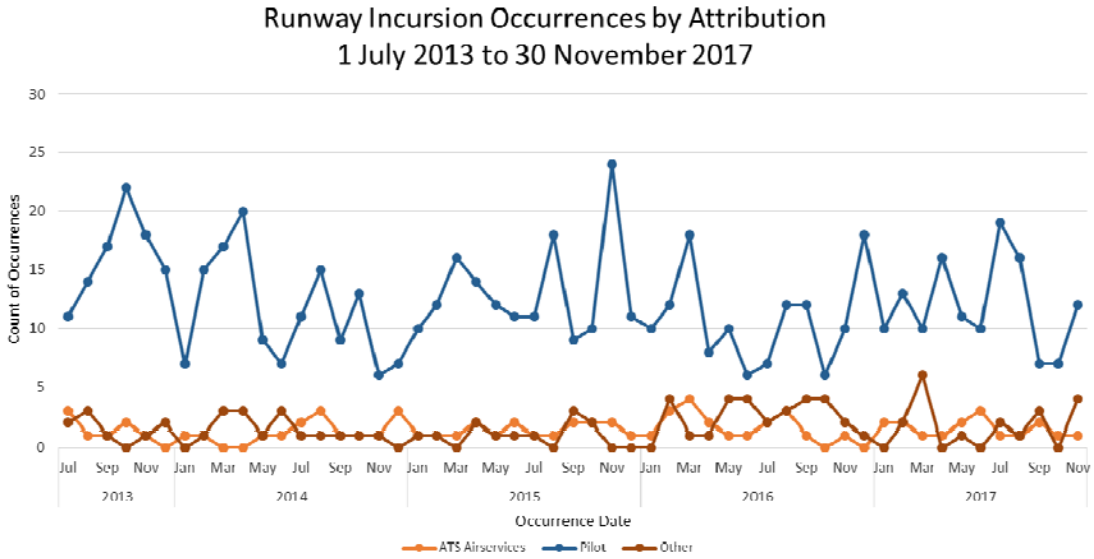
Runway Incursion Rate Benchmarking via CANSO in 2016 (RIs per 100,000 Runway Movements)

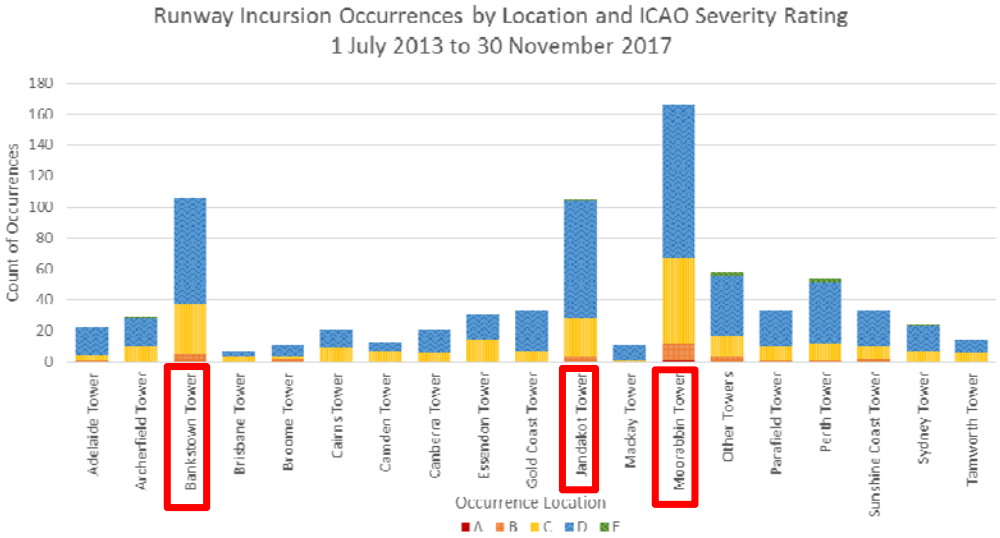


Long-term trend

Consistent trend of RI occurrences (ATS and Pilot attributed) over the last five years.

Pilot attributed RI occurrences are on average 9.5 times higher than ATS attributed RI occurrences.

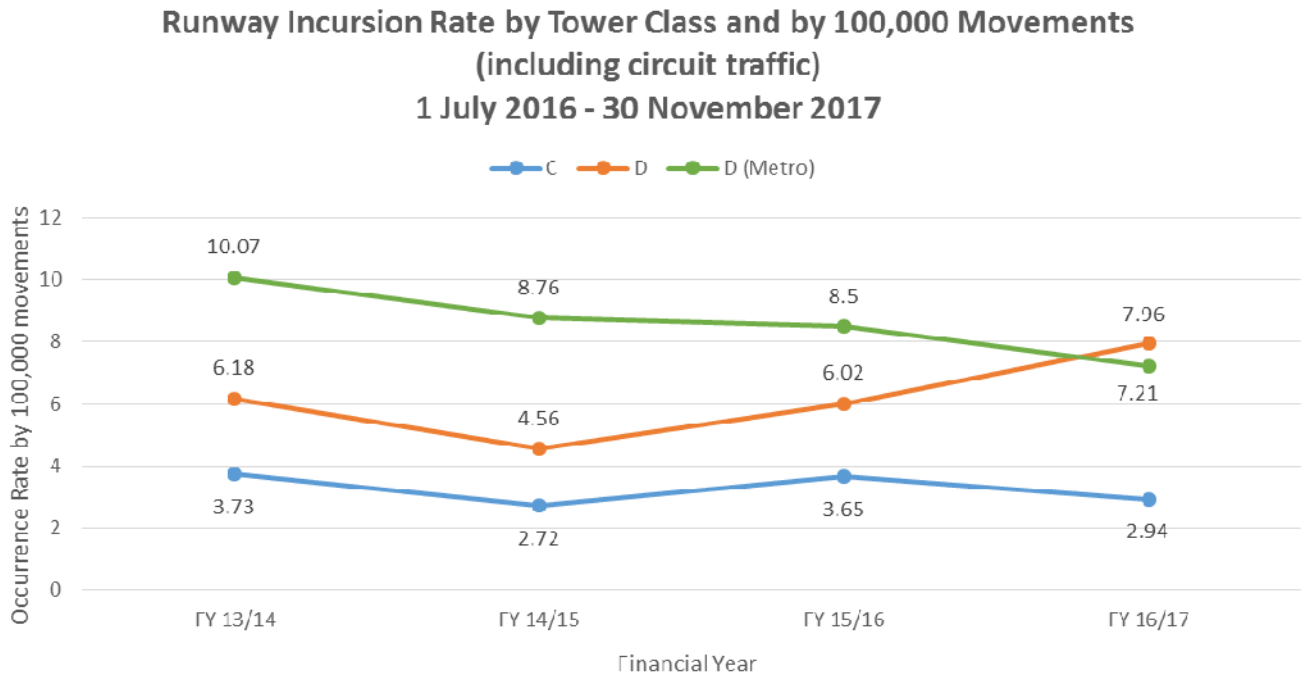




Bankstown, Jandakot and Moorabbin accounted for 47% of all RI occurrences

RI rate by aerodrome types

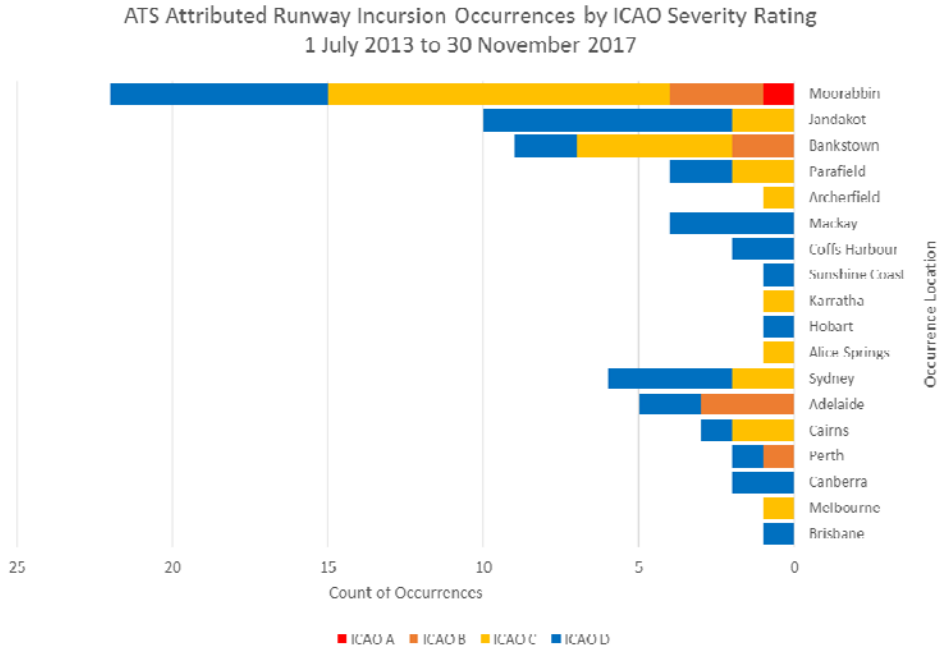
- Class C airports have the lowest RI occurrence rate. These airports typically have more sophisticated airport infrastructure and surveillance technologies.
- The increasing occurrence rate over time for the Class D aerodromes is driven by the increase in pilot attributed occurrences at Sunshine Coast. Operations at Sunshine Coast have changed significantly over the past four years. General aviation (GA) activities declined during FY 13/14 and FY 14/15 and increased again during FY 15/16. RPT activities increased during FY16/17.
- There was a slight decrease in the occurrence rate at Metro D aerodromes in FY 16/17.

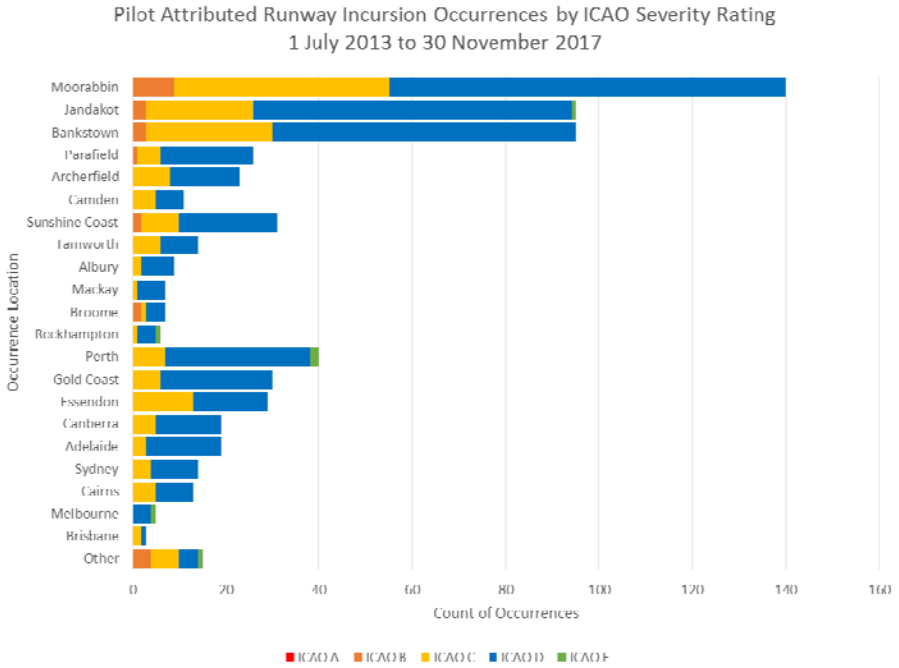


RI occurrences by attribution and location

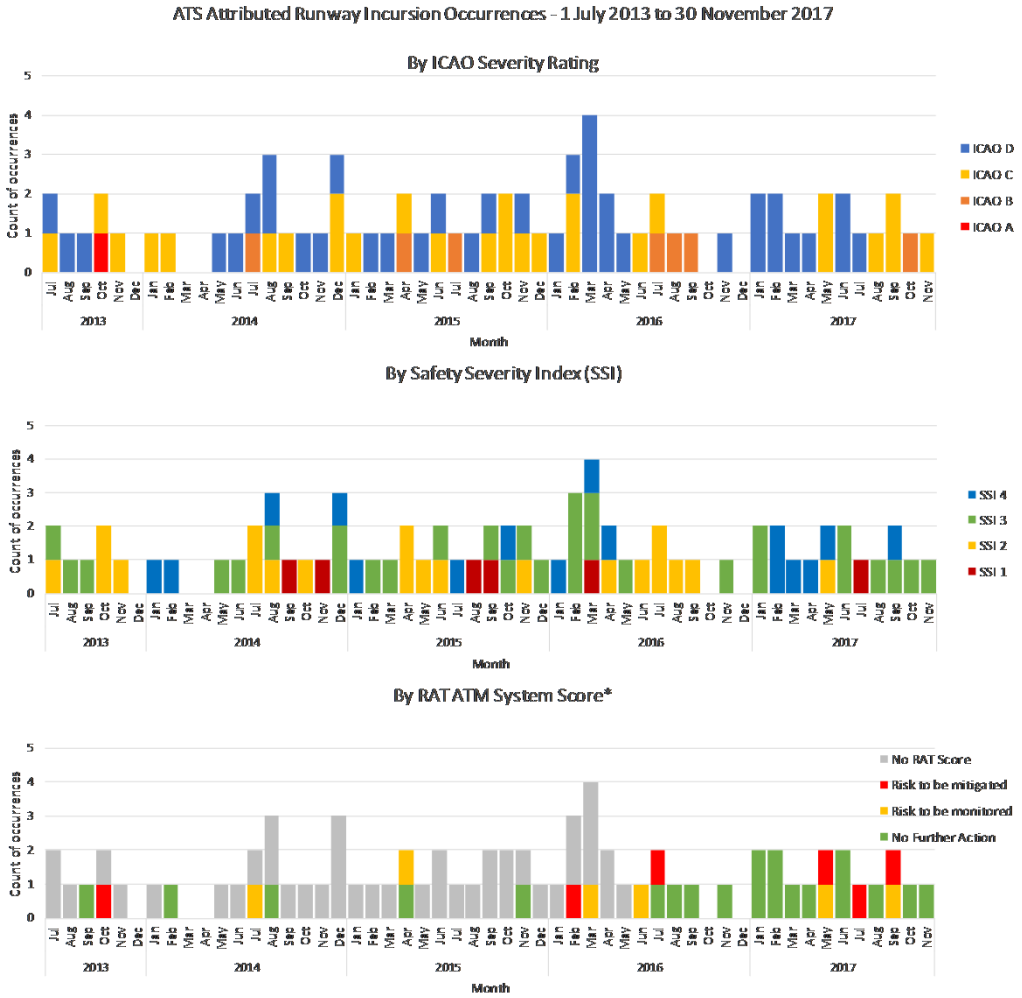
For the period of 1 July 2013 to 30 November 2017:

- Metro D aerodromes recorded the highest number of RIs, potentially impacted by the aerodrome layout; a lack of system level protections such as stop bars; and the high proportion of training operations and general aviation activities at these aerodromes.
- Moorabbin, Bankstown and Jandakot accounted for half of all RI occurrences (54% of ATS attributed occurrences and 51% of pilot attributed occurrences).
- Of non Metro Class D aerodromes, Sunshine Coast recorded the highest number of pilot attributed RIs. Perth recorded the highest number of pilot attributed RIs for capital city airports.
- Very low number of ICAO Severity A and B occurrences for both ATS and pilot attributed occurrences.





ATS attributed RI occurrences

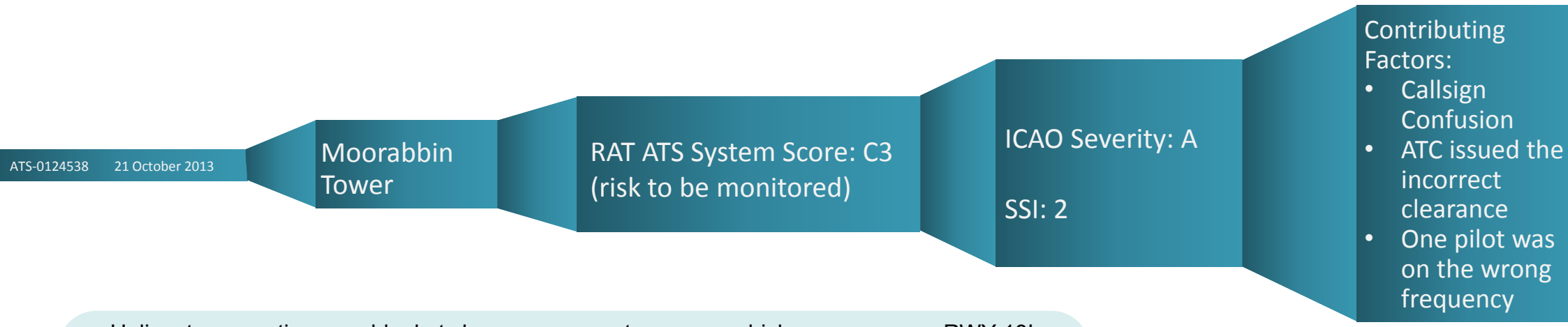


- The one (1) ICAO Severity A ATS attributed RI occurrence was recorded at Moorabbin.

- Of the ATS attributed RI occurrences in the last 12 months, all but two (2) were detected by ATS.

- Three (3) ATS attributed RI occurrences required further risk mitigation based on RAT assessment (noting RAT assessments prior to April 2017 were not validated).

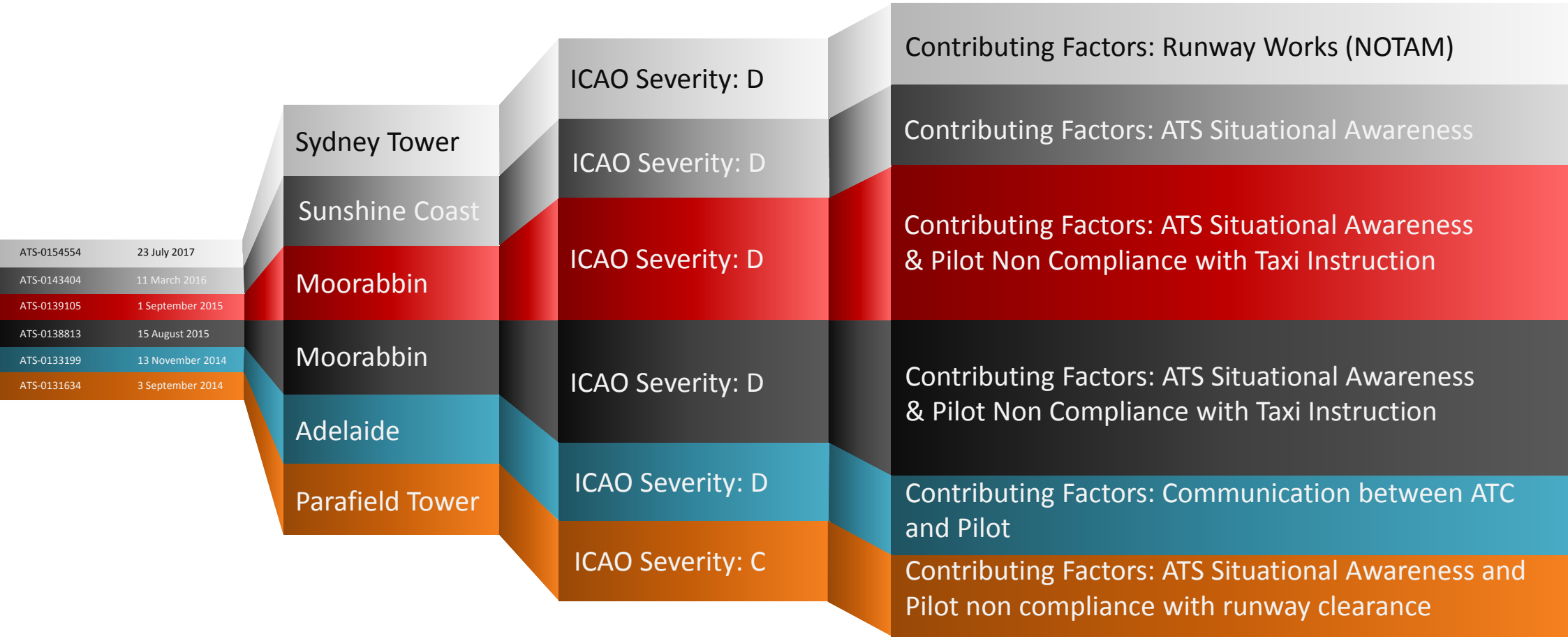
ATS attributed ICAO Severity A RI occurrence



- Helicopter operating on a blanket clearance on eastern grass which encompasses RWY 13L.
- A second, fixed wing, IFR aircraft cleared for take-off on non-duty RWY 13L due to preceding VFR aircraft ahead at the holding point for 17L.
- As the IFR aircraft IBI rotated, the ADC was alerted to the presence of the helicopter on the upwind threshold of RWY 13L by a controller occupying an inactive position
- As this point it was too late to initiate avoiding action.

ATS attributed SSI 1 occurrences

Situational awareness was a contributing factor in four (4) of six (6) ATS attributed RI occurrences with SSI 1.

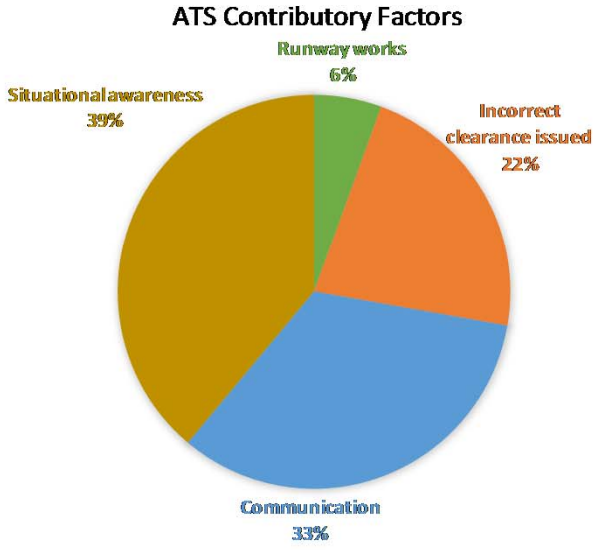


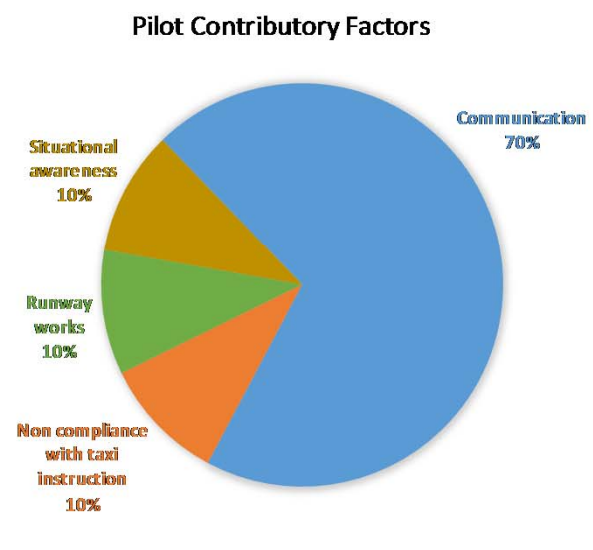
Contributing factors

For the period of 1 December 2016 to 30 November 2017 (12 months):

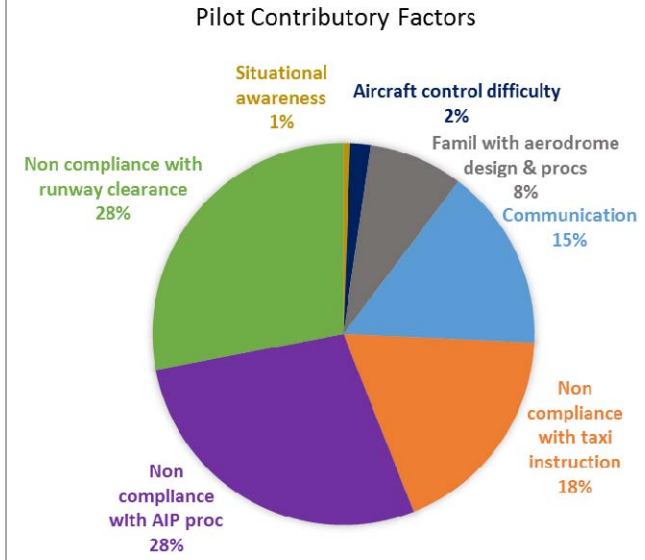
- **Communication** was a major contributing factor for both ATS and pilots in ATS attributed occurrences.
- **Situational awareness** was the most common contributing factor in ATS attributed occurrences.
- **Non-compliance** with ATC clearances or instructions (46%) and non-compliance with AIP procedures (28%) were the most common contributing factors in pilot attributed occurrences.

ATS ATTRIBUTED RUNWAY INCURSIONS
1 DECEMBER 2016 - 30 NOVEMBER 2017

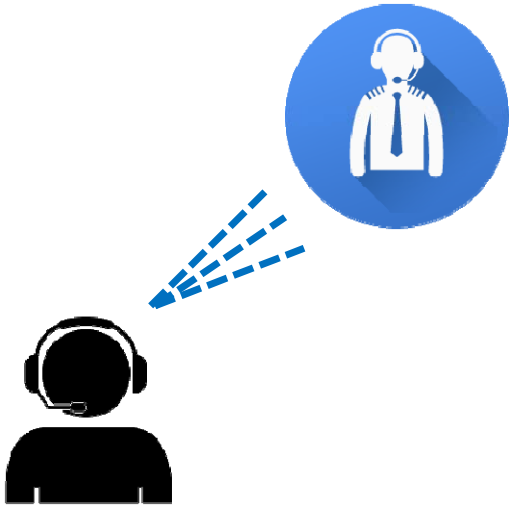




PILOT ATTRIBUTED RUNWAY INCURSIONS
1 DECEMBER 2016 - 30 NOVEMBER 2017



Lessons learned from safety investigations of ATS attributed RI occurrences – Communication

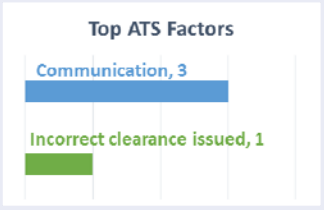
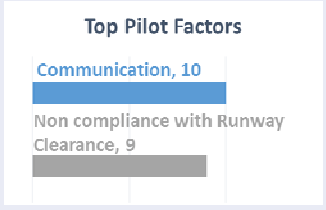
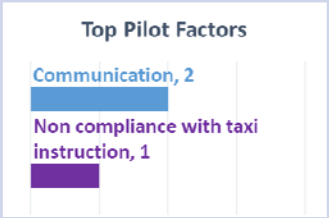
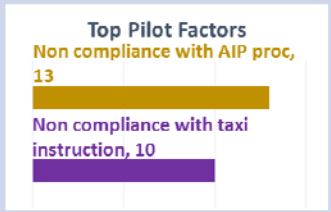


- The use of **standard phraseology** reduces the likelihood of misunderstanding by the recipients of the clearance.
- Where plain language conversational elements are communicated to pilots, the **critical element of control instructions** using standard phraseology must be reiterated by ATC to remove any potential ambiguity and misunderstanding.
- Controllers must ensure focused attention to the **critical elements of the read back**.

Lessons learned from safety investigations of ATS attributed RI occurrences – Situational awareness

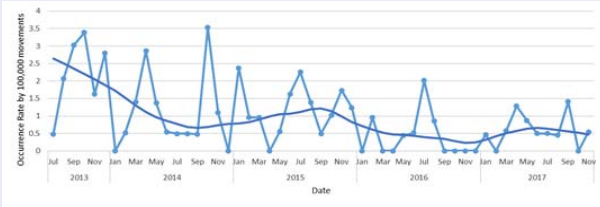
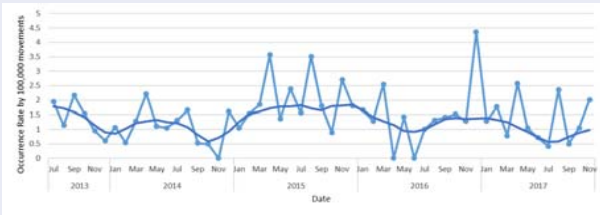
- Controllers are required to ensure that all critical operational information (e.g. NOTAM information on runway availability) is reviewed in full prior to accepting a handover of an operational position.
- Relying on memory is not a robust defensive technique. Incorporating all key elements of data sources available, such as the active RWY Bay, is part of a comprehensive scan to maintain or update situation awareness.
- Memory prompts such as traffic running sheets supplement visual observations and support working memory. Use traffic running sheets correctly, consistently and reliably to support working memory.
- One primary purpose of a scan is to confirm that a plan to assure separation is appropriate and aligned with the actual traffic disposition. A scan is only effective when information is effectively incorporated into your mental model. Understand the primary purpose of a scan and avoid the pitfall of conducting routine actions for the sake of compliance, without incorporating the critical elements of the operational information and not understanding what has been scanned.
- When processing non-routine operations, it is imperative that a robust scan is maintained.
- Where tasks are time critical, do not take shortcuts with scanning technique. Understand your own scan technique and ensure it is performed with intent and not out of habit.

Locations – Summary over the past 12 months

Location	Factors in ATS Attributed Occurrences*	Factors in Pilot Attributed Occurrences*	Risk Analysis Tool - ATS System Scores	ICAO Severity Rating
All Locations	 		**Risk to be mitigated = 3** **Risk to be monotored = 2** **No Action Required = 11**	ICAO B = 8 ICAO C = 54 ICAO D = 121 ICAO E = 3
Bankstown	 		**Risk to be mitigated = 1** **Risk to be monotored = 1** **No Action Required = 1**	ICAO A = 0 ICAO B = 0 ICAO C = 6 ICAO D = 8 ICAO E = 0
Jandakot	 		**Risk to be mitigated = 0** **Risk to be monotored = 0** **No Action Required = 4**	ICAO A = 0 ICAO B = 0 ICAO C = 4 ICAO D = 22 ICAO E = 1
Moorabbin	 		**Risk to be mitigated = 0** **Risk to be monotored = 1** **No Action Required = 4**	ICAO A = 0 ICAO B = 6 ICAO C = 21 ICAO D = 20 ICAO E = 0

***Multiple Factors recorded for each Occurrence**

Zooming in on Metro D aerodromes

Location	Runway Incursion Rate by 100,000 Movements (including circuit traffic) 1 July 2013 - 30 November 2017 (No seasonality trend confirmed)	Summary of movement activity (Extracted from Airspace Research Application)	
Bankstown		**Activity Type Operations**	**Proportion of**
		Circuits[1]	52.55%
		General Aviation[2]	45.04%
		Non-Scheduled[2]	2.19%
		Scheduled[2]	0.04%
Jandakot		**Activity Type Operations**	**Proportion of**
		Circuits[1]	52.61%
		General Aviation[2]	43.29%
		Non-Scheduled[2]	4.05%
		Scheduled[2]	0.01%
Moorabbin		**Activity Type Operations**	**Proportion of**
		Circuits[1]	55.84%
		General Aviation[2]	42.64%
		Non-Scheduled[2]	1.00%
		Scheduled[2]	0.51%

1: 1 Circuit = 1 Touch and Go 2: Arrivals and Departures

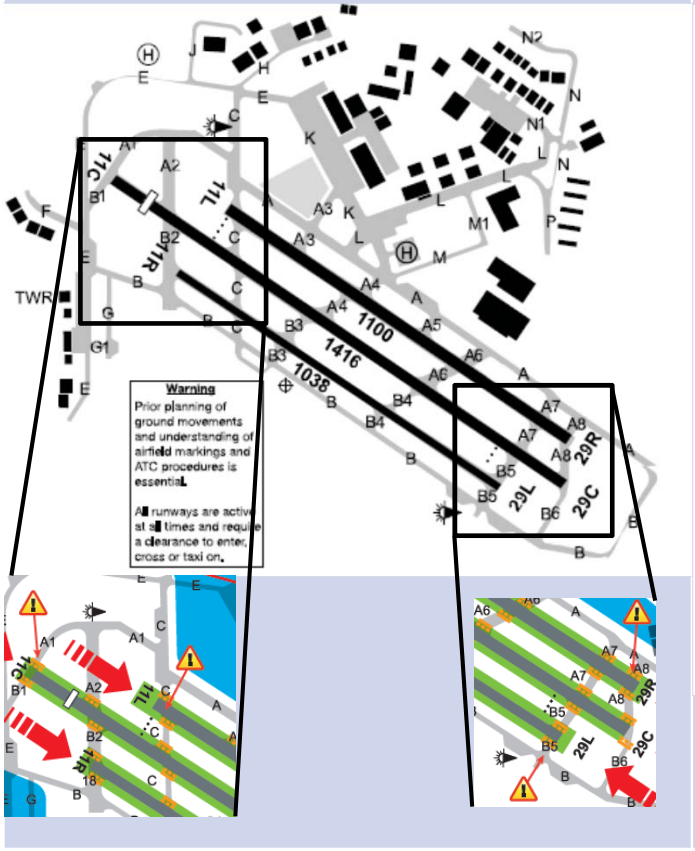
Operational Context at Metro D Aerodromes YSBK / YPJT / YMMB

- **Aerodrome infrastructure**
  - Complex aerodrome layout, with multiple parallel runways and taxiways (some of which are unused)
  - While the aerodromes are compliant with CASR MOS 139 requirements, there are opportunities for infrastructure improvement which can provide increased RI risk mitigations (e.g. additional signage and aerodrome markings, guard lighting)
  - At least 9 % of RI occurrences (n=8) recorded in the last 12 months involved non-duty runways. (Runways listed in RI reports are not always identified as non-duty runways in the description of occurrences)
- **Safety technology**
  - Lack of advanced surveillance or runway safety net technologies in use
- **Operator factors**
  - High proportion of flight training activities (e.g. up to 90% of movements in YMMB), and large number of English Second Language (ESL) pilots (minimum 40-50% of students), increasing challenges in communications, understanding of clearances and shared situational awareness
  - High variation in flying experience, particularly for operations in controlled airspace
  - High turnover of instructors resulting in the difficulty in sustaining the effects of safety improvement actions
- **Local runway safety initiatives**
  - Local Runway Safety Teams (LRST) are in operation to proactively address runway safety, including known hot spots, with safety publications and ERSA entries
  - A standard ATC briefing package has been developed for flying schools. Further promotional effort is still required.

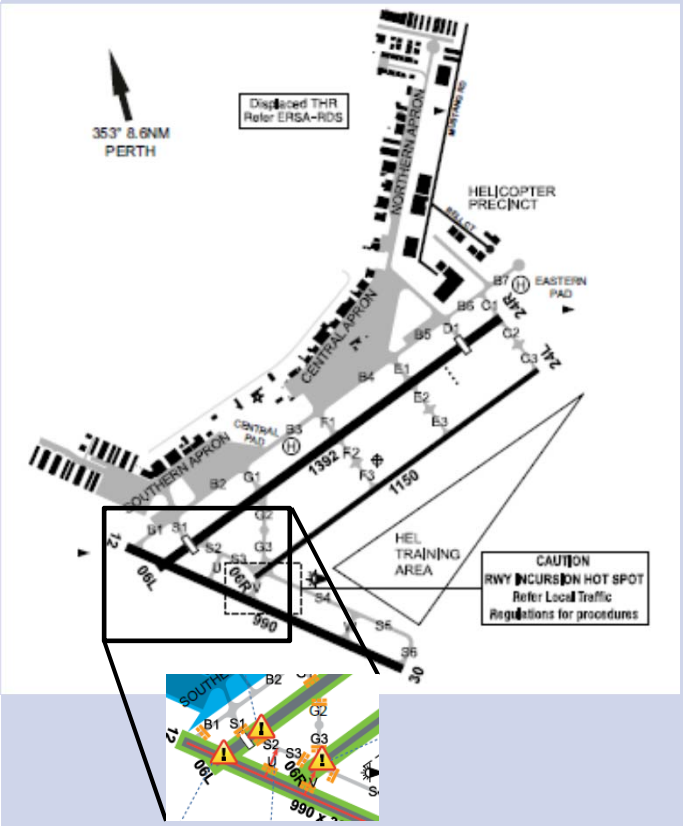
Hot spot diagrams

These diagrams show the most common areas for RI occurrences. Hotspot diagrams are regularly updated and available to the public at http://www.airservicesaustralia.com/flight-briefing/pilot-and-airside-safety/runway-safety/

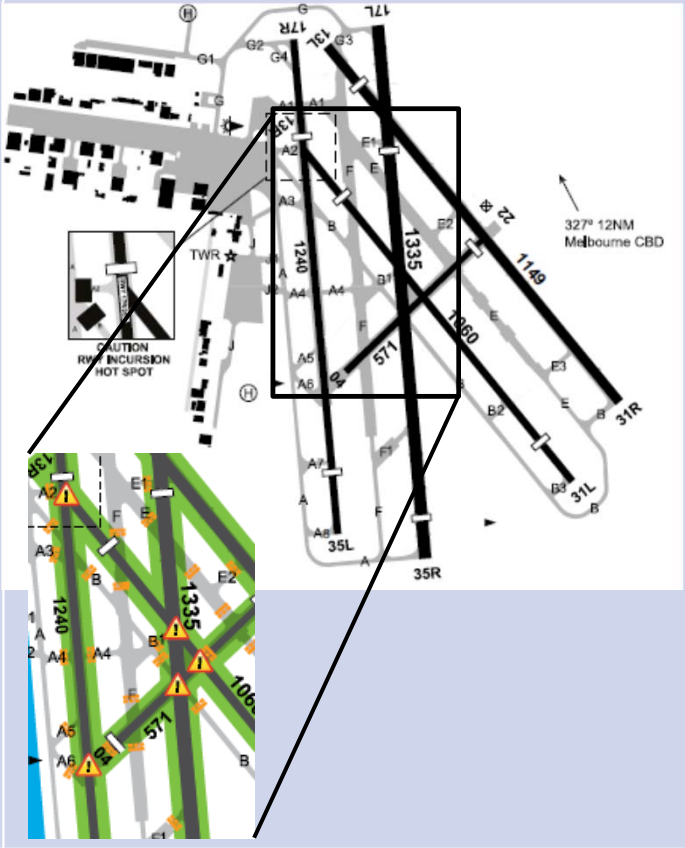
Bankstown



Jandakot



Moorabbin



Existing safety promotions effort to prevent RI

- **Runway incursion**

ICAO defines a runway incursion to be "*Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take off of aircraft*" (ICAO Doc 4444–PANS-ATM).

Runway incursions are an ongoing safety concern, with approximately 15-20 occurring in Australia every month and around the world resulting in fatal collisions between aircraft, and aircraft and vehicles. Reducing the number of runway incursions is paramount to improving runway safety.

Please review the documents below for more information on how you can avoid being involved in a runway incursion.

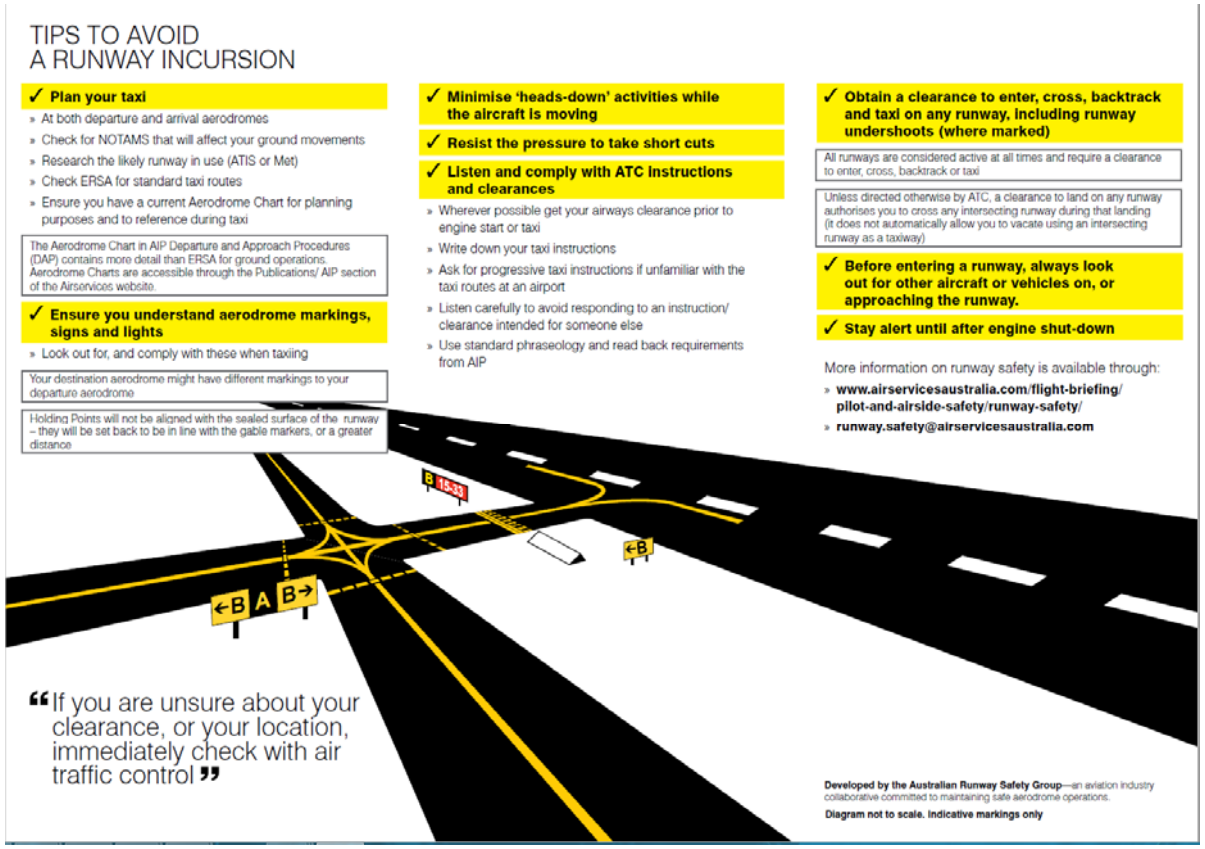
- Pilot's Guide to Runway Safety booklet
- Tips to avoid a runway incursion flyer

Fortunately, most runway incursions have no immediate safety consequences. However, there are regular incursions (particularly at the capital city Class D airports) that have significant potential for a collision.

Incident reports show that runway incursions do not occur randomly around the aerodrome, but are often clustered at particular locations. These are known as 'hotspots'.

Runway incursion hotspots
Hotspot diagrams are an ICAO endorsed and internationally recognised method of providing information about aerodrome locations that have an increased risk for incursions. The diagrams provide recommendations for ensuring runway safety. Significant hot spots may be included in the aerodrome diagrams in ERSA and DAP. Airservices have developed hotspot flyers for the following airports, which can greatly help you reduce your risk of a runway incursion:

- Tips for flying – Moorabbin
- Tips for flying – Bankstown
- Tips for flying – Parafield
- Tips for flying – Jandakot
- Tips for flying – Archerfield
- Sunshine Coast aerodrome
- Gold Coast aerodrome



Safety promotions captured common contributing factors and RI hot spots

TIPS FOR FLYING AT MOORABBIN

Moorabbin is a complex metropolitan Class D airport used by a diverse range of fixed and rotary wing pilots—ranging from students to commercial operations.

The aerodrome layout, with multiple runways, is essential for the type of operations at Moorabbin. However, this design coupled with varying pilot experience levels can lead to a range of common errors made by pilots.

Here are some tips for pilots to reduce the chances of errors when operating at Moorabbin.

AIR TRAFFIC CONTROL (ATC) CLEARANCES

Points to consider:

- Start approval is required for circuit training—it is important that you start and taxi (or proceed to the run-up bay) within a reasonable time of the start approval to avoid unnecessary delays to other aircraft.
- Taxi clearance is required prior to taxi anywhere on the manoeuvring area (ie. not the apron). For example, after landing, a taxi clearance is required to go anywhere on the aerodrome once you have vacated the runway. If you require to cross a runway, include this in your taxi request.
- At Moorabbin the run-up bay is part of the apron and aircraft may taxi from the main apron to the run-up bay after obtaining start approval without obtaining a taxi clearance. You will need a taxi clearance prior to taxiing from the run-up bay. Aircraft leaving the run-up bays are required to give way to aircraft on the taxiways.
- If you need to use taxiway A to access the run-up bay you must obtain a separate taxi clearance
- If a run-up is not required, obtain a taxi clearance before leaving the apron.
- It is recommended that you include your position on the aerodrome, including which run-up bay you are in, to assist ATC and other pilots or airside drivers to identify you.
- Make sure you include your intentions so that ATC can give you appropriate instructions.
- You need a specific clearance from ATC to enter, cross, taxi along, line up on, backtrack on or take off from ANY runway (even if that runway is not the runway in use).
- Never cross or enter any runway unless in receipt of a specific clearance addressed to you that includes your callsign and the words "CROSS/ ENTER RUNWAY XX".
- A landing clearance includes authorisation to cross any runway intersecting your landing runway during the landing roll. Do not stop on a runway after landing on it. For example: if cleared to land on RWY 31L and unable to vacate prior to RWY 35L, you do not need another clearance to cross it. Roll through and vacate via A2.

There are several runway incursion hotspots at Moorabbin. These are detailed in ERSA and on Airservices Moorabbin Runway Incursion Hotspot map available at www.airservicesaustralia.com/flight-briefing/pilot-and-airside-safety/runwaysafety or from the tower.

COMMUNICATIONS AND READBACKS

Using non-standard radio calls or readbacks affects the ability of ATC to understand your intentions and confirm that you have understood your clearance.

If your readback is incorrect or incomplete, ATC will need to confirm your understanding; leading to additional conversation, complexity, workload and frequency congestion. This may affect you, or other aircraft, by increasing the chances of incorrect information being passed or received.

Points to consider:

- Always read back:
  - the words "HOLDING POINT" and the holding point identifier
  - the runway designator

For example ("HOLDING POINT GOLF THREE, RUNWAY ONE THREE LEFT, ABC").

- An instruction to overfly or join upwind will normally be issued when the traffic is such that ATC cannot sequence you directly onto a leg of the circuit. Your instructions will include a specified level.
  - For example: "DEF, MOORABBIN TOWER, MAINTAIN 1500, JOIN UPWIND RUNWAY XX" or "[OVERFLY THE FIELD, CONTACT TOWER ON (freq) OVERHEAD]".
- With an instruction to overfly, ATC will instruct you to contact the appropriate frequency for the circuit. When overhead report on that frequency.
- After reporting overhead, the tower will issue you with relevant traffic to follow or avoid and clear you for a visual approach. Depending on the disposition of the traffic, commence your descent to circuit altitude and track to the circuit position as instructed. If descent is not immediately available, ATC will reiterate the level to maintain as well as tracking instructions.
  - For example: "GHI CLEARED VISUAL APPROACH JOIN LATE DOWNWIND RUNWAY 35 L FOLLOW THE CESSNA ON FINAL", or "GHI, MAINTAIN 1500, CONTINUE TRACKING WEST, REPORT SIGHTING" etc.
- You must not land without a landing clearance. If you haven't received a landing clearance by your decision height, commence a go around. Notify ATC as soon as you can and be aware of helicopters that may be operating just outside the flight strip or overflying the landing threshold not below 500 FT to land on one of the HLS.
- Do not commence your crosswind turn until you have crossed:
  - RWY 17 – Lower Dandenong Road
  - RWY 35 – Centre Dandenong Road
  - RWY 31L – The Kingston Centre.
- When the circuit is busy, advise Tower when you are on downwind for your second last touch and go. This will allow them to start taxiing the next aircraft waiting to join the circuit.

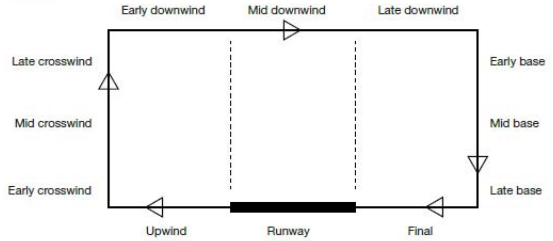
MORE INFORMATION

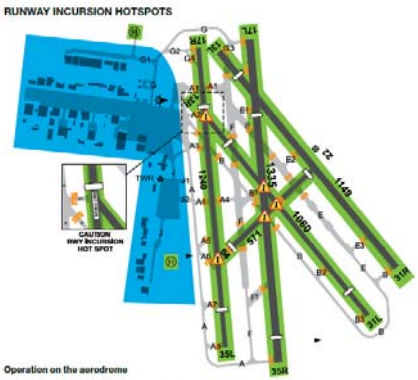
Airservices has a range of information to assist pilots on topics including runway safety, airspace infringements, operating in Class D airspace and working with ATC. These products are available at: www.airservicesaustralia.com/flight-briefing/pilot-and-airside-safety

CASA's OnTrack program provides pilots with information on operating at Moorabbin and other aerodromes. OnTrack is available at: ontrack.casa.gov.au

Information correct at time of printing. Refer to AIP, ERSA, DAP and NOTAM for current, authoritative information. For more information contact safety.promotions@airservicesaustralia.com

Diagram 1: Moorabbin OCT





Runway Safety Enhancement Opportunities

- A National Runway Safety Enhancement Group is being established to facilitate the cooperation and collaboration across the aviation industry to enhance runway safety performance in Australia. This group will complement and support the LRSTs.
- Work is underway to assess the status and effectiveness of implementing global recommended actions to improve runway safety.
- Specifically targeting Metro D aerodromes:
  - Continual focus on working with flying schools and the wider General Aviation (GA) community on local issues around runway safety.
  - Consistent renewal in the provision of safety promotion (considering the turnover of instructors)
  - Engaging with industry to jointly assess the feasibility of implementing new runway incursion alerting technologies and practices with GA, training organisations and airport operators.
  - Enhancing safety education packages to emphasise the importance of on-ground phases of flight, such as:
    - Pre-flight planning, particularly around taxiing
    - Situational awareness, knowledge of and compliance with procedures required for on-ground operations
    - Responses to abnormal situations

Key System Defences

Technology	Overview	Metro D	Class D	Class C
Lighting				
Guard light ('wig-wags')	A pair of unidirectional yellow lights flashing continuously, positioned at each side of a taxiway at the marked and signed Holding Point where the taxiway is about to join a runway.	Not installed	Not installed	BN/SY/ML Guard lighting at all RWY/TWY intersections. PH/AD/CB/CS at holding points/intersections for main RWY.
Stop bar	Series of unidirectional red lights embedded in the pavement, positioned at right angles to the taxiway centreline.	Not installed	Not installed	SY/ML: Stop bars at all RWY/TWY intersections PH to be commissioned early 2018
Situational Awareness Aid				
Advanced Surface Movement Guidance and Control System (A-SMGCS)	Provides automatic identification of all transponder-equipped aircraft and vehicles. Visual and aural alarms alert controllers to potential conflicts enabling early intervention and corrective action.	Not installed	Not installed	Installed in SY/ML/BN/PH. Utilised for safety in traffic management and situational awareness.
Safety Net (Alerting)				
Runway Awareness and Alerting System	Uses airport data stored in the EGPWS database, coupled with GPS and other onboard sensors, to monitor the movement of an aircraft around the airport.	Not installed in Australia		
Runway Status Lights (RWSL)	Fully automatic, advisory safety system which provides direct alerts to both vehicles and pilots independently of the normal traffic control system operated by ATC.	Not installed in Australia		

Reference Information

Non Compliance with AIP Proc:

Extract from AIP ENR 1.1-36 2.16:

2.16 **Taxiing After Landing**
2.16.2 After landing, unless specified otherwise by ATC, an aircraft must comply with the following:
a. Promptly vacate the runway without backtracking.
b. Change from the aerodrome frequency to the SMC frequency (where established) when vacating the runway strip, and obtain an ATC taxi instruction.
c. Not cross any runway that intersects the taxi route unless in receipt of a taxi instruction and a “CROSS RUNWAY (number)” instruction from ATC.
d. Taxi to the destination via the most direct taxiway(s) available.

2.16.5 Aircraft required to hold short of a runway must hold at the appropriate holding point for that runway, or the runway strip edge at the intersection of a crossing runway.
2.16.6 When separate frequencies for aerodrome control and surface
movement control are in use, the pilot in command, on landing, must change from the aerodrome control frequency to the SMC frequency on vacating the runway strip, and then transmit the aircraft callsign and, if applicable, parking bay number. A pilot in command may “**REQUEST DETAILED TAXI INSTRUCTIONS TO (location)”.**