REVISED AERONAUTICAL IMPACT ASSESSMENT V4.0

PROPOSED BUILDING DEVELOPMENT

42-60 RAILWAY PARADE, BURWOOD NSW

CLIENT – HOLDMARK NSW PTY LTD

J0440

27 October 2016

A.C.N. 053 868 778

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V2.0	Final Report	15 March 2016	BWS	BR
V3.0	Revised Final Report – new building heights	16 September 2016	BR	BWS
V4.0	Revised Final Report – increased building heights	27 October 2016	BR	BWS

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1. INTRODUCTION

In March 2015, the Ambidji Group Pty Ltd prepared an Aeronautical Impact Assessment (AIA) for Holdmark NSW Pty Ltd for the proposed development of a number of buildings at 42-60 Railway Parade, Burwood, NSW. This AIA was subsequently submitted to Sydney Airport Corporation Limited (SACL) for consideration by SACL and other aviation organisations including the Civil Aviation Safety Authority (CASA) and Airservices Australia (AsA). In February 2016, a revised AIA was submitted.

In the submissions, approval was requested for the penetration of Prescribed Airspace for Sydney and Bankstown Airports by buildings and construction cranes. In each penetration case, safety and regularity of operations were addressed.

In December 2015, January 2016 and June 2016, responses from CASA and AsA were received via SACL, (refer Appendix A) stating that the penetrations of the Prescribed Airspaces were not approved or supported. The mitigations offered in the AIA's were apparently not considered.

As a result, this revised AIA has been prepared to address the CASA and AsA responses. Specific changes to the previous submissions include:

- Reduction in the building height to minimise penetration of the RTCC, Sydney OHS and to avoid a permanent penetration of the Bankstown OHS, and to avoid any penetration of PANS-OPS surfaces.

- Reduction in the crane height to minimise penetration of the RTCC surface.

A meeting will be requested with SACL, CASA and AsA to discuss this revised AIA and for the approval of the building construction which will not impact on safety and the regularity of airspace and airport operations.

2. SUMMARY OF THE REVISED AIA

This revised aeronautical assessment was conducted to consider the impacts of the proposed revised building development at 42-60 Railway Parade, Burwood NSW.

In the AIA, temporary penetration by the crane means a period of up to up to 3 months.

With regard to Prescribed Airspace, this revised AIA concludes that:

- The proposed development to a building height of 163.5 m AHD and crane height of 181.5 m AHD will infringe the Sydney Outer Horizontal Surface (OHS) of 156 m AHD by 7.5 m, and the crane will temporarily penetrate this surface by 25.5 m;
- The Bankstown OHS of 160 m AHD will be penetrated by 3.5 m, and temporarily penetrated by cranes by 21.5 m;
- The lowest PANS-OPS surfaces at Sydney of 184.7 m AHD and at Bankstown will not be penetrated by the building and crane;
- The Radar Terrain Clearance Chart (RTCC) surface of 152 m AHD will be penetrated permanently by the building by 11.5 m, and temporarily by the crane by 30 m.

A safety study has shown that the penetration of the OHS will not impact on safety or the regularity of operations at Sydney and Bankstown Airports.

The permanent penetration of the RTCC surface by the building and temporary penetration by the crane will result in a permanent increase in the RTCC vectoring altitude from 1500 ft to 1600 ft within 3 nm of the building site.

Some vectoring altitudes within 3 nm of the building site to the north are already at or above 1600 ft and 1700 ft. It is not expected that the permanent and temporary increases in the RTCC vectoring altitudes will have a significant impact on ATC traffic handling.

The increases in the RTCC vectoring altitude to 1600 ft will result in a permanent increase in the Final Approach Fix (FAF) altitude for the Bankstown NDB-A approach from not below 1500 ft to not below 1600 ft. This increase in the FAF altitudes will not impact on the safety and regularity of aircraft operations using the NDB-A approach.

RTCC CHANGES - SAFETY IMPACT:

As the standard MOC of 1000 ft has been applied to the building and crane heights, there will be no impact on safety.

The Bankstown NDB-A approach can still be conducted within the maximum descent gradients specified in the ICAO PANS-OPS document.

RTCC CHANGES - IMPACT ON REGULARITY OF OPERATIONS:

It is considered that there will be minimal impact on traffic handling for Sydney and Bankstown Airports. Traffic handling can be simulated if further analysis is required.

The developer may be charged for any expenses involved in the processing of any changes to published AIP documents, ATC procedures and changes to controller displays.

The Prescribed Airspaces of Camden Airport and the RAAF Base at Richmond and the Western Sydney Airport will not be impacted.

The building will penetrate the clearance plane of the Sydney Terminal Area Radar (TAR) by 35 m. Airservices Australia may require an engineering examination to determine if this penetration will have an adverse impact on the performance of this radar. However alternative surveillance of the airspace in the vicinity of the site can be provided by the Cecil Park TAR, and for suitably equipped aircraft by the Sydney Terminal airspace WAM system and by ADS-B surveillance.

The performance of the navigation aids and communication facilities in the Sydney region will not be impacted.

The standard helicopter routes in the vicinity of the development site will not be impacted.

At the time of the preparation of this report, the developer has not advised if there will be a plume rise from the building roofs exceeding 4.3 m/s. If the rise exceeds 4.3 m/s, a plume rise assessment will be required to be conducted by CASA.

CONCLUSION

In summary, based on the provisions of the Airports (Protection of Airspace) Regulations 1996, there appears to be no impediment to the Department of Infrastructure and Regional Development approving the development of the site as revised, subject to approval for permanent or temporary penetrations of the Sydney and Bankstown Airport OHS and RTCC surfaces. Consideration of the application by DIRD, Sydney Airport Corporation Ltd., the Civil Aviation Safety Authority and Airservices Australia would be required.

3. INTRODUCTION TO THE REVISED AIA

The Ambidji Group Pty Ltd has been tasked by Holdmark NSW Pty Ltd to prepare a revised Aeronautical Impact Assessment for the proposed development of a number of buildings at 42-60 Railway Parade, Burwood, NSW. The proposed maximum building height for the tallest building is 163.5 m AHD.

Construction cranes will be a maximum height of 18 m above the maximum building height, resulting in a crane height of 181.5 m AHD during the construction period.

The site layout is shown at Appendix B, and a glossary of Aeronautical Terms and Abbreviations is shown at Appendix C.

The development site is located 10.2 km from the Sydney Airport Aerodrome Reference Point (ARP), and 11.65 km from the Bankstown Airport ARP. Figure 3.1 shows the location of the development site in relation to Sydney and Bankstown Airports.

Figure 3.1 - Location of the development site in relation to Sydney and Bankstown Airports.

This report will form the basis of the technical component of a revised application to the Department of Infrastructure and Regional Development, via Sydney Airport Corporation Limited (SACL) seeking approval of the proposed development under the APARs. In accordance with the APARs, SACL is responsible for co-ordinating the inputs from other aviation agencies, including CASA and Airservices Australia.

Subsequent to any approval granted for the development plan as proposed, an additional and related approval will need to be sought by the developer for cranes (temporary obstructions) required during the construction period.

4. METHODOLOGY

This report considers the existing facilities and procedures at Sydney International Airport, Bankstown Airport, Camden Airport, the proposed Western Sydney Airport and RAAF Base Richmond, each of which has or will have PANS OPS surfaces or OLS which may exist above or near the proposed development site. Published helicopter routes are also examined.

This aeronautical study was undertaken as follows:

- Obstacle Limitation Surface infringements were accurately determined based on the siting information and airport layouts as detailed in Australian Aeronautical Information Publications (AIP) and publicly available Airport Master Plans and Prescribed Airspace charts;
- the relevant publicly available instrument approach and departure procedures were examined in detail to determine whether the development would impose any restriction on those procedures. Any restriction on the instrument procedures would have to be examined by Airservices Australia to assess the impact to these procedures and associated safety regulation standards at Sydney, Bankstown and Camden Airports and civilian procedures published in AIP for RAAF Base Richmond.
- existing flight paths along with likely future flight paths for Sydney airport were examined in relation to the proposed development to determine if there would be any impact on future procedures;
- Civil Aviation Orders specify the minimum requirements for clearance of obstacles by an aircraft that has suffered a failure of a critical engine during take-off. The contingency procedures analyse the minimum safe altitudes (and therefore relate to maximum allowable obstacle heights) required in such a circumstance. These procedures are developed by airline operators in accordance with CASA requirements to cover the situation of one engine inoperative (OEI) condition. As they are proprietary procedures, evaluation of the potential impact would be undertaken during consideration of the proposed development by Sydney airport and airline operators;
- published helicopter routes were examined;
- an assessment was undertaken of potential impacts on navigational aids, air traffic control communications and radar coverage;
- the requirement for a plume rise assessment by CASA was examined; and
- a concise summary was made of findings and conclusion as to whether there are any impediments to the likelihood of the proposal gaining approval.

5. ANALYSIS OF OBSTACLE LIMITATION SURFACES (OLS)

The object of the OLS is to define a volume of airspace in proximity to the airport which should be kept free of obstacles that may endanger aircraft in visual operations, or during the visual stages of an instrument approach. The intention is not to restrict or prohibit all obstacles, but to ensure that either existing or potential obstacles are examined for their impact on aircraft operations, and that their presence is properly taken into account.

Since they are relevant to visual operations, it may sometimes be sufficient to ensure that the obstacle is conspicuous to pilots, and this may require that they be marked or lit.

Analysis of the proposed development in relation to the OLS has been undertaken with reference to APARs and CASA Manual of Standards (MOS) Part 139.

5.1 SYDNEY AIRPORT OLS

The development site is located in the area of the OLS Outer Horizontal Surface (OHS) published for Sydney Airport as shown in Figure 5.1 below. The height of this surface at the development site is 156 m AHD.

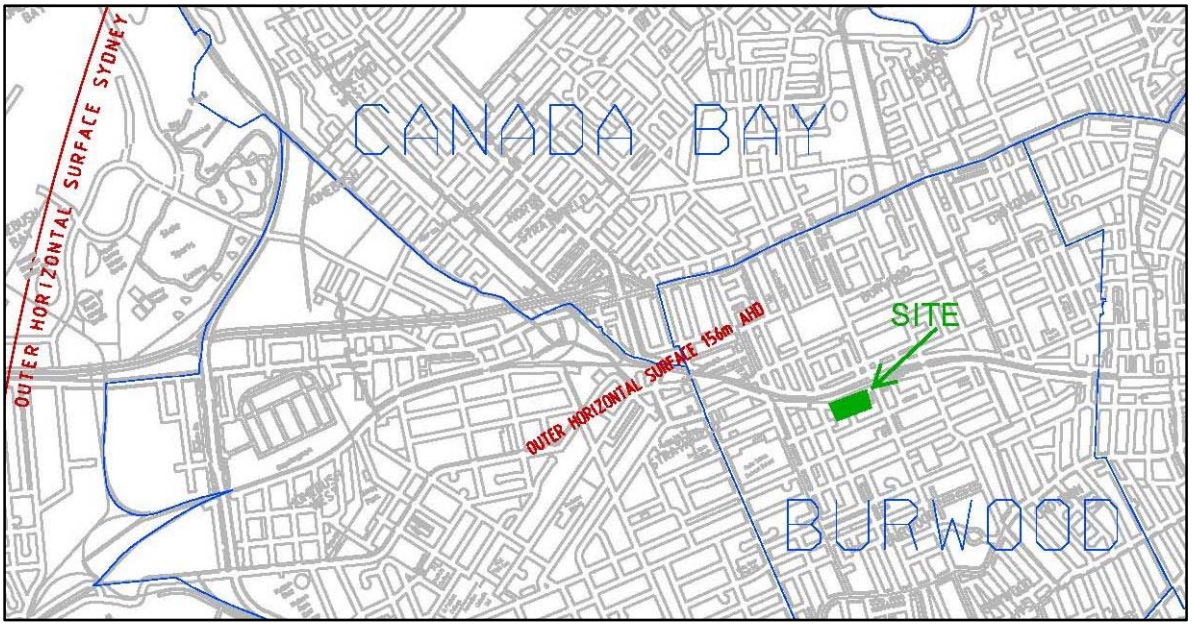


Figure 5.1 Sydney Airport - Obstacle Limitation Surfaces (Source: Sydney Airport OLS Chart 20 MAR 2015)

The building height of 163.5 m AHD will penetrate the OHS by 7.5 m. During construction cranes to a height of 181.5 m AHD will penetrate the OHS by 25.5 m.

These penetrations will require approval. A safety case for the penetration of the Sydney (and Bankstown) OHS is shown in Section 5.3.

5.2 BANKSTOWN AIRPORT OLS

The development site is located in the area of the OLS Outer Horizontal Surface (OHS) published for Bankstown Airport as shown in Figure 5.2 below. The height of this surface at the development site is 160 m AHD.

The location of an existing mast at 225 m AHD that penetrates the OHS is also shown in Figure 5.2.

The building height of 163.5 m AHD will penetrate the OHS by 3.5 m, and construction cranes to a height of 181.5 m AHD will penetrate the OHS by 21.5 m.

CASA MOS Part 139 Section 7 Para 7.1.3.2 contains a list of the OLS surfaces that are required to be published for aerodromes such as Bankstown which have non precision instrument runways. The OHS is not included in this list. An OHS is only required for aerodromes that have precision instrument runways (Para 7.1.3.3).

There is a long term proposal in the Bankstown Airport Master Plan to install Precision Approach ILS for RWYs 11C and 29C at Bankstown, and in that case an OHS would be required in accordance with the CASA MOS.

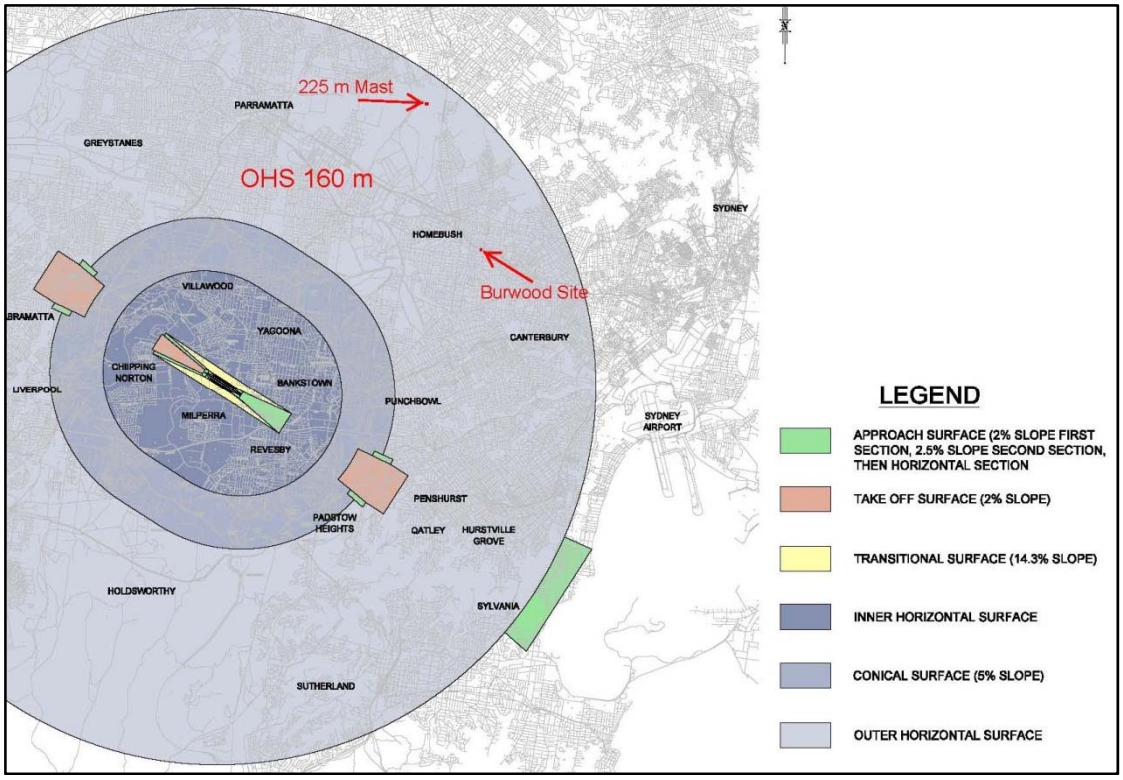


Figure 5.2: Bankstown Airport - Obstacle Limitation Surfaces (Chart Source: Bankstown Airport Master Plan 2014)

5.3 PENETRATIONS OF THE SYDNEY AND BANKSTOWN OHS

ICAO Annex 14 Aerodromes Chapter 4 Obstacle Restriction and Removal does not require an OHS to be provided, but refers to the Airport Services Manual Doc 9137 Chapter 6 for guidance.

CASA has decided to require an OHS to be provided for aerodromes that have precision approach runways. Sydney Airport does have precision approach runways, and Bankstown may have in the future.

The Airport Services Manual Chapter 6 provides the following guidance regarding the provision of an OHS:

1.2.2 *Outer horizontal surface*

1.2.2.1 In the experience of some States, significant operational problems can arise from the erection of tall structures in the vicinity of airports beyond the areas currently recognized in Annex 14 as areas in which restriction of new construction may be necessary. The operational implications fall broadly under the headings of safety and efficiency.

1.2.2.2 *Safety implications.* It is particularly desirable to review carefully any proposal to erect high masts or other skeletal structures in areas which would otherwise be suitable for use by aircraft on wide visual circuits, on arrival routes towards the airport or circuit, or on departure or missed approach climb-paths. Avoidance by marking or lighting cannot be relied upon in view of the relatively inconspicuous character of these structures, especially in conditions of reduced visibility, and notification of their existence will similarly not always guarantee avoidance.

1.2.2.4 In view of these potentially important operational considerations, authorities may consider it desirable to adopt measures to ensure that they have advance notice of any proposals to erect tall structures. This will enable them to study the aeronautical implications and take such action as may be at their disposal to protect aviation interests. In assessing the operational effect of proposed new construction, tall structures would not be of immediate significance if they are proposed to be located in:

a) an area already substantially obstructed by terrain or existing structures of equivalent height; and
b) an area which would be safely avoided by prescribed procedures associated with navigational guidance when appropriate.

As can be seen in Para 1.2.2.2 above, the concern is in relation to the erection of *"high masts or other skeletal structures".* The development at Burwood involves substantial high rise buildings and not masts. The risk to safety is much reduced compared with the difficulty in sighting a high mast.

In Para 1.2.2.4 b), it is stated that *"tall structures would not be of immediate significance if they are proposed to be located in … an area which would be safely avoided by prescribed procedures associated with navigational guidance when appropriate".*

As can be seen in Section 6 below "Analysis of PANS-OPS Surfaces", these surfaces for the prescribed procedures for instrument approaches and departures for Sydney and Bankstown

airports are not penetrated by the proposed buildings, and therefore these are *"not of immediate significance"*.

It should be noted that many buildings and roof top masts and towers in the Sydney CBD area penetrate the OHS and procedures ensure that safety is maintained. A 225 m AHD radio mast at Wentworth Point (shown in Figure 5.2) penetrates the Bankstown OHS.

So although the OHS is penetrated, it is considered that there is no effect on safety as existing procedures will ensure that the building is *"located in an area which would be safely avoided by prescribed procedures associated with navigational guidance"*.

5.4 CAMDEN AIRPORT OLS

The OLS for Camden Airport extends to approximately 4.5km from the ARP at Camden Airport. As the development site is approximately 42 km from Camden Airport, the Camden OLS is not located over the proposed development site.

5.5 RAAF BASE RICHMOND OLS

The OLS for RAAF Base Richmond extends to approximately 15 km from the ARP at RAAF Base Richmond. As the development site is approximately 43 km from RAAF Base Richmond, the RAAF Base Richmond OLS is not located over the proposed development site.

5.6 WESTERN SYDNEY AIRPORT OLS

This airport is not yet constructed; however planning is well advanced including the layout of runways, which are proposed to be aligned north east/south west. This proposed airport is 35.4 km to the west of the development site.

The indicative OLS is published in Para 2.2.5 of the October 2015 Western Sydney Airport (WSA) Draft Plan and Figure 5.3 shows the indicative WSA OLS in relation to the site.

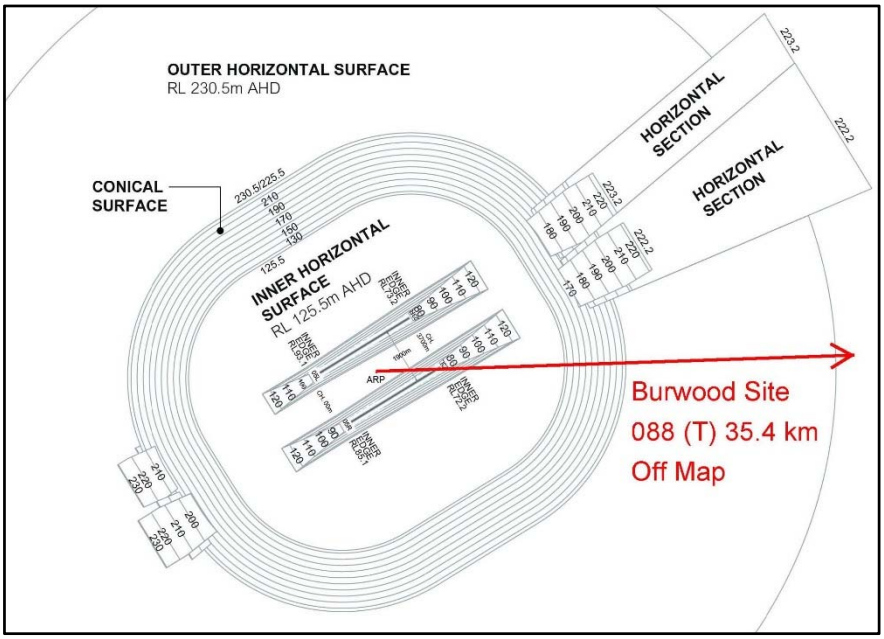


Figure 5.3 Western Sydney Airport OLS

The Burwood site is expected to be well outside the OLS areas for this airport.

6. ANALYSIS OF PANS OPS SURFACES

This analysis considers the PANS OPS surfaces for Sydney, Bankstown and Camden Airports, RAAF Base Richmond and the Western Sydney Airport.

PANS OPS surfaces detail essential areas and obstacle clearance requirements for the achievement of safe, regular instrument flight operations. The instrument flight procedures enable pilots to either descend from the high en-route environment of cruise type flight to establish visual contact with the landing runway, or climb from the runway after take-off to the en-route environment, with a prescribed safe margin above terrain and obstacles, by use of aircraft instruments and radio navigation aids or GPS in conditions where the pilot cannot maintain visual contact with the terrain and obstacles due to inclement weather conditions.

There are numerous PANS-OPS surfaces at Sydney and other airports within the Sydney Basin.

The PANS-OPS surfaces are published in the Sydney and Bankstown Airport Master Plans and Prescribed Airspace Charts. The Instrument Flight Procedures published in the AIP DAP amendment 147 dated 10 November 2016 and CASA MOS Part 173 Standards Applicable to Instrument Flight Procedures Design and ICAO Doc 8168 PANS-OPS have been used for reference.

Note 1: In the AIP all distances are shown in Nautical Miles (nm) and Altitudes in feet (ft) for instrument flight procedures. Displays to pilots are in the same format.

Note 2: The aircraft category (CAT) depends on a number of aircraft performance parameters, and is published in the PANS-OPS document.

6.1 SYDNEY AIRPORT ANALYSIS OF PANS OPS SURFACES

An extract from the Sydney Airport chart for PANS-OPS surfaces (dated 20 March 2015) and also showing the development site is shown in Figure 6.1. This figure shows that the lowest PANS-OPS at the site is 184.7 m AHD. Obstacles such as buildings and cranes are normally not permitted above this surface.

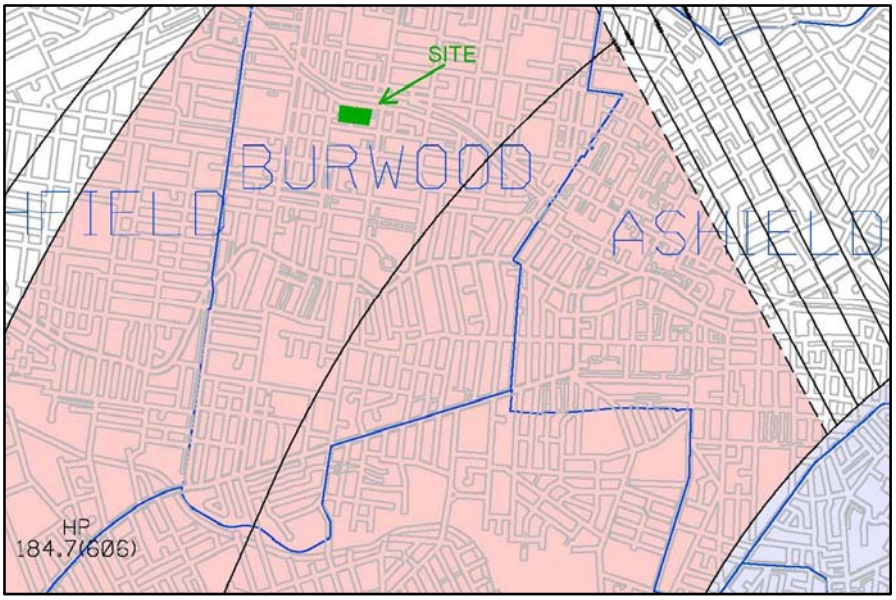


Figure 6.1 Extract from Sydney Airport PANS-OPS Chart dated 20 March 2015

The PANS-OPS surface height of 184.7 m AHD will not be penetrated by the building height of 163.5 m AHD and crane height of 181.5 m AHD.

6.2 BANKSTOWN AIRPORT ANALYSIS OF PANS-OPS SURFACES

The PANS-OPS surfaces and the development site are shown in Figure 6.2. The site is outside the PANS-OPS surfaces (including those proposed for ILS approaches) and therefore will not impact on the Bankstown PANS-OPS.

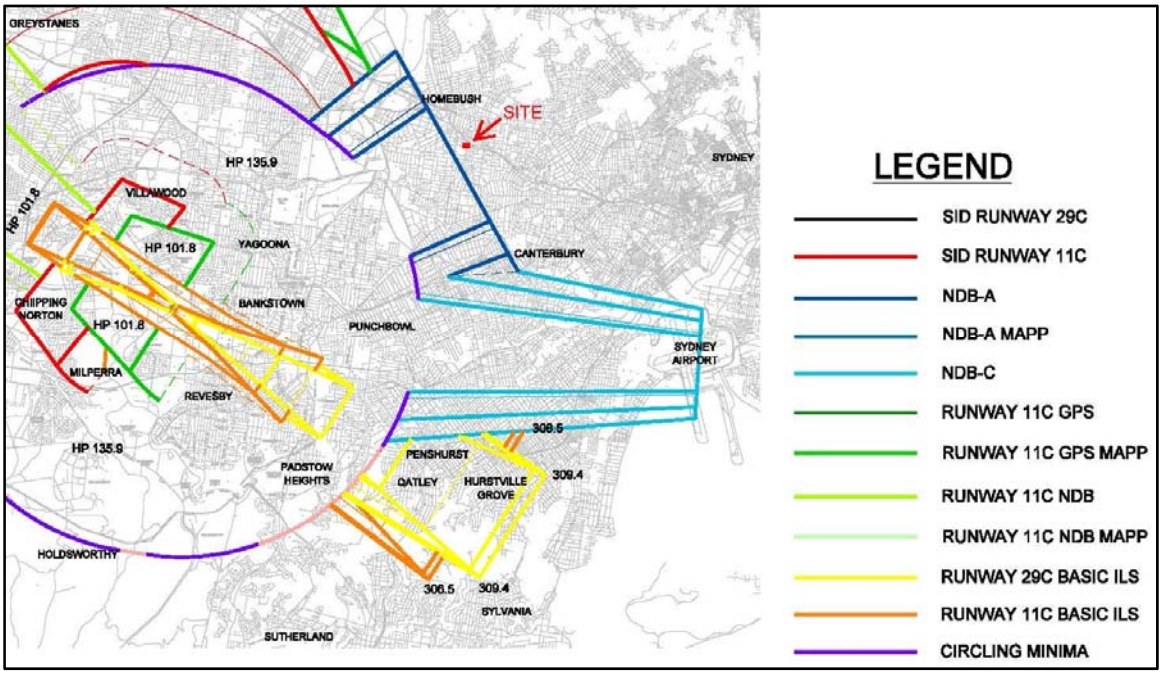


Figure 6.2 Bankstown PANS-OPS Surfaces (Chart from Bankstown Airport Masterplan)

6.3 CAMDEN AND RICHMOND AIRPORTS PANS-OPS SURFACES

Camden and Richmond airports are both located at least 42 km from the Burwood Site. At this distance the site is well clear of the PANS-OPS surfaces at these airports.

6.4 WESTERN SYDNEY AIRPORT PANS-OPS SURFACES

The PANS-OPS surfaces for this proposed airport have not yet been published, however as the airport is located 35.4 km west of the Burwood site the PANS-OPS surfaces are not expected to be impacted by the development.

7. ANALYSIS OF THE RADAR TERRAIN CLEARANCE CHART (RTCC) SURFACES

RTCC surfaces are used by Sydney Air Traffic Controllers for altitude assignment in the Sydney Airspace when radar vectoring aircraft. Although the surfaces are published in metres AHD by SACL, for operational use the surfaces plus a 1000 ft Minimum Obstacle Clearance (MOC) are displayed at ATC workstations.

All height references for ATC and pilots are in feet AMSL (AHD), and distances are in Nautical Miles (NM), and these terms will be used in this section of the report.

The RTCC surfaces are an amalgamation of circles of 3 nm radius round significant obstacles. The surfaces in ft (blue text) and minimum assignable altitudes in ft (black text) as displayed to controllers, plus a 3 NM radius (magenta) round the Burwood site are shown in Figure 7.1.

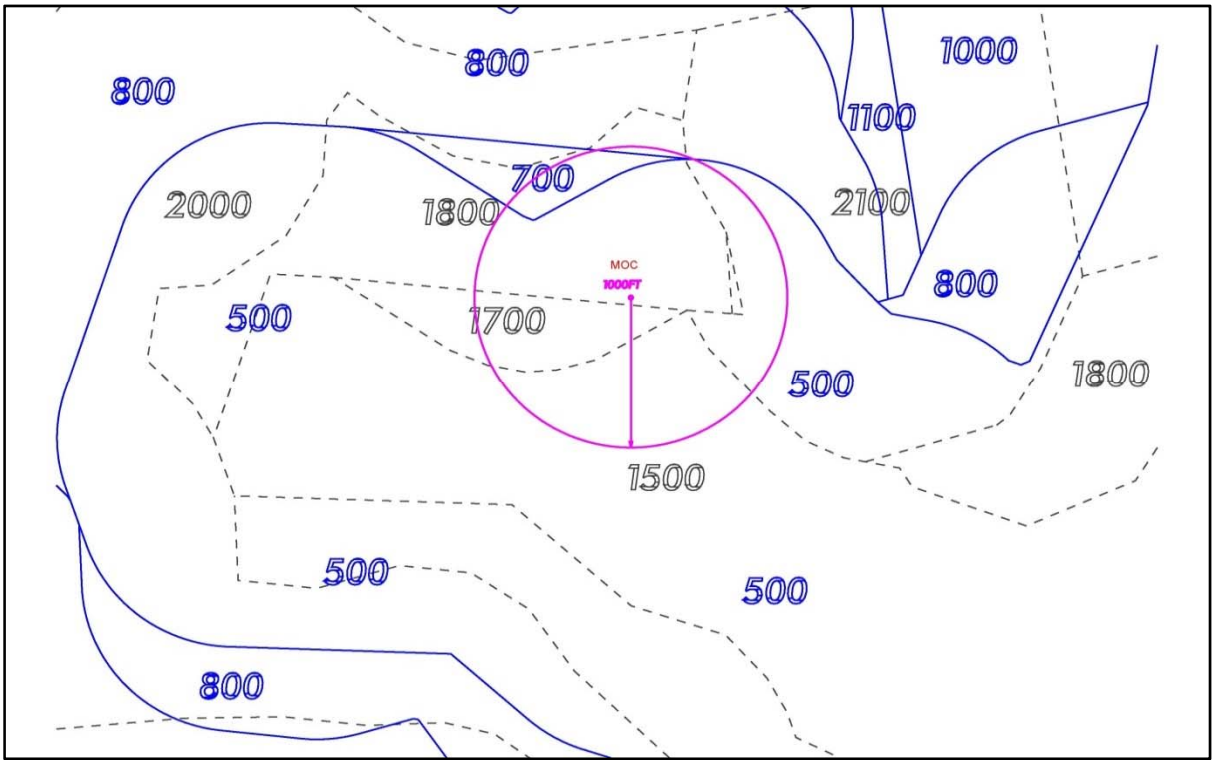


Figure 7.1 RTCC surfaces and the Burwood Site. Source AsA

As can be seen from Figure 7.1, a 3 NM radius of the development site extends into an RTCC area where the assignable altitude (in black) is 1500 ft. If the proposed heights for the building and crane are approved, this assignable altitude will have to be permanently increased to 1600 ft, as follows:

- Building height 163.5 m = 537 ft + MOC of 1000 ft = 1537 ft rounded up to 1600 ft.
- Crane height 181.5 m = 596ft + MOC of 1000 ft = 1596 ft rounded up to 1600 ft.

Some of the RTCC assignable altitudes within a 3 NM radius of the site are already equal to or exceed 1600 ft. Only the areas where the present assignable altitude is 1500 ft will be impacted.

Although increases in the assignable altitude will have an impact on traffic handling by ATC, it is considered that this will not be significant for Sydney traffic. Statistics on radar vectoring are not maintained by Sydney ATC, however an examination of typical vectoring procedures in which aircraft may fly within 3 nm of the Burwood site shows that:

Vectoring for right downwind for RWY 16R and 16L approaches:

- The lowest Initial fix altitudes are 3000 ft for RWY 16R and 4000 ft for RWY 16L, so descent below these altitudes is not possible;
- After overflying the Burwood area, aircraft will enter RTCC areas where the minimum vectoring altitude is 1700 ft or above.

Vectoring for left downwind for RWY 34L and RWY 34R approaches:

- The lowest Initial fix altitudes are 3000 ft for RWY 34R and 4000 ft for RWY 34L, so descent below these altitudes is not possible;

Vectoring for left downwind for RWY 07 approaches:

- The lowest Initial fix altitude is 3000 ft for these approaches, so descent below this altitude is not possible;

Considering the above, there will be little impact on the vectoring of Sydney airport traffic. If more data is required, a survey of controllers can be made to obtain a cross section of opinion, or traffic handling can be examined using ATC radar simulators and experienced Sydney controllers. The developer will meet the cost of this as required.

The developer may also have to meet the expenses incurred by AsA in redrawing the RTCC surfaces and software changes to ATC workstations at Sydney.

Whilst the increases in the RTCC altitudes are considered to be insignificant for Sydney Airport traffic, there will be an impact on Bankstown Airport traffic conducting the NDB-A approach to this airport. This is examined in Section 7.1 below.

7.1 EXAMINATION OF THE BANKSTOWN NDB-A APPROACH PROCEDURE

A copy of this approach procedure as published in the AsA AIP DAP is shown in Figure 7.2 below.

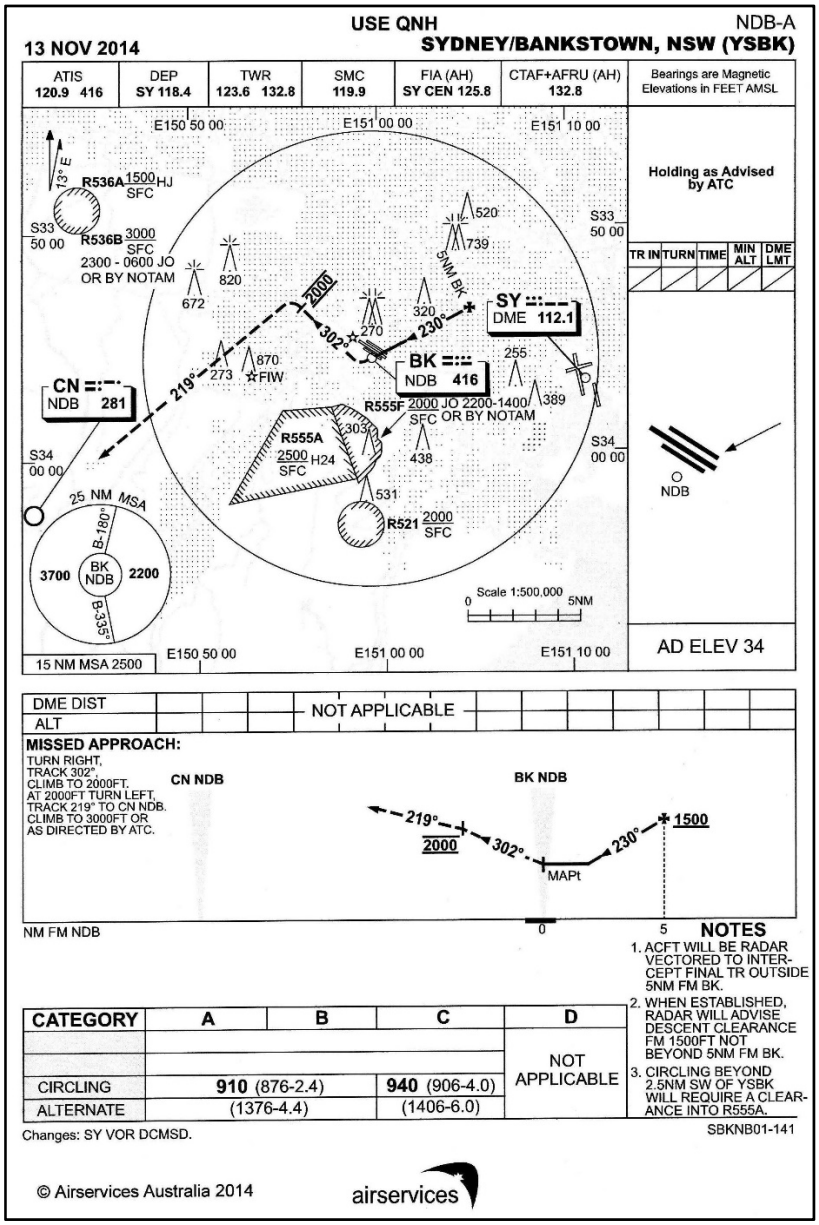


Figure 7.2 Bankstown NDB–A Approach Procedure. Source AsA AIP DAP

As can be seen in the NOTES panel in Figure 7.2, it states that “ACFT WILL BE RADAR VECTORED TO INTERCEPT FINAL TR OUTSIDE 5 NM FR BK”

The Final Approach Fix (FAF) **+** is shown at 5 NM BK, altitude **1500**. This means that the aircraft must be vectored at or above 1500 ft to intercept the final approach track of 230° (M) or 243° (T) before reaching 5 NM from BK. After passing 5 NM BK descent is made to the circling altitude of 910 ft (CAT A&B aircraft) or 940 ft (CAT C aircraft).

Note that aircraft categories are published in the ICAO PANS-OPS document, CASA MOS and the Australian AIP. The category depends on aircraft performance parameters.

The FAF is located where the current radar vectoring assignable altitude is 1500 ft. However if the building and crane heights are approved this altitude would need to be increased to 1600 ft.

Aircraft will still be able to commence descent from 1600 ft and conduct the approach complying with the criteria for the final approach gradient as specified in ICAO DOC 8168 PANS-OPS Part 1 Section 4 Chapter 5 para 5.3.1.

This specifies a maximum descent gradient of 6.5% for CAT A&B aircraft, and 6.1% for CAT C aircraft. The horizontal distance of 4.56 nm (27725 ft) for calculation of these gradients is measured from the FAF (5 NM BK) to the first useable portion of the landing area which is the threshold of RWY 29R at Bankstown. The vertical distance is the difference between the FAF altitude and the circling altitude.

Table 7.1 below shows the current descent gradient and that are applicable for the increased FAF altitude of 1600 ft.

	Circling Alt ft		Vertical Dist FAF to MDA ft		Horizontal Dist in ft FAF to NDB	**Gradient %**	
FAF ft	CAT A&B	CAT C	CAT A&B	CAT C		**CAT A&B**	**CAT C**
1500	910	940	590	560	27725	**2.1**	**2.0**
1600	910	940	690	660	27725	**2.5**	**2.4**

Table 7.1 Descent Gradients

The maximum descent gradients of 6.5% for CAT A&B aircraft and 6.1% for CAT C aircraft are not exceeded for FAF altitude of 1600 ft.

AsA may publish an amended procedure showing **1600** ft at the FAF. The developer may be charged for the AsA expenses incurred in these publications.

In discussions with Sydney ATC management the advice was that the Bankstown NDB A approach was used very infrequently. The airspace used for this approach results in the loss of two landing slots at Sydney, and pilots prefer to make the RWY 11C RNAV approach at Bankstown in poor weather conditions.

The increase in the RTCC assignable altitude and FAF altitude from 1500 ft to 1600 ft will not impact on the safety or regularity of the Bankstown NDB-A approach procedure.

7.2 SUMMARY OF THE IMPACT OF THE INCREASES IN RTCC ALTITUDES

SAFETY IMPACT:

As the standard MOC of 1000 ft has been applied to the building and crane heights, there will be no impact on safety.

The Bankstown NDB-A approach can still be conducted within the maximum descent gradients specified in the ICAO PANS-OPS document.

IMPACT ON REGULARITY OF OPERATIONS:

It is considered that there will be minimal impact on traffic handling for Sydney and Bankstown Airports. Traffic handling can be simulated if further analysis is required.

8. FUTURE AIRPORT DEVELOPMENTS

A study of the available Master Plans for the airports within the Sydney Basin has not revealed any plans to make changes to the OLS, airfield layouts, move navigation aids or significantly change flight procedures at those aerodromes.

Political pressures due to noise and aircraft safety in the area is also likely to limit the expansion of aircraft operations in the region.

The airline community is heading toward the use of Performance Based Navigation (PBN) systems which allow them to operate more accurately near airfields. This will allow them to avoid some noise sensitive areas, while maintaining existing probability based safety standards.

9. CONTINGENCY PROCEDURES – ENGINE INOPERATIVE FLIGHT PATHS

Contingency procedures are proprietary procedures developed by airline operators to cover the situation of a failure of a critical engine, called one engine inoperative (OEI) condition. As they are proprietary procedures, Ambidji is unable to assess any impact the proposed building development may have on contingency procedures.

The airline operators that use Sydney Airport would need to determine whether the existing contingency procedures need modification to allow for the additional height of the proposed development over that of the existing buildings in the area. This assessment would normally occur during consideration of the development application by Sydney Airport and the airline operators at the airport.

In the context of operations at Camden, the RAAF Base Richmond and the Western Sydney Airport, the proposed development is located too far away to have any consequence on contingency procedures at these aerodromes.

10. RADAR PERFORMANCE IMPACT

The Sydney Airport Terminal Area Radar (TAR), comprising of Primary Surveillance Radar (PSR) and Secondary Surveillance Radar (SSR) is located on the airport 10.76 km from the buildings site, at an antenna elevation of 34.5 m AHD

There is another TAR located at Cecil Park, 24.66 km from the buildings site, at an antenna elevation of 161.27 m AHD.

10.1 CLEARANCE REQUIREMENTS FOR RADARS

CASA Manual of Standards (MOS) Part 139 Aerodromes publishes the clearance requirements for radars. The section of the MOS that applies to the development site is:

> *11.1.14.4*
>
> *The following clearance requirements are to be maintained:*
>
> *(a) No intrusion within 1 km of the radar into a height surface 5 m below the bottom of the antenna. No intrusion between the radar and the possible location of any desired targets, i.e. roughly speaking above 0.5 degrees elevation at any distance.*

(b) No metallic or other electrical reflective surfaces anywhere which subtend an angle of more than 0.5 degrees when viewed from the radar, e.g. fences, power lines, tanks as well as many buildings. All overhead power lines within 1 km must be aligned radially from the radar or be located at least 10 degrees below horizontal from the antenna.

10.2 CLEARANCE REQUIREMENTS FOR THE SYDNEY TAR

The elevation of the Sydney TAR antenna is 34.5 m AHD, and the distance to the development site is 10776 m. The elevation of a 0.5° plane from the antenna at the site is:

10776 x Tan 0.5° = 94 m + TAR elevation of 34.5 m = 128.5 m AHD.

The building height of 163.5 m AHD will penetrate the 0.5° plane of the Sydney TAR by 35 m.

Airservices Australia may require an engineering analysis to be undertaken to determine what impact this penetration would have on the Sydney TAR. If this is done by Airservices the developer would be charged. Ambidji can also provide a qualified radar engineer to undertake this task under commercial arrangements with the developer.

However there are alternative airspace surveillance sensors that could be utilised to minimise any impact on the performance of the Sydney TAR. These are:

- The Cecil Park TAR provides similar radar coverage in the airspace to that of the Sydney TAR, and in fact is coverage backup for the latter radar.
- In addition to the radars, a Wide Area Multilateration (WAM) surveillance system is installed in the Sydney region, and this provides airspace surveillance for Mode S transponder equipped aircraft in the airspace in the vicinity of the development site. WAM is a distributed sensor system and is not subject to the same clearance requirements and building impact on performance as radars. As most aircraft operating in the Sydney controlled airspace are required to be equipped with Mode S transponders, the WAM system is another suitable coverage alternative to the Sydney TAR.
- Automatic Dependant Surveillance – Broadcast (ADS-B) surveillance is also provided for ADS-B equipped aircraft in the Sydney terminal airspace and this system is also another surveillance alternative to the Sydney TAR, but only for ADS-B equipped aircraft.

10.3 CLEARANCE REQUIREMENTS FOR THE CECIL PARK TAR

The elevation of the Cecil Park TAR antenna is 161.27 m AHD, and the distance to the buildings site is 24660 m. The elevation of a 0.5° plane from the antenna at the site is:

24660 x Tan 0.5° = 215.2 m + TAR elevation of 161.27 m = 376.47 m.

As the 0.5° plane from this radar is well above the building height, the clearance requirements for this radar will not be impacted.

10.4 CONCLUSIONS OF RADAR CLEARANCE REQUIREMENTS

The building height of 163.5 m AHD will penetrate the clearance requirement of the Sydney TAR by 35 m.

Airservices Australia may require an engineering analysis to be conducted to confirm if the penetration of the clearance requirement impacts on the performance of the Sydney TAR.

Even if there is an impact on the performance of the Sydney TAR, there are two other sensors (the Cecil Park TAR and the WAM surveillance system) which together can provide alternative primary and secondary surveillance coverage in the airspace in the vicinity of the buildings.

ADS-B surveillance is also an alternative to the Sydney TAR for ADS-B equipped aircraft.

11. POTENTIAL IMPACT ON AIRPORT NAVIGATION AIDS AND COMMUNICATION FACILITIES

SYDNEY AIRPORT

An extract from the SACL Navigation Aids Prescribed Airspace Chart for protection of Navigation Aids is shown in Figure 11.1. The Burwood site is 5.7 km from the nearest boundary of the Navigation Aids protected surface, and is off the edge of the chart.

The development at the Burwood site will not impact on the performance of the Navigation Aids at Sydney Airport.

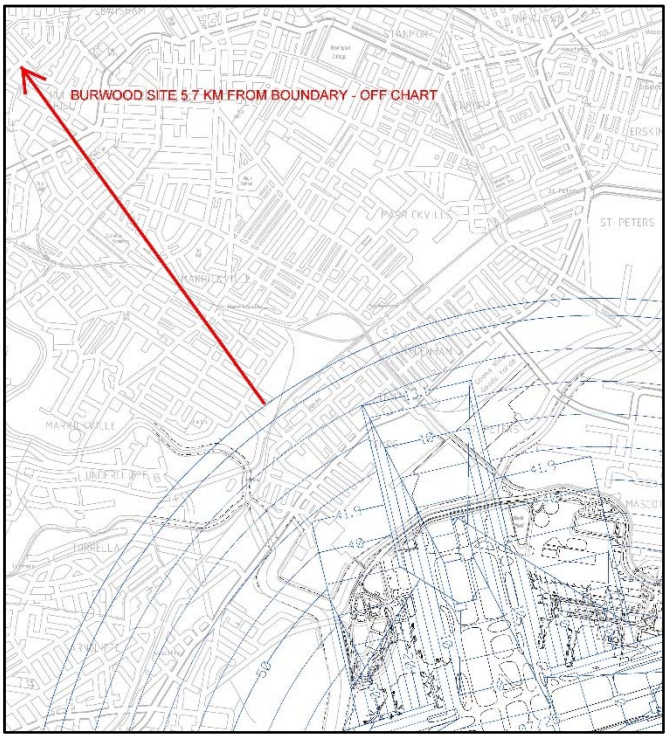


Figure 11.1 Extract from SACL Prescribed Airspace for Sydney Airport Navigation Aids

BANKSTOWN NDB

CASR Part 139 MOS stipulates a clearance area of 150m around NDB facilities.

As the development site is approximately 12 km from this NDB, the development is outside the requisite clearance zone for the Bankstown NDB.

ATC COMMUNICATION FACILITIES

Reliable VHF communications require a clear line of sight path between the base station and aircraft using the facilities.

The current configuration of the buildings surrounding Sydney and Bankstown Airports does not restrict the ATC communication facilities located on the Control Towers at Sydney and Bankstown Airports. The proposed building development is unlikely to impact upon ATC communication facilities in the area.

12. HELICOPTER ROUTES

Numerous coded clearances for helicopter operations at Sydney are published in the AIP ERSA document. The significant segments of the routes for clearances passing in the vicinity of the development site are:

ROSEHILL 4 INBOUND:

TR FM Rosehill Racecourse to Rookwood Cemetery then via the Cooks River and Canterbury Racecourse..... ALT 1,000 ft

ROSEHILL 4 OUTBOUND:

Reverse routeing to the inbound route at ALT 1,000FT.

This route passes approximately 2500 m to the South West of the development site.

The building development will not impact on the ROSEHILL 4 clearance route.

13. OBSTRUCTION LIGHTING OF BUILDINGS AND CRANES

The proposed building and crane heights will penetrate the OLS associated with Sydney Airport and cranes will penetrate the Bankstown Airport OLS, and CASA may require obstruction lighting to be installed.

14. DEPARTMENT OF DEFENCE REQUIREMENTS

The nearest Department of Defence airport with publicly available PANS OPS procedures is RAAF Base Richmond. Due to its distance from the proposed development (approximately 43 km) and ATC arrangements in the area, the proposed development is unlikely to impact on Defence operations.

The Australian Army has a helicopter base at the Holsworthy Army Barracks, approximately 24km south-west of the proposed development site. Holsworthy does not have any PANS OPS procedures available and operations there will not be affected by the proposed development.

15. PLUME RISE ASSESSMENT

At the time of the preparation of this report, the developer has not advised if there will be a plume rise exceeding 4.3 m/s. If the rise exceeds 4.3 m/s a plume rise assessment will be conducted by CASA. If the rise is less then no assessment will be required.

16. CONCLUSIONS

This revised aeronautical assessment was conducted to consider the impacts of the proposed building development at 42-60 Railway Parade, Burwood NSW.

In the AIA, temporary penetration by the crane means a period of up to up to 3 months.

With regard to Prescribed Airspace, the AIA concludes that:

- The proposed development to a building height of 163.5 m AHD and crane height of 181.5 m AHD will infringe the Sydney Outer Horizontal Surface (OHS) of 156 m AHD by 7.5 m, and the crane will temporarily penetrate this surface by 25.5 m;
- The Bankstown OHS of 160 m AHD will be penetrated by 3.5 m, and temporarily penetrated by cranes by 21.5 m;
- The lowest PANS-OPS surfaces at Sydney of 184.7 m AHD and at Bankstown will not be penetrated by the building and crane;
- The Radar Terrain Clearance Chart (RTCC) surface of 152 m AHD will be penetrated permanently by the building by 11.5 m, and temporarily by the crane by 30 m.

A safety study has shown that the penetration of the OHS will not impact on safety or the regularity of operations at Sydney and Bankstown Airports.

The permanent penetration of the RTCC surface by the building and temporary penetration by the crane will result in a permanent increase in the RTCC vectoring altitude from 1500 ft to 1600 ft within 3 nm of the building site.

Some vectoring altitudes within 3 nm of the building site to the north are already at or above 1600 ft and 1700 ft. It is not expected that the permanent and temporary increases in the RTCC vectoring altitudes will have a significant impact on ATC traffic handling.

The increases in the RTCC vectoring altitude to 1600 ft will result in a permanent increase in the Final Approach Fix (FAF) altitude for the Bankstown NDB-A approach from not below 1500 ft to not below 1600 ft. This increase in the FAF altitudes will not impact on the safety and regularity of aircraft operations using the NDB-A approach.

RTCC CHANGES - SAFETY IMPACT:

As the standard MOC of 1000 ft has been applied to the building and crane heights, there will be no impact on safety.

The Bankstown NDB-A approach can still be conducted within the maximum descent gradients specified in the ICAO PANS-OPS document.

RTCC CHANGES - IMPACT ON REGULARITY OF OPERATIONS:

It is considered that there will be minimal impact on traffic handling for Sydney and Bankstown Airports. Traffic handling can be simulated if further analysis is required.

The developer may be charged for any expenses involved in the processing of any changes to published AIP documents, ATC procedures and changes to controller displays.

The Prescribed Airspaces of Camden Airport and the RAAF Base at Richmond and the Western Sydney Airport will not be impacted. The Prescribed Airspace of Bankstown Airport will be subject to a temporary penetration only.

The building will penetrate the clearance plane of the Sydney Terminal Area Radar (TAR) by 35 m. Airservices Australia may require an engineering examination to determine if this penetration will have an adverse impact on the performance of this radar. However alternative surveillance of the airspace in the vicinity of the site can be provided by the Cecil Park TAR, and for suitably equipped aircraft by the Sydney Terminal airspace WAM system and by ADS-B surveillance.

The performance of the navigation aids and communication facilities in the Sydney region will not be impacted.

The standard helicopter routes in the vicinity of the development site will not be impacted.

At the time of the preparation of this report, the developer has not advised if there will be a plume rise from the building roofs exceeding 4.3 m/s. If the rise exceeds 4.3 m/s a plume rise assessment will be conducted by CASA. If the rise is less then no assessment will be required.

CONCLUSION

In summary, based on the provisions of the Airports (Protection of Airspace) Regulations 1996, there appears to be no impediment to the Department of Infrastructure and Regional Development approving the development of the site as revised, subject to approval for permanent or temporary penetrations of the Sydney and Bankstown Airport OHS and RTCC surfaces. Consideration of the application by DIRD, Sydney Airport Corporation Ltd., the Civil Aviation Safety Authority and Airservices Australia would be required.

APPENDIX A

Responses from CASA and AsA

Australian Government
Civil Aviation Safety Authority

Airways and Aerodromes Regulation
File Ref: F15/6685-41
Your Ref: 15/0688

15/12/2015

Mr Ted Plummer
Manager Government Relations
Sydney Airport Corp Ltd
Locked Bag 5000
Sydney NSW 2020

Dear Mr. Plummer,

PROPERTY DEVELOPMENT, 42-60 RAILWAY PARADE, BURWOOD, NSW

I refer to the request for advice from CASA under the Airports (Protection of Airspace) Regulations 1996 regarding the above proposal.

CASA has assessed the proposed buildings at 42-60 Railway Parade, Burwood, NSW.

The height of the proposed tallest building at this site, including antennas and other equipment, is 182.6 m above AHD or 162 m Above Ground Level (AGL). At this height this building will infringe the outer horizontal surface by 26.6 m.

The consultant's report shows that the tallest building will infringe the Lowest Sector Altitude surfaces for Sydney Airport by 30.6m.

CASA advises that construction of the proposed building at the site would have an unacceptable effect on the safety of existing and future air transport operations at Sydney Airport.

Yours sincerely,

Dilip Mathew
Manager Aerodromes

Adelaide • Brisbane • Cairns • Canberra • Darwin • Melbourne • Perth • Sydney • Tamworth • Townsville
GPO Box 2005 Canberra ACT 2601 Telephone 131 757 www.casa.gov.au

Australian Government
Civil Aviation Safety Authority

Airways and Aerodromes Regulation

File Ref: F15/6685-42
File Ref: F15/0687

15/12/2015

Mr Peter Bleasdale
Sydney Airport Corp Ltd
Locked Bag 5000
Sydney NSW 2020

Dear Mr. Bleasdale,

TOWER CRANE: 42-60 RAILWAY PARADE, BURWOOD, NSW

CASA has assessed the proposed crane operations at the above location.

The tower crane is proposed to operate to a maximum height of 200.6 m above Australian Height Datum (AHD) or 179.6 m Above Ground Level (AGL) and would penetrate the outer horizontal surface by up to 44.6 m.

The consultant's report shows that the proposed tower crane would infringe the Lowest Sector Altitude surfaces for Sydney Airport by 48.6m and the lowest PANS-OPS surface by 15.9m.

The tower crane is scheduled to be in place for 8 years.

CASA advises that the installation and operation of the tower crane would have an unacceptable effect on the safety of existing and future air transport operations at Sydney Airport.

Yours sincerely,

Dilip Mathew
Manager Aerodromes

Adelaide • Brisbane • Cairns • Canberra • Darwin • Melbourne • Perth • Sydney • Tamworth • Townsville
GPO Box 2005 Canberra ACT 2601 Telephone 131 757 www.casa.gov.au

Airservices Comments

14 JAN 16

Because this is considered a long term penetration of PANS-OPS under the Airports (Protection of Airspace) Regulations 1996, Airservices cannot support the application however, at a maximum height of **152.4m/500ft AHD** the crane can operate without affecting the above procedure.

7 JUN 2016

I refer to your request for Airservices assessment of a property development to be located at 42-60 Railway Parade, Burwood.

Airspace Procedures

Tower Crane

With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a revised height of 192.6m (632ft) AHD the tower crane will negatively affect ATC operations as well as the following procedure at Sydney Airport:

- Circling CAT D.

Because this is considered a long term penetration of PANS-OPS under the Airports (Protection of Airspace) Regulations 1996, Airservices cannot support the application however, at a maximum height of 184.71m (606ft) AHD the building will not affect the above procedure or ATC operations (however, see RTCC comment below).
Note: procedures not designed by Airservices at Sydney Airport were not considered in this assessment.

Property Development

With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at a height of 182.6m (600ft) AHD the property development will not affect any sector or circling altitude, nor any instrument approach or departure procedures at Sydney Airport.

RTCC

With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at heights of:

Appendix

- 182.6m (600ft) AHD – property development; and
- 192.6m (632ft) AHD - tower crane.

The above activities *will affect* the radar terrain clearance chart (RTCC) for Sydney Airport. The maximum height of the property development and the tower crane can go to without affecting the Sydney RTCC is 152.39m (500ft) AHD which is the limiting surface at this site.

CNS Facilities

This proposal for a property development to a maximum height of 182.6m AHD and a tower crane to the maximum height of 192.6m AHD at 42-60 Railway Parade, Burwood will not adversely impact the performance of any Airservices Precision/Non-Precision Nav Aids, Anemometers, HF/VHF/UHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.

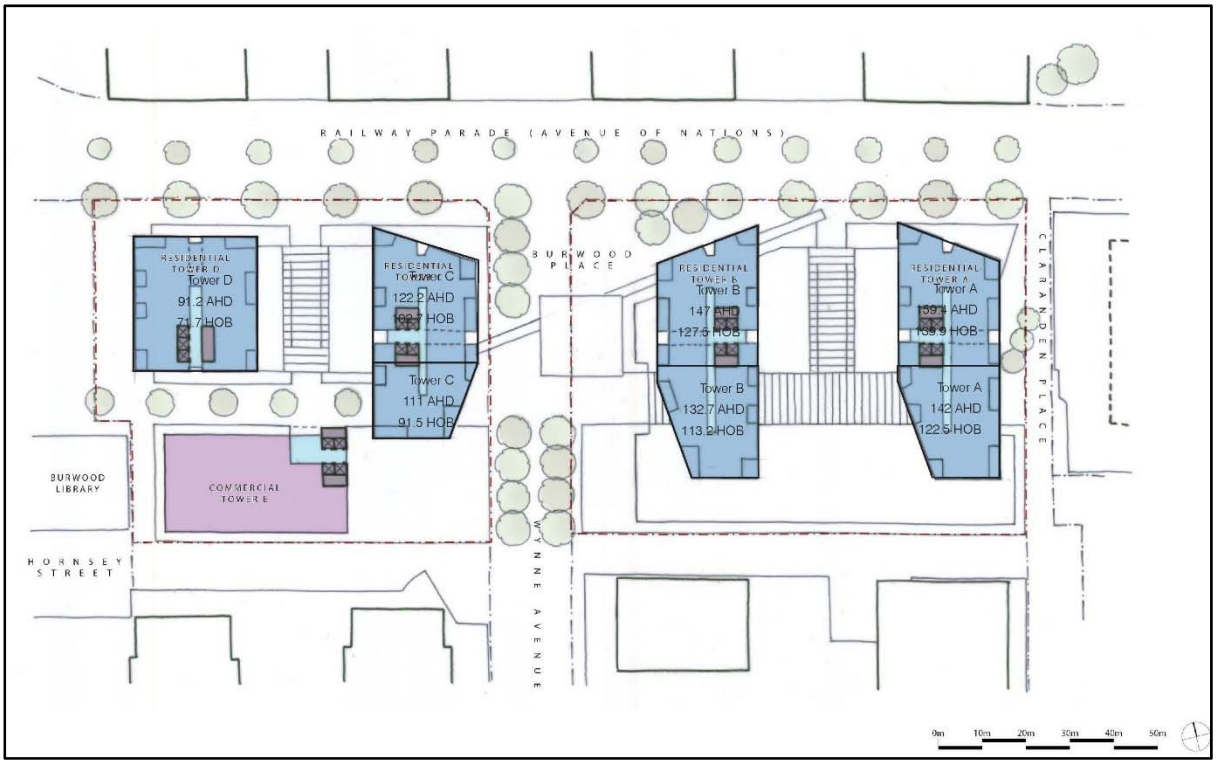
Kind regards

Carly
Carly Fiumara
Airport Development Assistant
Air Traffic Management – Service Support
t 02 6268 4725 | **e** carly.fiumara@airservicesaustralia.com
NOTE: I work part-time from Monday to Wednesday and between the hours of 0730

Appendix

APPENDIX B

SITE LAYOUT



Burwood Development Site Layout

The heights of buildings shown in the above figure are not current. The maximum building height is 163.5 m AHD, and this height has been used for calculations in the report.

Appendix

APPENDIX C

Glossary of Aeronautical Terms and Abbreviations

APPENDIX C

GLOSSARY OF AERONAUTICAL TERMS and ABBREVIATIONS

AERONAUTICAL STUDY GLOSSARY

To facilitate the understanding of aviation terminology used in this report, the following is a glossary of terms and acronyms that are commonly used in aeronautical impact assessments and similar aeronautical studies.

AC (Advisory Circulars) are issued by CASA and are intended to provide recommendations and guidance to illustrate a means, but not necessarily the only means, of complying with the *Regulations*.

Aeronautical study is a tool used to review aerodrome and airspace processes and procedures to ensure that safety criteria are appropriate.

AIPs (Aeronautical Information Publications) are publications promulgated to provide operators with aeronautical information of a lasting character essential to air navigation. They contain details of regulations, procedures and other information pertinent to flying and operation of aircraft. In Australia, AIPs may be issued by CASA or Airservices Australia.

Air routes exist between navigation aid equipped aerodromes or waypoints to facilitate the regular and safe flow of aircraft operating under IFR.

Airservices Australia is the Australian government-owned corporation providing safe and environmentally sound air traffic management and related airside services to the aviation industry.

Altitude is the vertical distance of a level, a point or an object, considered as a point, measured from mean sea level.

ATC (Air Traffic Control) service is a service provided for the purpose of:

a. preventing collisions:
    1. between aircraft; and
    2. on the manoeuvring area between aircraft and obstructions; and
b. expediting and maintaining an orderly flow of air traffic.

CASA (Civil Aviation Safety Authority) is the Australian government authority responsible under the *Civil Aviation Act 1988* for developing and promulgating appropriate, clear and concise aviation safety standards. As Australia is a signatory to the ICAO *Chicago Convention,* CASA adopts the standards and recommended practices established by ICAO, except where a difference has been notified.

CASR (Civil Aviation Safety Regulations) are promulgated by CASA and establish the regulatory framework *(Regulations)* within which all service providers must operate.

Civil Aviation Act 1988 (the Act) establishes the CASA with functions relating to civil aviation, in particular the safety of civil aviation and for related purposes.

ICAO (International Civil Aviation Organization) is an agency of the United Nations which codifies the principles and techniques of international air navigation and fosters the planning and development of international air transport to ensure safe and orderly growth. The ICAO Council adopts standards and recommended practices concerning air navigation, its infrastructure, flight inspection, prevention of unlawful interference, and facilitation of border-crossing procedures for international civil aviation. In addition, the ICAO defines the protocols for air accident investigation followed by transport safety authorities in countries signatory to the Convention on International Civil Aviation, commonly known as the *Chicago Convention*. Australia is a signatory to the *Chicago Convention.*

IFR (Instrument Flight Rules) are rules applicable to the conduct of flight under IMC. IFR are established to govern flight under conditions in which flight by outside visual reference is not safe. IFR flight depends upon flying by reference to instruments in the flight deck, and navigation is accomplished by reference to electronic signals. It is also referred to as, “a term used by pilots and controllers to indicate the type of flight plan an aircraft is flying,” such as an IFR or VFR flight plan.

IMC (Instrument Meteorological Conditions) are meteorological conditions expressed in terms of visibility, distance from cloud and ceiling, less than the minimum specified for visual meteorological conditions.

LSALT (Lowest Safe Altitudes) are published for each low level air route segment. Their purpose is to allow pilots of aircraft that suffer a system failure to descend to the LSALT to ensure terrain or obstacle clearance in IMC where the pilot cannot see the terrain or obstacles due to cloud or poor visibility conditions. It is an altitude that is at least 1,000 feet above any obstacle or terrain within a defined safety buffer region around a particular route that a pilot might fly.

MOS (Manual of Standards) comprises specifications *(Standards)* prescribed by CASA, of uniform application, determined to be necessary for the safety of air navigation.

NOTAMs (Notices to Airmen) are notices issued by the NOTAM office containing information or instruction concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to persons concerned with flight operations.

Obstacles. All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.

OLS (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.

PANS-OPS (Procedures for Air Navigation Services - Aircraft Operations) is an Air Traffic Control term denominating rules for designing instrument approach and departure procedures. Such procedures are used to allow aircraft to land and take off under Instrument Meteorological Conditions (IMC) or Instrument Flight Rules (IFR). ICAO document 8168-OPS/611 (volumes 1

and 2) outlines the principles for airspace protection and procedure design which all ICAO signatory states must adhere to. The regulatory material surrounding PANS-OPS may vary from country to country.

PANS OPS Surfaces. Similar to an Obstacle Limitation Surface, the PANS-OPS protection surfaces are imaginary surfaces in space which guarantee the aircraft a certain minimum obstacle clearance. These surfaces may be used as a tool for local governments in assessing building development. Where buildings may (under certain circumstances) be permitted to penetrate the OLS, they cannot be permitted to penetrate any PANS-OPS surface, because the purpose of these surfaces is to guarantee pilots operating under IMC an obstacle free descent path for a given approach.

Prescribed airspace is an airspace specified in, or ascertained in accordance with, the Regulations, where it is in the interests of the safety, efficiency or regularity of existing or future air transport operations into or out of an airport for the airspace to be protected. The prescribed airspace for an airport is the airspace above any part of either an OLS or a PANS OPS surface for the airport and airspace declared in a declaration relating to the airport.

Regulations (Civil Aviation Safety Regulations)

VFR (Visual Flight Rules) are rules applicable to the conduct of flight under VMC. VFR allow a pilot to operate an aircraft in weather conditions generally clear enough to allow the pilot to maintain visual contact with the terrain and to see where the aircraft is going. Specifically, the weather must be better than basic VFR weather minima. If the weather is worse than VFR minima, pilots are required to use instrument flight rules.

VMC (Visual Meteorological Conditions) are meteorological conditions expressed in terms of visibility, distance from cloud and ceiling, equal or better than specified minima.

Appendix

ABBREVIATIONS

Abbreviations used in this report, and the meanings assigned to them for the purposes of this report are detailed in the following table:

Abbreviation	Meaning
AC	Advisory Circular (document support CAR 1998)
ACFT	Aircraft
AD	Aerodrome
AHD	Australian Height Datum
AHT	Aircraft height
AIP	Aeronautical Information Publication
AIRPORTS ACT	Airports Act 1996, as amended
AIS	Aeronautical Information Service
ALT	Altitude
AMSL	Above Minimum Sea Level
APARs	Airports (Protection of Airspace) Regulations, 1996 as amended
ARP	Aerodrome Reference Point
AsA	Airservices Australia
ATC	Air Traffic Control(ler)
ATM	Air Traffic Management
BRA	Building Restricted Area (for GP)
CAO	Civil Aviation Order
CAR	Civil Aviation Regulation
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
Cat	Category
DAP	Departure and Approach Procedures (charts published by AsA)
DER	Departure End of (the) Runway
DEVELMT	Development
DME	Distance Measuring Equipment
Doc nn	ICAO Document Number nn
DIRD	Department of Infrastructure and Regional Development. (Formerly Dept. of Infrastructure, Transport, Regional Development and Local Government and Department of Transport and Regional Services (DoTARS))
DOTARS	See DIRD above
ELEV	Elevation (above mean sea level)
ENE	East North East
ERSA	Enroute Supplement Australia
FAF	Final Approach Fix
FAP	Final Approach Point
ft	feet
GLS	Ground Based Augmentation Landing System

Appendix

Abbreviation	Meaning
GNSS	Global Navigation Satellite System
GP	Glide Path
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organisation
IHS	Inner Horizontal Surface, an Obstacle Limitation Surface
ILS	Instrument Landing System
ISA	International Standard Atmosphere
km	kilometres
kt	Knot (one nautical mile per hour)
LAT	Latitude
LLZ	Localizer
LONG	Longitude
m	metres
MAPt	Missed Approach Point
MDA	Minimum Descent Altitude
MGA94	Map Grid Australia 1994
MOC	Minimum Obstacle Clearance
MOS	Manual of Standards, published by CASA
MSA	Minimum Sector Altitude
MVA	Minimum Vector Altitude
NASAG	National Airports Safeguarding Advisory Group
NDB	Non Directional Beacon
NE	North East
NM	Nautical Mile (= 1.852 km)
nnDME	Distance from the DME (in nautical miles)
NNE	North North East
NOTAM	NOtice To AirMen
OAS	Obstacle Assessment Surface
OCA	Obstacle Clearance Altitude
OCH	Obstacle Clearance Height
OHS	Outer Horizontal Surface
OIS	Obstacle Identification Surface
OLS	Obstacle Limitation Surface
PANS-OPS	Procedures for Air Navigation Services – Operations, ICAO Doc 8168
PBN	Performance Based Navigation
PRM	Precision Runway Monitor
QNH	An altimeter setting relative to height above mean sea level
REF	Reference
RL	Relative Level
RNAV	aRea NAVigation
RNP	Required Navigation Performance
RPA	Rules and Practices for Aerodromes — replaced by the MOS Part 139 — Aerodromes

Appendix

Abbreviation	Meaning
RPT	Regular Public Transport
RTCC	Radar Terrain Clearance Chart
RWY	Runway
SFC	Surface
SID	Standard Instrument Departure
SOC	Start Of Climb
STAR	Standard ARrival
TAR	Terminal Approach Radar
TAS	True Air Speed
THR	Threshold (Runway)
TNA	Turn Altitude
TODA	Take-Off Distance Available
V_n	aircraft critical Velocity reference
VOR	Very high frequency Omni directional Range
WAC	World Aeronautical Chart