ASSESSMENT FOR THE POTENTIAL FOR WIND SHEAR

QANTAS GROUP FLIGHT TRAINING CENTRE, MASCOT

WE665-01F04(REV1)- WS&T REPORT

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Prepared for:

Qantas C/- APP Corporation Pty Ltd

Level 7, 166 Miller Street,

North Sydney, NSW 2060

Attention: Mr Michael Terrett

WINDTECH Consultants Pty Ltd ABN 72 050 574 037
Head Office: 607 Forest Road, Bexley, NSW 2207, Australia
P +61 2 9503 0300 E reception@windtech.com.au W www.windtechconsult.com
Sydney | Abu Dhabi | London | Melbourne | Mumbai | New York | Shanghai | Singapore

DOCUMENT CONTROL

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EXECUTIVE SUMMARY

This report is in relation to the proposed Qantas Flight Training Centre located at 297 King Street, Mascot. It presents an opinion on the likely impact of the proposed design in creating building generated windshear and turbulence on Sydney Airport Runways. This assessment is based on an examination of the architectural drawings which have been prepared by the project architect Noxon Giffen, received in February, 2019. No wind tunnel tests have been undertaken for the subject development. The development consists of the Qantas Flight Training Centre and Carpark with RL's 24.5m and 47.33m respectively.

Buildings located near runways have the potential to generate wind shear and turbulence which may affect the operations of the airport. Partly in response to this risk, the Dutch Aerospace research organisation (NLR) prepared a detailed report titled "Wind Criteria due to obstacles at and around airports" (NLR Report, 2010). This report includes recommendations with regard to the construction of buildings near runways. A detailed review titled "Guidance Material: Building-induced wake effects at Airports" was conducted for use by aviation safety authorities. These reports formed the basis for the recommendations contained in Guideline B of National Airports Safeguarding Advisory Group (NASAG) Framework. The guidelines and guidance material aim to manage and reduce the risk of building generated wind shear and turbulence at airports near runways. These Guidelines were updated in May 2018.

The NASAG guidelines are also referenced within the City of Botany Bay Development Control Plan. The NASAG guideline defines an assessment trigger area which the development must be within. For this assessment the development has been compared against the criteria stated in the updated NASAG Guideline B. They are defined as follows:

- The variation in mean wind speed due to wind disturbing structures must remain below:
    - The "7 knot along-wind windshear criterion".
      7 knots (3.6 m/s) parallel to the runway centreline (or extended runway centreline) at heights below 61m above ground level (AGL). Any speed deficit change of 7 knots or greater must take place over a distance of at least 100m.
    - The "6 knot across-wind windshear criterion":
      6 knots (3.1 m/s) perpendicular to the runway centreline (or extended runway centreline) at heights below 61m AGL. Any speed deficit change of 6 knots or greater must take place over a distance of at least 100m.
- The "4 knot turbulence criterion". The standard deviation of wind speed must remain below 4 knots (2.1 m/s) at heights below 61m AGL.

An analysis of 21 years of wind climate data from Sydney Airport has been analysed to determine the direction, strength and frequency of winds. This data has been used in conjunction with the mean wind speed deficit to determine the likelihood of occurrence of an adverse wind shear event, as an input for the NASAG assessment guidelines.

The Flight Training Centre is 1,135m from the touch down zone of Runway 25 and 1,175m from the touchdown zone of Runway 16R. The height of the centre is below the 1:35 rule height threshold and therefore does not pose a windshear or turbulence risk.

The Car Park is 1,255m from the touch down zone of Runway 25 and 1,274m from the touch down zone of Runway 16R. This is outside the NASAG zone of influence and therefore does not pose a windshear or turbulence risk

1 GLOSSARY & ABBREVIATIONS

Term	Definition
The Site	Qantas Airways Limited owned land in Mascot to the north of Sydney Kingsford Smith Airport consisting of Lots 2-5 DP 234489, Lot 1 DP 202747, Lot B DP 164829 and Lot 133 DP 659434. Current site improvements include including at-grade car parking for Qantas staff, an industrial shed to store spare aviation parts, a substation, a disused gatehouse, a Sydney Water Asset with two driveways over it, the Qantas catering facility and Qantas tri-generation plant.
The Project	The construction of a new Flight Training Centre and ancillary uses to replace the existing facility on the Qantas Jetbase that will be impacted by RMS' Sydney Gateway Project.
Mascot Campus	Over 19ha of Qantas Airways Limited controlled land in Mascot to the north of Sydney Kingsford Smith Airport consisting of freehold and leased land. The following lots are owned by Qantas: Lot 133 DP 659434; Lots 4 & 5 DP 38594 Lot 23 DP 883548; Lots 1 & 2 DP 738342; Lot 3 DP 230355; Lot 4 DP 537339; Lots 2 & 4 DP 234489; Lot 4 234489; Lot 1 DP 81210; Lot 1 DP 202093; Lot 1 DP 721562; Lot 2 DP 510447; Lot 1 DP 445957; Lot B DP 164829 and Lot 1 DP 202747 and equates to 16.5ha of land. The following lots are leased by Qantas: Lot 14 DP 1199594 and Lot 2 DP 792885 and equates to 2.7ha of land.
Jetbase	Qantas leased land within the boundaries of Sydney Kingsford Smith Airport.
Sydney Gateway Project	A RMS Project including a road and rail component that is intended to increase capacity and improve connections to the ports to assist with growth in passenger, freight and commuter movements across the region, by expanding and improving the existing road and freight rail networks.

Abbreviation	Definition
NLR	Dutch Aerospace Research Organisation
SEARs	Secretary's Environmental Assessment Requirements
NASAG	National Airports Safeguarding Advisory Group
RMS	Root Mean Square

2 IMAGE INDEX

3 INTRODUCTION

Wintech Consultants has been commissioned by Qantas Airways Ltd (Qantas) to prepare this report in accordance with the technical requirements of the Secretary's Environmental Assessment Requirements (SEARs), and in support of the SSD 10154 for the development of a new flight training centre at 297 King Street, Mascot.

4 DESCRIPTION OF SITE AND LOCALITY

The site is located at 297 King Street, Mascot and comprises of land known as Lots 2-5 DP 234489, Lot 1 DP 202747, Lot B DP 164829 and Lot 133 DP 659434. The site is identified in Figure 1. An aerial image of the site relative to the runways is given in Figure 2.

Key features of the site are as follows:

- The site is approximately 5.417ha and is an irregular shape. It is approximately 240m in length and maintains a variable width of between approximately 321m in the Northern Portion of the site and approximately 90m along the King Street frontage (refer to Figure 1)
- The site possesses a relatively level slope across the site. An open Sydney Water drainage channel bisects the northern portionof the site in an east-west direction. There are some isolated changes in level immediately adjacent to this channel. A Site Survey Plan accompanies the application which details the topographc characteristics of the site.
- Multiple mature Plane Trees are scattered throughout the site. A variety of native and exotic tress and vegetation also exist around the perimeter of the site which help screen the site from surrounding uses.
- Site improvements include at-grade car parking for Qantas staff, an industrial shed to store spare aviation parts, a substation, a disused gatehouse, a Sydney Water Asset with two driveways over it, the Qantas catering facility and Qantas tri-generation plant.
- The site forms part of a larger land holding under the ownership of Qantas that generally extends between Qantas Drive to the west, Ewan Street to the south, Coward Street to the north, with the Qantas "Corporate Campus" fronting Bourke Road.
- Vehicular access to the site from the local road network is available from King Street. The site has intracampus connections along the northern boundary in the form of two connecting driveways in the northeastern and north-western corner of the site along the northern boundary which link it to the broader Mascot Campus.
- The site is located within the Bayside LGA.

Key features of the locality are:

- **North:** The site is bounded to the north low scale industrial development, beyond which is Coward Street. Further north of the site is the Mascot Town Centre which is characterised by transport-oriented development including high density mixed-use development focussed around the Mascot Train Station.

- **East:** The site is bordered to the east by commercial development including a newly completed Travelodge hotel which includes a commercial car park. Additional commercial development to the east includes the Ibis Hotel and Pullman Sydney Airport fronting O'Riordan Street.
- **South:** The site is bounded to the south by King Street, beyond which is Qantas owned at-grade car parking and other industrial uses. Further south is the Botany Freight Rail Line and Qantas Drive beyond which is the Domestic Terminal at Sydney Airport.
- **West:** The site is bordered to the west by the Botany Freight Rail Line and Qantas Drive, beyond which lies Sydney Kingsford Smith Airport and the Qantas Jetbase (location of the current Flight Training Centre)

Figure 1: Aerial Image of the Site Location

Figure 2: Site Location Relative to Runways

5 PROJECT DESCRIPTION

Safety is Qantas' first priority. The flight training centre is a key pillar of this value. The facility enables pilots and flight crews to undertake periodic testing to meet regulatory requirements by simulating both aircraft and emergency procedural environments. The Project seeks consent for the construction and operation of a new flight training centre, and associated ancillary uses including a multi-deck car park. The Project is comprised of the following uses:

Flight Training Centre

The proposed flight training centre will occupy the southern portion of the site. It is a building that comprises 4 core elements as follows:

- An emergency procedures hall that contains;
    - cabin evacuation emergency trainers,
    - an evacuation training pool, o door trainers,
    - fire trainers
    - slide descent towers,
    - security room,
    - aviation medicine training and equipment rooms.
- A flight training centre that contains:
    - a flight training hall with 14 bays that will house aircraft simulators,
    - integrated procedures training rooms, computer rooms, a maintenance workshop, storerooms, multiple de-briefing and briefing rooms, pilot's lounge and a shared lounge.
- Teaching Space that contains
    - training rooms,
    - classrooms and two computer based exam rooms.
- Office Space
    - Office space for staff and associated shared amenities including multiple small, medium and large meeting rooms, think tank rooms, informal meeting spaces, a video room and lunch/tea room.
- Ancillary spaces including the reception area at the ground floor, toilets, roof plant and vertical circulation. The external ground floor layout will include a loading dock, at-

grade car parking for approximately 35 spaces and a bus drop-off zone at the northern site boundary.

Car Park

The proposed multi-deck car park will be located to the north-east of the flight training centre and adjacent the existing Qantas catering facility and tri-generation plant. The car park is 13 levels and will provide 1,500 spaces for Qantas staff. Vehicle access to the car park will be provided via King Street, Kent Road and from Qantas Drive via the existing catering bridge.

6 WIND CLIMATE OF THE SYDNEY REGION

The Sydney region is governed by three principal wind directions, and these can potentially affect the subject development. These winds prevail from the north-east, south and west. A summary of the principal time of occurrence of these winds throughout the year is presented in Table 1 below. This summary is based on a detailed analysis undertaken by Windtech Consultants of recorded directional wind speeds obtained at the meteorological station (current position) located at Kingsford Smith Airport by the Bureau of Meteorology (recorded from 1995 to 2016). From this analysis, a directional plot of the annual and weekly recurrence winds for the Sydney region is also determined, as shown in Figure 3. The frequency of occurrence of these winds is also shown in Figure 3.

As shown in Figure 3, the southerly winds are by far the most frequent wind for the Sydney region, and are also the strongest. The westerly winds occur most frequently during the winter season for the Sydney region, and although they are typically not as strong as the southerly winds. North-easterly winds occur most frequently during the warmer months of the year for the Sydney region.

Table 1: Principal Time of Occurrence of Winds for Sydney

Month	Wind Direction		
	North-Easterly	Southerly	Westerly
January	X	X	
February	X	X	
March	X	X	
April		X	X
May			X
June			X
July			X
August			X
September		X	X
October	X	X	
November	X	X	
December	X	X	

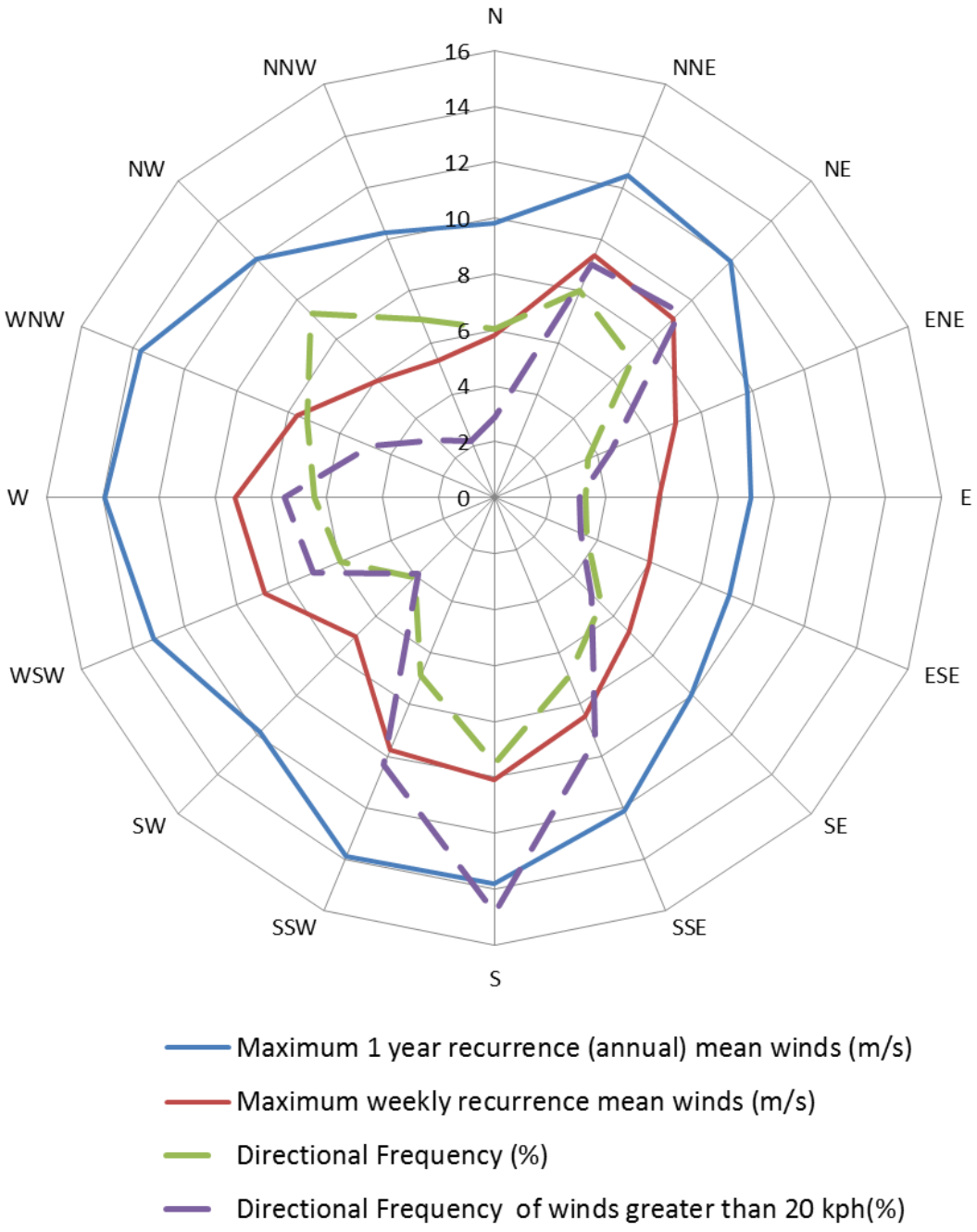

Figure 3: Annual and Weekly Recurrence Mean Wind Speeds, and Frequencies of Occurrence, for the Sydney Region (based on 10-minute mean observations from Kingsford Smith Airport from 1995 to 2016, corrected to open terrain at 10m)

7 ASSESSING BUILDING GENERATED WINDSHEAR AND TURBULENCE

Buildings located near runways have the potential to generate wind shear and turbulence which may affect the operations of the airport. Partly in response to this risk the Dutch Aerospace research organisation (NLR) prepared a detailed report titled "Wind Criteria due to obstacles at and around airports" in 2010 (Nieuwpoort, et al, 2010). This report includes recommendations with regard to the construction of buildings near runways. An important conclusions was that buildings that have a distance to the runway centreline that is less than 35 times their height should be subject to aerodynamic modelling. This is a very conservative rule.

The NLR report provides several criteria to determine the influence of buildings on runway operations. This includes the "4 knot RMS Criterion", the "6 knot criterion" for across runway mean wind speeds and "7 knot criterion" for along runway mean wind speeds. In addition to the abovementioned criteria the NLR report also defined a zone of influence for planned construction within the vicinity of the runway and suggested that the impact of new buildings within this zone on wind conditions along the runway be investigated.

A detailed review of the area was also conducted for use by Australia aviation safety authority's title "Guidance Material: Building-induced wake affects at Airports". These reports formed the basis for the recommendations contained in Guideline B of National Airports Safeguarding Advisory Group (NASAG) Framework. The guidelines and guidance material aim to manage and reduce the risk of building generated wind shear and turbulence at airports near runways. These Guidelines were updated in 2018.

7.1 Mean Wind Speed Deficit Criteria

The NLR report provides the following assessment criteria:

7 knot criterion

> The variation in mean wind speed due to wind disturbing structures must remain below 7 knots along the aircraft trajectory at heights below 200ft. The speed deficit change of 7 knots must take place over a distance of at least 100m (p4 of NLR report).

6 knot criterion

> The variation in mean wind speed due to wind disturbing structures must remain below 6 knots across the aircraft trajectory at heights below 200ft. The speed deficit change of 6 knots must take place over a distance of at least 100m (p4 of NLR report).

The figure presented in the NLR report has been more clearly expressed in the recent review and is reproduced below (Figure 4).

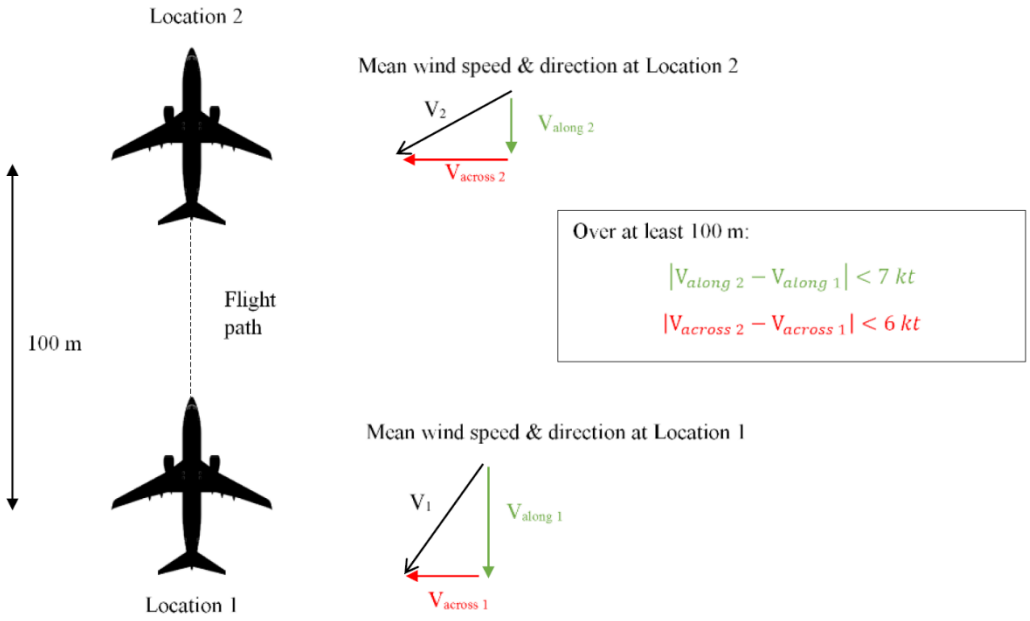

Figure 4: Interpretative sketch of NLR Criteria (Rohr et al, 2016)

4 knot criterion

> The gust/turbulence components in horizontal direction caused by a wind disturbing structure in combination with the meso-scale surface roughness must remain below RMS values of 4 knots (p 175 of NLR report).

In this context meso-scale surface roughness refers to terrain features that extend over several kilometres such as city centres, suburbs of houses, forests, grassland and lakes. Meso-scale surface roughness is also referred to as terrain roughness.

The wind may be considered to be the sum of a mean (average) component plus a fluctuating component. The fluctuating component varies with time whereas the mean is constant over the averaging time. For the natural wind flow the fluctuating component is considered to be generated by turbulence. Features of the turbulent component include that it varies rapidly and that it is random. Due to its random nature the turbulent component can be difficult to characterise and several measures exist to describe it. As the turbulence has a mean value of zero, one measure of the degree of turbulence is the standard deviation or root-mean-square (RMS) of the fluctuating component. Figure 5 shows a sketch of a wind speed time series with the mean and RMS labelled as well as their formal definitions.

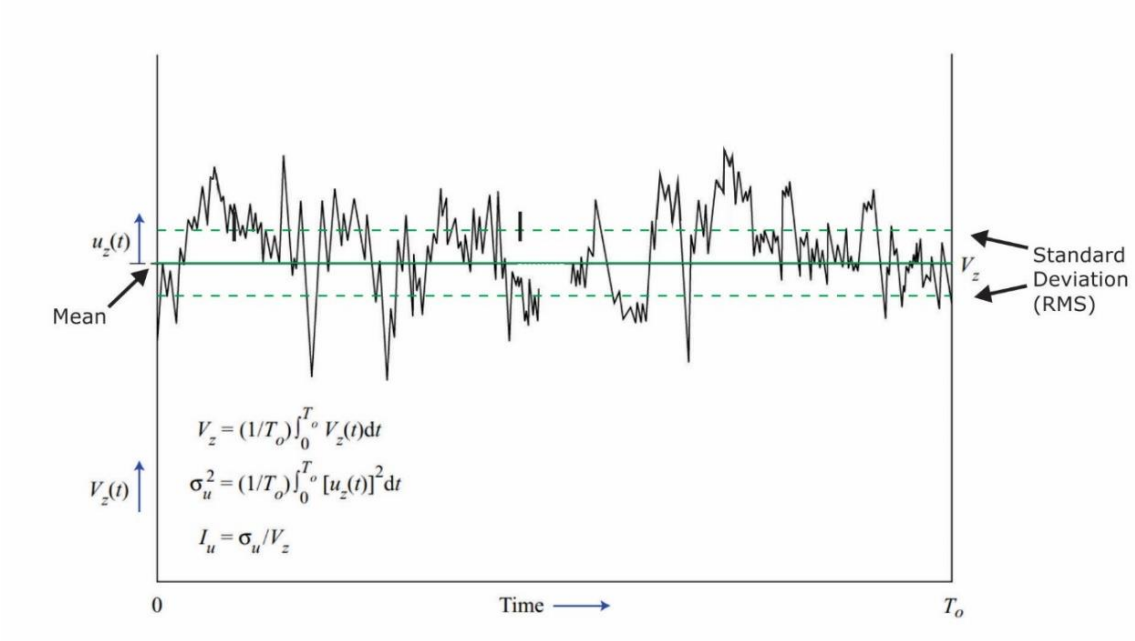

Figure 5: Sketch of a wind speed time series (Sketch 3.1 ESDU 83045)

There is the inherent RMS turbulence in the wind flow that is present at the airport site due to surrounding terrain features such as houses and trees. This is also referred to as the background levels of RMS turbulence. In the context of the "4 knot" criteria this is the RMS turbulence generated by the meso-scale surface roughness.

7.2 Zone of Influence and Assessment Trigger Area

The NLR report discusses two zones of influences, the first is for stand-alone structures and the second is for planned structures as shown in Figure 6. In addition to the abovementioned criteria the NLR report also defined a zone of influence for planned construction within the vicinity of the runway and suggested that the impact of new buildings within this zone on wind conditions along the runway be investigated.

Guideline B of the NASAG framework also defined a zone of influence which only extends 500m along the runway instead of 1500m.

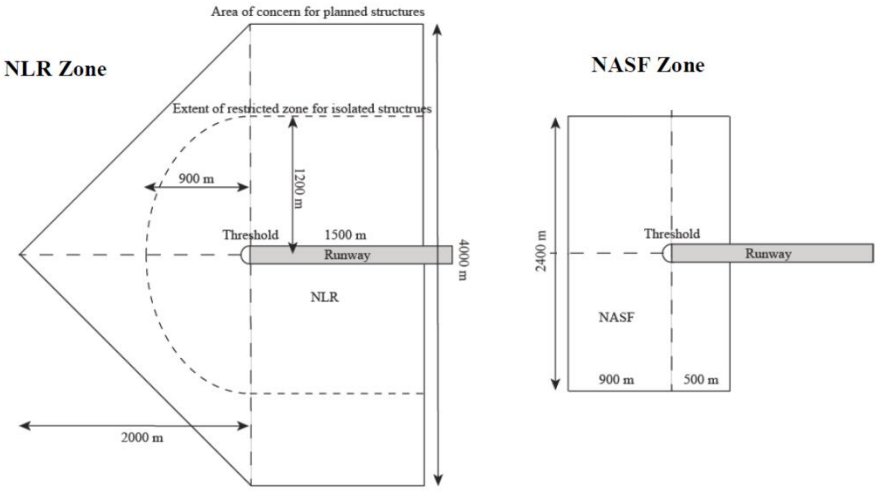

Figure 6: Comparison of Zone of Influence between the NLR report and NASAG (Rohr et al, 2016)

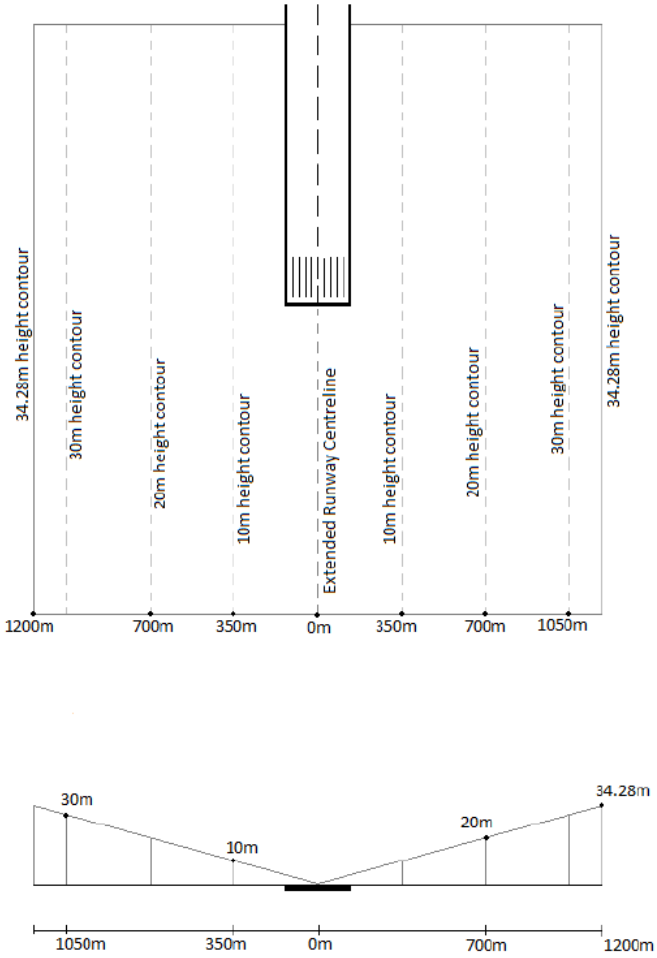

Figure 7: Comparison of Zone of Influence from NASAG overlayed with 1:35 rule (NASAG)

7.3 Guideline B of NASAG Framework (May 2018)

The updated Guideline B presents a building assessment methodology to apply to buildings nearby to runways. In addition to the criteria and zone of influence mentioned above, the key points are listed below:

- Buildings should preferably not be sited near the touch-down zones of runways
- Wherever possible, buildings should avoid being orientated at 45 degrees to the runway
- The actual risk of a building-induced windshear event involves a statistical analysis indicating the likelihood of occurrence of an adverse event.
- The variation in mean wind speed due to wind disturbing structures must remain below:
    - 7 knots (3.6 m/s) parallel to the runway centreline (or extended runway centreline) at heights below 61m AGL. Any speed deficit change of 7 knots or greater must take place over a distance of at least 100m. The "7 knot along-wind windshear criterion".
    - 6 knots (3.1 m/s) perpendicular to the runway centreline (or extended runway centreline) at heights below 61m AGL. Any speed deficit change of 6 knots or greater must take place over a distance of at least 100m. The "6 knot across-wind windshear criterion".
- The standard deviation of wind speed must remain below 4 knots (2.1 m/s) at heights below 61m AGL. The "4 knot turbulence criterion".
- For an adverse event to occur the following factors need to occur simultaneously:
    - Building is of a shape and size to generate a wake disturbance that exceeds the 7 knots criterion
    - The wind occurs in a direction crosswind to the runway and is strong enough to generate an event which exceeds the 7 knots criterion
- The calculation of the mean wind speed deficit (BWD) can be used to determine if and how often the 7 knots criterion will be exceeded.
- The assessment may be conducted using a desktop approach for simple buildings or using wind tunnel modelling for complex buildings.

7.4 Criteria used in this Assessment

In this assessment the following criteria have been considered as defined by the NASAG framework:

- 7 knots along the aircraft trajectory in 100m criterion
- 6 knots across the aircraft trajectory in 100m criterion
- 4 knot RMS turbulence criterion using the maximum horizontal component of turbulence

The desktop method to estimate the potential for an exceedance of the 7 knot criteria, as outlined in the NASAG Guideline has been used as well as a consideration of the prevailing wind directions.

7.5 Natural and Building Induced Wind Gusts

As shown in Figure 5 above, the natural wind has a mean and fluctuating component and the large magnitude fluctuating components are normally called gusts or the peak wind speed. The ratio gust wind speed and the mean wind speed depends on the height of the measurement and the up wind land use (terrain roughness). For example, there is less turbulence and hence a smaller ratio between the mean and gust wind speeds if the upwind land use is a lake compared with a dense urban area.

The occurrence of the gusts is inherently random; however, it is assumed that they have a given probability distribution and hence they can be described using the measured RMS turbulence value. There is a theoretical ratio between the mean wind speed, the turbulence levels and the maximum gust within a time period. For example, a standard anemometers condition of the largest 3s duration gust in a 10 minute period will be 45% greater than the average wind speed over that 10 minute period.

The presence of buildings within the atmospheric boundary layer alters the turbulent nature of the winds. The buildings do not add to the overall energy in the wind, but they can locally accelerate the winds, for example at the corners of buildings. They can also decrease the wind speed in the lee of the building and increase the local turbulence of the winds. It should be that the turbulence in the immediate wake of a building differs from the natural wind turbulence and that the wake turbulence is partially dependent on the shape of the building.

8 BUILDING WINDSHEAR AND TURBULENCE ASSESSMENT

The location of the proposed development relative to the eastern end of the 07/25 runway and northern end of 16R/34L is shown in Figure 8. The closest distance between the development and the approach flight path to runway 07/25 is 1,135m and this occurs when winds occur from 345°. This location (Point A, Figure 8) is approximately 420 m from the centre of the touch down zone. The closest distance between the development and the approach flight path to runway 16R/34L is 1,175m and this occurs when winds occur from 77°. This location (Point B, Figure 8) is approximately 436 m from the centre of the touch down zone.

From Runway 07/25 the Flight Training Centre is within the NASAG zone of influence at a distance of 1,135m (Figures 5 and 6), however the Carpark is not at a distance of 1,255m. From runway 16R/34L the Flight Training Centre is within the NASAG zone of influence at a distance of 1,175m and the Carpark is not at a distance of 1,274m.

8.1 Runway 25

Airservices Australia data indicates that the end of Runway 25 (33°56'15".1S, 151°11'23".8E) has an elevation of 6.0m. Based on the 1:35 rule, at a distance of 1,135m from the centreline, the building needs to be less than 32.4m above the runway or RL 38.4m, to be within the 1:35 rule and therefore not require further examination for their potential to generate wind shear and turbulence.

As shown in Section 1, the Flight Training Centre is below the 1:35 rule height of 32.4m in relation to Runway 25. As per Clause 25 of the NASAG Guideline, structures that do not penetrate the 1:35 surface, do not pose a windshear or turbulence risk and may be approved without further consideration of windshear and/or turbulence.

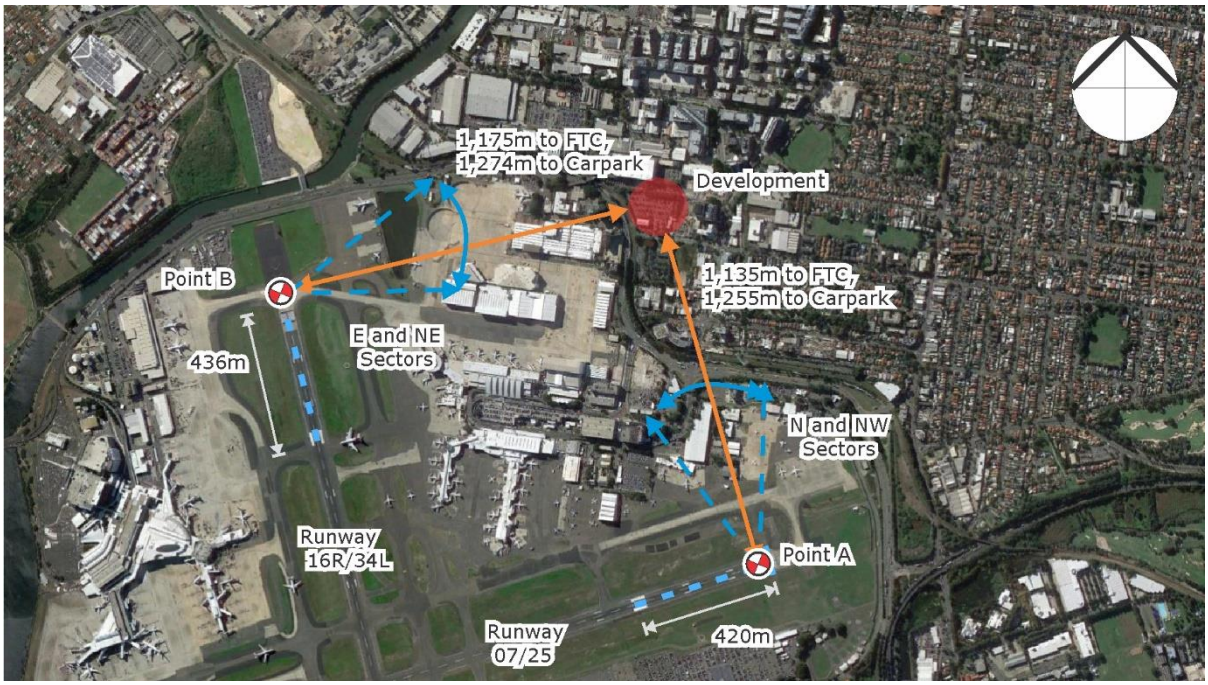

Figure 8: Development Relative to Runways

For building generated windshear and turbulence caused by the current development to occur along the approach path to Runway 25/07, winds must occur from the north or north-westerly wind directions and the wind must also have a sufficient strength to generate these conditions. As shown in Figure 2 the north and north-westerly direction is not a frequent strong wind direction for Sydney.

Furthermore, Sydney Airport has two parallel north-south runways, 16R/34L and 16L/34R and when winds occur from the north or north-westerly directions it is likely that aircraft will be instructed to land on these runways not runway 25. Based on these operational considerations it is not expected that building generated windshear and turbulence will impact of aircraft landing on Runway 25.

8.2 Runway 16R

Airservices Australia data indicates that the end of Runway 16R (33°55'45".7S, 151°10'17".8E) has an elevation of 2.1m. Based on the 1:35 rule, at a distance of 1,175m from the centreline, the building needs to be less than 33.6m above the runway or RL 35.7m, to be within the 1:35 rule and therefore not require further examination for their potential to generate wind shear and turbulence.

As shown in Section 1, the Flight Training Centre is below the 1:35 rule height of 33.6m in relation to Runway 16R. As per Clause 25 of the NASAG Guideline, structures that do not penetrate the 1:35 surface, do not pose a windshear or turbulence risk and may be approved without further consideration of windshear and/or turbulence.

For building generated windshear and turbulence caused by the current development to occur along the approach path to Runway 16R, winds must occur from the east or north-easterly wind

directions and the wind must also have a sufficient strength to generate these conditions. As shown in Figure 2 the north-easterly direction is a frequent strong wind direction for Sydney.

As a result, when strong winds occur from the east to north-easterly directions it is likely that aircraft will be instructed to land runway 25/07. Based on these operational considerations it is not expected that building generated windshear and turbulence will impact of aircraft landing on Runway 16R.

9 RISK ASSESSMENT AND MITIGATION MEASURES

Matter	Potential Impact	Likelihood	Consequence	Risk Level	Proposed Mitigation Measure
No associated risks	-	N/A	N/A	N/A	-

10 REFERENCES

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