Jacobs Group (Australia)

Hunter Power Project - Aeronautical Impact & Risk Assessment of the Plume Rise

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strategic airspace

Prepared by Consultants:

strategic airspace

Strategic Airspace Pty Limited
ABN: 60 097 857 415

PO Box 235, Bondi Junction NSW 1355
Australia

Tel: +61 2 8957 2278

Email - Attn: Exec@StrategicAirspace.com

Client:

Jacobs

Jacobs Group (Australia) Pty Ltd
ABN: 37 001 024 095

PO Box 312, Flinders Lane
Melbourne VIC 8009
Australia

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Document Title: **Hunter Power Project - Aeronautical Impact & Risk Assessment of the Plume Rise**

Purpose / Abstract:

This report has been prepared for Jacobs Group (Australia) (Jacobs) as part of an Environmental Impact Study (EIS) being undertaken by Jacobs for Snowy Hydro Limited (SHL). The study investigates the impact of a proposed new gas fired peaking power station near Kurri Kurri in the Hunter Valley, NSW. The proposed power station will comprise two F Class Open Cycle Gas Turbines (OCGT). The power station will also be able to operate on diesel as a backup fuel to cover the contingency that natural gas might not be available when it is required to supply electricity to the National Electricity Market (NEM).

The purpose of this report is to present the investigation findings of the aeronautical impact and risk assessment for the proposed power station. Whilst two scenarios were initially modelled — Scenario One (single OCGT) and Scenario Two (two OCGTs) — this report focusses on the now final proposal of the EIS, Scenario Two. Further, the findings have been updated and extended in this report to include:

- *Information obtained during airspace user consultation meetings at Cessnock and Maitland Airports and from remote consultation with other potential stakeholders, including Defence; and*
- *A more detailed risk assessment with proposed mitigations.*

The Civil Aviation Safety Authority (CASA) will use the plume rise assessment criteria outlined in the Advisory Circular AC 139-5 V3.0 (Feb-2019), an adjunct to the Manual of Standards (MOS) Part 139, to assess the impact of the plume rise on aviation operations in the vicinity of the proposed site. AC 139-5 V3.0 requires that plume rise modelling using the TAPM modelling software be performed to assist in assessing the potential hazard presented by the proposed power station. This has been arranged by Jacobs for the purpose of this assessment.

The report concludes that CASA is likely to advise the NSW government that the plume rise is acceptable because the likelihood and consequence of the risk to safety of aircraft is assessed to be in the acceptable, or at worst tolerable, range. Proposed control measures to mitigate risk have been applied to an assessment of the possible likelihood of aircraft of different types encountering the plume rise at various altitudes, based on the 5-year simulation plume rise model, to examine residual risk. These provide a conservative level of protection.

Noting that the proposal is for a peaking power station, the actual risk probability to aircraft is further reduced by the fact that the maximum Capacity Factor sought in the EIS is only 12% per year (wherein the Capacity Factor could be representative of the expected hours of operation based on full load operation throughout the year); and the risk probability would be substantially less for the currently expected operation based on a Capacity Factor of 2% per year.

The risk control measures proposed have been recommended to mitigate potential impact to an Acceptable Level of Safety (ALoS), as required by CASA. Such measures include the addition of symbology and information to relevant aeronautical charts and publications, and the implementation of obstacle lights to be activated when the plant is operating.

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1. Executive Summary

Jacobs Group (Australia) (Jacobs) is preparing an Environmental Impact Statement (EIS) for Snowy Hydro Limited (SHL) for a new gas fired peaking power station at the site of the former Hydro Aluminium Kurri Kurri Smelter in the Hunter Valley region of New South Wales. Strategic Airspace (StratAir) undertook an aeronautical assessment, as part of the EIS, to assess the potential impact that the plume rise might have on aircraft operations in the vicinity of the power station.

Snowy Hydro proposes to develop a power station on the Kurri Kurri site comprising two F Class Open Cycle Gas Turbine (OCGT). The power station will also be able to operate on diesel as a backup fuel to cover the contingency that natural gas might not be available when it is required to supply electricity to the National Electricity Market (NEM). Approval is being sought for operations up to a Capacity Factor[1] of 12% of the year (10% on natural gas and 2% on diesel); however, it is expected that likely operations would result in a Capacity Factor of 2% in any given year.

The approximate location of the centre of the two gas turbine stacks is:

Latitude / Longitude:	32° 47' 08.85" S	151° 28' 42.48" E	
MGA94 Easting / Northing / Zone	357515 m E	6371435 m N	56

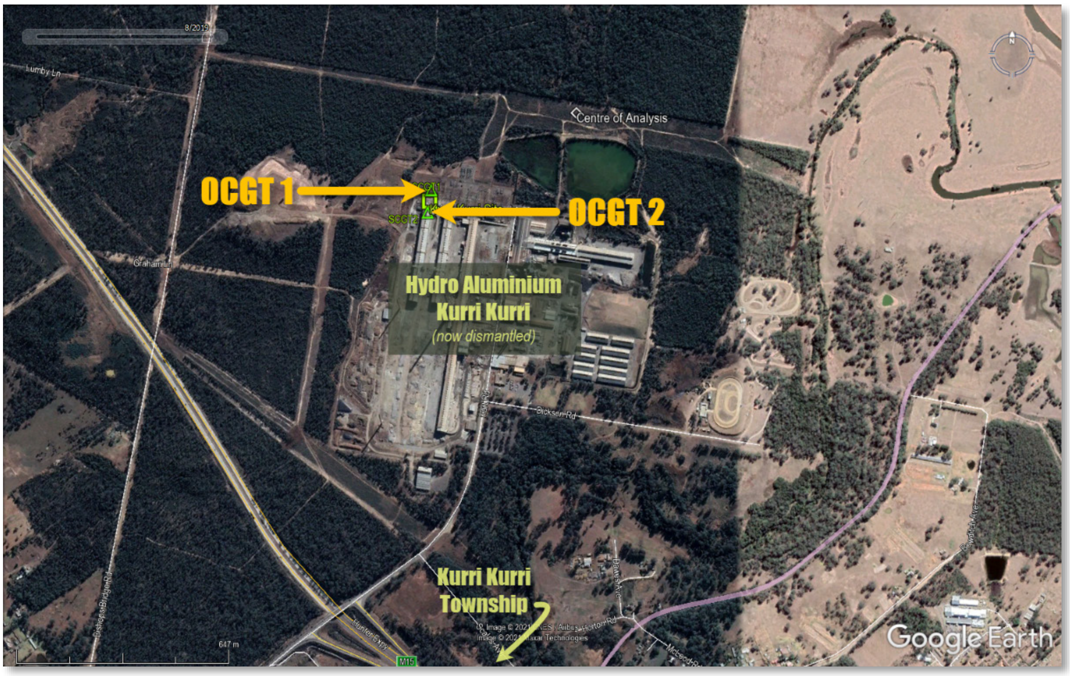


Figure 1 — Location of Proposed Turbines with reference to Hydro Aluminium Kurri Kurri

The closest airports to the proposed site are Maitland Airport (approximately 9.5 km (5.1 NM) north of the site) and Cessnock Airport (approximately 13km (7 NM) west of the site). The site is located in Class G airspace, and beneath airspace restricted (when activated) to military aircraft flying out of Williamtown RAAF airbase with low-level non-military traffic allowed only up to a maximum altitude of 4500ft Above Mean Sea Level (AMSL), the equivalent of 1372m Australian Height Datum (AHD). Maitland Airport has one PANS-OPS approach procedure, the new power station will be near the outer edge of the secondary area of the missed approach procedure and is therefore considered to have no effect on the missed approach procedure. The proposed site is outside the Obstacle

1 The Capacity Factor could be considered as representative of the expected hours of operation based on full load operation throughout the year.

Limitation Surfaces (OLS) that protect visual approach, landing and take-off. Cessnock Airport currently has only visual operations and the proposed site is outside the OLS for this airport. Cessnock Airport plans to upgrade the current runway to support instrument procedures.

Each of these airports host several flight training schools; training flights from these airports regularly operate near the proposed power station site at an altitude of approximately 1500ft AMSL. The management of both airports stated that the proposed power station plume would not present a significant hazard to training flights, provided some means of identification of the location of the power station hazard was implemented. There are also General Aviation operations to/from both airports and in the general vicinity of the site. Other airports in the vicinity are sufficiently remote from the proposed site to not require special consideration in this study.

It would appear from stakeholder comments obtained during local briefing and consultation meetings that there are a reasonable number of relatively low level of Visual Flight Rules (VFR) 'enroute' flights that may fly near the proposed site at altitudes generally in the region of 1500ft – 3000ft AMSL. The minimum allowable elevation (under VFR regulations) for these flights is 1000ft above any built feature such as the power station, which would equate to ~1200ft AMSL. At this altitude:

- The power station would be visible to VFR aircraft from some distance away; therefore, aircraft could easily avoid over-flying the power station.
- At the minimum allowable altitude for VFR flight operations:
  - The plume velocity would only exceed 6.1m/s for less than 5% of the time the power station is operating (noting that as a peaking power station it will not operate continuously and, under the EIS, up to a maximum of 12% of the time) — where 6.1 m/s is at the lower end of the 'moderate' turbulence for most aircraft.
  - The plume velocity will never exceed 10.6m/s, which is the lower bound of what would be considered 'severe' turbulence, above 1000ft AMSL.
  - Most aircraft (ultralights and small helicopters at low speed being the exception) would not be affected by a plume rise velocity of 6.1m/s.
  - On the rare occasion that an aircraft may suffer an 'appreciable change in altitude or attitude' requiring an adjustment to flight controls, pilots have sufficient altitude to regain control before getting dangerously close to the ground.
  - Ultralight aircraft and helicopters may be affected at low altitudes by vertical plume velocities as low as 4.3m/s. While this is not mentioned in CASA's current Advisory Circular (AC) on plume rise assessment, it is known that the AC is being revised following the difficulties that arose with Energy Australia's Tallawarra project. Hence, StratAir has included 4.3m/s as a 'critical velocity' for ultralight aircraft and helicopters in the risk assessment analysis.

A motorway, railway and some powerlines in the vicinity of the proposed site are major features that may be used for low-level visual navigation — as depicted in the extract from the relevant Visual Navigation Chart (VNC) (Figure 4, p10) and illustrated in annotated imagery from GoogleEarth (Figure 9, p22). Their proximity to the site has been considered in determining the likelihood of aircraft passing overhead the site/near the exhaust plume.

CASA requires that any plume rise that has an exit velocity greater than 6.1m/s be assessed for its potential impact on aviation safety. This requirement is specified in CASA's Advisory Circular (AC) 139-5 V3.0 published in January 2019. This latest AC does not specify a maximum allowable plume velocity at an elevation/altitude where a plume is likely to conflict with a possible flight path as it did in the previous ACs[2]. The latest AC states that

2 The maximum velocity was 4.3 m/s in the original AC (2004) and 10.6 m/s in the AC published in November 2012

CASA will select a Critical Plume Velocity (CPV) during its assessment process. Presumably, this selection is based upon the type of aircraft and type of operations likely to be affected by the plume. However, it is unlikely that CASA will use a CPV greater than 10.6m/s, because this was the CPV defined in the 2012 version of the AC (based on the fact that this is the upper limit of the *moderate* turbulence range above which there is a higher risk of the turbulence that could contribute to loss of control of an aircraft; see also Table 5 in section 3.4B Introduction of Higher Benchmark Velocities, p12).

Plume modelling for the proposed gas turbine configurations at the site has been performed by Jacobs. The modelling considered two scenarios: a single OCGT and a dual OCGT configuration. The gas turbine used in the plume modelling was that with the highest potential plume rise and which might be selected as the turbine for the project. Only the dual OCGT scenario is considered in the risk assessment analysis.

From the plume model data, the frequency of plume at the given vertical velocities (4.3m/s, 6.1m/s and 10.6m/s) exceeding various altitudes was evaluated in relation to key flight altitudes based on VFR flight altitudes (minimum regulated altitudes and observed flight altitudes in the vicinity), instrument flight altitudes and airspace limits. This data was then evaluated for potential risk to aircraft of various types, based on a mix of quantitative and qualitative assessment of risk probability and severity of consequence (refer section 6.2, p27, and Appendix 4 — Risk Assessment Matrix).

The first pass risk assessment was based on the plume rise modelling data (resulting from a simulation of continuous operation over five (5) years) and a combination of aircraft types, flight altitudes and speeds in order to examine the likelihood and severity of a risk to aircraft when the plant is operating. On this basis, the majority of cases evaluated result in a risk classification in the Acceptable level. None result in an Unacceptable risk assessment. To handle those cases which fell into the Tolerable level, control measures have been proposed to reduce the probability and/or severity of the risk to either a more Tolerable Level or to an Acceptable Level.

The control measures proposed to mitigate risk to aircraft include:

- Publication of a plume rise symbol on relevant aeronautical navigation charts, including the Newcastle Visual Navigation and Terminal Charts and the Enroute Low Chart
  (A Danger Area is not considered necessary because the plume rise is sufficiently laterally and/or vertically clear of airports, instrument procedure tracks, reporting points, VFR routes and airspace constraints.)
- Publication of a simple chart graphic (to provide clear location reference for VFR pilots) and information and advisory notes in the ERSA AD entries for Maitland and Cessnock Airports
- Activation of obstacle lights when the plant is operating.

The frequencies of plume exceedance were also factored by the anticipated operating time (2% of the time) and the maximum operating time sought in the EIS (12%), which shows a vastly reduced risk probability to aircraft.

Based on the very low risk probability to aircraft, and the proposed suite of mitigations intended to help ensure that aircraft do not fly directly over the site (or if they do, not at low altitude), it is highly likely that the plume rise from the power station would not have an adverse impact on the safety, regularity or efficiency of air traffic operations to nearby airports and in the vicinity of the site. It is anticipated that CASA will accept the impact and risk assessment as documented, and the proposed control measures to reduce risk.

2. Introduction

Snowy Hydro Limited (SHL) is planning to develop a new gas fired power station at the site of the former Hydro Aluminium Kurri Kurri Smelter. Jacobs Group (Australia) (Jacobs) is preparing an Environmental Impact Statement (EIS) for SHL for this proposed development.

Jacobs engaged Strategic Airspace Pty Limited (StratAir) to conduct an aeronautical impact and risk assessment study and prepare this report which will form part of the project's EIS submission to the Department of Planning, Industry and Environment (DPIE). The DPIE will seek CASA's opinion as to the effect the power station plume rise may have on aviation safety in the vicinity of the power station.

SHL ('the proponent') is seeking approval from the NSW Minister for Planning and Public Spaces under the NSW Environmental Planning and Assessment Act 1979 (EP&A Act) for the Proposal.

The Proposal involves the construction and operation of a power station and electrical switchyard, together with other associated infrastructure. The power station would have a capacity of up to approximately 750 megawatts (MW) which would be generated via two heavy duty gas turbines. Although primarily a gas fired power station, the facility would also be capable of operating on diesel as required, if there were a constraint or unavailability in the natural gas system and there was a need to supply electricity to the National Electricity Market (NEM).

The proposed power station would operate as a "peak load" generation facility supplying electricity at short notice when there is a requirement in the NEM. The major supporting infrastructure that is part of the Proposal would be a 132 kV electrical switchyard located adjacent to the Proposal Site. The Proposal would connect into existing 132 kV electricity transmission infrastructure located adjacent to the Proposal Site. A new gas lateral pipeline and gas receival station will also be required and this would be developed by a third party and be subject of a separate environmental assessment and planning approval. Other ancillary elements of the Proposal include:

- Storage tanks and other water management infrastructure;
- Fire water storage and firefighting equipment such as hydrants and pumps;
- Maintenance laydown areas;
- Stormwater basin;
- Diesel fuel storage tank(s) and truck unloading facilities;
- Site access roads and car parking; and
- Office/administration, amenities, workshop/storage areas.

Construction and commissioning activities are anticipated to commence early 2022 and the Proposal is intended to be fully operational by the end of 2023.

The nearest airports to the Kurri Kurri site are Maitland and Cessnock. Maitland Airport, which is the closest airport and home to the Royal Newcastle Aero Club (RNAC), has a single instrument (PANS-OPS) procedure. Cessnock Airport, home to a number of flying schools and a destination for many air tourers to the region, currently has no instrument procedures but is planning to implement one in the foreseeable future. There are several nearby smaller aerodromes or airstrips that also need to be considered.

The Proposal Site is located in Class G airspace, and also under a restricted military zone which, when activated by the Royal Australian Air Force (RAAF) at Williamtown, limits civil air traffic to a maximum altitude of 4500ft (1372m). A motorway, railway tracks and power lines are major features that are likely to be used for low-level visual navigation near the proposed site: their proximity to the site is considered in determining the likelihood of aircraft passing overhead the site/near the exhaust plume.

This aeronautical assessment is based on plume modelling provided by Jacobs using TAPM V4.0 and uses a methodology similar to that outlined in CASA's Advisory Circular 139-05(v3.0) — Plume Rise Assessments. This modelling considered two scenarios: single OCGT (Scenario One) and dual OCGTs (Scenario Two), but only the dual OCGT scenario is considered in this report. This is because the plume and potential risk posed by the single OCGT scenario is significantly less than that of the dual OCGT scenario.

The modelling results provide the frequency at which the plume will exceed selected velocities at relevant heights. The selected velocities are those considered by CASA to pose a hazard to particular types of aircraft. This provides a basis for assessing the risk posed to aircraft operations over the proposed power station.

This assessment focuses on the potential impact of the proposed power station on aircraft operating to/from Maitland and Cessnock Airports, transiting overhead the proposed power station, and touring or training in the airspace in the vicinity of the site. The proposed power station does not pose any risk to aircraft approaching or departing from other nearby airports because they are too remote from the power station.

The assessment includes consideration of the following factors for Maitland and Cessnock Airports:

- Analysis of the impact on the Obstacle Limitation Surfaces (OLS).
- Analysis of the impact on PANS-OPS instrument approach procedures to the airport.
- Consideration of the potential effect on published IFR traffic routes in the vicinity of the proposed power station.
- Consideration of the potential effect on VFR traffic that might come near the proposed power station.

Detailed consultation with all the various authorities, the airport operators and other relevant stakeholders has been undertaken.

The conclusion of the assessment provides an indication as to how the authorities might view the proposed power station and what mitigation, if any, might be required to remove any potential concerns.

2.1 NSW Planning Secretary's Environmental Assessment Requirements (SEARs)

SEARs for the preparation of an environmental impact statement (EIS) for the Hunter Power Project (previously referred to as the Kurri Kurri Power Station Project) (SSI-12590060) were issued by DPIE on 5th February 2021. A Key Issue in relation to aviation was stated as:

> *Hazards and Risks*
> *— a plume rise impact assessment prepared in accordance with CASA's guidelines for conducting plume rise assessments, and an assessment of the potential impact to aviation in the vicinity of the project.*

CASA's current guidelines are set out in the Advisory Circular AC 139-05 v3.0 Plume Rise Assessments. The regulatory and technical aspects of the Advisory Circular are discussed in more detail in section 3.4 Regulatory Context and Methodology (p12).

The following table lists the steps in the Plume Rise Assessment Process as defined in the AC, status notes and cross-references to relevant sections in this report.

Table 1 — Anticipated SEARs / AC 139-05 Process Steps Index

No	*Step(s)*	*Status / Comment*	*Reference*
1 & 2	Proponent Assessment of Plume Velocity & Form Submission	This report and the underlying plume rise modelling study by Jacobs document the Proponent's assessment. As the exit velocity exceeds 6.1m/s an application must be submitted to CASA. However, CASA has advised (Jan-2021) that these documents are to be first submitted as part of the EIS to DPIE. It is understood that DPIE will then refer the application to CASA.	—
3	Assessment of CPV & CPH by CASA	Following referral by DPIE, to be undertaken by CASA	Section 4 (p16)
4	CASA to Conduct Preliminary Airspace Risk Assessment	It is anticipated that CASA will critically review the impact and risk assessment documented in this report.	Section 6 (p25) Appendix 4 — Risk Assessment Matrix
5	Aviation Stakeholder Engagement	Conducted as part of this study	Section 5 (p24) Appendix 3 — Stakeholder Consultation Feedback
6	Impact Assessment	Conducted as part of this study	Section 6 (p25) Appendix 4 — Risk Assessment Matrix
7	Mitigation of the Impact of the Plume Rise Proposal	The AC states that CASA will work with the proponent to determine appropriate risk control measures, with potential control measures being: ➢ Engineering design or physical containment ➢ Procedural ➢ Reducing the exposure Based on the analysis documented herein, StratAir and the proponent believe that the first two types of mitigations are not required. Exposure reduction measures have been proposed herein.	Section 6.3 (p28) Section 7 (p32)

Ultimately, CASA will advise DPIE on the safety matters related to the power station plume rise risk and any mitigation required, and the Minister for Planning and Public Spaces will take this into account in issuing a decision in terms of the EP&A Act.

3. Aeronautical Impact Context

3.1 Location of the Proposed Gas Turbines

The location of the proposed power station exhaust stacks is provided in the table below.

Table 2 — Reference Assessment Coordinates

Gas Turbine Stack	*Geographic Coordinates — Latitude & Longitude*	*GDA94-MGA Coordinate Conversion Easting & Northing (Zone 56)*
OCGT1	32° 47' 07.722" S 151° 28' 42.682" E	357520 E 6371471 N
OCGT2	32° 47' 09.958" S 151° 28' 42.259" E	357510 E 6371402 N
OCGT Site Centre (for general reference)	32° 47' 08.85" S 151° 28' 42.48" E	357515 E 6371435 N

The centre of the 2x OCGTs is considered as the primary reference point for this assessment.

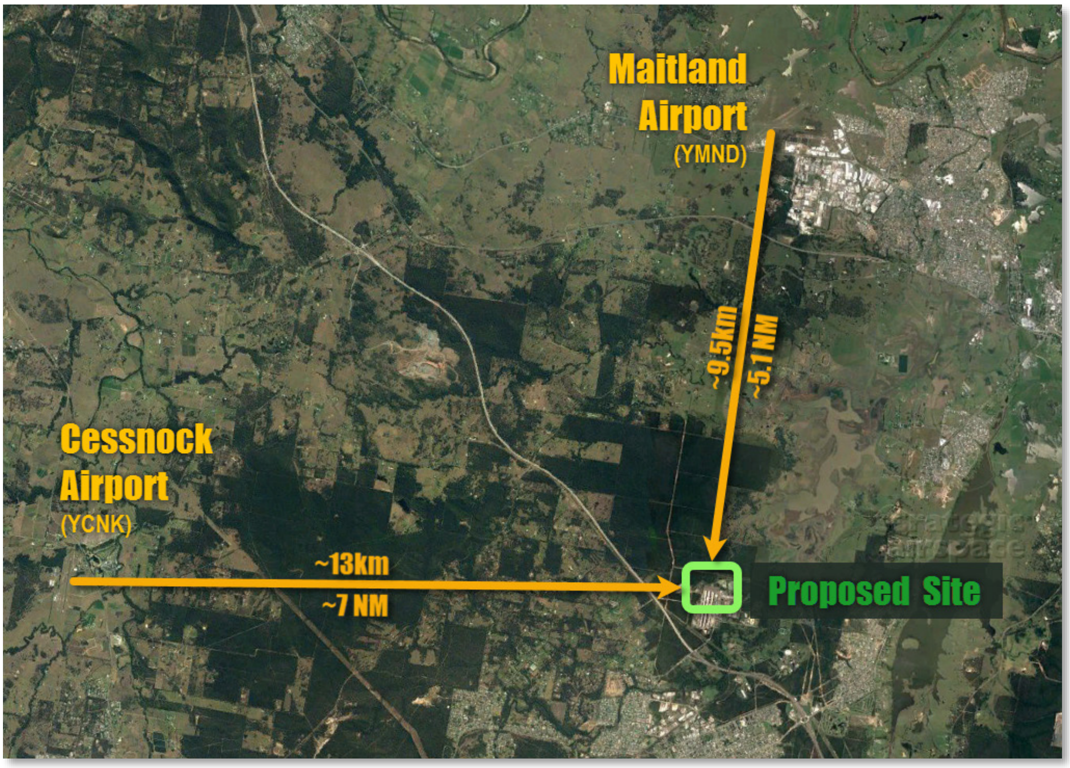


Figure 2 — Location of Proposed Site relative to the Two Nearest Airports: Maitland & Cessnock

3.2 Nearby Aerodromes

The relative locations of the two closest airports — Maitland and Cessnock Airports — are shown in Figure 2 above. Maitland Airport's elevation is 26m AHD and Cessnock Airport's elevation is 63m AHD.

For reference, the proposed site has a ground elevation of 14m AHD, and the stacks are 36m high. The average ground elevation within 2km radius being ~30m AHD.

3.2.1 Maitland Aerodrome

Maitland Airport is owned and operated by the Royal Newcastle Aero Club (RNAC). It has one instrument (IFR) procedure and supports visual (VFR) operations in Visual Meteorological Conditions (VMC).

Preliminary discussions with the RNAC Operations Manager indicated that training operations from the airport do involve flying near the proposed power station site. However, the power station is not seen as a hazard for these operations as VFR pilots usually fly at or above 1500ft AHD in that specific area.

3.2.2 Cessnock Aerodrome

Cessnock Airport is owned and operated by Cessnock Council. Currently it supports only visual operations (VFR). There are plans to lengthen and re-surface the current runway and implement a GNSS (PANS-OPS) approach so that it can support instrument (IFR) approach operations. This will expand the training capability of the airport.

The airport is mostly used for training and general aviation. It currently has three flying schools (for aeroplane and helicopter flight training) and a fourth, which is larger than the combined current three, is considering moving to Cessnock. When the fourth moves to Cessnock there will be over 50 training aircraft operating from the airport.

3.2.3 Other Nearby Aerodromes

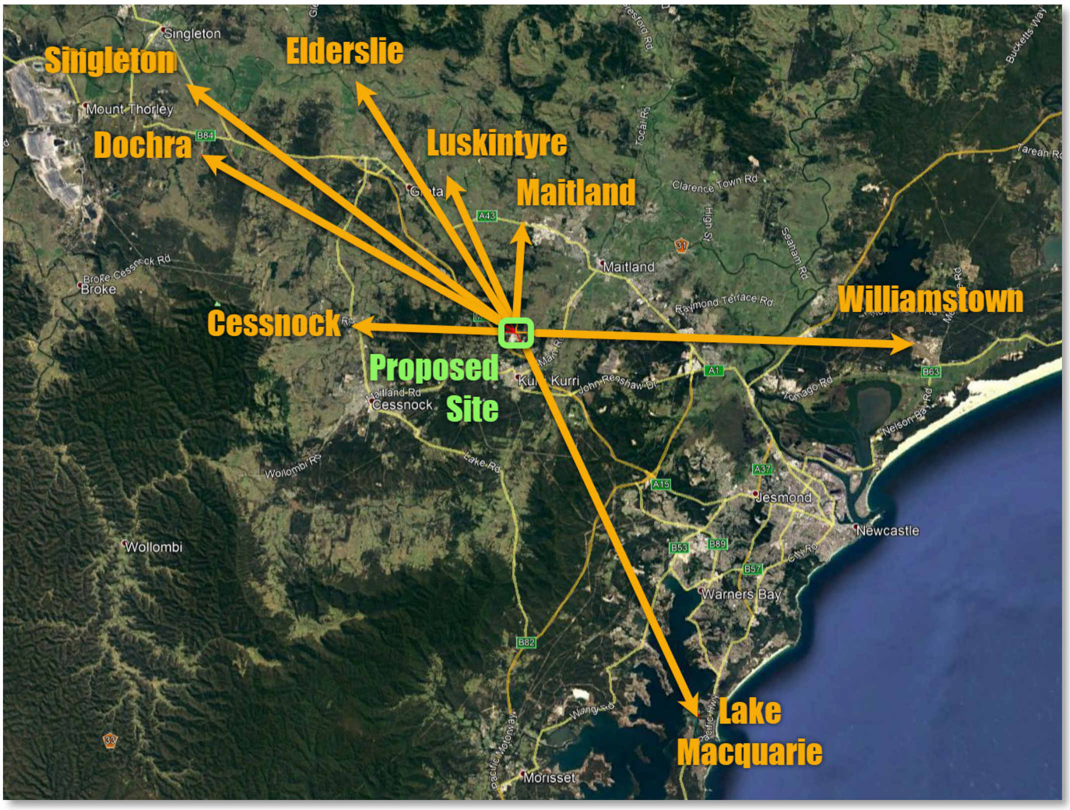


Figure 3 — Aerodromes in the Vicinity of the Proposed Site

Luskintyre airfield is only slightly further away from the site at ~14km. The airfield is used mainly as a home-base for vintage aircraft restoration and as such has only limited traffic flying in/out. Other busier aerodromes are further away but enroute traffic to/from those aerodromes may still be affected by the proposed power station.

Table 3 — Aerodromes in Vicinity of the Proposed Site

Aerodrome (ICAO Designator)	*Distance*	*Relative to Site*	*Significance*
Maitland (YMND)*	9.5 km *5.1 NM*	N	General Aviation and flight training.
Cessnock (YCNK)	13 km *7 NM*	E	General Aviation and flight training.
Luskintyre (YLSK)	14 km *7.6 NM*	NNW	Aircraft restoration and museum
Elderslie (YEES)	24 km *13 NM*	NNW	General Aviation and flight training.
Dochra (YDOC)	29 km *15.7 NM*	WNW	Military reserve air strip.
Williamtown (YWLM)*	33 km *17.8 NM*	E	Joint Civil/Military Airport (Newcastle) RAAF operations and flight training.
Singleton (YSGT)	33 km *17.8 NM*	NW	Military reserve air strip.
Lake Macquarie (YLMQ)*	35 km *18.9NM*	SSE	Gyrocopter, Microlite (powered gliders), Helicopter and parachuting.

** Instrument flight procedure(s) published for this aerodrome*

3.3 Aeronautical Environment

3.3.1 Training Area between Maitland and Cessnock Airports

The airspace around the proposed site is part of a larger *de facto* flight training area and is also used for general aviation purposes.

Whilst pilots may fly as low as 500ft AGL there, they must fly no lower than 1000ft AGL over populated and built-up areas — and in this case it is worth noting that the site is only 2.6km from the township of Kurri Kurri and about 1.5km from the nearest rural housing to the south and south-east. As such, it is reasonable to assume that pilots would fly in that specific vicinity no lower than 1000ft AGL in any case.

Refer also to section 4.5 Visual (VFR) Operations Assessment (p21).

3.3.2 Airspace

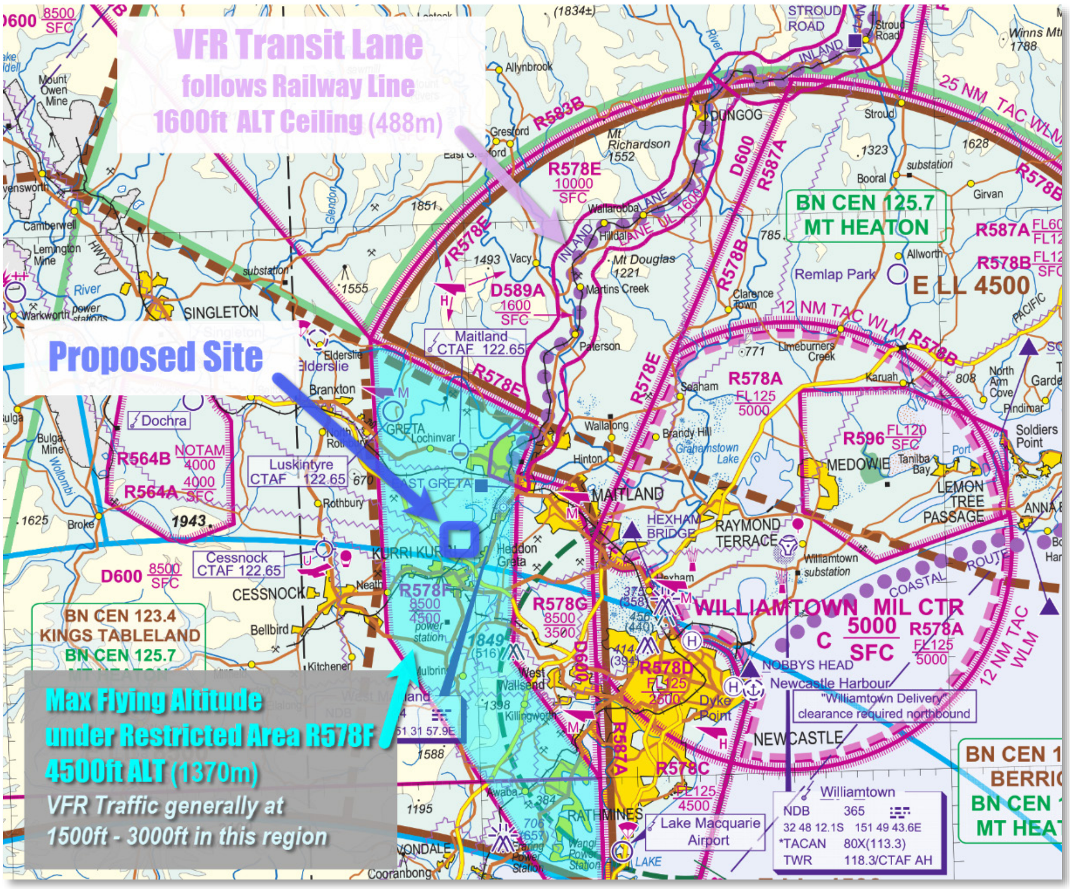
The site is located within Class G airspace, which allows for uncontrolled flights at low altitudes, up to 8500ft. The flight schools located in Cessnock and Maitland Airports generate a lot of low-level traffic in the area for training purposes. The area is also often used for tourist and sightseeing flights transiting from Williamtown and Sydney towards the Hunter Valley. There is also some regular ultralight traffic traversing the area out of Lake Macquarie.

Approximately 1km north of the proposed site is an area that is used regularly for helicopter training down to the ground (see Figure 11 below). The area is approved by CASA for use as a training area as published in the Operations Manual of training schools authorised to use that training area.

Some of the light traffic would regularly make use of a low-level corridor with an entry/exit point at 8.4km (4.5NM) North-North-East of the proposed site. The Inland Lane Ultralight corridor (covered by D589A going from ground to 1600ft) allows small aircraft to transit the military restricted area R578E (which covers a significant area from ground to 10,000ft) rather than having to circumnavigate it.

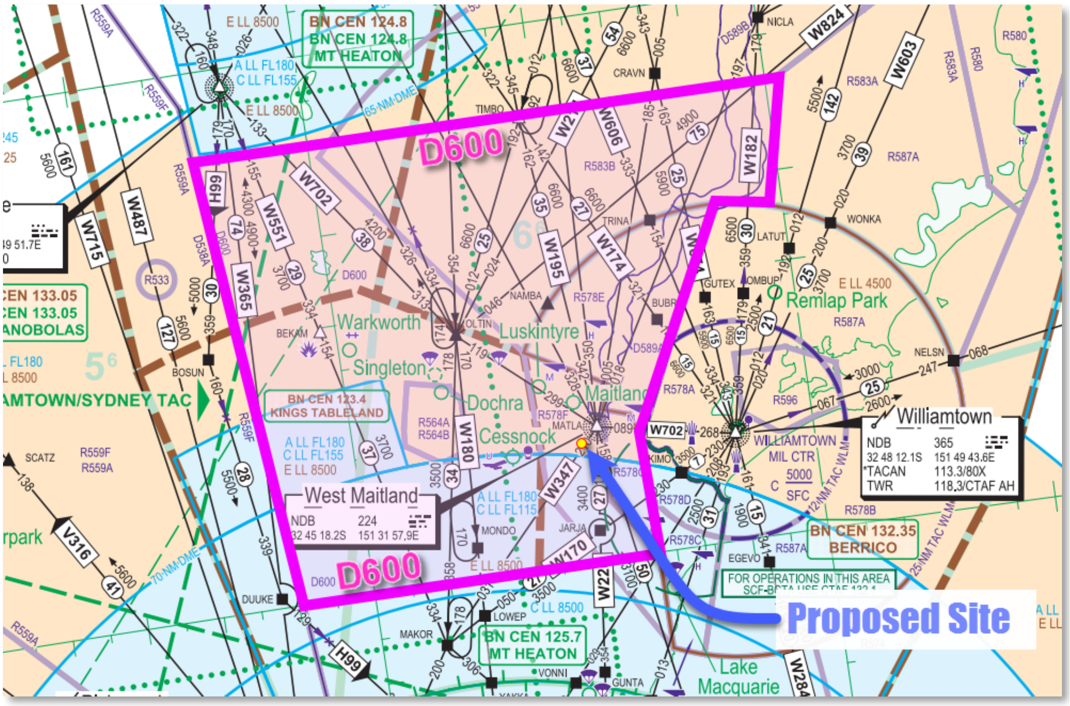
A military restricted airspace (R578F) may be activated at any time by the RAAF at Williamtown which would effectively force any civil air traffic transiting over the site to remain below 4500ft AMSL. A military danger area (D600) also covers the site from ground to 8500ft, which would be intended to be used as a military jet corridor when activated. The size of D600 makes it highly unlikely that even when used any military jets will transit overhead the site (refer Figure 5 below).

The location of the proposed power station is also shown below on the Newcastle Visual Navigation Chart (VNC). This chart shows most of the features that a pilot might use for visual navigation (such as roads, railways, power lines, built-up areas) as well as features a pilot should be aware of (such as airspace boundaries and limits).



Source: Airservices Australia, Newcastle VNC 05-Nov-2020

Figure 4 — Site Location, highlighted on the Newcastle Visual Navigation Chart (VNC)



Source: Airservices Australia, Newcastle Enroute Low 3 05-Nov-2020

Figure 5 — Extent of the D600 Danger Area

When flying using Visual Flight Rules (VFR) pilots will mostly follow prominent land features for navigation, such as railways, motorways and powerlines, albeit with a slight offset to the right so they can maintain visual contact with the feature. The significance of this is further elaborated upon in section 4.5 below.

Traversing the Class G airspace are two airways which pilots can use to navigate in bad visibility (IFR). Airways W347 and W702 pass just north and east of the site respectively. The airways have a minimum flight altitude of 3500ft and 3000ft respectively. The potential impact on aircraft traversing the airways is discussed in section 4.4 below.

The site also lies under the areas covered by Minimum Sector Areas (MSAs) related to instrument flight procedures for Maitland, Williamtown (Newcastle) and Lake Macquarie Airports.

3.3.3 Aircraft & User Types

The user community in the region includes flight training schools, flight students, PPL (private pilot licence) and RPL (recreational pilot licence) pilots and powered paraglider (PPG) pilots — including students and pilots from regions outside the Hunter Valley who wish to use the area for training and skills upgrading, and as a destination for tourism activities. It was not possible during this study to determine with any reasonable accuracy the number of aircraft which fly near the site.

Different aircraft types will be affected to a different extent by the plume exhaust, depending on their typical speed and weight:

Table 4 — Manual of Aviation Meteorology Classification of Turbulence Intensity

Type	*Description*
UL	Ultralights - eg, gyrocopters & microlites (powered paragliders), these are typically extremely lightweight and fly low and slow.

Type	*Description*
HEL	Helicopters - (excluding large heavy &/or heaving twin-engine helicopters used for fire-fighting, emergency, medical transport and so forth which would be regarded as light aircraft), these are typically heavier than ultralights, yet also fly at relatively low speeds. The tethering type rotors typically used on light helicopters pose an increased risk compared to regular light aircraft, due to the possibility of negative g's causing the rotor hub to impact the mast (mast-bumping).
LA	Light aircraft, such as single-engine Approach Category A aircraft, and including acrobatic and historic aircraft. For the purpose of the risk assessment for the plume rise, large &/or heavy twin-engine helicopters are considered in this category as well.
LLA	Large Light aircraft, such as twin-engine and small Approach Category B aircraft, generally likely to be touring aircraft flying into the region for tourism activities.
MIL	Military jets and similar fast moving traffic.
RPT	Regular Public Transport aircraft transiting near the site are generally small commuter type aircraft. These are multi-engine aircraft with typical weights high enough to make them practically immune to the effects of all but the most extreme vertical plume rises. Due to their mass and typical flight altitudes, these aircraft are not specifically listed in the risk assessment.

3.4 Regulatory Context and Methodology

CASA's approach to plume rise assessments has changed over the years; the different approaches are documented in various versions of CASA's Advisory Circular 139-5 "Plume Rise Assessments". These changes and their effects are discussed below. CASA's Advisory Circular 139-5(3.0) Plume Rise Assessments, published in January 2019, is the current version.

A General Background

One of the potential hazards to aircraft operations near airports that is identified in the Airports Act 1996 is high velocity vertical gas/exhaust plumes. The Act does not define what is meant by 'high velocity'. Subsequently CASA decided (to provide it with a means of enforcing the intention of the Act) that any vertical plume with a velocity greater than 4.3m/s could possibly be a hazard to some aircraft performing certain types of operation. So, 4.3m/s was included in the Airports (Protection of Airspace) Regulations 1996 (APARs). associated with the Airports Act. Unfortunately, CASA's corporate memory does not include any rationale as to why 4.3m/s was determined to be an appropriate critical velocity.

With the publication of the regulations and the initial plume rise assessment advisory circular, AC 139-5(0), 4.3m/s became the Australian standard for the Critical Plume Velocity (CPV) — under this regulation plumes could not exceed 4.3m/s if aircraft were at all likely to fly through them.

Note 1: There is no international standard, and some countries do not consider plume rise as a potential hazard. Also, the use of 4.3m/s as the CPV has been questioned/criticised by some respected international authorities.

Note 2: The Hunter Power Project does not require approval under the APARs because the nearby airports and their airspace do not fall under the Airports Act or the Regulations. However, the assessment process under the current AC 139-5 remains applicable.

B Introduction of Higher Benchmark Velocities

The *Manual of Aviation Meteorology*, published in 2003 by Airservices Australia but written by the Bureau of Meteorology (CASA was also involved in the development of the manual), gives different values for the 'Classification of Turbulence Intensity' that seem more reasonable than 4.3m/s. However, no reference is provided for the source of these numbers.

Table 5 — Manual of Aviation Meteorology Classification of Turbulence Intensity

Turbulence Class	*Velocity Range (m/s)*	*Potential Effects on Aircraft at the Altitude at which the Gaseous Efflux Velocity is Measured*
Light	**1.5 – 6.1**	Can cause momentary changes in altitude and attitude
Moderate	**> 6.1 – 10.6**	Can cause appreciable changes in altitude and attitude
Severe	**> 10.6 – 15.2**	Can cause large abrupt changes in altitude and attitude and a momentary loss of control
Extreme	**> 15.2**	Where it can be practically impossible to control the aircraft, and which can cause structural damage

The 2012 version of AC 139-05 introduced the *light* and *moderate* velocities but retained the 4.3m/s as the threshold or trigger for more detailed assessment (this lowest threshold will remain in the AC as long as the value is retained in 4.3m/s in associated regulations). In the 2012 version, if the exit velocity exceeded 4.3m/s the plume had to be assessed using the methodology described in the AC. 10.6m/s was defined as the Critical Plume Velocity (CPV). Critical Plume Height (CPH) was defined as height above which the plume velocity is always below the CPV.

Thus, an aircraft, of a type that might be affected by a plume rise, would avoid *severe* or *extreme* turbulence if it is always above the CPH when operating overhead a power station. Conversely, if the minimum altitude at which an aircraft performed a certain procedure is below the CPH then the plume rise needs to be considered as a hazard to the aircraft.

The latest AC (139-5 v3.0, published January 2019) increases the threshold exit velocity to 6.1m/s but does not specify a CPV. It simply states that CASA will assess the circumstances and decide upon a CPV. The 4.3m/s gets a mention but is no longer used in any meaningful way. Thus, CASA has made provision for more discretion in the assessment of plume rises.

In summary, the current criteria used by CASA are as follows:

- If a plume has an exit velocity greater than 6.1m/s then it must be assessed by CASA.
- CASA will only consider a plume rise as a hazard to aviation if it is likely to interfere with aircraft operation when aircraft are vulnerable. 'Vulnerable' is a little subjective; generally, for aircraft to be vulnerable they would be travelling at low speed at low altitude with the aircraft configured for take-off or landing and pilot is likely to have a high workload.
- CASA would not consider a plume with a velocity greater than 10.6m/s (as this is severe turbulence) at an altitude at which aircraft operate as safe for aircraft to fly through unless all such aircraft were heavy, traveling at high speed and appropriately configured.
- At any given altitude where the velocity might be between 6.1m/s and 10.6m/s CASA would probably apply a risk assessment using factors such as: number of different types of aircraft, weight and speed of aircraft, likely configuration, likely pilot workload and opportunity to avoid the plume.

C Introduction of Risk Assessment when Assessing Plume Rises

The 2012 AC introduced the concept of applying a risk assessment methodology to the plume rise assessment.

The 2019 AC now includes risk assessment as a means of determining the safety (or otherwise) of a plume rise. However, the risk assessment methodology that would be expected by CASA today is slightly different to the one CASA favoured in 2007. The means of determining the acceptability of likelihood and severity has changed in the intervening period to conform with that suggested by the International Civil Aviation Organisation (ICAO).

D Manual of Standards (MOS) Part 173 Rules for Plume Rises

The current version of MOS Part 173, which are the Australian regulations related to PANS-OPS instrument procedures, refers to gas efflux in only one section: 8.1.1.6 Danger Area Associated with High-Velocity Gas Efflux. It prescribes stipulations about minimum lateral and vertical clearances from plume-rise Danger Areas that must be included when designing conventional and GPS-based (RNAV) procedures. For RNAV procedures, the nominal final approach and missed approach tracks must clear the edge of a Danger Area by a minimum of 1000m.

E Example Precedent — Tallawarra B Power Station

In 2019 a project for the augmentation of the Tallawarra Power Station met significant resistance during consultation with aviation industry representatives, which resulted in the need to re-engineer the exhaust stack. This has led to uncertainty concerning the application of CASA's criteria for plume rise assessments.

There were a number of concerns with Tallawarra, as follows:

- The proposed site is very close to the aerodrome — approximately 4.3km from the Aerodrome Reference Point.
- The proposed efflux plume penetrated the Horizontal Surface of the OLS; this surface is intended to protect visual circling patterns used when aircraft are manoeuvring at low level to land.
- The criteria used by CASA was not appropriate for some of the smaller (ultralight) aircraft that use the airport. Moderate turbulence for normal fixed wing aircraft is considered extreme turbulence for ultralight aircraft.

Though the industry feedback was extremely negative in the case of the Tallawarra project, the situation is significantly different with the proposed Hunter Power Project because:

- The site is more than double the distance from the nearest airfield (9.5m vs 4.3km) and well outside the OLS for all nearby airports.
- Aircraft are not manoeuvring to landing at this distance and there is no impact on circuit traffic patterns. The traffic near Kurri Kurri would be considered enroute traffic and are flying faster and at greater altitude (than near Tallawarra) and hence less likely to be affected by the plume.

The significance of the plume interfering with the traffic pattern stems from the possibility that it may distract the pilot as they assess other traffic in the pattern and adjust accordingly. Additionally, the aircraft is being set up for an approach which involves lower speeds nearer the ground and the aircraft has extended control surfaces which will exacerbate the impact of vertical air movements. Near Kurri Kurri aircraft are in the enroute phase of flight where the pilots' main concern is navigation (ie, identifying ground features) and the aircraft is configured for cruise with higher speed, "clean" control surfaces and no close traffic.

In summary, the objections raised for the Tallawarra B power station are not relevant to the proposed Hunter Power Project.

3.4.2 Obstacle Limitation Surfaces (OLS)

Obstacle Limitation Surfaces are a set of planar and conical surfaces around an airport that are intended to limit the development of obstacles around the airport. The precise geometry of the OLS is determined by the runway geometry and the types of operations performed at the airport. The OLS are (primarily) intended to protect visual operations or the visual parts of instrument procedures.

The OLS may be penetrated by buildings, cranes and plume rises provided they do not impact the safety of the current types of operations in any way. Often CASA will require installation of warning lights on structures that penetrate the OLS including those that have a plume rise emanating from it.

For aerodromes like Maitland and Cessnock there are an Inner Horizontal Surface (IHS) and a Conical Surface to protect visual manoeuvring in the vicinity of the aerodrome. The IHS protects most of the area where pilots would manoeuvre using visual navigation, while the conical surface acts as a buffer area to account for occasional outliers in this type of manoeuvring.

3.4.3 PANS-OPS Instrument Approach and Departure Procedures

Instrument approach and departure procedures are used for safely landing or taking-off in poor weather conditions when visual flight cannot be used — ie, in Instrument Meteorological Conditions (IMC). The rule set for designing safe instrument approaches is called PANS-OPS (‘Procedures for Air Navigation Standards – Operations’, the navigation, design rules and safety standards which are developed and maintained by a panel of international experts organised by the International Civil Aviation Organisation (ICAO). In Australia these are regulated by the Manual of Standards (MOS) Part 173. Generally, PANS-OPS defines a set of protection surfaces used for analysing obstacles beneath the flight path; obstacles may not penetrate these surfaces. The surfaces are placed so that they are above all obstacles and maintain a vertical safety buffer beneath the minimum safe segment altitude for each phase of flight.

Under CASA’s rules a plume rise must have its CPH lower than the operating altitude of the minimum safe segment altitudes to remove any risk; otherwise, a risk assessment should be performed, and potential acceptable mitigations identified. One such acceptable mitigation might be to raise the relevant minimum obstacle clearance altitude (MOCA). It is mentioned as a possible mitigation in the latest AC, but it might not be possible or acceptable in some circumstances. If raising the MOCA is not possible then some other form of appropriate mitigation would need to be found.

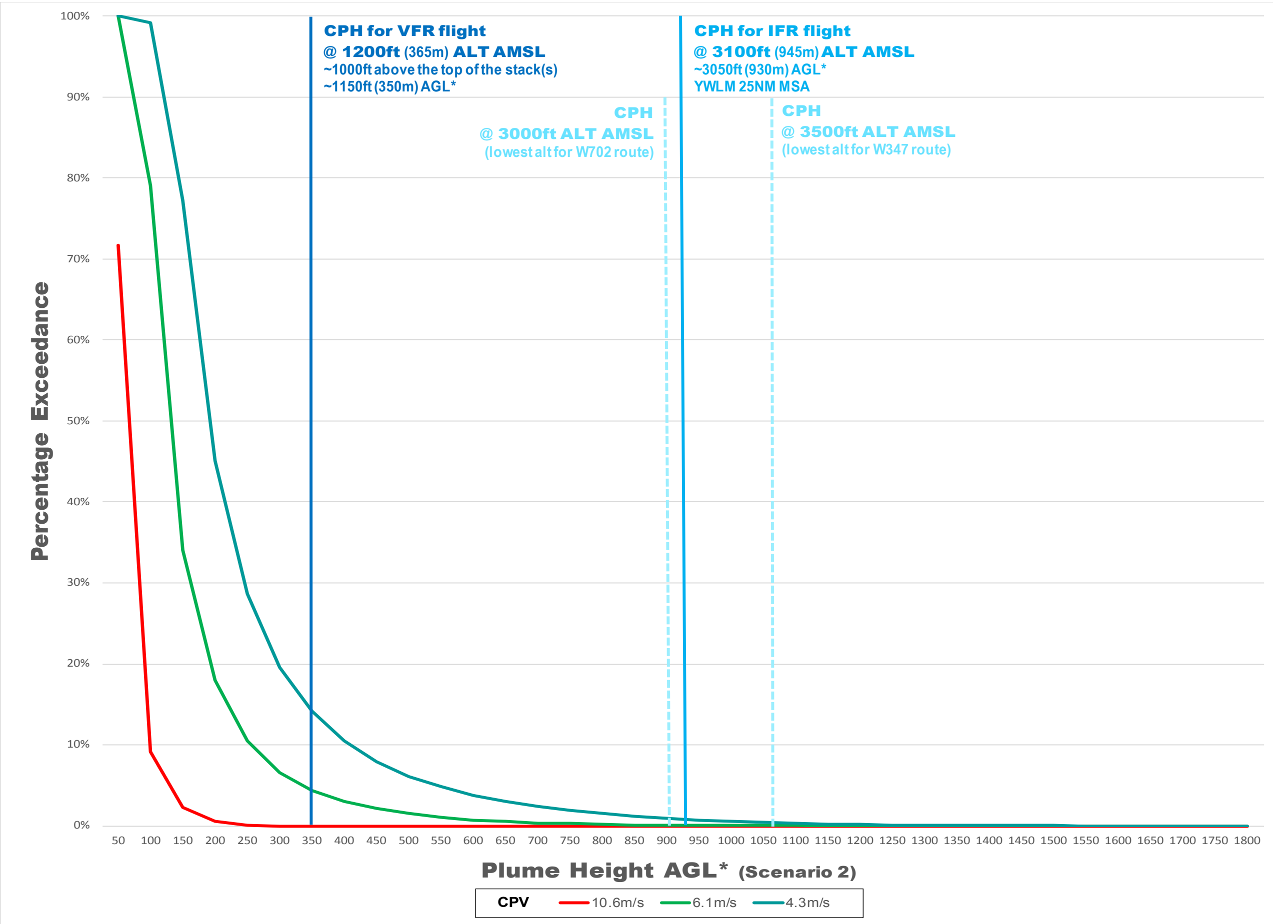
3.4.4 Other Considerations

Aside from the OLS and PANS-OPS related airspace protection, consideration is also given to potential impact on aircraft using airways over the site, and aircraft operating under visual flight rules (VFR), ie those that are navigating using only visual reference to the ground).

4. Analysis

4.1 Modelling of the Gas Efflux Plume(s)

Plume rise modelling has been undertaken by Jacobs using TAPM V4.0. The modelling assumes continuous operation of the gas turbines and uses weather data over a five-year period, as required by the AC. As previously noted, only the plume modelling results for Scenario Two are assessed for the EIS.



*Notes: * **Heights AGL** : Heights above Ground Level at the Stack*
Ground Height at Stack: 14m AHD. Stack Height 36m AGL. Ground Elev within 2NM of Stack 15-60m AHD (average ~30m AHD).
VFR Flight - Assumes flying 1000ft overhead the stack(s)
IFR Flight - Assumes flying no lower than 3100ft ALT AMSL as per the 25NM MSA for Williamtown (YWLM)

Figure 6 — Highest CPH for Visual and Instrument Flights (Scenario Two)

The Plume Height / Percentage Exceedance graph shows the percentage of time the plume rise would be above each 'benchmark' plume velocity (6.1m/s and 10.6m/s; 4.3m/s is considered as a 'critical' benchmark velocity for ultralight aircraft) at any height above ground if the power station were to be operated 24/7. Key heights above ground and equivalent altitudes for visual (VFR) operations and instrument (IFR) operations are shown as vertical blue lines. See also sections 4.3, 4.4 and 4.5 below for explanations of these key heights in relation to PANS-OPS flight procedures, IFR flights using the airways, and visual flight operations.

The percentages of exceedance can be used to assess risk to an aircraft if it is flying overhead when the power station is operating and consider control measures that could be implemented to reduce risk further. Note however that the modelling results are based on a 5-year simulation of continuous operation, and therefore the percentage frequencies of exceedance cannot be simply equated to the risk probability to aircraft — because it does not take into account the peaking nature of the station.

SHL are seeking approval to operate the power station at up to 10% of the year on gas and up to 2% of the year on diesel. However, it is likely that the power station will operate only 2% of the year and that operation can be anytime of the day or night but it is considered more likely during daylight hours than at night. Operating at such low percentages throughout the year significantly reduces the risk to aviation near the power station.

Further, the plume modelling does not distinguish between gas turbine and diesel-generation operation, where the latter has a lower plume rise profile — hence analysis of risk based on non-continuous operation is also conservative.

Table 6 — Scenario Two: Statistical Frequency of Plume Exceedance by Velocity & Altitude Bands — When the Plant is Operating

EIS Scenario 2: 2 x OCGT

3σ (99.7%) Certainty of Exceedance	
2σ (95.5%) Certainty of Exceedance	
3σ (99.7%) Certainty of NO Exceedance	***Exceedance practically impossible***
2σ (95.5%) Certainty of NO Exceedance	*Significant confidence of no exceedance*

Frequency of plume vertical velocity exceeding 4.3, 6.1 and 10.6 m/s in height bands

Height (m AGL)	Frequency of plume vertical velocity exceeding 4.3 m/s at each height (%)	Frequency of plume vertical velocity exceeding 6.1 m/s at each height (%)	Frequency of plume vertical velocity exceeding 10.6 m/s at each height (%)	Avg ALT (ft MSL) in Vicinity
50	100.00%	100.00%	71.67%	
100	99.26%	79.07%	9.16%	430
150	77.25%	34.10%	2.28%	590
200	45.06%	17.94%	0.51%	750
250	28.59%	10.55%	**0.07%**	920
300	19.56%	6.62%	**0.00%**	1080
350	14.16%	4.33%	**0.00%**	1250
400	10.51%	3.02%	**0.00%**	1410
450	7.92%	2.09%	**0.00%**	1570
500	6.05%	1.48%	**0.00%**	1740
550	4.79%	1.05%	**0.00%**	1900
600	3.74%	0.73%	**0.00%**	2070
650	2.99%	0.52%	**0.00%**	2230
700	2.43%	0.34%	**0.00%**	2400
750	1.93%	**0.25%**	**0.00%**	2560
800	1.55%	**0.14%**	**0.00%**	2720
850	1.20%	**0.10%**	**0.00%**	2890
900	0.94%	**0.07%**	**0.00%**	3050
950	0.71%	**0.04%**	**0.00%**	3220
1000	0.55%	**0.03%**	**0.00%**	3380
1050	0.43%	**0.01%**	**0.00%**	3540
1100	**0.29%**	**0.00%**	**0.00%**	3710
1150	**0.22%**	**0.00%**	**0.00%**	3870
1200	**0.14%**	**0.00%**	**0.00%**	4040
1250	**0.10%**	**0.00%**	**0.00%**	4200
1300	**0.06%**	**0.00%**	**0.00%**	4360
1350	**0.03%**	**0.00%**	**0.00%**	**4530**
1400	**0.01%**	**0.00%**	**0.00%**	ABV R578F LL

4.1.1 Plume Velocity Sensitivity Analysis

As the gas turbine and exhaust stack for the Proposal have not yet been selected, certain parameters including the exhaust stack exit diameter (and hence velocity) and height may be subject to minor changes from the values adopted in this assessment. As a result, a sensitivity analysis was conducted which used a 9m taller exhaust stack (45m height AGL), along with a stack exit velocity of 50 m/s (twice that used in this assessment), to determine the effects on the plume rise from the Proposal's two exhaust stacks. The analysis indicated that the maximum height at which the plume vertical velocity falls below the vertical velocity thresholds of 4.3 m/s, 6.1 m/s and 10.6 m/s would not be more than 10m higher for each case (which equates to an upper range of 33ft of altitude).

Thus, based on the modelling conducted, it was determined that the difference in plume height as a result of an increased stack exit velocity should not result in a significant change to that presented in this report and therefore would have a very similar level of risk to aircraft — the difference would be negligible and would be mitigated by the recommended control measures.

4.2 OLS Analysis

The nearest runway is at Maitland Airport (RWY 05/23). It is 1226m long with the threshold elevation of RWY05 at 85ft (25.9m AHD). As a Code 3 runway, it has an Inner Horizontal Surface (IHS) of 4km with a height of 45m above the lowest threshold elevation and a Conical Surface that rises with a 5% slope up to 75m above the IHS. For this Code of runway an Outer Horizontal Surface is not required. At 9.1km from the nearest runway threshold, the proposed site is located well clear of the OLS, which has a maximum radius of 5.5km measured from any of the runway thresholds. The site is also clear of the OLS of Cessnock Airport.

4.3 PANS-OPS (IFR) Operations Assessment

All aerodromes in the vicinity of Kurri Kurri with instrument (PANS-OPS) procedures, except for Maitland, are located relatively far away from the proposed development (>20km), and their runways and flight paths are oriented in such a manner, that the plume rise from the proposed power station will remain clear of the flight patterns associated with those PANS-OPS procedures. There are no instrument procedures currently published for Cessnock Airport however the airport owner is planning to have an RNAV (GNSS) approach implemented in 2021-2022. This new procedure will not be affected by the power station plume rise.

Minimum Sector Altitudes (MSA), which are arrival and general flight manoeuvring safety areas with radii of 30NM (56km) around every aerodrome with instrument approaches, could potentially be affected by the plume rise as they overlap the proposed site. The aerodromes that have an MSA extending over the proposed site are:

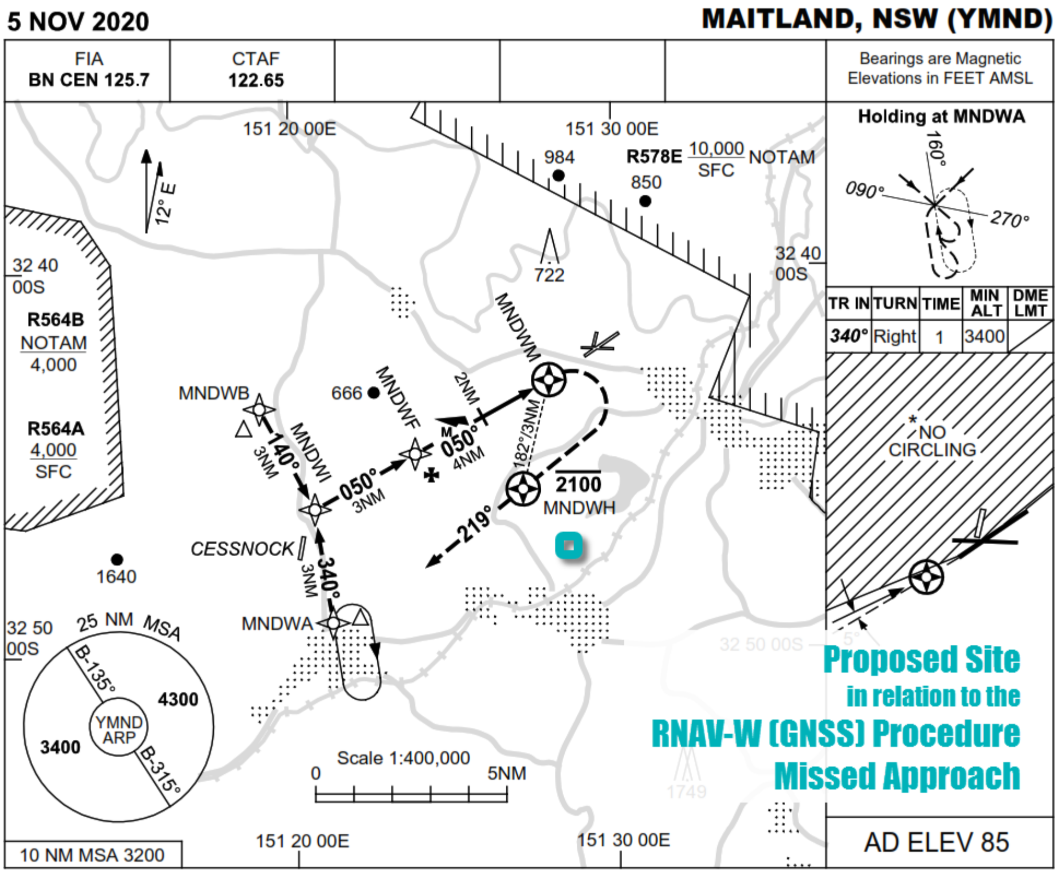
- Williamtown — MSA @ 3100ft (945m AHD)
- Maitland — MSA @ 3200ft (975m AHD)
- Lake Macquarie — MSA @ 3300ft (1006m AHD)
- *Cessnock — Future MSA for planned new RNAV Instrument Flight Procedure: reasonably anticipated to be no lower than any of the above*

These are the lowest altitudes at which aircraft operating under IFR will manoeuvre to join any of the published procedures at those aerodromes.

A summary of the PANS-OPS considerations is provided in the table below.

Table 7 — Summary of PANS-OPS Procedure Analysis

Procedure Type	*Procedure Height Limit*	*Percentage Exceedance*	*Comments & Potential Impact*
PANS-OPS Manoeuvring Surfaces			
Williamtown 25NM MSA *(Lowest MSA)*	**945m AHD** **931m AGL**	**>6.1m/s** **0%**	Aircraft will be too high to be affected by the plume rise. Probability of plume exceeding 6.1m/s at this height is 0%.
Visual Manoeuvring: Maitland & Cessnock*	**—**	**—**	The site is located outside the protection area for visual circling manoeuvres for Cat A & B aircraft for Maitland. * The site is outside the extent of future Cat A circling for the planned instrument flight procedure for Cessnock.
PANS-OPS Procedure Surfaces — Maitland			
RNAV-W	*** Say 2000ft** **~610m AHD**	**>6.1m/s** **0.73%**	The plume is near (8% in from) the outer edge of secondary protection area of the Missed Approach, approximately 3420m left of the fly-over MNDWH holding waypoint which has an altitude restriction of *not above 2100ft at the waypoint (see Figure 7 below). At an altitude of say 2000ft*, the probability of exceedance of the plume at 6.1 m/s is ~0.73%, which can be considered a 2σ Certainty of No Exceedance (refer to Table 6 above). If one was to also factor this by the probability of containment of the fix, which is no less than 95% according to PANS-OPS, the probability of the aircraft being overhead when the plume was operating and exceeded 6.1m/s is statistically negligible. Based on an estimated operating time at full load of about 2% per year the percentage of exceedance drops to 0.015%, and for a max 12% Capacity Factor per year the percentage of exceedance is below 0.09%: in both cases this could be considered a negligible risk. In relation to Part 173 design stipulations (refer section 3.4D, p14), the plume would not require any change to the existing procedure if a Danger Area were to be required by CASA (as an example, it would also be clear of a 0.5NM Danger Area by ~1500m).
Instrument Departures	**—**	**—**	N/A — There are no instrument departures from Maitland Airport
PANS-OPS Procedure Surfaces — Cessnock			
Future RNAV	**—**	**—**	The site would be outside any protection areas for a new RNAV procedure (planned as a circling procedure with a default landing on RWY35)
Instrument Departures	**—**	**—**	N/A — There are no plans for an instrument departure procedure for Cessnock Airport



Source: Airservices Australia, AIP DAP 05-Nov-2020

Figure 7 — Site in relation to the RNAV-W PANS-OPS Procedure to Maitland

In summary, there is almost no risk from the plume rise to aircraft using IFR procedures. The plume velocity is practically never high enough at the minimum altitudes for the relevant PANS-OPS procedures such that it might cause anything more than momentary 'hardly noticeable' effect on aircraft.

4.4 Operations Assessment of IFR Flights using Airways

The site is near an intersection of two low airways at the MATLA waypoint, which is located approximately 6km (3.3NM) to the north-east of the site.

The airways are:

- W347 — which connects the waypoint MAKOR in the south-west with MATLA; and
- W702 — which connects the waypoint OLTIN in the north-west to MATLA.

Airway W347 has a MEA (Minimum Enroute Altitude) of 3500ft, W702 has a lower MEA at 3000ft. Though the MEA for W702 is lower than the lowest applicable MSA for any of the nearby aerodromes, the primary protection area for the airway does not pass over the site, which implies that it is highly unlikely (less than 3 sigma[3]) that any aircraft following that airway would actually pass over the site.

3 3 sigma (3σ), or 3 Standard Deviations (3 SD), is a statistical term related to probability theory. Using a normal distribution, 3 sigma equates to 99.7%. In probability theory, any value that lies within the 99.7% probability is regarded as a *near certainty*.

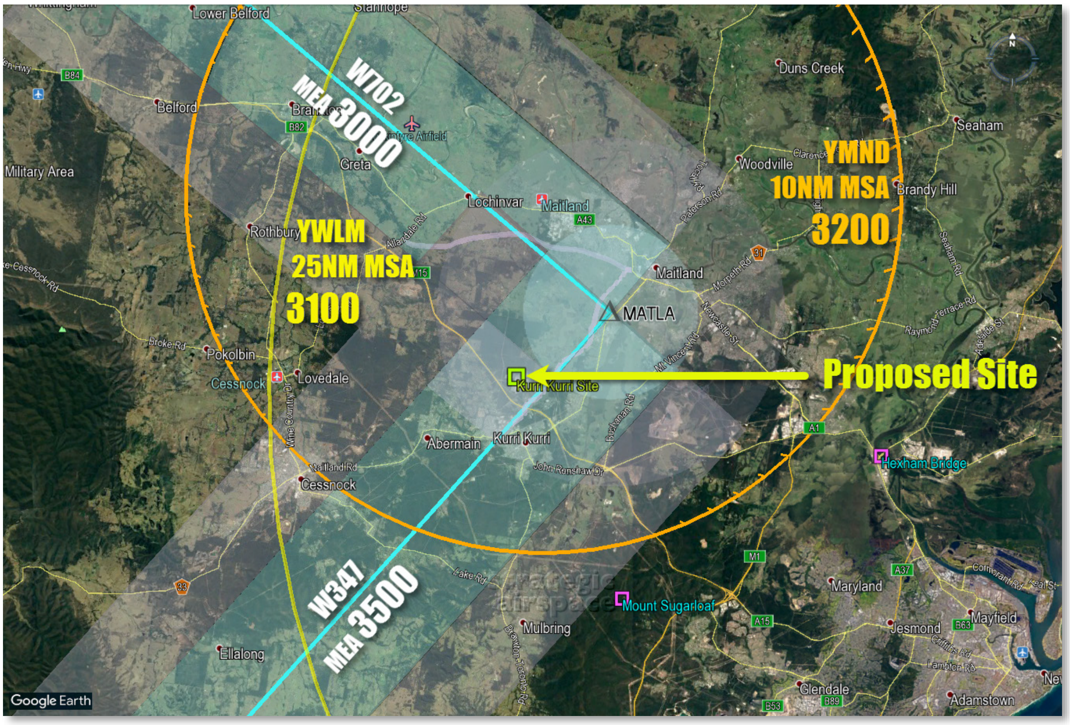


Figure 8 — Airways Over the Site and the Overlapping Maitland & Williamtown MSAs

4.5 Visual (VFR) Operations Assessment

The following has been noted about visual operations in the vicinity of the proposed site:

- Flight training for fixed wing and rotor aircraft in the general area between Maitland and Cessnock Airports, extending across the north of Kurri Kurri and the proposed site, and extending east to Hexham and Mt Sugarloaf.
- General VFR Flights — Not definable. Listed below for information are key features that may be used by pilots for visual tracking and navigation.
  - There is a low flying corridor going S-N along the railway with an entry/exit point over Maitland Station approximately 8km NNE of the proposed site.
  - There is a motorway just South West of the proposed site and a railroad track East of the site. These features may be used for reference by pilots flying visually.
  - There are nearby powerlines to the north and east of the proposed site.
- VFR transits from the south (eg, Sydney) by tourists and students to the Hunter Valley for pleasure or training flights
  - Whilst not normally definable, it is known that pilots will often take a track through a gap in the hills from the Pacific Highway during times of low visibility and/or a low ceiling, and then track north. If flying to Maitland the track is most likely to pass immediately to the east of the Kurri Kurri site, as illustrated in Figure 10 and Figure 11 below.
- There is a military restricted area overhead the site with a lower limit of 4500ft, which means non-military VFR traffic must remain below that altitude when passing overhead the site to avoid infringing the restricted area (when it is activated). This area, R578F, is depicted in Figure 4 above (p10).

  Airservices Australia is in the process of reviewing the airspace around Williamtown and in 2020 conducted remote consultation with local stakeholders, including airports, the RNAC and flying schools. It is understood that one of the objectives was to lower some airspace sectors which could potentially *reduce the maximum altitudes for VFR operations. It is unlikely that there will be any adverse impact on the SHL project as the changes proposed by Airservices do not cover the military restricted airspace.*

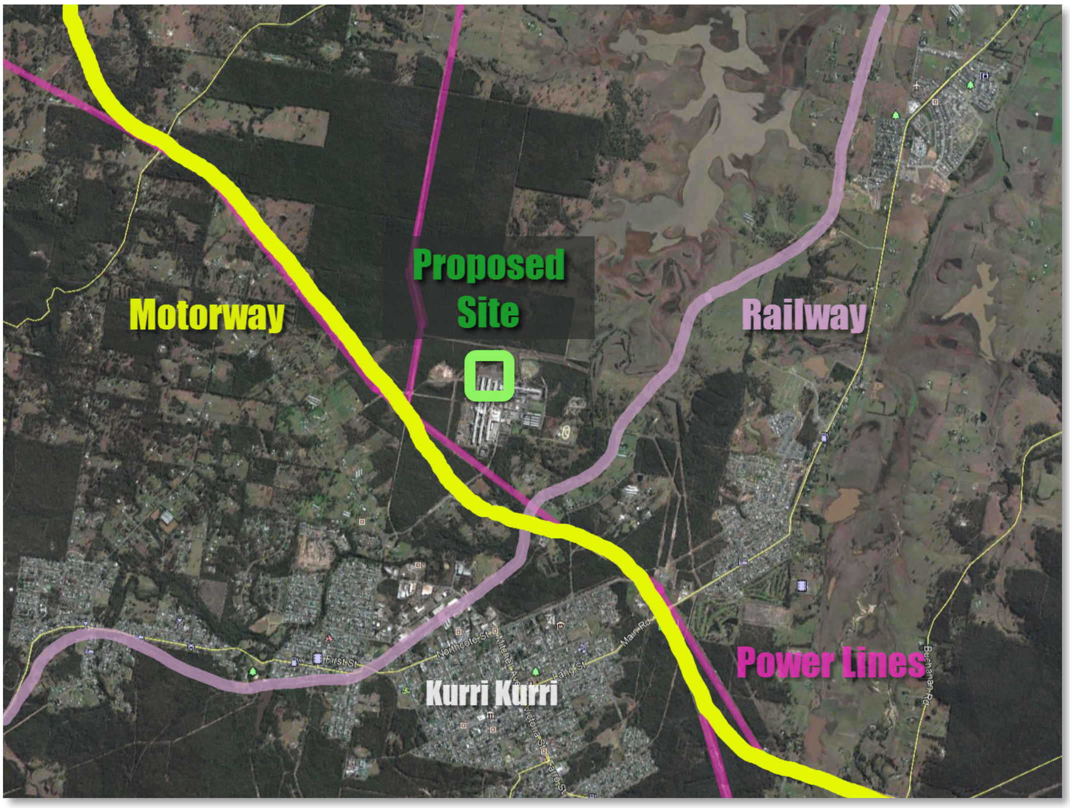


Figure 9 — Key Features that may be used when Flying Visually

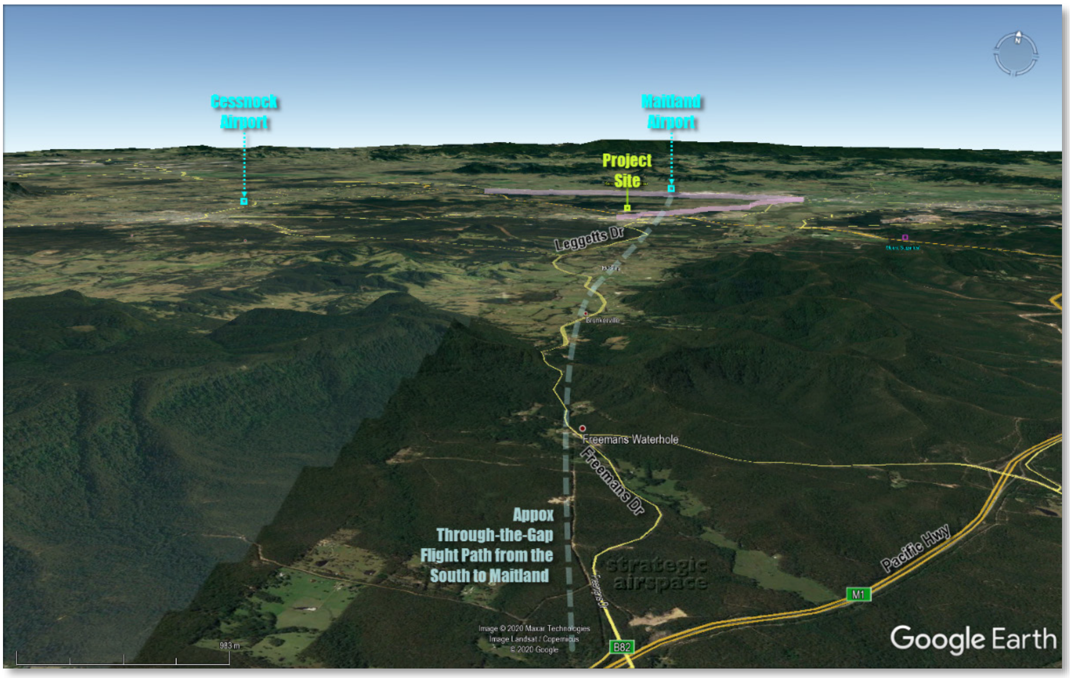


Figure 10 — Approximate Flight Path used by VFR Pilots from the South Transiting "Through the Hills" in times of Low Visibility or a Low Ceiling

During the day in good weather conditions pilots are allowed to fly as low as 500ft outside built-up areas, but they have to maintain a 1000ft height over built-up areas and remain 1000ft above the highest obstacle in a 10NM radius when flying at night. Local aerodromes also promote "fly neighbourly" principles, which promote the practice of flying at 500ft above the legally required minimum to reduce noise impact on the ground. As such it is reasonable to assume that most flights will pass overhead an industrial installation at no less than

1000ft above the tallest obstacle (the exhaust stacks) most of the time, which in that vicinity translates to an altitude of ~1200ft AMSL. At this altitude over the proposed site the plume would be almost entirely dissipated more than 95% of the time if the plant operated continuously (as per the 5-year model simulation results) — but if the plant operated only 2% of the time as expected, the frequency of exceedance of 6.1m/s over the year drops to ~0.09%, which is less than once per year. Note also that this is a conservative altitude as local stakeholders have reported that, from their experience, the majority of aircraft would transit over the general area at altitudes from 1500-3500ft.

It is also noted that there is a CASA-approved low flying area for helicopter training north of the site, as depicted in Figure 11 below. This area, which permits helicopters to conduct training from ground elevation to 500ft AGL, is used by the helicopter training organisations based in Lake Macquarie and Cessnock. As the closest part (the south-western corner) of this area is approximately 1km north of the proposed Kurri Kurri site, there should be no reason for helicopters to fly low over the site to access this area at less than 500ft AGL.

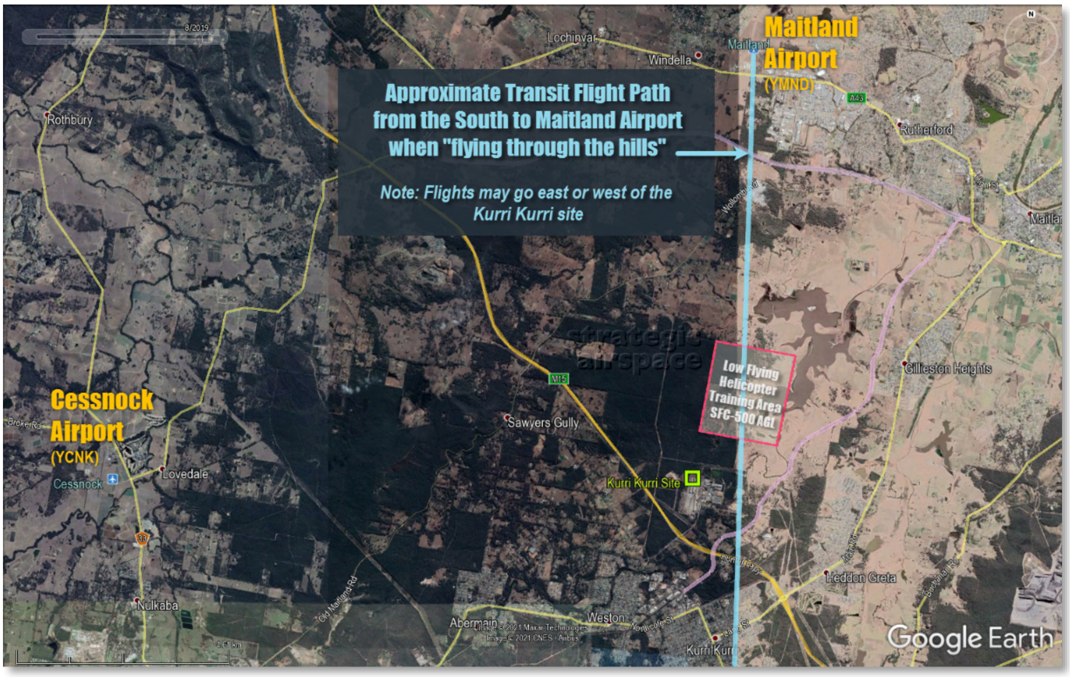


Figure 11 — Low Flying Helicopter Training Area north of the Kurri Kurri Site & Overhead View of the VFR Transit to/from the South

5. Consultations

Briefing and consultation meetings were held with local stakeholder organisations and individuals in the Hunter Valley in late December 2020 at both Maitland Airport (Royal Newcastle Aero Club) and Cessnock Airport.

Remote consultations by phone and email were also held during the period November 2020 through January 2020 with organisations who were unable to attend the local consultation meetings in the Hunter Valley, including training organisations from Lake Macquarie Airport, Defence (for RAAF Williamtown), Airservices and CASA.

In summary, local stakeholders advised that training operations and general VFR flight do involve flying near the proposed power station site, which previously was visible because of the tall stacks of the former, demolished aluminium smelter plant.

The consensus was that the power station is not seen as a hazard for these operations as VFR pilots usually fly at or above 1500ft AMSL in that specific area. All agreed that the best form of mitigation is publication of the plume site on charts (VNC and VTC). Some proposed that obstacle-type lights be activated when the plant was operating, a suggestion which was regarded as favourable and do-able by the Snowy Hydro representatives at the local stakeholder meetings. Some queried whether a Danger Area would be put in place, and a few thought it would be useful not so much for local flyers but for pilots flying in from elsewhere who may not necessarily see the plume symbol on a VNC or VTC (or be able to accurately locate it or appreciate potential impact) but would see a Danger Area on their electronic charts (eg, via an Electronic Flight Bag application on an iPad or tablet).

At the time of this report, the Department of Defence (as the operator of Williamtown Airport) has been provided with the Feb-2021 version of this report and the Jacobs Plume Rise report and other information requested in order to support their evaluation of this project. This process is ongoing.

Project briefing material has also been made available to other potential stakeholders through the Aviation State Engagement Forum (AvSEF). Feedback via this mechanism is open until close of business on 31st March 2021 (refer https://www.avsef.gov.au/nsw-proposed-kurri-kurri-gas-fired-power-station-hunter-valley)

Records of stakeholders at the Hunter Valley meetings and those contacted remotely, and their feedback, can be found in Appendix 3 — Stakeholder Consultation Feedback.

6. Risk Assessment

The vertical velocity of the plume may be considered as a hazard to certain types of aircraft at low altitudes. This section identifies the risks and proposes a range of mitigations for those circumstances where the application of control measures could reduce the risk to a level As Low As Reasonably Practicable (ALARP) or an Acceptable Level of Safety (ALoS).

The tabular data in Appendix 4 — Risk Assessment Matrix provides a detailed analysis of the risks the vertical plume rise poses to various types of aircraft at the minimum altitudes at which they are likely to operate.

6.1 ICAO Risk Classification

The risks are classified in accordance with the Safety Risk Assessment Matrix documented in ICAO Doc 9859 Safety Management Manual (SMM), as recommended by CASA in their Safety Risk Management Guide (SMS for Aviation — A Practical Guide, 2nd Edition, December 2014).

Table 8 — ICAO Doc 9859 SMM Safety Risk Assessment Matrix

		Risk severity				
		A	B	C	D	E
Risk probablility		Catastrophic	Hazardous	Moderate	Minor	Negligible
5	Frequent	5A	5B	5C	5D	5E
4	Occasional	4A	4B	4C	4D	4E
3	Remote	3A	3B	3C	3D	3E
2	Improbable	2A	2B	2C	2D	2E
1	Extremely improbable	1A	1B	1C	1D	1E

As specified in the matrix above, risks are classified as either unacceptable (red), tolerable (orange) or acceptable (green) based on the likelihood (probability) and severity of the risk (consequence). Where mitigation is possible a secondary assessment of the risk is made to determine if the mitigation would be able to reduce the risk classification, in accordance with the ALARP principles, to a tolerable or acceptable level that can be regarded as an Acceptable Level of Safety.

This approach has been adopted in the risk assessment undertaken as part of this study.

The ICAO definitions for Risk Probability and Risk Severity, as defined in ICAO Doc 9859 SMM, are provided in Table 9 and Table 10 below.

Table 9 — ICAO Doc 9859 Table 1: Safety Risk Probability Table

Likelihood	*Meaning*	*Value*
Frequent	Likely to occur many times (has occurred frequently)	5
Occasional	Likely to occur sometimes (has occurred infrequently)	4
Remote	Unlikely to occur, but possible (has occurred rarely)	3
Improbable	Very unlikely to occur (not known to have occurred)	2
Extremely improbable	Almost inconceivable that the event will occur	1

Table 10 — ICAO Doc 9859 Table 2: Example Safety Risk Severity

Severity	*Meaning*	*Value*
Catastrophic	• Aircraft / equipment destroyed • Multiple deaths	A
Hazardous	• A large reduction in safety margins, physical distress or a workload such that operational personnel cannot be relied upon to perform their tasks accurately or completely • Serious injury • Major equipment damage	B
Major	• A significant reduction in safety margins, a reduction in the ability of operational personnel to cope with adverse operating conditions as a result of an increase in workload or as a result of conditions impairing their efficiency • Serious incident • Injury to persons	C
Minor	• Nuisance • Operating limitations • Use of emergency procedures • Minor incident	D
Negligible	• Few consequences	E

6.1.1 Risk Probability

There are several components of the risk probability as follows:

- *The probability that the plume rise is present (ie, that the power station is operating).* The maximum operating time for which approval is being sought is 12% per annum, which means that there is a maximum probability of 0.12 that the power station would be operating at any given time. However, based on an expected operation time of 2% per year, there would be a significantly reduced probability of 0.02 that it will be operating at any given time.
- *The probability that the plume vertical velocity is greater than any appropriate critical value.* The critical values are somewhat dependent upon the type of aircraft and the type of operation. For example, an ultralight aircraft will have a lower tolerance to a given plume velocity than a light or heavier/faster fixed wing aircraft.
- *The probability that the plume velocity is greater than any particular critical value at any particular altitude* — which can be derived from the percentage exceedance graphs. This is dependent upon the exit

temperature which can be monitored to ensure the original modelling assumptions are correct.

- *The probability that an aircraft performing a particular type of operation is directly overhead the exhaust stack* — cannot be determined with any certainty. However, some 'rules-of-thumb' can be applied in some circumstances.

6.1.2 Risk Severity

Risk severity is dependent upon a number and combination of factors as outlined below:

- Type of aircraft — the grouping of likely aircraft types is defined in section 3.3.3 Aircraft & User Types (p11).
- Pilot experience — this is not explicitly modelled in the Risk Assessment Matrix but is somewhat implicit in the types of aircraft.
  We also assume that all pilots who fly near the proposed site have the essential basic competencies that can be assumed according to their pilot licences such as Student Pilot Licences with solo privileges, Private Pilot Licence (PPL) or RPL (Recreational Pilot Licence) and associated currency/recency requirements of their licences. Further, an implicit mitigation for training pilots is that they will be flying with their instructors.
- Configuration of aircraft — it is assumed that all aircraft flying very near to or directly overhead the site are in transit because:
  - approach and landing, initial missed approach, and take-off phases of flight are considered irrelevant due to the distance of the site from nearby landing fields; and
  - the site is adjacent to an existing built-up area and is likely to be part of a visible industrial park style complex, and so it is assumed that pilots will not attempt to undertake aerial acrobatic nor stall recovery type training manoeuvres.
- Speed and proximity of aircraft to the ground — these factors are included in the Risk Assessment Matrix.

6.2 Summary of Risk Assessment

The first pass risk assessment was the plume rise modelling data (resulting from a simulation of continuous operation over five (5) years) in order to examine the likelihood and severity of a risk to aircraft when the plant is operating. On this basis, the majority of cases evaluated result in a risk classification in the Acceptable (green) level. None result in an Unacceptable (red) risk assessment.

Of those cases which, upon evaluation, fall into the Tolerable (orange) level, control measures have been proposed to reduce the probability and/or severity of the risk to either a more Tolerable Level or to an Acceptable Level. These cases are clearly displayed in Appendix 4 — Risk Assessment Matrix.

It is impossible to estimate the number or frequency of aircraft (of any type) flying in close proximity to the power station. Were this statistic available, or even possible to estimate, the probabilities derived from the plume modelling and the plant operating frequency should be multiplied by the number of close proximity aircraft per time period. It should be noted that all the proposed controls are intended to limit the number of aircraft in close proximity so if any of the controls are implemented the number of aircraft overflying or in close proximity diminishes dramatically and can effectively be ignored.

The few cases where, if an Ultralight, Helicopter or Light Aircraft were to pass over the site at 600ft AMSL (~500ft AGL) at low speed, the possible severity on those occasions where the plume rise exceeded that altitude at 10.6m/s could not be minimised — noting however that the probability of exceedance is very low: 0.05% (~4 hours per year) if operating 2% of the time as anticipated; and 0.27% (or less than 1 day per year) if operating at the maximum 12% of the time.

The frequency of exceedance of any vertical velocity (4.3m/s or higher) drops significantly to a level where there is a 3 sigma or 99.7% probability[4] of no exceedance above 1200ft AMSL (1000ft above the stacks) when operating at the expected 2% operating time — this means a probability of encountering plume exceedance less than once per year (and never at 10.6m/s).

The reduced probabilities of exceedance are shown in the '2*% Op pa*' and '12*% Op pa*' columns in the Risk Assessment Matrix.

Regardless of the very low probabilities of risk to aircraft, the best form of mitigation is to promote a situation whereby low overflight of the site, especially at low speed, does not occur.

6.3 Proposed Risk Control Measures

Several fairly simple control measures that can be implemented to diminish any of the "tolerable" risks have been identified. These measures, listed below, are intended to reduce the likelihood of an incident occurring. The best form of mitigation is to help ensure that an aircraft does not fly directly over the site, or if it does not at low altitude at low speed.

The proposed mitigations are:

- **Publication of a plume rise symbol on aeronautical navigation charts (the Newcastle VTC and VNC, and the Enroute Low 3)**.
  An example is depicted in Figure 12 below.
  - We propose that the plume rise symbol be published — but without a top altitude, for several reasons.
    - The value of annotating a top altitude on the charts should be questioned and the methods for determining any top altitude should be considered.
    - For example, if a maximum altitude is proposed, what vertical velocity (ie, 4.3 m/s or 6.1 m/s) would the altitude be based on? If 6.1 m/s, there is a higher probability that the plume exceedance on a given day and time may affect an ultralight if it was to overfly the plume at the noted altitude. Conversely, if the noted altitude was based on 4.3 m/s, this may adversely constrain all other aircraft. And would the altitude be based on a 0% no exceedance, or a percentage which would be within an acceptable level of safety (eg, 99.7% frequency of no exceedance)?
    - CASA has previously recommended top altitudes to be published with plume rise symbols on navigation charts (eg, for Laverton on the Melbourne VNC and VTC), but it is now difficult to trace the basis of the altitude calculation, and it is possible that the published value is no longer appropriate.
    - Regardless of what vertical velocity may be used, if required, the practice of rounding up the top altitude to the nearest 1000ft is considered overly conservative, especially in this case where most flight operations would

4 *Ibid*
This can also be read that any frequency of exceedance less than 0.3% (1 – 0.997) is regarded as *practically impossible* according to probability theory.

be adjusted in the 100s of feet and there is a maximum altitude for non-military flight operations overhead due to the MIL restricted area R578F which has a lower limit of 4500ft.

- Two existing Plume Rise symbols (located south and west-south-west of Williamtown Airport) on existing aeronautical charts — the Newcastle VNC and VTC and additionally on the Enroute Low 3 chart — do not have top altitude annotations. These can be considered as a precedent for not annotating the proposed Plume Rise symbol for the Hunter Power Project.
- The charting of a plume rise symbol (without a top altitude) is recommended and will probably be required by CASA.

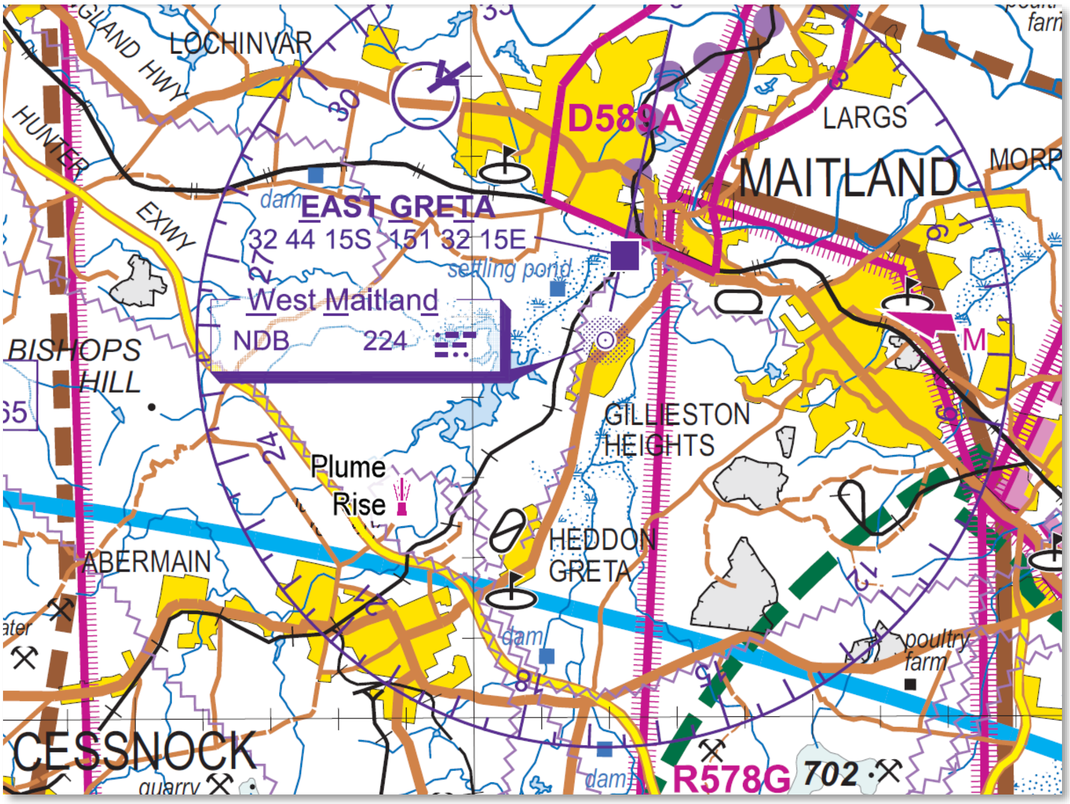
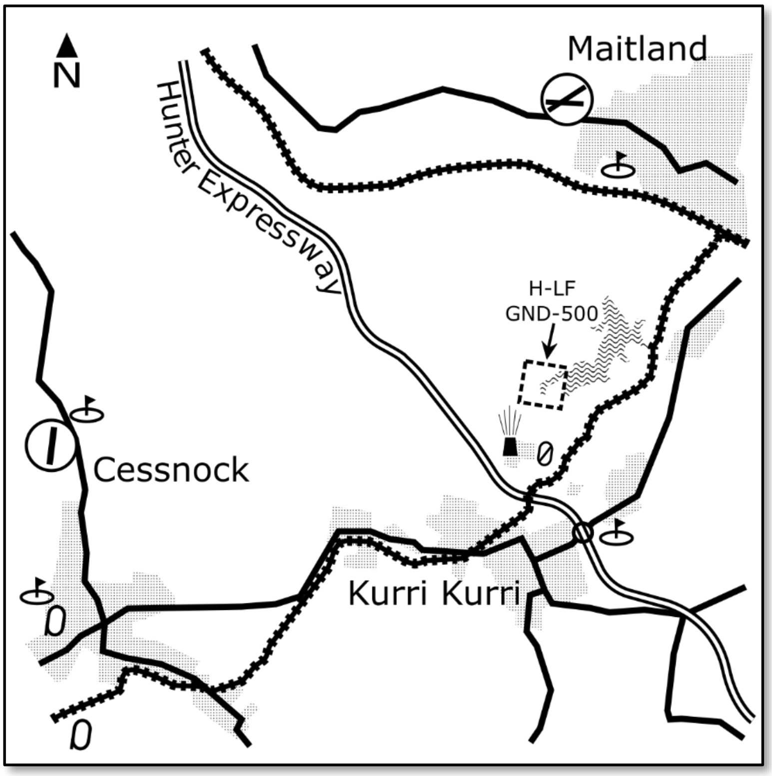


Figure 12 — Example of a Plume Rise Symbol on the VTC

- **Notes and/or a Diagram in the Additional Information section in the ERSA Aerodrome pages for Maitland and Cessnock Airports**
  — as per the example in Figure 13 below.
  - It would be the responsibility of each airport to submit this data to Airservices for publication in ERSA and maintain it.
  - Any such diagram should also include depiction of the Low Flying Helicopter Training Area, which appears not to be published in publicly available aeronautical charts or other AIP information (but only in the Operations Manuals of Training Operators approved to use this area).
  - This will provide the most effective means of conveying accurate location information for VFR pilots (especially those doing flight training) — but will be of value only to those who read the ERSA AD information for Cessnock and/or Maitland Airports.
  - We propose to include a note to avoid overflight. The example provided below includes a suggested advisory minimum overflight altitude of 2500ft. As an advisory minimum it does not require aircraft to fly above this altitude; it is suggested purely as a means of discouraging direct or low altitude overflight. At 2500ft there is practically no chance (<3 sigma) of the plume exceeding

6.1m/s and only a minimal possibility (<2 sigma[5]) of the plume exceeding 4.3m/s based on the 5-year continuous operation model — but with substantially reduced likelihood because as a peaking power station it will not operate continuously.



MAITLAND AIRPORT (YMND)

4 Helicopter Low-Flying Area GND-500FT 173 BRG MAG 4.0 NM from Maitland (YMND) AD

5 Gas Efflux Plume 177 BRG MAG 5.1 NM from Maitland (YMND) AD — north of Kurri Kurri, 1km west of Loxford Park Speedway and 1km south of the Low-Flying Helicopter Training Area. Obstacle lights active when operating. Avoid overflying below 2500ft when operating.

CESSNOCK AIRPORT (YCNK)

4 Helicopter Low-Flying Area GND-500FT 072 BRG MAG 7.2 NM from Cessnock (YCNK) AD

5 Gas Efflux Plume 079 BRG MAG 7.0 NM from Cessnock (YNCK) AD — north of Kurri Kurri, 1km west of Loxford Park Speedway and 1km south of the Low-Flying Helicopter Training Area. Obstacle lights active when operating. Avoid overflying below 2500ft when operating.

Figure 13 — Proposed Additional Information for the ERSA AD Pages for Maitland & Cessnock Airports

- **Lighting on the exhaust stacks that are activated when the power station is operating**.
  - If required, CASA would provide a recommendation on the type of obstacle lights to be used.
  - If this is agreed, the Plume Rise symbol on the VNC and VTC could potentially include the annotation '*Lit when Operating*' — subject to guidance by CASA.
  - This may be the most effective mitigation.

As an alternative to publishing a Plume Rise symbol on navigation charts, a small Danger Area centred on the two OCGTs is also a control measure that may be considered appropriate by CASA. In examining this is a potential requirement, we make the following notes:

5 Whilst 3 sigma (Footnote 3, p20) is regarded as a near certainty for a normal distribution in statistical probability theory, 2 sigma (2 SD, 95.5%) can be considered as *significant* in terms of confidence.

- Regarding how the upper altitude limit of a Danger Area is calculated, we refer you to the cautionary notes above for consideration of determining the top altitude to be published for a Plume Rise symbol. If CASA deems that a Danger Area is required, we recommend a top altitude of no higher than 2000ft (which is based on a 2 sigma certainty of no exceedance of 4.3m/s).
- The extent of potential 0.3NM and 0.5NM Danger Area options are illustrated in Figure 14 below for information. Such radii would be more than sufficiently conservative, considering that modelling found a maximum horizontal displacement of 220m (0.12NM) for the 4.3m/s exceedance and 74m (0.04NM) for the 6.1m/s exceedance.

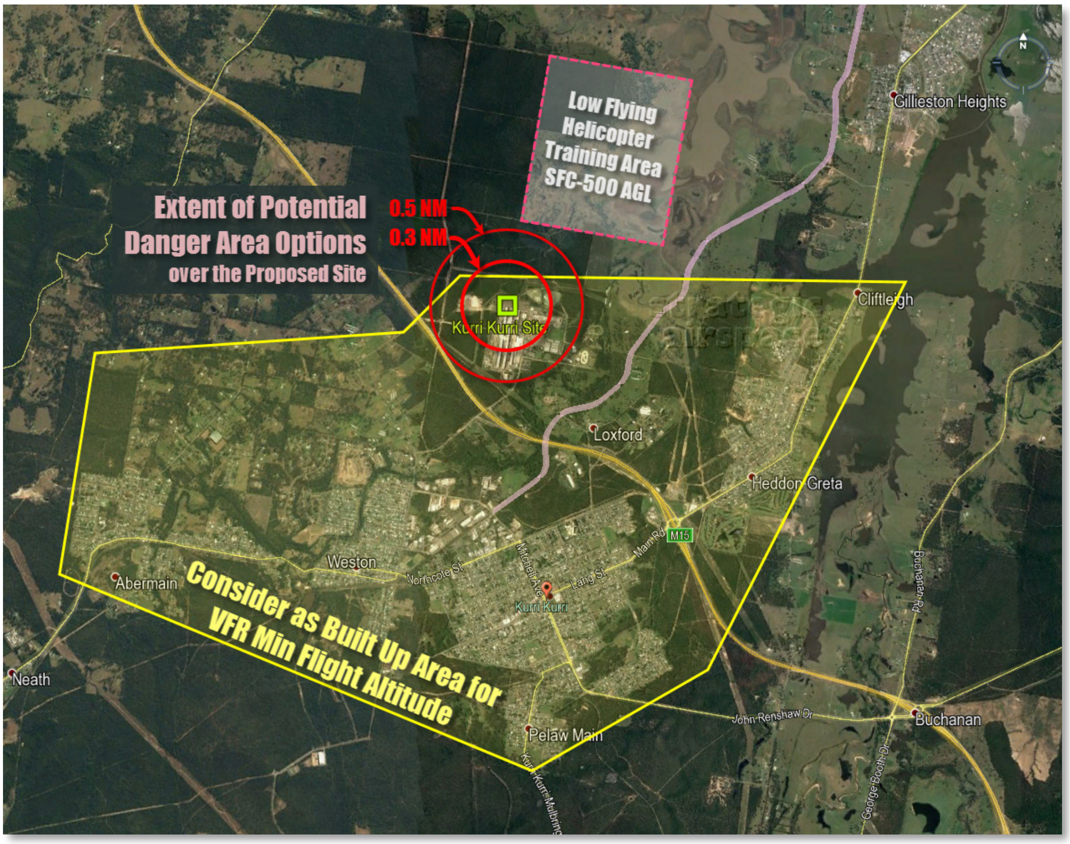


Figure 14 — Extent of Potential Danger Areas in relation to the Local Built-Up Area and the Low Flying Helicopter Training Area

However, it is likely that a Danger Area will not be required because the plume rise satisfies criteria previously used by CASA for other sites (including Laverton in Victoria) when deciding whether to promulgate a Danger Area or instead use a plume rise symbol on navigation charts. These criteria are understood to be based on sufficiency of lateral and/or vertical clearance of airports, instrument procedure tracks, reporting points, VFR routes and airspace constraints.

Such lateral and vertical clearances of the Kurri Kurri site from such features have been described elsewhere in this report. We also note that a Danger Area would not be required under MOS Part 173 to reduce risk to the Maitland RNAV approach because the site is sufficiently far (~3400m) from the nominal track of the missed approach (refer to Table 7, p19).

Further, given the low probability of plume exceedance at low VFR altitudes (say 1200ft) based on estimated operating times, and the risk reduction via the other control measures proposed, we believe that a Danger Area will not be necessary.

7. Conclusion

All plume rises from gas-fired power stations can potentially be considered a hazard to aviation. However, in this case, the factors which reduce the risk are:

- The site is outside the circuit and circling areas of the two closest airports.
- Aircraft in the area will generally be operating at cruising speeds and altitudes.
- The site is very close to the northern side of Kurri Kurri township — and so could potentially be considered as part of the built-up area of the town and nearby facilities.
- A risk assessment process has determined that the probability of risk and severity to aircraft is low, with the majority of hazard cases examined evaluated as being in the Acceptable range and all within an Acceptable Level of Safety.
  When factoring the probability of plume exceedances by the anticipated operating time (2%) and maximum operating time for which approval is being sought (12%), the risk to aviation is further reduced.
- The mitigations proposed will not limit the use of the surrounding airspace and can be used to inform pilots of the location of the plume and to avoid overflight when operating. Local stakeholders agreed that the site would not be problematic for local aviation, as long as pilots had a means of knowing where the site was and when the power station was operating.
  Ultimately, CASA will recommend which control measures are appropriate.
- The best mitigation is the simplest: provide sufficient information and measures to promote a situation that encourages pilots to not fly overhead the power station at low altitudes.

It is anticipated that CASA will accept the impact and risk assessment as documented, and the proposed control measures to reduce risk.

APPENDICES

APPENDIX 1 — ABBREVIATIONS

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

Abbreviation	*Meaning*
AC	Advisory Circular (document supporting CAR 1998)
ACFT	Aircraft
AD	Aerodrome
ADS-B	Automatic Dependent Surveillance – Broadcast: an aircraft location identification and tracking service facilitated by satellite signals and ground tracking stations, similar to (but more accurate than) radar
AFB	Air Force Base
AGL	Above Ground Level (Height)
AHD	Australian Height Datum
AHT	Aircraft Height
AIP	Aeronautical Information Publication
Airports Act	Airports Act 1996, as amended
AIS	Aeronautical Information Services
ALARP	As Low As Reasonably Practicable
ALC	Airport Lease Company
ALoS	Acceptable Level of Safety
Alt	Altitude
AMAC	Australian Mayoral Aviation Council
AMSL	Above Minimum Sea Level
ANEF	Australian Noise Exposure Forecast
ANSP	Airspace and Navigation Service Provider
APACL	Australia Pacific Airports Corporation Limited, owner of Melbourne and Launceston Airports
APCH	Approach
APARs, or A(PofA)R	Airports (Protection of Airspace) Regulations, 1996 as amended
ARP	Aerodrome Reference Point
AsA	Airservices Australia
ASDA	Accelerated Stop Distance Available
ATC	Air Traffic Control(ler)
ATM	Air Traffic Management
BA (Planning)	Building Application or Building Approval (Planning)
BAC	Brisbane Airport Corporation
BCC	Brisbane City Council
CAO	Civil Aviation Order
CAR	Civil Aviation Regulation
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
Cat	Category
CBD	Central Business District
CCGT	Combined Cycle Gas Turbine
CG	Climb Gradient
CNS/ATM	Communications, Navigation, Surveillance / Air Traffic Management
CPA	Cairns Port Authority, Operators Of Cairns Airport
DA (Aviation)	Decision Altitude (Aviation)

Abbreviation	*Meaning*
DA (Planning)	Development Application or Development Approval (Planning)
DAH	Designated Airspace Handbook
DAP	Departure and Approach Procedures (published by AsA)
DEP	Departure
DER	Departure End (of the) Runway
DEVELMT	Development
DH	Decision Height
DITRDC / DIRD / DIRDC	2020: Department of Infrastructure, Transport, Regional Development & Communications (Commonwealth) Formerly the Department of Infrastructure, Transport, Cities and Regional Development DITCRD); and prior to Jun-2019, the Department of Infrastructure, Regional Development & Cities (sometimes also abbreviated as Infrastructure)
DME	Distance Measuring Equipment
Doc nn	ICAO Document Number nn
DoD	Department of Defence
DODPROPS	Dependent Opposite Direction Parallel Runway OPerations
DPIE	NSW Department of Planning, Industry & Environment (formerly DPE)
EIS	Environmental Impact Study
ELEV	Elevation (above mean sea level)
ENE	East North East
ERSA	EnRoute Supplement Australia
ESE	East South East
FAF	Final Approach Fix
FAP	Final Approach Point
Ft	Feet
GDA94	GDA is the Geocentric Datum of Australia. It has been implemented as the standard datum since 1994.
GLS	GNSS Landing System — a precision landing system like ILS but based on augmented GNSS using ground and satellite systems.
GNSS	Global Navigation Satellite System
GP	Glide Path
HIAL	High Intensity Approach Light
HLS	Helicopter Landing Site
IAS	Indicated Air Speed
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
IHS	Inner Horizontal Surface, an Obstacle Limitation Surface
ILS	Instrument Landing System, a precision approach landing system
IMC	Instrument Meteorological Conditions
IPA	Integrated Planning Act 1997, Queensland State Government
ISA	International Standard Atmosphere
IVA	Independent Visual Approach
Km	Kilometres
Kt	Knot (one nautical mile per hour)
LAT	Latitude
LDA	Landing Distance Available
LEP	Local Environment Plan (Planning

Abbreviation	*Meaning*
LLZ	Localizer
LONG	Longitude
LSALT	Lowest Safe ALTitude
M	Metres
MAPt	Missed Approach Point
MDA	Minimum Descent Altitude
MDH	Minimum Descent Height
MDP	Major Development Plan
MGA94	Map Grid Australia 1994
MOC	Minimum Obstacle Clearance
MOCA	Minimum Obstacle Clearance Altitude
MOS	Manual Of Standards, published by CASA
MP	Master Plan
MSA	Minimum Sector Altitude
MVA	Minimum Vector Altitude
NASF	National Airports Safeguarding Framework
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
NNW	North North West
NOTAM	NOTice to AirMen
NPR	New Parallel Runway (Project, Brisbane Airport)
OAR	Office of Airspace Regulation (CASA)
OCA	Obstacle Clearance Altitude (in this case, in AMSL)
OCGT	Open Cycle Gas Turbine
OCH	Obstacle Clearance Height
ODPROPS	Opposite Direction Parallel Runway OPerations
OHS	Outer Horizontal Surface, an Obstacle Limitation Surface
OLS	Obstacle Limitation Surface, defined by ICAO Annex 14; refer also CASA MOS Part 139
PANS-OPS	Procedures for Air Navigation — Operations, ICAO Doc 8168; refer also CASA MOS Part 173
PAPI	Precision Approach Path Indicator (a form of VGSI)
PBN	Performance Based Navigation
PRM	Precision Runway Monitor
RAAF	Royal Australian Air Force
RAPAC	Regional Airspace and Procedures Advisory Committee
REF	Reference
RL	Relative Level
RNAC	Royal Newcastle Aero Club
RNAV	aRea NAVigation
RNP	Required Navigation Performance
RPA	Rules and Practices for Aerodromes — replaced by the MOS Part 139 — Aerodromes

Abbreviation	*Meaning*
RPT	Regular Public Transport
RTCC	Radar Terrain Clearance Chart (refer also MVA)
RWY	Runway
SACL	Sydney Airport Corporation Limited
SID	Standard Instrument Departure
SMS	Safety Management System
SODPROPS	(Independent) Simultaneous Opposite Direction Parallel Runway OPerations
SPP	State Planning Policy, Queensland (specifically SPP 1/02: Development in the Vicinity of Certain Airports and Aviation Facilities)
SSDA	State Significant Development Application
SSP	State Significant Precinct
SSR	Secondary Surveillance Radar
STODA	Supplementary Take-Off Distance Available
STAR	STandard Arrival
TAR	Terminal Approach Radar
TAS	True Airspeed
THR	THReshold (of Runway)
TMA	TerMinal Area
TNA	Turn Altitude
TODA	Take-off Distance Available
TORA	Take-Off Runway Available
VFR	Visual Flight Rules
VIS	Visual
VMC	Visual Meteorological Conditions
V_n	Aircraft critical velocity reference
VNAV	Vertical NAVigation
VOR	Very high frequency Omni-directional Range
VSS	Visual Segment Surface
WAC	Westralia Airports Corporation, operators of Perth Airport
WAM	Wide-Area Multilateration
WNW	West North West
WSW	West South West
WGS84	World Geodetic System 1984
WSA	Western Sydney Airport — Sydney's second international airport

APPENDIX 2 — PANS-OPS PROCEDURES

The latest versions of the IFPs consulted were from the Departure and Approach Procedures (DAP) Amendment 165, effective from 5-Nov-2020 to 24-Mar-2020, published by Airservices Australia at the time of consultation) — as indicated below.

Table 11 — Index of Instrument Flight Procedures for the Nearby Airports

Chart	*Effective Date (Amdt No)*
MAITLAND (NSW) (YMND)	
AERODROME CHART	5-Nov-2020 (Am 165)
RNAV-W (GNSS)	5-Nov-2020 (Am 165)
WILLIAMTOWN (YWLM)	
AERODROME CHART PAGE 1	13-Aug-2020 (Am 164)
AERODROME CHART PAGE 2	5-Nov-2020 (Am 165)
SID WILLY THREE DEPARTURE (RADAR)	5-Nov-2020 (Am 165)
SID RWY 12 ALPHA (RNAV)	16-Aug-2018 (Am 156)
SID RWY 12 BRAVO (RNAV)	16-Aug-2018 (Am 156)
SID RWY 30 NORTH (RNAV)	16-Aug-2018 (Am 156)
SID RWY 12/30 SOUTH (RNAV)	16-Aug-2018 (Am 156)
DME OR GNSS ARRIVAL	28-Feb-2019 (Am 158)
ILS-Z OR LOC-Z RWY 12	5-Nov-2020 (Am 165)
ILS-Y OR LOC-Y RWY 12	5-Nov-2020 (Am 165)
NDB RWY 12	5-Nov-2020 (Am 165)
NDB-Z RWY 30	5-Nov-2020 (Am 165)
NDB-Y RWY 30	5-Nov-2020 (Am 165)
RNAV (GNSS) RWY 12	5-Nov-2020 (Am 165)
RNAV (GNSS) RWY 30	5-Nov-2020 (Am 165)
LAKE MACQUARIE AIRPORT (YLMQ)	
RNAV (GNSS) 070	1-Mar-2018 (Am 154)

Last Modified: 2020-09-14

Source: http://www.airservicesaustralia.com/aip/aip.asp

APPENDIX 3 — STAKEHOLDER CONSULTATION FEEDBACK

Royal Newcastle Aero Club / Maitland Airport Stakeholders & Consultation Feedback

Table 12 — Attendees at the RNAC / Maitland Airport Consultation Meeting

Name	*Organisation & Role*
Glen Thomson	Royal Newcastle Aero Club (RNAC) — Head of Operations
Sam Lewis	Student Pilot
Greg Kennewell	RNAC ARO / FI Aerodrome Reporting Officer / Flying Instructor
Andrew Bill	RNAC FI

Table 13 — RNAC / Maitland Airport Stakeholder Feedback

Topic / Question / Issue	***Answer / Further Discussion***	***Action Items***
Timing of operation of the plant?	SHL responded that the timing of the plant operation is difficult to predict but will be more dominant during peak demand hours for households but can be operating during normal airport operation.	—
Light craft flying in the surrounding area at low speeds	The comment was made that gyrocopters and microlights (powered hang-glider, aka (‘*weight shifters*’) often fly in the area at low altitudes and at speeds of ~40-50 knots. It was said that they come from Belmont Airport / Lake Macquarie Airport (YLMQ). Cathy Pak-Poy (Strategic Airspace) reported that she had spoken to Ron Hibberd (Airborne / Lake Macquarie Airport in late November) who said that the airspace there is irrelevant to their activities. Notes on charts as warning for pilots was also discussed.	⇨ SHL: made queries with paragliding contact, but no response to date (11/1/2021) ⇨ StratAir: Follow-up with gyrocopter / microlight training (Airborne) and any other relevant clubs or organisations that can be identified.
‘Normal’ flight altitude over the site and approach to Maitland	Attendees indicated that 1500-1600 ft ALT was a common altitude used by aircraft flying in the general vicinity and over the site and on the visual approach to Maitland Airport.	
Maitland moving their authorised aerobatics area ~3 NM to the south, closer to the plant site	The proposed minimum altitude is 2000 ft. The airport is working through this proposal with CASA. A likely date for approval by CASA was not available. When approved the information would normally only be available in their airport operations manual (*TBC*). StratAir queried whether a diagram or map-based figure could be provided so that the proposed zone could be included in the risk analysis. StratAir also requested the contact details for the CASA officer who was assessing the application (for consultation).	⇨ Maitland Airport’s ARO: Provide to StratAir a copy of relevant info (eg, diagram or map of the acrobatic zone, plus airspace and any other constraints applicable) plus, if possible, the relevant CASA contact details.
The differences between the plumes from gas turbines vs coal-powered electricity generation plants?	SHL responded that coal-fired plants generated low temperature and low velocity plumes from tall stacks as well as from “cooling” towers. These plumes (and the stacks) are visible in visual met conditions (VMC). By contrast, the gas-fired peaking plants had much lower stacks and plumes with higher exit velocities (depending on the plant used). As indicated in the presentation material, these plumes may not be visible, and the vertical velocity of the plume varies with the temperature and wind conditions.	—
How do other airports manage and treat plume rise obstacles at/near their sites?	This question arose during a discussion of potential mitigations, such as information in relevant aeronautical charts and documents and even potentially the application of a Danger Area over the site.	—

Topic / Question / Issue	*Answer / Further Discussion*	*Action Items*
Maitland Airport Attendees Summary	Attendees agreed that the plume rise from the proposed power station at Kurri Kurri was not going to be a problem for them, as long as people know it's there. Information methods discussed included symbol/note on Newcastle VTC and VNC. StratAir also suggested the idea of including info and a diagram in the Additional Information section of the Aerodrome's ERSA FAC details. It was noted that this was the airport's responsibility. The ARO commented that it may not be possible to continuously add information/symbols to the ERSA FAC. They commented that it may pose an issue for Sydney-based students and visitors approaching from the south, who generally fly up through the gap in the hills (see diagram on next page) and direct to the airport. The comment was made that some such visitors would only be aware of the plume if a Danger Area was published because then it be clearly visible to them on their electronic charts used for navigation planning and in-flight.	—

Cessnock Airport Stakeholders & Consultation Feedback

Table 14 — Attendees at the Cessnock Airport Consultation Meeting

Name	*Organisation & Role*
Emma McDermott	Cessnock City Council Principal Strategic Planner
Elie Abi	Hunter Valley Aviation Base Manager
Anthony Moore	Hunter Valley Aviation Senior Instructor
Tony Allan	Cessnock City Council Airport Operations Coordinator
Oliver McCelland	Hunter Valley Helicopters
Marty Peters	Aerohunter Flight Training CFI
Glenn Graham	Aerohunter
Bob Finch	Hunter Recreational Flying Club (HRFC)
Keith McGeachie	HRFC

Table 15 —Maitland Airport Stakeholder Feedback

Topic / Question / Issue	*Answer / Further Discussion*	*Action Items*
Timing of operation of the plant: is there a notification period before start-up?	Snowy Hydro responded that no notification was proposed as the plant needs to be able to start up immediately whenever required. While the plant could operate at any time of the day, summer late afternoons would be the most likely time. Separately there was a discussion of NOTAMs at Colongra power station on the Central Coast (none currently). *Given the lack of a suitable notification period before start-up nor foreknowledge of the duration of operation, NOTAMs are not considered a practical mitigation.*	—

Topic / Question / Issue	*Answer / Further Discussion*	*Action Items*
Maitland moving their authorised aerobatics area ~3 NM to the south, closer to the plant site	Aerobatic training area has been in existence since the 1970s and is currently located north of the plant site. If the training area is to be amended, where is there information on this, where is it published? How would you even know if you were flying through it? Aerobatics over or near the site is concerning.	No immediate action. StratAir is to obtain further information from Maitland Airport and possibly also CASA for risk assessment.
Confined Helicopter Training Area	The helicopter training and low flying training areas — approved by CASA and defined in the Operations Manual. Still to be confirmed if this is an issue that StratAir needs to include in the Aviation/Airspace Risk Assessment for the proposed plant. A copy of the relevant information will help to clarify this situation.	⇨ Cessnock Airport's ARO: Provide to StratAir a copy of relevant info (eg, diagram or map of the heli training / low flying areas & any other constraints applicable) as defined in the Operations Manual.
Pilots flying through the gap in the hills from the south, especially during poor weather conditions	The same issue was raised at Maitland Airport. They commented that it may pose an issue for Sydney-based students and visitors approaching from the south, who generally fly up through the gap in the hills (see diagram on next page) and direct to the airport. Snowy Hydro mentioned that during strong winds (typical during poor weather conditions) the plume dissipates (although this does not necessarily cover the case where the winds are light, but the cloud base is low and/or visibility is poor). Therefore, the presence of the plume needs to be noted for all relevant airports (especially Cessnock & Maitland).	—
Potential mitigations — obstacle lighting when the plant is operating	It was agreed that lights would be good to warn pilots that the plant is operating. A comment was made that due to the visual impact of lights (high intensity during the day) they would need to be directional so as to not affect nearby residents.	—
Potential mitigations — FAC info, chart notes & symbols, Danger Area	Items discussed included publication of information in relevant aeronautical charts and documents and even the idea of including info and a diagram in the Additional Information section of the Aerodrome's ERSA FAC details. Participants did not support an extensive Danger Area but would have no objections to a small Danger Area being defined above the plant site.	—
Plume composition: could low oxygen snuff out an aircraft engine? (Bob Finch)	*Snowy Hydro Response after the On-Site Consultation Session* *At our other stations such as Laverton North and Colongra, which are very similar in nature to the proposed station, measurements are taken of the exhaust gas within the top of the stack just before it is released to the atmosphere. At this point, an area of approximately 10m in diameter, oxygen is between 14% and 15% of the exhaust by volume. The rest of the exhaust is made up predominantly of carbon monoxide, carbon dioxide, and oxides of nitrogen. As soon as the exhaust leaves the stack, and the gases expand from the physical restriction of the exhaust stack, significant dilution with atmospheric oxygen occurs.* *So, based on existing test results it is not possible to say exactly what the oxygen content of the plume is at height, it would be pretty reasonable to estimate a high level of oxygen by the time the plume gets to a couple of hundred feet above ground, and then increasing thereafter.*	⇨ Snowy Hydro: Response provided herein

Topic / Question / Issue	*Answer / Further Discussion*	*Action Items*
Any impact on Council's plans for the Airport? (Emma McDermott)	Cessnock Council's strategic plans include expansion of the airport and the future implementation a new RNAV(GNSS) approach procedure: the proposed plant should not adversely impact these plans. StratAir responded that, given the distance of the site east of the airport (12.8km / 6.9NM) and the north-south orientation of the runway, the Kurri Kurri project would not adversely impact these plans — in fact no direct impact at all on these plans is anticipated.	—

Remote Consultations

Table 16 —Remote Consultations & Feedback

Organisation	*Contact*	*Date/Time*	*Impact*	*Comment*
Lake Macquarie Airport / Airborne Flight Training	Rob Hibberd, CEO Lake Macquarie Airport Director, Airborne	26-Nov-2020	N	Rob said that the airspace at Kurri Kurri is irrelevant to their activities. Discussed notes on charts as warnings for pilots.
Airborne Flight Training	Russell Duncan, CFI	11-Jan-2021 27-Jan-2021	N	*Follow-up contact after Cessnock & Maitland stakeholders referred to ultralights in the vicinity of the site.* Russell confirmed Rob Hibberd's comments that the airspace around the site is of negligible impact to them. He also stated that he assumed that the plume rise would be charted. He said that the only time they would do training there would be on transit flights to other airports, such as Luskintyre
Skydive Elderslie – NSW Sport Parachuting	Website telephone	27-Nov-2020	?	No answer. No response.
Skyline Aviation Group	CFI via Receptionist	11-Jan-2021	?	No response.
Matt Hall Aerobatic	Matt Hall	11-Jan-2021	?	No response.
Civil Aviation Safety Authority (CASA)	Dilip Mathew	10-Dec-2020	tba	CASA was contacted but advised that they will not provide feedback at this stage of the project. CASA will evaluate the proposal, including this report, after the EIS application has been lodged with DPIE and formally referred to them.
	Brad Parker A/g Branch Manager Air Navigation, Airspace & Aerodromes	14-Jan-2021	N/A	Extract of CASA's response to the Request for SEARs: *CASA notes that the proponent has already conducted a preliminary assessment of the plume rise impact. CASA's understanding is that the proponent will conduct the final assessment of the plume rise on completion of the detailed design of the proposed power station.* *CASA commends the proponent for demonstrating a good understanding of CASA's Advisory Circular AC 139-05 v 3.0 Plume Rise Assessments and of the need to conduct an aeronautical impact assessment of the project given the presence of aerodromes in the area.*
	Dilip Mathew	11-Mar-2021	N/A	CASA convened a joint meeting with DPIE, Jacobs & StratAir for coordination and clarification. CASA will provide advice on safety matters to DPIE.
Airservices Australia	Daniel Jackson Project Manager	05-Nov-2020	N	Re the then proposed changes to the Williamtown airspace:

Organisation	*Contact*	*Date/Time*	*Impact*	*Comment*
				• He expects the SIDs & STARs into Williamtown to remain pretty much as is • The emphasis will most likely be making what they currently do compliant, and change some processes such as reduce tactical vectoring and use more Smart-Track • The VFR lane north of Maitland unlikely to change • The CTR also unlikely to change Airservices has no responsibility for the military airspace. He did say however that he anticipated that Defence would not reduce the lower level of Restricted Area above Kurri Kurri.
Defence	Tim Hogan	11-Nov-2020	?	Preliminary info prior to the Hunter Valley consultation meetings. Follow-up info & email
	Charles Mangion Director, Land Planning & Regulation	18-Jan-2021	N/A	Extract of the Dept of Defence's response to the Request for SEARs: *…the Environmental Impact Statement should include a plume rise impact assessment in accordance with CASA guidelines for conducting plume rise assessment.* *Defence is satisfied that SEARs requirements are adequate to enable an investigation of the impact of the project, particularly in relation to any plume associated with the project and the possible impact it may have on Defence operations at RAAF Base Williamtown. Defence requests that the proponent engage with Defence regarding this project and seeks comments regarding the proposed plume assessment.*
	Tim Hogan	25-Jan-2021	tba	Further information email, including copies of the Local Stakeholder Briefing Presentation and compiled feedback from meetings at Cessnock & Maitland Airports
		10-Feb-2021		Extension of time for response
		18-Feb-2021		Defence unable to provide further feedback at this time. Defence's internal stakeholders commented that they cannot complete a formal assessment without the final plume rise assessment reports and they (and Airservices, to whom they have also referred) require site coordinates and plume rise diameter info. They understand that the final plume assessment reports will not be available until after the EIS is lodged with DPIE. ⇨ *Note Defence request for a copy of the Plume Rise and Aviation Assessment reports as soon as possible after submission of the EIS.*
		19-Feb-2021		Site location coordinate, plume radii & plume exceedance table emailed to Defence to assist in their ongoing preliminary evaluation.
		5-11 Mar-2021		Reports (Aero/Risk v2.1.1 & Plume Rise 210224 R1) provided. Confirmation of information queried by EO, Airspace Protection
Aviation Safety Exchange Forum (AvSEF)	Secretariat	11-Mar-2021	tba	Project summary and briefing pack posted on the AvSEF NSW projects webpage (12-Mar-2021) for the information of NSW Stakeholders registered with AvSEF. https://www.avsef.gov.au/nsw-proposed-kurri-kurri-gas-fired-power-station-hunter-valley Feedback period open until COB 31-Mar-2021. No feedback from AvSEF was received.

APPENDIX 4 — RISK ASSESSMENT MATRIX

Risk Assessment Matrix

Risk when the Plant is Operating — *Op 2% pa* — *Op 12% pa*

ID	*HazCat AcftType*	*HazCat AcftSpeed*	*HazCat Alt.FtAMSL*	*HazCat PlumeVelocity*	*(Model) % Exceedance*	*Likelihood*	*Severity*	*Risk Grade*	*Mitigation Actions*	*Residual Likelihood*	*Residual Severity*	*Residual Risk*	*Acceptability*	*(Op 2%pa) % Exceedance*	*(Op 12%pa) % Exceedance*
5	Ultralight	Low	1200	6.1 m/s	4.30%	1	C	1C	Not required				Yes (no mitigation)	0.09%	0.52%
6	Ultralight	Cruise	1200	6.1 m/s	4.30%	2	C	2C	Plume Symbol on Nav Charts, Info in ERSA AD, Plume active Obst Lights	1	C	1C	Yes - with Mitigation	0.09%	0.52%
7	Ultralight	Low	3000	6.1 m/s	0.07%	1	D	1D	Not required				Yes (no mitigation)	0.00%	0.01%
8	Ultralight	Cruise	3000	6.1 m/s	0.07%	3	D	3D	Plume Symbol on Nav Charts, Info in ERSA AD, Plume active Obst Lights	2	D	2D	Yes - with Mitigation	0.00%	0.01%
11	Ultralight	Low	1200	4.3 m/s	14.10%	3	C	3C	Plume Symbol on Nav Charts, Info in ERSA AD, Plume active Obst Lights	1	C	1C	Yes - with Mitigation	0.28%	1.69%
12	Ultralight	Cruise	1200	4.3 m/s	14.10%	3	D	3D	Plume Symbol on Nav Charts, Info in ERSA AD, Plume active Obst Lights	2	D	2D	Yes - with Mitigation	0.28%	1.69%
13	Ultralight	Low	3000	4.3 m/s	0.90%	1	C	1C	Not required				Yes (no mitigation)	0.02%	0.11%
14	Ultralight	Cruise	3000	4.3 m/s	0.90%	2	D	2D	Not required				Yes (no mitigation)	0.02%	0.11%

ID	HazCat AcftType	HazCat AcftSpeed	HazCat Alt.FtAMSL	HazCat PlumeVelocity	(Model) % Exceedance	Likelihood	Severity	Risk Grade	Mitigation Actions	Residual Likelihood	Residual Severity	Residual Risk	Acceptability	(Op 2%pa) % Exceedance	(Op 12%pa) % Exceedance
19	Helicopter	Low	1200	6.1 m/s	4.30%	1	C	1C	Not required				Yes (no mitigation)	0.09%	0.52%
20	Helicopter	Cruise	1200	6.1 m/s	4.30%	2	D	2D	Not required				Yes (no mitigation)	0.09%	0.52%
21	Helicopter	Low	3000	6.1 m/s	0.07%	1	D	1D	Not required				Yes (no mitigation)	0.00%	0.01%
22	Helicopter	Cruise	3000	6.1 m/s	0.07%	1	E	1E	Not required				Yes (no mitigation)	0.00%	0.01%
25	Helicopter	Low	1200	4.3 m/s	14.10%	2	D	2D	Not required				Yes (no mitigation)	0.28%	1.69%
26	Helicopter	Cruise	1200	4.3 m/s	14.10%	3	E	3E	Not required				Yes (no mitigation)	0.28%	1.69%
27	Helicopter	Low	3000	4.3 m/s	0.90%	1	E	1E	Not required				Yes (no mitigation)	0.02%	0.11%
28	Helicopter	Cruise	3000	4.3 m/s	0.90%	2	E	2E	Not required				Yes (no mitigation)	0.02%	0.11%

ID	HazCat AcftType	HazCat AcftSpeed	HazCat Alt.FtAMSL	HazCat PlumeVelocity	(Model) % Exceedance	Likelihood	Severity	Risk Grade	Mitigation Actions	Residual Likelihood	Residual Severity	Residual Risk	Acceptability	(Op 2%pa) % Exceedance	(Op 12%pa) % Exceedance
33	Light Aircraft	Low	1200	6.1 m/s	4.30%	1	C	1C	Not required				Yes (no mitigation)	0.09%	0.52%
34	Light Aircraft	Cruise	1200	6.1 m/s	4.30%	2	D	2D	Not required				Yes (no mitigation)	0.09%	0.52%
35	Light Aircraft	Low	3000	6.1 m/s	0.07%	1	D	1D	Not required				Yes (no mitigation)	0.00%	0.01%
36	Light Aircraft	Cruise	3000	6.1 m/s	0.07%	2	E	2E	Not required				Yes (no mitigation)	0.00%	0.01%
39	Light Aircraft	Low	1200	4.3 m/s	14.10%	2	D	2D	Not required				Yes (no mitigation)	0.28%	1.69%
40	Light Aircraft	Cruise	1200	4.3 m/s	14.10%	3	E	3E	Not required				Yes (no mitigation)	0.28%	1.69%
41	Light Aircraft	Low	3000	4.3 m/s	0.90%	1	E	1E	Not required				Yes (no mitigation)	0.02%	0.11%
42	Light Aircraft	Cruise	3000	4.3 m/s	0.90%	2	E	2E	Not required				Yes (no mitigation)	0.02%	0.11%

ID	*HazCat AcftType*	*HazCat AcftSpeed*	*HazCat Alt.FtAMSL*	*HazCat PlumeVelocity*	*(Model) % Exceedance*	*Likelihood*	*Severity*	*Risk Grade*	*Mitigation Actions*	*Residual Likelihood*	*Residual Severity*	*Residual Risk*	*Acceptability*	*(Op 2%pa) % Exceedance*	*(Op 12%pa) % Exceedance*
47	Large Light Aircraft	Low	1200	6.1 m/s	4.30%	1	C	1C	Not required				Yes (no mitigation)	0.09%	0.52%
48	Large Light Aircraft	Cruise	1200	6.1 m/s	4.30%	1	D	1D	Not required				Yes (no mitigation)	0.09%	0.52%
49	Large Light Aircraft	Low	3000	6.1 m/s	0.07%	1	D	1D	Not required				Yes (no mitigation)	0.00%	0.01%
50	Large Light Aircraft	Cruise	3000	6.1 m/s	0.07%	2	E	2E	Not required				Yes (no mitigation)	0.00%	0.01%
53	Large Light Aircraft	Low	1200	4.3 m/s	14.10%	1	D	1D	Not required				Yes (no mitigation)	0.28%	1.69%
54	Large Light Aircraft	Cruise	1200	4.3 m/s	14.10%	1	E	1E	Not required				Yes (no mitigation)	0.28%	1.69%
55	Large Light Aircraft	Low	3000	4.3 m/s	0.90%	1	D	1D	Not required				Yes (no mitigation)	0.02%	0.11%
56	Large Light Aircraft	Cruise	3000	4.3 m/s	0.90%	3	E	3E	Not required				Yes (no mitigation)	0.02%	0.11%

ID	HazCat AcftType	HazCat AcftSpeed	HazCat Alt.FtAMSL	HazCat PlumeVelocity	(Model) % Exceedance	Likelihood	Severity	Risk Grade	Mitigation Actions	Residual Likelihood	Residual Severity	Residual Risk	Acceptability	(Op 2%pa) % Exceedance	(Op 12%pa) % Exceedance
61	Military Jet	Low	1200	6.1 m/s	4.30%	1	C	1C	Not required				Yes (no mitigation)	0.09%	0.52%
62	Military Jet	Cruise	1200	6.1 m/s	4.30%	1	D	1D	Not required				Yes (no mitigation)	0.09%	0.52%
63	Military Jet	Low	3000	6.1 m/s	0.07%	1	D	1D	Not required				Yes (no mitigation)	0.00%	0.01%
64	Military Jet	Cruise	3000	6.1 m/s	0.07%	2	E	2E	Not required				Yes (no mitigation)	0.00%	0.01%
67	Military Jet	Low	1200	4.3 m/s	14.10%	1	D	1D	Not required				Yes (no mitigation)	0.28%	1.69%
68	Military Jet	Cruise	1200	4.3 m/s	14.10%	1	E	1E	Not required				Yes (no mitigation)	0.28%	1.69%
69	Military Jet	Low	3000	4.3 m/s	0.90%	1	D	1D	Not required				Yes (no mitigation)	0.02%	0.11%
70	Military Jet	Cruise	3000	4.3 m/s	0.90%	3	E	3E	Not required				Yes (no mitigation)	0.02%	0.11%

Likelihood*

1	Extremely Improbable	Almost inconceivable that event will occur
2	Improbable	Very unlikely to occur
3	Remote	Unlikely, but possible to occur
4	Occasional	Likely to occur at least once
5	Frequent	Likely to occur many times

Severity

A	Catastrophic	Multiple deaths, equipment destroyed
B	Hazardous	Physical distress, serious injury, major equipment damage
C	Major	Serious incident, injury to persons
D	Minor	Nuisance, use of emergency procedures
E	Negligible	Few consequences

Probability: **NO Exceedance**

based on X% Operating Times

3σ (<99.7%)
Exceedance <1 day per year

2σ (≥95.5% & <99.7%)
Exceedance <1 time per 3 weeks

* *Assessment takes into account the % exceedance of the plume at stated Vertical Velocity (m/s)*
No exceedance of 10.6m/s above 1000ft

Notes re Operational Times per Annum (% /pa)
2% pa: Expected operation 2% of the year
12% pa: Max operating time as per EIS: 10% gas-fired and 2% using contingency diesel back-up