Question no.: 24

Program: n/a
Division/Agency: Airservices Australia
Topic: Land and Hold Short Operations at Melbourne
Proof Hansard Page: 123 (05 May 2016)

Senator Xenophon, Nick asked:

Mr Harfield: What it means is that the event of two aircraft—even in a go-around situation—coming to the intersection of the runway at the same time is reduced because of the fact that we have a different timing from when the aircraft are landing on the runway.
Senator XENOPHON: Could you provide documents in respect of that to the committee in due course.
Mr Harfield: Absolutely.

Answer:

The following safety documents which supported the reinstatement of Land and Hold Short Operations (LAHSO) at Melbourne Airport were provided to CASA in March 2016.

- The Safety Statement in support of the implementation of a 'stagger', whereby the aircraft are sequenced so that one will arrive at the threshold of one runway at a specified time before the other aircraft arrives at the threshold of the other runway to ensure segregation at the runway intersection in the event of a simultaneous go-around.
- The Safety Case in support of the development and delivery of enhanced compromised separation recovery training for Melbourne Aerodrome Controllers, which includes the procedures for manoeuvring aircraft in the event that separation is compromised due to a simultaneous go-around.
- A further risk analysis of simultaneous go-arounds during LAHSO at Melbourne, including the consideration of night time scenarios.
- A further Safety Assessment Report which demonstrated the overall safety of LAHSO (both day and night-time operations), taking into consideration all recently implemented additional risk controls, and outlined how the ongoing safety operation of LAHSO is being closely monitored.

On the basis of the safety work, CASA agreed with Airservices assessment that night time LAHSO operations at Melbourne could safely resume. The reinstatement of LAHSO at night became effective on 22 April 2016.

Attachments

A. Melbourne LAHSO Stagger Safety Statement
B. Separation Recovery for LAHSO Night Time operations at Melbourne
C. Analysis of Melbourne LAHSO go-arounds
D. Land and Hold Short Operations Safety Assessment Report (SAR) Addendum

airservices

Melbourne LAHSO Stagger Safety Statement

Document number

Version 1.0

Effective 3 March 2016

Prepared: [redacted]
ALM ML/CB TCU

[redacted]
Date: 2016.03.08 15:36:22 +11'00'

Proposed: [redacted]
ML/CB TCU and TWRs Lead ALM

[redacted]
Date: 2016.03.04 15:34:57 +11'00'

Authorised: [redacted]
A/Manager East Coast Services South

[redacted]
4 March 2016

Change summary

Version	Date	Change Description
1.0	3 March 2016	Initial issue

This document was created using the Safety Statement template C-TEMP0209 Version 1.

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1 Introduction

1.1 Background

Land and Hold Short Operations (LAHSO) is a high capacity runway mode used at Melbourne airport whereby an aircraft is allowed to land or take off on one while another aircraft is allowed to land and hold short on a crossing runway. The use of LAHSO at Melbourne is known to have a positive effect on the safe operation of the ATC network on the east coast of Australia by reducing the 'pressure' in the system. The ongoing use of LAHSO is supported by our airline partners and Melbourne airport.

There has been an increasing focus on the risks that might be associated with LAHSO and on 5th July 2015 there was a double go around occurrence at Melbourne. While the aircraft involved were never in unsafe proximity, the occurrence was considered to be significant enough to warrant an immediate review of the causal factors and identify any action that could reduce the likelihood of a similar occurrence.

In November 2015, after negotiation with the Civil Aviation Safety Authority (CASA), LAHSO at night was suspended until 31st March 2016 to permit additional assurance work to be undertaken. The introduction of staggered arrivals, to reduce the likelihood of a double go around leading to aircraft being placed in unsafe proximity, was one element of work that CASA wanted to be in place before night time LAHSO was reintroduced.

1.2 Safety Reporting Determination

A Safe Case Assessment and Reporting Determination (SCARD) workshop was held on 25 February 2016 and determined that outcome was minor and this additional Safety Statement was required – SCARD. A Preliminary Human Factors Assessment has been completed and minimal human factors issues were identified - PHFA.

1.3 Scope of the Change

The "stagger" in this case is a procedure whereby the aircraft are sequenced in such a way that one will always arrive at the threshold of one runway a specified time before the other aircraft arrives at the threshold of the other runway.

Whilst the concept introduces a level of dependence between the sequences to both runways, the foundation concept of LAHSO, that of both runways being available for simultaneous use, remains valid.

The stagger procedure proposed is a !Jl'if'for change to the way aircraft are processed for Melbourne runway 34 in MAESTRO during runway 27/34 LAHSO.

MAESTRO will be reconfigured by the Melbourne Flow (MFL) to 27/341 LAHSO at acceptance rate of 20 (180sec) during daylight hours and (202 seconds) during night time hours. Essentially, a three minute arrival sequence to each runway will be created during the day and a three minute 22 second sequence at night. The additional spacing at night is required to facilitate departures; the reason for this is explained below.

When a runway 34 arriving aircraft is within one minute of a runway 27 arrival, the MFL controller will manipulate MAESTRO to have the runway 34 arrival one minute behind the runway 27 arrival by freezing the runway 34 arrival or inserting a slot into the arrival sequence. The MFL will consult with the TCU and Tower Shift Managers and manipulate

MAESTRO to provide the optimum stagger outcomes for each LAHSO pair while accommodating suitable spacing to meet departure demand.

By applying the one minute difference at the thresholds and the fact that the runway 34 is an additional 1688 metres further from the intersection than runway 27 (2715m and 1027m respectively) the likelihood of aircraft being in close proximity at the intersection in the event of double go around will be significantly reduced or even eliminated.

1.4 Timing

The change is planned to be implemented on Thursday 10th March 2016. Prerequisite work includes:

- Finalisation and approval of all Safety work
- Publication of Local Instructions
- Approval of the Training Needs Analysis
- Delivery of training to MFL controllers
- Provision of briefings to Melbourne Tower and Melbourne En Route controllers

1.5 Roles and Responsibilities

Identify the roles and responsibilities of personnel responsible for performing the activities and/or providing the evidence upon which this Safety Statement relies.

Role	Individual	Responsibilities
ALM Training	[redacted]	Preparation of Concept of Operations Creation of simulator exercises for both TCU and TWR to prove concept and identify hazards. Development and delivery of training
ALM Administration	[redacted]	NRFC process to implement change
ALM Procedures (TCU)	[redacted]	Development of procedures. Oversight of implementation
ALM Procedures (ENR)	[redacted]	Preparation of delivery of briefing material to ML TWR staff
ALM Procedures (TWR)	[redacted]	Preparation of delivery of briefing material to ML ENR staff
ATC Lead Coordinator	[redacted]	Coordination of ATC activities
Program Manager	[redacted]	Oversight of this and other LAHSO assurance initiatives

2 Safety Argument

Safety Objectives and Requirements

Currently during LAHSO arrivals to each runway are treated as separate sequences and therefore, in the event of a double go around, two aircraft could possibly arrive at the intersection of the two runways simultaneously. The top-level safety goal is to reduce the likelihood of this occurring to as low as reasonably practicable (ALARP).

A number of options were considered including controller intervention in the sequence and the introduction of a runway dependency within MAESTRO. These other options were discounted as being technically unreliable, extremely labour intensive or potentially causing aircraft instability that would create an increase in go around occurrences.

Safety Benefits of the Change

The chosen option was selected as it had the following benefits:

- Limited intervention by ATC therefore less risk of unstable approaches
  - TCU controllers will not be required to vector, speed up or slow down aircraft during a critical stage of flight
- The Stagger is achieved using existing traffic management techniques.
  - Freezing of aircraft in the MAESTRO ladder and adjusting the wind input to achieve the desired outcome are current practises for FLOW endorsed controllers.
- Implementation of this change will be "invisible" to stakeholders
  - Enroute controllers will still process aircraft to achieve Feeder Fix times as is current practise. More emphasis will be placed on controllers meeting these times more accurately and consistently.
  - Aircraft will fly existing routes and STARs at published speeds as is current practise
- No changes to system or existing technological capability
- Implementation requires only minimal training and change management activities
  - SCARD, PHFA and TNA determined the change size as minor

Safety Risk Management

A preliminary hazard analysis was completed during the SCARD workshop and the only hazard identified was the potential for an increased likelihood of go around at night caused by pressure to get departing aircraft away. At night, simultaneous departures and arrivals are not permitted and the aerodrome controller must wait for the aircraft landing on runway 34 to state they are vacating the runway before releasing the next departure off runway 27. The nature of the stagger is such that the next arriving aircraft on runway 27 will be too close to guarantee a departing aircraft can get airborne in sufficienttime. The control identified for this hazard was to reduce the arrival rate at night from 40 to 36. The Tower visual simulator was used to test this reduction in arrival rate and it was proved to be successful.

To test the feasibility of the chosen solution a Eurocat Simulator exercise was developed by [redacted] On 10 December 2015 a number of qualified MFL controllers, listed below, attended the simulator to observe and comment on the exercise.

[redacted]

Similarly, a Melbourne Tower Simulator exercise was developed by [redacted], ALM, [redacted], ALM, [redacted] TWR Instructor and [redacted] simulator supervisor to demonstrate the feasibility of the new procedure. On 29th February 2016, a number of qualified tower and approach controllers, listed below, attended the simulator to observe and comment on the exercise.

[redacted]

These simulator sessions gave the staff involved a good insight into how the procedure would be implemented and the areas that needed to be included in the training and briefing materials required to support the change.

The success of the implementation of the stagger will be measured through analysis of Feeder Fix time accuracy and actual landing times as well as an ongoing monitoring of the number of go around occurrences during LAHSO. A formal Post Implementation Review (PIR) will be conducted three months after introduction. Data will be captured and analysed as soon as practicable after each day of operation in order to gain an early indication of the success or otherwise of this change.

<u>Communication and Consultation</u>

The LAHSO Project Steering Group (PSG), consisting of [redacted], Chief Air Traffic Controller, [redacted] Project Lead, [redacted], Manager East Coast Services South, [redacted], Program Manager, has maintained a keen oversight of the progress of this change and has endorsed the chosen option.

Tower and enroute staff have been involved in the development of these procedures and will be provided with a written briefing prior to the commencement of operations.

A written brief on the stagger and the impact on arrival rates was provided to all major airline LAHSO participants on Monday 29th February. No issues have been raised.

Melbourne Airport CEO was briefed on this proposal on Friday 26th February and airport managers were briefed on Wednesday 2nd March during the scheduled Aviation Relations meeting. They expressed their support for this initiative and have not raised any issues.

<u>Compliance to Requirements and Standards</u>

The design, development and implementation of the change does not require any changes to the current requirements or standards. The change is compliant with the existing ATC rule set.

A briefing on the stagger proposal was provided to CASA Standards on Wednesday 24th February. No issues were raised. This safety statement and other safety assurance work associated with reintroduction of LAHSO at night will be included in a formal submission to CASA later in March 2016.

<u>Training and Education</u>

The Training Needs Analysis was developed by [redacted], ALM Training, reviewed by [redacted], Operational Training Specialist, and approved by [redacted], Operational Training Manager.

3 Conclusion

In the development of this stagger procedure both a SCARD and PHFA were completed and the outcome of these processes indicated that the change was "Minor". Both Eurocat and Tower Simulator exercises were developed and assessed by SME's and as a result, the procedure was modified for night time operations. Consultation with internal and external stakeholders, including CASA, have not raised any issues with the safety or utility of this procedure. Training and briefing packages have been developed and appropriately reviewed and approved where necessary.

A preliminary hazard analysis was completed during the SCARD workshop and the only hazard identified was the potential for an increased likelihood of go around at night caused by pressure to get departures away. The agreed mitigation for this hazard was to reduce the arrival rate at night. This solution was successfully tested in the Tower simulator and has been incorporated into the procedures.

No additional risks have been identified.

Acronyms

Acronym	Definition
ATC	Air Traffic Control
ALM	ATC Line Manager
LAHSO	Land And Hold Short Operations
LA	Learning Academy
MAESTRO	Means to Aid Expedition and Sequencing of Traffic with Research of Optimisation
PHFA	Preliminary Human Factors Analysis
SCARD	Safety Case Assessment and Reporting Determination
STAR	Standard Arrival Route
TLI	Temporary Local Instruction
TNA	Training Needs Analysis

Attachments

Title	Document No.
LAHSO Concept of Operations	ATM ML1-1152793
SCARD	ATM ML1-1152791
PHFA	ATM ML1-1152792
TLI	ATM ML1-1152749
TNA	ATM ML1-1152795
LAHSO Program Management Plan	ATM-ML 1-1152787

airservices

Separation Recovery for LAHSO Night Time operations at Melbourne

All Phases Safety Case

SAF-SC-16004

Version 2.0

Effective 22 March 2016

Prepared: [redacted]
Project and Business Support Manager, Melbourne

[redacted]

Date: 2016.03.24 13:28:52 +11'00'

I declare that this <Safety Assessment Report/Safety Case>:

- has been prepared in accordance with the requirements of Airservices Safety Management System that are necessary to manage the Operational-Safety aspects of the change
- accurately reflects the Operational Safety Program performed in support of this change

---

Agreed: [redacted]
East Coast Services South, ATC Business Coordinator

[redacted]

I declare that the Operational Safety Program described within this <Safety A [redacted] ety Case

- accurately reflects the safety program performed in support of this char [redacted]
- includes outstanding activities that are incorporated within the change schedule, resource and budget planning

Date: 2016.03.24 13:30:18 +11'00'

Endorsed: Rob Weaver
Executive General Manager
Safety, Environment and Assurance

Digitally signed by WEAVER_RA
DN: dc=au, dc=gov, dc=airservices, dc=prd, dc=asanet, ou=Domain Users, ou=Win81 Users, cn=WEAVER_RA, email=rob.weaver@AirservicesAustralia.com
Date: 2016.03.24 13:57:24 +11'00'

I am satisfied, following review of this Safety Case, that it:

- describes a Safety Program that meets the requirements of the Safety Management System necessary to manage the Operational-Safety aspects of the change
- provides a valid, evidenced safety argument

Accepted: Greg Hood
Executive General Manger
Air Traffic Control

EGM-ATC
24/3/16

I am satisfied, following review of this <Safety Assessment Report/Safety Case>, that it:

- accurately describes the approved and executed Operational Safety Program
- provides a valid, evidenced safety argument that confirms the:
  - specified requirements have been adequately traced into the design
  - design has been implemented
  - technical transition and ongoing support have been adequately planned and reviewed to ensure the specified requirements are met
  - change, as implemented, ensures all identified Operational Safety risks associated with the design, technical implementation, transition, and ongoing technical operation are able to be managed to ALARP

Document Review Record

Those listed below have reviewed this document in the context of their area of expertise and in accordance with their area of accountability. All issues raised from the reviews have been addressed to the satisfaction of all reviewers.

Name	Role / Position	Date	Version
[redacted]	Unit Manager, Melbourne Project & Business Support	09-03-2016	0.3
[redacted]	ECSS ATC Business Coordinator	10/22- 03-2016	0.3 / 2.0
[redacted]	Senior Human Factors Specialist	08-03-2016	0.3
[redacted]	Change Assurance Manager	0/21- 03-2016	0.4 / 2.0
[redacted]	Manager, Project & Business Support	10/23- 03-2016	0.4 / 2.0
[redacted]	Chief Air Traffic Controller (CATC)	13/23-03-2016	0.4/ 2.0
[redacted]	ATS Integrity Manager	23-03-2016	2.0

Change summary

Version	Date	Change description
0.1	29 February 2016	Initial draft by [redacted]
0.2	8 March 2016	Initial draft reviewed by [redacted] and safety case updated
0.3	8 March 2016	Sent for PBS Manager ML and ECSS Business Coordinator review
0.4	10 March 2016	Sent for stakeholder review
0.5	16 March 2016	Briefing given to EGM SE&A
1.0	16 March 2016	Sent for signatures
2.0	22 March 2016	Amendments to address EGM SE&A and informal CASA feedback

This document was created using the All Phases SAR/SC template AA-TEMP-SAF-0004 Version 8

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Document storage locations:

Compromised Separation Recovery for LAHSO Night Time operations at Melbourne	**SAF-SC-16004**
Electronic copy – Word version	HO_CB0-3043786
Original signed copy – PDF version	HO-CB0-3043787

Safety Case Template Mapping:

Compromised Separation Recovery for LAHSO Night Time operations at Melbourne - All Phases Safety Case	All Phases SAR/SC template AA-TEMP-SAF-0004 Version 8
1. Executive summary	1. Executive summary
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3. Background	3. Background
4. Scope	4. Scope
5. Assumption, constraints and dependencies	5. Assumption, constraints and dependencies
6. Responsibilities	6. Responsibilities
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8.1 Training	8.1, 8.2, 8.3, 8.4, 8.6 9.1, 9.2 12.
8.2 Procedures	8.1, 8.2, 8.3, 8.4, 8.6 9.1, 9.2 10.
8.3 Limitations and shortcomings	8.5
8.4 Safety Management Activities	8.7, 8.8, 8.9 9.3, 9.4, 9.5, 9.6 11 13 15
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1 Executive summary

On the evening of 5th July 2015, in response to a potential compromised wake turbulence separation situation, a Melbourne Aerodrome Controller (ADC) issued a vector to an aircraft conducting a go around off Runway 34. Vectoring below the Minimum Vectoring Altitude (MVA) at night is not permitted as, unlike in the day time, terrain clearance responsibility cannot be assigned to the pilot.

A finding from the Airservices investigation into the occurrence found that the current compromised separation training package developed for Melbourne Aerodrome Controllers (ADC) did not contain training for night time operations; the exercises only addressed day Visual Meteorological Conditions (VMC) scenarios where vectoring below MVA is permitted[1].

In November of 2015 CASA raised concerns [Attach 1] regarding the ability of an ADC to safely manage a compromised separation event at night when LAHSO was in progress. CASA advised it would consider revoking a notice of intention to prohibit the use of LAHSO at night if (in part):

> *Airservices provides evidence to CASA that all ATCs endorsed for Melbourne Tower Aerodrome Control (ADC) have been assessed as competent in effective night-time compromised separation techniques which include the requirements associated with the Minimum Vectoring Altitude*

Having voluntarily suspended LAHSO at Melbourne Airport at night until 31st March 2016, Airservices conducted a number of activities to demonstrate that the ADC can safely manage a compromised separation event at night when LAHSO was in progress. This All Phases Safety Case describes those activities undertaken to produce the evidence in support of achieving the safety goal that:

> It is acceptably safe for an Aerodrome Controller (ADC) at Melbourne airport to vector an aircraft below the Minimum Vector Altitude (MVA) during Land and Hold Short Operations (LAHSO) at night in the event that separation is compromised due to simultaneous go around occurrences.

The activities undertaken were as follows:

- Airservices Instrument Flight Procedure (IFP) design unit confirmed that obstacle clearance could be achieved during a go around manoeuvre on headings up to 50 degrees right of the missed approach path on runway 34 and 50 degrees left of the missed approach path on runway 27. The scenarios developed for controller training limited heading changes to only 20 degrees left or right as this was deemed sufficient to achieve the required outcome; that being avoidance of a collision or near collision at the runway intersection.
- Compromised separation training package was updated with simulator exercises that included a variety of compromised separation scenarios; including transition from day to night time operations and LAHSO at night operations. All Melbourne ADC completed the compromised separation training and refresher training for night time LAHSO by 26th February 2016.

[1] CASR Part 172 Manual of Standards, Section 12.1.4.1

- Airline operators were consulted and indicated their support for the procedures following both observation of exercises in the Melbourne Tower simulator and validation in the Qantas B737 simulator
- Training and education for airline staff will be determined by each individual airline based on their internal processes. With the compromised separation recovery procedure proposed for night time operations being similar to the current day time procedure the amount of training or education required is not expected to be significant.
- A review of the Operational Risk Assessments (ORA) for Melbourne Tower and TCU was conducted in the context of the implementation of the compromised separation recovery procedure and no new hazards were identified. The implementation of the compromised separation procedures and associated training strengthen the recovery action should the top event occur. As such any changes to the risk baseline (ORA) will relate to strengthening recovery preparedness measures and escalation factor controls only. The ORA will be updated should CASA endorse the proposed change.

The work undertaken in support of this safety case has demonstrated that an aircraft's trajectory and pilot behaviour during a go around manoeuvre does not materially change from day to night. Therefore the same procedure as is currently used to vector aircraft during LAHSO in the day time can also be used to safely vector aircraft during LAHSO night time operations. Furthermore, terrain clearance can be maintained in a go around manoeuvre where the vector is limited to within 50 degrees left of the runway 27 missed approach path and 50 degrees right of the runway 34 missed approach path.

Having demonstrated that the vectoring of an aircraft below MVA at night can be safety managed this safety case is submitted to CASA for review to support the regulatory consideration and approval of issuing an instrument in respect of Manual of Standards (MOS) Part 172 Section 10.2.9. Should this be supported by CASA, an amendment to the AIP to reflect the new procedure, will be published.

2 Purpose

This document is an All Phases Safety Case and describes the outcomes of the safety management activities that were undertaken to produce evidence in support of achieving the top level safety goal (Goal 0) that:

It is acceptably safe for an Aerodrome Controller (ADC) at Melbourne airport to vector an aircraft below the Minimum Vector Altitude (MVA) during Land and Hold Short Operations (LAHSO) at night in the event that separation is compromised due to simultaneous go around occurrences.

It shall be demonstrated that Goal 0 has been achieved through the provision of evidence and argument in support of achieving the following sub-goals:

Goal 1: The procedure used to vector aircraft during daytime LAHSO operations can be used to safely vector aircraft during LAHSO operations at night

Goal 2: Night-time compromised separation training has been developed and delivered to Melbourne Aerodrome Controllers

The safety goal, strategy, sub-goals and required evidence to support the safety argument in respect of achieving the top level safety goal is depicted diagrammatically in the following GSN at Figure 1.

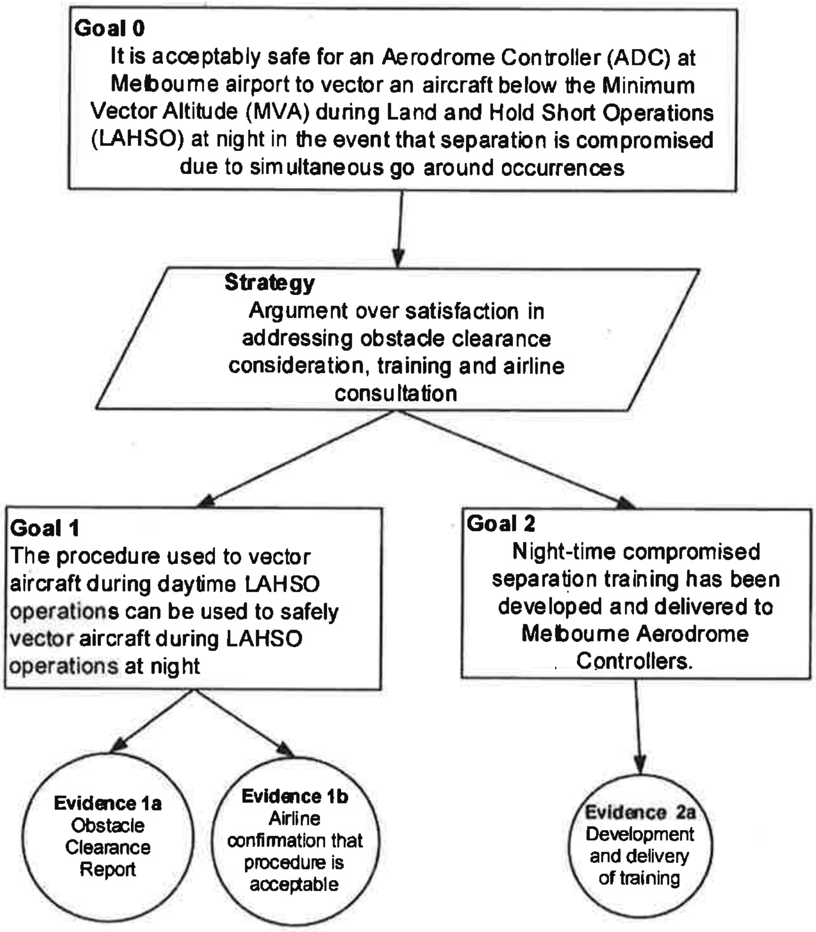

Figure 1. Goal Structure Notation

This document also seeks an exemption from the Manual of Standards (MOS) Part 172 Section 10.2.9. Granting such an exemption will provide controllers with the ability to vector an aircraft below MVA during LAHSO operations at night at Melbourne airport in the event of a compromised separation scenario.

It should be noted that this safety case and its supporting evidence seeks to implement a risk control in the event that separation is compromised due to simultaneous go around occurrence. In doing so, the document provided assurance to CASA in respect of concerns expressed regarding the ability of Melbourne Aerodrome Controllers (ADC) to safely manage a compromised separation event at night when LAHSO was in progress.

This document is not intended to provide a comprehensive argument in respect of reinstating LAHSO night-time operations at night.

A LAHSO SAR Addendum has been prepared and will be forwarded to CASA to report on a program of safety initiatives that have been implemented with the view of improving the systemic safety of LAHSO. The Addendum will present an updated operational risk baseline in support of the reintroduction of LAHSO at night.

This Safety Case has been prepared and submitted as a separate document from the LAHSO SAR Addendum as it seeks a regulatory exemption (requiring a safety case) which if granted would facilitate application of a risk control in the event that CASA endorses the reinstatement of LAHSO at night.

3 Background

On the evening of 5th July 2015, in response to a potential compromised wake turbulence separation situation, the Melbourne Aerodrome Controller (ADC) issued a vector to an aircraft conducting a go-around off Runway 34. Vectoring below the Minimum Vectoring Altitude (MVA) at night is not permitted as, unlike in the day time, terrain clearance responsibility cannot be assigned to the pilot.

A finding from an Airservices investigation into the occurrence was that the current compromised separation training package developed for Melbourne Aerodrome Controllers (ADC) did not contain training for night time operations. The exercises only addressed day Visual Meteorological Conditions (VMC) scenarios where vectoring below MVA is permitted[2].

In November of 2015 CASA raised concerns [Attach 1] regarding the ability of an ADC to safely manage a compromised separation event at night when LAHSO was in progress. CASA advised it would consider revoking the notice of intention to prohibit the use of LAHSO at night if (in part):

> *Airservices provides evidence to CASA that all ATCs endorsed for Melbourne Tower Aerodrome Control (ADC) have been assessed as competent in effective night-time compromised separation techniques which include the requirements associated with the Minimum Vectoring Altitude.*

As a result of these concerns, Airservices voluntarily suspended LAHSO at Melbourne Airport at night until 31st March 2016, during which time Airservices would conduct a comprehensive review of LAHSO operations.

3.1 Safety Case Assessment Reporting Determination

In accordance with AA-TEMP-SAF-0042 [Ref 1], a Safety Case Assessment and Reporting Determination (SCARD) was completed to determine the level of safety reporting necessary to support the procedural change [Attach 2].

The overall operational safety magnitude was reported as 'Minor'. However since this change proposes a procedural change, an instrument from CASA to allow exemption from the CASR Part 172 MOS has been requested through this safety case.

3.2 Preliminary Human Factors Assessment

A Preliminary Human Factors Assessment (PHFA) was completed on February 4th, 2016 [Attach 8]. The primary issues identified during this assessment related to the relevant training implications for ML Tower controllers, as well as updates to their procedures and phraseology. These issues are discussed further in Section 8 of this safety case.

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[2] CASR Part 172 Manual of Standards, Section 10.2.9.2 (c)

4 Scope

4.1 Current System

The Manual of Standards (MOS) Part 172 - Air Traffic Services, Section 10.2.9 Obstacle Clearance states the following with reference to vectoring:

10.2.9.1 When vectoring, ATC must provide at least 1000ft vertical clearance over any obstacle within:

(a) 3 NM of the aircraft when the range scale in not greater than 50 NM; or

(b) 5 NM of the aircraft when the range scale is greater than 50 NM.

10.2.9.2 These obstacle clearance requirements do not apply:

(a) when vectoring as part of an issued SID; or

(b) when ATC authorises a visual departure; or

(c) In VMC by day only, when ATC assigns responsibility for arranging obstacle clearance specifically to the pilot.

In a scenario where a controller has to resolve a potentially unsafe situation, such as compromised separation, the Manual of Air Traffic Service at Section 2.2.1.6 states that a controller should use "best judgement and initiative" when:

a) The safety or an aircraft may be considered to be in doubt; or

b) A situation is not covered specifically by these instructions

The double go around scenario during LAHSO at night is one example of such a situation and it would be the provisions of this rule that the controller would use to justify their decision to vector an aircraft that is below the Minimum Vector Altitude.

This safety case relates specifically to resolving a compromised separation scenario by vectoring during LAHSO at Melbourne at night. At night the provisions of 10.2.9.2 cannot be applied to this scenario and therefore an exemption form the MOS is required.

4.2 Compromised separation recovery for LAHSO night time operations at Melbourne airport

In addressing its own findings and CASA concerns, Airservices agreed to undertake the following activities:

1. Instrument Flight Procedures design staff will assess if obstacle clearance requirements can be met in the event a controller vectors an aircraft off the published missed approach paths *(Evidence 1a)*
2. Consult Airlines regarding the suitability of the compromised separation solution, with participation in the development of the ruleset changes and education material *(Evidence 1b)*
3. Develop night time LAHSO compromised separation simulator exercise (SIMEX) that will include training on vectoring at night as well as transition from day VMC to night procedures *(Evidence 2a)*

4. Deliver compromised separation refresher training to Melbourne Tower Aerodrome Controllers which to be completed as SIMEX training and not classroom *(Evidence 2a)*
5. Review the Melbourne LAHSO ORA in the context of changes to compromised separation procedures and training in support of re-instating LAHSO operations at night in Melbourne
6. Present an argument and evidence in the form of a Safety Case (this document) in support of seeking from CASA an exemption to MOS 172 Section 10.2.9

4.3 Out of Scope

It should be noted that at the time of writing this safety case Airservices is also managing a program of initiatives to improve the systemic safety of LAHSO operations. CASA have been regularly briefed on these initiatives and a Melbourne LAHSO Safety Assessment Report (SAR) Addendum in the process of being forwarded to CASA in support of reinstating night time operations. This SAR Addendum will present an updated operational risk baseline, which takes into account the additional controls that have been implemented to improve the systemic safety of LAHSO.

This safety case addresses just one aspect of that program which relates to the matter of compromised separation recovery and training at night for Melbourne tower aerodrome controllers.

4.4 Affected Systems

There are no systems affected by this change.

4.5 Affected Groups

Table 1 below lists the business groups affected by this change.

Table 1: Business groups affected by this change

Group Effected	Required action within this project
Melbourne Tower Aerodrome Controllers (ADC)	Required to undertake LAHSO compromised separation training for night time operations.
Melbourne Terminal Control Unit Controllers	To be consulted and be aware that aircraft may be vectored at night in a compromised separation scenario and be on an assigned heading rather than on the published missed approach path.
Learning Academy	Develop and deliver training to Melbourne ADC Update internal training material as required.
East Coast Services South Office of the Chief Air Traffic Controller, ATS Integrity	Development and delivery of changes to the rule-set (MATS, AIP) and the development of pilot educational material via an AIC
ATM Service and Support, Instrument Flight procedure Design	To investigate whether obstacle clearance requirements can be met if a vector off the published missed approach path is given.
Airline Operators authorised to conduct LAHSO	To be consulted on the development of the proposed procedure and be in agreement that they are able to comply with vector instructions at night. To provide education to their crews and, where they feel it necessary, to amend existing LAHSO training/refresher programs. Provide confirmation that they support the proposed changes for the reinstatement of LAHSO at night in Melbourne
Melbourne Airport	To be kept informed and provide support for the activities undertaken

5 Assumptions, constraints and dependencies

5.1 Assumptions

Resources will be made available to complete the work in the time allocated. The Safety Plan assumption that sufficient resources would be made available to complete the work on time has been met. There are no new assumptions.

5.2 Constraints

No new constraints have been identified to date.

5.3 Dependencies

Airline consultation on the safety and utility of the procedure. Airlines have been consulted. Refer to those consulted in Attachment 4 [Attach 4].

Training resources (including Learning Academy 360° visual simulator) are available for ML Tower Aerodrome Controllers. All training has been completed using the Learning Academy 360° visual simulator.

Instrument Flight Procedure design work to demonstrate that obstacle clearance can be assured on a range of headings left and right of the published missed approach path. Report has been completed and published [Attach 7].

CASA endorsement of the proposed change. This safety case and a Melbourne LAHSO SAR Addendum will be submitted to CASA for their endorsement.

6 Responsibilities

Table 2 below lists the safety related responsibilities assigned to stakeholder involved in executing the change.

Table 2: Stakeholder's safety responsibilities

Title and name	Primary responsibilities
EGM ATC Greg Hood	• Acceptance of Safety Case
EGM Safety Environment & Assurance Rob Weaver	• Endorsement of Safety Case
Change Sponsor [redacted] Manager, East Coast Services South (ECSS)	• Go/No-Go decision on change • Acceptance of Safety Plan • Review of Safety Case
Office of Chief Air Traffic Controller (CATC) [redacted] Chief Air Traffic Controller	• Acceptance of Safety Plan • Review of Safety Case
Change Manager [redacted] ATC Business Coordinator ECSS	• Completion of the change within the constraints of safety, time, cost, and scope
Melbourne Tower Air Traffic Control [redacted] - Acting ATC Line Manager [redacted] Check and Standardisation Supervisor	• ATC subject matter expertise (SME) input into training development
Learning Academy [redacted] - ATS Instructor (TWR/TMA) [redacted] - ATS Instructor (TWR/TMA) [redacted] - ATS Instructor (Standards Specialist)	• Development and delivery of updates to compromised separation training to include LAHSO at night
ATS Integrity [redacted] – ATS Integrity Manager	• Management of required AIP and AIC changes
Instrument Flight Procedures [redacted] – Chief Designer	• Obstacle clearance analysis
Regulatory Services [redacted] – Regulatory Services Manager	• Liaison with CASA
Change Assurance [redacted]	• Review of safety case in accordance with AA-NOS-SAF-0104
Safety, Environment and Assurance (SE&A) [redacted] – Senior Project Safety Specialist [redacted] Senior Human Factors Specialist [redacted] – Project and Business Support Manager Melbourne	• Facilitate SCARD / PHFA workshop • Preparation of Safety Plan and Safety Case
Safety Program Working Group (SPWG)	• Assist with the coordination of the project's safety objectives and activities • Communicate, advise, agree, recommend, prioritise and assist to achieve the safety program's objectives • Seek advice and guidance from invited specialists, subject-matter experts and other interested parties as necessary

7 Consultation and communication

The Change Manager is responsible for ensuring that all key internal and external stakeholders are consulted throughout the change program. The purpose of the consultation and communication process is to ensure that all relevant stakeholders are, where appropriate:

- Advised of project activities
- Able to provide subject matter expert input
- Involved in the decision making process

Table 3: Stakeholders consulted during the change program

Stakeholder	Aim / Nature of Communication	Evidence
Project Steering Group	To ensure appropriate governance and guidance	Meetings
Melbourne Tower and TCU staff Learning Academy	To engage staff in the development of procedures, safety management activities	Meetings / phone calls as required Development and delivery of simulator training [Attach 3]
ATS Integrity (ATSI)	Receive training	
Instrument Flight Procedures Design (IFP) Project & Business Support (PBS)	Meetings, workshops, emails, phone calls and verbal briefings, simulator training	
Regulatory Services CASA	Meetings, workshops, emails, phone calls and verbal briefings: Seek advice on regulatory compliance. CASA liaison and briefings	SCARD [Attach 2] PHFA [Attach 8] CASA update meetings / Quarterly CASA / Airservices Working Level Meetings CASA representatives attended a briefing and simulator session on 11th March 2016
Airline Operators	To gain support from airline operators that the procedure is acceptably safe and that they are willing to participate. Meetings, written and verbal briefings	Attendance at briefings [Attach 4] Qantas simulator session [Attach 5] Proposed change to AIP (draft) [Attach 6]
Melbourne Airport	Meetings, emails, phone calls and verbal briefings	Meetings / phone calls as required

8 Design and implementation process

8.1 Training

A Compromised Separation training package for Melbourne Aerodrome Controllers (ADC) already existed, however, it only addressed daytime scenarios. Learning Academy and Melbourne Tower staff worked together to develop simulator exercises to include a variety of compromised separation scenarios, including at night and the transition from day to night time operations. A TNA to support the development of a night time compromised separation training package was not required.

All Melbourne ADC completed the compromised separation training and refresher training for night time LAHSO by 26th February 2016. Completion of training was recorded under module R-OP-1112-S (V5) and staff training files were updated. Attachment 3 provides evidence from the Learning Academy that all training has been delivered and this constitutes provision of Evidence item 2a, in respect of Goal 2.

Training and education for airline staff will be determined by each individual airline based on their internal processes. However, as this change only seeks to make the current day time compromised separation procedure available for night time operations, the amount of training or education required is not expected to be significant and will be aligned with implementation of the new procedure in the Aeronautical Information Publication Australia (AIP).

8.2 Procedures

The night time compromised separation training includes a procedure whereby the ADC has to vector an aircraft that may be below the Minimum Vector Altitude (MVA).

To demonstrate that this procedures was safe in this limited scenario the following work was undertaken:

1. Airservices Instrument Flight Procedure (IFP) design unit was tasked to test whether obstacle clearance could be achieved during a go around manoeuvre on headings up to 50 degrees right of the missed approach path on runway 34 and 50 degrees left of the missed approach path on runway 27. The outcome of this work was that obstacle clearance could be achieved. The report is provided in Attachment 7 and constitutes Evidence item 1a in respect of Goal 1.

   "Avoiding Action" phraseology was developed in line with Airservices guidelines for a TRUCT (Trigger, Resolution, Urgency, Confirmation, and Traffic) response to compromised separation [Attach 6]. The phraseology was developed in consultation with airlines to ensure that the relevant urgency is conveyed, but also to ensure that this phraseology can form part of Aircrew education programs.

2. Airlines were consulted as to how the proposed go around manoeuvre reconciled with operating procedures and cockpit workload and to seek feedback on any perceived safety risks. This was achieved through site visits to the Tower simulator in Melbourne. Tigerair were unable to attend a simulator session but were however consulted via a teleconference meeting. All operators expressed support for the procedure. They were specifically asked the questions whether there was any difference in the operation of the aircraft by day and night. The answer to this question was consistently, no.

The airlines were then asked as to their willingness to allow their crews to manoeuvre the aircraft onto an assigned heading at a low altitude and during a period of high cockpit workload. The answer to this question was, yes, unless the pilot determined safety to be a prohibiting factor. A list of airlines, dates and the staff consulted is provided in Attachment 4 [Attach 4]. This constitutes Evidence item 1b in support of Goal 1.

The proposed procedure was validated in the Qantas B737 simulator where it was demonstrated that the procedure would be safe and effective should avoiding action need to be taken in the event of a double go around scenario. Attachment 5 provides minutes arising from this exercise and details a record of who attended, activities undertaken and outcomes achieved. This constitutes additional evidence in respect of Evidence item 1b.

The airlines were also consulted on the proposed changes to the AIP [Attach 6].

Records of correspondence with airline operators and evidence of consultation regarding document changes is captured in Airservices National Request for Change (NRFC).

8.3 Limitations and shortcomings

The work undertaken by IFP only considered headings up to 50 degrees left of the runway 27 missed approach path and 50 degrees right of runway 34 missed approach path. This is based on best practice whereby when faced with simultaneous missed approach conflict, controllers vector one aircraft behind the other aircraft and, therefore amended headings for the other aircraft would not be required.

The scenarios developed for controller training limited heading changes to only 20 degrees left or right as this was deemed sufficient to achieve the required outcome; that being avoidance of a collision or near collision at the runway intersection.

8.4 Safety management activities

There were five safety management activities identified in the safety plan [Attach 9]. The first two identified the need for the development of night time compromised separation recovery procedures and the design and delivery of training.

The third activity was to complete obstacle clearance analysis and the fourth was engagement with airline operators in order to validate the procedures and gain their endorsement for any changes required to the AIP.

At the time of writing, with the exception of final agreement on the change to AIP, these activities have been completed as described above.

The fifth activity required a review of the Operational Risk Assessments (ORA) for Melbourne Tower and TCU. This was completed in a meeting held on Monday 7th March 2016 [Attach 10].

The meeting noted that the proposed change does not introduce any new hazards that are not already captured within the risk baseline.

The compromised separation recovery procedures and associated training relate to strengthening recovery action should the top event occur. As such, any changes to the risk baseline (ORA) will relate to strengthening recovery preparedness measures and escalation factor controls only. The ORA will be updated should CASA endorse the proposed change. The minutes of the meeting are provided in Attachment 10 [Attach 10].

A pre-implementation review meeting will be held during the week beginning 28th March 2016 to confirm all training, records and procedures have been promulgated should CASA endorse re-instating LAHSO at night.

9 Conclusion

The Safety Case has argued that:

It is acceptably safe for an Aerodrome Controller (ADC) at Melbourne airport to vector an aircraft below the Minimum Vector Altitude (MVA) during Land and Hold Short Operations (LAHSO) at night in the event that separation is compromised due to simultaneous go around occurrences.

This constitutes the top level safety goal and achievement of this goal was broken down into sub-goals 1 and 2.

Goal 1 stated that "The procedure used to vector aircraft during daytime LAHSO operations can be used to safely vector an aircraft during LAHSO operational a night.

Evidence in support of Goal 1 was provided which included an Obstacle Clearance Report (Attach 7) and extensive Airline consultation, including a B737 simulator validation exercise (Attach 4 and Attach 5).

Goal 2 stated that "Night-time compromised separation training has been developed and delivered to Melbourne Aerodrome Controllers".

Evidence in support of Goal 2 included the provision of evidence from the East Coast Services South Business Coordinator (Attach 3) that the updated compromised separation training syllabus has been successfully delivered to Melbourne Aerodrome Controllers. It also includes a statement that CASA have audited the training files to confirm that the required training had been completed and correctly recorded.

The provision of evidence in support of each sub-goal has demonstrated achievement of the top level safety goal.

Airservices has demonstrated that it is acceptably safe for an ADC at Melbourne airport to vector an aircraft below the Minimum Vector Altitude (MVA) during LAHSO) at night in the event that separation is compromised due to simultaneous go around occurrences.

This safety argument provides the required evidence in support of seeking an exemption form MOS Part 172, Section 10.2.9 to enable controllers to exercise a risk control in the event that separation is compromised due to simultaneous go around occurrences.

10 Document review

10.1 Service Delivery Line/Business Branch or Unit

This safety case complies with Airservices Operational Safety Change Management Requirements [Ref 2] and Safety Assessment Preparation and Reporting [Ref 3] and has been prepared following the processes described therein.

On issue of this safety case it will have been reviewed by SE&A PBS Manager, Melbourne and ATC SMEs as indicated at the front of the document, to ensure compliance with the Airservices SMS.

All review feedback has been considered and where appropriate changes have been made to the document.

10.2 Safety, Environment and Assurance

On issue of this safety case it will have been reviewed by the Change Assurance Manager to ensure compliance with Safety Assessment Preparation and Reporting [Ref 3]. This review, and the consideration and incorporation of review comments, is required for all safety cases prior to the issue of the safety case to CASA for endorsement.

11 Definitions

Within this document, the following definitions, acronyms and abbreviations apply:

Term	Definition
ADC	Aerodrome Controller
AIP	Aeronautical Information Publication
ALM	ATC Line Manager
ATC	Air Traffic Control
ATM	Air Traffic Management
ATSI	ATS Integrity
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
CATC	Chief Air Traffic Controller
ECSS	East Coast Services South
EGM	Executive General Manager
IFP	Instrument Flight Procedures
IMC	Instrument Meteorological Conditions
LAHSO	Land and Hold Short Operations
MATS	Manual or Air Traffic Services
ML	Melbourne
MOS	Manual of Standards
MVA	Minimum Vectoring Altitude
ORA	Operational Risk Assessment
PHFA	Preliminary Human Factors Assessment
SCARD	Safety Case Assessment Reporting Determination
SE&A	Safety, Environment and Assurance
SIMEX	Simulated Exercise
SME	Subject Matter Expert
SPWG	Safety Program Working Group
SSO	Simulator Support Officer
VMC	Visual Meteorological Conditions

12 Attachments

No.	Title and version	Number/Link
1	CASA - Notice of proposed direction re LAHSO at Melbourne (File Ref: EF11/10239)	HO_CB0-3043682
2	SCARD – Compromised Separation Procedures during LAHSO at night at ML Airport (Version 1.0)	HO_CB0-3043683
3	Delivery of training and simulated exercises	HO_CB0-3043869
4	Attendance from Airlines	HO_CB0-3043781
5	Minutes for Qantas SIMEX visit	HO_CB0-3043780
6	Aeronautical Information Publication Australia – H316_draft	HO_CB0-3043797
7	Obstacle Clearance Report	HO_CB0-3043796
8	Preliminary Human Factors Assessment (PHFA)	HO_CB0-3043779
9	Safety Plan	HO_CB0-3043699
10	ORA Review Workshop – Meeting Minutes	HO_CB0-3043783

13 References

No	Title and version	Number/Link
1	Safety Case Assessment and Reporting Determination (SCARD) Template	AA-TEMP-SAF-0042
2	Operational Safety Change Management Requirements	AA-NOS-SAF-0104
3	Operational Safety Assessment Preparation and Reporting	AA-GUIDE-SAF-0104

File Ref: EF11/10239

2 November 2015

Mr Greg Hood
Executive General Manager
Air Traffic Control Group
Airservices Australia
GPO Box 367
CANBERRA ACT 2601

cc Jason Harfield
A/g Chief Executive Officer
Airservices Australia

PROPOSAL TO ISSUE A DIRECTION

I am writing to advise that on the basis of the following facts and circumstances I propose to issue the attached direction to an officer of Airservices Australia (**Airservices**) pursuant to regulation 11.245 of the *Civil Aviation Safety Regulations* 1998 (**CASR**).

FACTS AND CIRCUMSTANCES

1. Airservices' Operations Manual - Part 172 (Air Traffic Services) is approved by CASA. Section 16.2 (Provision of Standards, rules and procedures to staff) of the Manual states that the Manual of Air Traffic Services (**MATS**) and some other documents are the principal documents which prescribe Airservices' internal requirements as required to meet the standards in the Manual of Standards Part 172 – Air Traffic Services (**Part 172 MOS**).

   LAHSO

2. Land and Hold Short Operations (**LAHSO**) is an air traffic control (**ATC**) procedure for aircraft landing and holding short of an intersecting runway or point on a runway, to balance airport capacity and system efficiency with safety. Paragraph 10.13.5.1 of the Part 172 MOS states:

   > Notwithstanding aerodrome separation standards, operations by an aircraft landing on one runway and another aircraft either taking off or landing simultaneously on a crossing runway may be permitted subject to the provisions of LAHSO.

3. Paragraph 10.13.5.9 states:

   > In the application of LAHSO, controllers must:
   > (a) ensure that the published distance from the landing threshold to the hold short point of the crossing runway is adequate for the performance category of the aircraft as detailed in the Landing Distance Required (LDR) table below;
   > (b) alert aircraft that land and hold short runway operations are in progress by notification on the ATIS;
   > (c) issue directed traffic information to both aircraft participating in the procedure;
   > (d) ensure readback of a hold short requirement;

(e) withhold issuing a take-off clearance to a departing aircraft while another aircraft is landing on a crossing runway having been issued with a duly acknowledged hold short requirement, until such time that in the opinion of the controller, there is no possibility that both aircraft could occupy the intersection at the same time should the landing aircraft subsequently fail to hold short.

4. During LAHSO, paragraph 10.9.5.9.6 of the MATS authorises Air Traffic Controllers to permit simultaneous landings by day and night.

5 July 2015 incident

5. On 5 July 2015, there were simultaneous go-arounds involving two QANTAS Boeing 737 aircraft (registration VH-VXS and VH-VYE) at Melbourne Airport, Victoria. An Emirates Boeing 777 was departing runway 34 at the time. During LAHSO on runways 27 and 34 (crossing runways), these two 737 aircraft conducted simultaneous missed approaches at 6.11pm local time at night. Last light was at 5.42pm local time. During aircraft VH-VYE's missed approach from runway 34, air traffic control manoeuvred the aircraft to maintain wake turbulence separation with the departing Boeing 777. Airservices does not consider the incident to be a loss of separation.

6. This incident was initially reported by Airservices as a go-around and subsequently also reported as a ground proximity occurrence after it was recognised that one of the go-around aircraft (VH-VYE) was issued a vector whilst below the minimum vector altitude.

7. The Australian Transport Safety Bureau (**ATSB**) is investigating this incident.

16 January 2015 incident

8. There was a double go-around incident during daytime LAHSO at Melbourne Airport on 16 January 2015. This incident involved a Tiger Airways Airbus A320 which was on final to runway 27 whilst a QANTAS Airways Airbus A330 was on final to runway 34. They were conducting go around procedures on crossing runways at Melbourne Airport during LAHSO. The Airservices short investigation bulletin report summarised the incident relevantly as follows:

> Two aircraft went round from the converging LAHSO runways due to reported turbulence and overshoot sheer [sic]. The natural stagger which occurred between these aircraft resulted in vertical displacement which meant the conflict was adequately resolved.

9. There have been an additional 5 ATS incident reports (**CIRRIS**) submitted since 2013 that relate to LAHSO operations at Melbourne.

CASA concerns

10. CASA has previously expressed concerns to Airservices in relation to LAHSO at Melbourne Airport, most recently in my letter to Dr Weaver dated 28 July 2015 (CASA Ref: F11/10239).

11. CASA continues to be concerned about the safety of LAHSO at Melbourne Airport, particularly at night. The key concern is the safe management of simultaneous go-arounds from crossing runways, with the night time case having additional constraints on the possibility for ATC to assign responsibility for terrain clearance to pilots and limitations on the effectiveness of visual separation by ATC and between pilots. Associated contributory concerns are:

(a) The requirement for IFR aircraft to remain on the published missed approach procedure until reaching the lowest safe altitude,

(b) The procedural restrictions on ATC not to issue turn instructions applicable whilst the aircraft is below the Minimum Vector Altitude (MVA) during a go-around at night that take the aircraft outside the protections of the published missed approach. This restricts the ability to provide separation services for a time period, albeit short, of significance and introduces an additional discrete hazard in the Safety Management System (SMS) sense,

(c) The LAHSO Operational Risk Assessment (ORA) contains a threat of aircraft conducting missed approaches, however the existing controls have failed to manage this risk,

(d) ATC's inability to assure that a separation standard is applied between aircraft conducting simultaneous go-arounds has been assessed within Airservices (AA)'s SMS as a 'Major' consequence in AA's criteria for operational safety (AA-PROC-SAF-0105). This risk level is only acceptable as a Class B risk to AA as it is forecast to occur less frequently than once per year. AA's SMS assessment methodology assesses the ability to provide/not provide an ATS and precludes any assessment of the mid-air collision risk,

(e) The limitations on the ability of ATC to provide effective separation to aircraft at night based on visual observation,

(f) The limitations on pilots of IFR aircraft to see and manoeuvre to avoid one another at night,

(g) The LAHSO incident rate at Melbourne Airport,

(h) The higher rate of go-arounds at Melbourne Airport in comparison to other aerodromes,

(i) The increasing rate of go-arounds at Melbourne Airport,

(j) The analysis highlighting that the go-around rate at Melbourne Airport is up to 16 times as high for a second go-around in the minute after a previous go-around than for the first go-around,

(k) The increasing air traffic levels at Melbourne Airport,

(l) The lack of demonstrated training competency of air traffic controllers in the handling of night-time compromised separation including double go-arounds, and

(m) The lack of systemic segregation of LAHSO aircraft pairs through the runway intersection (that is, a 'stagger').

Go-arounds in LAHSO

12. In a report of Airservices entitled *Targeted Review of Melbourne Land and Hold Short Operations (LAHSO) Safety Assurance* 20 March 2015, the following was stated:

> **7.4.1 Operational Risk Assessment (ORA) Management**
> Prior to the finalisation of the Safety Assessment Report (SAR) in 2012 the Melbourne Tower and Terminal Control Unit (TCU) ORA did not identify LAHSO procedures. Following

a reported double go-around occurrence an unscheduled Safety Services review of the Melbourne Tower ORA was initiated.

The ORA review also considered the hazards and controls identified in the draft SAR hazard register although the register was still in 'development' and identified a number of 'yet to be met' controls. The register status workflow required the register to progress from 'development' to 'operational' where hazard register information is transferred to the respective operational risk assessments and assigned 'complete' following the post implementation review (PIR).

Following this ORA review the threats 'Aircraft conducts a missed approach during LAHSO' and 'Aircraft is unable to hold short during LAHSO' were included in the Melbourne Tower ORA on 7 January 2013.

7.4.4 Hazard review (Double Go-Around)
The SAR identified a hazard of two aircraft performing a go-around. The likelihood was assessed as occurring between 5-50 years and the consequence was classified as 'Major'. It was identified that a double go-around occurred at Melbourne during the preparation of the report however this was not associated with LAHSO operations. The SAR specified a requirement to update the risk should two aircraft go-around when LAHSO was in progress. The action to review the risk associated with double go-around was not explicitly assigned to an accountable manager.

The SAR LAHSO hazard register (Hazard #901/3) was reviewed in October 2012 after a query from Melbourne Tower regarding the assessed likelihood of a double go-around during LAHSO. The Executive General Manager (EGM) Safety, Environment & Assurance (SE&A) requested a quantitative analysis be conducted to revalidate the likelihood of a double go around which had been presented in the SAR. A Melbourne Go-around Study report was provided to SE&A and ATS Integrity in June 2013.

The report analysed LAHSO go-around rates for 2012 on runway 27 and runway 34, and defined a double go-around as two aircraft going around with a time interval less than 20 seconds at the intersection.

The analysis concluded that a double go-around is expected to occur once every 175 years. This analysis validated the likelihood presented in the SAR, however, as runway 34/09 LAHSO mode was suspended during the data capture period the mode was not assessed.

Finding 8 - The Review determined the data modelling completed to determine the likelihood of a double go-around did not incorporate the runway 34/09 LAHSO mode or environmental conditions including crosswind and downwind components.

13. Airservices' response report to the above report, dated May 2015, relevantly stated "*A re-assessment of the data modelling has been completed and a progress report has been developed and circulated for review prior to management endorsement.*"

14. Subsequently, data provided by Airservices in the '*LAHSO and Converging Runway Operations (CROPS) Safety Assessment Report (SAR) Addendum*' dated 31 August 2015, stated the following:

[Airservices] has also produced analysis on all go arounds that have occurred between 1st January 2012 to 28th February 2015. This analysis has provided two different likelihoods based on separation at the runway intersection:

- Likelihood of two go-arounds on crossing runways within 20 seconds at the intersection can be classified as yearly to 5 yearly
- Likelihood of two go-arounds on crossing runways within 60 seconds at the intersection can be classified as daily to yearly

As a result, the likelihood for Hazard 901/10, 2 aircraft perform a go-around, has increased in magnitude from that originally reported in the 2012 SAR. Assuming that the 20 second criteria is agreed to the description of major consequence using the Airservices risk matrix, when considering a revised likelihood of yearly to 5 yearly, this will result in a class 'B' risk.

...

In summary, the most significant risk associated with LAHSO relates to the residual Class B risk associated with double go-arounds. While a significant number of controls are already in place, additional controls are in the process of being implemented, and further new controls have been proposed in an effort to ensure the risk remains As Low As Reasonably Practicable (ALARP) and in the tolerable region, it is anticipated that it will continue to remain a Class B risk, subject to any further double go around occurrences. This is a result of the identified controls being mostly procedural in nature and limited in their effectiveness in controlling the double go around risk, particularly given a go around can be initiated by the pilot as well as ATC and it is not always predictable. (page 7)

...

Whilst go-arounds are initiated to assist crew and ATC avoid hazardous situations, poorly managed go-arounds can lead to an increase in risk or can introduce additional hazards. This is particularly the case at night and in IMC. (page 27)

...

Evaluate and assess risk with new controls

The consequence of 'Major' for a double go around has previously been agreed and accepted by the senior Management Team in the 2012 SAR. It was determined through the use of qualitative analysis and quantitative analysis that the initial risk would be between yearly and 5 yearly, however, it could be more towards the 'yearly' end resulting in a 'high' B class risk.

It was agreed that the implementation of the short term controls would reduce the likelihood, but not by order of magnitude, therefore it would still remain as a 'B' class risk. Due to the unknown effectiveness of the remaining medium and long term controls it was decided that the likelihood would decrease with their implementation however, by how much was unknown. It was agreed that the risk would need to be re-evaluated when the controls have been implemented. (page 30)

...

Hazard 901/10, 2 aircraft perform a go around has been reanalysed and the resulting residual risk has been identified as a 'B' class risk. The 'B' class risk has been assessed as a result of quantitative (Refer to section 9.3.5) and qualitative analysis. The consequence was qualitatively analysed in the LAHSO Internal HAZID workshop as Major)(Ref.14) and the likelihood has been derived from quantitative analysis (yearly- 5 yearly if the two go arounds occur within 20 seconds of each other) (Ref. 15).

If another double go around were to occur at Melbourne or Adelaide during LAHSO then the barriers and controls will be reviewed for continued effectiveness as part of the investigation process. The Safety and Performance unit of the Office of the Chief Air Traffic Controller will then identify if further analysis or updates to recorded risks is required. The annual review will ensure that the review is completed if no double go around situations occur during the 12 month period. (page 39)

...

As a result, the likelihood for Hazard 901/10, 2 aircraft perform a go around, has increased in magnitude from that originally reported in the 2012 SAR. Assuming that the 20 second criteria is agreed to meet the description of a 'major' consequences using the Airservices risk matrix, when considering a revised likelihood of yearly to 5 yearly, this will result in a 'B' class risk.

Additionally, since the December 2014 LAHSO PIR, two double go around[1] incidents have occurred in LAHSO at Melbourne. One was considered in the Operational Analysis Unit

[1] For the purposes of the report and the associated workshop held in July 2015 the definition of a double go around was stated as being two aircraft on approach to the nominated LAHSO runways who, in the event of them both conducting missed approaches, would cross the runways intersection within 60 seconds of each other. (Ref. Attachment 12)

assessment (V3.2), however as this assessment was already indicating a Class B risk, the second double go around occurrence resulted in the EGMs of SE&A and ATC requiring additional safety assurance activities to be conducted.

The Operational Analysis Unit updated their analysis to include the most recent double go around occurrence in Version 3.3 of the Risk Analysis of Melbourne LAHSO operation report. This resulted in the risk remaining as a Class B risk, although it was considered at the higher frequency end of the range.

The additional safety assurance activities included conducting a risk assessment workshop for ceasing LAHSO. In this workshop, two new hazards, one with a 'C' class the other with a 'D' class residual risk, were identified, as well as a number of new controls that are 'yet to be met'. (page 42)

...

In summary, the most significant risk associated with LAHSO relates to the residual Class B risk associated with double go arounds. While a significant number of controls are already in place, **additional controls are in the process of being implemented, and further new controls have been proposed in an effort to ensure the risk remains ALARP and in the tolerable region,** it is anticipated that it will continue to remain a Class B risk, subject to any further double go around occurrences. This is a result of the identified controls being mostly procedural in nature and limited in their effectiveness in controlling the double go around risk, particularly given a go around can be initiated by the pilot as well as ATC and it is not always predictable.

15. As noted, the recent analysis resulted in Airservices confirming the risk as a Class B risk but now at the higher end of the Class B risk range. Airservices states in the report that a double go-around is the most significant risk associated with LAHSO.

16. Further, page 27 of the report highlighted the fact that 'poorly managed go-arounds can lead to an increase in risk or can introduce additional hazards. This is particularly the case at night and in IMC. However, the analysis does not identify a double go-around in LAHSO at night as a discrete hazard.

Vectoring and Obstacle & Terrain Clearance

17. The Part 172 MOS requires ATC to apply the following obstacle clearances when vectoring:

When vectoring, ATC must provide at least 1 000 ft vertical clearance over any obstacle within:
(a) 3 NM of the aircraft when the range scale in not greater than 50 NM; or
(b) 5 NM of the aircraft when the range scale is greater than 50 NM.

These obstacle clearance requirements do not apply:
(a) when vectoring as part of an issued SID; or
(b) when ATC authorises a visual departure; or
(c) in VMC by day only, when ATC assigns responsibility for arranging obstacle clearance specifically to the pilot.

18. The MATS contains a number of provisions in relation to vectoring, obstacles and terrain clearance that relate to Tower operations, relevantly:

- *MATS -Operations below LSALT*

ATC may assign a pilot a level below LSALT provided that:

a) by night, to an IFR pilot that has reported 'VISUAL' or a VFR pilot, you prefix the clearance with 'WHEN ESTABLISHED IN THE CIRCLING AREA, ...'; or

b) by day:
   i. the IFR pilot has reported 'VISUAL'; and
   ii. 'VISUAL' is appended to the level assigned.

- *MATS - Approving pilot terrain clearance*

ATC may permit an aircraft being vectored or given a direct routing in VMC by day to arrange its own terrain clearance, provided that the responsibility is specifically assigned to the pilot.

- *MATS -Terrain clearance and range scales*

ATC must ensure that aircraft are at an altitude which provides a minimum 1000 FT vertical clearance above any obstacle within a radius of:

a) 3 NM of the aircraft when the range scale is not greater than 50 NM; and
b) 5 NM of the aircraft when the range scale is greater than 50 NM.

The obstacle clearance requirements for the above clause do not apply:

a) when vectoring as part of an issued SID;
b) when conducting a visual departure;
c) in VMC by day only, when ATC assigns responsibility for arranging obstacle clearance specifically to the pilot; or
d) when conducting an ATS surveillance system cloud break procedure.

- *MATS - Vectoring - tower controllers*

ATC may permit self-navigation. Whenever possible, permit aircraft to self-navigate and achieve requirements by instruction based on visual and flight path monitoring. VMC by day only. ATC may provide an IFR or VFR aircraft with a vector in VMC by day to ensure separation or assist with traffic management, when necessary.

- *MATS- Considerations prior to vectoring*

Prior to vectoring an aircraft, ensure that the commitment to provide a vectoring service will not be detrimental to other responsibilities and requirements. Consider:

a) disposition of other aerodrome traffic;
b) current and expected traffic levels; and
c) the extent of the vector.

Minimum Vector Altitude (MVA)

19. The Minimum Vector Altitude (MVA) is defined in MATS as the lowest altitude a controller may assign to a pilot in accordance with a radar terrain clearance chart.

20. The term "Visual" is defined in MATS as a term used by ATC to instruct a pilot to see and avoid obstacles while conducting flight below the MVA.

21. If ATC issue a vector to an IFR aircraft conducting a missed approach (and the heading is not part of the published missed approach procedure) then the aircraft is no longer under the obstacle clearance protection provided in the design of the terminal instrument flight procedure. Consequently, in these circumstances, it should be incumbent upon ATC to instruct the pilot to maintain visual terrain clearance while below MVA.

22. CASA notes than many operators of large aircraft that conduct high capacity operations do not normally permit the crew to conduct visual circling approaches or visual manoeuvring below the instrument approach's circling altitude. However, it is not clear on what basis Airservices accepts this risk by instructing large aircraft to perform a visual manoeuvre at night below the MVA or circling altitude.

23. CASA is of the view that the ATM system should not rely, as a primary means of defence, on vectoring or heading changes for IFR category aircraft at night that are below the appropriate minimum altitude.

Visual separation by Tower Controllers

24. Separation of aircraft using visual observation by ATC is authorised in MATS. A number of constraints are imposed on ATC by MATS, relevantly:

(a) Only provide visual separation when the projected flight paths of the aircraft do not conflict,

(b) Allow for the applicable tracking tolerances on the projected flight path,

(c) When applying visual separation, consider: aircraft performance characteristics, particularly in relation to faster following aircraft and closure rates; position of the aircraft relative to each other; projected flight paths of the aircraft; possibility of an ACAS RA due to closer proximity of operation; known weather conditions; and the possibility of visual errors,

(d) In providing visual separation, primarily use azimuth,

(e) Only conduct visual separation by judgement of relative distance or height when there are wide margins, and there is no possibility of the aircraft being in close proximity.

Note: *Visual determination of the relative distance of aircraft in close proximity can be in error or affected by optical illusion;*

25. LAHSO procedures in MATS require, amongst other things, that ATC make allowance for missed approaches, relevantly:

(a) Where conditions exist that increase the likelihood of missed approaches, tower controllers must advise the [Terminal Control Unit] TCU. TCU will advise a heading or range of headings that may be used by tower, without further coordination, and

(b) In the event of a missed approach, or dual missed approaches, the tower is responsible for maintaining visual separation until such time as another separation standard may be applied.

Visual separation by Pilots

26. Separation of aircraft using visual observation by pilots is authorised in MATS. A number of constraints are imposed on ATC in instructing a pilot to maintain visual separation from another aircraft. MATS states the following:

> Before assigning responsibility for visual separation to a pilot, consider the following:
> - aircraft performance characteristics, particularly in relation to faster, following aircraft and closure rates,
> - position of the aircraft relative to each other,
> - projected flight paths of the aircraft,
> - possibility of an ACAS RA due to closer proximity of operation; and
> - known weather conditions.

27. MATS states the following regarding the limitations to a pilot's ability to maintain visual separation:

- the field of vision from the cockpit,
- the contrast of aircraft with the background against which it will appear
- glare of the sun; and
- restrictions on atmospheric visibility which may not be currently apparent to the pilot e.g. loss of forward visibility following descent into a haze layer.

Visual separation in LAHSO

28. The visual separation risk controls applied in LAHSO rely on ensuring the tactical ability of ATC to see affected aircraft and provide tracking instructions to help the pilots see and avoid each other, or on traffic advice to pilots to assist them to see and avoid each other. Such risk controls are in contrast to strategic safety solutions such as the systemic segregation of aircraft pairs at the runway intersection.

29. In recognition of the limitations on visual separation MATS defines a number of considerations, as shown above, in the application of visual separation by Tower controllers and between pilots.

30. During a LAHSO go-around with an avoidance component, as well as the known issues with high cockpit workload, restricted visibility from the flight deck and sudden changes of trajectory close to the ground, the night time case requires the crew to obtain/retain situational awareness and acquire conflicting traffic against a background of cockpit, aerodrome and city lights. Accurate and timely visual acquisition is an essential first step in a see and avoid solution.

31. CASA is of the view that the ATM system should not rely, as a primary means of defence, on visual separation to resolve a double go-around during LAHSO at night.

Visual separation - NTSB recommendation to FAA

32. On 1 July 2013, the National Transportation Safety Bureau of the USA, in a safety recommendation to the FAA (A-13-024), stated in part:

> As shown by the events described in this letter, although a particular set of runways does not intersect on the ground, the assumption cannot be made that potential conflicts will not occur in the vicinity of the airport. When the pilot of a landing aircraft executes a go-around maneuver, as in the examples provided, air traffic controllers may be left with no viable options to ensure that safe separation exists between the go-around aircraft and aircraft operating to or from converging runways. In these events, the ATC tower controllers attempted to use tower visual separation rules to ensure the aircraft did not collide at the point where the flightpaths intersected. ..."
>
> "Because of the nature of the geometry of the encounters and the unexpected nature of the go-arounds, it was not possible for the ATC tower controllers to issue effective control instructions to ensure that the airplanes avoided each other. Therefore, visual separation procedures could not be successfully applied or asserted as an adequate means of resolving the conflicts. The NTSB is concerned that in these events, ATC was not able to ensure the safe separation of aircraft. Instead, separation was established by resorting to impromptu evasive maneuvers by pilots during critical phases of flight. The NTSB concludes that the lack of specific separation standards, similar to those defined in paragraph 3-9-8 of FAA Order 7110.65, "Air Traffic Control," applicable to departing aircraft and aircraft conducting a go-around from non-intersecting runways where flightpaths intersect, facilitates hazardous conflicts and introduces unnecessary collision risk.

Therefore, the National Transportation Safety Board makes the following recommendation to the Federal Aviation Administration:

Amend Federal Aviation Administration Order 7110.65, "Air Traffic Control," to establish separation standards similar to the provisions of paragraph 3-9-8 between an arriving aircraft that goes around and any combination of arriving or departing aircraft operating on runways where flightpaths may intersect. (A-13-024)

Increases in go-around and traffic rates at Melbourne

33. Additional recent analysis in an Airservices report entitled *'Likelihood of Melbourne LAHSO go-arounds'* dated 4 August 2015 concluded that the base go-around rate has increased over a three year period from 2 per 1,000 arrivals to 4.4 per 1,000 arrivals. This report stated that two significant periods exist where that rate was 8 go-arounds per 1,000 arrivals.

34. According to Airservices statistics, the total annual movement numbers at Melbourne Airport have increased around 8% between 2012 and 2014. This increase in movement numbers coupled with the increased go-around rate means that ATC faces the increased likelihood of simultaneous go-arounds on crossing runways during LAHSO. This is of concern to CASA, and CASA notes that the most recent double go-around event in July 2015 occurred shortly after Airservices published the March 2015 Targeted Review of Melbourne LAHSO referred to in paragraph 12 above.

LAHSO compromised separation techniques at night

35. The Airservices internal Operational Safety Investigation Report (ATS-0137977) into the 5 July 2015 LAHSO double go-around incident highlights (Section 3.6) that the current compromised separation training for Melbourne Tower includes LAHSO exercises designed for Visual Meteorological Conditions (VMC) by day only. The LAHSO exercises do not contain night operations.

36. The Investigation Report goes on to highlight that VMC by day compromised separation training scenarios include recovery from a go-around by vectoring with visual terrain clearance assigned to the pilot. The training does not consider night time scenarios where visual terrain clearance cannot be assigned to the pilot.

37. The Incident Report offers, as one of the contributory factors to the incident, that:

> The trained response by a controller in vectoring aircraft to recover from a loss of separation in LAHSO did not consider the scenario where aircraft are below the MVA at night. It is likely that both the MLA trainee and the [On the Job Training Instructor] OJTI defaulted to this trained response in vectoring QFA819.

38. CASA notes that potentially similar circumstances exist at Adelaide Airport; Airservices Operational Safety Investigation Report ATS-036974 refers.

Managing the LAHSO risk

39. Airservices has provided information to CASA on how it is managing the risk resulting from LAHSO operations, as follows:

(a) Airservices have already introduced a number of changes to LAHSO operations including:

- removing any use of "ad hoc" LAHSO (LAHSO now needs to be on the ATIS and planned for),
- introducing crosswind limits for the passive LAHSO runway,
- cancelling LAHSO on RWY09/34,
- extending the Melbourne Tower Shift manager hours of coverage to cover all LAHSO periods, and
- updating the Melbourne Tower training package.

(b) Airservices are investigating a number of future actions relating to LAHSO including:

- introducing steps to reduce the likelihood that unexpected aircraft performance leads to a missed approach,
- creation of a stagger by introducing "Runway Dependency within MAESTRO" (a current strategic flow management tool in use);
- introducing a new procedure for pilot initiated "off-mode" departure requests;
- mandated use of Instrument Approach Procedures during LAHSO; and
- limiting the use of high capacity modes (such as LAHSO) to periods of high demand only (i.e. lower demand periods managed in non-LAHSO configuration.

40. CASA notes that most of these risk controls are either recently implemented or in the process of being implemented and awaits the validation of their effectiveness based on suitable data collection and analysis over an appropriate period of time. Beyond the updating of the Melbourne Tower training package mentioned above, CASA also notes the absence of specific or intended mitigations to the double go-around during LAHSO at night.

Airport related considerations

41. Airservices relies on LAHSO operations in Melbourne in order to achieve airport efficiencies. The landing rate is around 44 aircraft per hour when using 2 runways with LAHSO and drops to around 24 per hour using a single runway. However, Airservices have not provided the arrival rate for two runways as used in non LAHSO configurations which is expected to be significantly higher than the single runway rate.

42. **Power to issue directions**

43. Regulation 11.245(1) of the CASR relevantly states that CASA may issue a direction about any matter affecting the safe navigation and operation of aircraft. I consider that the recent go-around incidents at Melbourne Airport, affect the safe operation of aircraft.

44. Regulation 11.245(2) of the CASR states CASA may issue a direction:

(a) only if CASA is satisfied that it is necessary to do so in the interests of the safety of air navigation; and

(b) only if the direction is not inconsistent with the Act; and
(c) only for the purposes of CASA's functions.

45. Having regard to the matters set out in this notice, I consider that it is necessary to issue a direction in the interests of the safety of air navigation, namely a direction that would prohibit the Executive General Manager, Air Traffic Control Group permitting simultaneous landings during LAHSO operations at Melbourne Airport at night. CASA notes LAHSO simultaneous landing and departure are restricted to day time only (see MATS 10.9.5.9.7 and paragraph 10.13.5.8 of the MOS).

46. Such a direction would not be inconsistent with the Act and would be for the purpose of CASA's functions, namely the safety regulation of civil air operations in Australian territory, as expressed in section 9(1)(a) of the Act.

47. I am providing you 7 days from the date of this notice to provide reasons in writing as to why CASA should not make such a direction.

48. In the event I make the proposed direction, I would consider revoking it if:

(a) Airservices provides evidence to CASA that all ATCs endorsed for Melbourne Tower Aerodrome Control (ADC) have been assessed as competent in effective night-time compromised separation techniques which include the requirements associated with the Minimum Vectoring Altitude; and

(b) Airservices provides evidence to CASA of the outcomes of an SMS analysis of the discrete hazard "Double go-around during LAHSO at night"; and

(c) Airservices identifies and implements a systemic safety solution that provides appropriate separation or segregation between aircraft conducting simultaneous go-arounds from the crossing runways at Melbourne Airport during LAHSO. In this regard, CASA is aware of Airservices' efforts to design a system that provides alternative means of air traffic segregation between arriving aircraft during LAHSO (a 'stagger' at the runway intersection). It is likely CASA will consider appropriate implementation of such a system as an acceptable systemic safety solution.

49. However, in the event the ATSB makes safety recommendations arising from the 5 July 2015 incident, CASA would also consider requiring Airservices to implement any recommended safety actions raised by the ATSB.

Yours sincerely

[redacted]

Executive Manager
Airways and Aerodromes Division
Delegate of Civil Aviation Safety Authority

EF11/10239

INSTRUMENT NUMBER CASA XXX

I, Peter Beilby Cromarty, Executive Manager, Airspace and Aerodrome Regulation Division, a delegate of the Civil Aviation Safety Authority, issue this instrument under subregulation 11.245 (1) of the *Civil Aviation Safety Regulations 1998.*

Peter Cromarty
Executive Manager
Airspace and Aerodrome Regulation Division

XX November 2015

Direction – Prohibiting simultaneous landings during Land and Hold Short Operations (LAHSO) at Melbourne Airport at night.

1 Commencement

This instrument commences on XX November 2015.

2 Application

This Direction applies to the Executive General Manager, Air Traffic Control Group, Airservices Australia.

3 Direction

The Executive General Manager, Air Traffic Control Group, Airservices Australia must ensure that no simultaneous landings during Land and Hold Short Operations are conducted at Melbourne Airport at night.

4 Expiry

Unless varied, suspended, revoked or cancelled this Instrument remains in effect until XX November 2017.

Compromised Separation Procedures during LAHSO at night for Melbourne Airport
Safety Case Assessment and Reporting Determination (SCARD)
Issue 1.0

NOTE: Due to compatibility issues with the new Standard Operating Environment (SOE), this version of the SCARD template will not automatically calculate the SCARD outcome, guidance has been included to allow the outcome to be manually determined.

Context

As specified by Operational Safety Change Management Requirements (AA-NOS-SAF-0104): A SCARD must be completed for changes to service levels, procedures or equipment that may affect the performance, functional or technical specification of a system or service; and organisational changes affecting safety accountabilities.

The SCARD template is designed to assist users to evaluate the change proposal, in order to determine what type of operational safety assessment and reporting is required.

Step 1: Change Details

Reference Number (Change Proposal/Project Proposal/ Project Number/NRFC/ASID)	ATC/0066.01.01.05	**Services/Systems/ Assets under change**	LAHSO Night time Compromised Separation

Change Description

Scope of Change
In the event that separation may be compromised, during night time LAHSO operations, a procedural change is proposed that would allow the Melbourne Tower Aerodome Controller (ADC) to issue a vector to an aircraft that is conducting a missed approach. This procedure is currently available during day time operations for LAHSO.

This proposed procedural change would allow controllers to do the same at night in order to provide additional assurance during the conduct of LAHSO during night time operations.

Note:
- The scope of this change requires an instrument from CASA to allow exemption from MOS 172, Section 12.1.4.1.
- This exemption would permit ATC to provide a vector resolution in the event of a double go-around during LAHSO operations at night, at Melbourne aerodrome only. This procedure is designed to reduce the risks associated with a double go-around where the aircraft may be in critical proximity. The risk of aircraft in critical proximity is approximately 1 in every 14 years (for day / night) and the risk of a collision or near collision is approximately 1 in every 6000 years. Refer to 'Analysis of Melbourne LAHSO go-arounds' report.

See further minutes captured as part of this workshop in Step 8 of this SCARD.

Step 2: SCARD Participants

List the persons participating in the completion of this determination:

Adequate representation from all appropriate areas of the business involved in or potentially affected by the change must be present during completion of the SCARD, for example (but not limited to):

- ATC operational representatives, System Supervisors, Operational Authorities, etc
- ARFF operational representatives, Station Command representatives, etc
- Engineering planning, design and integration representatives, maintenance and system operations representatives, software/hardware/data/infrastructure specialists, Technical and Maintenance Authorities and Chief Engineers, etc
- Training design and delivery representatives,
- Other applicable system owners.

This representation should also include subject matter expertise from any specialist safety disciplines relevant to the change, for example (but not limited to):

- System Safety, Human Factors and regulatory compliance representatives.

Changes potentially impacting external stakeholders must also include representation from these stakeholders as appropriate, for example (but not limited to):

- Airline representatives
- Airport representatives
- Regulatory representatives
- Vendor/Contractor representatives

NOTE: The SCARD may be rejected by the signatories in Step 9 if adequate representation is

Parathion may be comnot included. If guidance is required on appropriate attendees, contact FG SEA ASSURANCE

Name	Position	Date
[redacted]	ATC Line Manager – ML TCU	04/02/2016
[redacted]	ATC Business Coordinator – ATC	04/02/2016
[redacted]	ATS Instructor (TWR/TMA) – Learning Academy	04/02/2016
[redacted]	Senior ATS Specialist – CATC Office	04/02/2016
[redacted]	QF B737 Instructor / Flight Training Coordinator	04/02/2016
[redacted]	QF B737 Training First Officer	04/02/2016
[redacted]	B717 Training Captain	04/02/2016
[redacted]	ATC – ML Tower	04/02/2016
[redacted]	ATC – ML Tower	04/02/2016
[redacted]	ATC Line Manager – ML Tower	04/02/2016
[redacted]	Senior Project Safety Specialist	04/02/2016
[redacted]	Senior Human Factors Specialist	04/02/2016
[redacted]	Melbourne Project & Business Support Manager	Desktop Review

Step 3: Size of the Change

Complete the following questions to determine the size of the change. For each question, choose a rating from 1 (Low) to 7 (High); and provide justification. Then use the ratings to determine the overall size of the change

1	**Assess the significance of the change within Airservices.** *Consider the work areas affected. Consider the effects on P&E (Engineering disciplines, systems, locations), ATC (Service Delivery Lines, Enroute/TMA/Tower) and ARFF (stations, equipment, service).*	**Initial Rating** 2
Justification: This change is limited to ML Tower and ML TMA controllers; and only during LAHSO at night. There will be a limited range of pre-determined headings that air traffic controllers can issue to an aircraft conducting a missed approach.		

2	**Assess the significance of the change outside Airservices.** *Consider the number and extent of service users and/or stakeholders affected, including the interfaces between these parties.*	**Initial Rating** 3
Justification: Affects only those airlines that participate in LAHSO operations, i.e. Domestic airlines and Air New Zealand. Communicate to airlines the relevant changes in separation phaseology required. Also consult with airlines in terms of the education required for pilots. Seek instrument exemption from CASA.		

3	**Assess the operational impact of the change on the systems, service and users (i.e. operators, maintainers, etc).** *Does the change:* o *enhance existing system functionality, provide different/new/novel functionality, or remove functionality;* o *alter the services provided;* o *affect the users' roles including their required skills and abilities, HMI interaction, work environments, systems and procedures of work, responsibilities, organisation and staffing or teams and communication?*	**Initial Rating** 2	**Weighted Rating** = Initial Rating x 2 4
Justification: The change is within the current skill set of controllers. Currently controllers are able to provide a heading according to the published missed approach procedures during the day for LAHSO. The same procedure would be introduced for LAHSO at night.			

4	**Assess the technical impact of the change on the operating system(s).** *Does the change:* o *affect single or multiple systems (e.g. NAIPS/Eurocat/AFTN/MEX/ORS etc.);* o *affect operational or non-operational systems* o *introduce new, or reconfigure, hardware or software affecting operational capability and/or performance* o *affect system interfaces* o *affect redundancy, maintainability, integrity, etc* o *affect operational or business data and/or databases?*	**Initial Rating** 1	**Weighted Rating** = Initial Rating x 2 2
Justification: Nil			

5	**How complex is the implementation of and transition to the new or changed system or service?** *Consider:* o *temporary removal of a system, ghosting/mimicking, operational test and evaluation, control and monitoring, rollback/fallback required, etc* o *resources available, training, documentation, procedures, communication, time lines, approvals, etc*	**Initial Rating** 3	**Weighted Rating** = Initial Rating x 2 6
Justification: The transition is not considered complex, but training and education will need to be provided to controllers and consultation with Airlines regarding their education requirments that need to be completed prior to implementation. The Instrument Flight Procedure Team will need to complete an Obstacle Clearance Analysis for Melbourne Airport circling area.			

6	**How substantial is the education and training associated with the change?** *Consider type of training required and for whom, none, classroom, online or simulation, time line for design/development and roll-out, duration, resources for design/development and delivery, impact on operational resources, currency, recency and licensing requirements, ongoing/refresher requirements, etc.*	**Initial Rating** **3**

Justification:

Design and delivery of compromised separation training for all Melbourne tower controllers, which includes nightime LAHSO compromised separation training and compomised sepation by day and by night training.

Provide information for airline stakeholders who will decide how they will deliver their education programs. For example may include LAHSO compomised separation training as part of their cyclical simulation training, if required.

AIC or AIP to be developed to reflect any changes required to separation phaseology.

Total	**20**

Resultant size of the change (Small* - 9 to 25, Medium - 26 to 44, Large - 45 to 63) *** If any single <u>initial</u> rating is greater than 4, a result of Small must be increased to a result of Medium**	**Small**

Step 4: Operational Safety Impact of the Change

To assess the operational safety impact of the change, conduct an initial hazard identification to determine the potential operational safety hazards that may result from the change and complete the table below. Giving consideration to the number and severity of the potential hazards as well as the criticality of the impacted systems where listed on the System to Service List, complete the safety impact estimations shown below. For assistance completing this identification, refer to AA-GUIDE-SAF-0105C, or contact Safety & Environment Project & Business Support.

Note: *This process must only be used for the determination of the Operational Safety Impact. All Hazards identified through this process that require control and ongoing management, or further assessment must be recorded in HAZLOG and managed in accordance with AA-PROC-SAF-0105.*

Service/System	System Criticality	Potential Hazards	Controls		Effect on	
			Existing	Proposed	Airservices' Operations	Aircraft / Aircrew / 3rd Parties
LAHSO at Night		Aircraft issued a heading that conflicts with Terrain / Aircraft	Ground proximity warning system (GPWS) Tower Visual/Surveillance Monitoring (limited to below 2400ft – MVA) TCAS re-arms at 1000ft above ground level (AGL) Compromised Separation refresher training completed every < 3 years	Obstacle clearance analysis for ML airport circling area Available headings will de-conflict with both aircraft and terrain LAHSO compromised separation training for day and night operations Education in new procedure for Aircrew (e.g. AIC)	Increased workload for ATC (including TMA) to manage airspace	Decrease in safety margins
LAHSO at Night		Controller issues heading outside agreed area. Examples include: - Controller error, or - Intentionally due to following arrivals *This is already considered an existing hazard as it has more to do with a controller required to break from the rule set and doing whatever it takes to keep aircraft from collision or near collision. Currently controllers can issue a heading outside of agreed area if absolutely necessary.*	Ground proximity warning system (GPWS)	LAHSO compromised separation training for day and night operations	Increased workload for ATC (including TMA) to manage airspace	Aircraft in closer proximity of conflicting aircraft / terrain

Service/System	System Criticality	Potential Hazards	Controls		Effect on	
			Existing	Proposed	Airservices' Operations	Aircraft / Aircrew / 3rd Parties
LAHSO at Night		Procedure not followed due to: - Pilot not taking heading provided by controller, or - Controller / pilot unfamiliar with procedure	None – headings are currently not provided for night time operations.	LAHSO compromised separation training for day and night operations Education in new procedure for Aircrew (e.g. AIC)	Increased workload for ATC (including TMA) to manage airspace	Aircraft in closer proximity of conflicting aircraft
LAHSO at Night		As pilot responds to TCAS they don't obey ATC heading instructions *The likely scenario is that a heading will most likely be provided by ATC prior to TCAS re-arming.*	TCAS re-arms at 1000ft above ground level (AGL)	Consultation with Airlines (inclusive of AIP/AIC as required). Education completed by Aircrew (Note: procedure would be somewhat similar to the PRM breakout procedures for SY Airport)	Increased workload for ATC (including TMA) to manage airspace. Effectiveness of compromised separation recovery reduced.	Aircraft in closer proximity of conflicting aircraft

NOTES: 1) For newly developed systems, a System Criticality will need to be determined. The SCARD process will help inform this determination.
2) If any significant effect on external parties are identified, this assessment must be confirmed by the affected parties and must trigger their involvement in the ongoing management and control of the risk.
3) If any aspects of the change uncovered in this step were not considered in Step 3, the step should be re-validated.

1. Based on the identified Operational Safety hazards; Enter the estimated Operational Safety Impact of the change.	**Reasonable**	If unsure, the higher of the considered options should be chosen
2a. Are any of the identified Hazards Human Factors related or do they impact human performance?	**Yes**	If yes, please seek Human Factors support via PBSresourcing@airservicesaustralia.com
2b. Are any of the identified Hazards Software related?	**No**	If yes, please seek software assurance support via - PBSresourcing@airservicesaustralia.com (for projects) - _FG_PE_ENG_OPS (for other changes)

Step 5: Regulatory Impact

If unsure in the completion of this step, contact Operational Assurance & Regulatory Services (OARS) for assistance.

5.1 - Does the proposed change require an amendment to a Provider Certificate schedule (including exemptions and instruments)?

e.g. Introduce a new service, or change to an existing service under;

- CASR Part 139H (Aerodrome Rescue and Fire-Fighting Services)
- CASR Part 143 (Air Traffic Services Training)
- CASR Part 171 (Aeronautical Telecommunication and Radionavigation Services)
- CASR Part 172 (Air Traffic Services Provider) or
- CASR Part 173 (Instrument Flight Procedure Design).

NOTE: This includes 171 Operations Manual defined Level 1 Changes (i.e. a new ICAO defined service or a new type of airways system, or the removal of an ICAO defined service or a type of airways system.)

Yes ☒	A Safety Case is required. Use the link below to notify OARS of the requirement to prepare a Safety Case. **Continue onto Step 6**
No ☐	**Continue onto Question 5.2**

5.2 - Does the proposed change otherwise require approval from CASA?

e.g. Commissioning of new ATS facilities pursuant to CASR Part 172; changes to Airservices' Operations Manuals related to changes to the services under the CASR Parts listed above; or commissioning of new ARFFS vehicles or facilities pursuant to CASR Part 139H.

Yes ☒	A Safety Case or Safety Assessment Report may be required. Use the link below to contact OARS to discuss the change's safety reporting requirements. **Continue onto Step 6**
No ☐	**Continue onto Question 5.3**

To notify Operational Assurance & Regulatory Services (OARS) of the requirement for a Safety Case, or to discuss the change's safety reporting requirements, contact:
casa_compliance@airservicesaustralia.com

5.3 - Does the proposed change require notification to CASA prior to commissioning / notification to industry?

NOTE: This includes 171 Operations Manual defined Level 2 Changes (i.e. where a facility noticeable to the user is being decommissioned or where there is a significant reduction to the level of service). Refer to paragraph 3.2.1.4 of the CASR Part 171 MOS and paragraph 6.1.2.4 of the CASR Part 172 MOS regarding the regulatory requirements for a safety case.

Yes ☐	A Safety Case or Safety Assessment Report may be required. Use the link below to contact OARS to discuss the change's safety reporting requirements. **Continue onto Step 6**

No ☒	**Continue onto Step 6**

To contact Operational Assurance & Regulatory Services (OARS) to discuss the change's safety reporting requirements contact:
casa_compliance@airservicesaustralia.com

Step 6: Overall Operational Safety Magnitude

The Overall Operational Safety Magnitude is determined through a combination of the size of the change **and** its operational safety impact. Apply the results obtained from Steps 3 and 4 to the matrix below to determine the Overall Operational Safety Magnitude.

Overall Operational Safety Magnitude	**Operational Safety Impact**		
Size of the change	**Substantial**	**Reasonable**	**Minimal**
Large	☐ **Major**	☐ **Major**	☐ **Moderate**
Medium	☐ **Major**	☐ **Moderate**	☐ **Minor**
Small	☐ **Moderate**	☒ **Minor**	☐ **Minor**

Step 7: Operational Safety Reporting Requirements

Apply the results from Step 5 **or** Step 6 to the matrix below to determine the Operational Safety Reporting Requirements.

Note that a Step 5 requirement for a Safety Case or Safety Assessment Report overrides any lesser outcome from Step 6.

Outcome[1]	**To be reported as ...**	**Required Actions**
☒ **5.1 Response YES**	**Safety Case**	1. Establish Safety Program Working Group 2. Prepare Safety Plan 3. Execute Safety Program 4. Prepare Safety Case(s) (Indicate phasing below) ☐ Concept/Design & Impl. Phases ☒ All Phases
☒ **5.2 Response YES**	**Contact OARS to determine safety reporting and CASA notification or approval requirement.** **Discussion Outcome:** An exemption or request to vary a standard under CASR Part 172 requires the support of a safety case, as the proposed change will require CASA approval. This is also consistent with Step 5.2 of the SCARD. Refer to email: HO_CB0-3043534.	
☐ **5.3 Response YES**		
☐ **Major**		
☐ **Moderate**	**Safety Assessment Report**	1. Establish Safety Program Working Group 2. Prepare Safety Plan 3. Execute Safety Program 4. Prepare Safety Assessment Report(s) (Indicate phasing below) ☐ Concept/Design & Impl. Phases ☐ All Phases
☐ **Minor**	**Safety Statement**	1. Determine whether this SCARD is sufficient to constitute the Safety Statement and indicate below (see AA-NOS-SAF-0104 Section 4.3) 2. Execute Safety Program, as required 3. Prepare Safety Statement, if required 4. Attach SCARD or Safety Statement to RFC or change process ☐ SCARD Only ☐ Additional Safety Statement

[1] A manager with accountability for the change, or the EGM, SE&A, may impose a higher safety reporting requirement.

Step 8: Additional Information

The following points were raised during discussions, however had no bearing on the outcome of the SCARD. They have been recorded here as a way of capturing additional minutes:

• It was noted that International Aircraft (i.e. Non-LAHSO aircraft) could potentially be included in a LAHSO pair by error by approach controllers. In this scenario, the relevant aircrew may not be familiar with an exemption to vector below LSALT at night or not respond to ATC instructions. The workshop participants acknowledged that this scenario was no different to if it occurred during day time LAHSO operations and that tower controllers would be expected to manage the situation in the same way. It was therefore not considered an additional hazard as a result of making this procedural change. The following was therefore noted:

a) Non-LAHSO aircraft would be instructed to Go-Around as soon as the error was identified, which would be no different to if it occurred during day time LAHSO operations
b) International airlines would still receive relevant AIC/AIP publications, and
c) The airlines raised that there may be the option to potentially include in the ML Airport Approach plates additional reference regarding the exemption. This is to be considered further as to whether it is actually required.

• Some assumptions have been made about aircraft manoeuvrability capabilities. These will need to be confirmed in conjunction with the proposed headings and obstacle clearance analysis that is currently being completed. It was noted that when responding to ATC instructions to vector following a go around; the aircraft will typically be required to first establish a positive rate of climb, before executing any heading change. This will likely already be achieved as the aircrew will be initiating the go around and already engaging the associated climb/go-around procedures (e.g., TOGA switch).

• Additional questions were discussed regarding whether the relevant procedures will be manually flown by aircrew or executed via automatics. It was noted that this should be determined by the airlines based on what is the most suitable solution for specific aircraft/aircrew.

• TCAS alerts are quite loud and may impact aircrew's ability to hear/respond to ATC instructions. It was acknowledged that any TCAS alert will most likely not activate until well after ATC instructions have been issued (i.e. TCAS is inhibited below 1000 feet; will not activate until proximity to other aircraft infringed). As noted above, Aircrew will first aim to establish a positive rate of climb before executing any heading change.

• Consultation with Airlines suggests that the procedural change does not represent a considerable change and will not likely involve any additional formal training activities apart from education.

• It was raised whether there was any potential or even advantage to adding additional system tools, such as distance to threshold in the electronic flight strip, that may assist tower controllers when determining which aircraft to issue vector instructions to first (i.e. which aircraft is first). It was noted that further advice would be required from INTAS authorities as to what would be required to add such a change (i.e. a potential configuration change). It should be noted that this additional system tool would not be the only tool to be used in determing vectoring instructions and that controllers use a range of tools available to them now in the tower when assessing for such situations. It should be noted that this is not a requirement for day operations.

• The potential to increase the frequency of Compromised Separation Refresher training (as well as the LAHSO Specific at Night Comp Sep training) was discussed. It was suggested that any change to the frequency of this training should be managed by the ML Tower Unit.

• It was recognised that the proposed procedures are similar to those currently utilised in PRM Breakout procedures at SY Airport. It was acknowledged that relevant procedures and descriptions for ML Airport should be consistent with those used during PRM; however, that the relevant phraseology should be unique to the ML Airport scenario (i.e. "Avoiding Action" - See guidelines on a TRUCT response).

In preparation for the Safety Plan the following Safety Management Activities were identified, with most of them having already commenced:

1. Develop night time LAHSO compromised separation simulated exercise (SIMEX).
This has been completed.

2. ATC tower operators to complete Compromised Separation Refresher Training (to complete SIMEX training not classroom).
This has been developed with controllers currently undertaking the refresher training and training to be completed by the end of February 2016.

3. Obstacle clearance analysis for ML airport circling area.
This analysis is currently underway by the Airservices Operational Analysis Team.

4. Consultation with Airlines.
This is currently underway and being led by [redacted]

5. Airlines to determine relevant education requirements to accommodate updated procedures.
This will be undertaken through correspondence between Airservices and LAHSO Airlines. AIP/AIC to be developed by Airservices and communicated with the Airlines.

6. Aircrew to complete relevant education regarding updated procedures.
Airlines to provide feedback/evidence to Airservices as to how this is being managed and implemented.

Step 9: Approval

Note that a completed SCARD, once approved below, remains valid for 12 months from the date of its approval on the basis that the change detailed in Step 1 remains as-is in that period. If either a change in scope occurs or the SCARD expires after 12 months, the assessment made herein must be revalidated through either re-assessing and re-approving the SCARD, at a minimum, or completing and approving a new SCARD.

PREPARED BY	PROPOSED BY
[redacted] Senior Project Safety Specialist	[redacted] ATC Business Coordinator

The level at which this SCARD can be approved is determined by its Overall Operational Safety Magnitude from Step 6 as shown in the table below, however a higher level of approval can be sought if deemed appropriate. Where the change impacts multiple systems, services or business areas, approval from all relevant authorities, or a higher authority, must be sought.

Major	Branch Manager, Service Delivery Line Manager, Chief Fire Officer, Chief Information Officer
Moderate	Chief Engineer, Chief Technology Officer, Chief OA, Chief UA, ATC Line Manager, ARFF Regional Manager, Other Unit Manager
Minor	TA/MA, OA, UA, ATC Line Manager, ARFF Station Manager, Other Unit Manager

APPROVED BY	SIGNATURE	DATE
[redacted] Chief Air Traffic Controller	[redacted]	Digitally signed by [redacted] DN: cn=[redacted] o=Airservices, ou=Chief Air Traffic Controller, email=[redacted]irservicesaustralia.com, c=AU Date: 2016.02.14 09:04:45 +11'00'

By approving this SCARD you acknowledge that:

- You are satisfied that the SCARD process has been completed correctly
- Regarding your area of authority or accountability, appropriately experienced and/or qualified staff participated in the process
- Sufficient and valid information has been included to justify the outcome
- This SCARD has been approved within 30 calendar days of its completion.

Step 10: SCARD Record Management

A copy of the approved SCARD must be sent to Operational Assurance & Regulatory Services and Safety & Environment Project & Business Support at _FG_SEA_ASSURANCE. Operational Assurance & Regulatory Services will contact the proponent of the change if there are any outstanding regulatory issues with the completion of the SCARD.

The original signed copy of the approved SCARD must be stored in an organisationally approved document repository by the proponent of the change.

Project: Compromised Separation Procedures during LAHSO at night, at ML Airport

Workshop: Safety Case Assessment Reporting Determination (SCARD)

Venue: Wilson Room (1.44) Level 1 Building 330, Melbourne Complex

Facilitator: [redacted]

Date: 4th February 2016

Name	Position / Role	Relevant experience	Signature
[redacted]	ML TWR ATC	15 years TOWER	[redacted]
[redacted]	ATC INSTRUCTOR (FORMERLY ML TOWER)	25 years ATC	[redacted]
[redacted]	ATC LINE MANAGER ML TOWER	24 YEARS ATC	[redacted]
[redacted]	SENIOR ATS NTS Integrity SPECIALIST	35 Y'S ATC	[redacted]
[redacted]	BUSINESS COORD, ECSS	34 YRS ATC	[redacted]
[redacted]	HF SPECIALIST	10+ YEARS	[redacted]
[redacted]	B717 TRAINING CAPTAIN	15+ YEARS	[redacted]
[redacted]	B737 INSTRUCTOR QF	10+ years	[redacted]
[redacted]	QF B737 TRAINING FIRST OFFICER	15+ YEARS	[redacted]

Name	Position / Role	Relevant experience	Signature
[redacted]	ALM ML TCU	ATC 28 yrs	[redacted]
[redacted]	ALM ML TCU	ATC 17 yrs	[redacted]
[redacted]	SENIOR PROJECT SAFETY SPECIALIST	$5\frac{1}{2}$ Years Airservices	[redacted]

From: [redacted]
To: [redacted]
Cc: [redacted]
Subject: LAHSO - ADC Training [SEC=UNCLASSIFIED]
Date: Thursday, 24 March 2016 11:12:02 AM

Dear [redacted]

Training for the night compromised separation training has been completed by all qualified ADC at Melbourne. The course number is R-OP-112-S(V5). The training completion paperwork has been appropriately filed, however it has not yet been entered into SAP.

CASA audited the training files this week and noted that all the required training had been completed and correctly recorded

Regards

[redacted]

[redacted]

[redacted]

From: [redacted] (ATC Group)
Sent: Monday, 29 February 2016 5:48 PM
To: [redacted]
Cc: [redacted]
Subject: Airline participation in LAHSO [SEC=UNCLASSIFIED]

[redacted]

The following airline personnel have been involved in a review of the LAHSO comp sep procedure and safety work.

25 Nov 15 (LAHSO briefing, Melbourne ACE meeting)
[redacted] (Flying Operations Development Manager, Jetstar)
[redacted] (Jetstar)
[redacted] (Qantas)

14 Jan 2016 (LAHSO briefing and Sim Visit)
[redacted] (Chief Pilot Domestic, Virgin)
[redacted] (Virgin)
[redacted] (B737, TRE, Qantas)
[redacted] (B737 Instructor, Qantas)
[redacted] (Chief Pilot, Express Freighters)
[redacted] (Express Freighters)
[redacted] (Express Freighters)

19 Jan 2016 (LAHSO briefing and Sim Visit)
[redacted] (Senior Base Pilot, Qanatslink)

4 Feb 2016 (SCARD participation and Sim Visit)
[redacted] (B737 Instructor Qantas)
[redacted] (Qantas)
[redacted] (Cobham)

12 Feb 16 (LAHSO briefing via telephone)
[redacted] (Deputy Chief Pilot Tigerair)

17 Feb 2016 (LAHSO briefing and Sim Visit)
[redacted] (Flight Operation Manager, Regional Express)
[redacted] (Manager Training and Checking, Regional Express)
[redacted] (Regional Express)

22 Feb 2016 (LAHSO briefing and Sim Visit)
[redacted] (Air New Zealand)

24 Feb 2016 (LAHSO briefing and Sim Visit)
[redacted] (Jetstar)
[redacted] (Flying Operations Development Manager, Jetstar)

Regards

[redacted]
Business Coordinator
East Coast Services South
[redacted]

MEETING MINUTES

Meeting: LAHSO: Compromised Separation - Qantas 737 Simulation

Date: 11/02/16

Time: 07:00 – 12:00

Attendees:

Name	Position
[redacted]	Air Traffic Controller – Melbourne Tower
[redacted]	Air Traffic Controller – Melbourne Tower
[redacted]	Learning Academy Instructor (former Melbourne Tower)
[redacted]	Human Factors Specialist – Safety Group
[redacted]	B737 Instructor (Qantas)
[redacted]	B737 Instructor (Qantas)

Purpose: To facilitate an increased understanding of the cockpit environment; and in particular aircrew operations during LAHSO and in the event of a go around or missed approach.

Minutes: Airservices ATC Tower controllers, Training Specialists, and Human Factors specialists reviewed a series of operations in the Qantas B737 simulator at Airport West.

Activities completed in the B737 Simulator included:

- ML Approaches: Approaches were demonstrated on both Runway 34 and 27 during day, dusk and, night conditions.

- LAHSO Approaches (Note – ability to simulate additional aircraft in the B737 simulator is limited; however, Qantas instructors/pilots provided a detailed commentary regarding how LAHSO differed from normal operations during a ML approach (approaches were demonstrated on both Runway 34 and 27 during day, dusk and, night conditions).

- Demonstration of Go-Arounds/Missed Approaches: A series of Go-Arounds and Missed approaches were demonstrated from various positions Go-Around altitudes. Qantas instructors demonstrated how the proposed ATC vectors would be implemented by aircrew in the cockpit as well as the aircraft's response capabilities (e.g., climb rates, use of automatics, TCAS functionality etc.).

Outcomes: In conducting the activities in the B737 Simulator, both Airservices and Qantas staff discussed the proposed procedures outlined in the SCARD workshop held on 4/2/16 and indicated that they would be effective and represented a safe procedure should avoiding action need to be taken (i.e. in the event of a double go around occur during LAHSO).

Attendees also noted that the additional exposure and improved understanding of cockpit/ATC environments provided a significant benefit; with future similar activities at both Qantas and Airservices to be coordinated as required. Airservices will also look to incorporate this improved understanding of the cockpit environment into future training programs completed by ATC; particularly in regard to Compromised Separation and the execution of Go-Arounds or Missed Approaches.

TELEPHONE:
1300-306-630
(local call - Aust wide, except from mobile phone)
FAX: 02 6268 5111

AUSTRALIA
AERONAUTICAL INFORMATION SERVICE
AIRSERVICES AUSTRALIA
GPO BOX 367
CANBERRA ACT 2601

AIP SUPPLEMENT (SUP)

H36/16

E-mail: AIM.Editorial@airservicesaustralia.com

DATE: 2 April 16

LAND AND HOLD SHORT OPERATIONS (LAHSO)

1. INTRODUCTION

1.1 This SUP replaces SUP H92/15 with additional information added as indicated by change marks.

1.2 Airservices has conducted a review of LAHSO as part of ongoing safety management activities to ensure the procedure is being applied to the ALARP principle.

1.3 Findings were collated and some amendments to the procedure have been implemented. These changes are largely transparent to industry and include clarification of the passive runway nomination process which are reflected by changes to AIP ENR.

1.4 Airservices has also continued work on refining procedures for LAHSO in Melbourne to be able to recommence LAHSO by night post daylight saving on April 3rd 2016.

1.5 This work has included Airservices Instrument Flight Procedures Section reviewing the obstacle clearance requirements 50 degrees right of runway 34 and left of runway 27 at Melbourne where aircraft may be vectored during a go around.

1.6 This review identified that there was no impediment to ATC assigning headings in these sectors by night even when aircraft were below the minimum vectoring altitude.

1.7 Melbourne ATC have developed procedures to be able to advise aircraft, requiring to go around a heading from the latest go around altitude, usually 400ft.

1.8 This revised procedure will only be used where ATC, or the pilot in command, consider this to be the safest resolution of a go around or double go around during LAHSO.

2. AMENDMENT FOR AIP

2.1 Amendment required for the AIP:

GEN 2.2 DEFINITION AND ABBREVIATIONS

Some paragraphs included that do not change to show the flow of entries.

Active LAHSO Runway: The runway used during LAHSO for arriving aircraft issued with a hold short instruction.

Airborne Collision Avoidance System (ACAS): An aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground--based equipment to provide advice to the pilot on potential conflicting aircraft that are equipped with SSR transponders.

Parking Area: A specially prepared or selected part of an aerodrome within which aircraft may be parked.

Passive LAHSO Runway: The runway used during LAHSO for arriving and departing aircraft that have the full length available.

GEN 3.4

5.14.9 Arrival at Aerodrome

Circumstances	*Phraseologies*
7. When Landing Approved and LAHSO Are in Use	* Denotes pilot transmission •a. (*aircraft type*) DEPARTING (*or* LANDING) ON CROSSING RUN-WAY, HOLD SHORT RUNWAY (number) CLEARED TO LAND RUNWAY (*number*)
required readback	•b.* HOLD SHORT RUNWAY (*number*) CLEARED TO LAND RUNWAY (*number*)
When the full length of the landing runway subsequently becomes available	c. FULL RUNWAY LENGTH NOW AVAILABLE *Note: The 'hold short' lights will re-main illuminated even though the full length of the runway is*

Circumstances	*Phraseologies*
	available.
Where an aircraft operating on a flight number callsign cannot participate in LAHSO	d. *NEGATIVE (ACTIVE AND/OR PASSIVE) LAHSO e. (callsign) NEGATIVE (ACTIVE AND/OR PASSIVE) LAHSO

ENR 1.1

LAND AND HOLD SHORT OPERATIONS (LAHSO)

33. CONDITIONS FOR LAHSO

33.1 LAHSO may be conducted subject to the following conditions:

a. The wind for either the active or passive runway, including gusts, does not exceed:

(i) 20KT crosswind;

(ii) 5KT downwind on a dry runway; or

(iii) no downwind when the runway is not dry.

b. A simultaneous take-off and landing is permitted by day only.

c. Simultaneous landings are permitted by day and night.

d. The ceiling is not less than the minimum vectoring altitude (MVA) for the location where LAHSO are being conducted and visibility is not less than 8KM.

e. Visibility may be reduced to 5000M where ATC are assured of sighting the aircraft prior to a loss of the surveillance standard.

f. Advice to the departing aircraft may be given separately from the take-off clearance.

g. Instructions are issued to prevent a landing aircraft from crossing the Hold-Short Line when the intersecting runway is being used by another aircraft.

h. The distance from the landing threshold to the Hold-Short Line of the intersecting runway is adequate for the performance category of the aircraft being held short.

i. ERSA Aerodromes and Facilities (FAC) and/or Runway Distance Supplement (RDS) show "LDA for LAHSO" information. Pilots must ensure that the aeroplane can land safely within the LDA for LAHSO.

j. When the runway conditions are damp or wet, the braking characteristics must be assessed as GOOD by the captain of an aircraft in the same performance category prior to the landing aircraft being instructed to hold short. ATC will request pilot assessments of the braking characteristics hourly where weather conditions are deteriorating or remain unchanged.

k. The landing aircraft will not be instructed to hold short when low level wind shear ~~of intensity greater than light~~ is reported.

l. For active participants ground based visual or electronic glide slope guidance must be available and utilised.

m. After landing, the pilot must inform ATC immediately of any difficulty in complying with the ATC requirement to hold short of a crossing runway strip.

Note to l.) above: This requirement does not apply to performance category A and B non jet aircraft of less than 5700KG MTOW landing Runway 36 at Darwin.

34. PILOT ADVICE OF LAHSO APPROVAL

34.1 ATC will not intentionally issue, and a pilot must not accept, a clearance for a hold-short landing unless the pilot is LAHSO approved. Pilots who, at the time, expect and elect to participate actively in LAHSO must obtain the ATIS broadcast as early as possible and if within 200NM of destination, and if LAHSO is in progress, immediately confirm ability to participate by advising "LAHSO APPROVED" to the ATS unit currently providing services; eg, "MELBOURNE CENTRE, (call-sign) DESCENDING TO FLIGHT LEVEL TWO FIVE ZERO, LAHSO APPROVED."

34.2 Pilots of civil aircraft operating under a FNC as advised in flight notification, and pilots of Australian military aircraft, may omit the words "LAHSO APPROVED". Aircraft of operators who have advised in writing an intention not to participate will not be intentionally sequenced for LAHSO. Where an aircraft or crew that would normally participate actively or passively in LAHSO does not meet the criteria for participation this must be communicated to ATS at the earliest opportunity.

e.g. "MELBOURNE CENTRE, (callsign) NEGATIVE [ACTIVE AND/OR PASSIVE] LAHSO"

34.3 Pilots of aircraft (not operating a FNC flight) who expect and elect to actively participate in LAHSO and are obtaining terminal information and entering controlled airspace within 120NM of destination must advise the ATS unit with whom clearance request is made "LAHSO APPROVED";

e.g. "ADELAIDE CENTRE, (call sign), NINE ZERO DME ADELAIDE, RECEIVED (ATIS), MAINTAINING ONE ZERO THOUSAND, REQUEST CLEARANCE, LAHSO APPROVED."

34.4 When crews experience wind shear, early advice to ATC is essential to ensure timely information is passed to subsequent aircraft.

35. ATIS BROADCAST

35.1 Pilots will be alerted that LAHSO are in progress by a statement on the ATIS:

e.g. "DARWIN TERMINAL INFORMATION BRAVO, RUNWAYS 29 AND 36, LAND AND HOLD SHORT OPERATIONS IN PROGRESS, (wind, temperature, etc)"

35.2 Both the active and passive runways will be nominated on the ATIS to aid in crew situational awareness.

Note: The acronym LAHSO may be used at ATC discretion.

36. DIRECTED TRAFFIC INFORMATION

36.1 ATC is required to issue directed traffic information to both aircraft participating in LAHSO.

37. READ-BACK REQUIREMENT

37.1 In all cases, pilots must read back an ATC-issued requirement to hold short.

38. LANDING DISTANCE ASSESSMENT

38.1 ATC will normally sequence an aircraft for a runway which requires LAHSO only when the landing distance available for the aircraft is likely to be adequate in accordance with aircraft landing category criteria held by ATC.

38.2 ATC may sequence non-jet Category B aircraft below 5,700KG MTOW for LAHSO using the landing distance available from ERSA.ATC may sequence an aircraft for LAHSO regardless of category of aircraft where the pilot in command has advised

"LAHSO APPROVED". The pilot alone is responsible for ensuring that the LDA is equal to, or better than, that required for the prevailing circumstances.

38.3 Pilots should check the ERSA entry or ask ATC for landing distance available, and assess their landing distance requirements based on the landing weight and ambient weather conditions. The pilot must ensure that the LDA for LAHSO value for the runway meets or exceeds the relevant landing distance required, as calculated in accordance with section 11 of CAO 20.7.1B. ~~The pilot must ensure that aircraft manufacturer's landing distance figures (the demonstrated landing distance) are multiplied by 1.67 for dry conditions, or 1.92 for wet or downwind conditions.~~ In practice, doubling of the manufacturer's demonstrated minimum runway length requirements is recommended to cover all contingencies. ~~The manoeuvre that may be required in the event of a go-around must also be considered. Pilots must be aware that it may be impractical for ATC to provide visual or surveillance separation in the event of a go around. ATC will issue further traffic information once a go around has commenced and may issue avoidance advice where practicable.~~

39. GO AROUND DURING LAHSO

39.1 It is important for pilots to plan for action in the event of a go around. If a go around does occur, pilots must maintain safe separation from other aircraft, as it may be impractical for ATC to provide standard separation. Nevertheless, ATC will issue traffic information and, if appropriate – based on the relative position of aircraft, instructions for avoiding other aircraft.

39.2 When issued with avoiding action instructions, pilots should fly the specified heading without delay.

~~*Note:*~~

~~*1. An avoiding action turn may be given to either aircraft. The heading change will usually be no more than 20 degrees left or right.*~~

~~*2. A turn commenced at the minimum turn height for the aircraft, together with a climb at normal go-around climb rates, will provide adequate obstacle clearance.*~~

39.3 Regardless of any avoiding action instructions, pilots should always defer to any TCAS RA.

3. AMENDMENT FOR ERSA

3.1 Insert the following entry in the Flight Procedures section of the Melbourne (YMML) entry in ERSA:

FLIGHT PROCEDURES

7. LAND AND HOLD SHORT OPERATIONS (LAHSO)

7.1 LAHSO is used at Melbourne. See the YMML RDS for 'LDA for LAHSO' information.

7.2 In the event of a go-around, ATC may assign an avoiding action turn to either aircraft. The heading change will usually be no more than 20 DEG left or right.

7.3 A turn commenced at the minimum turn height for the aircraft, together with a climb at normal go-around climb rates, will provide adequate obstacle clearance.

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3.4. FURTHER INFORMATION

34.1 For additional information and to submit comments, pilots/ operators and interested parties should contact:

Office of the Chief Air Traffic Controller
ATS Integrity
atsintegrity@airservicesaustralia.com or
07 3866 3541

4.5. CANCELLATION

45.1 This SUP will be cancelled when the procedures are incorporated into AIP.

5.6. DISTRIBUTION

56.1 Airservices Australia website only.

Melbourne LAHSO Go Around Assessment

Version 1.2

Effective 13 April 2016

Prepared:	[redacted] [redacted]
Checked:	[redacted] [redacted]
Authorised:	[redacted] Chief Designer

Amendment record

Version	Date	Change description
1.2	13 April 2016	Analysis of terminal buildings changed to include Melbourne Airport data, Diagrams updated, Appendices 2 to 5 added.
1.1	1 April 2016	Appendix 1 added, Analysis of terminal buildings clarified, RWY 34 diagrams updated.
1	21 March 2016	Document creation.

Table of contents

1 Introduction

ECS South requested the assistance of IFP to address concerns raised by CASA regarding the risks associated with a double Go Around at Melbourne (YMML) during LAHSO operations.

The standard ATC compromised separation recovery includes instruction to the aircraft going around to fly a specific heading to the right of RWY 34 centreline or to the left of RWY 27 centreline, as appropriate.

IFP have been asked to do a quantitative assessment of the obstacles in the areas of interest and provide objective evidence that obstacle clearance will be maintained during this recovery procedure, under the normal operating conditions.

2 Limits and Assumptions

The following limitations and assumptions have been made in this assessment:

- Only Go Arounds initiated below 2400ft (highest MVA in the area) have been considered. Above this altitude, obstacle clearance will be ensured by application of MVA.

- For the determination of correlation of aircraft altitude and position relative to the landing threshold, aircraft are assumed to be on the 3° profile until crossing the landing threshold and on a climbing profile from the position 900m past the landing threshold.

- A Go Around can be initiated at any point from 2400ft on approach profile down to touch-down. However, it is assumed that aircraft will not commence a turn away from the runway centreline at heights of less than 50ft above the landing threshold elevation.

Note: It is acknowledged that most of the flight management systems on board modern aircraft will not initiate turns below 400ft AGL. However, 50ft was selected for the purpose of this evaluation as the lowest theoretically possible and the most conservative value for the purpose of obstacle clearance assessment. Turns initiated at heights above the height used in this assessment will simply result in an increased obstacle clearance margin.

- Aircraft are assumed to be on the relevant runway centreline before turning and climbing.

- Aircraft will stop descending and will be commencing a climb before they turn from the runway centreline.

- Aircraft on RWY 34 will only continue straight or be vectored right up to 50° from centreline.

- Aircraft on RWY 27 will only continue straight or be vectored left up to 50° from centreline.

- A minimum rate of climb during the Go Around is assumed to 1000ft/min. This rate of climb is considered conservative. The relation of this rate of climb to the climb gradient using a range of climbing speeds is given in the table below:

Rate of Climb (ROC)	1000 ft/min										
Ground Speed (kts)	140	160	170	180	190	200	210	220	230	240	250
Climb Gradient (ft/nm)	429	375	353	333	316	300	286	273	261	250	240
Climb Gradient (%)	**7.1**	**6.2**	**5.8**	**5.5**	**5.2**	**4.9**	**4.7**	**4.5**	**4.3**	**4.1**	**3.9**

- For the assessment of various elements of airport terminal building, the gradient of 3.9% was assumed – this being the gradient corresponding to 1000ft/min using the maximum speed of 250kt. This is also considered a conservative assumption since aircraft are likely to be accelerating from final approach speed (140-160kt) in the initial portion of the Go Around manoeuvre.

- The standard sources of obstacle and terrain data used for instrument flight procedure design have been utilised (see Section 3 below).

3 Data used in the assessment

IFP was provided with a diagram showing the positions of historical Go Arounds. This diagram shows that the Go Around can occur right up until the threshold of the runway.

- Recent obstacle assessments used to determine heights of buildings and cranes in the terminals area

- RAAF Obstacle data in the terminals area used for historical building heights

- Topographical and terrain contour data obtained from Geoscience Australia.

- Terminal building height and location information sourced from Melbourne Airport (see Appendices)

In accordance with Civil Aviation Safety Regulations (CASR) Part 139 Manual of Standards Chapter 7, management of temporary obstructions at an aerodrome is the responsibility of the aerodrome operator and they must report to CASA any infringement or potential infringement of the Obstacle Limitation Surface. Assessing the potential impact of temporary obstructions on extant procedures is a business as usual activity applicable to LAHSO and non-LAHSO operations equally.

In accordance with CASR Part 139 Manual of Standards Chapter 6.2, mobile obstructions are not permitted with the runway strip. The width of the runway strips at Melbourne, including the fly-over area, is 300m.

The impact of temporary obstructions on the compromised separation recovery procedure would be assessed and managed in the same way as any other extant procedure as per the regulations described above.

4 Analysis

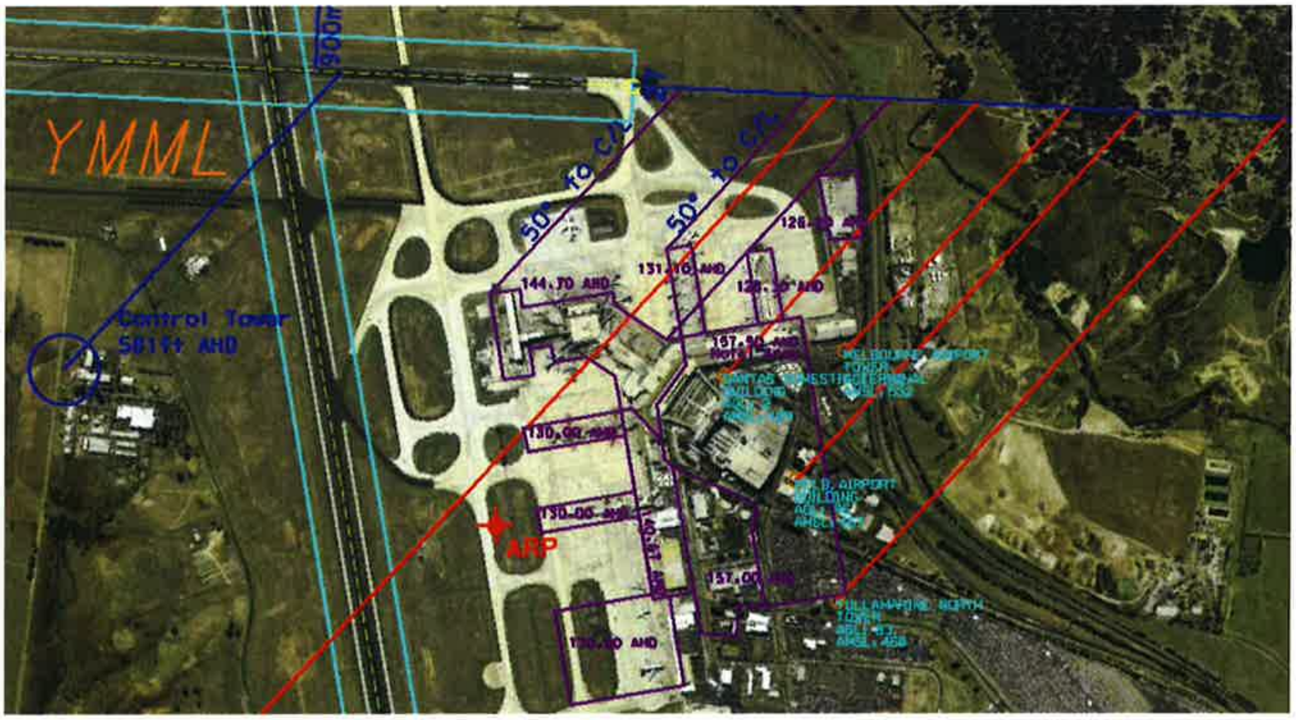
A) RWY 27 – Left turn up to 50°

Relevant Permanent Obstacles

Obstacle Name	Obstacle Altitude	Climb Distance*	Distance prior THR	Start Altitude	Altitude Achieved*
Control Tower	581ft	1147m	0m	457ft	603ft
Melbourne Airport Tower	532ft	936m	1240m	670ft	789ft
Qantas Domestic Terminal	409ft	1047m	975m	624ft	757ft
Melbourne Airport	467ft	1421m	1433m	703ft	884ft
Tullamarine North	460ft	1856m	1848m	774ft	1011ft
Melbourne Broadcast Site Sydenham Road Delahey	1041ft	8949m	570m	555ft	1700ft
TWY R Warehouses	415ft	297m	730m	582ft	620ft
Pier B	421ft	593m	728m	582ft	657ft
Pier C	431ft	594m	501m	501ft	619ft
Pier D (International)	475ft	791m	135m	480ft	581ft
Hotel Area	517ft	929m	728m	582ft	700ft

* Distances measured at 50° from the extended centreline. Altitude achieved based on 3.9% climb gradient.

There are currently no temporary obstacles in the vicinity of Melbourne airport notified by NOTAM.



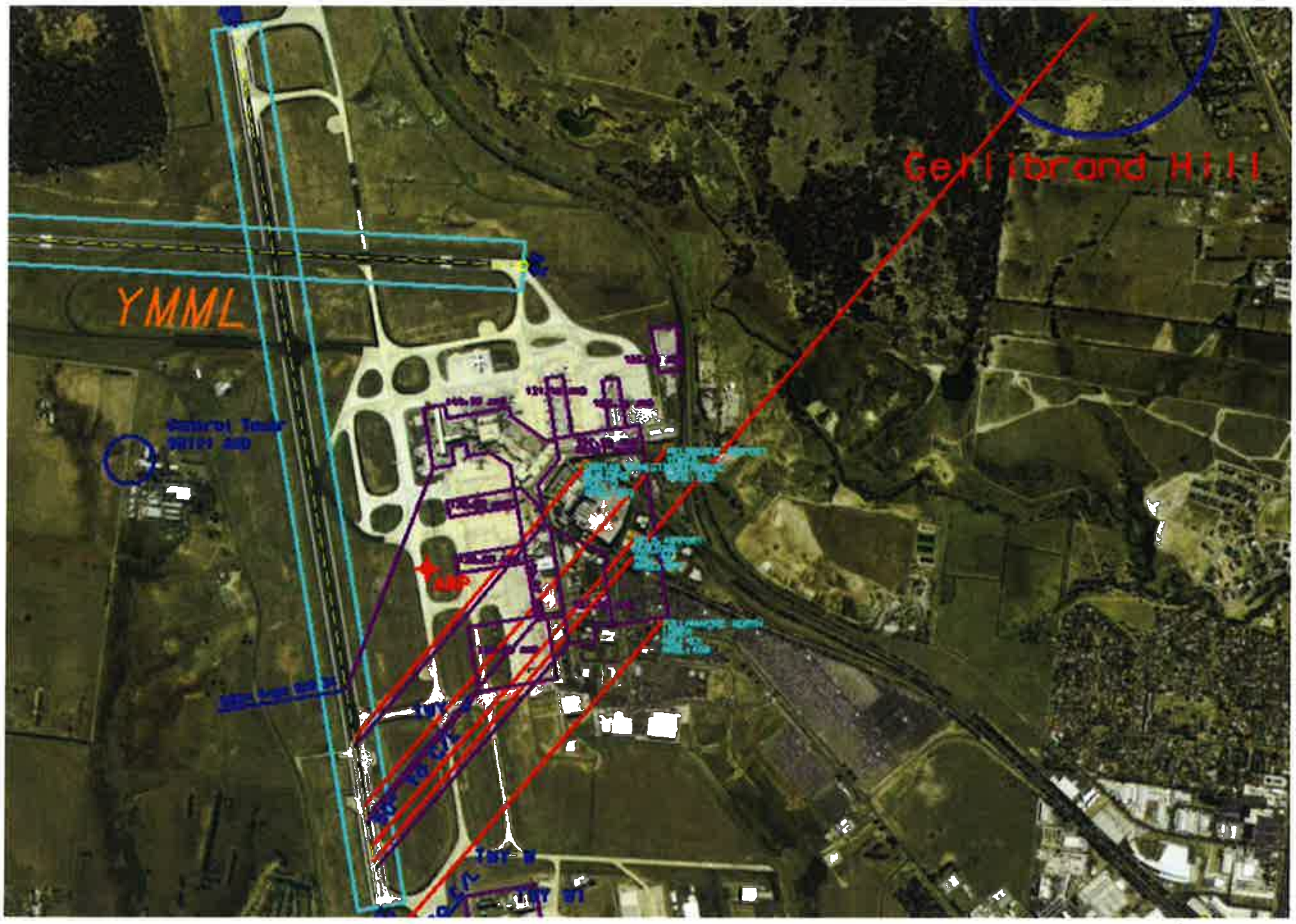
B) RWY 34 – Right turn up to 50°

Relevant Permanent Obstacles

Obstacle Name	Obstacle Altitude	Climb Distance*	Distance prior THR	Start Altitude	Altitude Achieved*
Melbourne Airport Tower	532ft	2210m	0m	380ft	662ft
Qantas Domestic Terminal	409ft	1988m	0m	380ft	634ft
Melbourne Airport	467ft	1828m	0m	380ft	613ft
Tullamarine North	460ft	1737m	156m	406ft	602ft
Gellibrand Hill	855ft	4640m	0m	380ft	973ft
Pier – App 2 Point S	427ft	699m	0m	380ft	469ft
Terminal – App 2 Point U	462ft	1065m	0m	380ft	516ft
Buildings – App 3 Point B	516ft	1217m	0m	380ft	535ft
Pier D (International)	475ft	975m	0m	380ft	504ft
Hotel Area	517ft	1195m	0m	380ft	532ft
TWY W1 Hangars	415ft	443m	302m	431ft	487ft

* Distances measured at 50° from the extended centreline, and direct to Pier D from the 900m point along centreline. Altitude achieved based on 3.9% climb gradient.

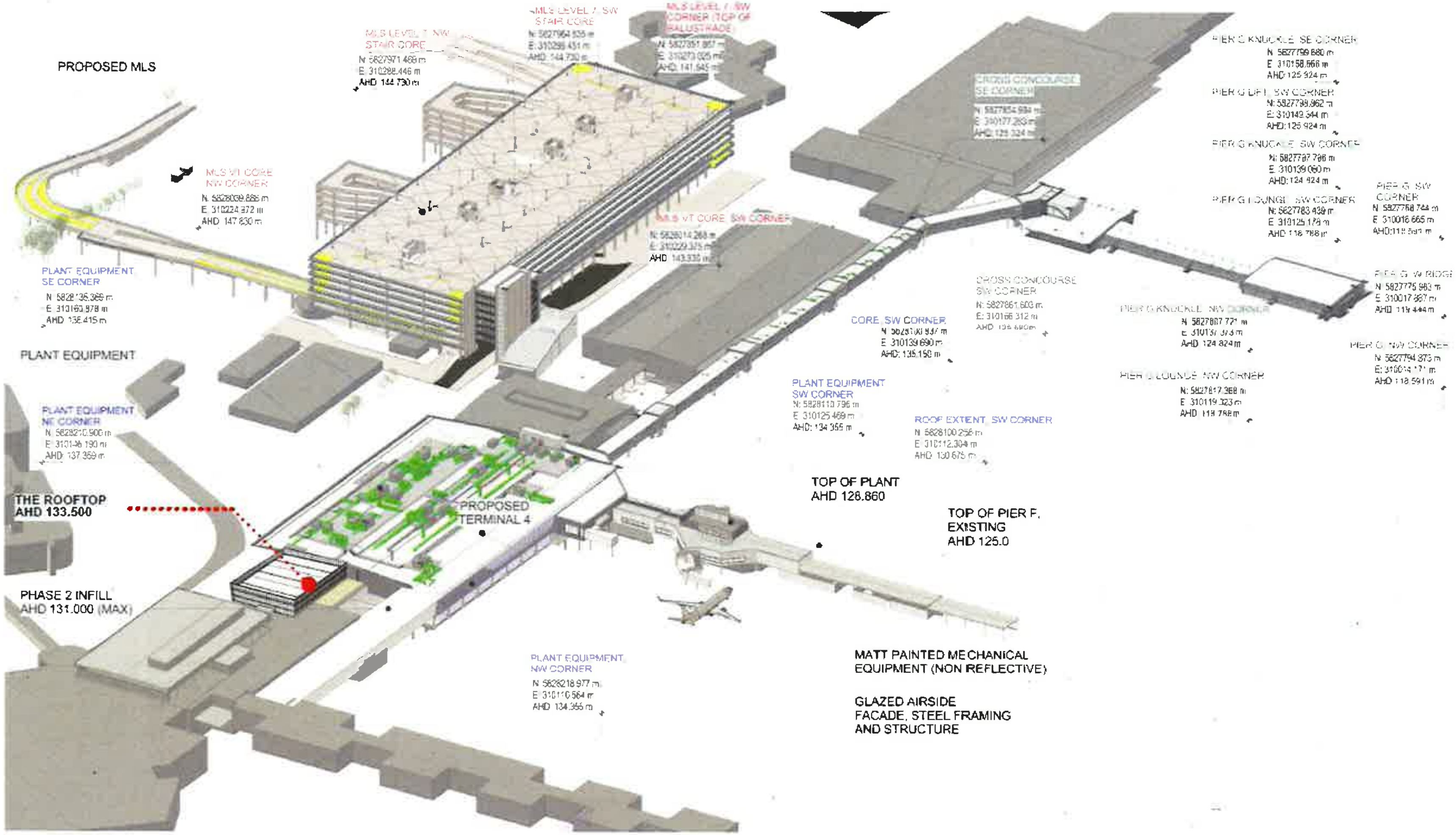
There are currently no temporary obstacles in the vicinity of Melbourne airport notified by NOTAM.



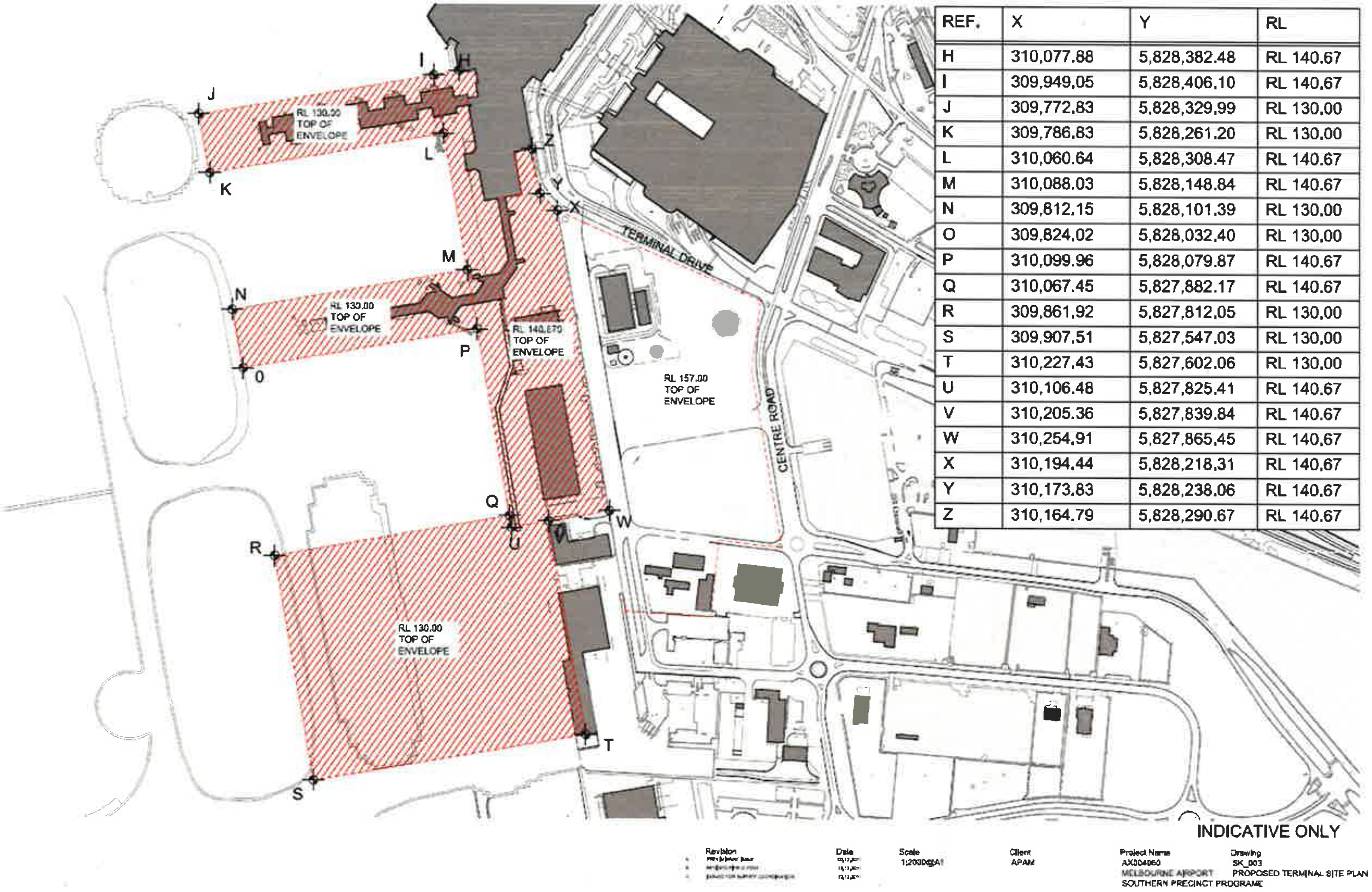
5 Conclusion

The assessment results confirmed that aircraft complying with the LAHSO compromised separation recovery procedure below the MVA, and climbing at a minimum rate of climb of 1000ft/min, will safely clear all relevant obstacles at the airport and its vicinity.

6 Appendix 1


PROPOSED MLS
PLANT EQUIPMENT SE CORNER
PLANT EQUIPMENT
PLANT EQUIPMENT NE CORNER
THE ROOFTOP AHD 133.500
PHASE 2 INFILL AHD 131.000 (MAX)
MLS VT CORE NW CORNER
MLS LEVEL 7 NW STAIR CORE
MLS LEVEL 7 SW STAIR CORE
MLS LEVEL 7 SW CORNER (TOP OF BALUSTRADE)
MLS VT CORE SW CORNER
PROPOSED TERMINAL 4
PLANT EQUIPMENT NW CORNER
CORE SW CORNER
PLANT EQUIPMENT SW CORNER
ROOF EXTENT SW CORNER
CROSS CONCOURSE SW CORNER
CROSS CONCOURSE SE CORNER
TOP OF PLANT AHD 126.860
TOP OF PIER F, EXISTING AHD 125.0
MATT PAINTED MECHANICAL EQUIPMENT (NON REFLECTIVE)
GLAZED AIRSIDE FACADE, STEEL FRAMING AND STRUCTURE
PIER G KNUCKLE SE CORNER
PIER G KNUCKLE SW CORNER
PIER G KNUCKLE NW CORNER
PIER G LOUNGE SW CORNER
PIER G LOUNGE NW CORNER
PIER G SW CORNER
PIER G NW CORNER

7 Appendix 2



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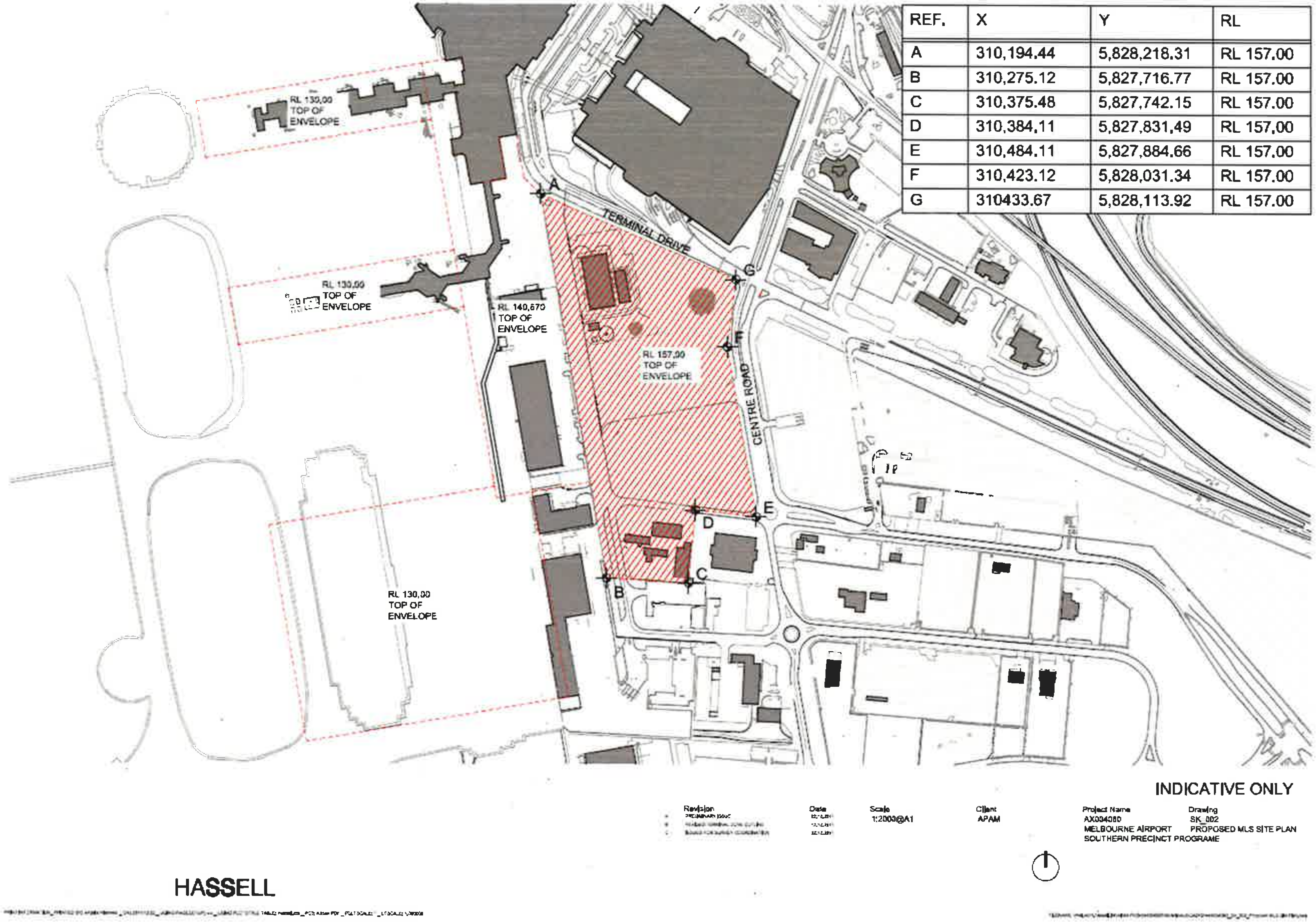
I	309,949.05	5,828,406.10	RL 140.67
J	309,772.83	5,828,329.99	RL 130.00
K	309,786.83	5,828,261.20	RL 130.00
L	310,060.64	5,828,308.47	RL 140.67
M	310,088.03	5,828,148.84	RL 140.67
N	309,812.15	5,828,101.39	RL 130.00
O	309,824.02	5,828,032.40	RL 130.00
P	310,099.96	5,828,079.87	RL 140.67
Q	310,067.45	5,827,882.17	RL 140.67
R	309,861.92	5,827,812.05	RL 130.00
S	309,907.51	5,827,547.03	RL 130.00
T	310,227.43	5,827,602.06	RL 130.00
U	310,106.48	5,827,825.41	RL 140.67
V	310,205.36	5,827,839.84	RL 140.67
W	310,254.91	5,827,865.45	RL 140.67
X	310,194.44	5,828,218.31	RL 140.67
Y	310,173.83	5,828,238.06	RL 140.67
Z	310,164.79	5,828,290.67	RL 140.67

HASSELL

8 Appendix 3



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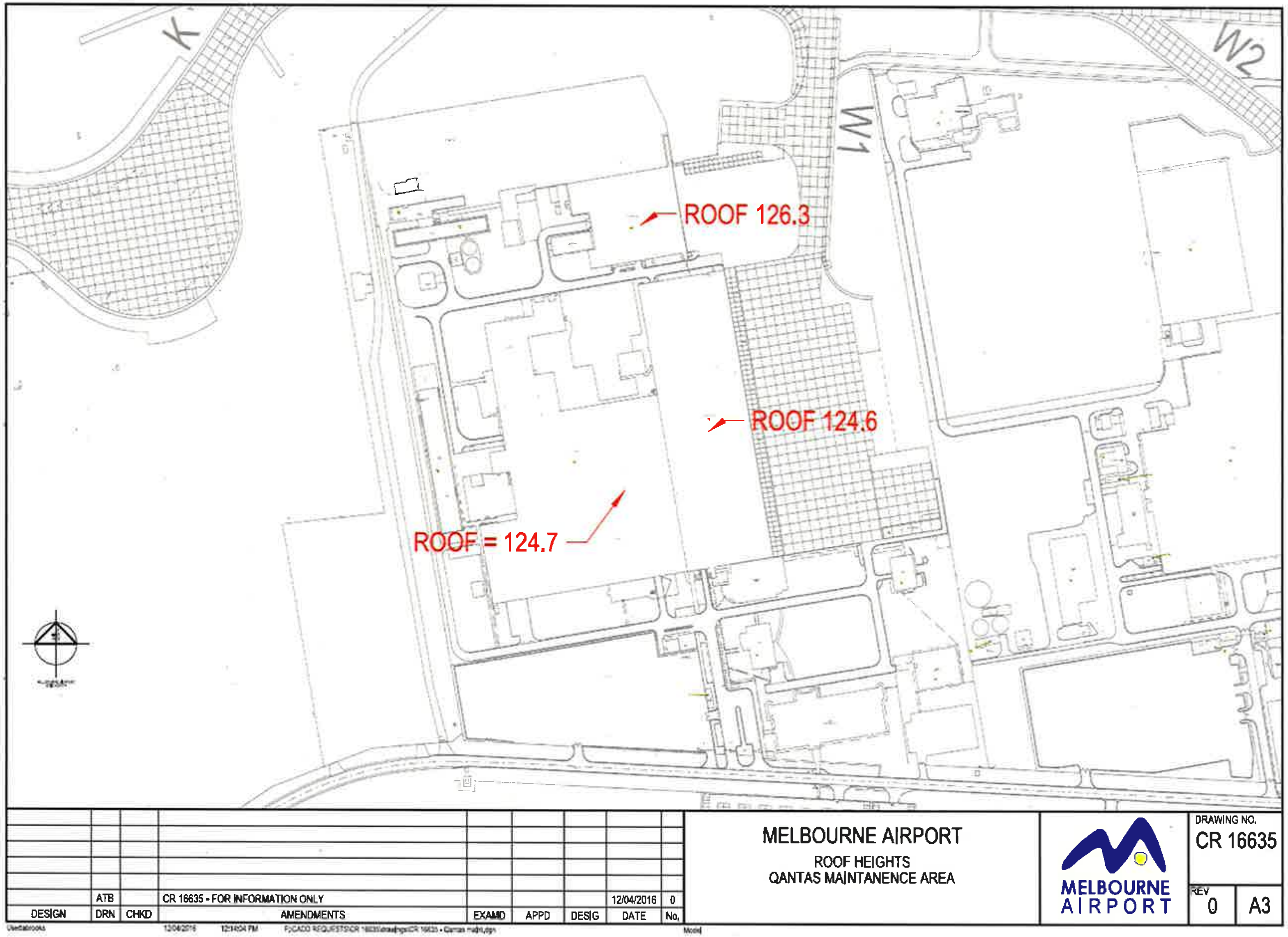
D	310,384.11	5,827,831.49	RL 157.00
E	310,484.11	5,827,884.66	RL 157.00
F	310,423.12	5,828,031.34	RL 157.00
G	310433.67	5,828,113.92	RL 157.00

9 Appendix 4


K
W2
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ROOF = 124.7
ATB
CR 16635 - FOR INFORMATION ONLY
12/04/2016
0
DESIGN
DRN
CHKD
AMENDMENTS
EXAMD
APPD
DESIG
DATE
No.
MELBOURNE AIRPORT
ROOF HEIGHTS
QANTAS MAINTANENCE AREA
MELBOURNE AIRPORT
DRAWING NO.
CR 16635
REV
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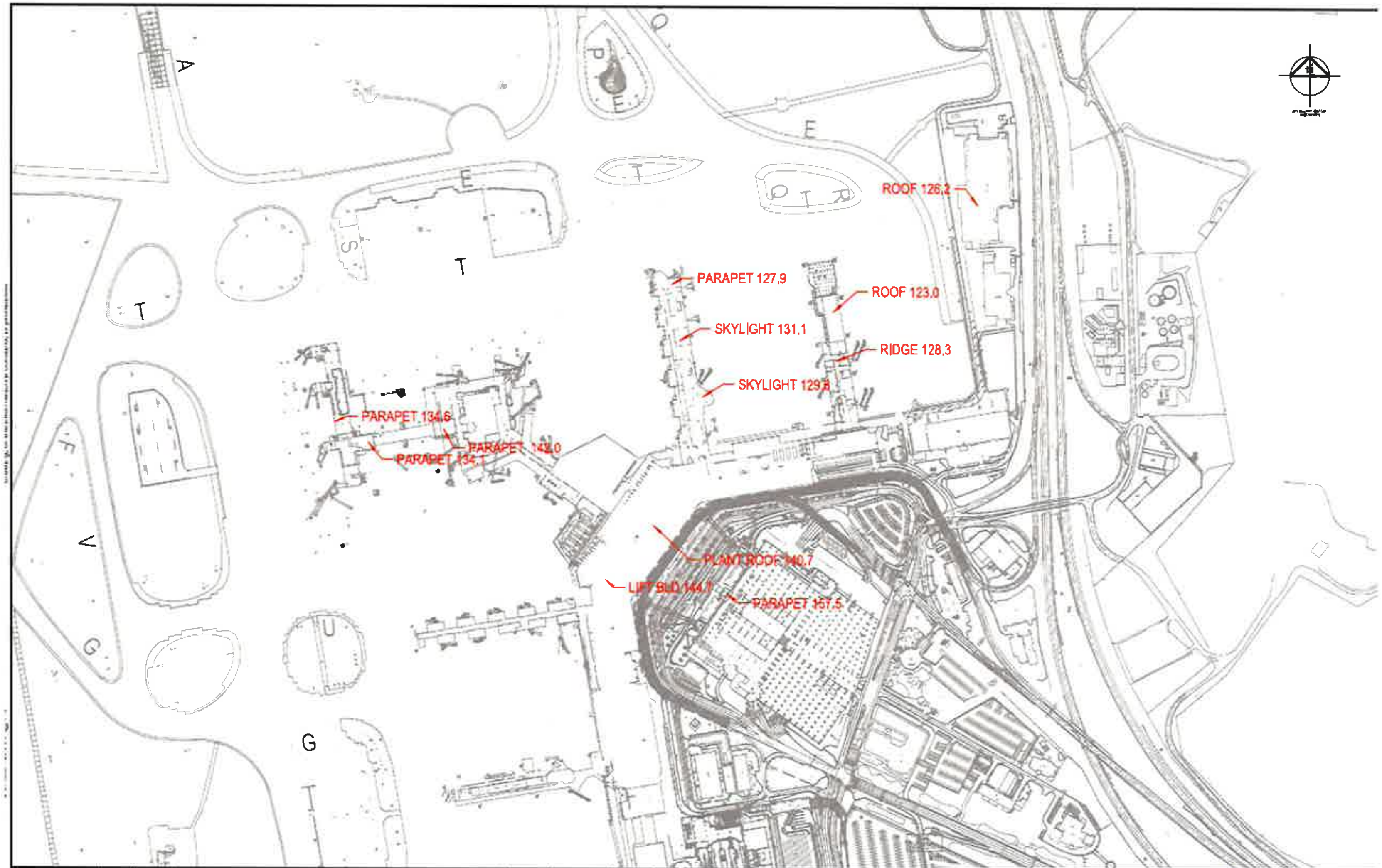
10 Appendix 5



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DESIGN	DRN	CHKD	AMENDMENTS	EXAMD	APPD	DESIG	DATE	No.

MELBOURNE AIRPORT
ROOF HEIGHTS
TERMINAL AREA

MELBOURNE AIRPORT

DRAWING NO. CR 16635
REV 0 A3

ML Airport Compromised Separation Procedures during LAHSO at Night:
Preliminary Human Factors Assessment

The purpose of the PHFA is to develop an understanding of the HF risks and benefits associated with changes to ML Airport Compromised Separation Procedures during LAHSO at Night (including a proposed exemption from MOS 172, Section 12.1.4.1).

Version 1.0

	Name and Title	Signature	Date
Prepared by:	[redacted] Senior Human Factors Specialist	[redacted] Digitally sign[redacted] by [redacted] DN: cn=[redacted] o=Airservices, ou=SE&A: Project and Business [redacted]pport, email=[redacted]airservicesaustralia.com, c=AU Date: 2016.03[redacted]8 11:18:27 +11'00'	
Accepted by:	[redacted] Change Manager	[redacted] Digitally sign[redacted] by [redacted] DN: cn=[redacted] o=Airservices Australia, ou=ECSS, email=[redacted]airservicesaustralia.com, c=AU Date: 2016.03[redacted]8 12:46:45 +11'00'	

[redacted] document has been distributed to the following stakeholders for review:

Name	Role / Position	Date	Version
[redacted]	ATC Line Manager – ML TCU	4/2/16	v.01
[redacted]	ATC Business Coordinator – ATC	4/2/16	v.01
[redacted]	ATS Instructor (TWR/TMA) – Learning Academy	4/2/16	v.01
[redacted]	Senior ATS Specialist – CATC Office	4/2/16	v.01
[redacted]	ATC – ML Tower	4/2/16	v.01
[redacted]	ATC – ML Tower	4/2/16	v.01
[redacted]	ATC Line Manager – ML Tower	4/2/16	v.01
[redacted]	Senior Project Safety Specialist	4/2/16	v.01
[redacted]	Senior Human Factors Specialist	4/2/16	v.01
[redacted]	Melbourne Project & Business Support Manager	4/2/16	v.01

Impact Statement

The following Human Factors impacts were identified during the PHFA review:

Human in the system (HMI): This is a procedural based change and does not impact HMI.

Working environment: There are no changes to the working environment resulting from this change.

Procedures, roles and responsibilities: In the event that separation may be compromised during LAHSO at night (e.g., a double go-around), a procedural change will allow the ML Tower ADC to issue a vector to an aircraft that is conducting a missed approach. This currently requires an aircraft to report as 'Visual' (i.e. not during IMC) and as such Airservices will request an Instrument from CASA to allow an exemption to Section 12.1.4.1 of MOS 172.

The updated procedures do not constitute a significant increase in task complexity in that controllers currently execute the proposed procedure during the day. The ADC will need to determine which aircraft to issue a vector to in the event of a double go around and effectively making this judgment at night may slightly increase difficulty; however, multiple cues remain available to assist the controller such as the surface movement radar, airborne radar, and visual cues (i.e. aircraft lights).

There is unlikely to be any further impacts to controller workload as it is likely that controller workload will already be high in the event of a double go around during LAHSO. External to ML Tower; TMA controller workload may be impacted by the new headings provided by the ADC; however, controllers should already be relatively familiar with these procedures as they are utilised during the day (Note: Comp Sep scenario following a double go-around is an extremely rare event). Potential implications for Essendon workload/situation awareness (i.e. additional comms and coordination); will also need to be examined in the event that however an aircraft going around from runway 34 is issued a vector conflicting with traffic departing Essendon.

Organisation and staffing: This change does not have any impact on organisation or staffing requirements; however, is a key component in LAHSO operations and ensuring all hazards are reduced to ALARP. It was also identified that complying with additional training requirements will place additional pressure on ML Tower staff and simulator availability.

Training and development: No new skills are required for this change as controllers already receive training associated with issuing compromised separation instructions. However, controllers will be provided additional training activities (including changes to training documentation and a specific Comp Sep LAHSO at Night Sim Ex) in order to establish familiarity with the relevant changes to procedures. The relevant LAHSO at Night Sim Ex has been developed and is currently being completed by ML Tower operators. Further work to determine the refresher and frequency requirements for this training will be conducted in consultation with ML Tower and Training Specialists.

Additional education activities will also need to be completed by the relevant Airlines (i.e. those able to participate in LAHSO); to ensure that aircrew are comfortable and familiar with the relevant changes to ATC procedures. Consultation with Airlines has already commenced and further activities are currently underway to determine and complete the relevant training activities. This will likely also include the distribution of an AIC/AIP.

Teams and communications: This change does not impact on ATC team dynamics or methods of communication; however, specific phraseology has been developed in order to accommodate the updated procedures outline above. Consultation has been completed with airlines to ensure the appropriate phraseology is developed and included within Aircrew training. The 'Avoiding Action' phraseology is also consistent with the wider Airservices guidelines for a TRUCT (Trigger, Resolution, Urgency, Confirmation, and Traffic) response to a compromised separation situation. Details regarding ATC phraseology will also form part of Aircrew education programs to ensure proper awareness and consistency.

Human Factors Resource Requirements: Given the scope of the HF impacts outlined above, some additional HF activities will need to be conducted to support the safety work completed for this change. The change manager should submit a request through the Work Package Management System (WPMS) for a human factors specialist for support.

1 Overview

Project title	ML Airport Comp Sep Procedures during LAHSO at Night	**Business area**	ATC
Project description	In the event that separation may be compromised, during night time LAHSO operations, a procedural change is proposed that would allow the Melbourne Tower Aerodrome Controller (ADC) to issue a vector to an aircraft that is conducting a missed approach. This procedure is currently available during day time operations for LAHSO. This proposed procedural change would allow controllers to do the same at night in order to provide additional assurance during the conduct of LAHSO during night time operations. Note: • The scope of this change requires an instrument from CASA to allow exemption from MOS 172, Section 12.1.4.1. • This exemption would permit ATC to provide a vector resolution in the event of a double go-around during LAHSO operations at night, at Melbourne aerodrome only. Statistical analysis indicates that this would be an extremely remote event with an order of magnitude estimated at 1 in every 6000 years		
Project Manager or other equivalent stakeholder	[redacted]		
Contributors to information contained in the assessment	[redacted]		
Prepared by	[redacted]	**Date**	4/2/16

Type of project (tick appropriate box)

Construction and Infrastructure	Navigation and Surveillance	Communications	Business Systems	Air Traffic Management	ATC Systems	Medium – Minor Works Program
☐	☐	☐	☐	✓	☐	☐

Phase of project lifecycle (tick appropriate box)

Initiating Phase	Planning Phase	Executing Phase	Closing Phase
✓	☐	☐	☐

Project documentation available	See SCARD
Key stakeholders	ML Tower, Airlines, ML TMA

The purpose of the Preliminary Human Factors Assessment (PHFA) is to assist Project Managers with the identification of human factors issues to inform the design and development of a new system, or a change to an existing system. It may also be used to for any other change within the operational environment.

For projects, this checklist should be completed by a Human Factors Specialist from Project Safety Services (PSS) in conjunction with the relevant Project Manager and other project stakeholders during the initiating phase of new projects. Where possible this should be done prior to completing the Safety Case Assessment and Reporting Determination (SCARD) so that the findings can be considered when determining the size of the change and the safety impact of the change.

The PHFA is divided into a high level assessment, Part A: Human factors initial checklist and Part B: Detailed assessment. The answers to the questions in Part A will help to determine which sections of Part B should be completed.

Consider the stakeholders listed in Table 1 and whether/how they will be impacted by the project from a human factors perspective.

Table 1 – Stakeholders

Stakeholder group	Impacted?*	Comments
Controllers (Tower)	Y	ML Tower
Controllers (Enroute)	N	No impact expected
Controllers (Approach)	Y	Updated procedures will have flow on effects for TMA
Flight Data Coordinator	N	
FMS	N	
NOC	N	
TOC	N	
UAS HF	N	
ARFF	N	
Corporate	N	
Learning Academy	M	Compromised Separation Training (including LAHSO Sim Ex) will need to be developed/updated.
External/Industry	Y	Airlines to be consulted regarding changes to compromised separation procedures at ML Airport and potential impacts. Consultation with CASA RE exemption to MOS 172
Other		

* Mark the relevant stakeholder who will be affected by the change to this item. Please note, this may include more than one stakeholder.

Upon completion, a PSS Human Factors Specialist will prepare a report which will outline the human factors issues identified during the analysis.

The output from the PHFA will assist in completing a Safety Case Assessment and Reporting Determination (SCARD) (AA-TEMP-SAF-0042), and in the identification of relevant human factors activities to be undertaken throughout the life of the project in order to address the issues identified.

2 Part A: Human factors initial checklist

Please answer all questions in Part A. If you answer **Yes** to any question in Part A, complete the corresponding section in Part B.

Human Factors elements and items*	Response Y M N N/A	Comments	What to do next?
1. Human in the system			
Will the proposed change impact upon the current human-machine interface (HMI) or introduce new HMI?	N	Change is procedural in nature and there are no impacts on HMI.	If you answered **Yes** to this question, please complete Part B: 1. Human in the system
2. Working environment			
Will the project affect the user's working environment and/or will the project change introduce new equipment, e.g. workstations, screens, input devices etc?	N	No change	If you answered **Yes** to this question, please complete Part B: 2. Working environment
3. Procedures, roles and responsibilities			
Will the proposed change impact user roles, responsibilities or tasks?	Y	Procedures will be updated to allow the ML Tower Aerodrome Controller (ADC) to issue a vector to an aircraft that is conducting a missed approach (during LAHSO at Night). (See Below for Details). Roles and responsibilities remain unchanged	If you answered **Yes** to this question, please complete Part B: 3. Procedures, roles and responsibilities
4. Organisation and staffing			
Will the change impact on staffing?	Y	This change does not have any impact on organisation or staffing requirements. Complying with training requirements will place additional pressure on ML Tower staff and simulator availability. NOTE: Proposed change is to support LAHSO at night.	If you answered **Yes** to this question, please complete Part B: 4. Organisation and staffing
5. Training and development			

Will the proposed change result in a requirement for users to be trained in new skills?	Y	No new skills need to be developed; however, awareness and knowledge of new procedure is required. The procedural change is within controllers' current skill set and controllers currently receive Comp Sep refresher training (<3 Year Sim Ex). A specific LAHSO at Night Sim Ex has also been developed to assist ML Tower Controllers to build familiarity with the change (As of 4th Feb, approximately $^{2}/_{3}$^{rds} of ML Tower Operators have completed this training. Annual ML Tower Classroom/CBT training will also be reviewed to align with the procedural changes outlined above.	If you answered **Yes** to this question, please complete Part B: 5. Training and development
6. Teams and communications			
Will the proposed change impact on the users' team dynamics, e.g. supervision, coordination, communication and collaboration?	M	No changes to team dynamics or interactions. Specific phraseology will need to be developed as per the updated Comp Sep procedures (See Below).	If you answered **Yes** to this question, please complete Part B: 6. Teams and communications

Y = Yes. The change is likely to have an impact on the item outlined and/or may require consideration.

M = Maybe. The change may have an impact on the item outlined, however at this time the nature of this is unknown.

N = No. The change is not likely to have an impact on the item outlined.

N/A = Not Applicable. The item does not apply.

Note: If all questions to Part A are 'N' or 'N/A' delete Part B and retain the remaining document as a record of the human factors assessment of the change

3 Part B: Detailed assessment

Complete the relevant section for which you answered **Yes** in Part A.

Human factors elements and items	**Response** **Y M N N/A**	**Relevant stakeholder(s)**	**Comments/Description**
1. Human in the system			
1.1. Will there be an introduction of a new Human Machine Interface (HMI) or will the existing HMI be altered?	N		
1.2. Will the information that is required to do the job be changed or will the information that is provided to users be changed?	N		
1.3. Will any new alerts or alarms be introduced?	N		
1.4. Will the level of automation change as a result of the new system or process?	N		
1.5. Is the change likely to introduce or increase the sources of human error?	N		
1.6. Is there a change to, or impact on, user roles, responsibilities, functions or tasks?	N		
1.7. Is there potential for the change to have an impact on the users' Situation Awareness?	N		
1.8. Will user behaviour or working methods be altered?	N		
1.9. Will there be an impact on how the user interacts with the system, e.g. different input and output devices?	N		
1.10. Will the change reduce the system's built in reliability or redundancy capability?	N		
1.11. Other	N		

Human factors elements and items	Response Y M N N/A	Relevant stakeholder(s)	Comments/Description
2. Working environment			
2.1. Will there be a change to the individual or team workspace, console design or layout?	N		
2.2. Will there be a change to equipment design or will additional support equipment/furniture be required?	N		
2.3. Will the change impact on the ability to accommodate peak staffing levels?	N		
2.4. Will the change impact the space or equipment available for On-the-Job Training?	N		
2.5. Will the change impact on the physical environment, e.g. noise, temperature, ambient, task lighting, etc, and/or the users' level of physical comfort?	N		
2.6. Other	N		
3. Procedures, roles and responsibilities			
3.1. Will the change introduce new procedures or alter current procedures (prescribed working methods and practices?	Y		Airservices will request an Instrument from CASA to allow an exemption to Section 12.1.4.1 of MOS 172. Procedures will be updated as follows: In the event that separation may be compromised during LAHSO at night (e.g., a double go-around), a procedural change will allow the ML Tower ADC to issue a vector to an aircraft that is conducting a missed approach (this currently requires an aircraft to report as 'Visual').
3.2. Will the change impact on management and leadership roles or responsibilities?	N		No impacts identified
3.3. Will the change have an impact on task demand or complexity?	Y		Minor changes to task complexity. Controllers may now issue a vector below LSALT at ML Airport at night, but this does not constitute a significant increase in complexity (i.e. controller will need to determine

Human factors elements and items	Response Y M N N/A	Relevant stakeholder(s)	Comments/Description
			which Comp Sep aircraft to issue vector; judgement at night may increase difficulty, yet multiple cues are available to assist – e.g., surface movement radar, airborne radar, and visual cues). Controllers will continue to receive Comp Sep refresher training in order to maintain familiarity with the relevant procedures (an updated LAHSO Comp Sep Night Sim Ex will also be developed)
3.4. Will the introduction of the change increase the risk of user task interruption or distraction?	N		No impacts identified – Task focus will likely already be high in a Comp Sep scenario
3.5. Will the change alter the users' level of workload?	M		Workload in a compromised separation scenario will likely already be high. Updates to the procedures are unlikely to have any further impacts on workload – Controllers will continue to receive Comp Sep refresher training in order to maintain familiarity with the relevant procedures. TMA controller workload may be impacted by the new headings provided by the ADC; however, controllers should already be relatively familiar with these procedures as they are utilised during the day (Note: Comp Sep scenario following a double go-around is an extremely rare event). Potential implications for Essendon workload/situation awareness (i.e. additional comms and coordination); will also need to be examined in the event that however an aircraft going around from runway 34 is issued a vector conflicting with traffic departing Essendon.
3.6. Other			
4. Organisation and staffing			
4.1. Will the change have an impact on resource management, e.g. availability of equipment and other assets?	Y	ML Twr/LA	Complying with training requirements will place additional pressure on ML Tower staff and simulator availability.
4.2. Will the change alter the reporting structure, e.g. changes to the Operational Command Authority?	N		
4.3. Will the transition of the change have an impact on users?	N		

Human factors elements and items	Response Y M N N/A	Relevant stakeholder(s)	Comments/Description
4.4. Will the change have an impact on staffing, e.g. workforce planning and resourcing, or recruitment?	N		
4.5. Is there a requirement for additional staff to 'shadow' operators during the initial implementation of the change?	N		
4.6. Will the change introduce any new physiological factors or have an impact on existing physiological factors, e.g. physical limitations, age, gender?	N		
4.7. Will the change introduce any new psychological factors or have an impact on any existing psychological factors, e.g. fatigue, stress, motivation, sleep?	N		
4.8. Other	N		
5. Training and development			
5.1. Will the change have an impact on training from a regulatory requirements perspective?	N		No changes to regulatory requirements. The procedural change is within controllers' current skill set. Comp Sep refresher training is currently completed by ML tower controllers annually, with a Comp Sep Sim Ex completed at least every 3 years (See ML Twr Refresher Training Program). An additional LAHSO Specific Comp Sep training (including LAHSO at night) has been developed. The training frequency requirements for these simulator activities will be reviewed by ML Twr.
5.2. Will the change introduce new competence requirements or impact on any existing competence requirements?	N		The procedural change is within controllers' current skill set – No change to training competencies
5.3. Will the change have an impact on the different training types, e.g. initial, refresher?	Y		Comp Sep refresher training is completed by ML tower controllers annually with a Comp Sep Sim Ex completed at least every 3 years (See ML Twr Refresher Training Program). There is no proposed change to the frequency of training; however, initial ADC training programs will be reviewed and updated to reflect the

Human factors elements and items	Response Y M N N/A	Relevant stakeholder(s)	Comments/Description
			new procedures (including the LAHSO Comp Sep Training Night Sim Ex).
5.4. Will there be an impact on training design or training needs?	M		LAHSO at night Comp Sep Sim Ex has been developed.
5.5. Will training documentation need to be developed, e.g. training plan, syllabus?	Y		Training documentation will need to be updated to reflect new procedures
5.6. Will there be an impact on training effectiveness (including transfer of training or legacy transfer?	N		No changes to training effectiveness expected. The addition of the LAHSO Night Sim Ex will provide further benefits to controllers.
5.7. Will there be an impact on existing emergency or unusual situation training or a requirement to introduce emergency or unusual situation training?	Y		The updated procedure relates specifically to a compromised separation scenario during LAHSO at Night.
5.8. Other	N		
6. Teams and communications			
6.1. Will there be a change to team interactions?	N		None Expected
6.2. Will there be a change to team structures or dynamics, e.g. addition of a new role, change in team hierarchy, co-operation, supervision?	N		None Expected
6.3. Will the change have an impact on the communication types or methods used, e.g. verbal, non-verbal, written, reporting or other fundamental operational or business communications?	N		None Expected
6.4. Will there be a change in communication processes including technology assisted communications?	N		None Expected
6.5. Will there be a change to or additions to phraseology?	Y		Phraseology will need to be updated to reflect changes to procedures identified above. Controllers will continue to receive Comp Sep refresher training in order to maintain familiarity with the relevant procedures and ensure correct phraseology (including tone/emphasis etc.) is issued in high pressure/stress scenarios.

Human factors elements and items	Response Y M N N/A	Relevant stakeholder(s)	Comments/Description
			Consultation completed with airlines to ensure appropriate phraseology is developed and included within Aircrew training. Relevant phraseology will form part of Aircrew education programs to ensure awareness and consistency. First aircraft Go Around controller provides traffic to other aircraft and restates clearance to land: **"(call sign) B737 ON THE CROSSING RUNWAY IS CONDUCTING A MISSED APPROACH, RUNWAY (number) CLEARED TO LAND"** Second aircraft goes around and controller gives avoiding action turn and traffic information: **"(call sign) AVOIDING ACTION, TURN (right/left) IMMEDIATELY (heading), CLIMB (level), (traffic)".** Heading is expected to change Left or Right 20 deg. 'Avoiding Action' is consistent with TRUCT (Trigger, Resolution, Urgency, Confirmation, and Traffic) response to a compromised separation situation.
6.6. Is there likely to be interference from competing sources of communication?	N		None Expected
6.7. Other	N		

Where required, please engage Project Safety Services Human Factors Specialists further for assistance in identifying the relevant human factors activities to be undertaken and resources required in order to address the potential issues identified.

airservices

Compromised Separation Recovery for LAHSO Night Time operations at Melbourne

Safety Plan

SAF-SP-16004

1.0

Effective 29 February 2016

Prepared: [redacted]
Senior Project Safety Specialist [redacted]

Date: 2016.03.01 17:25:46 +11'00'

I declare that this Safety Plan:

- has been prepared in accordance with the requirements of Airservices Safety Management System that are necessary to manage the Operational-Safety aspects of the change
- presents a Safety Program sufficient for the development of a robust case for the Operational Safety of the change

---

Agreed: [redacted]
East Coast Services South, ATC Business Coordinator [redacted]

Date: 2016.03.01 17:28:42 +11'00'

I declare that the Operational Safety Program described within this Safety Plan:

- has been incorporated within the change schedule, resource and budget pla[redacted]
- will be enacted as described, with any variations from the plan agreed and [redacted]

Endorsed: Rob Weaver
Executive General Manager
Safety, Environment and Assurance

Digitally signed by WEAVER_RA
DN: dc=au, dc=gov, dc=airservices, dc=prd, dc=asanet, ou=Domain Users, ou=Win81 Users, cn=WEAVER_RA, email=rob.weaver@AirservicesAustralia.com
Date: 2016 03 07 11:33:18 +11'00'

I am satisfied that, following review of this Safety Plan, that the Safety Program described herein meets the requirements of the Safety Management System necessary to manage the Operational-Safety aspects of the change

---

Accepted: [redacted]
Manager, East Coast Services South [redacted] 10/3/2016

I am satisfied, following review of this Safety Plan, that the Operational Safety Program described herein will:

- enable the lifecycle management of Operational Safety risks
- provide a basis for the development of a robust case for the Operational Safety of the change

---

Accepted: [redacted]
Chief Air Traffic Controller [redacted]

Date: 2016 03 10 17:27:03 +11'00'

I am satisfied, following review of this Safety Plan, that the Operational Safety Program descr[redacted]

- enable the lifecycle management of Operational Safety risks
- provide a basis for the development of a robust case for the Operational Safety of the c[redacted]

Document Review Record

Those listed below have reviewed this document in the context of their area of expertise and in accordance with their area of accountability. All issues raised from the reviews have been addressed to the satisfaction of all reviewers.

Name	Role / Position	Date	Version
[redacted]	Unit Manager, Melbourne Project & Business Support	24/02/2016	0.3
[redacted]	ECSS ATC Business Coordinator	24/02/2016	0.3
[redacted]	Senior Human Factors Specialist	24/02/2016	0.3
[redacted]	Change Assurance Manager	25/02/2016	0.3
[redacted]	Acting Manager, East Coast Services South	26/02/2016	0.3
[redacted]	Chief Air Traffic Controller (CATC)	26/02/2016	0.3

Change summary

Version	Date	Change description
0.1	12 February 2016	Initial draft by [redacted]
0.2	19 February 2016	Initial draft reviewed by [redacted] and safety plan updated
0.3	23 February 2016	Sent for stakeholder review
0.4	1 March 2016	Briefing given to EGM SE&A. Updated Section 3.1
1.0	1 March 2016	Sent for signatures

This document was created using the Safety Plan template AA-TEMP-SAF-0010 Version 8

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Document Storage Locations:

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1 Purpose

This document is an all phases safety plan and describes the safety management activities that will be undertaken in respect of changes to compromised separation procedures and training in support of re-instating Land and Hold Short Operations (LAHSO) operations at night at Melbourne airport.

Activities arising from this plan will be reported in an all phases safety case. The safety case and its supporting evidence will form one aspect of a program of initiatives that will be the basis for seeking CASA endorsement with respect to re-instating LAHSO operations at night and any associated exemptions.

2 Background

On the evening of 5th July 2015, in response to a potential compromised wake turbulence separation situation, the Melbourne Aerodrome Controller (ADC) issued a vector to an aircraft conducting a go-around off Runway 34. Vectoring below the Minimum Vectoring Altitude (MVA) at night is not permitted.

A finding from an Airservices investigation into the occurrence was that the current compromised separation package developed for Melbourne Aerodrome Controllers (ADC) did not contain training for night time operations; the exercises only addressed day Visual Meteorological Conditions (VMC) scenarios where vectoring below MVA is permitted[1].

In November of 2015 CASA raised concerns [Attach 1] regarding the ability of an ADC to safely manage a compromised separation event during Instrument Meteorological Conditions (IMC) when LAHSO was in progress. As a result of this concern, Airservices voluntarily suspended LAHSO at Melbourne Airport at night until 31st March 2016 during which time Airservices would conduct a comprehensive review of LAHSO operations.

3 Scope

3.1 Compromised separation recovery for LAHSO night time operations

In Attachment 1 CASA advised it would consider revoking the notice of intention to prohibit the use of LAHSO at night if (in part):

Airservices provides evidence to CASA that all ATCs endorsed for Melbourne Tower Aerodrome Control (ADC) have been assessed as competent in effective night-time compromised separation techniques which include the requirements associated with the Minimum Vectoring Altitude;

To address this requirement an update to the compromised separation training will be delivered, which will include LAHSO at night, and a procedural change is proposed that would allow the ADC to issue a vector to an aircraft that is conducting a go-around manoeuvre during IMC. The procedural change itself will require an instrument from CASA to allow exemption from MOS 172, Section 12.1.4.1.

[1] CASR Part 172 Manual of Standards, Section 12.1.4.1

It should be noted that at the time of writing this safety plan Airservices is also managing a program of initiatives to improve the systemic safety of LAHSO operations. This involves providing regular briefings to CASA and a separate report provided to CASA demonstrating assurance that LAHSO operations continue to be acceptably safe. This will culminate in an update to the LAHSO SAR in the form of an addendum which will present an updated operational risk baseline, which also takes into account the additional controls which have been implemented as a result of CASA's notice of proposed direction [Attach 1].

This safety plan and the subsequent safety case that follows will be addressing just one aspect of that program of initiatives, which is the matter of compromised separation training at night for Melbourne tower aerodrome controllers [Attach 1].

3.2 Safety Case Assessment Reporting Determination

In accordance with AA-TEMP-SAF-0042 [Ref 1], a Safety Case Assessment and Reporting Determination (SCARD) was completed to determine the level of safety reporting necessary to support the procedural change [Attach 2].

The overall operational safety magnitude was reported as 'Minor', however since this change would require an instrument from CASA to allow exemption from the CASR Part 172 Manual of Standards, a safety case is required.

3.3 Affected Systems

There are no systems affected by this change.

3.4 Affected Groups

Table 1 below lists the business groups affected by this change.

Table 1: Business groups affected by this change

Group Effected	Required action within this project
Melbourne Tower Aerodrome Controllers (ADC)	Required to undertake LAHSO compromised separation training for night time operations.
Melbourne Terminal Control Unit Controllers	To be consulted and be aware that aircraft may be vectored at night in a compromised separation scenario and be on an assigned heading rather than on the published missed approach path.
Learning Academy	Develop and deliver training to Melbourne ADC Update internal training material as required.
East Coast Services South Office of the Chief Air Traffic Controller, ATS Integrity	Development and delivery of changes to the rule-set (MATS, AIP) and the development of pilot educational material via an AIC
ATM Service and Support, Instrument Flight procedure Design	To investigate whether obstacle clearance requirements can be met if a vector off the published missed approach path is given.

Airline Operators authorised to conduct LAHSO	To be consulted on the development of the proposed procedure and be in agreement that they are able to comply with vector instructions at night. To provide education to their crews and, where they feel it necessary, to amend existing LAHSO training/refresher programs. Provide written evidence of their support that would be included in the safety case.
Melbourne Airport	To be kept informed and provide support for the activities undertaken

4 Assumptions, constraints and dependencies

4.1 Assumptions

Resources will be made available to complete the work in the time allocated.

4.2 Constraints

No constraints were identified at the time of writing this safety plan.

4.3 Dependencies

Airline consultation on the safety and utility of the procedure.

Training resources (including Learning Academy 360° visual simulator) are available for ML Tower Aerodrome Controllers.

Instrument Flight Procedure design work to demonstrate that obstacle clearance can be assured on a range of headings left and right of the published missed approach path.

CASA endorsement of the proposed change.

5 Responsibilities

Table 2 below lists the safety related responsibilities assigned to stakeholder involved in executing the change.

Table 2: Stakeholder's safety responsibilities

Title and name	Primary responsibilities
Change Sponsor [redacted] Manager, East Coast Services South (ECSS)	• Go/No-Go decision on change • Acceptance of Safety Plan / Safety Case
Office of Chief Air Traffic Controller (CATC) [redacted] Chief Air Traffic Controller	• Acceptance of Safety Plan / Safety Case
Change Manager [redacted] - ATC Business Coordinator ECSS	• Completion of the change within the constraints of safety, time, cost, and scope
Melbourne Tower Air Traffic Control [redacted] - Acting ATC Line Manager [redacted] – Check and Standardisation Supervisor	• ATC subject matter expertise (SME) input into training development
Learning Academy [redacted] - ATS Instructor (TWR/TMA) [redacted] - ATS Instructor (TWR/TMA) [redacted] - ATS Instructor (Standards Specialist)	• Development and delivery of updates to compromised separation training to include LAHSO at night
ATS Integrity [redacted] – ATS Integrity Manager	• Management of required AIP and AIC changes
Instrument Flight Procedures [redacted] – Chief Designer	• Obstacle clearance analysis
Regulatory Services [redacted] - Regulatory Services Manager	• Liaison with CASA
Safety, Environment and Assurance (SE&A) [redacted] – Senior Project Safety Specialist [redacted] - Senior Human Factors Specialist	• Facilitate SCARD / PHFA workshop • Preparation of Safety Plan and Safety Case
Safety Program Working Group (SPWG)	• Assist with the coordination of the project's safety objectives and activities • Communicate, advise, agree, recommend, prioritise and assist to achieve the safety program's objectives • Seek advice and guidance from invited specialists, subject-matter experts and other interested parties as necessary

6 Consultation and communication

The Change Manager is responsible for ensuring that all key internal and external stakeholders are consulted throughout the change program. The purpose of the consultation and communication process is to ensure that all relevant stakeholders are, where appropriate:

- Advised of project activities
- Able to provide subject matter expert input
- Involved in the decision making process

Table 3: Stakeholders consulted during the change program

<table>
<tr><th>Stakeholder</th><th>Aim / Nature of Communication</th><th>Evidence</th></tr>
<tr><td>Project Steering Group</td><td>To ensure appropriate governance and guidance</td><td>Meeting minutes</td></tr>
<tr><td>Melbourne Tower and TCU staff</td><td rowspan="2">To engage staff in the development of procedures, safety management activities</td><td rowspan="5">Meeting minutes

Development and delivery of simulator training package</td></tr>
<tr><td>Learning Academy</td></tr>
<tr><td>ATS Integrity (ATSI)</td><td>Receive training</td></tr>
<tr><td>Instrument Flight Procedures Design (IFP)</td><td rowspan="2">Meetings, workshops, emails, phone calls and verbal briefings, simulator training</td></tr>
<tr><td>Project & Business Support (PBS)</td></tr>
<tr><td>Regulatory Services</td><td rowspan="2">Meetings, workshops, emails, phone calls and verbal briefings:

Seek advice on regulatory compliance.

CASA liaison and briefings</td><td rowspan="2">SCARD

CASA update meetings / Quarterly CASA / Airservices Working Level Meetings</td></tr>
<tr><td>CASA</td></tr>
<tr><td>Airline Operators</td><td>To gain support from airline operators that the procedure is acceptably safe and that they are willing to participate.

Meetings, written and verbal briefings</td><td>Attendance at briefings and simulator sessions

Documented support for the implementation of the procedure

Documented evidence of education/training provided to their crews</td></tr>
<tr><td>Melbourne Airport</td><td>Meetings, emails, phone calls and verbal briefings</td><td>Meetings / phone calls as required</td></tr>
</table>

7 Safety management activities

The following safety management activities have been identified to provide safety assurance in support of re-instating LAHSO operations at night time.

Activity 1	**Develop night time LAHSO compromised separation simulated exercise**
Description / Objective	Develop night time LAHSO compromised separation simulator exercise (SIMEX) that will include training on vectoring at night as well as transition from VMC to night procedures.
Responsibility	Learning Academy and Melbourne Tower Training ALM
Tools	Learning Academy 360° visual simulator. Hardware and software required for exercise development
Inputs	Simulator exercises, scripts and briefings
Additional Resources	Learning Academy SIMEX development staff, Simulator Support Operators (SSO)
Outputs	A fit for purpose simulator training package for participants including briefing materials and instructor guides
Comments / Links	This activity has been completed and will be reported on in the safety case

Activity 2	**Completion of compromised separation refresher training**
Description / Objective	Melbourne Tower Aerodrome Controllers to complete compromised separation refresher training. To be completed as SIMEX training and not classroom. To be delivered to all ADCs by the end of Feb. Completion of this activity will prepare staff for the resumption of LAHSO during the hours of darkness.
Responsibility	All ADC qualified staff and all staff training for the ADC endorsement.
Tools	Learning Academy 360° visual simulator.
Inputs	Briefing material for staff and guides for instructors/SSO
Additional Resources	Melbourne Tower staff, Instructors and SSO
Outputs	Evidence of controller completion of training
Comments / Links	To be completed by the end of February 2016.

Activity 3	**Obstacle clearance analysis for ML airport circling area**
Description / Objective	Instrument Flight Procedures design staff will assess if obstacle clearance requirements can be met if a controller vectors an aircraft off the published missed approach path.
Responsibility	Chief Designer
Tools	IFP design tools
Inputs	Published missed approach procedures. PANS-OPS and other IFP design procedure documentation
Additional Resources	Procedure designers
Outputs	Evidence that describes whether or not obstacle clearance can be assured and if not what changes would need to be made to provide that assurance.
Comments / Links	

Activity 4	**Airline Operator consultation and participation**
Description / Objective	Consultation with Airlines regarding suitability of the compromised separation solution Participation in development of ruleset changes and education material (AIP/AIC as required) Airlines to determine internal education/training requirements Aircrew complete relevant education/training regarding updated procedures.
Responsibility	Change Manager, Melbourne Tower Training ALM, Learning Academy staff, ATS Integrity Airline training organisations
Tools	Learning Academy 360 degree simulator, instructors and SSOs Meeting rooms, projectors for meetings and briefings Airline training and education resources
Inputs	Briefing materials, e.g. PowerPoint.
Additional Resources	Change Manager, Human Factors Specialist, ATC staff, Airline Operators
Outputs	Evidence of airline consultation, including briefings and review of simulator exercises Documented support for the implementation of the procedure Documented evidence of education/training provided to aircrews AIP changes AIC
Comments / Links	

Activity 5	**Review Melbourne LAHSO ORA**
Description / Objective	Review the Melbourne LAHSO ORA in the context of the changes to compromised separation procedures and training in support of re-instating LAHSO operations at night in Melbourne
Responsibility	Project Safety Specialist
Tools	THESIS
Inputs	Melbourne LAHSO ORA
Additional Resources	Change Manager, PBS Manager, Melbourne, ECS-S Manager
Outputs	AA-FORM-SAF-0032 if change to ORA is required
Comments / Links	It should be noted that the proposed change does not introduce new hazards that are not already captured within the risk baseline. The compromised separation procedures and associated training relate to strengthening recovery action should the top event occur. As such any changes to the risk baseline (ORA) will relate to strengthening recovery preparedness measures and escalation factor controls only

8 Timelines and milestones

The table below indicates the planned timeframes for the safety activities to be undertaken.

Table 4: Planned milestones for safety management activities

Activity	Planned Completion date
Develop night time LAHSO compromised separation simulated exercise	Completed
Completion of compromised separation refresher training	February 2016
Obstacle clearance analysis for ML airport circling area	February 2016
Airline Operator participation	March 2016
Finalisation of safety plan	March 2016
Finalisation of safety case	March 2016

9 Resources

The resources (people and facilities) required to conduct the safety assessment work are outlined in Section 7.

Table 5 shows the members and advisors of the Safety Program Working Group.

Table 5: Safety Program Workshop Group

Member Role	Name
Change Manager	[redacted]
Senior Project Safety Specialist	[redacted]
Senior Human Factors Specialist	[redacted]
Tower ATC Subject Matter Expert (SME)	[redacted]
ATS Integrity Manager	[redacted]
Regulatory Services	[redacted]
Advisor Role	**Name**
Service Delivery Line Manager	[redacted]
Chief Air Traffic Controller	[redacted]
Tower ATC	Others as required
Learning Academy ATS Instructors	[redacted]

10 Training and education

As noted in Section 3.1 CASA placed the following requirement on Airservices [Attach 1]:

Airservices provides evidence to CASA that all ATCs endorsed for Melbourne Tower Aerodrome Control (ADC) have been assessed as competent in effective night-time compromised separation techniques which include the requirements associated with the Minimum Vectoring Altitude;

To address this Airservices has reviewed and updated its existing compromised separation training package to include compromised separation training for LAHSO at night.

In addition, refresher training in LAHSO operations is being conducted along with training on transitioning from 'day time' to 'night time' LAHSO operations. This is scheduled for completion by the end of February 2016.

11 Document review

11.1 Service Delivery Line/Business Branch or Unit

This Plan complies with Airservices Operational Safety Change Management Requirements [Ref 2] and Safety Assessment Preparation and Reporting [Ref 3] and has been prepared following the processes described therein.

On issue of this safety plan it will have been reviewed by SE&A PBS Manager, Melbourne and ATC SMEs as indicated at the front of the document, to ensure compliance with the Airservices SMS.

All review feedback has been considered and where appropriate changes have been made to the document.

11.2 Safety, Environment and Assurance

On issue of this safety plan it will have been reviewed by the Change Assurance Manager to ensure compliance with Safety Assessment Preparation and Reporting [Ref 3]. This review, and the consideration and incorporation of review comments, is required for all safety plans prior to the issue of the safety case to CASA.

12 Approvals

On issue of this safety plan it will have been endorsed by EGM SE&A. Acceptance of this safety plan will be required by Manager ECSS and CATC. The safety plan will then be provided to CASA for their information.

13 Definitions

Within this document, the following definitions, acronyms and abbreviations apply:

Term	Definition
ADC	Aerodrome Controller
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
ALM	ATC Line Manager
ATC	Air Traffic Control
ATM	Air Traffic Management
ATSI	ATS Integrity
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
CATC	Chief Air Traffic Controller
ECSS	East Coast Services South
EGM	Executive General Manager
IFP	Instrument Flight Procedures
IMC	Instrument Meteorological Conditions
LAHSO	Land and Hold Short Operations
MATS	Manual or Air Traffic Services
ML	Melbourne
MOS	Manual of Standards
MVA	Minimum Vectoring Altitude
ORA	Operational Risk Assessment
PBS	Project and Business Support
PHFA	Preliminary Human Factors Assessment
SCARD	Safety Case Assessment Reporting Determination
SE&A	Safety, Environment and Assurance
SIMEX	Simulated Exercise
SME	Subject Matter Expert
SPWG	Safety Program Working Group
SSO	Simulator Support Officer
VMC	Visual Meteorological Conditions

14 Attachments

No.	Title and version	Number/Link
1	CASA - Notice of proposed direction re LAHSO at Melbourne (File Ref: EF11/10239)	HO_CB0-3043682
2	SCARD – Compromised Separation Procedures during LAHSO at night at ML Airport (Version 1.0)	HO_CB0-3043683

15 References

No.	Title and version	Number/Link
1	Safety Case Assessment and Reporting Determination (SCARD) Template	AA-TEMP-SAF-0042
2	Operational Safety Change Management Requirements	AA-NOS-SAF-0104
3	Operational Safety Assessment Preparation and Reporting	AA-GUIDE-SAF-0104

airservices

LAHSO – Risk Review and ORA Review

Minutes

Workshop: Risk review and ORA review
Venue: Hodgson Room (1.29), Building 330
Date: Monday 7th March 2016 (1pm – 3pm AEST)

Meeting attendees: See also http://crcb20/documents/HO_CB0-3043785

Name:	Role
[redacted]	ATC line Manager
[redacted]	ALM ML Tower
[redacted]	ATC C&SS ML TCU
[redacted]	Acting ALM ML TCU
[redacted]	ALM ML TCU
[redacted]	ECSS Business Coordinator
[redacted]	PBS Manager Melbourne
[redacted]	Senior Human Factors Specialist
[redacted]	Human Factors Specialist

Facilitator: [redacted] – Senior Project Safety Specialist

Apologies: [redacted] (Acting ECSS SDL Manager), [redacted] (ALM ML Tower), [redacted] (ATC ML Tower), [redacted] (Technical Research Specialist), [redacted] (ATC C&SS ML TCU)

Purpose: The purpose of this meeting was to review hazards 5, 10, 15 and 18 from Hazlog Register #901 and SAR Addendum, and review the ORAs to consider what updates will be required.

Meeting Minutes:

Item / Subject	Minutes / Discussion
Meeting opened	• Project Safety Specialist opened the meeting and introduced the purpose and agenda for the workshop: o Review and re-assess residual risks from Hazlog #901 and SAR Addendum: ▪ Hazard No. 10 – Class B risk ▪ Hazards No. 5, 15, 18 – Class C risks ▪ The hazards reviewed were those taken from the 2015 SAR Addendum (Tables 5 and 6). Refer to SAF-SAR-120009-Add. o ORA review with respect to 'Compromised Separation Recovery Procedures' ▪ Review right hand side of bowtie o ORA review with respect to 'Stagger' ▪ Review left hand side of bowtie
Hazlog #901 – Hazard 5	• Hazard No.5 from SAR Addendum was assessed as a Class C Risk: o Likelihood = Daily – Yearly o Consequence = Minor • Upon review by the meeting attendees the risk classification has not changed. Likelihood and Consequence remain the same.

<table>
<tr><th>Item / Subject</th><th>Minutes / Discussion</th></tr>
<tr><td>Hazlog #901 – Hazard 10</td><td>Hazard No.10 from SAR Addendum was assessed as a Class B Risk:
Likelihood = Yearly – 5 Yearly
Consequence = Major
As noted by the ECSS Business Coordinator, Operational Analysis have updated their 'Risk Analysis of Melbourne LAHSO Operations' report, which has since seen the likelihood for a double go-around revised, as follows:
For a Critical Proximity scenario, i.e. where two aircraft are within 1NM laterally and 500ft vertically, the likelihood is estimated to be 1 in every 24years.
For a Near Collision scenario, i.e. where two aircraft are within 140ft laterally and 40ft vertically, the likelihood is estimated to be 1 in every 6500years.
Taking the worst case scenario the likelihood for this hazard therefore decreases to 5 in 50 years. The risk classification does however still remain as a Class B risk.</td></tr>
<tr><td>Hazlog #901 – Hazard 15</td><td>Hazard No.15 from SAR Addendum was assessed as a Class C Risk:
Likelihood = Daily – Yearly
Consequence = Minor
Upon review by the meeting attendees the risk classification has not changed. Likelihood and Consequence remain the same.</td></tr>
<tr><td>Hazlog #901 – Hazard 18</td><td>Hazard No.18 from SAR Addendum was assessed as a Class C Risk and was associated with prolonged non-LAHSO operations:
Likelihood = Daily – Yearly (initial) / Yearly – 5 Yearly (residual)
Consequence = Minor
Upon review by the meeting attendees it was agreed that there is no further change to this risk as currently there is no intention to cease LAHSO. Risk classification remains unchanged.</td></tr>
<tr><td>ORA review with respect to 'Compromised Separation Recovery Procedures'</td><td>As part of the work that is being carried out for the compromised separation recovery procedures, it was noted that the proposed change does not introduce any new hazards that are not already captured within the risk baseline. The potential hazards were still noted as part of the SCARD conducted on 04/02/2016.
The ML ORAs (Tower and TCU) were reviewed with the attendees and it was noted that the compromised separation recovery procedures and associated training relate to strengthening recovery action should the top event occur. Refer to ML Tower ORA-4 and ML TCU ORA-3 'Aircraft in conflict (LAHSO)' and consequence lines:
Aircraft Accident
Loss of Separation
Loss of Separation Assurance
As such any changes to the risk baseline (ORA) will relate to strengthening recovery preparedness measures and escalation factor controls only to the above consequence lines.
Until such time that LAHSO night time operations are re-instated the ORA is to be remain unchanged as these recovery preparedness measures are yet to be updated and implemented.</td></tr>
<tr><td>ORA review with respect to 'Stagger'</td><td>As part of the work that is being carried out to implement the 'Stagger' it was noted that this would be a barrier that would be included to the ML Tower ORA-4 and ML TCU ORA-3 ''Aircraft in conflict (LAHSO)' and threat line:
Aircraft(s) conducts a missed approach during Land and Hold Short Operations
Until such time that 'Stagger' is introduced the ORA is to be remain unchanged as the barrier is yet to be implemented.</td></tr>
</table>

Item / Subject	Minutes / Discussion
Hazard identified during 'Stagger' SCARD	• During the completion of the SCARD on 18/02/2016 the following hazard was identified: o 'Aerodrome controller (ADC) misjudges a departure gap which causes a go around. Note: Under LAHSO stagger runway 34 landings arrive after runway 27 landings. Cannot LAHSO a runway 27 departure with a runway 34 arrival at night. Aircraft landing on runway 34 must report when leaving the runway before a departure off runway 27 can be cleared for take-off. • This hazard was assessed as a class C risk with the proposed control being a reduced LAHSO rate during stagger. This has been trialled in the simulator and an arrival rate of 36 has been selected. This hazard has been recorded in Hazlog register #1239.
Updated hazards from Hazlog #901 incorporated in ORAs	• In the event that CASA endorses the LAHSO SAR Addendum submitted in respect of re-instating night operations the ORAs with respect to LAHSO will be updated to reflect any new risk controls that have been implemented since the last SAR Addendum update from July 2015. • The ORA reviews/updates to be initiated by the ECSS Business Coordinator with the help of the Safety Performance team from the CATC Office and ALMs from each location.
Next steps / Meeting closed	• Project Safety Specialist to forward minutes to stakeholders.

Analysis of Melbourne LAHSO go-arounds

airservices

Operational Analysis
Strategy, Systems and Analysis
Safety, Environment and Assurance
Airservices

Version 1.7

Effective 2016-01-13

Major Change Summary

Version	Date	Change Description
0.1	2015-11-01	Initial document written [redacted]
0.8	2016-01-14	Major editing and writing by [redacted]
1.0	2016-01-21	Additional editing by [redacted] and [redacted]
1.4	2016-02-12	Additional analysis and verification by [redacted] including data up to 2016-01-31.
1.7	**2016-03-03**	Incorporation of editorial changes by [redacted] and [redacted]

	Staff	**Signature**
Requested by	ATC and Safety groups	
Analysis	[redacted] Operational Analysis, SSA, SE & A	
Report and further analysis	[redacted] Operational Analysis, SSA, SE & A	[redacted]
Authorised	[redacted] Operational Analysis Manager, SSA, SE & A	[redacted]
Authorised	[redacted] Strategy Systems and Analysis Manager, SE & A	[redacted]

1 Executive Summary

This study considers the **likelihood of double go-arounds** during Land and Hold Short Operations (**LAHSO**) at Melbourne International Airport ('Melbourne'); it also considers the **risk of mid-air collision (MAC)** or **likelihood of Aircraft in Critical Proximity** (ACP). This work extends previous studies of LAHSO operations conducted in 2012 and 2015 [2] as requested by Airservices' Air Traffic Control and Safety groups. Large sections of the 2015 LAHSO analysis are included in this report to enable it to stand alone.

This study hence considers all data from January 1st 2012 through to January 31st 2016.

New LAHSO procedures were formally implemented on December 10th 2015 (see Page 7) and partially implemented prior to this date. This analysis includes data up to January 31st 2016 to specifically investigate this change.

Five events are evaluated, as specified below. The first three, DGA60, DGA40, and DGA20 events, only consider the horizontal proximity and Aircraft in Critical Proximity (ACP): a DGA60 event is where two go-arounds are within 60 seconds of each other at the runway crossing point. The last two, Mid-air collision (MAC) events, consider both the horizontal and vertical components.

1. **DGA60**: The likelihood of two go-arounds within 60 seconds:
   1.1. This may occur approximately every 1-3 years
   1.2. Aircraft longitudinal separation would be approximately 3 nautical miles (NM).
2. **DGA40**: The likelihood of two go-arounds within 40 seconds:
   2.1. This may occur approximately every 2-6 years
   2.2. Aircraft longitudinal separation would be approximately 2 NM.
3. **DGA20**: The likelihood of two go-arounds within 20 seconds:
   3.1. This may occur approximately every 4-13 years
   3.2. Aircraft longitudinal separation would be approximately 1 NM.
4. **ACP:** The likelihood of two Aircraft in Critical Proximity defined here as within 500 ft. vertically and 1 NM longitudinally:
   4.1. This may occur approximately every 15-50 years
   4.2. Aircraft longitudinal time separation reduced to approximately 20 seconds.
5. **MAC:** The likelihood of a mid-air collision defined here as two aircraft within 100 ft. longitudinally (0.9 seconds) and 42 ft. vertically with no TCAS or avoiding action:
   5.1. This may occur approximately every 6 500 years
   5.2. This may result in a collision or near-collision.

This current work extends the 2015 LAHSO study [2] to include data up to January 31st 2016 and also considers the likelihood:

- for day-time versus night-time operations
- for approaches via the SHEED waypoint
- in relation to departure frequency.

Each of these factors were identified by ATC subject matter experts as some possible causal factors for go-arounds at Melbourne. This work continues to assess the double go-around likelihood according to (cross- and down-) wind speed and previous go-around occurrences.

1.1 Main Results

The data and analysis indicate that during LAHSO:

1. night-time operations **do not** statistically increase go-around likelihood **(§ 7.1, Figure 9)**[1]
2. approaches via SHEED **do not** statistically increase go-around likelihood **(§ 7.2, Figure 11)**
3. occupied runways, due to departures, is a known cause for go-arounds (**§ 11.7)** however there is insufficient data to find a statistically significant correlation of go-arounds with departure frequency during LAHSO, although, as expected, during non-LAHSO operations departure frequency does increase go-around likelihood. **(§ 7.3, Figure 15)**

Additionally:

4. although **wind-speed** is in general a factor for increased go-around likelihood, it is **not a factor during LAHSO** operations due to weather restrictions for LAHSO operation **(§ 11.3, Figure 42, Figure 43)**
5. the LAHSO **go-around** likelihood has **decreased** in the last 12 months to 2.5 go-arounds per 1000 LAHSO arrivals **(§ 7.4, Figure 19)**
6. if a go-around has occurred there is a 1 in 20 chance that another arrival occurring within 60 seconds will also go-around (an increase from 2.5 to ~40-50 per 1000 arrivals) – **(§ 7.6,)**
7. the likelihood of a **double go-around** (within 20 seconds - DGA20) is approximately **1 in every 6.5 years** within the range 4-13 years **(§8, Figure 22)**
8. the risk of a **ACP** is approximately **1 in every 24** years within the range 9-29 years (§ 8)
9. the risk of a **mid air collision** is approximately **1 in every 6 500 years** or **8E-9 per approach**, within the range 4 000 to 13 000 years **(§ 8)**
10. insufficient data was available after December 10th 2015 to determine whether procedure changes have affected the go-around rate, however, there has been a consistent decrease in rate since January 2015. **(§ 8)**
11. if two aircraft do arrive at the crossing point at the same time, there is a ~2% chance that their vertical separation is small enough to cause a collision, assuming no pilot avoiding action. **(§ 7.9)**

The collision risk values of 8E-9 per arrival is in the mid-to-upper range of internationally acceptable approach target levels of safety which are usually in the range of 1E-9 to 1E-8 per approach **(§ 9)** . Alternatively, if a measure of risk is made in terms of number of years between collisions, then the collision risk of order 1 every 6,500 years is within acceptable international risk levels which are usually of order 100-1,000 years for typical en-route or approach operations. The relatively large times-scale of 6,500 years is due to the relatively lower arrival rate per year for Melbourne LAHSO operations

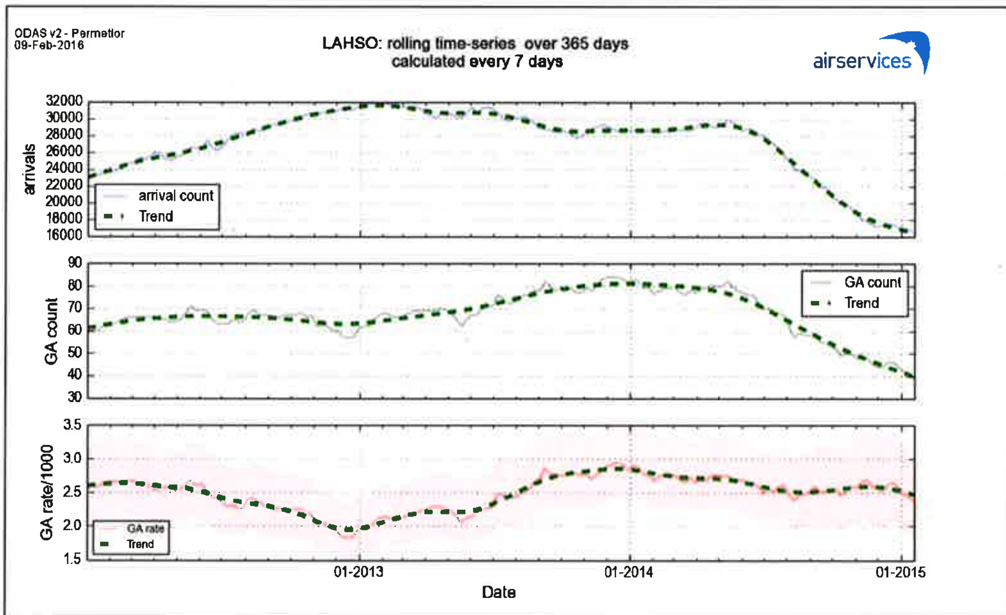
The current risk assessment is conservative and may overestimate the risk.

Hence the collision risk appears to be within acceptable international target levels of safety.

[1] Relevant sections, denotes §, and figures are included as hyperlinks.

1.2 Summary of key graphical results.

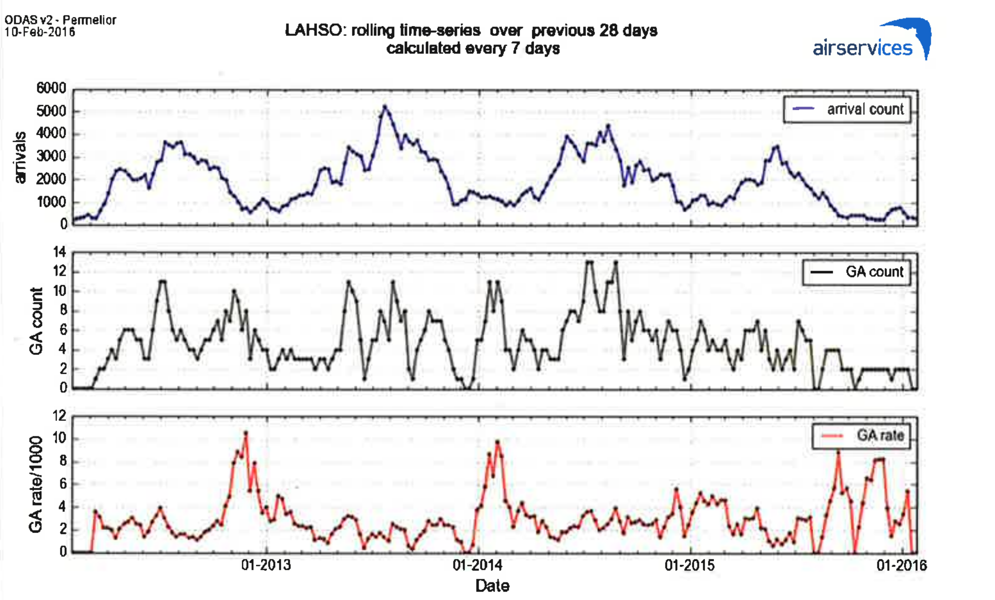
This section tabulates some key graphical results from the report for easy reference.



Average LAHSO usage has declined over the last 12 months

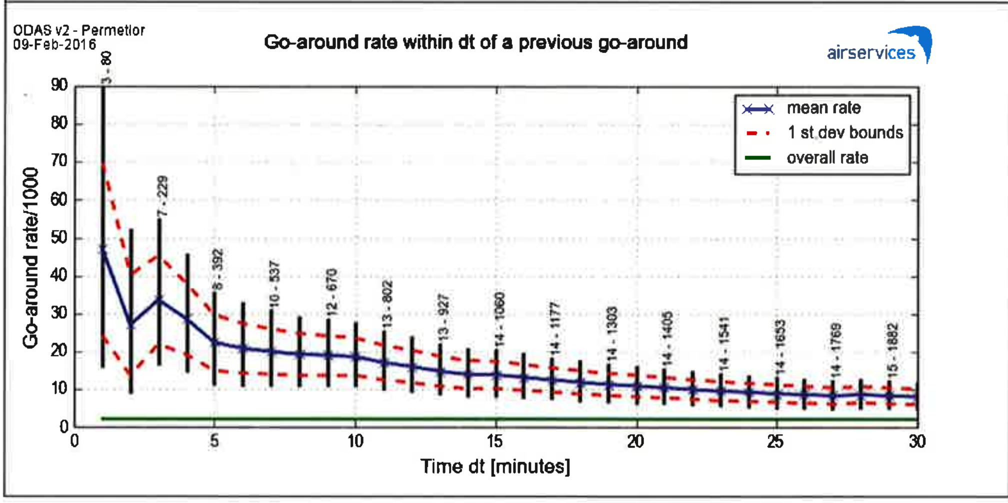
LAHSO go-around rate has declined slightly to 2.5 per 1000 approaches.

See **Figure 19** for details.



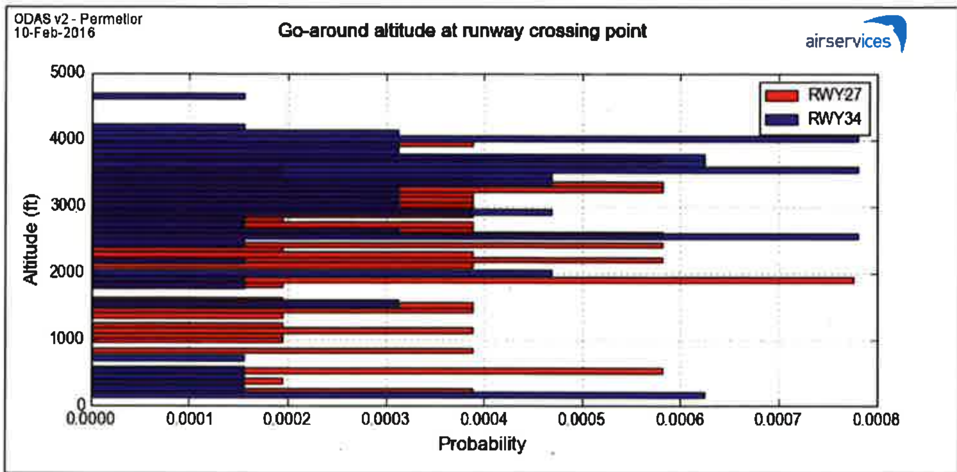
LAHSO usage is seasonal.

See **Figure 18** for details.



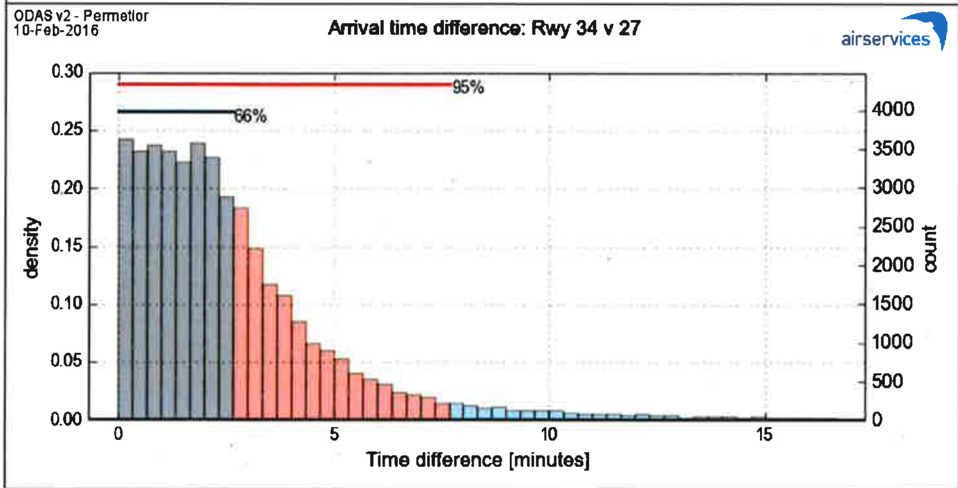
LAHSO go-around rates increase for a period after a previous go-around. That is, following on go-around, the next approach is more likely to also go around.

See **Figure 22** for details



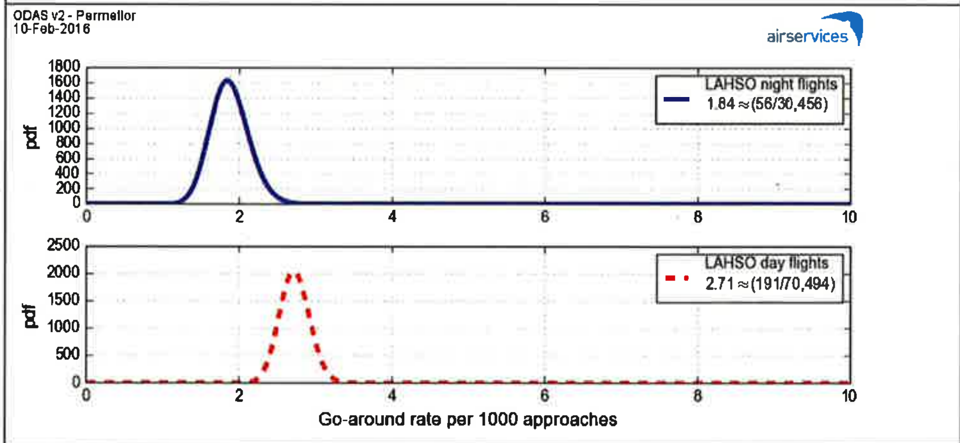
The altitudes of go-arounds at the crossing point are broadly distributed up to 4000 ft. The gives the likelihood of vertical separation less than 42 ft (an aircraft height) of 2.2%.

See **Figure 26** for details



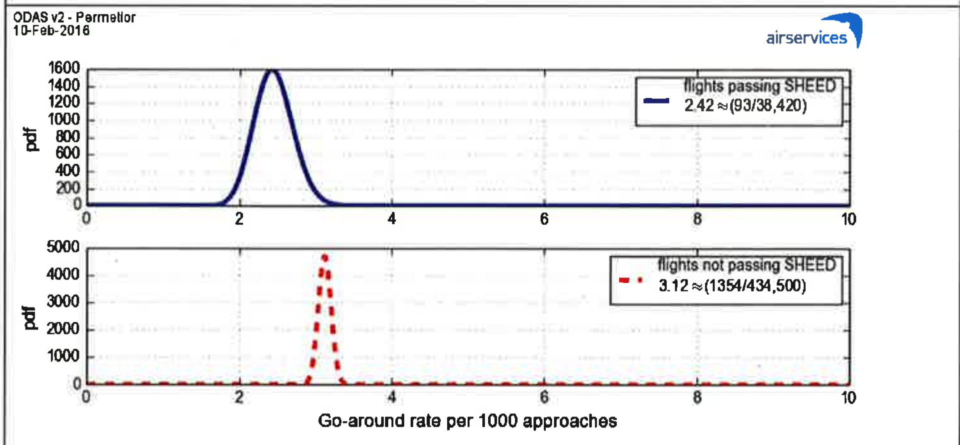
Approximately 66% of pairs arriving during LAHSO times arrive within ~3 minutes of each other. This gives a probability of 0.23 that aircraft arrive within 1 minute of each other.

See **Figure 23** for details



LAHSO go-around rates are not higher during night-time operations.

See **Figure 9** for details



LAHSO go-around rates are not higher for aircraft approaching via SHEED.

See **Figure 11** for details

2 Introduction and Background

In mid-2015, Operational Analysis (OA) was tasked by Air Traffic Control (ATC) Group with reviewing aircraft arriving at Melbourne International Airport ('Melbourne') that performed a go-around manoeuvre, as well as determining the go-around rates, and analysing the likelihood of a double go-around (DGA) during Land and Hold Short Operations (LAHSO). This study [2] identified numerous factors that required further testing and verification. Significant Air Traffic Control (ATC) subject matter expertise (SME) was involved in the study itself and in the post-analysis of the report as part of Airservices' Safety Management System (SMS).

The 2015 LAHSO study [2] focussed on the go-around rates over time and the probability that two aircraft perform go-arounds within 20 seconds (DGA_{20}) or 60 seconds (DGA_{60}) of each other. DGA_{20} and DGA_{60} were chosen arbitrarily as no formal definition or mathematical derivation exists for what constitutes a 'double go-around'. The DGA_{60} definition is suitable as a metric allowing analysis of trends and indicating events worthy of investigation. The DGA_{20} definition is suitable as a metric associated with a higher risk occurrence.

A key result in the 2015 study [2] was that the existence of one go-around in the time immediately prior to an arrival significantly increases the probability of a second go-around: some go-around causal factors (such as wind or occupied runways) persist long enough to affect arrivals on both runways.

The 2015 study [2] also considered correlations of go-around rates with cross- and down-wind components. The analysis indicated that for general operations wind was a significant factor in elevating go-around rates. However, the restricted conditions that exist during LAHSO showed only a small, and not statistically significant, correlation with wind. The analysis indicated that wind was not a significant factor in go-around rates during LAHSO but retaining current wind restrictions during LAHSO was warranted.

The 2015 study [2] showed no statistically significant correlation of go-around rate during LAHSO due to visibility or traffic density (number of arriving aircraft). Case by case analysis of actual go-arounds occurrences indicated that runway occupancy due to departing aircraft was a key causal factor.

The 2015 study [2] indicated a possible rise in the LAHSO go-around rate over time. This current 2016 LAHSO study, which includes more data and a refined methodology using annual rolling averages to smooth out seasonal peaks, now indicates a gradual decrease in the go-around rate since January 2015.

The ATC SMEs suggested further work to investigate correlations with:

- off-mode departures on runway 34
- arrivals via the SHEED waypoint
- night-time operations.

This current study includes analysis on these three correlations.

For completeness this current study includes key results from the 2015 LAHSO analysis [2].

Go-arounds

Using flight trajectory data a go-around is considered to be an aircraft that approaches the runway within 6.5 NM of the runway threshold and does not land. The distance 6.5 NM was chosen by considering the Departure and Approach Procedures (DAP) published by Airservices. According to the instrument approach procedures for precision and non-precision approaches at

Melbourne airport, earliest final approach starts at 6.5 nautical miles from the corresponding runway threshold.

December 10th 2015 procedure changes

The changes made on 10th Dec were as follows:

1. Instrument approaches are to be used during LAHSO, hence removing SHEED arriva[2]ls.
2. The STAR allocation was changed with aircraft via ARBEY (TUNKA) and WENDY being directed to RWY 34, and aircraft via LIZZI, WAREN and BADGR being directed to RWY27.
3. The LAHSO mode will not be considered unless there is 5 minutes or more delay in the system; this ensures use of the mode when it is required not when it is simply convenient.

There is also continuing work to reduce the number of "off mode" departures during LAHSO. This should result in a reduction of runway occupied Go Arounds from RWY34 during LAHSO.

Melbourne Runway Configuration

This section gives a brief description of key features of the Melbourne runway configuration. **Figure 1** shows the terminal chart for Melbourne and a schematic of the key features for this study.

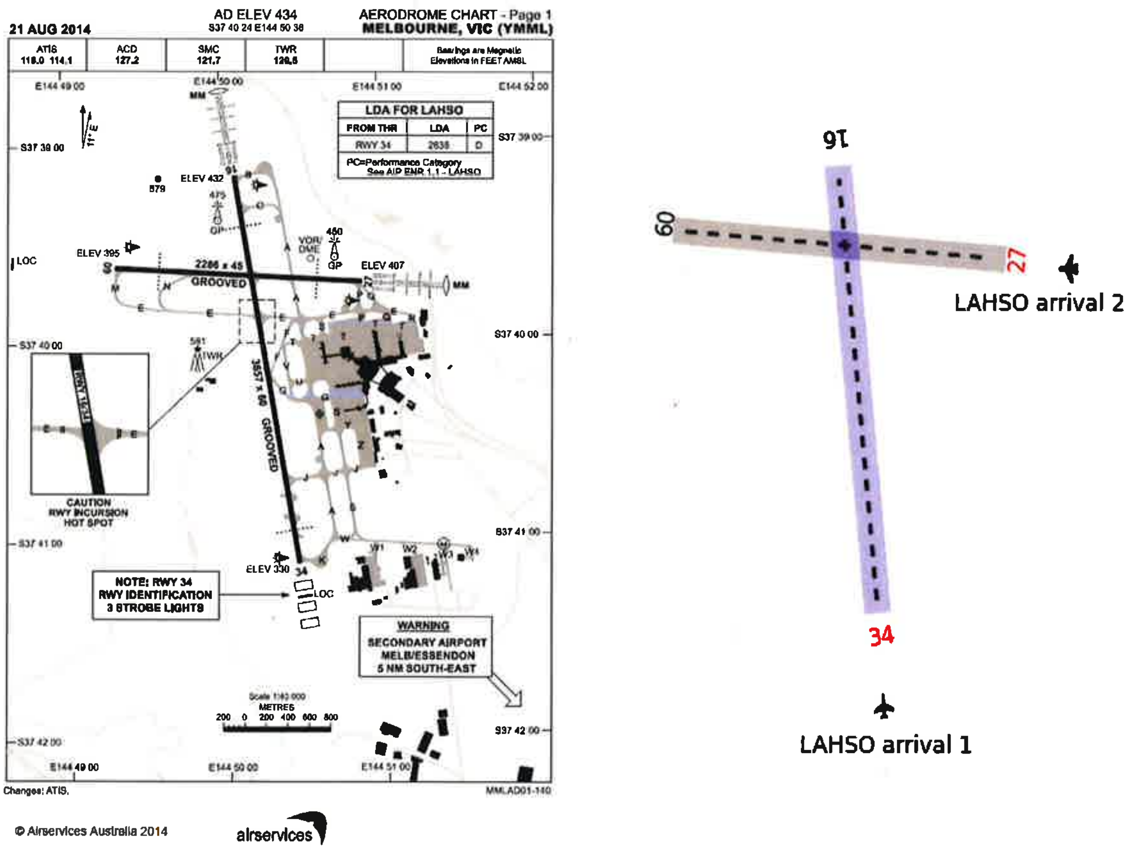


Figure 1: *Melbourne International Airport aerodrome chart (source: DAP: Departure and Approach Procedures) and schematic diagram of the main features for this LAHSO study. The main southerly runway (runway 16) runs from the top of the page down (at a heading of 160 degrees), while the northerly runway*

2 The removal of SHEED in the new procedures indicates a need to analyse the affect of arrivals by this waypoint as ATC SMEs consider these arrivals to be a factor in go-around rates.

(runway 34) runs from the bottom of the page up (at a heading of 340 degrees). Runway 09 runs left to right (west to east) and runway 27 runs right to left (east to west).

2.1 Typical LAHSO arrivals

This section shows some sample LAHSO arrival trajectories to provide a physical picture of the scenario. ***Figure 2*** shows a sample of arriving traffic to Runway 27 during LAHSO while ***Figure 3*** shows a sample of arrivals to Runway 34 during LAHSO. The SHEED waypoint is indicated in ***Figure 3*** as arrivals via this waypoint have short final approach of ~2.8NM.

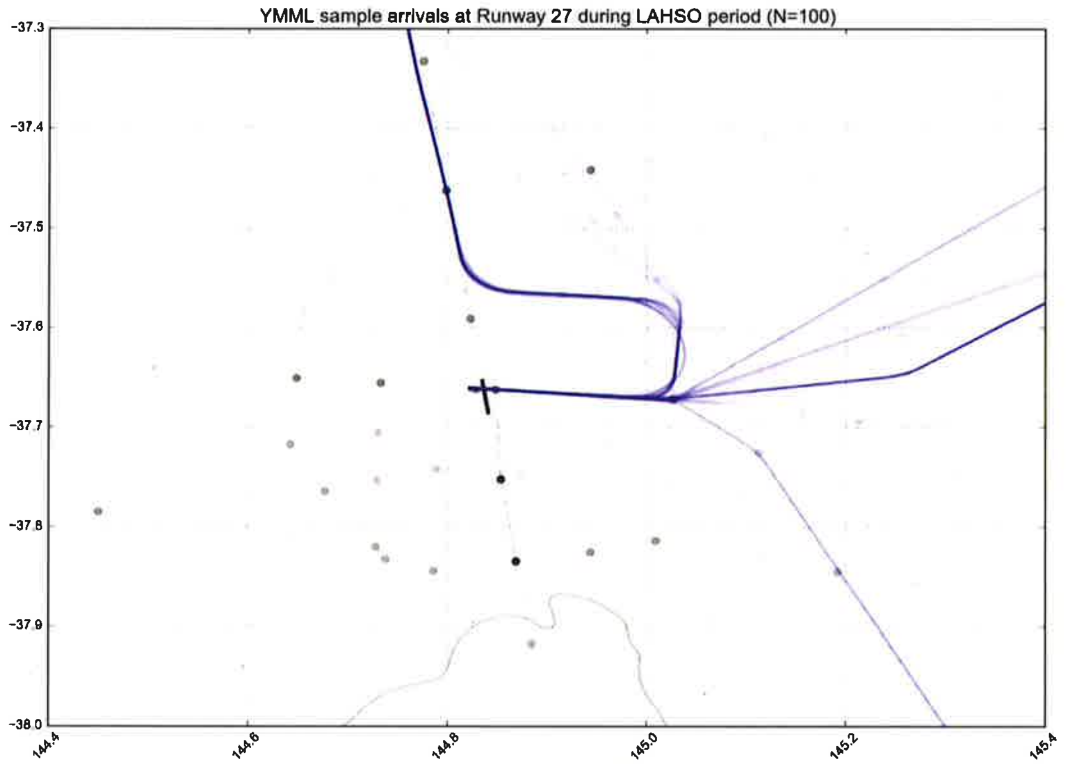


Figure 2: *A sample of 100 arrivals at Runway 27 during LAHSO operations. Dots indicate waypoints.*

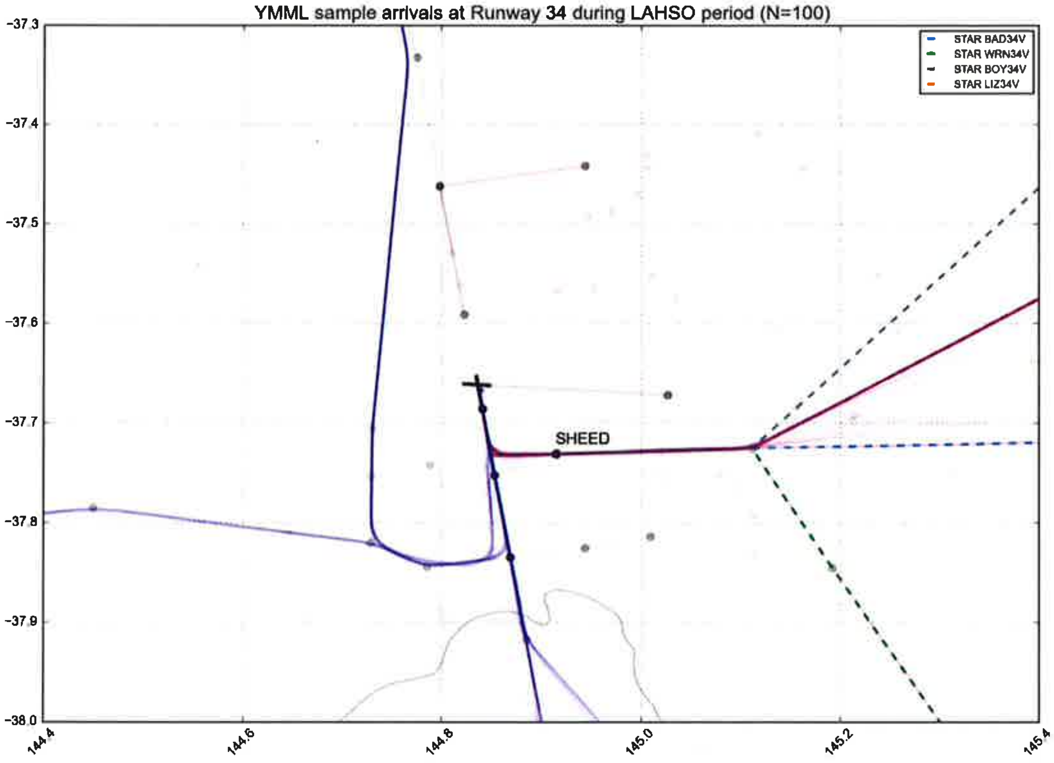


Figure 3: *A sample of 100 arrivals to Runway 34 during LAHSO. The waypoint SHEED is indicated as this is the subject of further study. The dashed lines indicate STARs which use the SHEED arrival.*

2.2 Melbourne LAHSO operations

This section gives a brief description of key elements and definitions of LAHSO operations relevant to this analysis.

LAHSO is an air traffic control procedure that allows aircraft to land and 'hold short' (stop) before an intersecting runway or point on the landing runway (see ***Figure 4*** for reference). The LAHSO procedure is internationally recognised and an Australian Civil Aviation Safety Authority (CASA) approved method to balance airport capacity and air traffic system (ATS) efficiency with safety considerations.

12.2.1.3 Crosswind/downwind limitations

Do not nominate a runway for use when:

Runway conditions	Wind
Completely dry	Crosswind exceeds 20 kt including gusts
	Downwind exceeds 5 kt including gusts
Not completely dry	Crosswind exceeds 20 kt including gusts
	There is a downwind component

12.2.1.3.1 Wind in excess of criteria - Refer IMA V32_01

Except during LAHSO, you may nominate a runway when crosswind or downwind exceeds the specifications of Clause 12.2.1.3 if:

a) required by noise abatement legislation;

b) an alternative runway does not exist; or

c) a take-off or landing, as applicable, is not possible on an alternative runway.

See MATS 12.2.1.3 Crosswind/downwind limitations

Figure 4: *Example of LAHSO conditions extracted from Manual of Air Traffic Services, MATS 12.2.1.3.*

Aircraft permitted to depart from a runway other than the nominated departure runway are referred to as "off-mode departures". Off-mode departures may result in go-arounds if there is delay during take-off or taxiing resulting in an occupied runway for arrivals.

2.3 Related Literature

This section describes some of the literature relating to analysis of LAHSO double go-arounds or similar operations. None of the references directly study LAHSO operations and the likelihood of double go-arounds or risk of a collision due to go-arounds. Most studies in this area relate to either classical risk-based analysis [1], Monte Carlo simulations of intersecting runways [3] or trajectory simulation studies of converging runway operations [5,6,7,8,9,10]. Several of these publications also deal with the appropriate target levels of safety (TLS) for approaches and related measures for quantitative collision risk. Some publications also give numerical proportions for the causal factors for missed approaches that are similar to results from Airservices own data presented here.

In 1995 Airservices did an internal study on 'Simultaneous operations on intersecting runways (SIMOPS)' [1]. This report noted the differences and similarities between the ICAO SOIR manual (Simultaneous Operations on Intersecting Runways) and FAA documentation and restrictions relating to this procedure. The appendix to this report contains a risk assessment by VRJ Risk Engineers Pty Ltd. This report focussed on the probability of an aircraft failing to 'hold short' and physical risk factors (i.e. brake failure, red versus orange lights), rather than the double go-around risk. Fault tree type risk analysis was used. This report mentions the double go-around risk but provides limited information which can be used within this current LAHSO study.

Henry et al. 2013 [3] used a Monte Carlo simulation based on historic aircraft trajectories to investigate the collision risk for aircraft arriving and departing on intersecting runways. In this case the risk involves the arriving aircraft performing a go-around. This Monte-Carlo simulation approach is not adopted in the present LAHSO report as sufficient trajectory data from actual flights is available to determine the parameters appropriate for the model. A similar study by Eckstein et al. 2010 [4] focussed on the data collection and simulation model rather than the risk assessment.

A series of publications by staff at the National Aerospace Laboratory NLR [5,6,7,8,9,10] considered the related problem of converging runways (***Figure 6***) [Simultaneous Converging Instrument Approaches (SCIA) and Dependent Converging Instrument Approaches (DCIA)] at Amsterdam Airport; the main risk is a double go-around where one aircraft does not perform the correct go-around procedure that involves a sharp left turn. The approach in these papers was to numerically simulate aircraft missed approach trajectories for a range of operating conditions. Petri nets (a type of event sequence diagram or fault tree) were used to analyse the variety and probability of difference causal factors. The collision risk values in his modelling are of order 1E-9 per approach.

Speijker [7] references data on missed approaches (see the extract in ***Figure 5***) as well as quoting statistics of 1-2 missed approaches per 1000 arrivals, based on world-wide KLM data. They used values between 2 and 10 missed approaches per 1000 arrivals due to a high rate of missed approaches on the specified runways and simulated four different aircraft sizes and trajectory types. This current 2016 LAHSO study considers only a single 'typical' aircraft, which is nominally equivalent to a B737 in size, but use the available data to find the actual range of aircraft altitude at the crossing point: The interpretation of Melbourne data in this LAHSO analysis indicates that the division into aircraft types will not change the results for the LAHSO study, but would unnecessarily complicate the analysis. This work uses a dependency factor $0<\rho<1$ to characterise how dependent a go-around on one runway is to a go-around on the second runway. This LAHSO study finds data that supports this dependency.

The approach used by the NLR team has the advantage of being able to simulate a range of proposed scenarios or mitigations to determine whether any procedure changes will decrease the collision risk. The disadvantage of this approach, which is not purely data driven, is that simulation results may have unknown bias and may not fully reflect the complexities of real traffic. A key result in the NLR analyses was that the missed approach height strongly influenced the risk. The analysis in this LAHSO analysis also confirms this finding.

The appendix gives an extract from [10] showing a breakdown of missed approach causes for Amsterdam airport. In broad terms it appears to reflect global standard go-around causes.

The NLR publications quote target level of safety (TLS) measures from different sources as being:

- 5E-9 per flight hour for each dimension for mid-air collision
- 1E-7 per approach for collision with obstacles
- 1E-7 per flight hour or 1.5E-7 per movement for accidents in all flight phases
- 1E-8 per approach and landing
- 2.5E-8 per flight hour or 3.5E-8 per movements for European ATC direct contribution to an accident.

The ICAO Manual on use of Collision Risk Model (CRM) for ILS Operations ICAO Doc 9274 describes the practical use of an Obstacle Clearance CRM Model. It quotes a Target Level of Safety of 1E-7 per approach. Paul et al. 2006 [30] quotes a TLS value of 1E-8 risk per movement (departure or arrival).

Speijker [7,29] referenced statistics quoting the accident rate per arrival at 'reasonably safe' major airports as 7E-7. As only a small proportion (~4%) would be due to ATC errors and design this equates to an ATC collision risk of order 2E-8. This work similarly argues for a TLS of order 4E-9 to 1E-8 per approach and one collision every 500-5000 years. Calculated collision risks for a converging runway system were quoted as 3.6E-9 per approach, and a probability of a LOS of

7.4E-5 per approach or 15 per year which he notes as being 'very high'. The author notes the acceptable TLS per approach is between 1E-9 and 1E-8 or 2E-4 and 2E-3 per year.

This brief summary of relevant literature indicates that several different approaches can be taken to assess the risk for LAHSO operations. The use of Monte Carlo simulations based on performance characteristics of many aircraft types has merit. In particular this method is very good at estimating risk for new procedure designs or changed operations. These simulation methods however, take considerable time to construct and require long simulation times to calculate results. They are also limited by the numerous assumptions within the modelling and open to wide interpretation and discussion as to the relevance of each assumption.

The approach taken within this LAHSO study is to purely examine the statistical history of the traffic flow and the actual go-around likelihood. This has the benefit of being relatively simple to calculate and understand, with fewer possible sources of modelling error. For the case of Melbourne LAHSO operations, over four years of data allows analysis with a statistically sound basis in trajectory data.

	Density type	**Dirac**	**Dirac**	**Dirac**	**Uniform**	**Uniform**
Reason	**Percentage**	**100 ft**	**300 ft**	**600 ft**	**600-1200 ft**	**100-1200 ft**
Runway occupied	27.2%	4.5%	22.7%			
Unstable approach	20.4%		6.8%	4.5%	2.3%	6.8%
Turbulence	6.8%	4.5%				2.3%
Flap problems	13.6%			2.3%	4.5%	6.8%
Wind-shear	22.7%	11.3%	6.8%	2.3%	2.3%	
Weather	2.4%					2.4%
Other	6.9%	2.3%	2.3%			2.3%
Percentage	100%	22.6%	38.6%	9.1%	9.1%	20.6%

Figure 5: *Extract from Speijker 2007 [7] with the reason and modelling distribution used for the missed approach. Of particular relevance to this LAHSO study is the 27.2% occupied runway statistics that is an identified factor for LAHSO go-arounds. Please see this reference for the full context.*

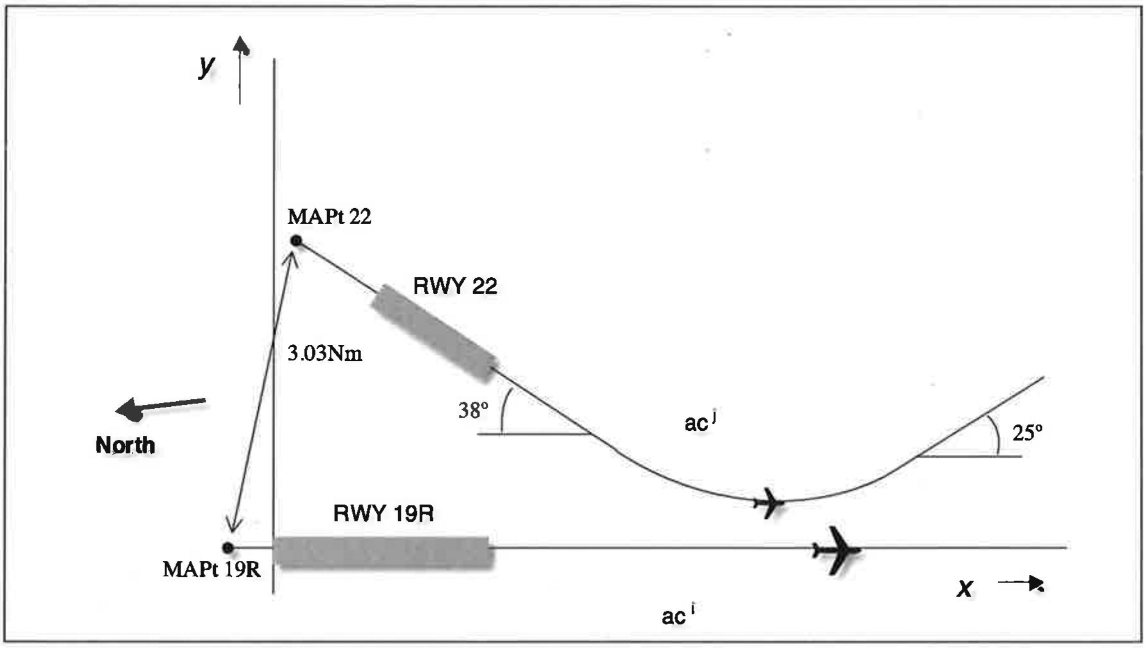


Figure 6: *Extract from Blom et al. 2003 [10] illustrating the geometry of runways 19R and 22 at Amsterdam Airport Schiphol and the AIP specified approach paths. In this case the risk involves aircraft ac^j (top) not correctly performing a left turn on the missed approach. Please see this reference for the full context.*

3 Aims

The aims of this analysis are to mathematically analyse go-arounds and double go-arounds at Melbourne International Airport; this will assist ATC subject matter experts (SMEs) in their overall assessment of LAHSO risk and benefits as part of Airservices' Safety Management System. In particular the study considers:

1. go-around rates during LAHSO
2. the likelihood of double go-arounds during LAHSO
3. the likelihood of an ACP due to double go-arounds during LAHSO
4. the risk of mid-air collision due to double go-arounds during LAHSO.

This analysis extends the previous 2015 LAHSO study [2] by considering:

5. data up to January 2016
6. the go-around rates:
    a. during day-time / night-time operations
    b. for approaches via the SHEED waypoint
    c. in relation to runway departure rates (number of departures in the ten minutes prior to a LAHSO arrival).
7. data after December 10^{th} 2015 when a number of procedural changes were implemented.

4 Scope

The analysis in this report was restricted to data from January 1st 2012 to January 31st 2016, (1,492 days) including:

- flight track information sourced from Airservices surveillance data (ADS-B, radar and ADS-C) and Flight Data Records (FDR), obtained from Airservices Operational Data Analysis Suite (ODAS)
- Melbourne runway definitions sourced from Aeronautical Data Management System (ADMS) aeronautical data
- runway usage and LAHSO times sourced from Automatic Terminal Information Service (ATIS) data.

This study does not consider in detail the causal factors for go-arounds, apart from correlations with:

- visibility
- cross- and down-winds magnitude
- arrivals via the SHEED waypoint
- daytime versus night time operations
- departure runway rate.

It is beyond the scope of this current analysis to consider other factors such as aircraft approach speed or angle, pilot actions, aircraft malfunctions or birds. The Operational Analysis group in Airservices is currently developing methods for analysis of unstable approaches from aircraft trajectory data. When completed, this will enable further analysis into the causal factors for go-arounds. Identifying unstable approaches from trajectory data is a difficult problem since many of the aircraft parameters and criteria described in airline SOP (standard operating procedures) for unstable approach (for example wheels down and cockpit procedures complete) cannot be easily derived from trajectory data.

It is not the purpose of this report to make recommendations regarding the use of LAHSO; subject matter experts within ATC have a more complete knowledge of LAHSO in the operational context. The aim of this report is to analyse available aircraft trajectory data to identify any significant trends or correlations that can be correctly interpreted by ATC SMEs.

5 Data

This section summarises the data used within the analysis and comments on any data limtations.

Table 1 below summarises some of the key data values analysed in this report.

Note that the small number of LAHSO arrivals on Runway 16 is an artefact of inaccurate LAHSO times within ATIS. Operationally aircraft do not land and hold short on Runway 16. Given that erroneously designated LAHSO arrivals consist of only 0.3% of all identified LAHSO flights indicates that this data inaccuracy has little effect on overall likelihood estimates.

Since the go-around rate on Runway 16, and approaches outside LAHSO, have higher go-around rates than the average rate, inclusion of this data within our model will over-estimate the likelihood and risk calculations. In all risk modelling there will be small levels of error and uncertainty in the data. It is important that these errors over-estimate the risk to ensure the results are conservative. In this present LAHSO study this is the case.

	Group/rwy	arrivals	arrivals per day	go-arounds	go-around rate per 1000	rate bounds (per 1000)
January 1st 2012 to January 31st 2016 1492 days	**all**	462 609	316	1 412	3.1	2.9 - 3.2
	16	227 421	155	563	2.5	2.3 - 2.7
	27	110 339	75	248	2.2	2.0 - 2.5
	34	112 499	77	559	5	4.6 - 5.3
	9	1600	1	42	26.2	20 - 33
	LAHSO	100 651	68	247	2.5	2.2 - 2.7
	16 LAHSO*	328	0	2	6.1	2.5 - 19.0
	27 LAHSO	63 761	43	99	1.6	1.3 - 1.8
	34 LAHSO	36 318	24	143	3.9	3.4 - 4.5
	9 LAHSO	244	0	3	12.3	5.6 - 31.3
2015 365 days	**all**	109 502	300	345	3.2	2.9 - 3.4
	16	55 162	151	139	2.5	2.2 - 2.9
	27	27 480	75	57	2.1	1.7 - 2.6
	34	26 532	72	137	5.2	4.5 - 5.9
	9	328	0	12	36.6	23 - 58
	LAHSO	17 074	46	44	2.6	2.0 - 3.3
	16 LAHSO*	52	0	0	0	0 - 55
	27 LAHSO	10 252	28	18	1.8	1.2 - 2.6
	34 LAHSO	6717	18	26	3.9	2.8 - 5.4
	9 LAHSO	53	0	0	0	0 - 54

Table 1: *Summary of data showing total number of arrivals, go-arounds and rates for different groupings of data. The go-around rates are expressed per 1000 arrivals and the rate-bounds indicate the 95% confidence level in this rate. *The small number of LAHSO arrivals on Runway 16 is an artefact of inaccurate LAHSO times within ATIS. Operationally aircraft do not land and hold short on Runway 16.*

6 Methods

This section describes the methods used in collating and interpolating the aircraft trajectory and operational context data.

6.1 Frequency and duration of LAHSO

This section provides an overview on the duration and frequency of the period when LAHSO was in operation, as extracted from Automatic Terminal Information Service (ATIS) records. ***Figure 7*** illustrates the monthly hours when LAHSO was in use for each runway.

ATIS records do contain some inaccurate data where LAHSO was recorded to still be in use but where it is doubtful that LAHSO was actually being applied. This occurred when LAHSO was initiated in an evening and not removed from ATIS records till 6 am the next day. Equally, LAHSO may be suspended when winds exceed a threshold but a delay will occur before this is entered into ATIS. This was noted in the 2015 LAHSO study and addressed by ATC as part of Airservices' Safety Management System. The period when LAHSO may have been inaccurately recorded in ATIS corresponds to periods with little or no arriving traffic and hence will not unduly affect the results in this report.

Since go-around rates are higher during non-LAHSO periods, inclusion of a small amount of non-LAHSO arrivals within our LAHSO data will over-estimate the risk and hence ensure the risk calculations are conservative.

Figure 7 illustrates a significant drop in LAHSO operating hours in from late 2015. This is due to both an improvement in ATIS recording and a real reduction in the period when LAHSO was in place.

This section shows: a clear seasonality to LAHSO operations, with peaks during the southern winter period; and, a reduction in LAHSO times from late 2015.

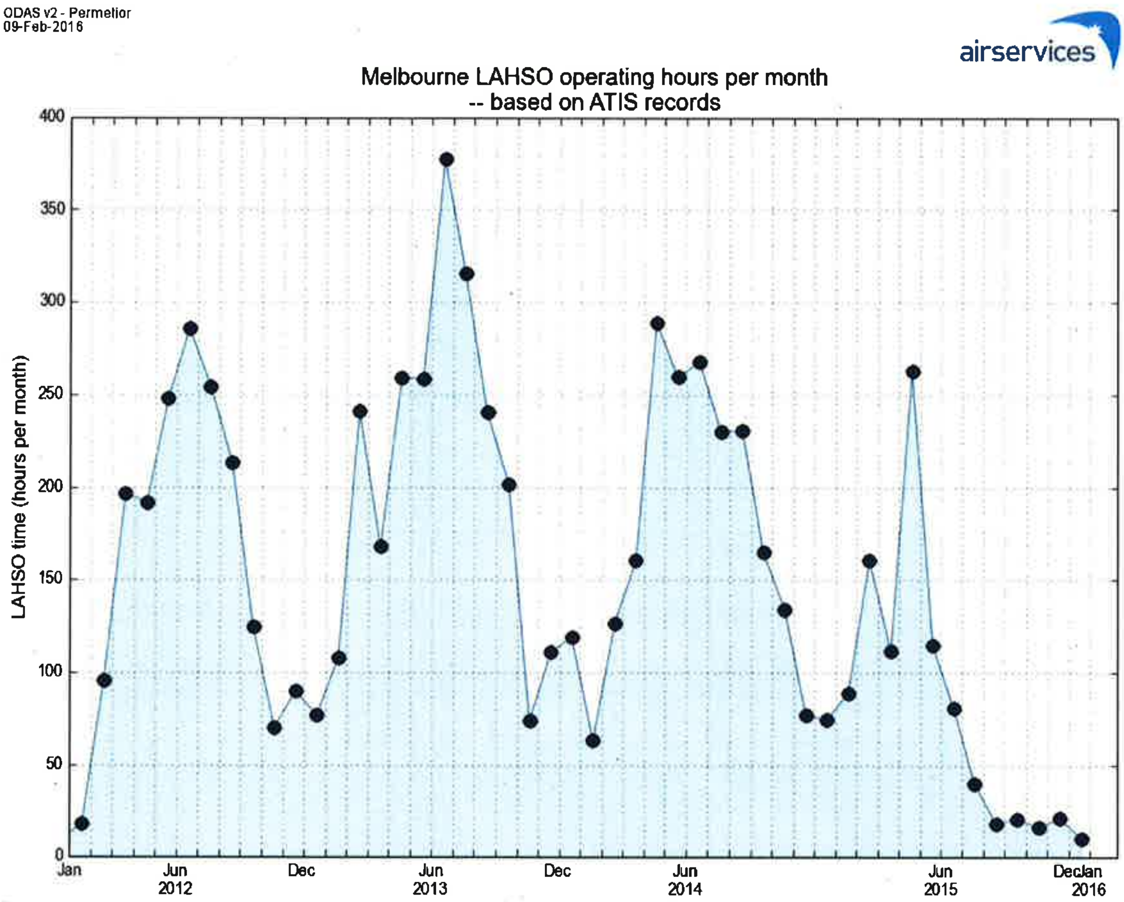


Figure 7. *Overall LAHSO operation as hours per month recorded in ATIS from 1st January to January 31st 2016.*

6.2 Capturing a go-around from trajectory data

It is non-trivial to estimate from trajectory data which aircraft performs a go-around, and the precise positions and times where the aircraft initiates the go-around and crossed the runway threshold or runway crossing points. ***Figure 8*** shows an example go-around detected on approach to Runway 16. The approach detection zone is 6 NM from the runway threshold and 2 NM wide. The go-around initiation point is indicated on the graph. Linear interpolation between data points (usually every 5 seconds) is used to estimate the times and positions at key points. Appendix 11.2.1 is extracted from the 2015 LAHSO study and provides a little more detail on this trajectory methodology. Section 11.2.1 gives further examples and details regarding the detection of go-arounds from trajectory data.

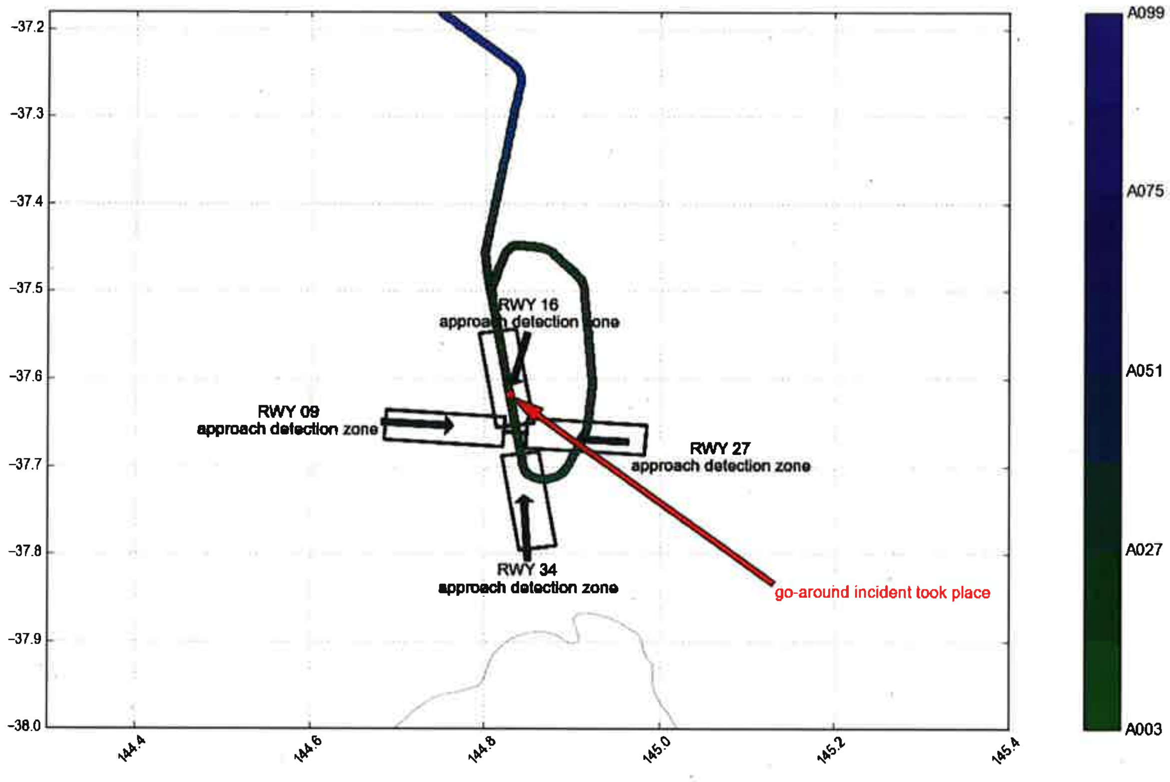


Figure 8: *Illustration of go-around detection. The go-around 'location' is assumed to be the point of lowest altitude as this can easily be found within the surveillance data. The runway detection zones are shown and the colour coding of the track indicates altitude. Here the aircraft approaches from the North to Runway 16.*

6.3 Data validation

Aircraft trajectory data was extracted from ODAS and separately validated to be better than 99% accurate on most applicable metrics. Within the Melbourne Terminal Area available ADS-B and Radar data is extremely accurate and positional and time data can be considered to be accurate to within a second and 10 feet. Only flights with valid flight plans were available within the ODAS version 2.4 used here. Hence, some non-regular IFR flights, such as survey and navaid calibration tests, may not be included within the analysis.

Go-arounds can be determined from CIRRIS occurrence data records and from ODAS trajectory data. Due to the large volume of aircraft trajectories analysed it cannot be guaranteed that every go-around has been captured. Appendix 11.2.2.3 is an evaluation section from the 2015 LAHSO study that compares CIRRIS go-around data with ODAS trajectory go-around data. The evaluation determined that the method of identification of go-arounds used within this study is sufficiently accurate and reliable to inform the risk assessment. Due to time constraints CIRRIS data from after the 2015 LAHSO study period (up to May 2015) was not included in this additional comparison, since the 2015 LAHSO study had well demonstrated the accuracy and reliability of the go-around detection algorithm.

7 Results

This section explores the main results. These include sections on go-arounds rates:

- for night-time arrivals versus day time arrivals
- for arrivals via SHEED waypoint
- as a function of departure frequency and runway of departure
- as a time series
- as a function of cross- and down-wind components
- being dependent on a previous go-around

These are followed by analysis of the:

- vertical profile and altitude of go-arounds at the runway threshold and crossing point
- go-around initiation distance.

After these results are used to establish key parameters, a simple probability model is used to estimate the double go-around rate, the likelihood of a loss of separation and the collision risk.

7.1 Day and night occurrence during LAHSO

This section explores Melbourne LAHSO arrivals categorised by day- or night-time. Night-time was determined by the astronomical time of sunset and not by definitions of twilight or last light. Given the uncertainty in cloud cover, weather conditions and variability in all parameter estimates this is sufficient to inform the risk of day-time versus night-time go-around likelihoods. There were 67,792 arrivals (158 go-arounds) during LAHSO day-time operations and 31,936 arrivals (87 go-arounds) during the night-time in the sample

Figure 9 shows the estimation of the go-around rates for flights arrived during LAHSO day- and night-time operations. The estimate of the go-around rate is 2.71 per 1000 arrivals during the day with standard deviation 0.2. During night-time the rate was 1.84 go-arounds per 1000 arrivals with standard deviation 0.2. These two values (2.71 and 1.84) are not statistically different to a 95% confidence level. However, the **data indicates that it is statistically unlikely the night-time LAHSO go-around rate is larger than the day-time rate.**

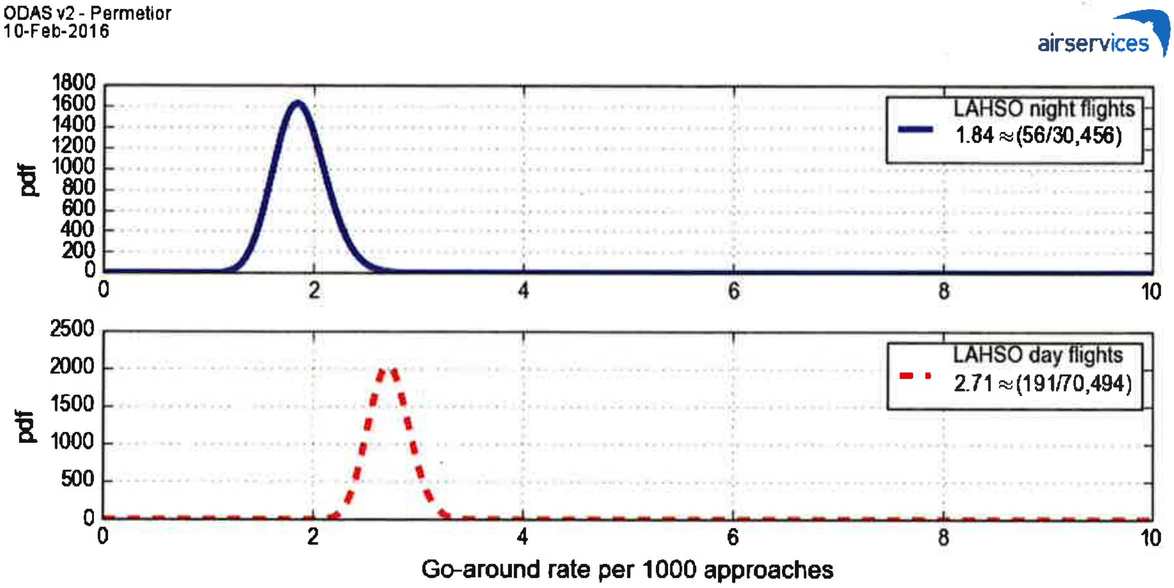


Figure 9. (LAHSO only) *The top plot shows the estimation of the go-around rate of flights arrived during LAHSO night-time operations (approx. 1.84 per 1000). The red bottom plot shows the estimation of the go-around rate for the flights arrived during LAHSO day-time operations (approx. 2.7 per 1000). The y-axis is a scaled probability density function (pdf) for the parameter estimate. That is, given finite data the estimate of a rate has a level of uncertainty. These plots show the certainty of the rate. For the top data the go-around rate is approximately 1.8 but the spread of the graph indicates the uncertainty in this result.*

The main result from this subsection is that the go-around rate for Melbourne arrivals during LAHSO night-time operations is not larger than the rate during day-time LAHSO operations.

7.2 Approach waypoint – SHEED

This section explores Melbourne LAHSO arrivals using the standard arrival route approach LIZZI TWO Victor arrival which overflies the waypoint SHEED onto a short 2.8NM final approach (see ***Figure 10***). Anecdotal evidence provided by ATC SMEs indicated that aircraft arriving via SHEED waypoint may experience an increase in go-arounds due to the short final approach distance. A total of 9,600 (9.5%) arrivals used SHEED versus 91,350 arrivals using other waypoints.

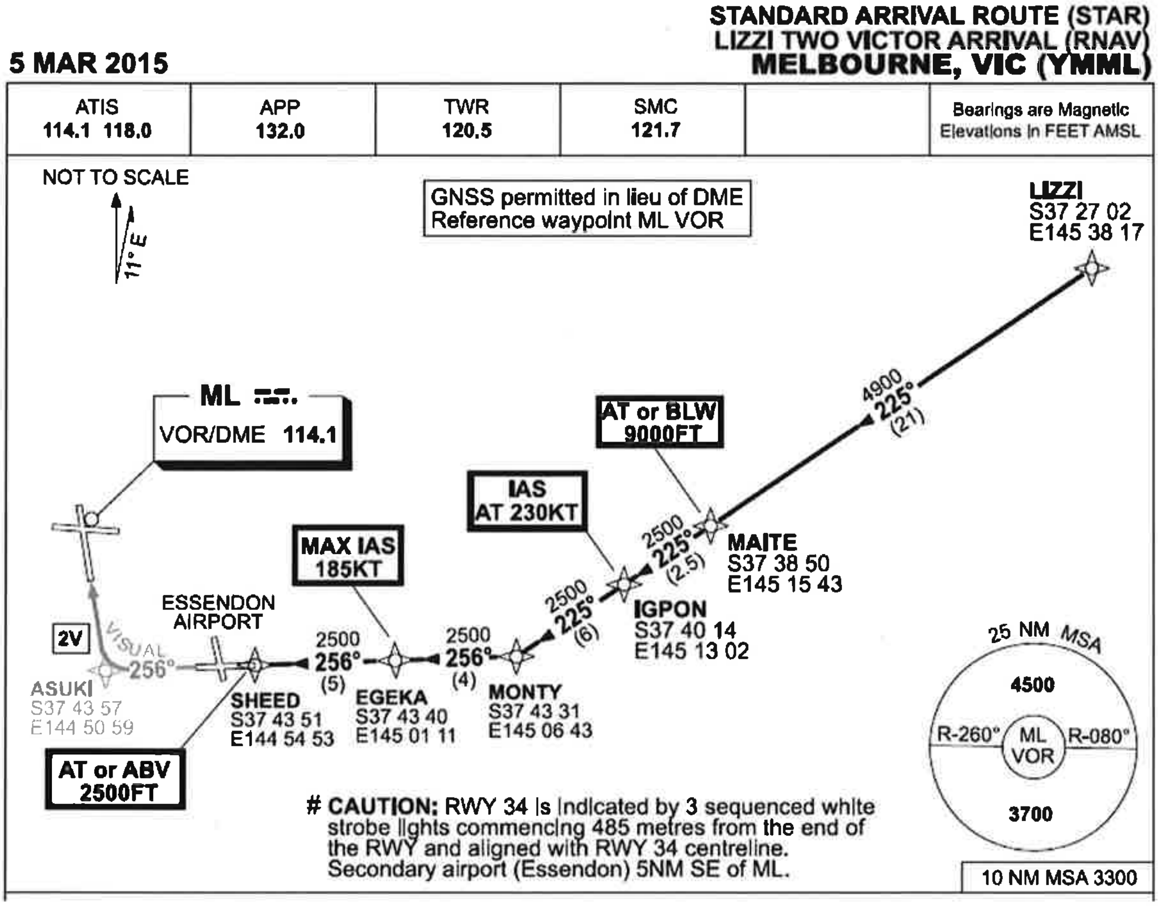


Figure 10. *LIZZI Two Victor Arrival (source: DAP 13 Jan 2016).The waypoint SHEED is indicated near the bottom left followed by a tight right turn onto a 2.8NM final approach.*

Figure 11 shows the estimation of the go-around rates for flights passing the approach waypoint SHEED versus all other arrivals. The top plot is the estimate of the go-around rate for SHEED arrivals (1.67 per 1000) and the bottom red plot for all other arrivals (2.53 per 1000). The difference between these values is **not** statistically significant to a 95% confidence level. However, it is highly unlikely that arrivals via SHEED have a higher go-around rate than other arrivals. This result is purely for detected 'go-arounds' and may not reflect rates for unstable approaches. A separate study currently being done by Operational Analysis is considering metrics for measuring unstable approaches with application to SHEED arrivals.

The main result from this subsection is that arrivals by SHEED do not have a statistically significant higher go-around rate. This go-around rate may not reflect the proportion of unstable approaches via SHEED that is the subject of a separate study underway by Airservices.

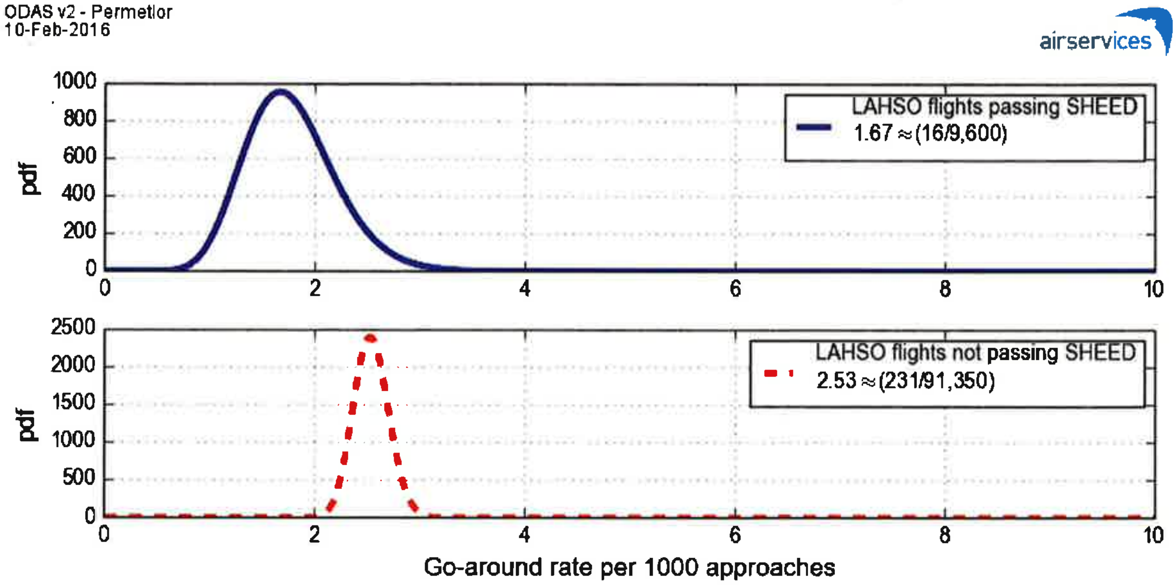


Figure 11. (LAHSO only) *Go-around rate comparison for aircraft passing or not passing the SHEED waypoint. The two rates are not statistically different with rates of 1.67 and 2.53 per 1000 approaches. The reference numbers (i.e. 16/9,600) indicate 16 go-arounds with 9,600 approaches. The go-around rate for flights passing SHEED might be lower than the ones not passing SHEED but the result is not statistically significant. The y-axis is a scaled probability density function for the parameter estimate. That is, given finite data the estimate of a rate has a level of uncertainty.*

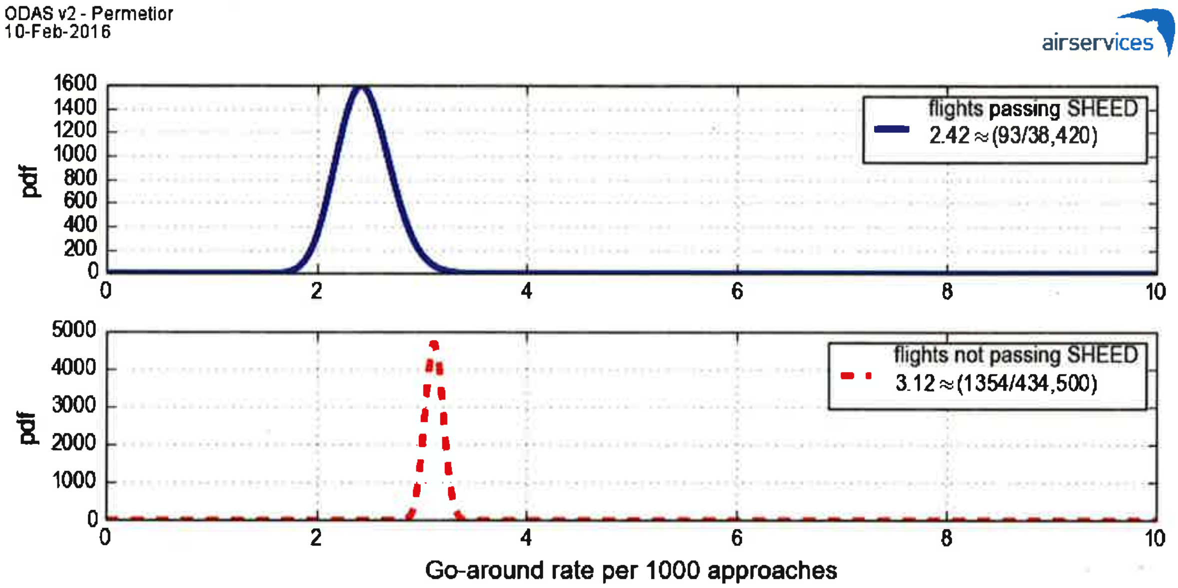


Figure 12: ***(LAHSO and Non-LAHSO).*** *Go-around rate comparison for aircraft passing or not passing the SHEED waypoint. The two rates are statistically different with 2.42 and 3.12 go-arounds per 1000 approaches respectively. The reference numbers (i.e. 93/38,420) indicate 93 go-arounds with 38,420 approaches. The y-axis is a scaled probability density function for the parameter estimate. That is, given finite data the estimate of a rate has a level of uncertainty.*

7.3 Runway occupancy - Departures on runways

This subsection considers the impact of runway departures on go-around rates. From investigation of go-around occurrences, occupied runways was clearly identified as a risk factor for go-arounds. This section explores whether the overall density of departures is a contributing factor to go-arounds by considering the number of go-arounds as a function of the number of departures within 10 minutes prior to an arrival.

The choice of 10 minutes is arbitrary: a lower value gives sample sizes too small for meaningful analysis while a longer time period distorts results by not having the departure density at the time of arrival. The results will indeed show that during LAHSO this data limitation implies that no conclusion can be made. For all arrivals (LAHSO and non-LAHSO) sufficient data is available.

Figure 13 provides a histogram for the number of departures in the ten minutes prior to a LAHSO arrival. Note that the green columns represent 'departures on runway' (both 27 and 34), that is, the number of arrivals where there were no departures on any runways in the 10 minutes prior to arrival. This is not the sum of the individual values for each runway. Having no departures on one runway is not related to having no departures on the second runway. This may appear counter-intuitive on a first reading.

Based on data up to November 30th 2015[3] there were 82,248 LAHSO arrivals with at least 1 departure in the 10 minutes prior to arrival and 16,459 (16%) arrivals with no departures in the 10 minutes prior. ***Figure 14*** shows the estimation of the go-around rate at 1.8 per 1000 arrivals when there are no departures in the 10 minutes prior to arrival, and the bottom (red) plot shows an estimated go-around rate of 2.6 per 1000. As expected there is a correlation between departures and go-around rate during LAHSO.

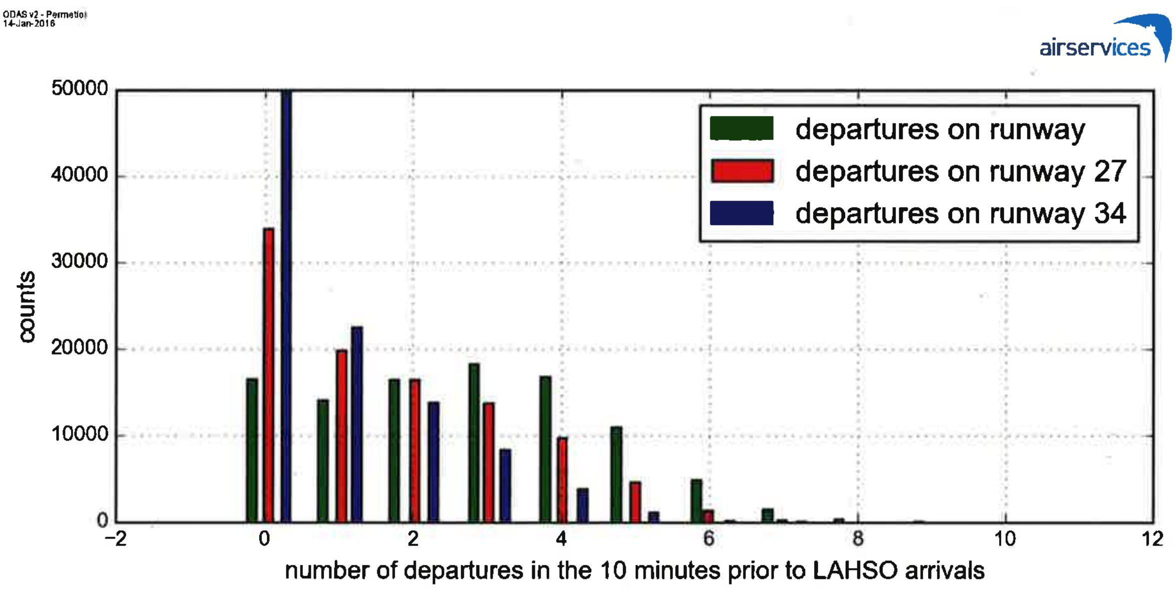


Figure 13: (LAHSO only) *Histogram of the number of departures in the 10 minutes prior to a LAHSO arrival. The green (left most columns) represent a departure on any runway. Note that having no departures on any runways is NOT the sum of no departures on 27 plus no departures on 34: having no departures on Runway 34 may also mean no departures in that period on Runway 27.*

[3] This section is based on data only up to November 30th 2015 as part of an earlier study. Procedural changes from December 2015 may bias the results if included. There is insufficient data since December 2015 to do a separate analysis on this data set.

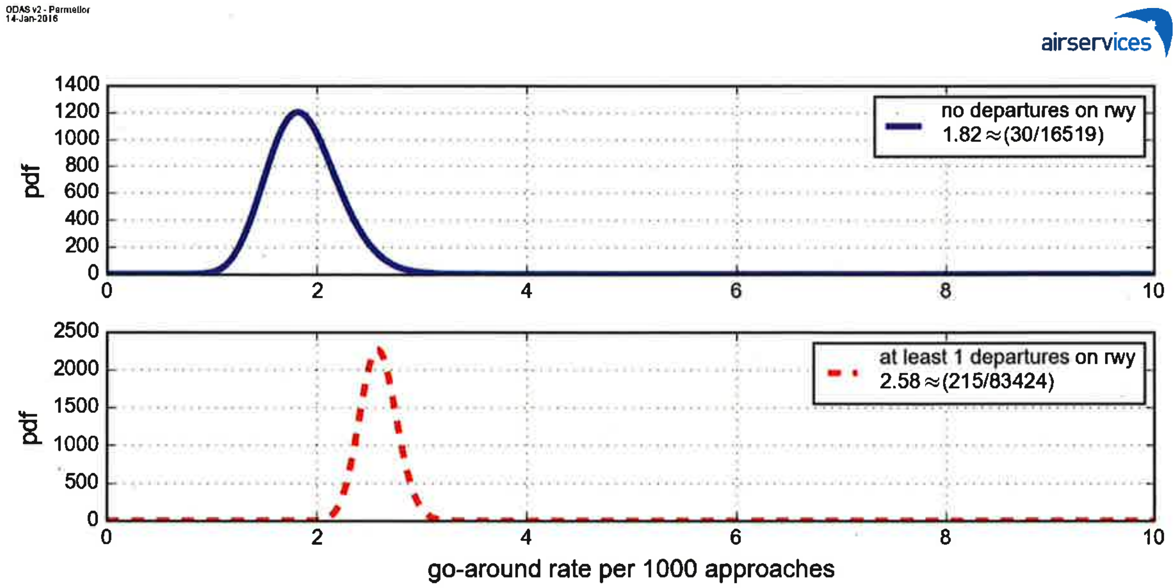


Figure 14. (LAHSO only) *The top plot shows the estimation of the go-around rate during Melbourne LAHSO for arrivals with no departures on a runway prior to arrival (1.82 per 1000). The red bottom plot shows the estimation of the go-around rate for arrivals with at least 1 departure within 10 minutes prior to arrival (2.58 per 1000).*

Figure 15 and ***Figure 16*** explore whether go-around rates are dependent on the number of departures from Runway 34 (that is, off-mode departures) in the ten minutes prior to an arrival. These show no change in the go-around rate as a function of the number of departures.

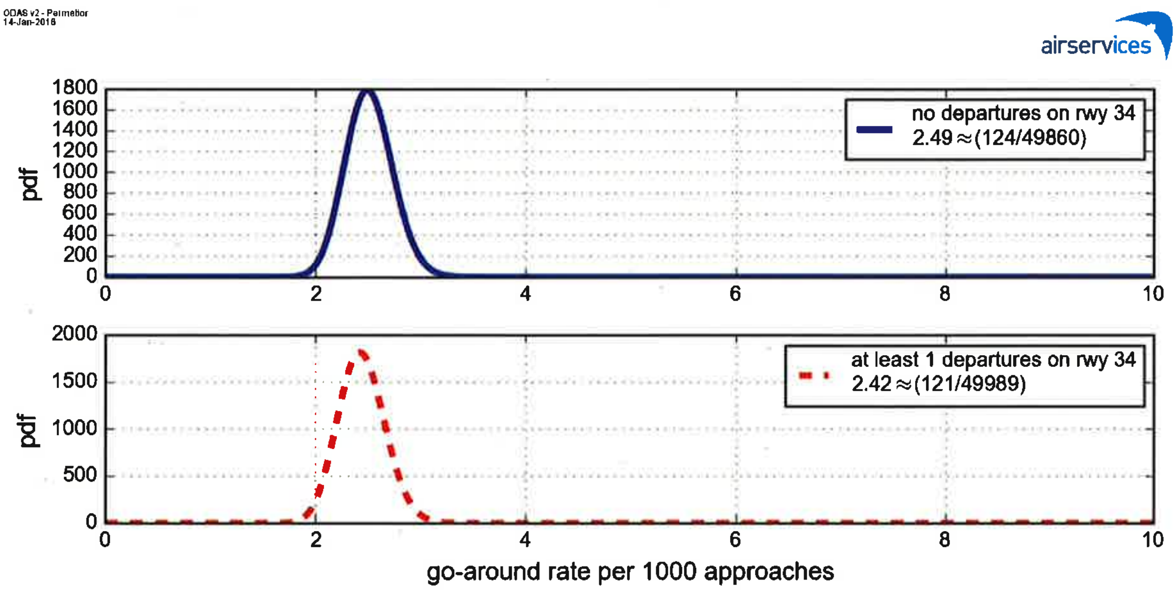


Figure 15: (LAHSO only) *Go-around rates for arrivals when there are either no-departures off runway 34 in the 10 minutes prior to the arrival (top blue graph) or at least 1 departure off runway 34 (bottom red dashed graph). There is no statistical difference.*

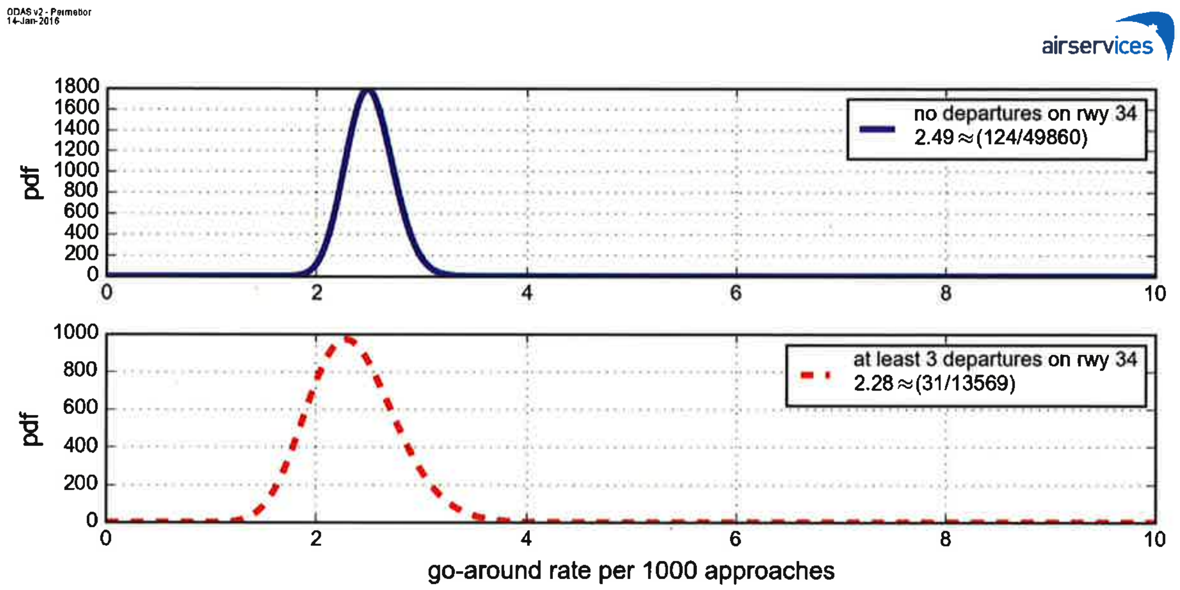


Figure 16: (LAHSO only) *Go-around rates for arrivals when there are either no-departures off runway 34 in the 10 minutes prior to the arrival (top blue graph) or at least 3 departures off runway 34 (bottom red dashed graph). There is no statistical difference.*

Figure 17 shows the same result as ***Figure 14*** except for <u>all</u> arrivals (**non LAHSO** operations as well). This clearly shows that in general the go-around rate is much higher (4 go-arounds per 1000 arrivals) than if no departures occurred in the 10 minutes prior to arrival. This is to be expected since occupied runways due to delayed departures are a known causal factor for go-arounds.

Figure 14 and ***Figure 17*** do show however, that during LAHSO the effect of occupied runways is smaller. This indicates that the reduced number of departures during LAHSO do indeed reduce the frequency of go-arounds due to occupied runways compared to non-LAHSO operations.

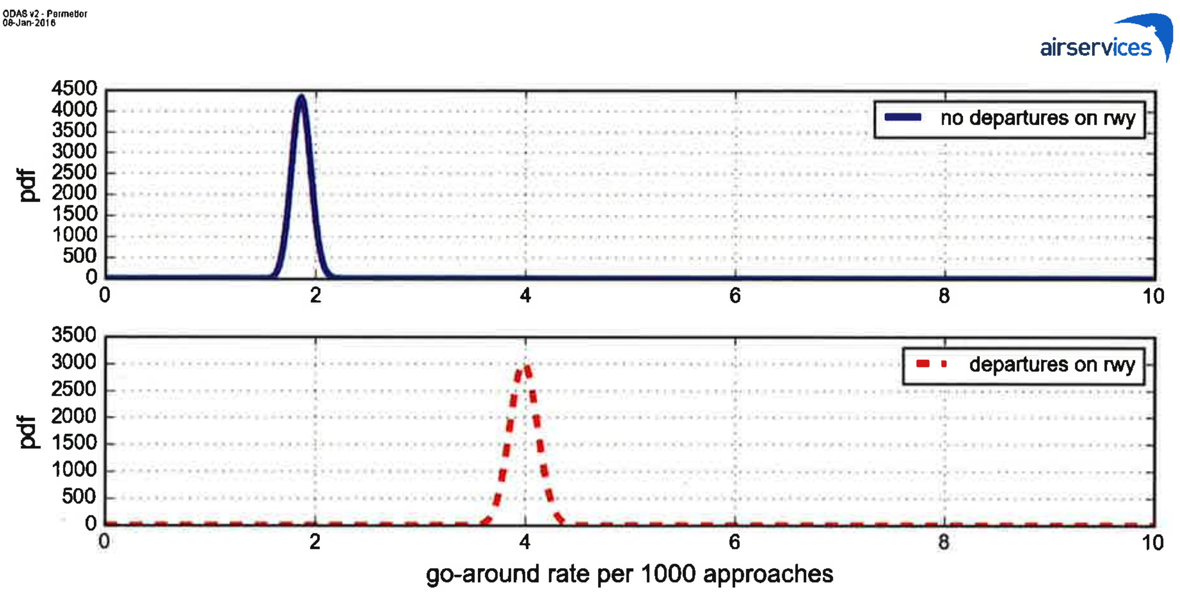


Figure 17. <u>(LAHSO and Non-LAHSO)</u> *The top plot shows the estimation of the go-around rate of arrivals for all operations with no departures on a runway in the ten minutes prior to arrival (approx. 1.7 per 1000). The red bottom plot shows the estimation of the go-around rate for arrivals where there was at least one departure on a runway prior to arrival (approx. 4.0 per 1000). The two go-around rates are significantly*

different. This affect may not be causative since high go-around rate may be a result of high traffic density which is also correlated with high departure density.

The main result from this subsection is that although delayed departures are a known cause of go-arounds (an occupied runway), there is insufficient data during LAHSO operations to establish a relationship between go-around rate and departure frequency. For all operations (LAHSO and non LAHSO) this relationship is clear, with high departure frequency directly related to higher go-around rates, as expected.

7.4 Go-around rate time-series

This section considers whether any evidence exists for a change in the go-around rate over time.

Figure 18 shows, from top to bottom, the number of arrivals during LAHSO, the number of go-arounds and the go-around rate as a moving average of 28 days. Data points are calculated every 7 days. The same seasonality for LAHSO arrivals is shown as in ***Figure 7.*** The go-around count has no trend, varying between 0 and 14 for each 28 day period. The go-around rate per 1000 arrivals does show a pattern explored in more detail in ***Figure 19.***

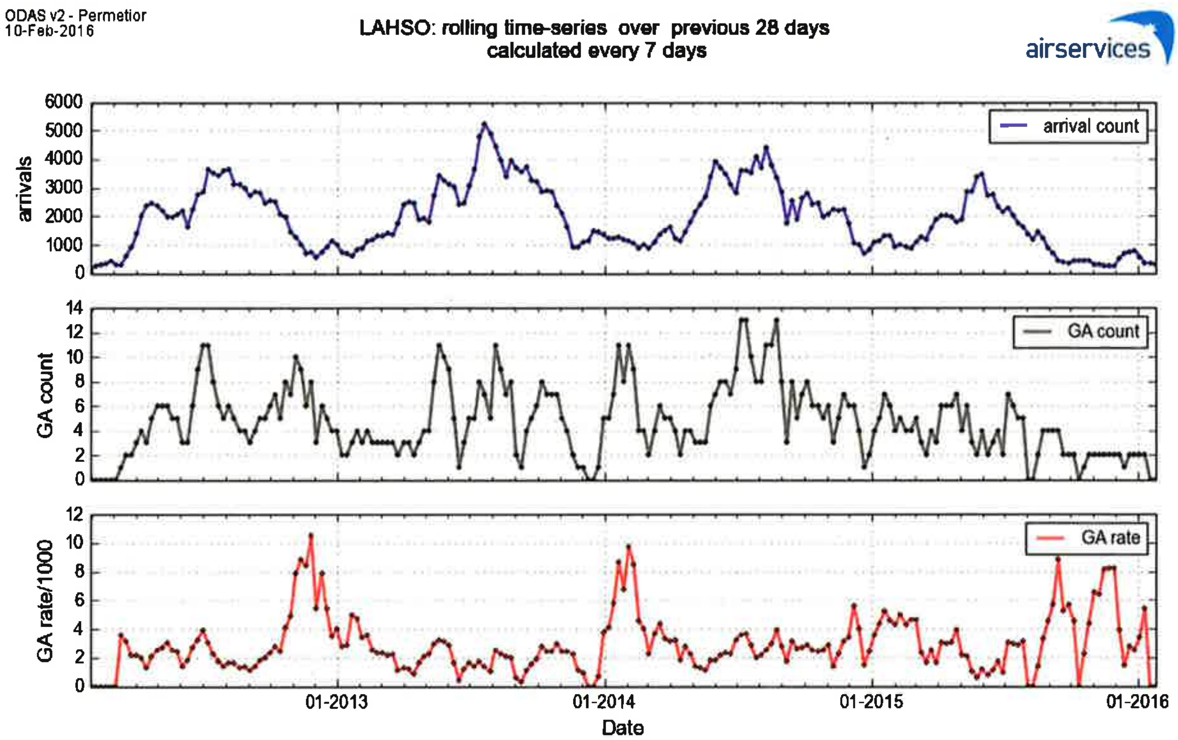


Figure 18: (LAHSO only) *Arrivals, go-arounds and go-around rate as a function of time. Each plot is calculated using a rolling average of 28 days, with data estimated every 7 days. The top plot is the number of arrivals in each 28 day period. The middle plot shows the number of go-arounds and the bottom plot shows the go-around rate per 1000 arrivals. Note the strong peaks for approximately October 2012 and January 2014, the rate for the latter part of 2015 shows a greater variation due to the reduced number of LAHSO arrivals giving a greater uncertainty in the rate.*

Figure 19 indicates that the yearly go-around rate has varied between 2.0 and 3.0 per 1000 approaches over the three years of available data. Note however that the uncertainty in this rate is of order +/- 0.5 go-arounds per 1000 arrivals. The go-around rate has steadily decreased since the start of 2015 to a rate of 2.5 per 1000 arrivals.

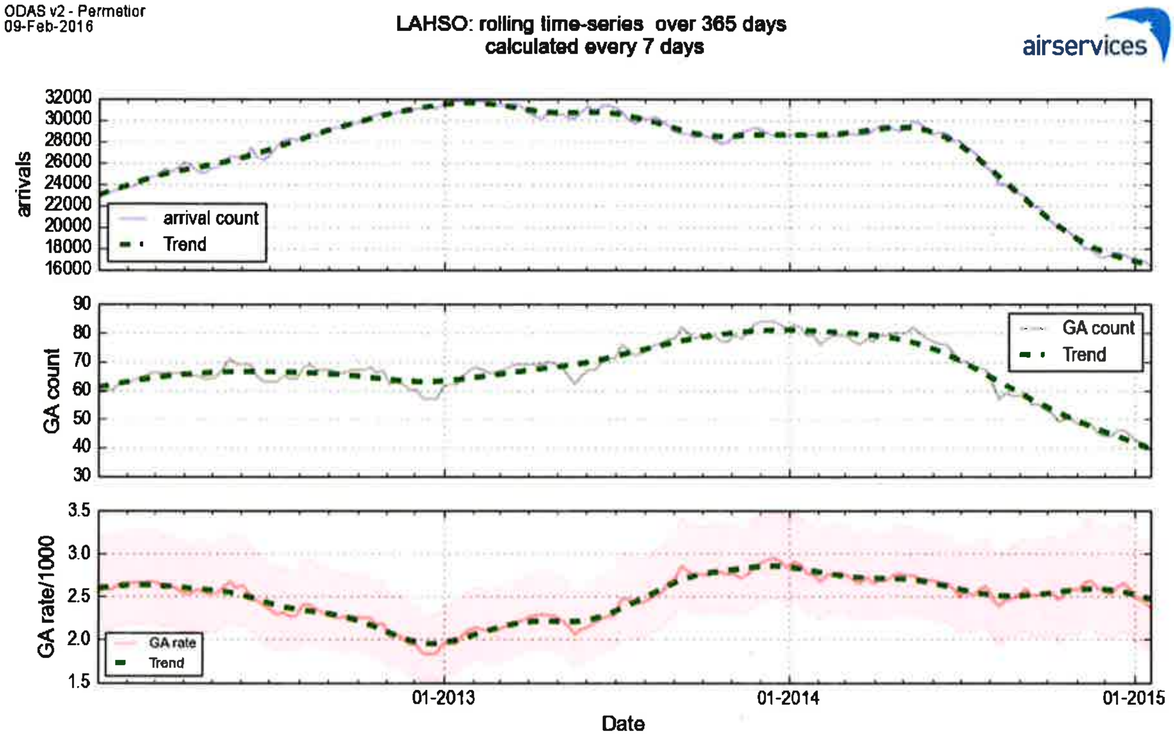


Figure 19: (LAHSO only) *These results are averaged over the next 365 days allowing trends to be easily determined. The top graph shows the number of LAHSO arrivals, the middle graph the go-around count and the bottom graph the go-around rate per 1000 arrivals. Each graph has a smoothing trend line and the lower plot has the uncertainty in the rate indicated by the shaded region. Note the clear reduction in arrivals in 2015. The lower plot shows a stabilisation and reduction in the go-around rate over the last year from a height of 3.0 to 2.5 per 1000 arrivals.*

This section shows that the go-around rate per 1000 arrivals has decreased in the last 12 months from a peak of 3.0 to 2.5 per 1000 arrivals.

7.5 Go-around rate as a function of wind components

The 2015 LAHSO study [2] showed that go-around rates do depend in general on cross- and down-wind levels, but that the restrictions on when LAHSO can be used successfully mitigates this dependency.

In addition, wind is a trigger for ceasing LAHSO, but this may not immediately appear in the ATIS data. Hence, some high wind conditions appearing in the data may correspond to this transition out of LAHSO as the weather deteriorates.

Figure 20 shows the estimate of the go-around rate (during LAHSO) overall and for winds of 10-20 knots. The go-around rates are not different to within a 95% confidence level. ***Appendix 11.3*** detail of the analysis of go-around rates with wind levels.

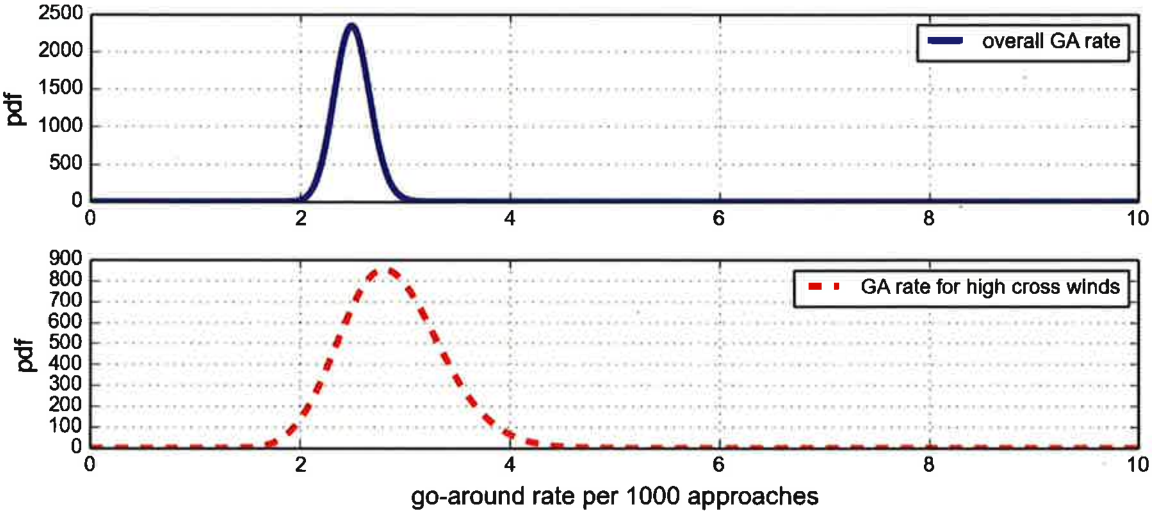


Figure 20: (LAHSO only): *The top plot shows the estimation of the go-around rate during LAHSO operations (2.5 per 1000). The red bottom plot shows the estimation of the go-around rate when the cross wind was in the range of 10 to 20 knots. The rate may be marginally higher but was not statistically significant. The y-axis is the probability density function for the parameter estimate. That is, given finite data the estimate of a rate has a level of uncertainty. These plots show the certainty of the rate.*

7.6 Dependency of go-around rates on previous go-arounds

This section explores whether the existence of one go-around implied an increased likelihood of another go-around. It might be expected that a causal factor for go-arounds may persist for some time, increasing the likelihood of another go-around in the short term.

Figure 21 shows the estimation of the go-around rate during LAHSO operations overall, and if a previous go-around had occurred within the last hour. Considering the go-arounds for all LAHSO approaches, the rate was 2.5 go-arounds per 1,000 approaches. However, if a go-around had occurred within the last hour, the rate increased to approximately 5.6 go-arounds per 1,000 approaches. In other words, the likelihood of a go-around was twice as high if a go-around had already occurred in the last hour. Note that the value of 5.6 had a large standard deviation of 1.3, however the two means were statistically different to a 98% confidence level.

It is expected that go-around rates would increase if a go-around had just occurred. Whatever causal factors contribute to go-arounds, these may be expected to be present for a time period in the order of minutes to an hour. These may be due to weather conditions, traffic levels, occupied runways or other unknown factors beyond the scope of this report.

Figure 22 shows similar results to ***Figure 21*** but for a range of times from 1 minute up to 30 minutes. The figure shows that the likelihood of a go-around is much higher in the time immediately following an earlier go-around. This makes sense physically, since the causal factors for some go-arounds will persist for a short time after the first go-around. For example, an occupied runway may persist for 1-2 minutes and cause a second go-around to occur for the subsequent flight. Other causal factors, such as an unstable approach, may not be correlated: the cause of the first go-around may have no impact on the second go-around.

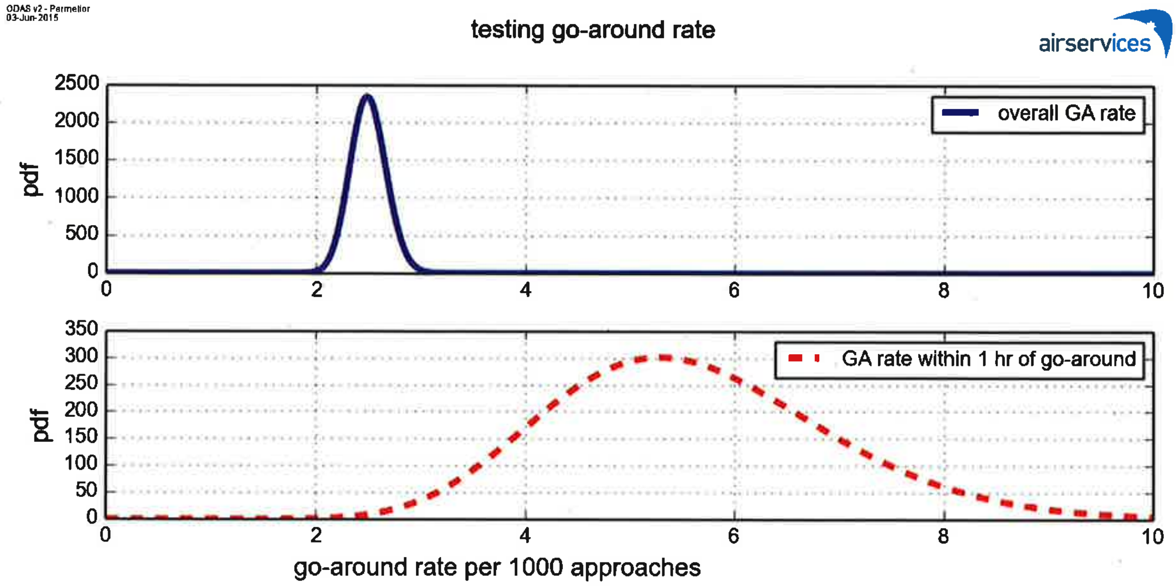


Figure 21: ***(LAHSO only)*** *Estimation of the go-around rate (per 1000 approaches) during LAHSO operations. The top plot shows a go-around rate of 2.5 go-arounds per 1000 approaches. The bottom plot estimates the go-around rate within one hour of a previous go-around. In this case the mean is 5.6 and is statistically different (to 98% confidence) from the rate of 2.5.*

In ***Figure 22*** the vertical axis is the go-around rate per 1000 arrivals for all arrivals within a time dt of an earlier arrival. The horizontal axis is the time period dt in minutes (In ***Figure 21*** this time period was 1 hour). The blue line is the mean rate (i.e. approximately 14/1060*1000 for dt=15 minutes). Each vertical line represents the 96% uncertainty in this estimate (approximately +/- two standard deviations – see ***Section 11.5*** for more detail). The red dashed line is the 66% uncertainty (approximately one standard deviation from the mean). The number (i.e. 3-80 indicate the number of go-arounds (3) in the number of arrivals (80) for that sample). The overall rate of go-arounds (2.5 per 1000) is indicated by the horizontal line. Thus, despite the uncertainty in the estimate of the rate, it is significantly higher than the base rate.

Figure 22 takes into account all statistics for double go-arounds: the value of 3 – 80 (3 go-arounds out of 80 arrivals within one minute of an earlier go-around) directly measures this contribution to the risk.

Statistical-significance calculations were done to test whether the different rates are significantly different from the base rate of 2.5 per 1000, given the large uncertainty in the estimates. For all cases shown in ***Figure 22*** the statistical significance was >95%, and usually above 98%.

The main conclusion of ***Figure 22 is*** that there is sufficient evidence that the correlated go-around rate is approximately 40-50 per 1000 arrivals, increased from a base rate of 2.5 per 1000 arrivals.

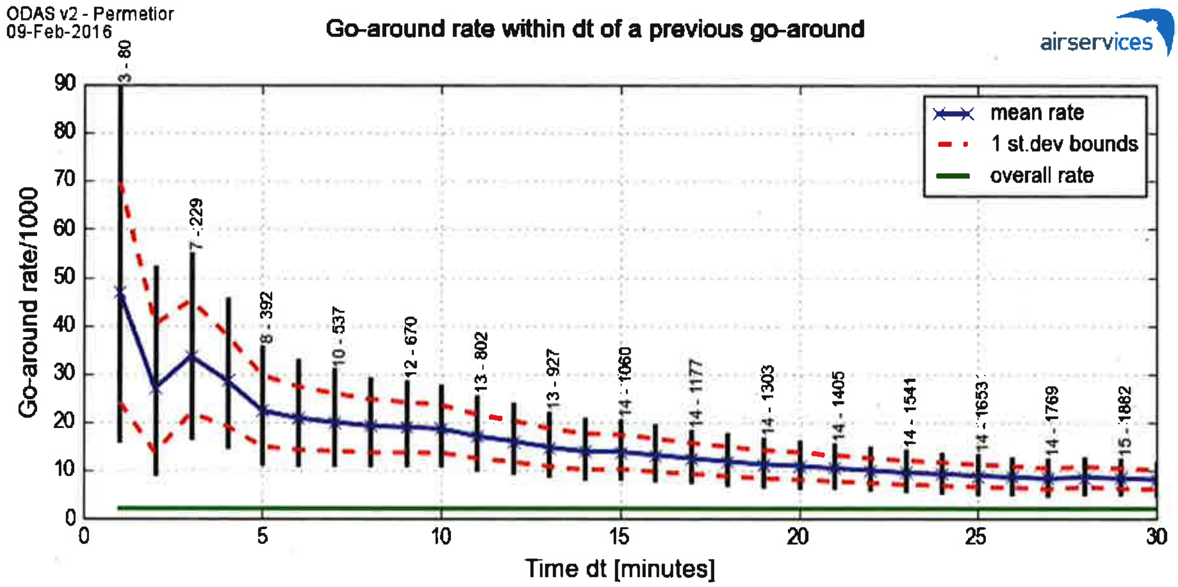


Figure 22: (LAHSO only) *LAHSO go-around rate (per 1000 arrivals) within a time dt of a previous go-around. For example, there were 1060 arrivals within 15 minutes of a previous go-around and of these 14 were go-arounds (denoted 14-1060). This results in a mean rate of ~13 with a 95% confidence that the true value is within [8,21]. The increase in rate to ~47 go-arounds per 1000 arrivals for dt = 1 strongly indicates that go-arounds are more likely in the time immediately following an earlier go-round: that is, the events are correlated. The red-dashed lines give an idea of uncertainty in the rate estimation (~1 standard deviation) while the black lines give the 5-95% uncertainty levels (~2 standard deviations). Hence the 'drop' in mean value for dt=2 minutes is a statistical artefact within the confidence bounds.*

This result has direct implications on the risk of double go-arounds. If a first go-around has occurred, then the likelihood of a second go-around is at least 10-20 times as likely to occur immediately afterwards.

There is insufficient data to form relationships between the rates of go-arounds on one runway given a go-around on a second runway. This analysis simply considers the go-arounds on any runway given a previous go-around within the last hour on any runway.

The main result of this section was that after one go-around had occurred; a second go-around **was 10-20 times as likely to occur within the next minute** if an aircraft arrives in this time.

7.7 Distribution of separation times for LAHSO arrivals

This section calculates the proportion of aircraft on crossing runways arriving within a time τ_c of each other. ***Figure 23*** shows the distribution of times between arrivals on one runway and the next arrival on the second runway. Importantly the distribution is nearly uniform for 66% of the sample which simplifies the analysis. ***Table 2*** gives numerical values for key times based on ***Figure 23***. Hence, 23% of aircraft pairs during LAHSO arrive within 1 minute of each other and 7.6% within 20 seconds of each other.

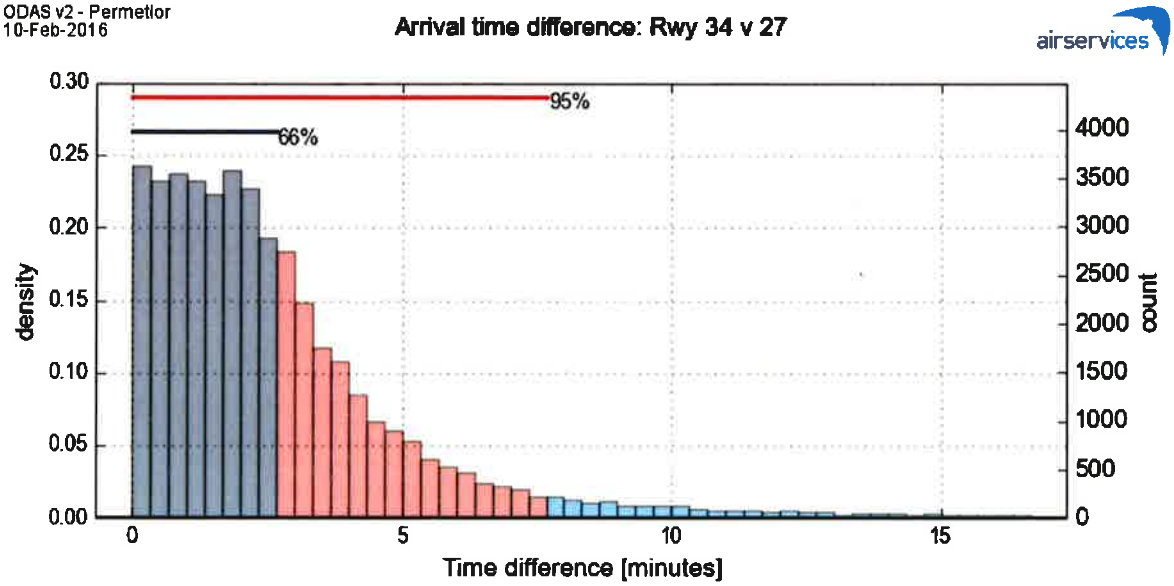


Figure 23: (LAHSO only) *Distribution of time between consecutive arrivals on Runway 27 and Runway 34. Note the near uniform distribution of times for 66% of the sample which occur within 2.5 minutes.*

Table 2. *Probability of LAHSO arrivals' separation time less than specified threshold τ_c.*

Threshold τ_c	**Probability that $\tau < \tau_c$ between arrival pairs on different runways**
20 seconds	0.076
40 seconds	0.152
1 minutes	0.23
2 minutes	0.46

7.8 Predicted versus arrival time accuracy at feeder fix and threshold

A recent study by Dr Jesper Bronsvoort (LAHSO Stagger Theoretical Feasibility Study) [31] considered how accurately aircraft arrive at a feeder fix and at the runway threshold given a MAESTRO specified time. This allows investigation of whether it is possible to easily stagger arrivals at the crossing runways to mitigate the collision risk of double go-arounds.

Figure 24 shows an extracted figure from paper [31], giving the distribution of arrival time error at the feeder fix and runway. These distributions are very broad with standard deviations of order 1 minute. The paper then shows that attempting to create a desired stagger of 20 seconds would be ineffective in significantly mitigating the risk, since there would still be sufficient overlap in the aircraft arrival distributions. The paper indicated that higher stagger values would be necessary to mitigate the double go-around likelihood, or a reduction of the feeder fix and threshold distribution.

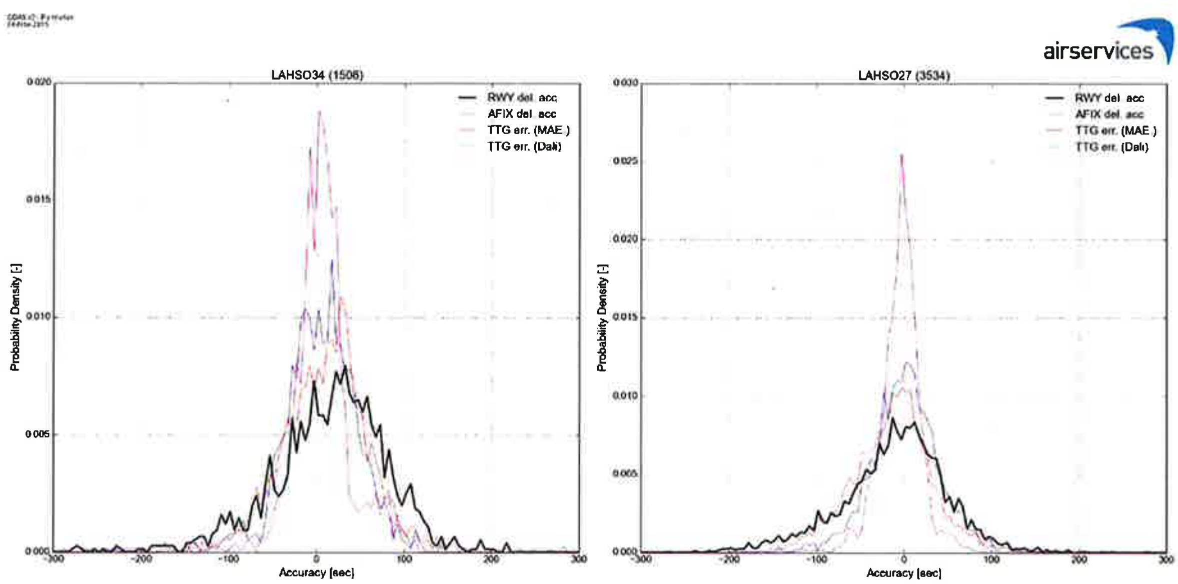


Figure 24: *Runway delivery accuracy (RWY del. acc.), arrival fix delivery accuracy (AFIX del. acc.), and MAESTRO time-to-go error (TTG err. (MAE)) for runway 34 (left) and runway 27 (right) arrivals during LAHSO. For reference, Airservices experimental trajectory predictor Dali time-to-go error (TTG err. (Dali)) has been added to indicate potential benefit of improving trajectory prediction accuracy. Extract from reference [31]. Please see this paper for the full context.*

7.9 Altitude profiles of go-arounds

This section explores the vertical profile of LAHSO go-arounds at runway crossing. This is used to explore the risk of collision by including the vertical position distribution in the calculations. For this analysis all go-arounds can be considered, during LAHSO and non-LAHSO operations.

Figure 25 shows example trajectories for aircraft undergoing a go-around on either Runway 27 (red) or Runway 34 (blue). The key result is the distribution of altitudes at the runway crossing point is almost uniformly distributed up to 4000 ft. – thus making it unlikely (2% chance) that two aircraft undergoing simultaneous go-arounds will be vertically separated by less than 42 ft. (an aircraft height and hence a possible collision) or within 500 ft (for calculation of ACP likelihood). The vertical distributions of the aircraft at the threshold are given in ***Figure 26.***

Importantly ***Figure 26*** also shows a limitation of altitude data in the vicinity of airports. There are numerous sources of error in the recording and estimation of altitude such as the pressure setting at the airfield (QNH). When on descent through FL110, the pilot changes the reference pressure on the altimeter from a standard 1013hPa to the sea-level pressure as reported at the airfield. Whilst altitude data is corrected by operational ATC systems (Eurocat) the diverse data sources within ODAS (a merging of Radar, ADS-B and other data) may not have this correction which can be of order +/- 300 ft. Since this error is small relative to the overall altitude variation (of order 4,000 ft), and will be applied equally to aircraft on all runways, there should be no effect on the estimation of the vertical overlap probability used in the risk calculations.

Figure 27 shows the point of lowest altitude as a distance from the runway threshold.

Figure 28 shows the numerically-derived convolution of the two distributions from ***Figure 26*** from which the percentages (2.2% and 25%) corresponding to two aircraft being vertically separated by less than 42 ft. (a collision risk) or 500 ft. (an ACP likelihood) are derived. The triangular shape of the convolution distribution is to be expected given the near uniform distribution for the heights as indicated in ***Figure 26.*** The convolution is used to estimate the risk of one aircraft being at height *h* and the second aircraft begin with a vertical distance *v* of this height.

If interest in ***Figure 26*** is the high proportion of traffic at the crossing point over 1000 ft. Above this threshold TCAS RA are in operation which will further mitigate the collision risk.

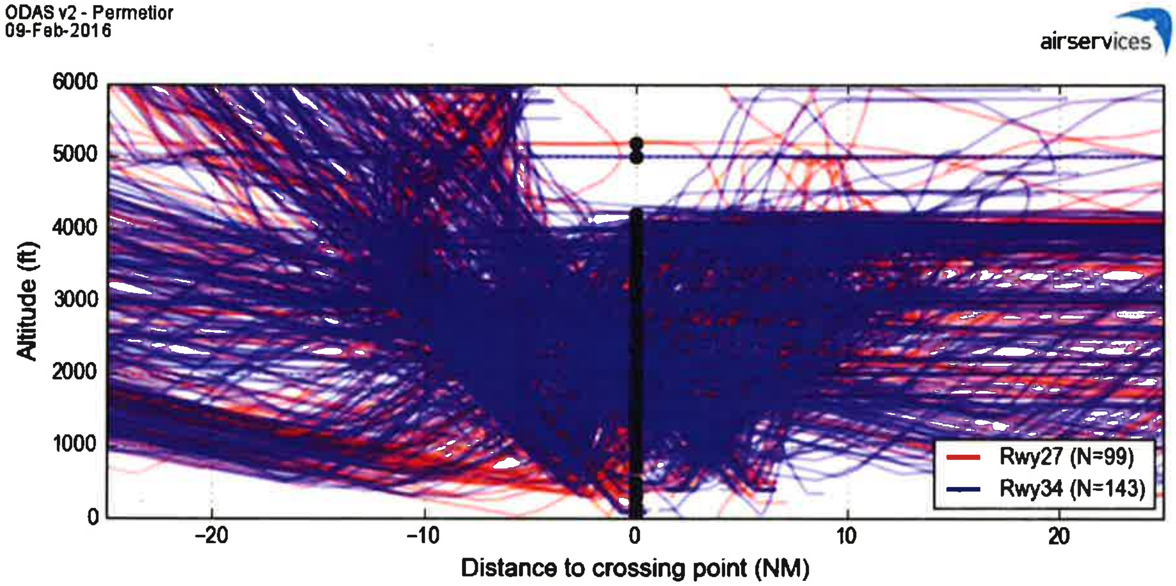


Figure 25: (LAHSO) *Go-around aircraft trajectories during LAHSO operations. Red indicates go-arounds on Runway 27 and blue on Runway 34. The black dots indicate the crossing point. Of importance here is the broad distribution of altitudes during the go-arounds corresponding the broad position of go-around initiation.*

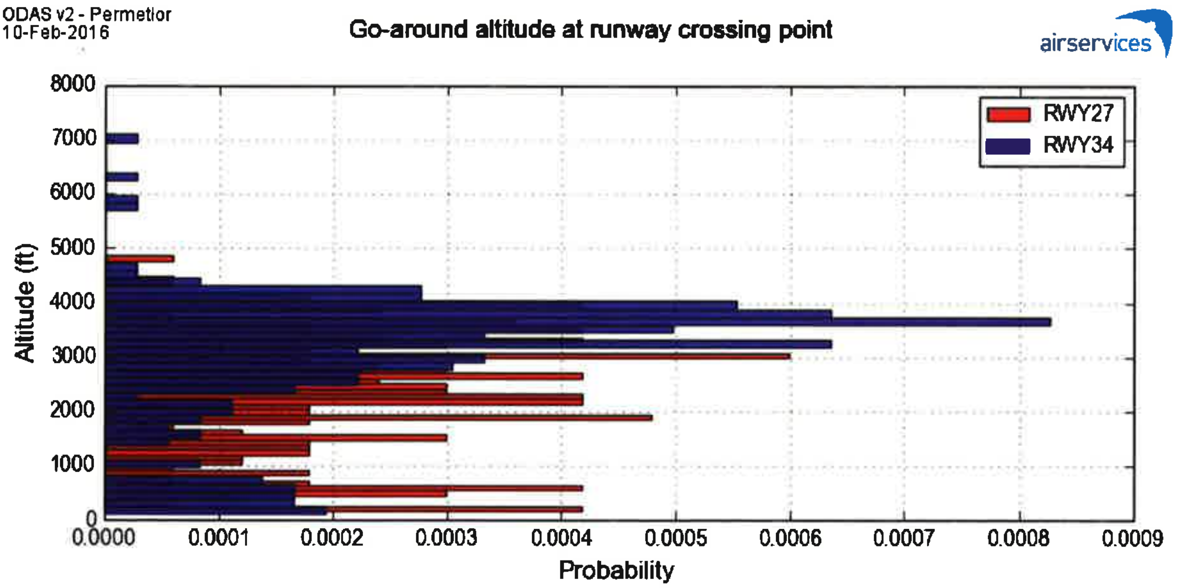


Figure 26: (LAHSO and NON-LAHSO) *Distribution of altitudes at runway crossing point for Runway 27 and 34 go-arounds. Both runways have a large altitude range. Thus the altitude of aircraft near the crossing points are nearly random up to 4000 ft. Note that some variation is due to errors with altitude estimates as discussed in the main body of the report.*

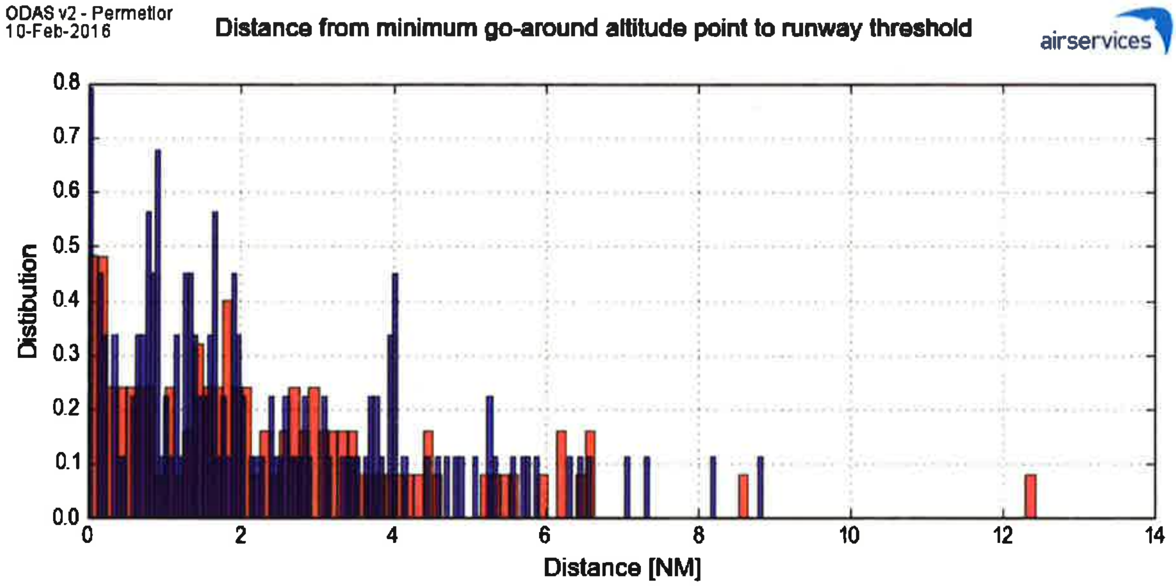


Figure 27: (LAHSO) *Distribution of go-around initiation point (as measured by point of lowest altitude) in Nautical Miles to runway threshold.*

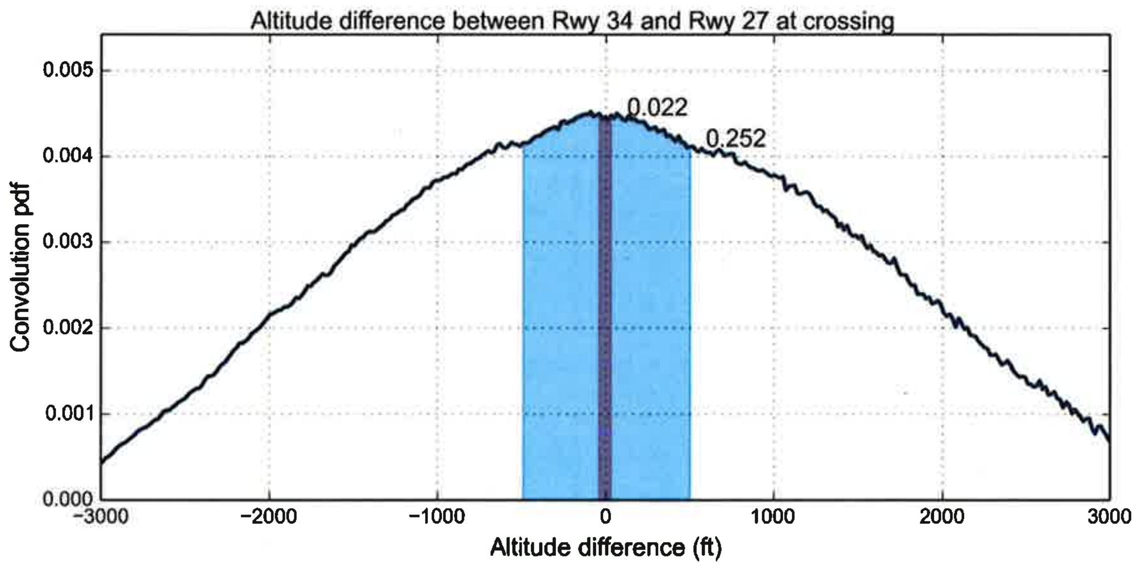


Figure 28: (LAHSO and non-LAHSO) *Altitude difference between any two randomly chosen go-arounds from Runway 27 and Runway 34. The shaded red region approximately indicates the probability difference corresponding to two go-arounds being within 42 ft. vertically of each other (2.2%) and risking collision if they are also coincident in time. The blue region indicated those within 500 ft. (25.2%).*

This section showed in the vertical dimension only, there is a 2.2% probability that any two go-arounds will be vertically separated by less than 42 ft. **if** they happen to arrive at the crossing point at the same time.

8 Likelihood and Risk Calculations

This section examines the likelihood of double go-around, mid-air collision (MAC) or aircraft in critical proximity (ACP) due to LAHSO double go-arounds. This analysis extends the analysis of the 2015 LAHSO study [2] to include the vertical separation at the crossing point; when combined with the separation in time at the crossing point, and the likelihood of a double go-around, this can inform the risk of a collision or a ACP.

The essential metrics of this analysis are the following key values:

- DGA_{60}: The likelihood of two go-arounds within 60 seconds of each other.
- DGA_{40}: The likelihood of two go-arounds within 40 seconds of each other.
- DGA_{20}: The likelihood of two go-arounds within 20 seconds of each other.
- ACP: The likelihood of two aircraft within 500 ft. vertically and 1 NM longitudinally.
- MAC: The likelihood of two aircraft within 140 ft. longitudinally (0.9 seconds) and 42 ft. vertically.

8.1 Typical Aircraft Dimensions

The typical aircraft dimensions (based on flight hours or arrivals) correspond to that of a B737 with lateral and longitudinal dimensions of order 140 ft. and height 42 ft. (12 metres).

The longitudinal and lateral dimensions of 140 ft. are equivalent to a time separation at the crossing point of 0.9 seconds (280 ft./ 472 ft./sec) assuming a typical speed of 180 knots.

It is possible to numerically calculate the collision risk for a range of aircraft sizes, analysing all possible combinations of aircraft dimensions in proportion to arrival statistics. However, due to the linearity of the risk calculations this will result in a similar risk to using a simple average aircraft size. Given the uncertainty of other parameters in the modelling it is not necessary to further refine the parameters relating to aircraft dimensions.

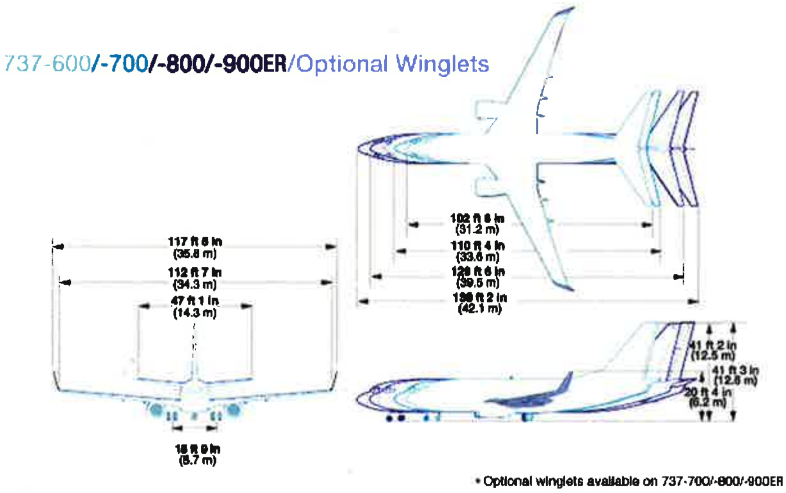


Figure 29: *Typical dimension of B737-800 which represents the typical aircraft size: http://www.jetaviationphotos.it/Aeroporti-Aerei/Dati_Aerei/Boeing/737.gif*

8.2 Speed at Crossing Point

The approximate speed at the crossing point is needed in the calculations of mid-air collisions. ***Figure 30*** gives a distribution of aircraft speeds at the crossing point during a go-around. The mean value of 181 knots is reasonable. Calculation of aircraft speed from trajectory data will contain additional errors due to the necessary differentiation of interpolated and approximate position and time values. For the purposed of the risk calculations used here, only the mean speed is needed and the approximate value of 180 knots is both appropriate and realistic.

It is possible to do the risk calculations integrating over the distribution of aircraft speeds for all combinations of aircraft. However, as with aircraft size, the linearity of the risk calculation implies the resulting risk will be similar to that found using just the mean aircraft speed.

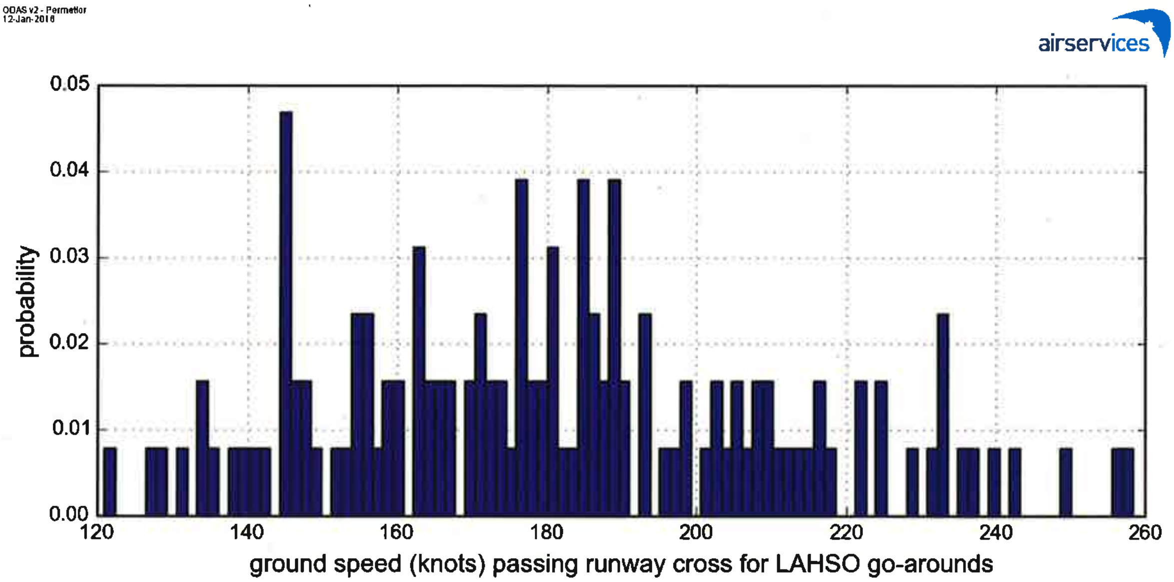


Figure 30: (LAHSO only) *Ground speed distribution at the crossing point for aircraft performing a go-around. The mean is 181 knots and the standard deviation 30 knots. Speed calculations from trajectory data will have a moderate level of error due to the additional calculations required to find speed. The mean of 180 knots is an appropriate estimate for the risk calculations.*

8.3 Likelihood Method

This section explores the mathematical methodology used to calculate the double go-around likelihood. This is the same as the 2015 LAHSO report [2].

A double go-around (DGA) was defined as an aircraft pair where each aircraft performed a go-around and the time difference at the runway intersection was less than some specified threshold that was denoted as τ_c.

The simple approximation of the probability assuming the events are independent is:

$$P(DGA) = N(\,\gamma_{27}\gamma_{34}\,(F_{27}(\tau_c) + F_{34}(\tau_c))$$

where N is the number of aircraft pairs, γ_{27} is the go-around rate per approach to runway 27, γ_{34} was the go-around rate during LAHSO for Runway 34, and each F is the probability that aircraft arrives on one runway within time (τ_c) of arrival at the second runway. The more accurate and general probability of at least one double go-around in a year of LAHSO operations is

$$P(at\ least\ 1\ DGA) = 1 - \left(1 - \gamma_{27}\gamma_{34}\,(F_{27}(\tau_c) + F_{34}(\tau_c)\right) + \gamma_{27}^2\gamma_{34}^2 F_{27}(\tau_c)F_{34}(\tau_c)\,)^N$$

where

- γ_{27} is the go-around rate during LAHSO for Runway 27
- γ_{34} is the go-around rate during LAHSO for Runway 34
- $F_{27}(\tau_c)$ is the probability there is an arrival on Runway 34 within τ_c of a prior arrival on Runway 27
- $F_{34}(\tau_c)$ is the probability there is an arrival on Runway 27 within τ_c of a prior arrival on Runway 234
- N is the larger of the number of arrival pairs (34 to 27; 27 to 34)

and

- τ_c is the time difference at the runway intersection of a consecutive arrival pair during LAHSO in operation.

To understand the value of N, consider arrivals on runways A and B occur as AABAABABAA. There are then three pairs (AB) and three pairs (BA). The overall risk is approximately F $(3\gamma_A\gamma_{\frac{B}{A}}+3\gamma_B\gamma_{\frac{A}{B}})$ with F the probability that pairs arrive within τ of each other. Thus, although there are 6 sets of aircraft pairs, the formula given correctly uses N=3 as the maximum of either (AB) or (BA) pairs.

These equations assume that the go-around rates are independent of each other. It would be expected that if one go-around has occurred due to meteorological conditions there will be an increased likelihood of a go-around on the second runway. Thus the simple equation is now:

$$P(DGA) = N\left(\gamma_{27}\gamma_{34/27}F_{27}(\tau_c) + \gamma_{34}\gamma_{27/34}F_{34}(\tau_c)\right).$$

Here $\gamma_{34/27}$ is the go-around rate on 34 **given** a go-around recently on 27 which is higher than just γ_{34} , that is $\gamma_{34/27} \gg \gamma_{34}$ and is $\gamma_{27/34} \gg \gamma_{27}$.

In simple language: this formula expresses the risk that:

- a go-around occurs on one runway, **and**
- a second flight occurs on the second runway within a small time τ_c, **and**
- this second flight performs a go-around.

There is clearly no risk if the flight on the second runway arrives much later than the first arrival.

8.4 Calculating of a ACP Likelihood

Assuming typical aircraft speeds of 180 knots, then for two aircraft to be longitudinally separated by 1 NM they would need to pass the same crossing point within T = (1NM)/(180 NM/hr) ~ 20 seconds of each other (rounding up to be conservative). Given the data, there is a 25% chance these aircraft being within 500 ft. vertically of each other.

8.5 Calculating of a Mid-Air Collision Likelihood

Assuming typical aircraft speeds of 180 knots then for two aircraft to be separated by 280 ft. (140 ft. per aircraft) they would need to pass the same crossing point within ~ 0.92 seconds of each other. Given the data there is a 2.2% chance these aircraft will also be within 42 ft. of each other vertically.

8.6 Parameters Assumption for the Risk Model

It is possible to construct a variety of plausible mathematical models given the available data and the uncertainty in the parameters. Here a conservative model is used with:

- 20,000 LAHSO arrivals per year (in 2015 the number of arrivals reduced from a peak of ~30,000 arrivals to below 20,000 arrivals) – See ***Figure 19.***
- 0.2264 of all arrivals form LAHSO pairs (i.e. there are 22 LAHSO pairs for every 100 arrivals during LAHSO)
- $\gamma_{34} = 2.5$ (per 1000): This is the mean rate for all runways in 2015 – See ***Figure 19.***
- $\gamma_{27} = 2.5$ (per 1000): This is the mean rate for all runways in 2015 – See ***Figure 19.***
- $\gamma_{34/27} = 40$ (per 1000): See ***Figure 22.***
- $\gamma_{27/34} = 40$ (per 1000): See ***Figure 22.***
- $F_{27}(\tau_c) = F_{34}(\tau_c) = 0.23 \times \tau_c$ (based on approaches within $\tau_c =$ one-minute of each other): See ***Figure 23.***
- Speed of aircraft = 180 knots: See ***Figure 30.***

8.7 Summary of Likelihood Calculations

This section summaries the main likelihood calculations based on the updated data and assumptions listed in ***Section 8.3.***

The results in ***Table 3*** shows key time and distance separation values appropriate for each category DGA_{60}, DGA_{40}, DGA_{20}, ACP, MAC: for example DGA_{60} are separated in time by 60 s which corresponds approximately to 3 NM distance separation at the crossing point. For DGA_{60} shows that there is a 2.3E-5 (0.0023%) chance of an arrival undergoing a go-around within 60 seconds of another go-around. This probability is an estimate which could be in the range 1.1E-5 to 3.6E-5. Given current arrival rates of 20,000 LAHSO arrivals per year this DGA_{60} likelihood corresponds to one in every 1.4-4.4 years. Given previous LAHSO arrival rates of order 30,000 per year this would correspond to a DGA_{60} event every 0.9-2.9 years: this is clearly reflected in the 3 such occurrences in the last 4 years.

A key value in ***Table 3*** is the MAC (Mid-Air Collision) risk of 7.8E-9 per arrival. This is highlighted since this can be compared with other Target Level of Safety measures used internationally (see ***Section 2.3***). The Target Level of Safety is discussed in the next section in more detail.

	DGA60	DGA40	DGA20	ACP	MAC
Time separation	60s	40s	20s	20 s	0.92 s
Distance Separation	3 NM	2 NM	1 NM	1 NM	280 ft
Vertical Separation	Not considered	Not considered	Not considered	500 ft	42 ft
P (event per arrival)	2.3E-05	1.5E-05	7.7E-06	2.0E-06	**7.8E-09**
bounds	1.1E-05 to 3.6E-05	7.6E-06 to 2.4E-05	3.8E-06 to 1.2E-05	1.0E-06 to 3.1E-06	3.8E-09 to 1.2E-08
Mean number of years between events @ 20,000 arrivals per year	2.2 yrs	3.3 yrs	6.5 yrs	24 yrs	6500 yrs
bounds	1.4 to 4.4 yrs	2.1 to 6.6 yrs	4.2 to 13 yrs	15 to 50 yrs	4000 to 13000
Mean number of years between events @ 30,000 arrivals per year	1.4 yrs	2.2 yrs	4.3 yrs	16.5 yrs	4200 yrs
bounds	0.9 to 2.9 yrs	1.4 to 4.4 yrs	2.8 to 8.8 yrs	10 to 34 yrs	2800 to 9000

Table 3: *Summary of likelihood result. The mean number of years between events is shown using the original LAHSO arrival rate of 30,000 per year and the recent estimate of 20,000 per year. Highlighted is the Collision Risk value of 7.8E-9 which can be compared with similar international measures as in* ***Section 2.3*** *and* ***Section 9.***

9 TLS Discussion

The collision risk values estimated here are of order 7.8E-9 per arrival. This may be compared with other Target Level of Safety (TLS) collision risk metrics used in other operations. Typical values quoted in the literature (see the literature review in Section 2.3) have Target Levels of Safety (TLS) per approach of between 1E-9 and 1E-8.

The yearly estimate of collision risk of order 1 every 6500 yrs is of the same order as found by Speijker [7,29] for their study of converging runways. In en-route risk analysis the TLS is of order 5E-9 per dimension per flight hour that equates to a mid-air collision rate of order 1 every 100-300 years for typical airspaces.

Comparing risk per arrival, per flight hour or per year can be misleading; airspaces have very different characteristics in terms of the number of operations and the risk per operation. A risk of 1E-7 may be acceptable if the operation only occurs once a year, but unacceptable if the operation occurs 1 million times per year.

Of importance here is the relative magnitudes of the risk for LAHSO against similar other international standards. In this case the risk per arrival is at the mid-to-upper range of similar standards, and the risk per year is in of the same order as similar standards.

Figure 26 shows that the high proportion of traffic at the crossing point are over 1000 ft. Above this threshold TCAS RA are in operation which will further mitigate the collision risk. Traditionally collision risk modelling in aviation does not include TCAS conservatively assuming that the risk is applied to the underlying airspace system.

Hence the risk estimates calculated for LAHSO appears to be at the mid-to-upper range of an acceptable TLS but not exceeding it.

10 Conclusions

The main results in this report showed that, given the available data and reasonable assumptions for most parameters:

1. a monitoring DGA_{60} event may occur every 1-4 years
2. a reportable DGA_{40} event may occur every 2-6 years
3. a reportable and major DGA_{20} event may occur every 4-13 years
4. an Aircraft Critical Proximity (ACP) event may occur every 15-50 years
5. mid-air collisions or near collisions may occur every 6 000 years
6. the mid-air collision risk is ~7.8E-9 per approach during LAHSO.

A DGA_{60} event is where two aircraft on crossing runways go-around within 60 seconds of each other. Other DGA events are similarly defined.

The data shows that during LAHSO, go-around rates:

7. are **not** statistically dependent on wind speeds between 10-20 knots
8. **are** caused by delayed Runway 34 departures but insufficient data is available to find a relationship with departure frequency during LAHSO
9. do **not** increase with SHEED arrivals
10. do **not** increase with night-time operations.

The go-around rate during LAHSO:

11. is currently estimated as ~2.5 per 1000 approaches
12. has declined since January 2015.

The recorded times for LAHSO operations:

13. has decreased since mid 2015. This appears to be due to both improved recording of LAHSO times within ATIS and reduced operations of LAHSO.

The estimated collision risk of 7.8E-9 per approach appears to be consistent with, and not exceed, similar international target levels of safety.

There is insufficient data in the period since December 10th 2015 to establish any statistically significant change in LAHSO go-around rats due to changed procedures.

11 Appendices

The appendices contain additional information designed to complement the main body of the report, or provide additional detail. The appendix also contains sections taken directly from the 2015 LAHSO study[2] to make this report complete without distracting from the main body of the report.

For internal Airservices reference, the link below is the internal Operational Analysis (Airservices) directory for files and data used in this report:

\\filecbr\arm\AAA_NEW_ARM\Projects\2016_Q1\OA_2016_Q1_32_LAHSO_10Dec

11.1 Definitions

Within this document, the following definitions apply.

Term	Definition
ACP	Aircraft in Critical Proximity (defined here as within 500 ft. vertical and 1 NM longitudinally)
ADMS	Aeronautical Data Management System
AIM	Aeronautical Information Management
ATIS	Automatic Terminal Information Service
ATC	Air Traffic Control
Beta distribution	A continuous probability distribution (see Appendix and http://en.wikipedia.org/wiki/Beta_distribution)
Bernoulli trial	In the theory of probability and statistics, a Bernoulli trial (or binomial trial) is a random experiment with exactly two possible outcomes, "success" and "failure", in which the probability of success is the same every time the experiment is conducted. http://en.wikipedia.org/wiki/Bernoulli_trial
CIRRIS	Corporate Integrated Reporting and Risk Information System
CROPS	Converging runway operations
DAH	Designated Airspace Handbook
DGA	Double Go-around
FIB	Flight Information Broker
FIR	Flight Information Region
ft.	feet
GA	Go-around
IFR	Instrument Flight Rule
Kts	Knots
LAHSO	Land and hold short operations
MAC	Mid Air Collision (defined here as within 140 ft. longitudinally and 42 ft. vertically).
MATS	Manual of Air Traffic Systems
NM or nm	Nautical Miles
OA	Operational Analysis: a unit within SSA
ODAS	Operational Data Analysis Suite: This is python-based numerical suite of tools for analysis of airspace flight data. It was developed within Operational Analysis

ORA	Operational Risk Assessments
pdf	**Probability density function.** In probability theory, a probability density function (PDF), or density of a continuous random variable, is a function that describes the relative likelihood for this random variable to take on a given value. The probability of the random variable falling within a particular range of values is given by the integral of this variable's density over that range—that is, it is given by the area under the density function but above the horizontal axis and between the lowest and greatest values of the range. The probability density function is nonnegative everywhere, and its integral over the entire space is equal to one. https://en.wikipedia.org/wiki/Probability_density_function
Rego	Aircraft Registration
RWY	Runway
RPT	Regular Public Transport
SEA	Safety, Environment and Assurance Group: a major group within Airservices
SIGMET	Significant Metrological Conditions
SME	Subject Matter Expert
SSA	Strategy Systems and Analysis: a Branch within SEA
VFR	Visual Flight Rules
WX	Weather
1E-5	1×10^{-5}, Exponential notation

11.2 Data validation

This section gives an overview of data validation methods based on data from January 1st 2012 to February 28th 2015. This section is extracted from the 2015 LAHSO study [2] and hence does not contain the additional data to January 31st 2016, since the results below indicate the methodology is valid.

11.2.1 Go-around occurrences identified by surveillance track data

This subsection demonstrates some of the methods used to determine go-around occurrences from surveillance data: the aim is to verify, where possible, the identification of go-arounds. The method identifies a flight's initial approach runway, final landing runway, and go-around incident time (if a go-around occurred).

To detect the landing and go-arounds four "approach detection zones" zones were defined for the Melbourne runways 09, 16, 27 and 34. These started at the runway thresholds with a dimension of 2 nautical miles (plus runway width) perpendicular to runway heading and 6.5 nautical miles (NM) along the runway heading. The distance 6.5 NM was chosen by considering the Departure and Approach Procedures (DAP) published by Airservices. According to the instrument approach procedures for precision and non-precision approaches at Melbourne airport, earliest final approach started at 6.5 nautical miles from the corresponding runway threshold.

Landing and go-around performance were assessed based on the altitude change within the zones and the change of heading when entering and exiting the zones. A visualization of those approach detection zones was shown in ***Figure 31.***

Figure 32 demonstrates a sample flight which approached from the North, descended and attempted to land on Runway 16. Instead of landing the aircraft performed a go-around and finally landed on the same runway on its second attempt. The colour of the track indicated the change in altitude. The red point is an estimation of where the go-around commenced.

The identification of go-arounds from surveillance data can be problematic, due to the wide variety of aircraft approach trajectories. Hence each go-around is visually inspected to ensure correct identification. ***Figure 33*** shows twelve examples of go-arounds which were identified by the analysis program as being go-arounds. ***Figure 34*** shows four examples of approaches which were initially identified by the program as being go-arounds but subsequently modified after visual inspection.

The visual inspection of track data provides an additional level of confidence in the ability to correctly determine go-arounds from surveillance data.

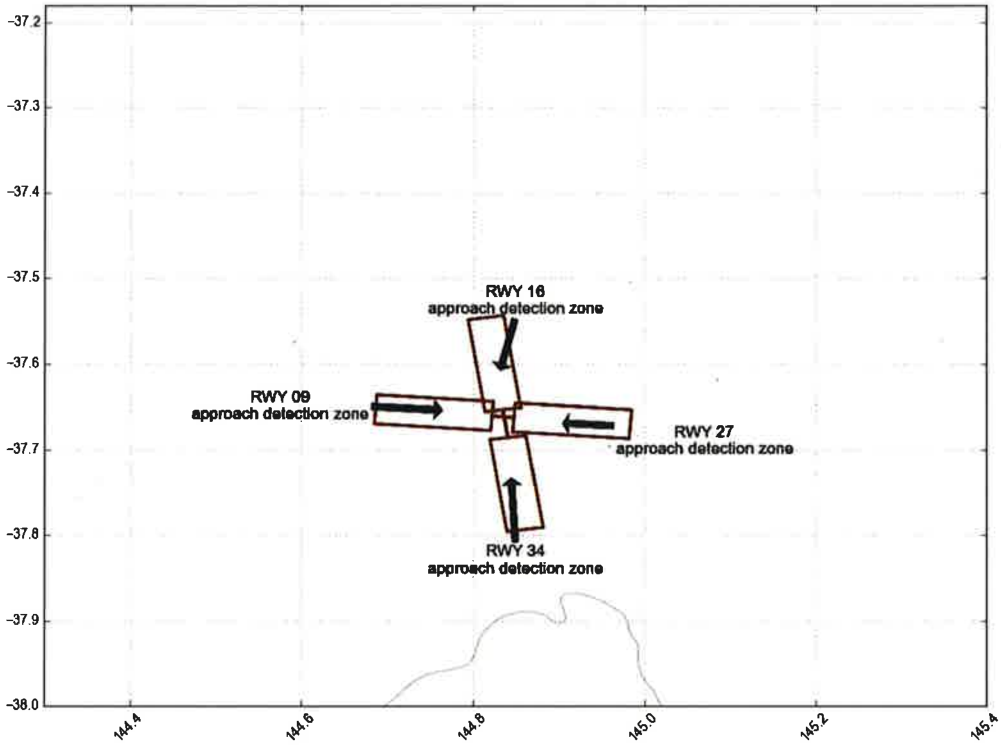


Figure 31: *Approach detection zones for Runways 09, 16, 27, 34 at Melbourne International Airport. Each zone is 6 NM from the runway threshold and 2 NM wide.*

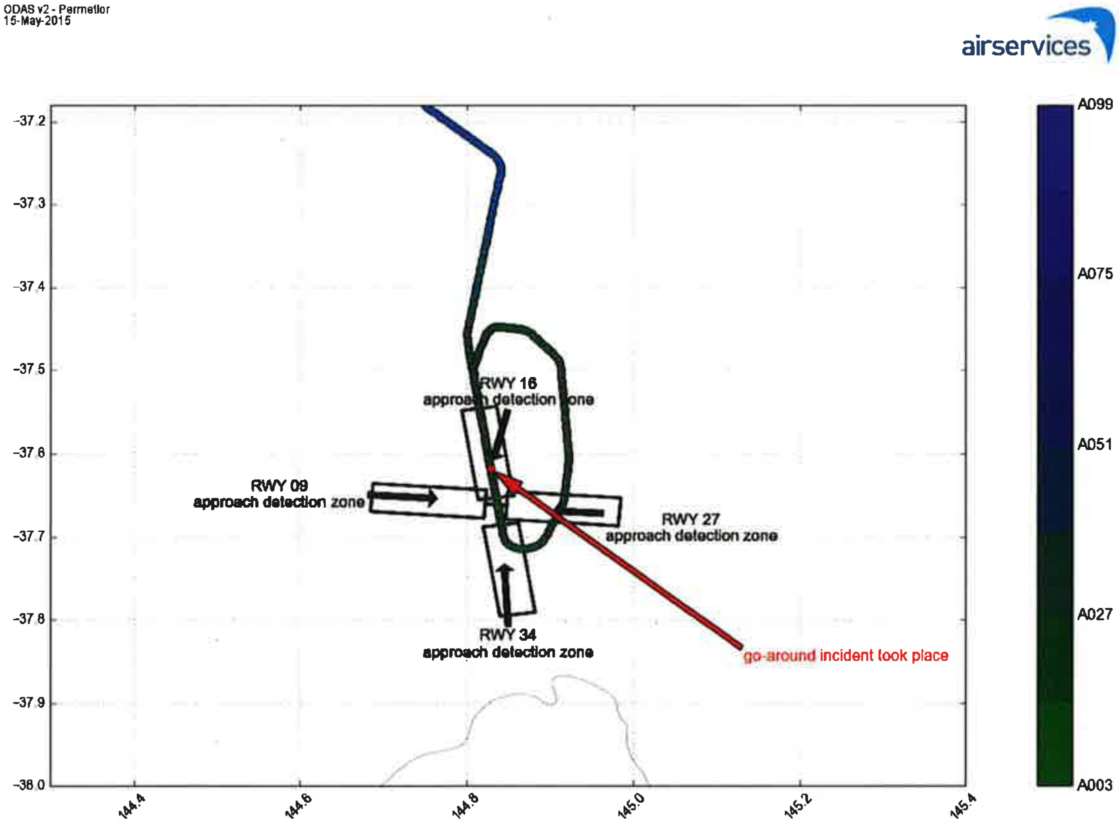


Figure 32: *Illustration of go-around detection (the flight departed from Adelaide on May 4th 2014 08:44:00 UTC and arrived at Melbourne on May 4th 2014 10:01:00 UTC with callsign QFA694, registration VHVYF and ODAS ID 20140504-0835-QFA694-0).*

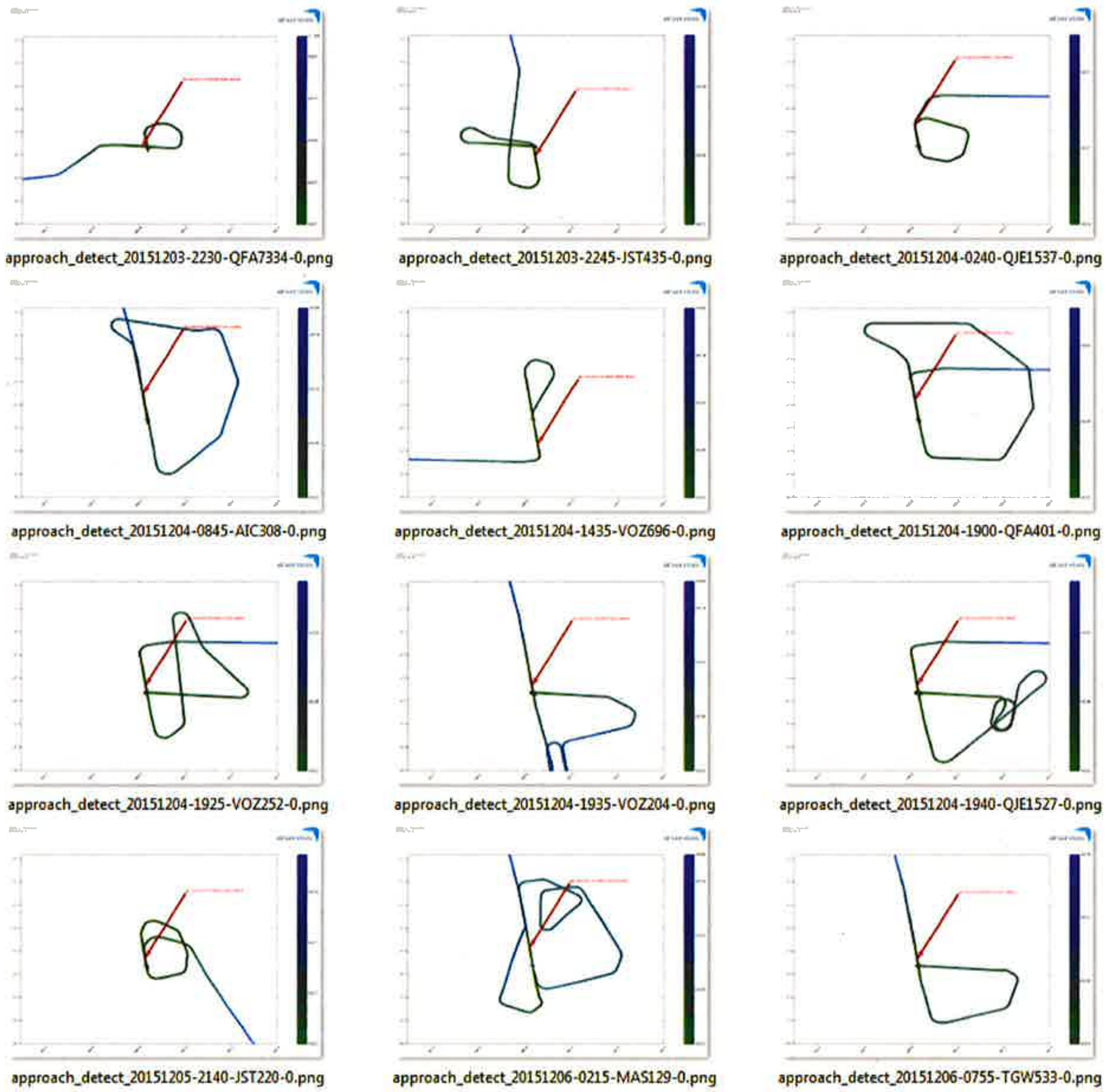
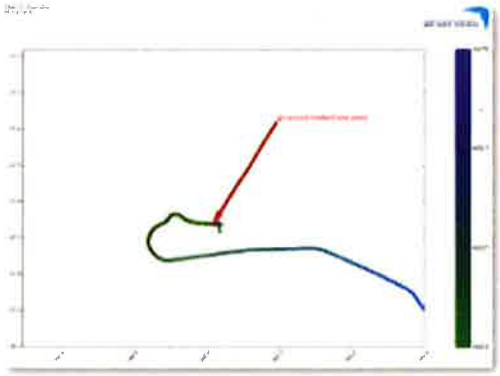


Figure 33: *Example of 12 go-arounds identified from surveillance data. Each one is visually tested to ensure it is a go-around.*



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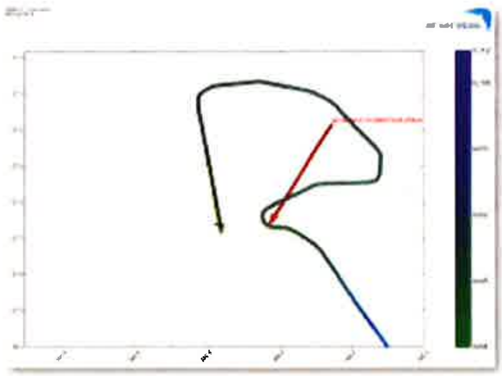

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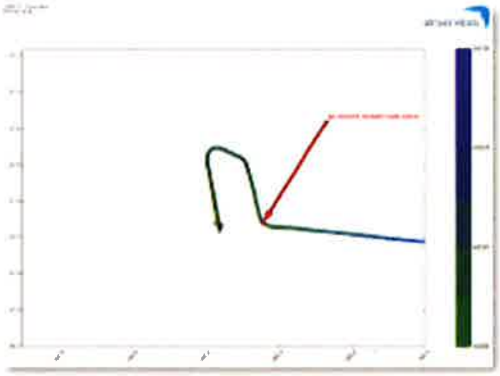
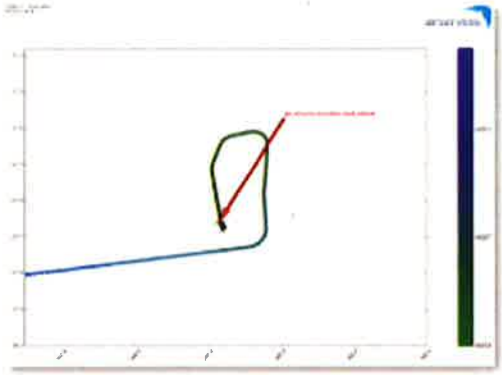


approach_detect_20151219-0400-QFA158-0.png



approach_detect_20151209-0405-VOZ686-0.png

Figure 34: *Example of four approaches which were visually identified as not being go-arounds and hence removed from the list of go-arounds.*

This section shows that analysis program, when combined with a visual check of traffic patterns, can correctly identify go-arounds from surveillance data.

11.2.2 Validation between CIRRIS and ODAS data

Go-arounds at Melbourne International Airport were compared between CIRRIS records and ODAS surveillance data. It was necessary to

- verify the existing CIRRIS records with another data source such as Surveillance track data
- recover the go-arounds which were not reported by CIRRIS.

Operational Analysis (OA) within Airservices developed an advanced data analysis tool named ODAS (Operational Data Analysis Suite) which contained a verified surveillance-data database. Based on this:

- the process to match CIRRIS records with Surveillance track data by incident time, flight callsign, registration and aircraft type was implemented
- a methodology to detect go-arounds from surveillance track data was developed.

11.2.2.1 ODAS-identified go-arounds:

ODAS identified 1,114 flights (from January 2012 – February 2015) as potential go-arounds, where about 239 events were actually classified as missed approaches (rather than go-arounds) and were therefore excluded from this analysis.

During the time period analysed, 875 go-arounds were recorded for YMML with 759 having sufficient information to attempt a match to ODAS data. Of these, 739 flights had confirmed ODAS surveillance go-arounds. Thus approximately 13% could not be accurately matched to an ODAS record due to inaccurate or missing information in CIRRIS to identify the corresponding flight.

It was expected that there would be a discrepancy between the two data sources, with both having limitations. The 87% correlation between the two data sources was considered to be sufficient to create a data set suitable for this analysis: CIRRIS data may not have sufficient information to identify a flight; ODAS data requires code to test vast volumes of flight track data to find flights with go-around characteristics and in some cases precise flight data is missing or inaccurate.

Of key importance was the identification of the exact time of the go-around. Here ODAS data was used, as this provided accurate ADS-B or radar data recording of the go-around time.

11.2.2.2 CIRRIS go-arounds:

The CIRRIS definition of go around incidents is as follows:

"When the final approach to land of an aircraft is terminated and the aircraft conducts a go around procedure.
Note: Not reportable where an aircraft initiates a published missed approach procedure because visual flight could not be established by the minima."

There were totally 875 go-around incidents recorded in CIRRIS for Melbourne arrivals from January 2012 to February 2015. During the matching process:

- some records were with insufficient information and thus failed to match. The following CIRRIS record was an example:

  "21/03/2013 03:55:00 AM, Missed approach due windshear. Primary Occurrence Type: Go Around"

- some CIRRIS go-around incidents could not be identified from surveillance track data, for example (ref to ***Figure 35***):

  "19/07/2013 09:23:00 AM, JST971 initiated a missed approach on runway 34 due wx. Primary Occurrence Type: Go Around."

- some records might have inaccurate information, for example:

  "05/07/2013 02:33:00 PM, TGW363 WAS ON SHORT FINAL FOR R34 WHEN THE PILOT ELECTED TO CONDUCT A GO AROUND DUE TO WINDSHEAR. WINDSHEAR HAD BEEN REPORTED BY PRECEEDING ARRIVALS AND THE WARNING WAS ON THE ATIS. Rego: VNG. Primary Occurrence Type: Go Around."

  However, after searching the surveillance data, the flight with callsign TGW363 was with registration VHVNQ rather than VHVNG, departed from YBBN on July 5th 2013 01:16:00 PM and arrived at YMML on the same day 03:18:00 PM, and did not perform a go-around. On the other hand, the flight with registration VHVNG on that day did not perform a go-around either.

In conclusion there were about 13% records in CIRRIS records that were not clear or could not be identified from surveillance track data. Most of the unmatched records were before July 2013 which was migrated from ESIR to CIRRIS.

11.2.2.3 CIRRIS records vs go-arounds identified by track data

Among the 759 identified CIRRIS records 741 flights (97%) were able to be confirmed as go-arounds from surveillance track data.

Table 4 gives examples of some discrepancies between CIRRIS go-around data and available track data from ODAS. The reason for the discrepancies could be either uncorrected CIRRIS record or uncorrected surveillance data record.

Considering the last flight in ***Table 4*** as an example. The CIRRIS record states *"19/07/2013 09:23:00 AM, JST971 initiated a missed approach on runway 34 due wx. Rego: VGF"*.

By searching through surveillance data, the flight with ODAS id "20130719-0520-JST971-0" was found to be the most matched flight. This flight departed from Perth on July 19th 2013 05:49:00 UTC and arrived at Melbourne on the same day 09:22:00 UTC with callsign JST971, registration VHVGF. By visualising its track in ***Figure 35*** it is clear that it did not perform a go-around as noted in CIRRIS.

Table 4: *Example discrepancies between CIRRIS go-around records and surveillance data. The CIRRIS data does not appear to refer to the correct aircraft path as identified in ODAS.*

ODAS ID	
20130705-1230-TGW363-0	Could not find similar aircraft which performed a go-around
20121025-2050-JST771-0	insufficient information contained in ODAS
20131010-1545-QFA7338-0	wrong aircraft registration provided in CIRRIS
20130415-1300-CSN321-0	wrong date recorded in CIRRIS
20140404-2200-VOZ824-0	wrong date recorded in CIRRIS
20130719-0520-JST971-0	Recorded as go-around in CIRRIS yet not observed to have performed a go-around in the ODAS surveillance track data

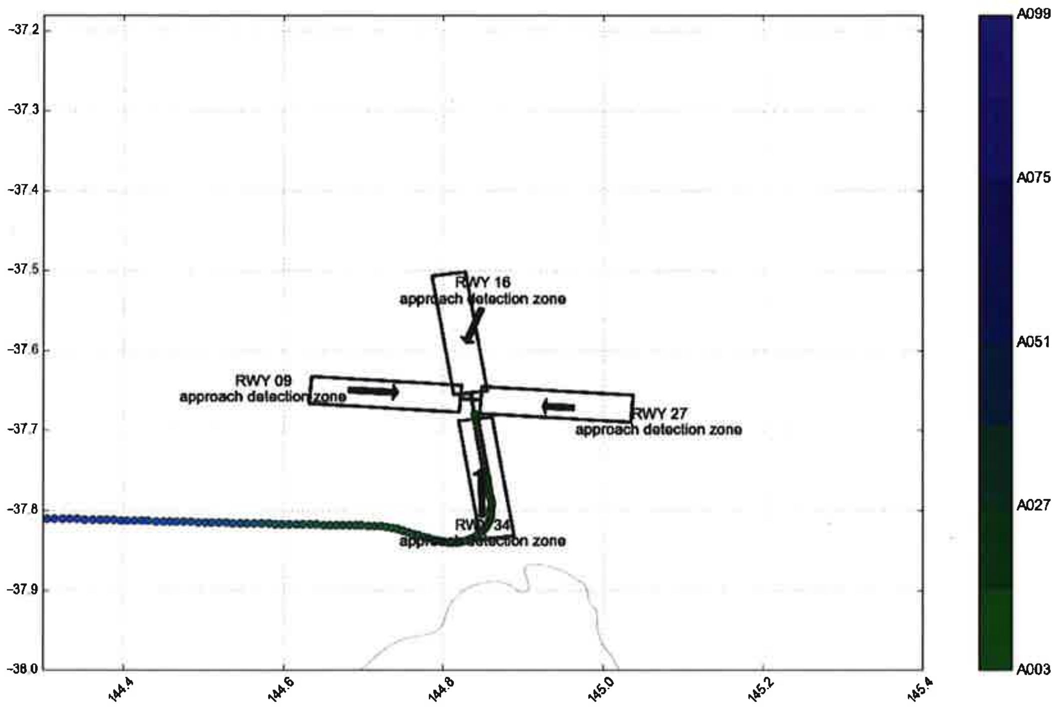


Figure 35: *Example of a flight path which was identified in CIRRIS as a go-around but which lands correctly. The flight departed from Perth on July 19th 2013 05:49:00 UTC and arrived at Melbourne on July 19th 2013 09:22:00 UTC with callsign JST971, registration VHVGF and ODAS ID 20130719-0520-JST971-0.*

Table 5 gives a list of flights detected within ODAS data as potential go-arounds but not able to be matched to data within CIRRIS.

Figure 36 and ***Figure 37*** show example flights detected by the surveillance data methodology but not matched in CIRRIS. However, some of these flights may not meet the technical definition of a go-around necessary for inclusion in CIRRIS and are artefacts of the procedure to automatically identify go-arounds from over 100,000 flights. Additionally some of the ODAS-identified go-arounds may be the same as un-matched CIRRIS go-arounds. For example ***Figure 37*** shows a flight which is most likely the following CIRRIS record which has no identification:

"11/01/2012 12:01:00 AM, Pilot initiated missed approach from late final due windshear. Advertised on CATIS and Sigmet. Primary Occurrence Type: Go Around."

This section shows the methodology used to identify go-arounds from surveillance data is sufficient to inform the risk calculations and consistent with CIRRIS data.

Table 5. *Samples of flights detected as go-arounds yet not recorded in CIRRIS.*

ODAS ID	Go-around incident time	Approach runway	Arrival runway
20120129-0445-PBN184-0	29/01/2012 10:17	34	34
20120420-2030-RXA3752-0	20/04/2012 23:04	16	16
20120420-2215-RXA3153-0	21/04/2012 0:44	16	16
20130213-2100-QFA609-0	13/02/2013 23:12	27	27
20130310-0300-QFA621-0	10/03/2013 5:21	34	34
20130629-0005-QLK79D-0	29/06/2013 0:58	16	16
20130802-0745-JST479-0	2/08/2013 9:35	34	27
20130912-0250-VOZ736-0	12/09/2013 5:43	16	16
20131020-0500-QFA447-0	20/10/2013 7:12	34	27
20131021-0135-VOZ1506-0	21/10/2013 4:17	16	16
20131120-0745-JST166-0	20/11/2013 11:13	16	27
20140731-0330-QFA437-0	31/07/2014 5:01	34	27
20140506-0005-VOZ262-0	6/05/2014 0:53	16	16
20141123-1730-VOZ149-0	23/11/2014 21:53	27	27
20150103-0540-JST706-0	3/01/2015 6:56	34	27
20150103-0535-VOZ232-0	3/01/2015 6:54	34	27
20150103-0300-VOZ101-0	3/01/2015 6:57	34	27
20150221-0500-QFA447-0	21/02/2015 6:40	16	16

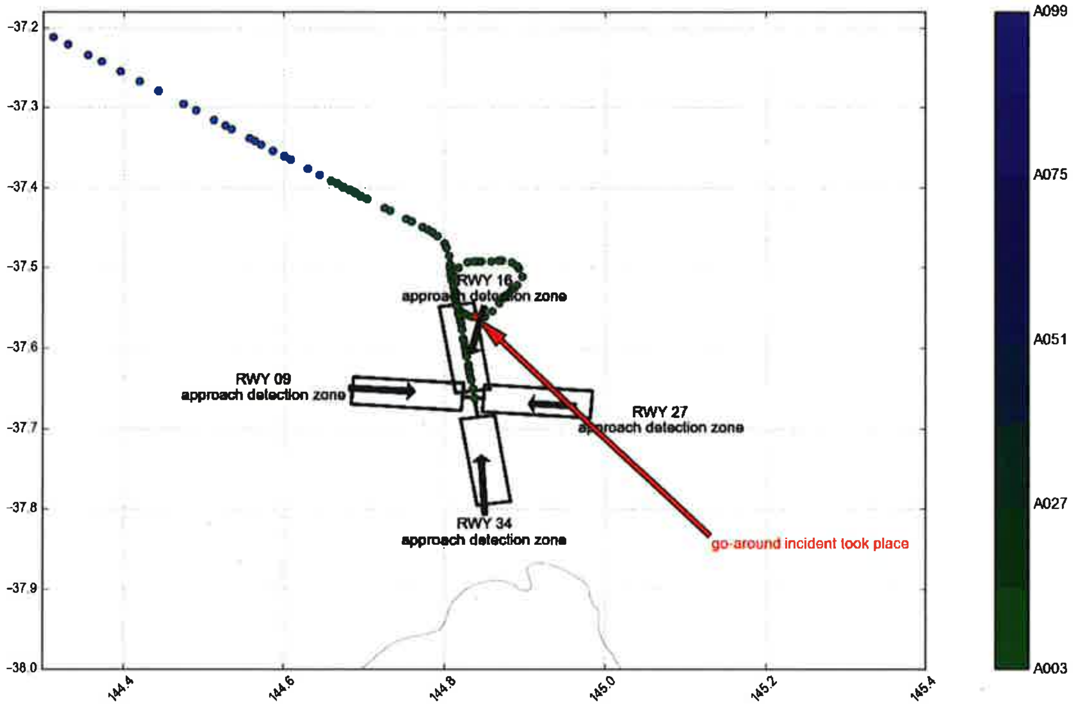


Figure 36: *Example flight which departed from WMKK on January 3rd 2012 02:15:00 UTC and arrived at Melbourne on January 3rd 2012 09:44:00 UTC with callsign MAS129, registration 9MMTD and ODAS ID 20120103-0215-MAS129-0. This flight was identified within ODAS as a potential go-around with no matching record in CIRRIS. I*

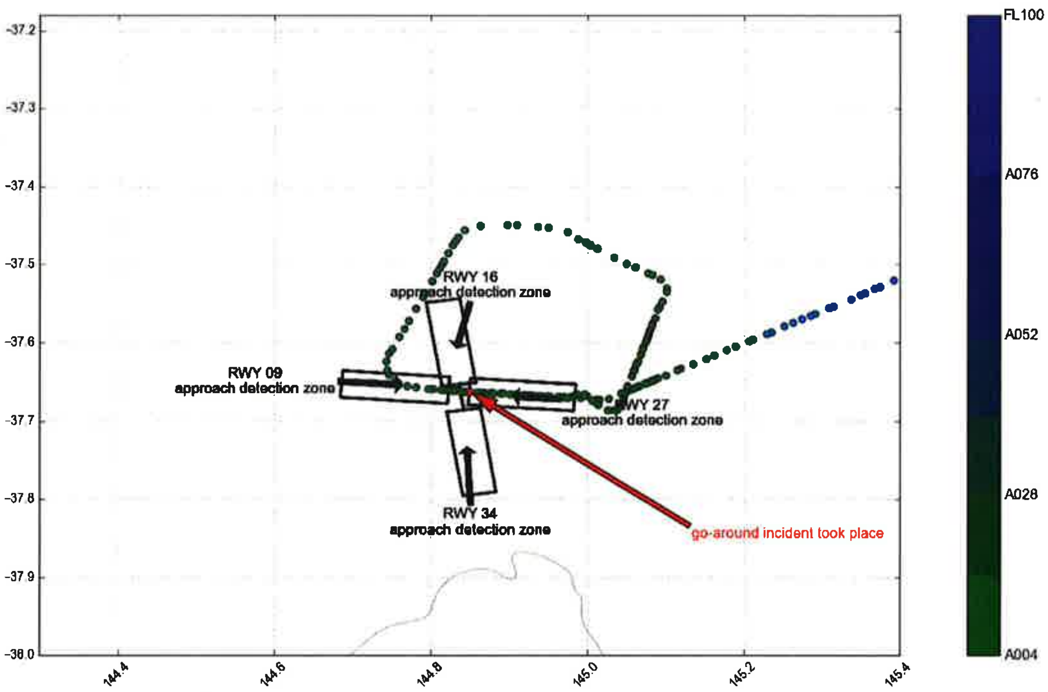


Figure 37: *An example of go-around detection (departed from Sydney on January 10th 2012 22:49:00 UTC and arrived at Melbourne on January 11th 2012 00:16:00 UTC with callsign UAL839, registration N180UA and ODAS ID 20120110-2240-UAL839-0). This flight was identified within ODAS as a potential go-around and most likely was included within CIRRIS but not 100% positively identified.*

11.2.3 Validation of day-night assignment

This section demonstrates with two simple examples the identification of day or night by the analysis routines. Table 6 illustrates two random flights and the determination of them arriving during the day or night. This is compared with externally published flight information (http://flightaware.com/) to demonstrate that the determination of day or night appears correct. Other random samples of flights were tested and similarly found to be correct. The Python module *pyephem* ***[32]*** and *pytz.timezone* ***[33]*** were used to establish time-zone information and sunset/sunrise times.

ODAS_id	UTC arrival at threshold	Local time arrival at threshold	Day or night?	Scheduled arrival time
20160106-2215-JST172-0	2016-01-07 01:49:31	2016-01-07 12:49:31	Day	12:34 AEDT
20160106-0800-QFA635-0	2016-01-06 10:11:04	2016-01-06 21:11:04	Night	*21:10 AEDT*

Table 6: *Example of two flights with UTC arrival time, Local arrival time and day-night determination from the analysis program. The scheduled arrival time via standard links is shown. Hence for this sample the program correctly identifies whether the aircraft arrives during the day or night.*

This section shows that the analysis program correctly identifies day or night for a given flight.

11.2.4 Validation of post November 2015 reduced LAHSO arrivals

This section provides validation that the reduction in LAHSO traffic levels from November 2015 (in ***Figure 7)*** was not an error within the data sources but a valid change in procedures. This would hence explain the apparent increase in the go-around rate shown in ***Figure 18*** and ***Figure 19*** for the week of November as a statistical artefact of reduced LAHSO operations and procedure changes.

ATC introduced modified LAHSO requirements that were formally implemented on 10th December 2015 but adopted prior to this date. This is reflected in the November 2015 data.

Figure 38 and ***Figure 39*** clarify this result. ***Figure 38*** demonstrates that all the arrivals were captured during the November 2015 period by comparing with a similar week in November 2014. The traffic arrival counts are statistically the same for each hour. ***Figure 39*** then shows that LAHSO was in use less during the November 2015 period as compared with the 2014 November period.

This section showed the reduction in LAHSO operating times and LAHSO arrivals is due to procedural changes and not an problem with data integrity.

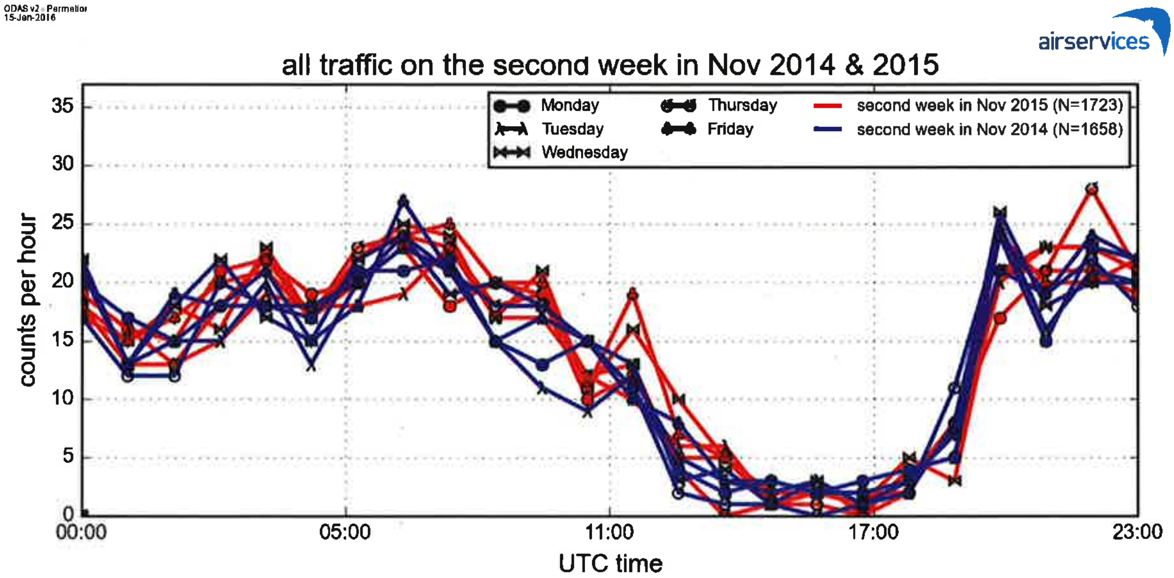


Figure 38: (LAHSO and non LAHSO) *Overall arrival count per hour at Melbourne as a function of UTC time of day for two comparable weeks in November 2014 and 2015. This shows that the overall traffic volume has not changed and the analysis has captured all appropriate data.*

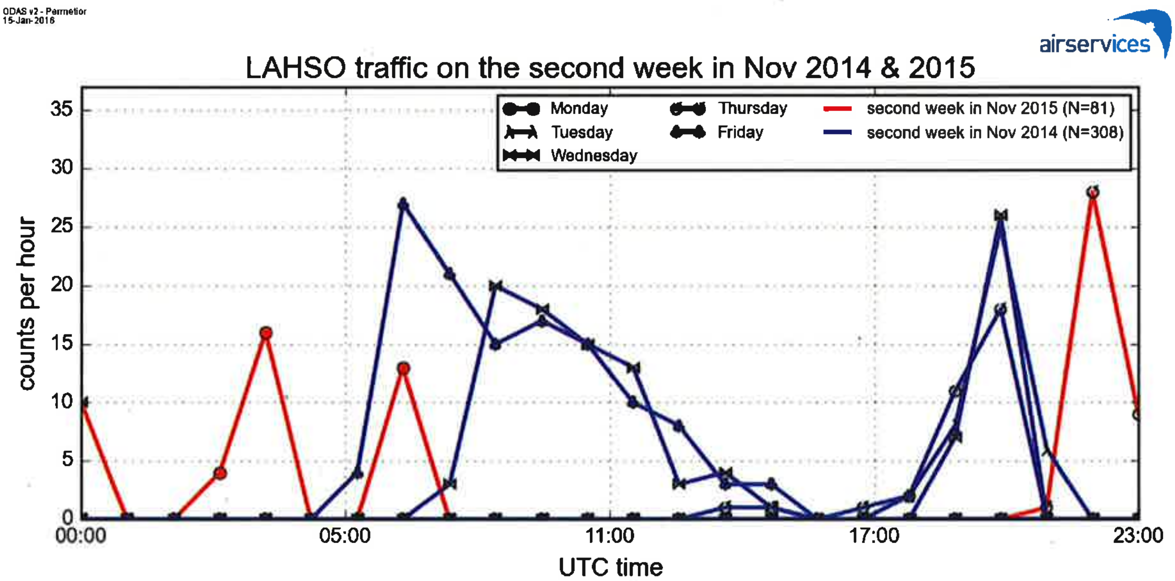


Figure 39: (LAHSO only) *Count of arrivals during LAHSO as a function of UTC time of day. It is clear that LAHSO was used less in the 2015 November week when compared to the comparable 2014 week.*

11.3 Is the go-around rate dependent on wind?

This section explores whether the go-around rate changes with meteorological factors. The study was restricted to LAHSO conditions only, noting that LAHSO is designed to not be implemented in extreme weather. Hence no real dependence of the go-around rate on meteorological factors during LAHSO is expected.

This section is taken from the 2015 LAHSO study [2] as further analysis was not necessary to further validate the results.

Meteorological information from ATIS

Meteorological information was obtained from Automatic Terminal Information Service (ATIS) records. Cross wind and downwind information were calculated for each runway. In this report, **down-wind was positive when it was in the direction of aircraft flying, negative** when it was in the **opposite** direction (a head wind). **Cross-wind** was **positive** when

- for Runway 27, wind from the north,
- for Runway 34, wind from the east.

ATIS data has limitations regarding the value of wind speeds, with a recorded wind speed not being correctly identified as either maximum or average. This gives an unknown error in the speed values used and this should be considered in the interpretation of results.

In order to review the meteorological conditions on each flight's initial arrival at Melbourne airport, a time was chosen when flights entered the approach detection zones at their first attempted arrivals.

Detailed spreadsheets were created for all flights arriving at Melbourne Airport between January 1st 2012 and February 28th 2015, with information on wind speeds and direction, visual distance and cloud base at their initial arrivals located at the following link (for staff with access privileges and can be made available on request):

\\Filecbr\arm\AAA_NEW_ARM\Projects\2015_Q1\Active\ODAS_request_ATC_LAHSO\data output\YMMLarrivals

In the appendix, scatter plots were used to display meteorological conditions at a flight's initial arrival approach for go-arounds and non-go-arounds. This helps to build illustrations of the impact of meteorological conditions on go-around occurrences.

Given the available data:

1. for most results, there is no statistically different go-around rate as a function of visibility, cloud base or down-wind conditions.
2. there are some small regions (small ranges of data) where combinations of cross-wind/downwind and cross-wind/visibility conditions align with a statistically significant increase in go-around rate. This may indicate possible causal factors for increased go-around rates suitable for further analysis.

Go-around rate with cross-wind

This section explores whether the go-around rate varies with the level of cross-wind. This is explored for both LAHSO conditions and in general. As LAHSO is not used when high cross winds exist, no dependence on go-arounds with wind is expected during LAHSO. However, some dependence of go-around rate on high winds when LAHSO is not used is expected.

The analysis considers winds in the range 10-20 knots since the LAHSO operations has an upper limit of 20 knots. This same lower limit is then used for all operations, for consistency, recognising that during non-LAHSO winds may be much higher than 20 knots.

Figure 40 shows the estimation of the go-around rate during LAHSO in general and when cross-winds larger than 10 knots exist. The rate does increase from 2.5 to 2.9 per 1,000 approaches but is only significant to 75%. That is, the difference between 2.9 and 2.5 is not statistically significant with the usual 95% significance test.

Figure 41 shows the same results as ***Figure 40,*** but for all operations during the analysis period. Here there is an increase in go-around rate with cross-winds above 10 knots from 3.0 to 4.0 per 1,000 approaches. This is to be expected. Further work can test how this rate changes with different speeds.

These figures also indicate that the current rules for restriction of LAHSO operations due to wind conditions are successful in reducing the risk of go-arounds.

There was insufficient data to examine results per runway.

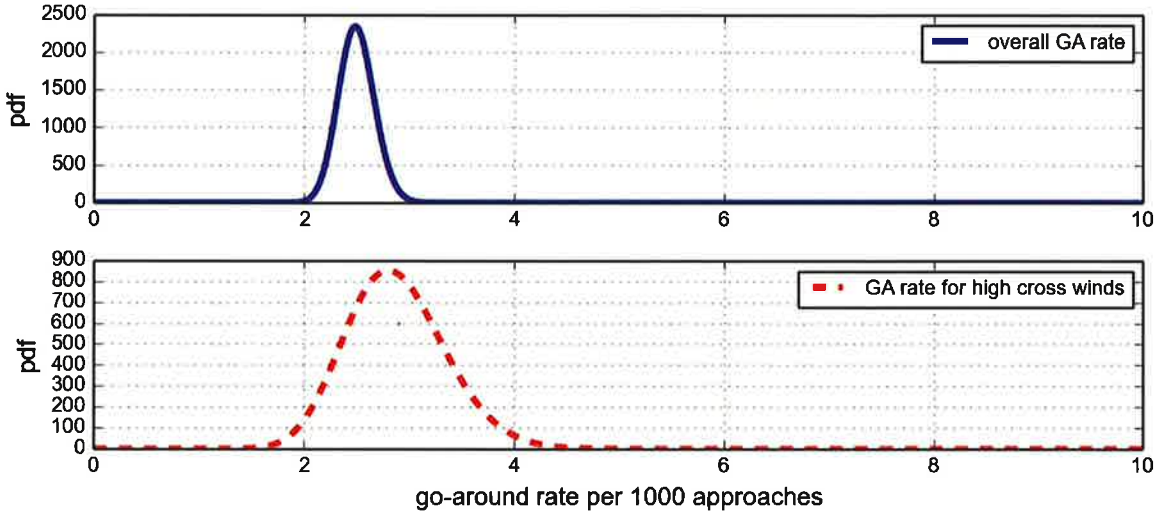


Figure 40: (LAHSO) *The top plot shows the estimation of the go-around rate during LAHSO operations (2.5 per 1000). The red bottom plot [10-20 knots] shows the estimation of the go-around rate when the cross wind was in the range 10-20 knots. The rate may be marginally higher but was not statistically significant. The y-axis is the probability density function for the parameter estimate. That is, given finite data the estimate of a rate has a level of uncertainty. These plots show the certainty of the rate. For the top data the go-around rate is approximately 2.5 but the spread of the graph indicates the uncertainty.*

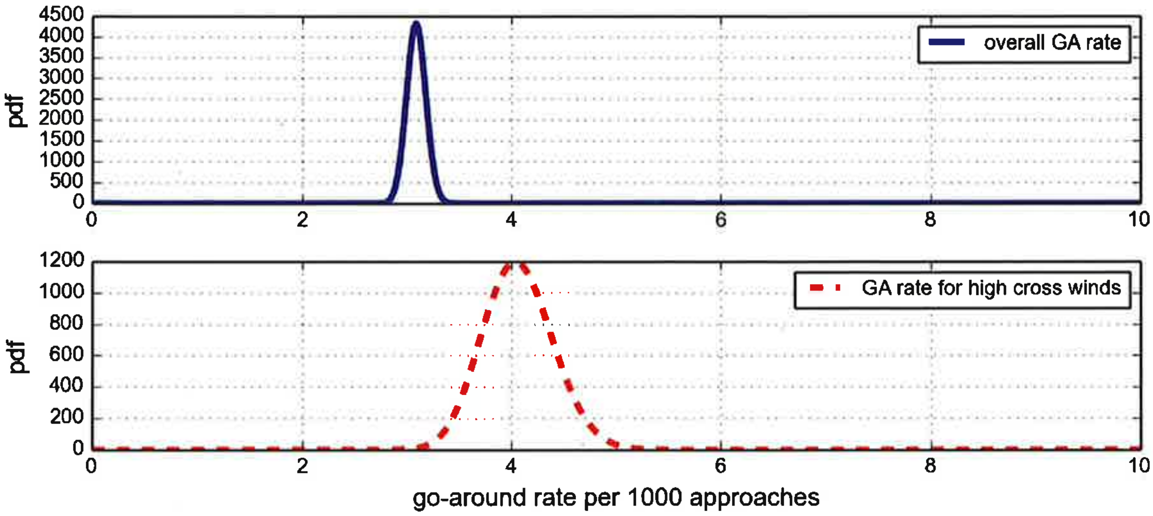


Figure 41: (LAHSO and not LAHSO) *The top plot shows the estimation of the go-around rate NOT just during LAHSO operations (3.2 per 1000). The red bottom plot [>10 knots] shows the estimation of the go-around rate (4.0) when the cross wind was stronger than 10 knots. The rate increase was statistically significant. The y-axis is the probability density function for the parameter estimate. That is, given finite data the estimate of a rate has a level of uncertainty. These plots show the certainty of the rate.*

This section showed that during LAHSO at Melbourne Airport in the analysis period, there **was no significant increase** in go-around rate with cross-wind conditions (10 – 20 knots), whereas outside LAHSO, the go-around rate was higher, with higher cross winds (> 10 knots). It can therefore be shown that restrictions on LAHSO operations during high cross-winds do effectively decrease go-around risk.

Go-around rate with down-wind

This section explores whether the go-around rate varied with the level of down-wind. This was explored for both LAHSO conditions and in general. As LAHSO is not used when high down-winds exist, no dependence on go-around with down-wind during LAHSO is expected. However some dependence of go-around rate on high winds when LAHSO is not used is expected.

Figure 42 shows the effect of a large down-wind component (>8 knots within the data sample) on go-around rate during LAHSO operations. There is a marginal increase in go-around rate from 2.5 to 2.8 which is only significant to 83%. Hence during LAHSO down-wind was not a critical factor. Note that, as explained earlier, the data used from ATIS for wind speed may not be representative of the actual speed used by ATC at the time of defining LAHSO operations: hence the value of 8 knots appearing in the data and may in fact represent actual operations of LAHSO near the 5 knot downwind limit.

Figure 43 shows go-around rates for all times (not just LAHSO). Here there was a statistically significant increase in go-around rate from 3.2 to 3.5 per 1000 approaches. Further investigation would most likely show an increase in this rate for higher down-winds.

There was insufficient data to examine results per runway.

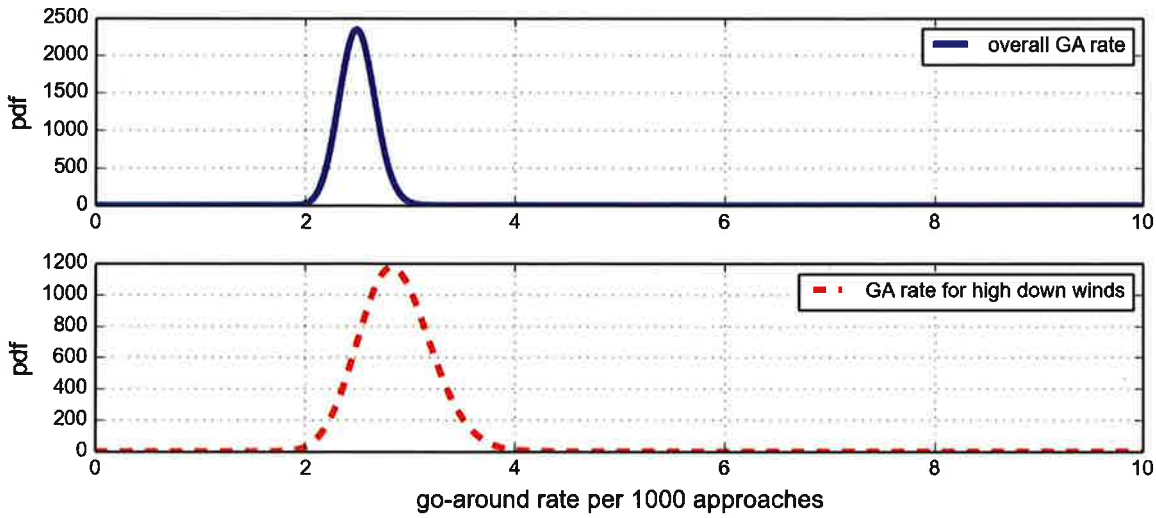


***Figure 42: (LAHSO)** Go around rate during LAHSO overall and with high down-winds (>8 knots). There was no significant difference in the go-around rate. That is, given finite data the estimate of a rate has a level of uncertainty. These plots show the certainty of the rate. For the top data the go-around rate is estimated to be 2.5 with the spread in the curve indicating the level of uncertainty.*

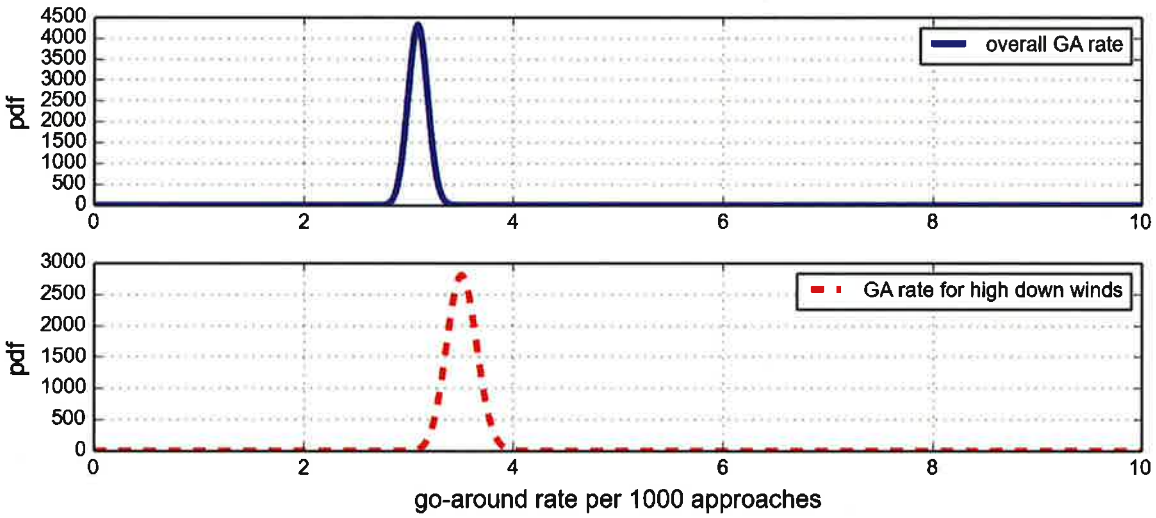


***Figure 43: (LAHSO and not LAHSO)** Go-around rate overall and with high down-winds (>8 knots). Results are NOT just during LAHSO operations. Here there is a significant increase in go-around rate from 3.2 to 3.5 per 1000. That is, given finite data the estimate of a rate has a level of uncertainty.*

This section showed that, during LAHSO at Melbourne Airport during the analysis period, there was **no significant increase** in go-around rate with **down**-wind, whereas without LAHSO restrictions, the go-around rate was higher with higher **down**-winds.

As noted earlier, the use of 8 knots may represent statistical error in the data and not a breach of LAHSO operation rules – this result simply indicates a need to continually monitor and assess operations with large downwind speeds and correctly affirms the current LAHSO restriction of 5 knots down-wind.

11.4 Is the LAHSO go-around rate dependent on aircraft arrival rates?

This section explored the hypothesis that the go-around rate was higher during times of high arrival rate. This would impact on the likelihood of go-arounds and imply that the average go-around rate cannot be used. Any increase in go-around rate may be due to aircraft not stabilising on approach due to time and traffic constraints in times of high arrival rates.

Figure 44 shows the estimation of the go-around rate for LAHSO operations with low traffic densities (<20 per hour) versus only those LAHSO operations with more than 20 arrivals per hour. There was an increase in the mean from 2.2 per 1000 to 3.0 per 1000. A statistical test shows that the two means satisfy 98% confidence in their difference.

This dependence may also be an artefact of go-around correlation and dependence: that a causal factor for one go-around may persist long enough to influence the next go-around. It is difficult to disentangle this effect from any possible underlying factor associated with large traffic flows.

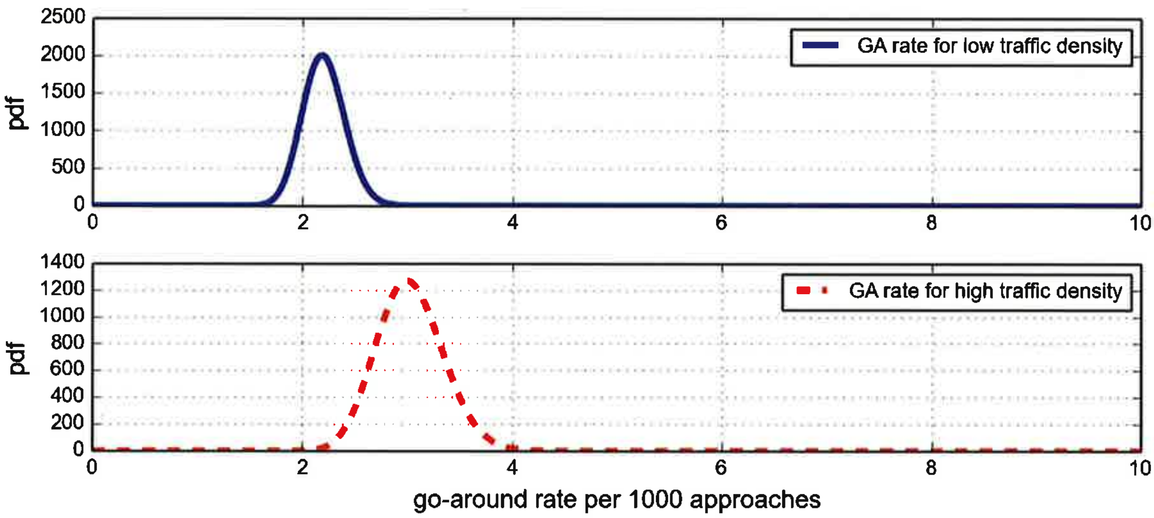


Figure 44: (LAHSO) *Estimation of the go-around rate (per 1,000 approaches) during LAHSO operations. The top plot is for all LAHSO approaches with low arrival rates (<20 per hour) whereas the bottom plot uses only data during high arrival rates (>20 per hour). The rate increases from 2.2 to 3.0 go-arounds per 1,000 approaches, and is statistically significant to 98% confidence.*

The main result from this section was that the LAHSO go-around rate at Melbourne Airport during the analysis period was larger during times of high arrival rates when compared to low arrival rates. This may be an artefact of the previous correlated go-around likelihood and will need further study.

11.5 Statistics of estimating go-around rate

This section explains some of the statistical methodology around how the go-around rate is estimated.

Each aircraft arrival is considered a Bernoulli trial: where the outcome is either success or failure (a go-around, termed here as an event or failure). If there are 3 events out of 1000 trials the estimated rate is 0.003 but there is a significant possibility the true rate is different from this. Bayesian probability methods allow us to estimate the distribution of the rate given this limited information; see for example reference [26].

Consider the simple case of a Bernoulli trial with **m** failures in **N** trials and the uncertainty in the failure rate **f=m/N**. The probability density function (pdf) that this rate has value *x* is given by

$$\frac{x^{a-1}(1-x)^{b-1}}{B(a,b)}$$

where *B(a,b)* is the Beta function. The parameters are:

$$a = 1 + failures,$$

$$b = 1 + N - failures.$$

The mean of this distribution is

$$mean = a/(a+b).$$

Figure 45 shows an example where the underlying rate is defined as 0.3 with data generated by a random number generator. In the top plot there were 58 failures in 200 trials. The distribution of the estimate of the failure rate is shown by the distribution centred on 0.29. In the lower plot there was less data with 11 failures in 40 trials giving a much broader estimate of the failure rate.

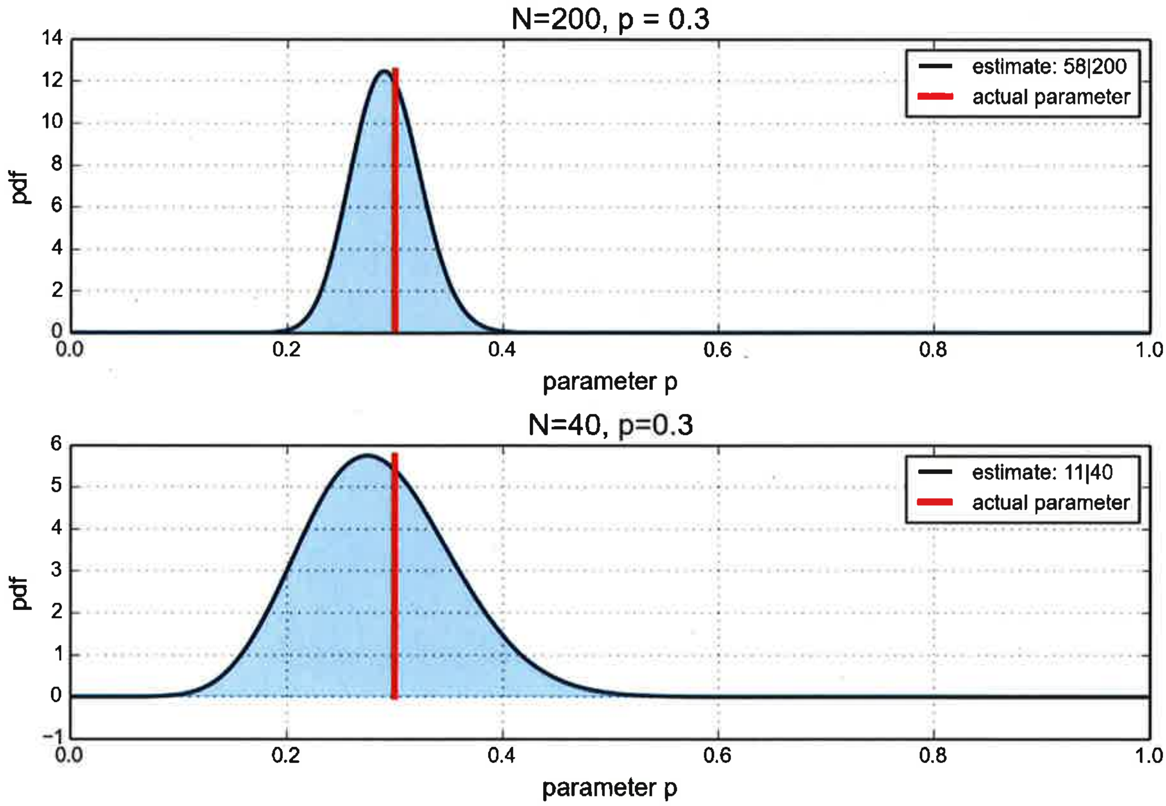


Figure 45: *Illustration of estimation of failure rate. The vertical axis is the probability density function for the estimate. Here the actual rate is 0.3 and random number generates are used to simulate the trial. In the top plot there were 58 events out of 200 trials hence the estimate is 0.29 with a standard deviation in this estimate of 0.032. In the lower plot there are only 40 trials and hence with less data the confidence in the estimate is lower indicated by the larger spread in the distribution.*

In probability theory and statistics, the Beta distribution is a family of continuous probability distributions defined on the interval [0, 1] parametrized by two positive shape parameters, denoted by α and β, that appear as exponents of the random variable and control the shape of the distribution http://en.wikipedia.org/wiki/Beta_distribution.

11.6 Statistical arguments regarding correlated go-arounds

This section expands on the crucial argument about go-arounds being correlated.

Consider event A and event B to occur with probability P(A) and P(B). If they are uncorrelated and independent then the risk of both happening is P(A) P(B). For example, the likelihood of getting a 6 by throwing a dice is 1/6. The probability of getting a 6 then a 6 by throwing the dice twice is simply 1/36.

However, sometimes event B is influenced by the same factors as event A. For example, the probability of a rainy day may be 1/10. But the probability of two rainy days in a row is not 1/100 since when one rainy day occurs it is more likely that the same weather is present the next day. Hence the probability of the first day being rainy and the second being rainy **given** the first day is rainy:

$P(A \& B) = P(A) P(B/A)$.

This same argument applies to go-arounds.

Some factors that cause go-arounds will persist for some time. Hence the likelihood of subsequent arrivals doing a go-around will be higher once a go-around has already occurred. They are not independent. Hence it is important to test the data to see if this is true. This can be done by counting the number of arrivals within a few minutes of a go-around and seeing if these arrivals have the same go-around rate. ***Figure 21*** shows that within a hour the rate is twice as high, while ***Figure 22*** shows that within one minute it is much higher (50 per 1000) than the base rate of 2.5 per 1000.

11.7 Causal analysis of go-arounds from CIRRIS data

This section is extracted from the 2015 LAHSO study [2] and gives an approximate breakdown of causal factors for go-arounds based on available CIRRIS data. It is beyond the scope of this report to analyse all causal factors for go-arounds and hence this table it given for information and reference only. **The key point to note is that an occupied runway is a significant causal factor for go-arounds.**

Table 7 gives a list of causal factors for go-arounds for Runway 34 while ***Table 8*** gives similar results for Runway 27. ***Table 9*** gives results for all runways.

Figure 46 is an extract from Blom et al. 2003 [10] showing causal factors for missed approaches at Amsterdam Schipol Airport.

Count of Report Number		
Reason	**Reason & Additional Coding**	**Total**
Departing Aircraft	Rwy occupied - Departing Aircraft	13
	Rwy occupied - Departing Aircraft - Slow to depart	8
	Rwy occupied - Departing Aircraft - Landing Aircraft slow to vacate	6
	Rwy occupied - Departing Aircraft - Held due possible FOD	5
	Rwy occupied - Departing Aircraft - Slow to line up	5
	Rwy occupied - Departing Aircraft - Rejected Take off	3
	Rwy occupied - Departing Aircraft - Insufficient spacing with next arrival	2
	Rwy occupied - Departing Aircraft - Aircraft technical issue	2

	Rwy occupied - Departing Aircraft - Landing Aircraft missed RET	2
	Rwy occupied - Departing Aircraft - Maintain Runway Sep standard	2
	Rwy occupied - Departing Aircraft - Aircraft held in lined up position	2
	Rwy occupied - Departing Aircraft - Auto release suspended	2
	Rwy occupied - Departing Aircraft - Crossed holding point	1
	Non-LAHSO departure - crossing runway 27	1
	Rwy occupied - Departing Aircraft - Maintain Wake Turbulence Standard	1
Landing Aircraft	Rwy occupied - Landing Aircraft	2
	Insufficient spacing - Landing Aircraft - Crossing runway 27	2
	Rwy occupied - Landing Aircraft - Insufficient spacing with next arrival	1
	Rwy occupied - Landing Aircraft - Slow to vacate	1
	Rwy occupied - Landing Aircraft - Missed RET	1
Maintenance of wake turbulence separation	(blank)	1
No reason provided by pilot	(blank)	7
Other	(blank)	9
	Too high	1
Taxiing Aircraft	(blank)	1
Technical	(blank)	9
Unstable Approach	(blank)	36
	Too high	13
	Due Turbulence	1
	Windshear	1
Vehicle/Personnel on Runway	(blank)	1
Wake turbulence reported by pilot	Wake turbulence reported by pilot	1
Weather	Windshear	33
	(blank)	31
	Due Turbulence	1
FOD	(blank)	5
Grand Total		**213**

Table 7: *Example of identified causal factors for Runway 34 go-arounds from CIRRIS data.*

Count of Report Number			
Reason	**Reason & Additional Coding**	**Total**	**%**
Departing Aircraft	Rwy occupied - Departing Aircraft	13	11.2
	Rwy occupied - Departing Aircraft - Slow to depart	8	6.9
	Rwy occupied - Departing Aircraft - Landing Aircraft slow to vacate	5	4.3
	Rwy occupied - Departing Aircraft - Landing Aircraft missed RET	4	3.4
	Rwy occupied - Departing Aircraft - Insufficient spacing with next arrival	4	3.4
	Rwy occupied - Unable to depart - Bird Activity	2	1.7
	Rwy occupied - Departing Aircraft - Held due possible FOD	1	0.9
	Rwy occupied - Aircraft over holding line at taxiway	1	0.9
	Rwy occupied - Departing Aircraft - Aircraft held in lined up position	1	0.9
	Rwy occupied - Departing Aircraft - Maintain Runway Sep standard	1	0.9
	Rwy occupied - Departing Aircraft - Aircraft technical issue	1	0.9

	Rwy occupied - Departing Aircraft - Rejected Take off	1	0.9
	Rwy occupied - Departing Aircraft - Rwy Crossing Aircraft - slow to cross	1	0.9
No reason provided by pilot	(blank)	5	4.3
Other	(blank)	4	3.4
	Non LAHSO arrival	1	0.9
	ATC unsure if LAHSO still running due change in weather	1	0.9
Rejected Take off	(blank)	1	0.9
Technical	(blank)	3	2.6
Unstable Approach	(blank)	14	12.1
	Due Turbulence	1	0.9
	Tailwind	1	0.9
	Too high	1	0.9
	Windshear	1	0.9
Vehicle/Personnel on Runway	(blank)	1	0.9
Weather	(blank)	30	25.9
	Windshear	6	5.2
	Excessive downwind	1	0.9
FOD	(blank)	2	1.7
Grand Total		**116**	100.0

Table 8: *Example of identified causal factors for Runway 27 go-arounds from CIRRIS data.*

Count of Report Number			
Reason	**Reason & Additional Coding**	**Total**	**%**
Departing Aircraft	Rwy occupied - Departing Aircraft	60	8.4
	Rwy occupied - Departing Aircraft - Slow to depart	31	4.3
	Rwy occupied - Departing Aircraft - Landing Aircraft slow to vacate	26	3.6
	Rwy occupied - Departing Aircraft - Landing Aircraft missed RET	18	2.5
	Rwy occupied - Departing Aircraft - Held due possible FOD	13	1.8
	Rwy occupied - Departing Aircraft - Slow to line up	13	1.8
	Rwy occupied - Departing Aircraft - Insufficient spacing with next arrival	9	1.3
	Rwy occupied - Departing Aircraft - Aircraft held in lined up position	8	1.1
	Rwy occupied - Departing Aircraft - Rejected Take off	6	0.8
	Rwy occupied - Departing Aircraft - Aircraft technical issue	5	0.7
	Rwy occupied - Departing Aircraft - Maintain Wake Turbulence Standard	4	0.6
	Rwy occupied - Unable to depart - Bird Activity	3	0.4
	Rwy occupied - Departing Aircraft - Maintain Runway Sep standard	3	0.4
	Rwy occupied - Departing Aircraft - Auto release suspended	2	0.3
	Rwy occupied - Departing Aircraft - Unable to depart due increasing tailwind	1	0.1
	Rwy occupied - Departing Aircraft - Crossed holding point	1	0.1
	Rwy occupied - Aircraft over holding line at taxiway	1	0.1
	Departing Aircraft	1	0.1
	Rwy occupied - Departing Aircraft - Rwy Crossing Aircraft - slow to cross	1	0.1
	Non-LAHSO departure - crossing runway 27	1	0.1

Landing Aircraft	Rwy occupied - Landing Aircraft - Slow to vacate	15	2.1
	Rwy occupied - Landing Aircraft - Missed RET	6	0.8
	Rwy occupied - Landing Aircraft	4	0.6
	Rwy occupied - Landing Aircraft - Insufficient spacing with next arrival	2	0.3
	Insufficient spacing - Landing Aircraft - Crossing runway 27	2	0.3
	Landing Aircraft - Insufficient spacing with next arrival	2	0.3
	Landing Aircraft - Emergency - possible Rwy closure	1	0.1
	Insufficient spacing - Preceding arrival	1	0.1
	Landing Aircraft - Maintain Wake Turbulence Standard	1	0.1
	Rwy occupied - Landing Aircraft - Stopped on Rwy	1	0.1
Maintenance of wake turbulence separation	(blank)	1	0.1
No reason provided by pilot	(blank)	25	3.5
Other	(blank)	43	6.0
	Non LAHSO arrival	1	0.1
	Too high	1	0.1
	Due excessive groundspeed	1	0.1
	ATC unsure if LAHSO still running due change in weather	1	0.1
	LAHSO conditions no longer existed due change in weather	1	0.1
Rejected Take off	(blank)	2	0.3
Taxiing Aircraft	(blank)	2	0.3
Technical	(blank)	32	4.5
Unstable Approach	(blank)	105	14.7
	Too high	31	4.3
	Due Turbulence	3	0.4
	Windshear	2	0.3
	Due Track shortening	2	0.3
	Due wind change event	2	0.3
	Aircraft Technical Issue	1	0.1
	Tailwind	1	0.1
	Due Mechanical turbulence	1	0.1
Vehicle/Personnel on Runway	(blank)	2	0.3
Wake turbulence reported by pilot	Wake turbulence reported by pilot	1	0.1
	Wake turbulence from preceding arrival	1	0.1
Weather	(blank)	121	16.9
	Windshear	66	9.2
	Excessive downwind	4	0.6
	Strong tailwind	2	0.3
	Due Turbulence	1	0.1
	Variable winds	1	0.1
	Turbulence	1	0.1
FOD	(blank)	15	2.1
Grand Total		**715**	100.0

Table 9: *Example of identified causal factors for all Runway go-arounds from CIRRIS data.*

Reason	Percentage
UNCOMMON CAUSES	**59.8 %**
Crew related	**4.2 %**
Misunderstood R/T	0.7 %
Wrong R/T frequency	1.3 %
Wrong approach charts	0.3 %
Cabin not ready	1.5 %
Unintended MA	0.5 %
Technical aircraft	**25.5 %**
Bird strike	0.9 %
Technical unknown	2.2 %
Technical various	1.1 %
Gear (door) problems	14.2 %
Flap problems	5.8 %
Autopilot / nav receiver	1.2 %
Unstable approach/landing	**24.9 %**
ILS failed	0.4 %
Wake turbulence	1.1 %
Unstable approach	5.7 %
Speed high	1.7 %
Altitude high	13.5 %
Ground Proximity Warning System alerts	2.6 %
Separation reasons	**4.1 %**
Lateral separation	3.8 %
TCAS	0.3%
Unknown	**1.1%**
Unknown	1.1 %
POTENTIALLY COMMON CAUSE	**40.2 %**
Late/no landing clearance	**21.2 %**
Blocked R/T, ATCo busy	2.6 %
Landing runway occupied by aircraft	16.6 %
Landing runway occupied by other	2.0 %
Weather	**19.0 %**
Visibility / Runway Visual Range / cloud	5.0 %
Wind (gust)	5.5 %
Wind shear	6.9 %
Lightning / showers	1.6 %
TOTAL	**100%**

Figure 46: *Percentages of controller reported reasons for initiation of a Missed Approach at Amsterdam Airport Schiphol, extracted from Blom et al. 2003 [10]. See this reference for the full context of the extract.*

11.8 References

Note:

SASP = ICAO Separation Airspace Safety Panel

RGCSP = Review of the general concept of separation panel (precursor to SASP)

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11.9 Table of Figures and Tables

TABLES

Land and Hold Short Operations (LAHSO) Safety Assessment Report (SAR) Addendum

Safety Assessment Report

SAF-SAR-12009-Add2

Version 1

Effective 24 March 2016

<table>
<tr><td>Prepared:</td><td>[redacted] Regulatory Services Manager</td><td>[redacted]
24 March 2016</td></tr>
<tr><td colspan="3">I declare that this Safety Assessment Report Addendum:
• has been prepared in accordance with the requirements of Airservices Safety Management System that are necessary to manage the Operational-Safety aspects of the change
• accurately reflects the Operational Safety Program performed in support of this change</td></tr>
<tr><td>Agreed:</td><td>[redacted] Business Coordinator, East Coast Services South</td><td>[redacted]</td></tr>
<tr><td colspan="3">I declare that the Operational Safety Program described within this Safety Assessment Report Addendum:
• accurately reflects the safety program performed in support of this change
• includes outstanding activities that are incorporated within the change schedule, resource and budget planning</td></tr>
<tr><td>Endorsed:</td><td>Rob Weaver
Executive General Manager.
Safety, Environment and Assurance</td><td>Digitally signed by WEAVER_RA
DN: dc=au, dc=gov, dc=airservices, dc=prd, dc=asanet, ou=Domain Users, ou=Win81 Users, cn=WEAVER_RA, email=rob.weaver@AirservicesAustralia.com
Date: 2016.03.24 14:49:59 +11'00'</td></tr>
<tr><td colspan="3">I am satisfied, following review of this Safety Assessment Report Addendum, that it:
• describes a Safety Program that meets the requirements of the Safety Management System necessary to manage the Operational-Safety aspects of the change
• provides a valid, evidenced safety argument</td></tr>
<tr><td>Accepted:</td><td>Greg Hood
Executive General Manager
Air Traffic Control</td><td>24/3/16</td></tr>
<tr><td colspan="3">I am satisfied, following review of this Safety Assessment Report Addendum, that it:
• accurately describes the approved and executed Operational Safety Program
• provides a valid, evidenced safety argument that confirms the:
  ◦ specified requirements have been adequately traced into the design
  ◦ design has been implemented
  ◦ technical transition and ongoing support have been adequately planned and reviewed to ensure the specified requirements are met
  • change, as implemented, ensures all identified Operational Safety risks associated with the design, technical implementation, transition, and ongoing technical operation are able to be managed to ALARP</td></tr>
</table>

Document Review Record

Those listed below have reviewed this document in the context of their area of expertise and in accordance with their area of accountability. All issues raised from the reviews have been addressed to the satisfaction of all reviewers.

Name	Role / Position	Date	Version
[redacted]	Operations Analyst	4, 8, 10 March 2016	0.1, 0.2
[redacted]	Melbourne Project and Business Support Manager	8 March 2016	0.1
[redacted]	Business Coordinator, East Coast Services South	10 March 2016	0.2
[redacted]	Manager, Project and Business Support Manager	11, 17 March 2016	0.2, 0.3
[redacted]	Change Assurance Manager	15 March 2016	0.3
[redacted]	Chief Air Traffic Controller	15 March 2016	0.3
[redacted]	A/Manager East Coast Services South	17 March 2016	0.3
[redacted]	ATS Integrity Manager	16-17 March 2016	0.3
Greg Hood	Executive General Manager, Air Traffic Control	17 March 2016	0.4
Rob Weaver	Executive General Manager, Safety, Environment and Assurance	24 March 2016	0.5

Change summary

Version	Date	Change description
Version 0.1	4 March 2016	Initial draft (incorporating Appendix 1 developed by [redacted]
Version 0.2	10 March 2016	Incorporate review comments from [redacted] outcome of document review meeting on 8 March 2016 and Appendix 3 developed by [redacted]
Version 0.3	11 March 2016	Incorporate review comments from [redacted] and [redacted] and Appendix 3 developed by [redacted]
Version 0.4	15 March 2016	Incorporate review feedback from [redacted] and include additional details in section 10 'safety performance monitoring'
Version 0.5	18 March 2016	Incorporate review feedback from EGM, ATC Group.
Version 0.6	24 March 2016	Incorporate review feedback from EGM, SE&A Group.
Version 1.0	24 March 2016	Final version for sign-off.

Table of Contents

1. Executive Summary

Land and Hold Short Operations (LAHSO) is a high capacity air traffic control procedure utilised to balance airport capacity and system efficiency with safety.

This Safety Assessment Report (SAR) Addendum presents an updated operational safety risk baseline associated LAHSO at Melbourne Airport as a result of systemic safety improvements implemented since the completion of the previous SAR Addendum in 2015.

To assure the ongoing safety of LAHSO, LAHSO rules and procedures have been subject to continual review and improvement. The procedural updates ensure consistent application of LAHSO procedures, enhance shared situational awareness between air traffic controllers (ATC) and pilots, and implement restrictions or other strengthened controls to maximise the balance between safety and efficiency of LAHSO.

Following the internal investigation of a double go-around event on 5 July 2015 and in response to related concerns from the Civil Aviation Safety Authority (CASA), additional actions have been taken to prevent the recurrence of a similar event. Airservices also voluntarily suspended LAHSO night-time operations at Melbourne from 10 November 2015.

During the period of November 2015 – March 2016, Airservices focused on implementing the following three actions to further address CASA concerns:

- Development and delivery of enhanced compromised separation recovery training for Melbourne Aerodrome Controllers (ADC) which include the procedures for vectoring aircraft below the Minimum Vectoring Altitude (MVA) at night.
- Conduct a further risk analysis of double go-around during LAHSO at Melbourne, including the consideration of night time scenarios.
- Implementation of a 'stagger' whereby aircraft are sequenced to achieve a predetermined relative runway threshold crossing time in order to reduce the potential collision risk at the runway intersection in the case of simultaneous go arounds.

The evidence of implementing these actions (detailed in separate safety documents which are referenced in this SAR Addendum) provides the critical artefact to inform the regulatory determination whether LAHSO at night can be reinstated.

This SAR Addendum has summarised the additional controls to address the concerns with the threat of a double go-around during LAHSO. The results from the risk study conducted in 2016 are also outlined, and include the following key findings:

- Night-time operations do not statistically increase go-around likelihood.
- The likelihood of a go-around during LAHSO has decreased in the last 12 months to 2.5 go-arounds per 1,000 LAHSO arrivals.
- The likelihood of a double go-around (within 60 seconds of each other at the runway crossing point) is between yearly and five yearly, and the likelihood of a double go-around (within 20 seconds) is

approximately 1 in every 6.5 years within the range of 4-13 years (i.e. between five and 50 years).

- The risk of an Aircraft in Critical Proximity (ACP) is approximately 1 in every 24 years within the range 9-29 years.
- The risk of a near collision or Mid-air Collision (MAC) caused by a double go-around is approximately 1 in every 6,500 years within the range 4,000-13,000 years and meets internationally acceptable target levels of safety.

The results from the study have informed the assessment of the risk of *aircraft in conflict* (which is the hazardous event identified in the Melbourne LAHSO Operational Risk Assessments (ORAs)) as a result of a double go-around during LAHSO. It supports the determination that the risk is managed to an acceptable level.

To validate the overall operational safety risk baseline associated with Melbourne LAHSO (both day and night time operations), the risk assessment as part of the 2015 SAR Addendum and relevant Melbourne ATC ORAs were reviewed. This includes the mapping of hazards information to the threat and controls/barriers presented in the ORAs. With consideration to the multiple layers of controls/barriers in place and implementation of all feasible systemic improvement actions, it has been confirmed that the overall risks associated with LAHSO at Melbourne are tolerable and are managed to as low as reasonably practicable (ALARP).

This report has provided the formal safety assurance documentation demonstrating that operational safety has been duly considered in determining the reinstatement of LAHSO at Melbourne at night. This is based on validating the operational safety risk baseline associated with LAHSO and confirming that the regulatory requirements for considering the reinstatement have been fully addressed.

The ongoing safety performance monitoring of LAHSO will utilise the information in the ORAs to gain the assurance of the effectiveness of risk controls and assess any changes to the threat profiles, taking into consideration factors such as LAHSO usage and operational benefits, traffic demand and findings from relevant safety analysis. The monitoring will be embedded as part of the day-to-day operational management of LAHSO in accordance with the safety risk management requirements under Airservices Safety Management System (SMS).

The effectiveness of additional risk controls identified in this report will be closely monitored on a continual basis during the period of April – June 2016. This will be supported by additional data collection and further risk study, including recording go-around occurrences during LAHSO and arrival time accuracy, and validation of the risk of aircraft in conflict as a result of a double go-around.

As part of the existing process, an annual review of LAHSO (tracked via CIRRIS) will be conducted by the Office of the Chief Air Traffic Controller (CATC) to provide ongoing assurance that the LAHSO risks are continuing to be managed in accordance with the SMS. This will include (but not limited to) review of ATC application of LAHSO procedures, CIRRIS reports (if any) and findings from relevant safety analysis.

2. Purpose

This report presents an updated operational safety risk baseline associated LAHSO at Melbourne Airport as a result of systemic safety improvements implemented since the completion of the previous SAR Addendum in 2015.

The purpose of the report is to:

- present the updated information on the controls and risk assessment of the hazards which were identified in the 2015 LAHSO SAR addendum, taking into consideration the systemic safety improvements to LAHSO
- demonstrate that the overall safety risks associated with LAHSO (both day and night-time operations) are tolerable and are managed to ALARP.
- provide the safety assurance evidence to support the reinstatement of LAHSO at night at Melbourne Airport.

3. Background

3.1 Use of LAHSO

LAHSO is a high capacity air traffic control procedure utilised to balance airport capacity and system efficiency with safety. The procedure involves dependent operations conducted on two intersecting runways whereby aircraft land and depart on one runway while aircraft landing on the other runway hold short of the intersection. The use of LAHSO is supported by airlines and airports, and is known to have a positive impact on the safety and efficiency of air traffic network by reducing capacity pressures in the National Airways System (NAS).

There has been an ongoing focus on the safety of LAHSO. The Civil Aviation Safety Authority (CASA) has also maintained close oversight of LAHSO, in particular, the risk associated with a double go-around during LAHSO at night.

3.2 Safety assurance activities

To assure the ongoing safety of LAHSO, Airservices has undertaken a number of safety analysis and reviews during 2012-2015 including:

- Land and Hold Short Operations (LAHSO) and Converging Runway Operations (CROPS) All Phases Safety Assessment Report (SAR) 2012 (19 November 2012) [Ref 1]
- LAHSO Safety Post Implementation Review (11 February 2015) [Ref 2]
- Targeted Review of Melbourne LAHSO Safety Assurance (20 March 2015) [Ref 3]
- Analysis of Likelihood of Melbourne LAHSO Go-arounds (4 August 2015) [Ref 4]
- Analysis of Independent Double Go-arounds on Runways A/B (29 July 2015) [Ref 5]
- LAHSO and CROPS SAR Addendum (31 August 2015) [Ref 6]

- Operational Safety Investigation Report of ATS-0137977 –Ground Proximity ECCS ML TWR [Ref 7].

The analysis and reviews allowed further risk controls to be implemented to minimise threats or potential for errors in the application of LAHSO.

3.2 Systemic improvements to LAHSO

As a result of the ongoing safety assurance activities, LAHSO rules and procedures have been reviewed and enhanced within relevant local instructions, Manual of Air Traffic Services (MATS) and Aeronautical Information Package (AIP). The procedural amendments are provided to minimise opportunities for erroneous or inconsistent application of LAHSO procedures, enhance shared situational awareness between ATC and pilots, and implement restrictions or other strengthened controls to maximise the balance between safety and efficiency of LAHSO.

Following the internal investigation of a double go-around event on 5 July 2015 and in response to CASA concerns (in particular, CASA's letter dated 28 July 2015 and 2 November 2015), additional actions have been taken to prevent a similar event and further reduce the overall risks associated with LAHSO to as low as reasonably practicable (ALARP). Airservices also voluntarily suspended LAHSO night-time operations at Melbourne Airport from 10 November 2015.

During the period of November 2015 – March 2016, Airservices focused on implementing the following three actions to further address CASA concerns:

- Development and delivery of enhanced compromised separation recovery training for Melbourne Aerodrome Controllers (ADC) which include the procedures for vectoring aircraft below the Minimum Vectoring Altitude (MVA) at night
- Undertaking a further risk analysis of double go-around during LAHSO at Melbourne, including the consideration of night time scenarios
- Implementation of a 'stagger' whereby aircraft are sequenced to achieve a predetermined relative runway threshold crossing time in order to reduce the potential collision risk at the runway intersection in the case of simultaneous go arounds.

The evidence of implementing these actions (which are detailed in separate safety documents prepared in accordance with Airservices Safety Management System (SMS)) provides the critical artefact to inform the regulatory determination whether LAHSO at night can be reinstated.

With consideration to all the systemic improvements implemented, Airservices has not identified any other practicable risk reduction measures which will provide further net safety benefit. This document demonstrates that the overall risks associated with LAHSO are tolerable and are managed to ALARP.

4. Scope

The scope of work undertaken in preparing this report includes the:

- review of relevant ATC Operational Risk Assessments (ORAs)
- review of the status of risk controls as identified in the 2015 SAR addendum, taking into consideration all recent safety improvement actions
- assessment of the residual risks associated with the hazards reported in the 2015 SAR Addendum, given the implementation of additional risk controls, and mapping of the risk information to relevant ORAs.

This report outlines the impact on the LAHSO operational safety risk baseline as a result of implementing all recent safety improvements. It is also linked to the following safety assurance documentation completed in March 2016:

- the safety case and associated safety plan in support of changes to compromised separation recovery procedures and training to incorporate vectoring aircraft below MVA at night [Ref 8]
- the safety statement in support of the implementation of stagger [Ref 9]
- the risk analysis of Melbourne double go-arounds including the consideration of night-time scenarios [Ref 10].

5. Assumptions, constraints and dependencies

There are no additional assumptions, constraints and dependencies other than those identified in the above-mentioned safety assurance documentation.

6. Responsibilities

The table below identifies the safety responsibilities in relation to the preparation of this SAR Addendum.

Name and Position	Responsibilities
Greg Hood Executive General Manager, Air Traffic Control	• Authorisation of the SAR Addendum • Authorisation of the reinstatement of LAHSO at Melbourne at night (subject to CASA endorsement)
Rob Weaver Executive General Manager, Safety Environment and Assurance	• Endorsement of the SAR Addendum
[redacted] Chief Air Traffic Controller	• Agreement to the SAR Addendum
[redacted] A/ Manager East Coast Services South	• Agreement to the SAR Addendum • Oversee and monitor the implementation of reinstatement of LAHSO at night at Melbourne
[redacted] Business Coordinator	• Development of the safety argument for the SAR Addendum

	• Managing the reinstatement of LAHSO at night at Melbourne within the constraints of safety, time, cost, and scope • Participating in risk/ORA review workshop • Coordinating the provision of ATC subject matter advice and resources to conduct risk / ORA reviews and analysis • Leading industry consultation and communications
[redacted] Regulatory Services Manager	• Preparation of the SAR Addendum • Liaison with CASA
[redacted] Operations Analyst	• Preparation of the Appendices of the SAR Addendum • Assistance with the review of Hazlog and ORA information
[redacted] Melbourne Project and Business Support Manager	• Assisting with the coordination of safety objectives and activities related to the preparation of the SAR Addendum • Review of the SAR Addendum
[redacted] Manager Project and Business Support	• Monitoring and oversight of the preparation of the SAR Addendum and related safety assurance activities • Review of the SAR Addendum
[redacted] ATS Integrity Manager	• Provision of subject matter advice on LAHSO risk controls • Review of the SAR Addendum
[redacted] Senior Project Safety Specialist	• Facilitation of risk/ORA review workshop • Managing update/closure of Hazlog information in consultation with ATC Group

Table 1. Safety Responsibilities

7. Operational safety risk baseline

7.1 Overview

To validate the operational safety risk baseline associated with Melbourne LAHSO (both day and night time operations), the risk assessment as part of the 2015 SAR Addendum and relevant Melbourne ATC ORAs were reviewed.

With consideration to the multiple layers of controls/barriers in place (as illustrated in Appendix A and detailed in Appendix B), it has been confirmed that the overall risks associated with LAHSO are tolerable and are managed to ALARP. The effectiveness of controls will continue to be assessed supported with data validation.

7.2 Review of risk assessment in 2015 SAR Addendum

Appendix 2 details the outcome of reviewing the hazards (from the Hazlog register 901) which were previously assessed in the 2015 SAR Addendum. The table lists the additional risk controls as a result of implementing all recent safety improvement actions and confirms the current residual risks.

A workshop conducted on 7 March 2016 reviewed the residual risks previously assessed at Class B and C level as reported in the 2015 SAR Addendum. It has been confirmed that there are no changes to the risk levels. This has considered that the effectiveness of recently implemented additional controls needs to be further tested and verified with data collection to provide the evidence to support any changes in the risk classifications. The workshop minutes are provided in [Attach 1]. In summary:

- For the Class B risk (Hazard #10 – *double go-around*), the likelihood has been updated to 'five to fifty years'. With the consequence remaining at 'Major', the residual risk remains at Class B. Further details on the analysis and assessment of this hazard is provided in Section 5.3 of this report.
- For the three Class C risks (Hazard #5 – *late notice of pilot non-participation in LAHSO*, Hazard #15 – *unplanned transition out of LAHSO*, and Hazard #18 – *demand exceeding capacity)*, there is no change to the likelihood and consequence.
- A new hazard (*ADC misjudging a departure gap causing a go around*) has been identified associated with the implementation of stagger. The residual risk is at Class C, with the control being a reduced LAHSO rate during stagger.

7.2 Mapping to ORAs

Appendix 1 and Appendix 3 shows how the hazard/risk information in Appendix 2 (based on Hazlog register 901) is mapped against the information in the following Operational Risk Assessments (ORAs) relevant to Melbourne LAHSO:

- Melbourne Tower ORA-4: Aircraft in Conflict (LAHSO)
- Melbourne Terminal Control Unit (TCU) ORA-3: Aircraft in Conflict (LAHSO)
- Melbourne Tower ORA-1: Conflict in the air.

The mapping activity has confirmed that all the hazards in Appendix 2 link to the threats recorded in the ORAs which have the potential to directly cause 'aircraft in conflict (LAHSO)'. It has also identified that a number of additional risk controls need to be captured in the above-mentioned ORAs. The required ORA changes to capture the additional controls will be processed using the Operational Risk Assessment Change Request and Acceptance Record [Ref 11] prior to re-introduction of LAHSO at Melbourne at night.

On the basis of the mapping activity (demonstrating the linkage of hazards recorded in Hazlog to the threats in ORA) and once all risk controls have been captured in the updated ORAs, the Hazlog register 901 will be closed. This has considered that that risk information relating to the hazards recorded in the Hazlog are transitioned and incorporated into the Melbourne Tower and TCU operational safety risk baseline to be monitored on an ongoing basis.

Refer to Section 10 on utilising the ORAs to review the ongoing effectiveness of risk controls and gain the assurance over the management and acceptability of risks associated with LAHSO at Melbourne.

7.3 Managing the risk of aircraft proximity due to double go-around

In contrast to 2015 SAR Addendum which highlighted 'double go-around' as a separate *hazard*, this report focuses on the ongoing operational safety risk of 'aircraft in conflict' as a result of the *threat* of double go-around. This reflects the evolving risk taxonomy in the transition to Threat Error Management (TEM) under the new Safety Intelligence Framework (SIF) which is being implemented at the time of preparing this report.

There has been an increasing focus on the threat of double go-around, particularly after the 5 July 2015 occurrence. While the aircraft involved were never in unsafe proximity, the occurrence was considered to be significant enough to warrant an immediate review of the casual factors and actions to reduce the likelihood of a similar occurrence.

Following the review of causes of double go-around scenarios, a number of additional key controls have been implemented to further manage the threat (e.g. by implementing restrictions to LAHSO and providing a systemic safety solution 'stagger'). The additional controls and their associated impacts are summarised below.

Additional control	Impact	Control implementation status
• Stagger	Reduce the potential collision risk at the runway intersection in the case of a simultaneous go around.	Trial and evaluation currently underway, with the intention to continue its operational implementation with ongoing collection of data to verify the resulting impact on the arrival spacing and rates during LAHSO and the effect on the threat of a double go-around.
• Only aircraft operationally requiring the use of Runway 34 for departures (off-mode departures[1]) are permitted to use it during LAHSO. Ad hoc requests will not be accommodated.	Reduce the likelihood of initiating events for a go-around during LAHSO by restricting 'off mode' departures, thereby reducing the likelihood of a double go-around.	Implemented in July 2015.

[1] Departures from Runway 34 (i.e. off mode departures) are a potential trigger for a go-around. They add complexity to ADC task due to the requirement to ensure sufficient spacing of approaching aircraft to both the active and passive runways to permit the departure to be clear of both runways before the next landing aircraft reaches the threshold.

• The use of 09/34 LAHSO mode has been suspended indefinitely[2].		
• Traffic landing on Runway 34 is required to be processed via an instrument approach procedure (IAP)[3] during LAHSO. • Remove the use of SHEED waypoint during LAHSO[4]. • The standard arrival route (STAR) allocation (from the east) was changed with arriving aircraft via ARBEY (TUNKA) and WENDY being directed to Runway 34, and arriving aircraft via LIZZI, WAREN and BADGR being directed to Runway 27.	Reduce the likelihood of unstable approaches (which is an initiating event for a go-around), thereby reducing the likelihood of double go-around.	Implemented in December 2015.
• Implementation of the requirement for LAHSO to be used only during periods of high demand (i.e. unless there is five (5) minutes or more delay in the system).	Reduce the likelihood of a double go-around by limiting the usage of LAHSO.	Implemented in December 2015.
• Delivery of night time compromised separation recovery training for ADC involving go-arounds for risk situations including (but not limited to) LAHSO at night.	Reduce the consequence of a double go-around by providing a means for ADC to vector aircraft below MVA at night. This is supported by ensuring that the design of the terminal instrument flight procedure provides	The training has been delivered for ADC at Melbourne. The promulgation of the changes to compromised separation recovery procedures via AIP is planned after CASA approval of the changes.

[2] This control has considered that all departures in 09/34 LAHSO mode are from Runway 34, and the rate of go-around during 09/34 LAHSO was significantly higher than other runway mode.
[3] This control has considered that an approach that becomes un-stablised below 1000 feet above airport elevation in IMC or 500 feet above airport elevation in Visual Meteorological Conditions (VMC) requires an immediate go-around. IAP require the aircraft to be established on the runway heading much further and ensure the aircraft fly the correct profile, compared to visual approaches.

[4] There is a heightened risk of unstable approaches when international aircraft were issued with the SHEED arrival.

• Update AIP and operator advice /communication to support the delivery of compromised separation recovery training (in progress).	the aircraft with the obstacle clearance protection.	

Table 2. Additional Controls for the Hazard of a Double Go-around

In early 2016, a study [Ref 10] was conducted which assessed the likelihood of a double go-around during LAHSO at Melbourne Airport, the likelihood of Aircraft in Critical Proximity (ACP) and the risk of near collision or Mid-air Collision (MAC). The collision risk analysis considered both the horizontal and vertical components.

The 2016 study provides an update to the previous risk studies conducted in 2012 and 2015 and covers day-time and night-time operations. It has considered additional key controls implemented by December 2015. The study utilised data from 1 January 2012 to 31 January 2016, including surveillance data, Flight Data Records (FDR) information, runway definitions and Automatic Terminal Information Service (ATIS) data.

The study has applied conservative risk assessment and confirmed the following findings [Ref 10]:

- Night-time operations do not statistically increase go-around likelihood.
- The likelihood of a go-around during LAHSO has decreased in the last 12 months to 2.5 go-arounds per 1,000 LAHSO arrivals.
- The likelihood of a double go-around (within 60 seconds) is one in every 1.4-4.4 years (i.e. 'between yearly and five yearly'). This is reflected in three such events in the last 4 years.
- The likelihood of a double go-around (within 20 seconds) is approximately 1 in every 6.5 years within the range of 4-13 years (i.e. 'between five and 50 years').
- The risk of an ACP is approximately 1 in every 24 years within the range 9-29 years.

The study has also confirmed that the risk of MAC caused by a double go-around is approximately 1 in every 6,500 years, or 8E-9 per approach in the range 4,000 to 13,000 years. This is within internationally acceptable approach target levels of safety which are usually in the range of 1E-9 to 1E-8 per approach. Alternatively in terms of number of years between collisions, the collision risk of 1 every 6,500 years is within acceptable international risk levels which are usually of the order 100-1,000 years for typical en-route or approach operations. The relatively large times-scale of 6,500 years is due to the relatively lower arrival rate per year for Melbourne LAHSO.

The ACP and MAC analysis has informed the assessment of the risk of *aircraft in conflict* (which is the hazardous event identified in the Melbourne LAHSO

ORAs) as a result of a double go-around during LAHSO. It supports the determination that the risk is managed to an acceptable level.

The majority of additional controls identified in Table 2 were implemented since late 2015. The staggered LAHSO trial commenced on 10 March 2016. While enhanced ATC compromised separation recovery training has been delivered, the changes to the compromised separation recovery procedures (for night-time scenarios, subject to CASA approval) are yet to be published via AIP at the time of preparing the report. The effectiveness of these controls are being continually monitored.

The risk of aircraft in conflict as a result of double go-around will be re-assessed at the end of June 2016 when all the controls have been embedded in ATC operations and supported with data collection and validation. This will include measuring the accuracy of achieving feeder fix times, time to go and predicted landing times to assess the impact of implementing the staggered arrivals.

8. Consultation and communication

Since late 2015, Airservices has been actively engaging with industry to gain confidence in the safety and utility of LAHSO procedures at Melbourne, and seek stakeholders' input and agreement to LAHSO systemic safety improvements. The industry consultation and communication activities are listed in Table 3.

These activities enabled Airservices to carefully consider the impact on industry of ongoing changes to LAHSO, taking into account safety, efficiency and service delivery benefits. They also provided early opportunity for operators to identify any flow-on changes required for their operational procedures and training/educational programs.

Activity	Date	Industry stakeholders
LAHSO briefing, Melbourne Airport Capacity Enhancement (ACE) meeting	25 Nov 2015	Jetstar, Qantas
LAHSO briefing and simulator visit	14 Jan 2016	Virgin, Qantas, Express Freighters
LAHSO briefing and simulator visit	19 Jan 2016	QantasLink
SCARD participation and simulator visit	4 Feb 2016	Qantas, Cobham
LAHSO briefing via telephone	12 Feb 2016	Tigerair
LAHSO briefing and simulator visit	17 Feb 2016	Regional Express
LAHSO briefing and simulator visit	22 Feb 2016	Air New Zealand

LAHSO briefing and simulator visit	24 Feb 2016	Jetstar
LAHSO briefing, Melbourne Airport Capacity Enhancement (ACE) meeting	9 Mar 2016	Jetstar, Qantas, Virgin, QantasLink, , Regional Express

Table 3. Industry consultation and communications

In addition, there have been frequent communications with CASA and ATSB through meetings and written status updates to ensure these agencies' visibility to the implementation of LAHSO safety improvements and manage their perceptions proactively.

9. Pre-implementation safety review

This report has provided the formal safety assurance documentation demonstrating that the operational safety has been duly considered in determining whether LAHSO at Melbourne at night can be reinstated. This is based on validating the operational safety risk baseline associated with LAHSO and confirming that the regulatory expectations for considering the reinstatement have been fully addressed.

Subject to CASA's endorsement of the reinstatement, a pre-implementation safety review meeting will be conducted to confirm the status of risk controls prior to the reinstatement.

10. Safety performance monitoring

The ongoing safety performance monitoring of LAHSO will utilise the information in the ORAs to gain the assurance of the effectiveness of risk controls and assess any changes to the threat profiles. This will take into consideration factors such as LAHSO usage and operational benefits, traffic demand during LAHSO (including arrivals, departures and delays) and findings from relevant safety analysis. The monitoring will be embedded as part of the day-to-day operational management of LAHSO and conducted in accordance with the safety risk management requirements under Airservices SMS.

The effectiveness of additional risk controls identified in this report will be closely monitored on a monthly basis during the period of April – June 2016. This will be supported by additional data collection and further risk study, covering aspects including (but not limited to):

- Go-around during LAHSO (including aircraft trajectories during a go-around, number and rate of go-arounds)
- Predicted versus actual arrival time accuracy at feeder fix and runway threshold
- Likelihood and risk analysis in relation to go-arounds and double go-arounds.

As part of the existing process, an annual review of LAHSO (tracked via CIRRIS) will be conducted by the Office of the Chief Air Traffic Controller (CATC) to provide ongoing assurance that the LAHSO risks are continuing to be managed in accordance with the SMS. This will include (but not limited to) the review of ATC application of LAHSO procedures, CIRRIS reports (if any) and findings from relevant safety analysis.

11. Conclusion

On the basis of implementing systemic safety improvement actions and review of safety risk analysis and assessment, this document has demonstrated that the overall risks associated with LAHSO at Melbourne are tolerable and are managed to ALARP.

The effectiveness of all LAHSO related risk controls in operation will continue to be monitored and assessed. This will provide the supporting evidence to support ongoing assurance that the overall risks continue to be managed to ALARP.

In addition, Airservices has completed the actions which have addressed the three requirements outlined in CASA's letter dated 2 November 2015 for considering the reinstatement of LAHSO at night. Supported with this document and subject to obtaining CASA endorsement, the reinstatement is planned for April 2016.

12. Document review

10.1 Service Delivery Line/Business Branch or Unit/Project and Business Support

This document has been peer reviewed by managers in Air Traffic Control Group and Safety, Environment and Assurance Group. All review comments have been considered and addressed in this document.

10.2 Safety Assurance

This document has been reviewed by Safety, Environment and Assurance Group (Change Assurance Manager) to ensure compliance with Safety Assessment Preparation and Reporting (AA-NOS-SAF-0104). All review comments have been considered and addressed in this document.

13. Acronyms

Acronym	Term
ACE	Airport Capacity Enhancement
ACP	Aircraft in Critical Proximity
ADC	Aerodrome Controller
AIP	Aeronautical Information Package
ALARP	As Low As Reasonably Practicable
ATC	Air traffic controller
ATIS	Automatic Terminal Information Service
ATSB	Australian Transport Safety Bureau
CASA	Civil Aviation Safety Authority
CATC	Chief Air Traffic Controller
FDR	Flight Data Record
IAP	Instrument Approach Procedures
IMC	Instrument Meterological Condition
LAHSO	Land and Hold Short Operations
LI	Local Instructions
MAC	Mid-air Collision
MATS	Manual of Air Traffic Services
NAS	National Airways System
ORA	Operational Risk Assessment
SAR	Safety Assessment Report
SMS	Safety Management System
SIF	Safety Intelligence Framework
STAR	Standard Arrival Route
TCU	Terminal Control Unit
TEM	Threat Error Management

14. Attachment

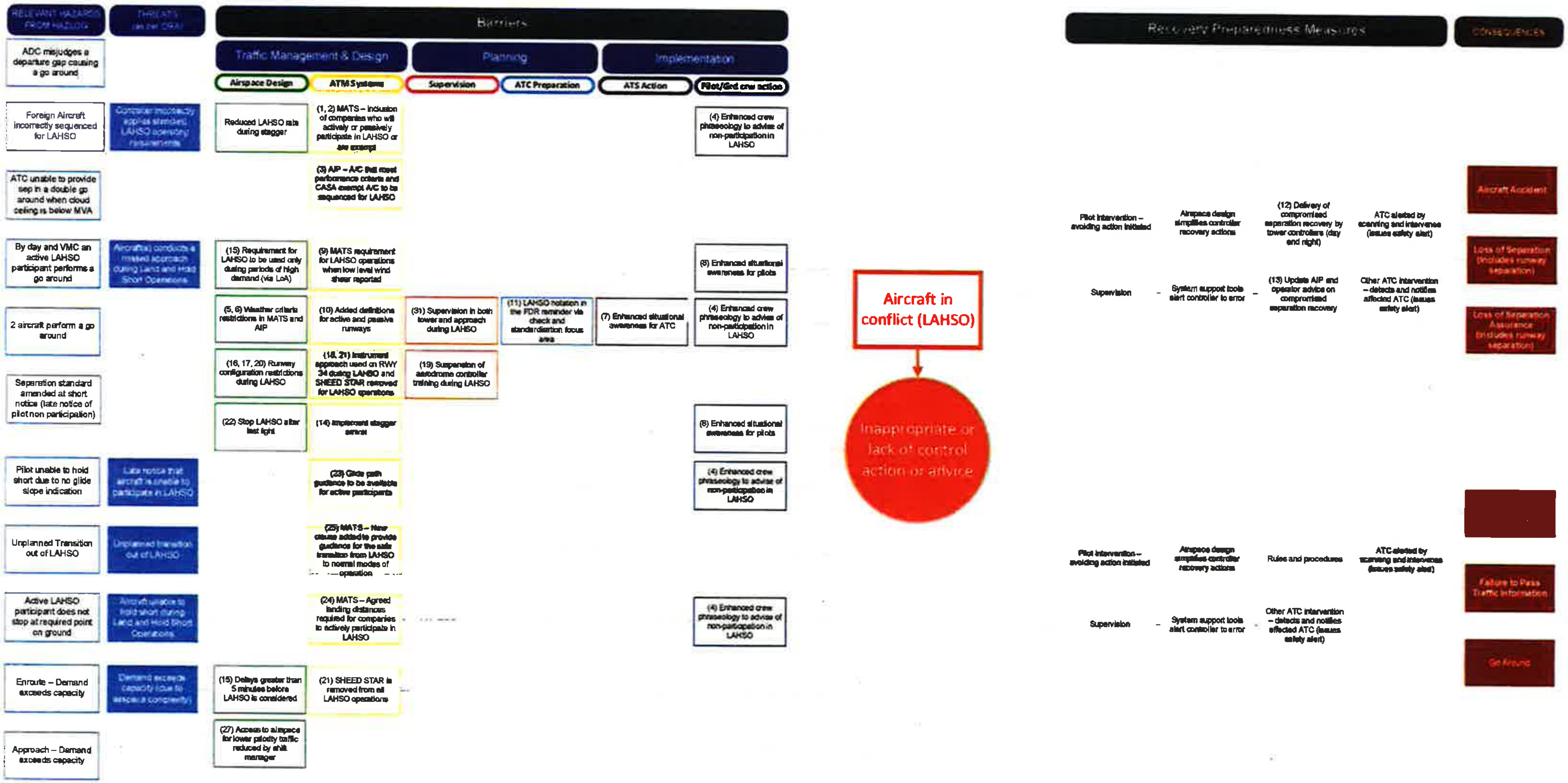
No	Title	Number/Link
Attachment 1	Minutes of LAHSO Risk Review Meeting on 7 March 2016	HO_CB0-3043783

15. References

No	Title	Number/Link
Reference 1	Land and Hold Short Operations (LAHSO) and Converging Runway Operations (CROPS) All Phases Safety Assessment Report (SAR) 2012 (19 November 2012)	SAF-SAR-12009
Reference 2	LAHSO Safety Post Implementation Review (11 February 2015)	SAF-PIR-12009-1
Reference 3	Targeted Review of Melbourne LAHSO Safety Assurance (20 March 2015)	C-REP0033
Reference 4	Analysis of Likelihood of Melbourne LAHSO Go-arounds (4 August 2015)	CASA_LAHSO_YMML_V3_5
Reference 5	Analysis of Independent Double Go-arounds on Runways A/B (29 July 2015)	HO_CB0-3027775
Reference 6	LAHSO and CROPS SAR Addendum (31 August 2015)	SAF-SAR-12009-Add
Reference 7	Operational Safety Investigation Report of ATS-0137977 –Ground Proximity ECCS ML TWR	HO_ML0-1135482.pdf
Reference 8	Separation Recovery for LAHSO Night Time operations at Melbourne All Phases Safety Case	HO_CB0-3043786
Reference 9	Safety statement in support of the implementation of stagger	ATM_ML1-1152796 Signed.pdf
Reference 10	Risk analysis of Melbourne double go-arounds including the consideration of night-time scenario	OA_2016_Q1_32_LAHSO_V1_7_signed.pdf
Reference 11	Operational Risk Assessment Change Request and Acceptance Record Template	AA-FORM-SAF-0032

Appendix 1. Controls/barriers in support of LAHSO at Melbourne

(Note the numbering against the controls/barriers corresponds to the information in Appendix 2)



Appendix 2. Hazards, controls and risk assessment impacted by LAHSO systemic safety improvements

Hazard No (from Hazlog 901)	Title	Strengthened / additional controls following recent safety improvement activities	Status of other yet-to-be-met controls identified in 2015 SAR Addendum	Current Residual risk
901/3	ATC unable to provide separation in a double go around when cloud ceiling is below MVA	• MATS - Placed restrictions, in excess of the CASR Part 172 Manual of Standards, for specific weather criteria that must exist to perform LAHSO **(5)**[5] • AIP - Added increased weather criteria, in excess of CASR Part 172 Manual of Standards, before LAHSO can be conducted **(6)**	• Raise the cloud ceiling to MVA + 1000ft (As a result of internal review this control is no longer required - Refer to CIRRIS ACT-0008541)	D
901/5	Separation standard amended at short notice (late notice of pilot non participation)	• MATS - Included the clause advising ATC that pilots may elect not to participate if they were concerned about situational awareness **(8)** • AIP - Changed the phraseology for crews to advise of non-participation in LAHSO to align with other phrases for consistency and ease of understanding **(4)** • Delivery of night time compromised separation training for Tower controllers involving go-arounds for risk situations including (but not limited to) LAHSO at night **(12)**		C
901/6	Pilot unable to hold short due to no glide slope indication	• AIP - Added the requirement for glide path guidance to be available for active participants – except Darwin where a separate hazard workshop identified that the aircraft being instructed to the hold short requirement on runway 36 were of light category below 5700kg Maximum take-off weight and regularly used aerodromes without glide slope guidance (23) Note: PAPI is required to be operational during LAHSO		Closed *As a result of procedural update, this hazard no longer exists*

[5] Bolded numbers against each control correspond to the numbering of controls/barriers in Appendix 1.

Hazard No (from Hazlog 901)	Title	Strengthened / additional controls following recent safety improvement activities	Status of other yet-to-be-met controls identified in 2015 SAR Addendum	Current Residual risk
901/8	By day and visual meteorological conditions (VMC) an active LAHSO participant performs a go around	• MATS - Added the requirement to nominate both active and passive runways on the Automatic Terminal Information Service (ATIS) to aid situational awareness for crews and ATC **(7)** • MATS - Included the clause advising ATC that pilots may elect not to participate if they were concerned about situational awareness **(8)** • MATS - Added the requirement to not give a 'HOLD SHORT' requirement when low level wind shear is reported **(9)** • AIP - Added the weather criteria for runway nomination to aid situational awareness for crews when conducting LAHSO **(8)** • AIP - Changed the phraseology for crews to advise of non-participation in LAHSO to align with other phrases for consistency and ease of understanding **(4)** • AIP - New clause added to emphasise that timely wind shear reports to ATC aid in overall operational safety **(8)** • AIP - Added definitions for active and passive runways **(10)** • AIP - New clause added to emphasise that both active and passive runways will be nominated to ensure that crews are aware which direction the crossing traffic will be coming from **(8)** • Remind controllers about LAHSO notation in the FDR through a check and standardisation focus area (note: this is an alternative implementation compared to the control 'implement a standardisation directive' as reported in the 2015 SAR Addendum) **(11)**	• Install windshear detection RADAR (Due to the lack of industry support, this control will not be implemented) • Use forecasted windshear/turbulence to cease LAHSO (Following PIR workshop it has been confirmed that actual wind shear reports should be the catalyst for transitioning from LAHSO - Refer to ACT-0008531 which has been verified) • Investigate updating the appropriate local instructions for taxiway availability during LAHSO (Following PIR workshop it has been confirmed that taxiway availability will be managed at a local level on a case by case basis - Refer to ACT-0008747 which has been verified) • Update MATS to confirm that aircraft with malfunctions are unable to participate in LAHSO (This control is no longer required. Following PIR workshop it has been confirmed that aircraft with malfunctions would not be normally sequenced for LAHSO, therefore no MATS entry is required - Refer to ACT-0008646 which has been verified)	D

Hazard No (from Hazlog 901)	Title	Strengthened / additional controls following recent safety improvement activities	Status of other yet-to-be-met controls identified in 2015 SAR Addendum	Current Residual risk
901/9	Active LAHSO participant does not stop at required point on ground	• MATS - Included agreed landing distances required for companies that have agreed to participate actively in LAHSO **(24)** • AIP - Changed the phraseology for crews to advise of non-participation in LAHSO to align with other phrases for consistency and ease of understanding **(4)**	• Investigate the possibility of updating site specific local instructions to manage hold short light intensity with weather conditions (Light intensity is adjustable, site specific LI update is under review)	**D**
901/10	2 aircraft perform a go around	• Delivery of night time compromised separation training for Tower controllers involving go-arounds for risk situations including (but not limited to) LAHSO at night **(12)** • Update AIP and operator advice/communication to support the delivery of compromised separation recovery training (in progress) **(13)** • Implement a stagger (in progress – trial commenced on 10 March 2015) and review the resulting impact on arrival spacing and rates during LAHSO with stagger **(14)** • The use of 09/34 LAHSO mode has been suspended indefinitely (as all departures in this mode are from runway 34) **(16)** • Only aircraft operationally requiring the use of runway 34 for departures ('off mode' departures) are permitted to use it during LAHSO. Ad hoc requests will not be accommodated **(17)** • Traffic on runway 34 are required to be processed via an instrument approach procedure during LAHSO to reduce the likelihood of go-around due to unstable approaches **(18)** • Supervision in both Tower and Approach must be in place to run LAHSO **(31)** • AIP - New clause added to emphasise that both active and passive runways will be nominated. This ensures that crews are aware which direction the crossing traffic will be coming from **(8)**	• Install windshear detection RADAR (Due to the lack of industry support, this control will not be implemented) • Use forecasted windshear/turbulence to cease LAHSO (Following PIR workshop it has been confirmed that actual wind shear reports should be the catalyst for transitioning from LAHSO - Refer to ACT-0008531 which has been verified) • Address fidelity limitations of simulator training (This control is no longer required. Compromised separation recovery training is implemented using the visual simulator. Limitations of the existing simulator with respect to INTAS capability are not a constraint on LAHSO) • Development and implementation of 'off mode' departure procedures to reduce the overall rate of go-arounds at Melbourne (This control is no longer required following the implementation of 'stagger') • Airspace Review (This control is no longer required specific to LAHSO. Melbourne	**B**

Hazard No (from Hazlog 901)	Title	Strengthened / additional controls following recent safety improvement activities	Status of other yet-to-be-met controls identified in 2015 SAR Addendum	Current Residual risk
		• Implementation of the requirement for LAHSO to be used only during periods of high demand **(15)** • Suspension of aerodrome controller training during LAHSO **(19)** • Instrument STARs - SHEED STAR is removed for all LAHSO operations **(21)** • Runway allocation from the east (STAR during LAHSO changed following the removal of SHEED. All arrivals from the east utilise RWY 27 whilst North and West arrivals utilise RWY 34 during LAHSO) **(20)** • Stop LAHSO after last light (suspension from November 2015) **(22)**	Basin airspace review is being considered (not specific to LAHSO). The allocation of STARs for arriving aircraft facilitates efficient use of the existing airspace volumes) • Investigate updating the appropriate local instructions for taxiway availability during LAHSO (Following PIR workshop it has been confirmed that taxiway availability will be managed at a local level on a case by case basis - Refer to ACT-0008747 which has been verified) • Update MATS to confirm that aircraft with malfunctions are unable to participate in LAHSO (This control is no longer required. Following PIR workshop it has been confirmed that aircraft with malfunctions would not be normally sequenced for LAHSO, therefore no MATS entry is required - Refer to ACT-0008646 which has been verified)	
901/13	Foreign Aircraft incorrectly sequenced for LAHSO	• MATS - Included companies who have advised they will actively and passively participate in LAHSO into MATS for Adelaide, Darwin and Melbourne airports **(1)** *Note: International operators do not participate in LAHSO at Adelaide.* • MATS - Consolidated aircraft who are subject to CASA exemption to participate actively and passively for Land and Hold Short Operations	• Maestro installed at Adelaide would cover the arrivals (This control is no longer required. Due to the traffic demands and LAHSO usage, there is currently no intention to install Maestro at Adelaide. Airservices is planning to assess the utility of LAHSO at Adelaide)	D

Hazard No (from Hazlog 901)	Title	Strengthened / additional controls following recent safety improvement activities	Status of other yet-to-be-met controls identified in 2015 SAR Addendum	Current Residual risk
		(LAHSO) into Manual of Air Traffic Services (MATS) so information was readily available to controllers **(2)** • AIP - Reiterated that ATC will consider all domestically registered flight number callsign aircraft that fit performance category A, B, or C* aircraft and those subject to CASA exemption will be sequenced for LAHSO **(3)** • Changed the phraseology for crews to advise of non-participation in LAHSO to align with other phrases for consistency and ease of understanding **(4)**		
901/15	Unplanned Transition out of LAHSO	• MATS - New clause added to provide guidance for the safe transition from LAHSO to normal modes of operation **(25)**	• Develop suitable trigger points to initiate LAHSO to achieve acceptable risk level (Entry trigger points have been determined and are contained in local instructions. Currently coordination between tower and approach ATC determines the need to transition into or out of LAHSO, dependent on approach and arrival demand. Work is in progress to consider exit trigger points - Refer to ATS-0006640. Coordination between tower and approach has also been reinforced in the supervisor package) • Build a parallel runway (Melbourne Only) (This is not a required control within Airservices scope of LAHSO)	C
901/16	Increase in collision risk due to workload and task complexity for Essendon Tower when LAHSO in	• MATS - New clause added to emphasise that the tower controller may terminate LAHSO if they considered conditions would adversely affect LAHSO		Closed *As SHEED has been removed, this hazard*

Hazard No (from Hazlog 901)	Title	Strengthened / additional controls following recent safety improvement activities	Status of other yet-to-be-met controls identified in 2015 SAR Addendum	Current Residual risk
	progress	• The use of 09/34 LAHSO mode has been suspended indefinitely (as all departures in this mode are from runway 34) • SHEED STAR is removed for all LAHSO operations		*no longer exists.*
901/17	Enroute – Demand exceeds capacity (as per ORA)	• Demand driven – delays must be calculated to be greater than 5 minutes for LAHSO to be considered **(15)**	• Additional resources in Grampian (This control is no longer required, with consideration to the LAHSO usage, the management of demand within existing resourcing capacity, and tower and aisle 2 supervision) • Airspace Review (This control is no longer required specific to LAHSO. Melbourne Basin airspace review is being considered (not specific to LAHSO). The allocation of STARs for arriving aircraft facilitates efficient use of the existing airspace volumes) • Additional parallel runway (Outside Airservices scope) • Strategic slot management plan (Outside Airservices scope. Strategic slot management is managed by the airport)	**D**
901/18	Approach - Demand exceeds capacity (as per ORA)	• Demand driven (Melbourne) – delays must be calculated to be greater than 5 minutes for LAHSO to be considered **(15)** • Reduce access to the airspace for lower priority traffic via coordination with the operator and as determined by the shift manager under normal process **(27)** • SHEED STAR is removed for all LAHSO operations **(30)**	• Investigate alternative modes (Whilst stagger is not an alternative mode, this control will be met through the development and implementation of 'stagger')	**C**

Hazard No (from Hazlog 901)	Title	Strengthened / additional controls following recent safety improvement activities	Status of other yet-to-be-met controls identified in 2015 SAR Addendum	Current Residual risk
			• Investigate the implementation of director (Director in Melbourne will not be implemented at this time) • Airspace Review (This control is no longer required specific to LAHSO. Melbourne Basin airspace review is being considered (not specific to LAHSO). The allocation of STARs for arriving aircraft facilitates efficient use of the existing airspace volumes) • Additional parallel runway (Outside Airservices scope) • Strategic Slot management plan (Outside Airservices scope. Strategic slot management is managed by the airport)	

Appendix 3. Mapping of hazard/risk information to ORAs

Hazard no. (from Hazlog 901)	Hazard Title	Threat as identified in Melbourne TCU/Tower ORAs	Are all controls identified in Appendix 1 captured as barriers/recovery preparedness measures in ORAs Yes/No	Controls yet to be reflected in the ORAs
901/3	ATC unable to provide separation in a double go around when cloud ceiling is below MVA	Aircraft(s) conducts a missed approach[6] during Land and Hold Short Operations	YES	
901/5	Separation standard amended at short notice (late notice of pilot non participation)	Late notice that aircraft is unable to participate in LAHSO	NO	• MATS - Included the clause advising ATC that pilots may elect not to participate if they were concerned about situational awareness • AIP - Changed the phraseology for crews to advise of non-participation in LAHSO to align with other phrases for consistency and ease of understanding
901/6	Pilot unable to hold short due to no glide slope indication	Late notice that aircraft is unable to participate in LAHSO	NO	• Notify early that the glide slope guidance is not working so that the pilot can make a decision • AIP - Added the requirement for glide path guidance to be available for active participants – except Darwin where a separate hazard workshop identified that the aircraft being instructed to the hold short requirement on runway 36 were of light category below 5700kg Maximum take-off weight and regularly used aerodromes without glide slope guidance

[6] The term 'missed approach' will need to be amended to 'go around' in the Melbourne LAHSO ORAs.

901/8	By day and VMC an active LAHSO participant performs a go around	Aircraft(s) conducts a missed approach during Land and Hold Short Operations	YES	
901/9	Active LAHSO participant does not stop at required point on ground	Aircraft unable to hold short during Land And Hold Short Operations	YES	
901/10	2 aircraft perform a go around	Aircraft(s) conducts a missed approach during Land and Hold Short Operations	YES	Note: Operational implementation of stagger planned to be incorporated in the ORA
901/13	Foreign Aircraft incorrectly sequenced for LAHSO	Controller incorrectly applies standard LAHSO operating requirements Note: The ORA barrier "additional LAHSO restrictions via TLI_15_0195" should be amended as the TLI no longer exists	NO	• MATS - Included companies who have advised they will actively and passively participate in LAHSO into MATS for Adelaide, Darwin and Melbourne airports • MATS - Consolidated aircraft who are subject to CASA exemption to participate actively and passively for Land and Hold Short Operations (LAHSO) into Manual of Air Traffic Services (MATS) so information was readily available to controllers • AIP - Reiterated that ATC will consider all domestically registered flight number call sign aircraft that fit performance category A, B, or C* aircraft and those subject to CASA exemption will be sequenced for LAHSO
901/15	Unplanned Transition out of LAHSO	Unplanned transition out of LAHSO	YES	
901/16	Increase in collision risk due to workload and task complexity for Essendon Tower when LAHSO in progress Note: As SHEED has	N/A		

	been removed, this hazard no longer exists.			
901/17	Enroute – Demand exceeds capacity (as per ORA)	Demand exceeds capacity (due to airspace complexity)	NO	• Demand driven – delays must be calculated to be greater than 5 minutes for LAHSO to be considered
901/18	Approach - Demand exceeds capacity (as per ORA)	Demand exceeds capacity (due to airspace complexity)	NO	• Demand driven (Melbourne) – delays must be calculated to be greater than 5 minutes for LAHSO to be considered • Reduce access to the airspace for lower priority traffic via coordination with the operator and as determined by the shift manager under normal process • SHEED STAR is removed for all LAHSO operations

airservices

LAHSO – Risk Review and ORA Review

Minutes

Workshop: Risk review and ORA review
Venue: Hodgson Room (1.29), Building 330
Date: Monday 7th March 2016 (1pm – 3pm AEST)

Meeting attendees: See also http://crcb20/documents/HO_CB0-3043785

Name:	Role
[redacted]	ATC line Manager
[redacted]	ALM ML Tower
[redacted]	ATC C&SS ML TCU
[redacted]	Acting ALM ML TCU
[redacted]	ALM ML TCU
[redacted]	ECSS Business Coordinator
[redacted]	PBS Manager Melbourne
[redacted]	Senior Human Factors Specialist
[redacted]	Human Factors Specialist

Facilitator: [redacted] – Senior Project Safety Specialist

Apologies: [redacted] (Acting ECSS SDL Manager), [redacted] (ALM ML Tower), [redacted] (ATC ML Tower), [redacted] (Technical Research Specialist), [redacted] (ATC C&SS ML TCU)

Purpose: The purpose of this meeting was to review hazards 5, 10, 15 and 18 from Hazlog Register #901 and SAR Addendum, and review the ORAs to consider what updates will be required.

Meeting Minutes:

Item / Subject	Minutes / Discussion

Meeting opened	• Project Safety Specialist opened the meeting and introduced the purpose and agenda for the workshop:
	  o Review and re-assess residual risks from Hazlog #901 and SAR Addendum:
	    ▪ Hazard No. 10 – Class B risk
	    ▪ Hazards No. 5, 15, 18 – Class C risks
	    ▪ The hazards reviewed were those taken from the 2015 SAR Addendum (Tables 5 and 6). Refer to SAF-SAR-120009-Add.
	  o ORA review with respect to 'Compromised Separation Recovery Procedures'
	    ▪ Review right hand side of bowtie
	  o ORA review with respect to 'Stagger'
	    ▪ Review left hand side of bowtie

Hazlog #901 – Hazard 5	• Hazard No.5 from SAR Addendum was assessed as a Class C Risk:
	  o Likelihood = Daily – Yearly
	  o Consequence = Minor
	• Upon review by the meeting attendees the risk classification has not changed. Likelihood and Consequence remain the same.

Item / Subject	Minutes / Discussion
Hazard identified during 'Stagger' SCARD	• During the completion of the SCARD on 18/02/2016 the following hazard was identified: o 'Aerodrome controller (ADC) misjudges a departure gap which causes a go around. Note: Under LAHSO stagger runway 34 landings arrive after runway 27 landings. Cannot LAHSO a runway 27 departure with a runway 34 arrival at night. Aircraft landing on runway 34 must report when leaving the runway before a departure off runway 27 can be cleared for take-off. • This hazard was assessed as a class C risk with the proposed control being a reduced LAHSO rate during stagger. This has been trialled in the simulator and an arrival rate of 36 has been selected. This hazard has been recorded in Hazlog register #1239.
Updated hazards from Hazlog #901 incorporated in ORAs	• In the event that CASA endorses the LAHSO SAR Addendum submitted in respect of re-instating night operations the ORAs with respect to LAHSO will be updated to reflect any new risk controls that have been implemented since the last SAR Addendum update from July 2015. • The ORA reviews/updates to be initiated by the ECSS Business Coordinator with the help of the Safety Performance team from the CATC Office and ALMs from each location.
Next steps / Meeting closed	• Project Safety Specialist to forward minutes to stakeholders.