Runway Incursion Analysis

Safety Performance Analysis, Safety and Assurance
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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)

<table>
<thead>
<tr>
<th>SSI NAME</th>
<th>DESCRIPTION</th>
<th>LEVEL OF CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSI 1</td>
<td>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.</td>
<td>Providence</td>
</tr>
<tr>
<td>SSI 2</td>
<td>Airservices ATS errors which are detected by pilots or other industry participants such as Foreign or Military ANSPs.</td>
<td>Pilot/other industry participants</td>
</tr>
<tr>
<td>SSI 3</td>
<td>Airservices ATS errors which were identified and rectified by Airservices ATS but not in an effective or efficient manner.</td>
<td>ATS but not effectively</td>
</tr>
<tr>
<td>SSI 4</td>
<td>Errors are identified and rectified in an appropriate manner by the Airservices ATS system.</td>
<td>ATS</td>
</tr>
</tbody>
</table>

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’.
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)
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.
• 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.
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

Moorabbin Tower

RAT ATS System Score: C3 (risk to be monitored)

ICAO Severity: A
SSI: 2

Contributing Factors:
• Callsign Confusion
• ATC issued the incorrect clearance
• One pilot was on the wrong frequency

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

Contributing Factors:
- ATS Situational Awareness
- Pilot Non Compliance with Taxi Instruction
- Communication between ATC and Pilot
- ATS Situational Awareness and Pilot non compliance with runway clearance
- Runway Works (NOTAM)
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.
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.
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

<table>
<thead>
<tr>
<th>Location</th>
<th>Factors in ATS Attributed Occurrences*</th>
<th>Factors in Pilot Attributed Occurrences*</th>
<th>Risk Analysis Tool - ATS System Scores</th>
<th>ICAO Severity Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Locations</td>
<td><img src="#" alt="Top ATS Factors" /> Situational Awareness, 7</td>
<td><img src="#" alt="Top Pilot Factor" /> Communication, 7</td>
<td></td>
<td>ICAO B = 8</td>
</tr>
<tr>
<td></td>
<td><img src="#" alt="Top ATS Factors" /> Communication, 6</td>
<td><img src="#" alt="Top Pilot Factor" /> Non compliance with Runway Clearance, 49</td>
<td></td>
<td>Risk to be mitigated = 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="#" alt="Top Pilot Factor" /> Non compliance with AIP proc, 49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bankstown</td>
<td><img src="#" alt="Top ATS Factors" /> Situational Awareness, 8</td>
<td><img src="#" alt="Top Pilot Factors" /> Communication, 1</td>
<td></td>
<td>Risk to be mitigated = 1</td>
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<tr>
<td></td>
<td><img src="#" alt="Top ATS Factors" /> Communication, 1</td>
<td><img src="#" alt="Top Pilot Factors" /> Non compliance with Runway Clearance, 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="#" alt="Top Pilot Factors" /> Non compliance with taxi instruction, 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jandakot</td>
<td><img src="#" alt="Top ATS Factors" /> Communication, 3</td>
<td><img src="#" alt="Top Pilot Factors" /> Communication, 2</td>
<td></td>
<td>Risk to be mitigated = 0</td>
</tr>
<tr>
<td></td>
<td><img src="#" alt="Top ATS Factors" /> Incorrect clearance issued, 1</td>
<td><img src="#" alt="Top Pilot Factors" /> Communication, 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><img src="#" alt="Top ATS Factors" /> Non compliance with Runway Clearance, 9</td>
<td><img src="#" alt="Top Pilot Factors" /> Non compliance with taxi instruction, 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moorabbin</td>
<td><img src="#" alt="Top ATS Factors" /> Situational Awareness, 3</td>
<td><img src="#" alt="Top Pilot Factors" /> Communication, 2</td>
<td></td>
<td>Risk to be mitigated = 0</td>
</tr>
<tr>
<td></td>
<td><img src="#" alt="Top ATS Factors" /> Incorrect clearance issued, 3</td>
<td><img src="#" alt="Top Pilot Factors" /> Non compliance with AIP proc, 13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="#" alt="Top Pilot Factors" /> Non compliance with taxi instruction, 11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Multiple Factors recorded for each Occurrence
## Zooming in on Metro D aerodromes

<table>
<thead>
<tr>
<th>Location</th>
<th>Runway Incursion Rate by 100,000 Movements (including circuit traffic) 1 July 2013 - 30 November 2017 (No seasonality trend confirmed)</th>
<th>Summary of movement activity (Extracted from Airspace Research Application)</th>
</tr>
</thead>
</table>
| **Bankstown** | ![Graph](#) | **Activity Type Operations**  
Circuits\(^1\) | 52.55\%  
General Aviation\(^2\) | 45.04\%  
Non-Scheduled\(^2\) | 2.19\%  
Scheduled\(^2\) | 0.04\% |
| **Jandakot** | ![Graph](#) | **Activity Type Operations**  
Circuits\(^1\) | 52.61\%  
General Aviation\(^2\) | 43.29\%  
Non-Scheduled\(^2\) | 4.05\%  
Scheduled\(^2\) | 0.01\% |
| **Moorabbin** | ![Graph](#) | **Activity Type Operations**  
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 / YPJ T / YM M B

- **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 YM M B), 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**


<table>
<thead>
<tr>
<th>Bankstown</th>
<th>Jandakot</th>
<th>Moorabbin</th>
</tr>
</thead>
</table>

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**Notice**

Prior allowing of ground movements and understanding of airport markings and ATC procedures is essential. Always follow ground instructions and remain aware of surrounding traffic.

**CAUTION**

Ramp Incursion Hot Spot

Refer Local Traffic Regulations for procedures.

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**Warning**

All runways are active at all times and may have different taxi routes. Use caution when entering or exiting the runway.
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 total collisions between aircraft, 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 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 EASA 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 – Fairfield
- Tips for flying – Jandakot
- Tips for flying – Archerfield
- Sunshine Coast aerodrome
- Gold Coast aerodrome

**Tips to Avoid a Runway Incursion**

- Plan your taxi
  - All departures and arrivals
  - Check for NAVAIDs that will affect your ground movements
  - Research the linky runway in use (ATIS or Not)
  - Check ENTRA for standard taxi routes
  - Ensure you have a current Aerodrome Chart for planning
  - Use the service for reference (GND)

- Minimise ‘head down’ activities while the aircraft is moving
  - Ensure you understand aerodrome markings, signage, and lights
  - Look out for and comply with these when taxiing
  - Your observation aerodrome might have different markings in your departure area

- Obtain a clearance to enter, cross, backtrack and taxi on any runway, including runway under/overdrawn (where marked)
  - Ensure an approval is obtained and a clearance is issued when required

**Observe and comply with ATC instructions and clearances**

- Wherever possible get your always clearance prior to engine start or taxi
- Write down your taxi instructions
- Ask for progressive taxi instructions if unfamiliar with the taxi route at an airport
- Listen carefully to avoiding an instruction/clearance needed for someone else
- Use standard phraseology and read back requirements from ATC

- Before entering a runway, always look out for other aircraft or vehicles on, or approaching the runway
- Stay until after engine shut down

More information on runway safety is available through:

- runway.safety@airservicesaustralia.com

Developed by the Australian Runway Safety Group (ARSG) on behalf of the aviation industry.

Diagram not to scale. Indicative markings only.
Safety promotions captured common contributing factors and RI hot spots
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

<table>
<thead>
<tr>
<th>Technology</th>
<th>Overview</th>
<th>Metro D</th>
<th>Class D</th>
<th>Class C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lighting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guard light (‘wig-wags’)</td>
<td>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.</td>
<td>Not installed</td>
<td>Not installed</td>
<td>BN/SY/ML Guard lighting at all RWY/TWY intersections. PH/AD/CB/CS at holding points/intersections for main RWY.</td>
</tr>
<tr>
<td>Stop bar</td>
<td>Series of unidirectional red lights embedded in the pavement, positioned at right angles to the taxiway centreline.</td>
<td>Not installed</td>
<td>Not installed</td>
<td>SY/ML: Stop bars at all RWY/TWY intersections. PH to be commissioned early 2018</td>
</tr>
<tr>
<td><strong>Situational Awareness Aid</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Safety Net (Alerting)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Runway Awareness and Alerting System</td>
<td>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.</td>
<td>Not installed in Australia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Runway Status Lights (RWSL)</td>
<td>Fully automatic, advisory safety system which provides direct alerts to both vehicles and pilots independently of the normal traffic control system operated by ATC.</td>
<td>Not installed in Australia</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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)”**.