05 August, 2014
Our File Ref: B14305AL001
Contact: Nick Borley

Landmark East Pty Ltd
C/- Dyldam Developments
Level 1, 74 Macquarie Street
Parramatta NSW 2150

Attention: Chemaine Shehadeh

RE: PROPOSED DEVELOPMENT 142 – 154 MACQUARIE ST, PARRAMATTA AERONAUTICAL STUDY

1. INTRODUCTION

REHBEIN Airport Consulting was engaged by Landmark East Pty Ltd to undertake an aeronautical study in relation to a proposed development at 142-154 Macquarie Street, Parramatta. This report sets out the assessment undertaken and findings of the study.

1.1 Proposed Development

The proposed development site is located approximately 20km north-west of Sydney Airport and 11km north of Bankstown Airport.

Preliminary drawings; SK-001, SK-002, and SK-003 provided by Landmark East Pty Ltd illustrate the subject site and the proposed development. As this development is in the conceptual stages, final site layout and building designs are yet to be determined. However, it is anticipated that due to the location and elevation of the development an aeronautical assessment will be required in order to identify the impacts on prescribed airspace, the associated risks to aviation safety and strategies to mitigate identified risk in order to achieve design approval. This assessment is intended to identify the aviation controls relative to the development of this site so as to facilitate the design process.

In undertaking this assessment the following assumptions are made and are based on an Urban Design Study[1] and information provided by the client;

- The final development will consist of three(3) individual residential towers located on the site;
- The final development will consist of one 60-storey tower, one 35-storey tower and one 25-storey tower;
- Floor to ceiling heights in the 60-storey are to be 3 metres above a 5m retail ground floor;
- An additional 12m above the roofline of the top storey has be added to accommodate for proposed lift overruns, antennas, flues and plant rooms;

[1] **GMU Urban Design & Architecture (GMU) – Urban Design Study 142 -154 MACQUARIE STREET – PARRAMATTA.**

- As the final layout of the site has not been finalised, a 200.9m structure over the full extent of the site has been assumed for this assessment;
- The highest building elevation including a lift overrun allowance is calculated to be 194m Above Ground Level (AGL);
- The average ground elevation across the site is 6.9m AHD;
- The overall height of the highest tower within the development is therefore calculated at 200.9 metres AHD; and
- The two lower towers are calculated to be 93.9m metres and 127.9 m AHD respectively.

1.2 Scope of Study

This aeronautical study considers the potential impact of the proposed development on the following:

- Bankstown Airport Obstacle Limitation Surfaces;
- Bankstown Airport PANS-OPS surfaces;
- Bankstown Airport Navigational Aids;
- Sydney Airport Obstacle Limitation Surfaces (OLS);
- Sydney Airport PANS-OPS;
- Sydney Airport Navigational Aids;
- Sydney Airport Terminal Area Radar (TAR);
- An assessment of One Engine Inoperative (OEI) procedures for operators at Bankstown and Sydney Airports; and
- Identify likely impacts of construction operations and applicable restrictions to aviation operations.

2. PRESCRIBED AIRSPACE

Sydney Airport and Bankstown Airport are federally leased airports, operated by Sydney Airport Corporation Limited (SACL) and Bankstown Airport Limited (BAL) respectively. As federally leased airports, they are subject to the *Airports Act 1996* and the regulations made pursuant to it, including the *Airports (Protection of Airspace) Regulations 1996*. Those Regulations prescribe airspace around the airports for protection from intrusion by obstacles, namely the airspace defined by the airport's Obstacle Limitation Surfaces (OLS) and the PANS-OPS protection surfaces and includes those surfaces planned to accommodate future expansion or new procedures at the airport.

No permanent penetration of the prescribed PANS-OPS protection surfaces is permitted. Temporary penetrations of prescribed PANS-OPS protection surfaces and permanent or temporary penetrations of the prescribed OLS may be permitted, with or without conditions.

Ordinarily, the approval process for proposed developments in relation to prescribed airspace involves notice of the proposal being given to the relevant airport operator(s), who then passes it to both Airservices Australia and the Civil Aviation Safety Authority (CASA) for their assessment. Airservices Australia is primarily focussed on the PANS-OPS surfaces, as well as potential impacts on communication, navigation and surveillance (CNS) facilities. CASA would review the impact on the OLS. Depending on the nature and location of the proposal, the airport

operator may also have a view about its potential impact. The consolidated views of both agencies and the airport operator are then passed to the Department of Infrastructure and Regional Development, which is responsible for making a decision after reviewing the advice.

The general nature of the OLS and PANS-OPS surfaces are expanded upon in the following sub-sections.

2.1 Obstacle Limitation Surfaces

The OLS is a set of imaginary surfaces associated with an aerodrome. They define the volume of airspace that should ideally be kept free from obstacles in order to minimise the danger to aircraft during an entirely visual approach or during the final visual segment of an instrument approach procedure. These surfaces are of a permanent nature and comprise the reference datum which defines an obstacle. Anything above the vertical limits of the OLS is regarded as an obstacle.

The Manual of Standards for Part 139 (MOS Part 139) of the Civil Aviation Safety Regulations (CASR) defines the OLS for certified aerodromes such as Sydney Airport and Bankstown Airport.

Some penetrations of the OLS are permissible if they are judged not to interfere with the safety, efficiency or regularity of existing or future operations at an airport. Pursuant to the *Airports (Protection of Airspace) Regulations 1996* (APARs), this is a matter for the Department of Infrastructure and Regional Development to determine based on advice from CASA, Airservices and the airport operator. An approval may also be granted with conditions, such as a requirement to mark and/or light the structure in a particular way.

2.2 PANS-OPS Surfaces

Airspace associated with aircraft instrument procedures is defined by the Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) protections surfaces for an aerodrome. These surfaces are ascertained in accordance with the criteria in the International Civil Aviation Organisation (ICAO) *Procedures for Air Navigation Services - Aircraft Operations* (Doc 8168, PANS-OPS) and are also protected by the Airports (Protection of Airspace) Regulations 1996.

The PANS-OPS surfaces are intended to safeguard an aircraft from collision with obstacles when the pilot is flying solely by reference to instruments. Protection of these surfaces is critical, as pilots may be navigating without any visual reference outside the aircraft.

The designer of an instrument approach procedure through application of the PANS-OPS criteria determines the lateral extent of the areas needed for an aircraft to execute a particular manoeuvre. The designer then applies a Minimum Obstacle Clearance (MOC) to structures, terrain and vegetation within that area to determine the lowest altitude at which the manoeuvre can be safely executed. Numerous published procedures exist for both Sydney Airport and Bankstown Airport. The extent of the protected areas for the

procedures varies depending on the type of procedure and the segment of the procedure.

3. SYDNEY AIRPORT OLS

Figure 1 illustrates the proposed development site in relation to the Sydney Airport obstacle limitation surfaces (OLS).

The site is located outside and beyond the lateral dimensions of the surfaces associated with Sydney Airport and is therefore not of concern in relation to the Sydney Airport OLS.

4. SYDNEY AIRPORT PANS-OPS

The proposed development site is located beneath a number of PANS-OPS protection surfaces associated with the published instrument approach procedures at Sydney Airport:

A preliminary review of the instrument procedure charts published in the AIP Departure and Approach Procedures (AIP-DAP) has been undertaken by REHBEIN Airport Consulting. The magnitude of surface pentrations and the number of instrument approach procedures likely to be affected by this development will be confirmed by the custodians of the data, Airservices, in their review as part of the approval process under the APARs.

Our preliminary review indicates that the proposed development will be located within the lateral area of protected airspace associated with the Sydney Airport 10 nautical mile (NM) Minimum Safe Altitude (10NM MSA). This surface is considered to be the most restrictive of the PANS-OPS surfaces associated with Sydney Airport operations.

Under the assumption that the 10Nm MSA is the most restrictive PANSOPS surface the following calculation has been undertaken to determine if an infringement of this surface exists.

Published Altitude	2100 ft (640m)
Less MOC[2]	984 ft (300m)
PANSOPS Surface	1116 ft (340m)
Site Elevation AHD	22.6 ft (6.9m) approximate.
Building Elevation AGL	636.5 ft (194m)
Total Building Elevation	659 ft (200.9m) AHD

The proposed development's maximum RL of 200.9m AHD will therefore not impact on the Sydney Airport PANS-OPS.

[2] Minimum Obstacle Clearance.

5. RADIO NAVIGATION AND SURVEILLANCE EQUIPMENT

5.1 Navaids

Sydney airport navigation aids (navaids) which have the potential to be affected by the proposed development include:

- VHF Omni-directional Range (VOR);
- Distance Measuring Equipment (DME);
- Instrument Landing Systems (ILS); and
- Ground Based Augmentation System (GBAS).

Of these, the only facilities which have protection areas extending sufficiently far to be impacted by the proposed development are the ILS. As the proposed development is removed from the extended centrelines of all runways, none of the ILS protection surfaces should be infringed by the development.

Bankstown Airport navaids which have potential to be affected by the proposed development currently include a ground based Non Directional Beacon (NDB). Assessment of the protection areas in relation to this facility indicates that the proposed development is beyond the extent of the area defined as requiring protection.

Bankstown Airport Master Plan additionally indicates potential for an Instrument Landing System (ILS) to be installed. The protection areas associated with this system area generally aligned with the runway centreline. Due to the location of the development relative to the alignment of runways at Bankstown Airport it should not encroach on any of the associated ILS protection areas should one be installed.

5.2 Terminal Area Radar (TAR)

Buildings and other solid structures can create shadow areas for radar coverage. The potential for shadow areas is based on the extent to which the building may obscure a line of sight from the radar facility.

A 3-dimensional assessment has been undertaken to determine the lateral and vertical extent of protrusion of the proposed development at 142 -154 Macquarie Street Parramatta on the radar line of sight. **Figure 2** shows the lateral and vertical extent of the ‘shadow’ that would be created by the proposed development.

Advice from Airservices in relation to other proposed developments in the vicinity indicates that there exists a Radar Terrain Clearance Chart (RTCC) surface at 800 feet (243.8m) AHD, which may not be penetrated. The proposed development maximum RL of 200.9m AHD should enable allowance for cranes during construction to avoid penetrating the RTCC surface.

Airservices will need to confirm the potential impact of the proposed development on the Sydney Airport TAR in their review as part of the approval process under the APARs.

6. BANKSTOWN AIRPORT OLS

Bankstown Airport is a significant airport for flying training and other general aviation activity. It has three (3) parallel runways aligned at 111°/291° magnetic and designated Runways 11L/29R, 11C/29C and 11R/29L.

The future OLS for Bankstown Airport, which includes provision for the installation of a precision instrument approach procedure on one runway, extends outwards from the Aerodrome Reference Point (ARP) for 15,000m. The proposed development at 142 – 154 Macquarie Street Parramatta lies within the Outer Horizontal Surface of Bankstown Airport's future OLS. **(Figure 3.)** The elevation of the future OLS outer horizontal surface is 156.0m AHD. Assessment of the proposed development heights for the three tower development indicated that only the proposed 60-storey tower would penetrate the obstacle limitation surface. The magnitude of this penetration is calculated to be 44.9m however appropriate mitigation measures to this risk are discussed in section 11. The additional two towers proposed for the site remain beneath the surface and are therefore not of concern in relation to the OLS.

7. BANKSTOWN AIRPORT PANS-OPS

Bankstown Airport has a number of existing and future instrument approach procedures. A desktop assessment of the procedures indicates that the proposed development of 142 – 154 Macquarie street Parramatta is located within the lateral obstacle inspection splay associated with the missed approach procedure for RWY 11C NDB. The PANS-OPS surface at this location is calculated to be approximately 300m AHD. With the highest building proposed for the site at 200.9m AHD no penetration of the PANS-OPS surface will exist.

8. ONE ENGINE INOPERATIVE (OEI) PROCEDURES

The position and vertical magnitude of the proposed development relative to Bankstown Airport constitutes a need to undertake an assessment on the likely impacts on the protection of aircraft in an emergency situation and who are operating on one engine. The criteria for the construction of the OLS and PANS-OPS protection surfaces do not consider aircraft performance in an emergency configuration.

The development of procedures for the protection of operations in OEI configuration is the responsibility of individual operators. In general terms however aircraft certification requirements require that a multi-engine aeroplane be able to maintain height on one engine at 5000 ft., at its maximum take-off weight in the standard atmosphere (temperature and pressure). This is not always achievable due to factors such as aircraft serviceability, piloting skills and environmental factors. It is desirable, however, that an OEI aircraft maintain a climb gradient of 2.5%. It has been assumed for this assessment that aircraft operating from Bankstown Airport will be able to achieve a baseline single engine climb performance of 2.5%. If this is the case an aircraft departing Bankstown and suffering an engine failure immediately after take-off would gain approximately 275m of altitude should it be track directly toward the development site whilst continuing this performance climb. In this OEI scenario the aircraft would be approximately 282m AHD by the site and approximately 81m (266 ft.) above the highest tower within the development.

Since no criteria exists for the clearance of obstacles in an emergency situation the theoretical clearance calculated within this assessment provides a level of confidence that the development would not pose a collision risk within the scenario. The acceptance of this risk however still remains the responsibility of the operator.

9. STAKEHOLDER CONSULTATION

Preliminary stakeholder consultation was undertaken with identified operators at Bankstown Airport to assess any potential impacts that may be encountered should this development proceed. The relevant stakeholders identified included those that operated multi engine aircraft and included: Toll Aviation; Skyforce Aviation; Wingaway; and General Aviation Maintenance (GAM).

Stakeholders where asked specifically to comment on OEI procedures and whether the proposed development would factor as an increase in risk in this regard. Stakeholders were also asked to comment on the philosophy adopted in this assessment and whether performance figures were realistic and represented current industry standards. The results of the preliminary stakeholder feedback are summarised as:

- The OEI 2.5% climb gradient adopted for this assessment is a minimum and would be considered acceptably conservative by operators;
- Most operators based their OEI calculations on an ideal 3.3% climb gradient as this represented the current IFR departure procedure;
- Stakeholders did not identify the proposed development as having any greater risk to their operations than what already exists with similar developments in the area; and
- The position of the development was far enough away from the airport to allow manoeuvring in the event of an engine failure and was clear of the normal approach and departure paths associated with operations at Bankstown Airport.

10. EXISTING BUILDINGS AND SHIELDING

New obstacles which penetrate the OLS in the vicinity of an existing obstacle can be considered to be shielded under certain circumstances. The Civil Aviation Safety Authority (CASA) sets out the principles which apply to the assessment of shielding in Section 7.4 of the CASA Manual of Standards (MOS) Part 139 – Aerodromes.

The location of the proposed development beneath the outer horizontal surface dictates that paragraph 7.4.2.3 of CASA MOS Part 139 provides the relevant criterion in relation to shielding:

'The new obstacles may be accepted if it is in the vicinity of an existing obstacle, and does not penetrate a 10% downward sloping conical shaped surface from the top of the existing obstacle … '

REHBEIN Airport Consulting has not been provided with any existing or proposed development data on which to base the application of the shielding principle. Based on REHBEIN Airport Consulting's archival data for the area in question, it would appear that there are no existing buildings sufficiently close to the proposed

development to meet the shielding criterion as set down by CASA MOS Part 139 paragraph 7.4.2.3.

11. OBSTACLE MARKING AND LIGHTING

The proposed development would constitute a permanent obstacle penetrating the future Bankstown Airport OLS outer horizontal surface by 44.9m.

CASA's general approach to obstacles is that every effort should be made to implement the OLS standards and limit the introduction of new obstacles.

However, objects penetrating the OLS which are not deemed to be shielded, and which are assessed by CASA as not posing an unacceptable hazard to aircraft operations, may be permitted to remain. In these circumstances, they must be marked and/or lit.

CASA MOS Part 139 paragraph 8.10.1.2 states that CASA may permit an obstacle to remain unmarked when it is sufficiently conspicuous by nature of its shape, size or colour. Whilst details of proposed colour schemes are not known, it is reasonable to consider that the size and shape of a three tower residential development would serve to make it sufficiently conspicuous to pilots of aircraft operating under visual flight rules by day.

Under the Civil Aviation Regulations, CASA may determine that a proposed object which will intrude into navigable airspace will require to be provided with obstacle lighting.

Under CASA MOS Part 139 paragraph 9.4.1.2 (a) (iii), and obstacle which extends above the outer horizontal surface of a runway intended for use at night would trigger this requirement.

It is therefore considered that CASA will require the proposed development at 142 - 154 Macquarie Street Parramatta to be provided with medium-intensity obstacle lighting in accordance with CASA MOS Part 139 paragraph 9.4.2.4 (b) or (c). The lighting should consist of one or more obstacle lights located as close as practicable to the top of the building (which includes any protruding structures such as communications antenna) and arrange so as to indicate the points or edges of the building highest in relation to the OLS, in accordance with CASA MOS Part 139 paragraph 9.4.3.1.

12. CONSTRUCTION STAGE IMPACTS

During construction, cranes will be required to extend above the maximum RL of the building in order to complete the construction of the permanent structure. Details of construction sequencing, methods and proposed cranes are not known at this stage. Penetrations of prescribed airspace by cranes during construction constitute a separate and distinct controlled activity under the *Airports (Protection of Airspace) Regulation 1996* and are therefore typically subject to a separate application. However, an initial assessment of expected impacts on prescribed airspace during construction has been undertaken.

Based on the use of a tower crane, which might typically extend to a height of 25m above the permanent structure, to construct the upper storeys of the highest tower, this could result in a temporary obstacle with a maximum RL of approximately 226m AHD during the latter stages of construction. This would result in a penetration of the Bankstown Airport future OLS outer horizontal surface by approximately 69.9m. It is envisaged that construction of this development would be completed in the short term where as the future prescribed airspace is in the longer term planning for the airport. Under the current prescribed airspace an outer horizontal surface is not required therefore should construction be completed prior to the prescribing of the future airspace model no OLS penetration would exist.

A temporary obstacle with a maximum RL of approximately 226m would need to be assessed by CASA and SACL. Given the extent of the penetration should construction commence post the prescribing of the future OLS it is envisaged that cranes will need to be lit with a medium intensity obstacle lights at the top and additional low-intensity lights to indicate the full height of the structure in accordance with MOS Part 139 paragraph 9.4.3.6. CASA may also direct the use of high intensity obstacle lights during daylight hours in lieu of marking.

Based on the assumption that a 25m crane will be utilised in the construction phase of all buildings within the development, cranes will penetrate Bankstowns future OLS during the construction of the tallest tower with the other two towers not being of suffucent height to encroach on the airspace.

13. PLUME RISE ASSESSMENT

Aircraft operations in various stages of flight may be affected by an exhaust plume of significant vertical velocity.

CASA will need to conduct an assessment of all possible exhaust plumes in accordance with CASA Advisory Circular AC-139-5(1) *Plume Rise Assessments* (copy attached).

The proponent needs to complete CASA Form 1247 Application for Operational Assessment of a Proposed Plume Rise (copy attached) with the relevant details once these are available, and submit the form directly to CASA at the Office of Airspace Regulation (OAR) via oar@casa.gov.au in order to commence the assessment process.

Further details on plume rise assessment requirements can be obtained by reference to AC139-5(1) or by contacting OAR.

14. CONCLUSION

The preceding report sets out REHBEIN Airport Consulting's assessment of the impacts on prescribed airspace associated with the proposed development at 142-154 Macquarie Street,Parramatta.

The highest tower planned within the proposed development will penetrate the future Bankstown Airport OLS outer horizontal surface. Based on the information available, the building will not be shielded by existing permanent obstacles. Marking is not considered necessary as the building will be conspicuous by virtue of its size, shape

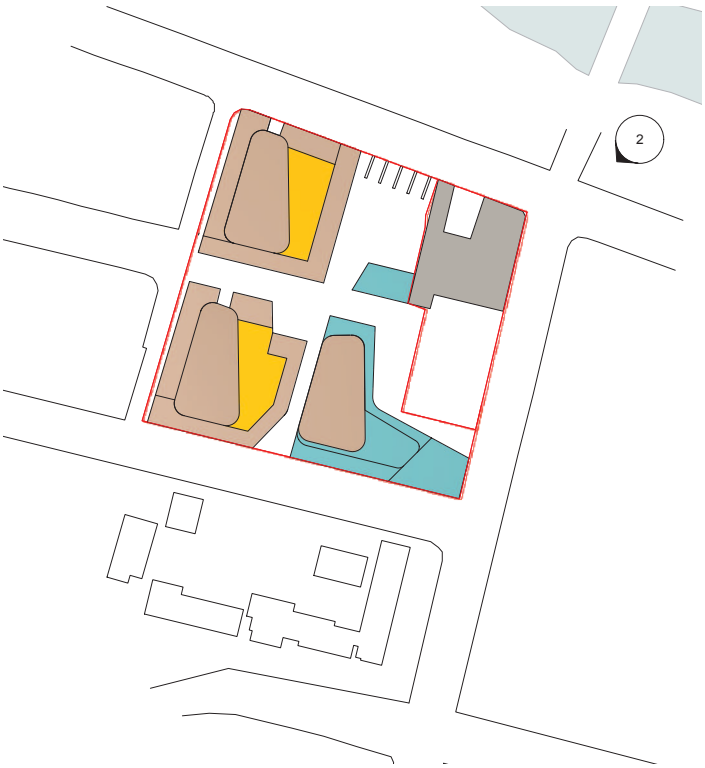
and colour by day. The building should be lit in accordance with the relevant provisions of CASA Manual of Standards Part 139 as indicated herein.

Penetrations of the Bankstown Airport future OLS would occur from the use of cranes during construction, however it is envisaged that construction would be completed before this future airspace surface is prescribed. The development should not result in any permanent or temporary penetration of either Bankstown or Sydney Airport's PANS-OPS surfaces.

Yours faithfully
For and on behalf of
LAMBERT & REHBEIN (SEQ) PTY LTD

N. BORLEY
PRINCIPAL AVIATION CONSULTANT

Enc: Urban Design Study
SK-001 – 003
Figures 1 – 3
CASA AC 139-5(1)
CASA Form 1247



1 PLAN
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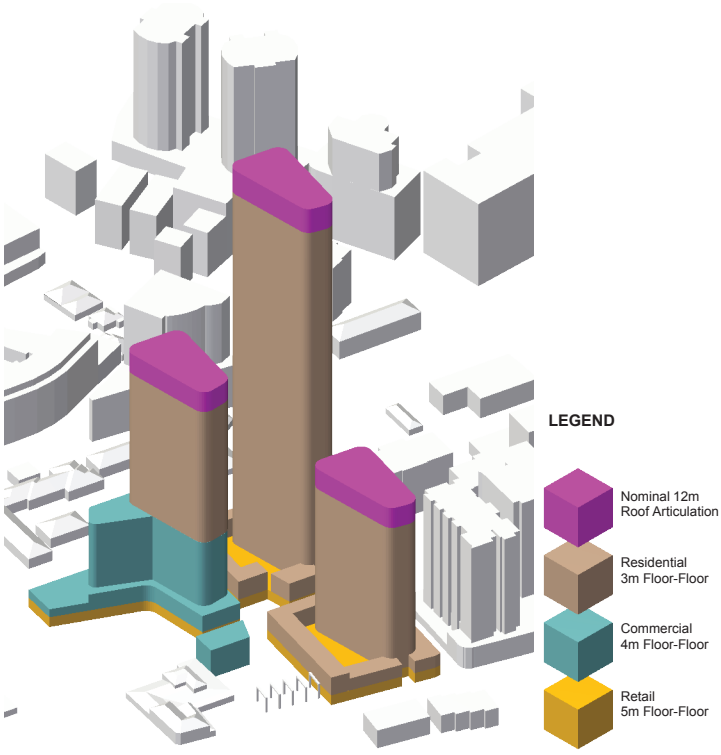

2 AXONOMETRIC VIEW
1:1500 @ A3

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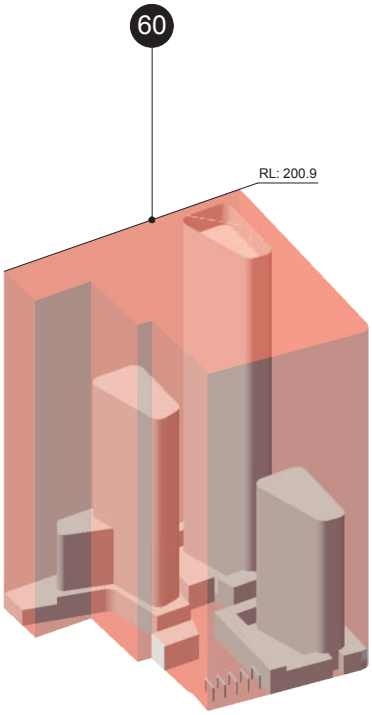
dyldam

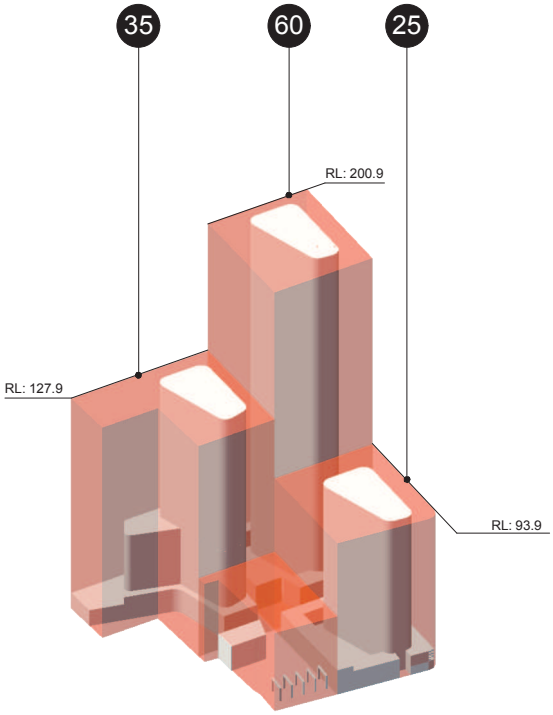
AVIATION SKETCH - Background

DWG NO.	**SK-001**
PROJECT No.	**1401**
PLOT DATE	**10/7/14**
REVISION	**A**



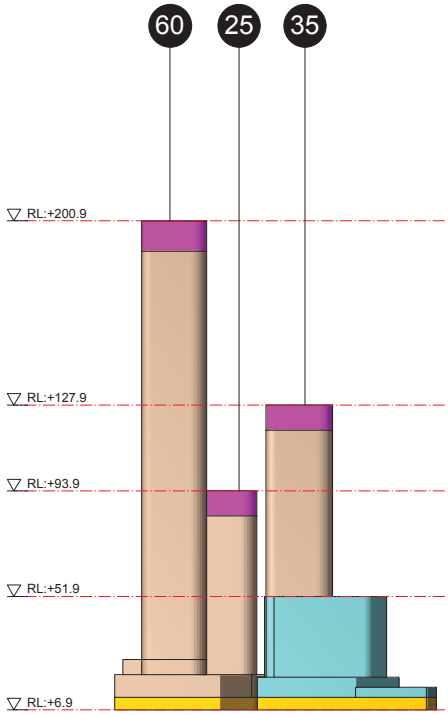
1 STRATEGY 01

TEST:
Whole of site extruded to full 60 storeys
This way the tallest tower can move anywhere on the site if it is required to through negotiation with council.



2 STRATEGY 02

TEST:
Current scheme with full height of buildings in each quadrant at the preferred configuration.



3 CURRENT SCHEME SOUTH ELEVATION

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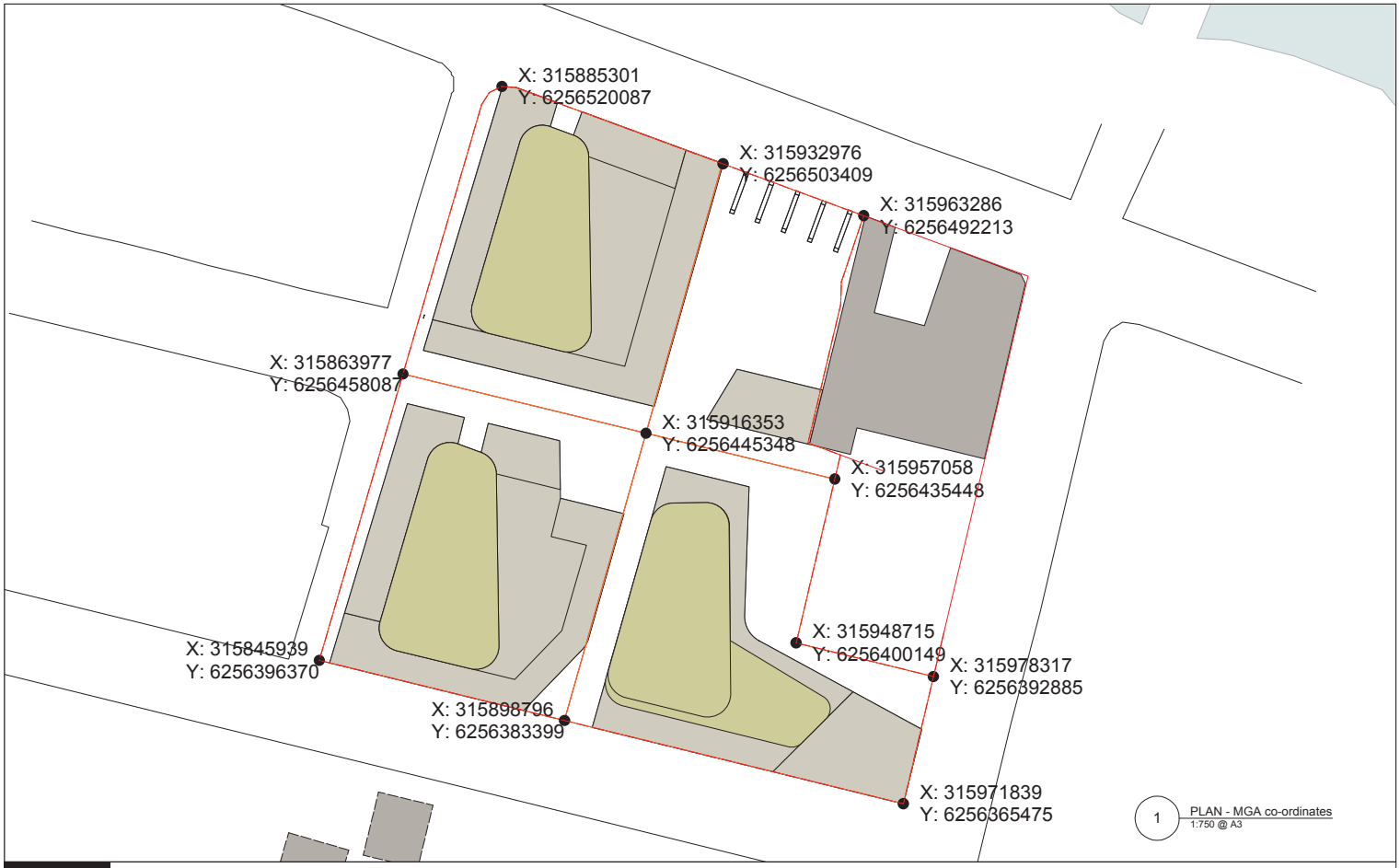
AVIATION SKETCH - strategies

DWG NO.	**SK-002**
PROJECT No.	**1401**
PLOT DATE	**10/7/14**
REVISION	**A**



1 PLAN - MGA co-ordinates
1:750 @ A3

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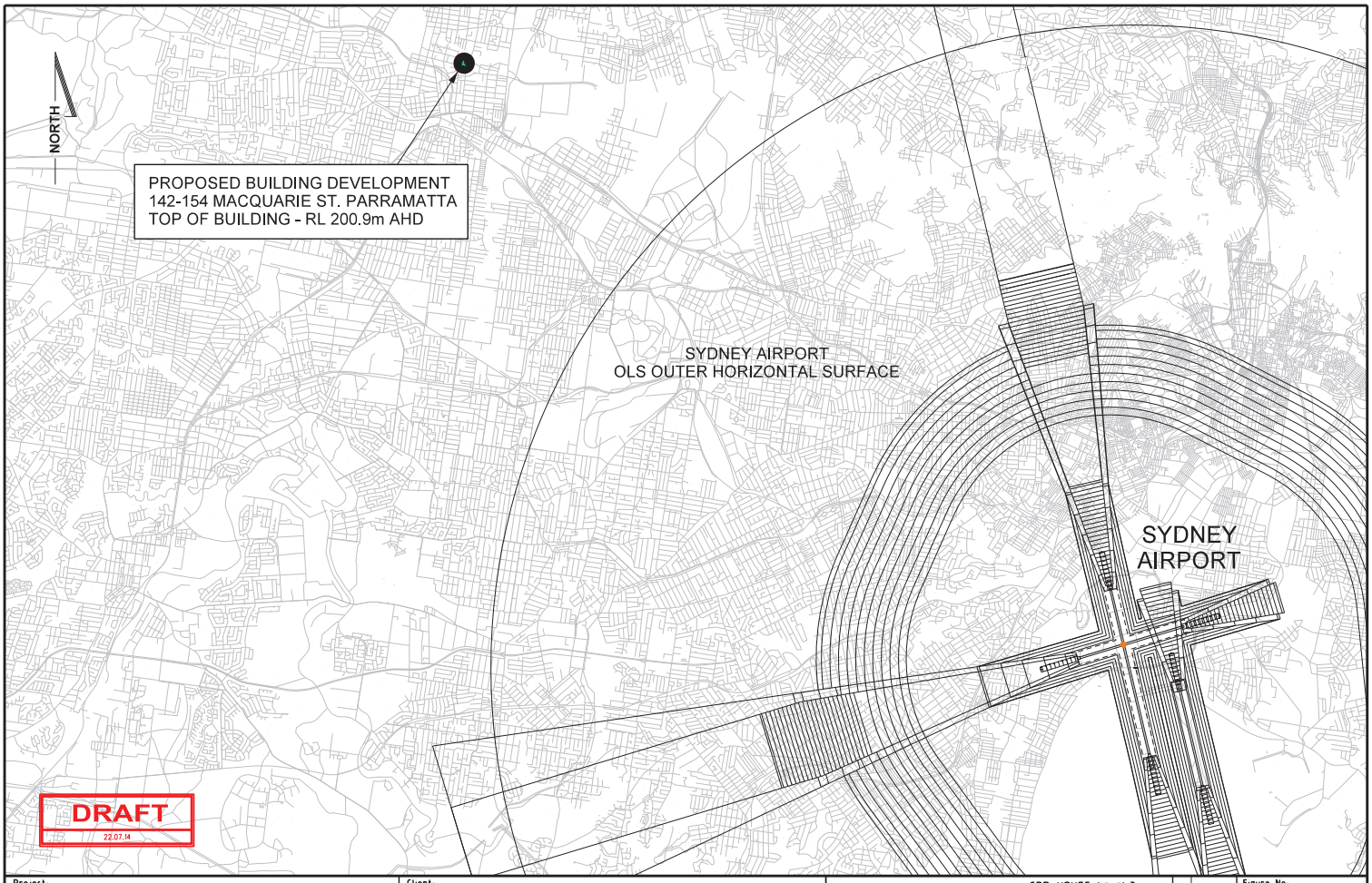
PLAN - MGA co-ordinates

DWG NO.	**SK-003**
PROJECT No.	**1401**
PLOT DATE	**10/7/14**
REVISION	**A**



Project: PROPOSED BUILDING DEVELOPMENT
142-154 MACQUARIE ST. PARRAMATTA

Client: LANDMARK EAST PTY LTD

Title: AERONAUTICAL ASSESSMENT
SYDNEY AIRPORT
OBSTACLE LIMITATION SURFACE

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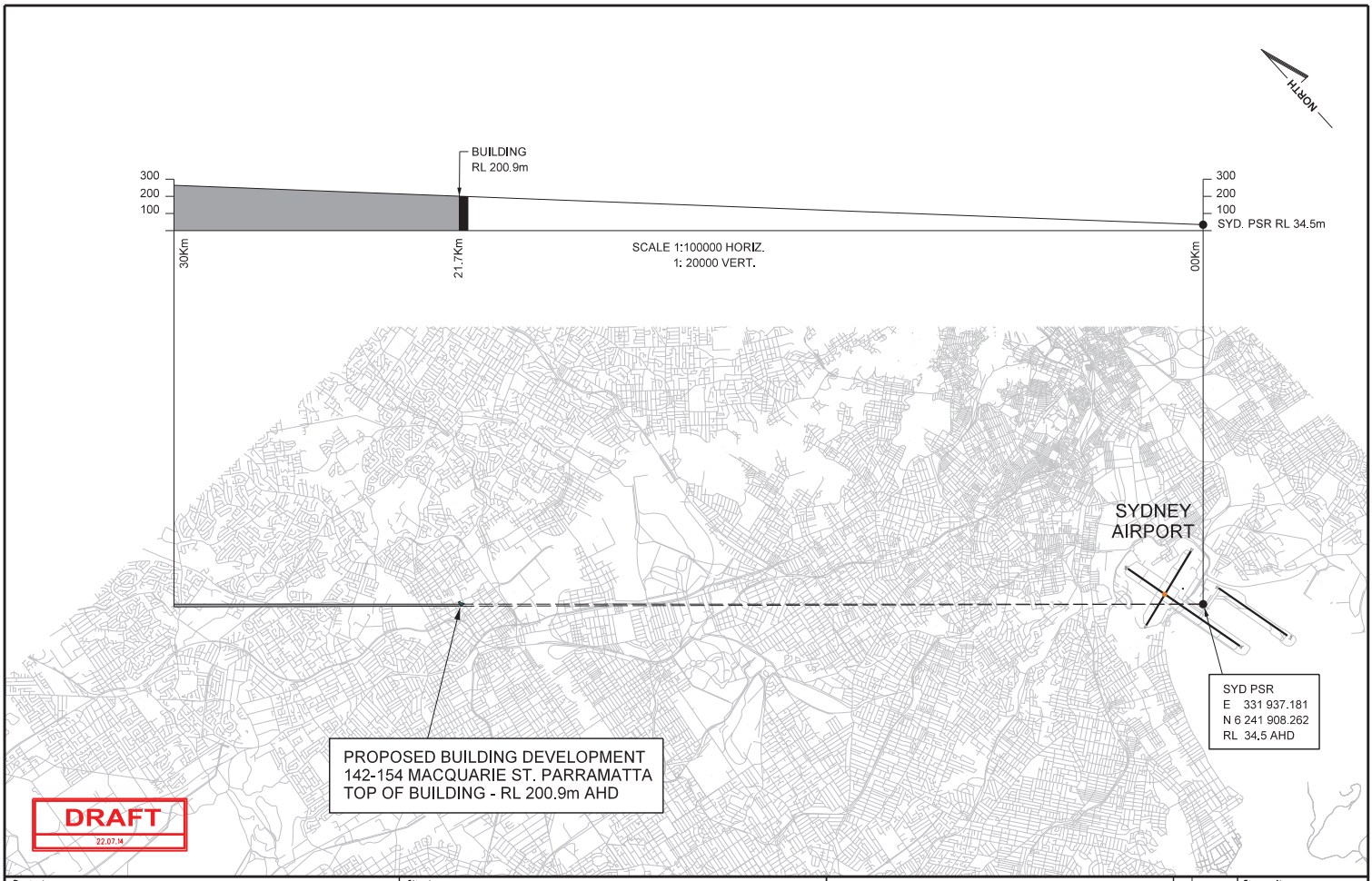
Drawn CMF | Checked NJB | Approved BJH

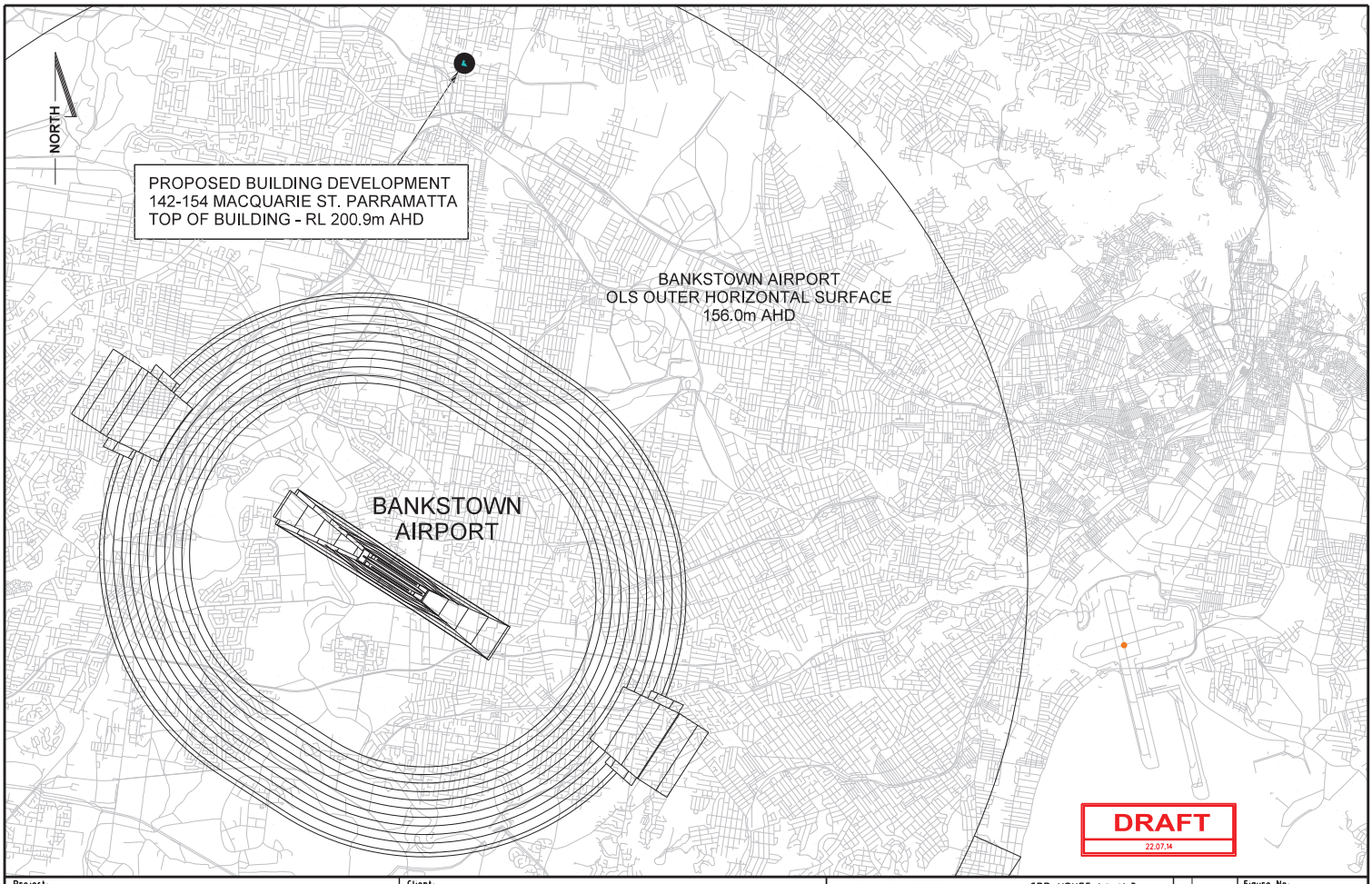
0 | 22.07.14
Rev. | Date

Figure No: FIGURE 1

Scale: 1-80000 | A3
File Ref: B14305 | Sheet Size



Project: PROPOSED BUILDING DEVELOPMENT 142-154 MACQUARIE ST. PARRAMATTA	Client: LANDMARK EAST PTY LTD Title: AERONAUTICAL ASSESSMENT SYDNEY AIRPORT TERMINAL AREA RADAR (TAR)	REHBEIN Airport Consulting CBD HOUSE, Level 3 120 WICKHAM STREET FORTITUDE VALLEY QLD 4006 A C N 126 939 768 TELEPHONE (07) 3250 9000 FACSIMILE (07) 3250 9001 EMAIL mail@ar.net.au Drawn CMF | Checked NJB | Approved BJH	Figure No: FIGURE 2 Scale: 1:100000 A3 File Ref: B14305 Rev. 0 Date 22.07.14



Project: PROPOSED BUILDING DEVELOPMENT
142-154 MACQUARIE ST. PARRAMATTA

Client: LANDMARK EAST PTY LTD

Title: AERONAUTICAL ASSESSMENT
BANKSTOWN AIRPORT
FUTURE OBSTACLE LIMITATION SURFACE

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Drawn CMF | Checked NJB | Approved BJH

Rev. 0 | Date 22.07.14

Figure No: FIGURE 3

Scale: 1:80000 | Paper Size A3

File Ref: B14305

Australian Government
Civil Aviation Safety Authority

Advisory Circular

AC 139-5(1) NOVEMBER 2012

PLUME RISE ASSESSMENTS

CONTENTS **Page**

1. REFERENCES

- Regulation 6 of the Airspace Regulations 2007.
- Regulation 139.370 of the *Civil Aviation Safety Regulations 1998* (CASR 1998) – Hazardous Objects.
- Part 173 of CASR 1998 – Instrument Flight Procedure Design.
- *Manual of Aviation Meteorology*, Bureau of Meteorology (Published by Airservices Australia, 2003).

Advisory Circulars (ACs) are intended to provide advice and guidance to the aviation community to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material. The purpose of this AC is to provide guidelines for conducting plume rise assessments.

Where an AC is referred to in a 'Note' below the regulation, the AC remains as guidance material.

ACs should always be read in conjunction with the referenced regulations.

This AC has been approved for release by the Executive Manager, Standards Division.

2. PURPOSE

2.1 The purpose of this Advisory Circular (AC) is to provide:

- a standard method of determining the critical velocity of a vertical exhaust plume so that the impact of a plume near aerodromes and away from aerodromes can be assessed in a consistent and reliable way;
- guidance to persons involved in the design, construction and operation of facilities with vertical exhaust plumes about the information required to assess the potential hazard from a plume to aircraft operations; and
- guidance to proponents and stakeholders on the plume rise assessment process.

2.2 The Civil Aviation Safety Authority (CASA) has identified that there is a need to assess the potential hazard to aviation posed by vertical exhaust plumes in excess of 4.3 metres per second (m/s) velocity. Relevant legislation includes the potential hazard, under Regulation 139.370 of CASR 1998 and the potential danger, under Regulation 6 of the Airspace Regulations 2007.

3. STATUS OF THIS ADVISORY CIRCULAR

3.1 This is the first revision of the AC relating to conducting plume rise assessments and replaces AC 139-5(0) issued in June 2004. It has been simplified due to the introduction of computer-based modelling (referred to as the "Screening Tool", see paragraph 5.1) to assist in the assessment process. The plume rise assessment process has also been clarified.

4. ACRONYMS

AC	Advisory Circular
AD INSP	Aerodrome Inspector
AD OPR	Aerodrome Operator
CASA	Civil Aviation Safety Authority
CASA OAR	CASA Office of Airspace Regulation
CASR	Civil Aviation Safety Regulations 1998
CPH	Critical Plume Height
CPV	Critical Plume Velocity
LSALT	Lowest Safe Altitude
m/s	metres per second
OLS	Obstacle Limitation Surface
TAPM	The Air Pollution Model
TIFP	Terminal Instrument Flight Procedure

5. DEFINITIONS

5.1 For the purposes of this document:

Buoyancy Enhancement describes a situation in which multiple vertical exhaust plumes in close proximity can merge to alter the plume characteristics.

Critical Plume Height means the height up to which the plume of critical velocity may impact the handling characteristics of an aircraft in flight such that there may be a momentary loss of control.

Critical Plume Velocity means the velocity at which the vertical plume rise may affect the handling characteristics of an aircraft in flight such that there may be a momentary loss of control.

Obstacle Limitation Surfaces are a series of planes associated with each runway at an aerodrome that defines the desirable limits to which objects may project into the airspace around the aerodrome so that aircraft operations may be conducted safely.

Regulated Aerodromes are Certified and Registered aerodromes to which the CASR Part 139 - Aerodromes applies. At these aerodromes the aerodrome operator must ensure that the obstacle limitation surfaces are established in accordance with the standards set out in these regulations.

Screening Tool is the computer generated method of plume rise analysis used by CASA's Office of Airspace Regulation (OAR) to derive the heights at which the plume rise velocity is 4.3 m/s and 10.6 m/s. The Screening Tool is based on The Air Pollution Model (TAPM) methodology which includes a buoyancy enhancement factor for multiple plumes.

TAPM is The Air Pollution Model derived by the CSIRO.

Terminal Instrument Flight Procedure means an instrument approach procedure or instrument departure procedure. These procedures are protected by a series of design surfaces. Penetration of the design surfaces will result in an alteration to the associated instrument approach or departure procedure. Copies of the design surfaces for an aerodrome can be obtained from the aerodrome operator.

6. BACKGROUND

6.1 Exhaust plumes can originate from any number of sources. For example: industrial facilities release process emissions through stacks or vents; industrial flares create an instantaneous release of hot gases during the depressurisation of gas systems; cooling towers produce large volumes of buoyant gases that can rise a significant distance into the atmosphere and exhaust gases from power generation facilities can produce plumes of varying velocities during different operating scenarios.

6.2 Aircraft operations in various stages of flight may be affected by an exhaust plume of significant vertical velocity (i.e. a plume rise). A light aircraft in approach configuration is more likely to be affected by a plume rise than a heavy aircraft cruising at altitude. In addition, helicopters and light recreational aircraft may be severely affected by a high temperature plume and the altered air mixture above an exhaust plume and should therefore avoid low flight over such facilities.

6.3 Part 139.370 of CASR 1998 provides that CASA may determine that a gaseous efflux having a velocity in excess of 4.3 m/s is or will be a hazard to aircraft operations because of the velocity or location of the efflux.

6.4 The *Manual of Aviation Meteorology (2003)* defines severe turbulence as commencing at a vertical wind gust velocity in excess of 10.6 m/s; which may cause a momentary loss of control.

7. KEY STAGES OF THE PLUME RISE ASSESSMENT PROCESS

7.1 The key stages of the plume rise assessment process are:

- completion of Form 1247 by the proponent;
- assessment of the critical plume velocity (CPV);
- assessment of the critical plume height (CPH);
- assessment of the impact of the plume; and
- implementation of mitigation.

7.2 More detail on the process is provided at Appendix A to this AC.

8. ASSESSMENT OF CRITICAL PLUME VELOCITY (CPV)

8.1 The CPV under scrutiny (4.3 m/s or 10.6 m/s) will be determined based on the type of operations at the location and any associated risks identified by CASA. Considerations may include the following:

- phase of flight affected;
- size of aircraft affected;
- geographical factors such as high terrain;
- frequently used flight paths;
- navigation method in use (visual versus instrument);
- presence of Air Traffic Control;
- human factors considerations; and
- proximity to a regulated aerodrome.

9. ASSESSMENT OF CRITICAL PLUME HEIGHT (CPH)

9.1 CASA will determine the CPH for the CPV under scrutiny using the Screening Tool.

9.2 A plume rise not exceeding a velocity of 4.3 m/s at exit does not require assessment by CASA. However, augmentation of an existing facility producing a plume rise may require CASA assessment. If in doubt, a completed Form 1247 should be forwarded to CASA for screening assessment.

9.3 To guide in the planning process preliminary screening of locations under consideration can be undertaken. To discuss this option contact CASA OAR (email: oar@casa.gov.au). Alternative methods of assessment may also be put forward for consideration by CASA.

10. ASSESSMENT OF THE IMPACT OF THE PLUME RISE PROPOSAL

10.1 The impact of the plume rise proposal is assessed using the CPH at the location.

10.2 Near aerodromes the plume rise may penetrate the obstacle limitation surface (OLS) and may therefore be referred to a CASA Aerodrome Inspector (AD INSP)/Aerodrome Operator (AD OPR) to check this impact and any requirements for obstacle lighting or markings.

10.3 In the vicinity of aerodromes the plume rise may impact Terminal Instrument Flight Procedures (TIFPs). If so, CASA may determine that it is a hazard under Regulation 139.370 of the CASR 1998. If the proposal cannot be altered to avoid this impact, changes to TIFPs may be required. Government planning authorities will be advised to include these requirements in the development approval. Should the impact of the plume rise be significant, such that it would be difficult to achieve re-design of TIFPs without compromising the safety and/or environmental impact of the resulting design, CASA may not support the proposal.

10.4 Away from aerodromes, if the plume rise affects air routes and Lowest Safe Altitudes (LSALTs), this may require the CASR Part 173 authority (Airservices Australia) to make changes to these which may have cost implications for proponents.

10.5 When necessary, CASA will refer proposals to other relevant authorities including: the Department of Defence, Airservices Australia, GE Aviation (Naverus), Jeppesen and the Department of Infrastructure and Transport.

10.6 In some circumstances, the impact of the plume rise may be difficult to determine using the OAR Screening Tool. In such cases, CASA may request a detailed plume rise assessment be conducted which may have cost implications for proponents. Proponents should refer to the technical brief for further information (refer to paragraph 12 of this AC).

11. MITIGATION OF THE IMPACT OF THE PLUME RISE PROPOSAL

11.1 Mitigation options for a plume rise exceeding the relevant CPV may include the following:

- insertion of a symbol and a height on aviation charts to enhance awareness of the plume rise;
- designation of a Danger Area in accordance with Regulation 6 of the Airspace Regulations 2007 to alert pilots to the potential danger to aircraft flying over the area; and
- designation of a Restricted Area in accordance with Regulation 6 of the Airspace Regulations 2007 to restrict the flight of aircraft over the area.

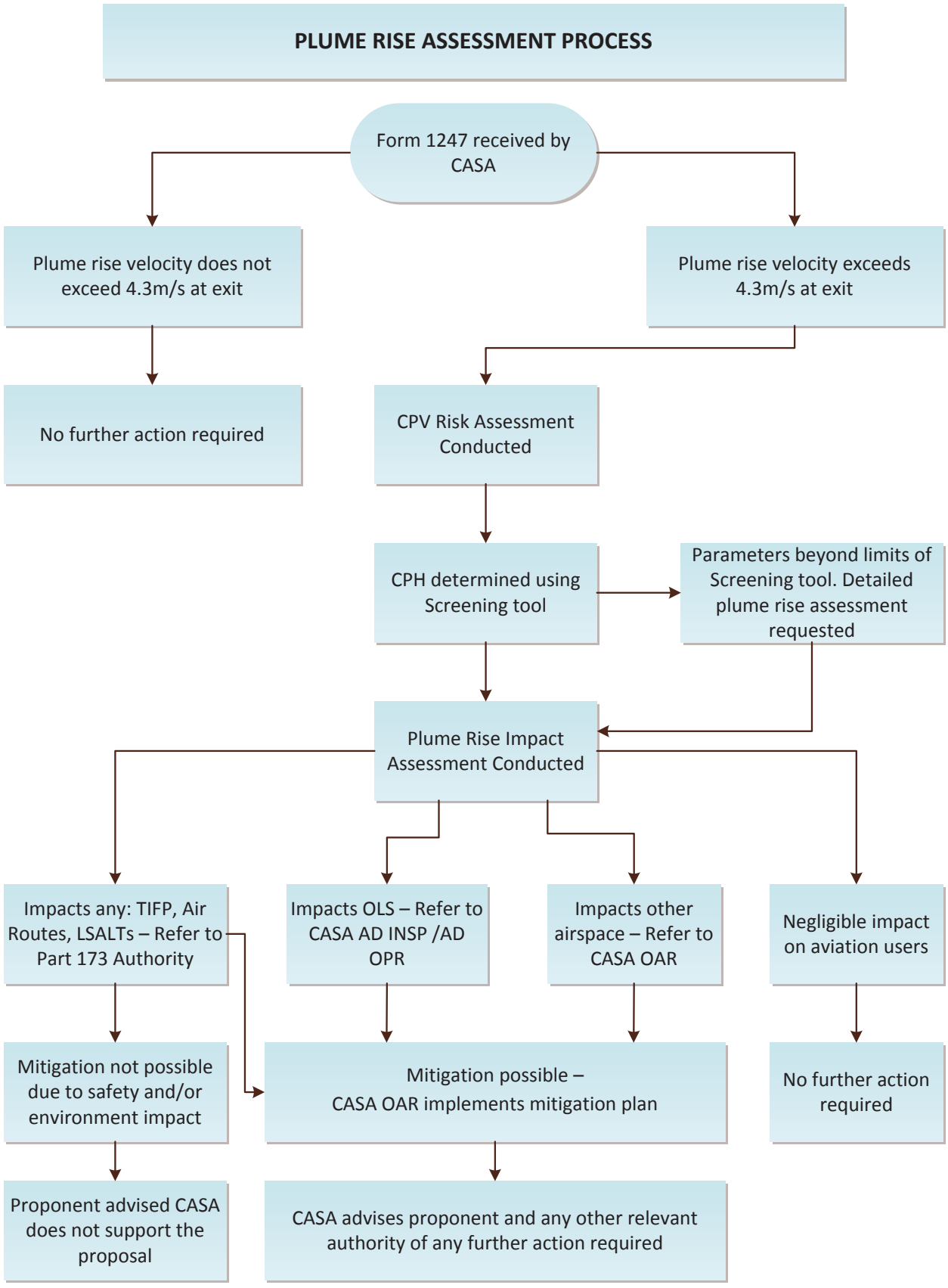
12. FURTHER INFORMATION

12.1 A technical brief regarding the application of plume rise models for the purpose of detailed plume rise assessments is available on request from CASA OAR.

Executive Manager
Standards Division

November 2012

APPENDIX A


PLUME RISE ASSESSMENT PROCESS
Form 1247 received by CASA
Plume rise velocity does not exceed 4.3m/s at exit
Plume rise velocity exceeds 4.3m/s at exit
No further action required
CPV Risk Assessment Conducted
CPH determined using Screening tool
Parameters beyond limits of Screening tool. Detailed plume rise assessment requested
Plume Rise Impact Assessment Conducted
Impacts any: TIFP, Air Routes, LSALTs – Refer to Part 173 Authority
Impacts OLS – Refer to CASA AD INSP /AD OPR
Impacts other airspace – Refer to CASA OAR
Negligible impact on aviation users
Mitigation not possible due to safety and/or environment impact
Mitigation possible – CASA OAR implements mitigation plan
No further action required
Proponent advised CASA does not support the proposal
CASA advises proponent and any other relevant authority of any further action required

Australian Government
Civil Aviation Safety Authority

Application for Operational Assessment of a Proposed Plume Rise

Proponent Details

Contact Name	
Company Name	
Address	
Phone (BH)	
Email Address	
Date Submitted	
File Reference: (CASA use only)	

Details of the Proposed Facility and Prior Consultation

1. Type of facility	
2. Location of the nearest town (direction and distance)	
3. Location of the facility in latitude and longitude (degrees, minutes, seconds)	
4. Proximity to any other existing or planned facility that generates a plume rise (if known)	
5. Distance to the nearest aerodrome or landing area incl. helicopter landing sites	
6. Height of the stack or tallest structure at the site above ground level (AGL)	
7. Elevation of the location of the facility above mean sea level (AMSL)	
8. Date the facility will commence operation	
9 A. For single stacks: ▪ Stack exit velocity (metres per second) ▪ Stack exit temperature (degrees Celsius) ▪ Stack radius (metres) ▪ Stack height (metres above ground level)	

9 B. For multiple stacks please give median, mean and range for each parameter: ▪ Stack separation distance (metres) ▪ Stack exit velocity (metres per second) ▪ Stack exit temperature (degrees Celsius) ▪ Stack radius (metres) ▪ Stack height (metres above ground level)	
9 C. For facilities with multiple configurations please give the parameters for the worst case scenario: ▪ Stack separation distance (metres) ▪ Stack exit velocity (metres per second) ▪ Stack exit temperature (degrees Celsius) ▪ Stack radius (metres) ▪ Stack height (metres above ground level)	
9 D. For facilities with multiple configurations please give the parameters for the normal operating scenario: ▪ Stack separation distance (metres) ▪ Stack exit velocity (metres per second) ▪ Stack exit temperature (degrees Celsius) ▪ Stack radius (metres) ▪ Stack height (metres above ground level)	
10. Details of any prior consultation with: ▪ CASA ▪ Dept of Defence ▪ Aerodrome Operator ▪ Other relevant party	

Submitted By:

Name:		Signature:	
Contact Phone:			
Email Address:		Date:	