AVIATION PROJECTS

September 2023

AVIATION PROJECTS: AVIATION IMPACT ASSESSMENT

SOUTHERN CROSS WIND FARM

Prepared for Yilgarn Holdings Pty Ltd

AVIATION PROJECTS

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0.3	Third draft – inclusion of Southern Cross aerodrome future operations			

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ACRONYMS

AAAA	Aerial Agricultural Association of Australia
AC	Advisory Circular
AFAC	Australasian Fire and Emergency Services Council
AGL	above ground level
AHD	Australian Height Datum
AIA	aviation impact assessment
AIP	Aeronautical Information Package
AIS	aviation impact statement
ALA	aircraft landing area
ALARP	as low as reasonably practicable
AMSL	above mean sea level
ARP	Aerodrome Reference Point
AS	Australian Standards
AsA	Airservices Australia
ATSB	Australian Transport Safety Bureau
BoM	Bureau of Meteorology
CAAP	Civil Aviation Advisory Publications
CAO	Civil Aviation Orders
CAR	Civil Aviation Regulation (1988)
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation (1998)
CFIT	controlled flight into terrain
CNS	communications, navigation and surveillance
CTAF	common traffic advisory frequency
DAH	Designated Airspace Handbook
EIS	environmental impact statement
ERC-H	en-route chart high
ERC-L	en-route chart low
ERSA	En Route Supplement Australia
GA	general aviation

ICAO	International Civil Aviation Organization
IFR	instrument flight rules
IMC	instrument meteorological conditions
LGA	local government area
LSALT	lowest safe altitude
MOC	minimum obstacle clearance
MOS	Manual of Standards
MSA	minimum sector altitude
NASAG	National Airports Safeguarding Advisory Group
NASF	National Airports Safeguarding Framework
NDB	non-directional (radio) beacon
OLS	obstacle limitation surface
PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
PSR	primary surveillance radar
RAAF	Royal Australian Air Force
RFDS	Royal Flying Doctor Service
RPT	regular public transport
RSR	route surveillance radar
SSR	secondary surveillance radar
TIFP	terminal instrument flight procedures
VFR	visual flight rules
VFRG	visual flight rules guide
VMC	visual meteorological conditions
WMTs	wind monitoring towers
WTGs	wind turbine generators

UNITS OF MEASUREMENT

ft	feet	(1 ft = 0.3048 m)
km	kilometres	(1 km = 0.5399 nm)
m	metres	(1 m = 3.281 ft)
nm	nautical miles	(1 nm = 1.852 km)

DEFINITIONS

Definitions of key aviation terms are included in **Annexure 2**.

EXECUTIVE SUMMARY

Introduction

Yilgarn Holdings Pty Ltd (Yilgarn) is proposing to develop the Southern Cross Wind Farm (the Project), located approximately 12 km southeast of the outskirts of Southern Cross township and approximately 10 km southeast of Southern Cross aerodrome to the closest part of the Project Area, in Western Australia's Wheatbelt region.

Yilgarn is currently undertaking detailed planning and environment investigations for the Project and has engaged Aviation Projects to prepare an Aviation Impact Assessment (AIA) for the Project.

The Project is proposed to consist of a maximum of 10 wind turbine generators (WTGs).

The configuration of ancillary infrastructure including transmission lines and the Project substation is currently under investigation and not specified for this assessment.

This AIA has been prepared to support a development application by the Proponent for submission to the Shire of Yilgarn and for approval by the relevant Development Approval Assessment Panel (DAP) in accordance with the Western Australian planning framework.

This AIA assesses the potential aviation impacts associated with the Project and provides aviation safety advice in respect of relevant requirements of air safety regulations and procedures and informs and documents consultation with relevant aviation agencies.

This AIA report includes an Aviation Impact Statement (AIS) and a qualitative risk assessment to determine the need for obstacle lighting and marking for client review and acceptance before submission to external aviation regulators.

Project description

The Southern Cross wind farm will comprise the following infrastructure relevant to this aviation impact assessment:

- up to 10 wind turbines with a maximum (worst-case) overall height (tip height) of up to 240 m above ground level (AGL)
- the highest proposed wind turbine generator (WTG) is WTG#1 with a ground elevation of 438 m Australian Height Datum (AHD) and overall height of 678 m AHD (2224.41ft AMSL)
- Associated power storage and transmission infrastructure (not yet specified).

Conclusions

Based on a comprehensive analysis and assessment detailed in this report, the following conclusions were made:

Certified airports

1. The Project is within 30 nm of Southern Cross aerodrome and will affect the Procedures for Air Navigation Services - Aircraft Operations PANS-OPS surfaces.

Aircraft Landing Areas (ALAs)

2. There are no verified ALAs in the vicinity of the Project.

Obstacle Limitation Surfaces

3. The Project will not infringe the obstacle limitation surface of any certified aerodrome.

Air Routes and Lowest Safe Altitude

4. The Project will impact the grid LSALT of 3000 ft (by 224.41 ft).

Aviation Facilities

5. The Project will not infringe any protection areas associated with aviation facilities.

Radar

6. The Project site is located outside the stated ranges of ATC Surveillance Radar Systems located in the Perth area.

Aviation Impact Statement (AIS)

7. Based on the Project WTG layout and maximum blade tip height of up to 240 m AGL, the blade tip elevation of the highest WTG associated with both proposed WTG configurations, will not exceed 678 m AHD (2224.41 ft AMSL) and:
    - will not infringe Southern Cross aerodrome (YSCR)'s obstacle limitation surfaces
    - infringes the PANS-OPS surfaces of Southern Cross aerodrome and will require amendments to both instrument approach procedures
    - the infringements to the YSCR PANS-OPS surfaces will not create an impact to the existing flight paths
    - will require an increase to the LSALT for air route V242
    - will require an increase to the Grid LSALT
    - will not have an impact on operational airspace
    - is wholly contained within Class G airspace
    - is outside the clearance zones associated with civil aviation navigation aids and communication facilities.

Obstacle lighting risk assessment

8. Aviation Projects has undertaken a safety risk assessment of the Project and concludes that WTGs don't require obstacle lighting to maintain an acceptable level of aviation safety. The use of obstacle lights are not specifically required by Part 139 MOS 2019 but may be recommended by CASA and should be considered as an additional safety measure.

Consultation

9. Refer to Section 5 for detailed responses from relevant aviation stakeholders. The consultation process has started and will continue through review of the Development Application. The risk assessment will be updated and this report finalised based on the feedback received during the consultation process. Feedback will be documented in this report.

Summary of key recommendations

A summary of the key recommendations of this AIA is set out below.

The full list of recommendations and associated details are provided in Section 11 'Recommendations' at the end of this report.

1. 'As constructed' details of the coordinates and elevations of the WTGs should be provided to Airservices Australia, using the Vertical Obstruction Data form (https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf to the following email address: vod@airservicesaustralia.com
2. The Proponent should consider engaging with local aerial agricultural operators and aerial firefighting operators in developing procedures for such aircraft operations in the vicinity of the Project site.
3. Details of the final wind farm layout should be provided to local and regional aircraft operators prior to construction so they can plan their operations accordingly.
4. Details of the wind farm layout should be provided to the Shire of Yilgarn (as operator of Southern Cross aerodrome) so the wind farm location can be reported in En Route Supplement Australia (ERSA).
5. The rotor blades, nacelles and towers of the WTGs should be painted in white, typical of most wind turbines operational in Australia to ensure they are visible to pilots during the day.
6. Overhead transmission lines and/or supporting poles associated with the Project that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial agriculture operators and marked in accordance with Part 139 Manual of Standards (MOS) Chapter 8 Division 10 section 8.110 (7) and section 8.110 (8) where applicable.

1. INTRODUCTION

1.1. Situation

Yilgarn Holdings Pty Ltd (Yilgarn) is proposing to develop the Southern Cross Wind Farm (the Project), located approximately 12 km southeast of the outskirts of Southern Cross township and approximately 10 km southeast of Southern Cross aerodrome to the closest part of the Project Area, in Western Australia's Wheatbelt region.

Yilgarn is currently undertaking detailed planning and environment investigations for the Project and has engaged Aviation Projects to prepare an Aviation Impact Assessment (AIA) for the Project.

The Project is proposed to consist of a maximum of 10 wind turbine generators (WTGs).

The configuration of ancillary infrastructure including transmission lines and the Project substation is currently under investigation and not specified for this assessment. This AIA assesses the potential aviation impacts, provides aviation safety advice in respect of relevant requirements of air safety regulations and procedures, and informs and documents consultation with relevant aviation agencies.

This AIA report includes an Aviation Impact Statement (AIS) and a qualitative risk assessment to determine the need for obstacle lighting and other applicable mitigation for client review and acceptance before submission to external aviation agencies.

The AIA and supporting technical data will provide evidence and analysis supporting the development application to demonstrate that appropriate risk mitigation strategies have been identified.

1.2. Purpose and Scope

The purpose and scope of work is to prepare an AIA for consideration by Airservices Australia, CASA and Department of Defence and support a development application to be submitted to the Shire of Yilgarn.

The AIA specifically responds to the following key legislation, approvals, and guidance material:

- WA Government Department of Planning, Lands and Heritage, Position Statement: Renewable energy facilities, March 2020
- Civil Aviation Safety Authority, Civil Aviation Safety Regulations 1998 (CASR) and associated material
- NASF Guideline D: Managing the Risk to aviation safety of wind turbine installations (wind farms)/Wind Monitoring Towers
- Other specific requirements as advised by Airservices Australia.

Assistance will be provided in support of stakeholder consultation and engagement in preparing the assessment and negotiating acceptable mitigation to identified impacts.

1.3. Methodology

Aviation Projects conducted the task in accordance with the following methodology:

1. Confirm the scope and deliverables with the Proponent (or representative)
2. Review client material
3. Review relevant regulatory requirements and information sources

4. Prepare a draft AIA and supporting technical data that provides evidence and analysis for the planning application to demonstrate that appropriate risk mitigation strategies have been identified
5. Prepare an AIS and a qualitative risk assessment to determine need for obstacle lighting and marking
6. Identify risk mitigation strategies that provide an acceptable alternative to night lighting. The risk assessment was completed following the guidelines in *ISO 31000:2018 Risk Management – Guidelines*
7. Consult with relevant Councils (if required), Part 173 procedure designers (if required) and aerodrome operators of the nearest aerodrome/s to seek endorsement of the proposal to change instrument procedures (if applicable)
8. Consult/engage with stakeholders to negotiate acceptable outcomes (if required)
9. Finalise the AIA report for client acceptance when responses received from stakeholders for client review and acceptance.

1.4. Aviation Impact Statement (AIS)

The AIS included in this report (see Section 6) includes the following specific requirements as advised by Airservices Australia:

Aerodromes:

- Specify all certified aerodromes that are located within 30 nm (55.56 km) of the project site
- Nominate all instrument approach and landing procedures at these aerodromes
- Review the potential effect of the Project operations on the operational airspace of the aerodrome(s)

Air Routes:

- Nominate air routes published in ERC-L & ERC-H which are located near/over the project site and review potential impacts of Project operations on aircraft using those air routes
- Specify two waypoint names located on the routes which are located before and after the obstacles

Airspace:

- Nominate the airspace classification – A, B, C, D, E, G etc where the project site is located

Navigation/Radar:

- Nominate radar navigation systems with coverage overlapping the site.

1.5. Material reviewed

Material provided by the Proponent for preparation of this assessment include:

- SCWF Aviation AHD Info 240 m.xlsx
- SCWF Aviation AHD Info 250m.xlsx
- SCWF Layout 230912.jpg
- SCWF North Updated Layout Aug 2023.jpg

- SCWF South Updated Layout Aug 2023.jpg
- Southern Cross Location Plan.pdf
- Southern Cross Wind Farm Layout.pdf
- WTG Config.jpg.

2. BACKGROUND

2.1. Site overview

The closest township to the wind farm is Southern Cross, approximately 12 km northwest from the closest part of the Project Area. The City of Perth is located approximately 330 km west of the Project Area.

The Project is located in the Shire of Yilgarn Local Government Area (LGA).

An overview of the Project Area is provided in Figure 1 (source: Yilgarn, Google Earth).

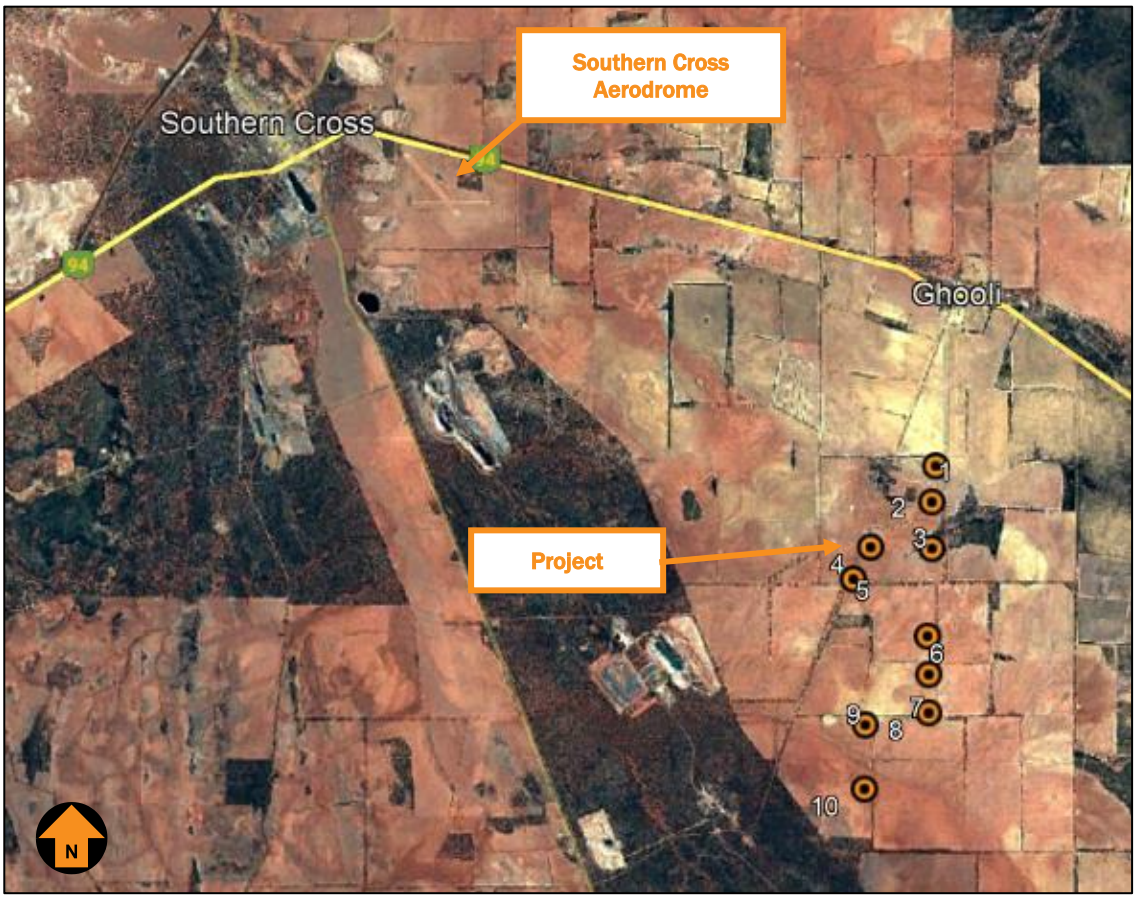


Figure 1 Project Site Overview

2.2. Project description

The Southern Cross wind farm is proposed to include the development of wind turbines with a hub height of 150 m AGL, 180 m rotor diameter and maximum tip height of 240 m AGL.

The configuration WTGs is shown relative to the location of Southern Cross aerodrome (YSCR) in Figure 2 (Source, Yilgarn, Google Earth).

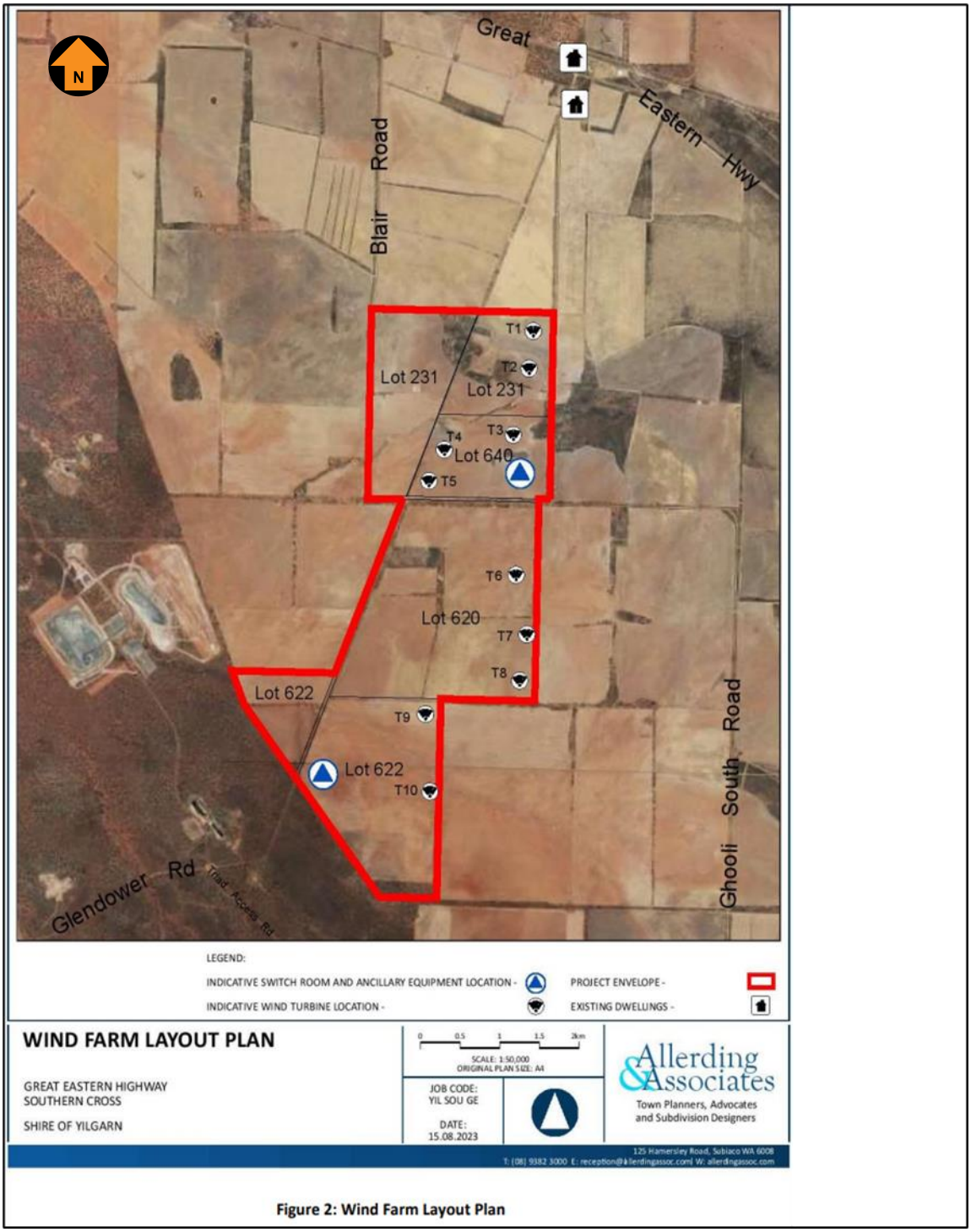


Figure 2: Wind Farm Layout Plan

Figure 2 WTG Layout

The configuration of the transmission lines and substation is still under investigation and not specified for this assessment.

Table 1 shows the location(s) and site elevation(s) for each proposed WTG site (Source, Yilgarn)

The WTG location responsible for the maximum Project height is highlighted.

The maximum Project height is identified as:

- WTG1, with a maximum tip height of 678 m AHD (2224.41 ft AMSL)

Table 1 WTG location and elevation

WTG #	Easting	Northing	Terrain Elevation (m AHD)	WTG Max Height (m AGL)	WTG Tip Height (m AGL)	WTG Tip Height (ft AMSL)
1	733567.00	6536327.00	438	240	678	2224.41
2	733483.00	6535674.00	424	240	664	2178.48
3	733468.00	6534828.00	422	240	662	2171.92
4	732349.00	6534880.00	408	240	648	2125.98
5	732019.00	6534307.00	400	240	640	2099.74
6	733357.00	6533235.00	398	240	638	2093.18
7	733367.00	6532536.00	393	240	633	2076.77
8	733351.00	6531837.00	387	240	627	2057.09
9	732184.00	6531641.00	379	240	619	2030.84
10	732142.00	6530471.00	381	240	621	2037.40

2.3. Wind monitoring tower description

A wind monitoring tower (WMT) will be installed in the central part of the Project Area with a maximum height of 120 m AGL.

Aviation Projects conducted a separate aviation impact assessment for the proposed WMT on 8 September 2023 (Reference 107801-01).

Table 2 provides the full details of the WMT.

Table 2 WMT Details

Item	WMT
Location (Lat, Lon)	31°18'18"S 119°26'23"E
Ground elevation at site (approximate)	393 m AHD
Height of WMT AGL	120 m AGL
Height of tower	513 m AHD (1683 ft AMSL)
Reported to Airservices Australia?	TBA when final location is determined

3. EXTERNAL CONTEXT

This chapter explores the federal, state, and local planning context that may impact the Project. Each section will explore and respond to the planning context to identify any conflict between the Project and applicable planning requirements.

3.1. Western Australia Planning Commission

The Western Australian Planning Commission normally administers responsibility for approving renewable energy facilities through local councils.

The Department of Planning, Lands and Heritage has published Position Statement: Renewable energy facilities (March 2020) on behalf the Western Australia Planning Commission. These guidelines provide advice to inform planning decisions about a wind energy facility proposal.

The intent of this position statement is to:

- outline the Western Australian Planning Commission (WAPC) requirements to support the consistent consideration and provision of renewable energy facilities within Western Australia
- identify assessment measures to facilitate appropriate development of renewable energy facilities.

The position statement applies to the preparation and assessment of planning instruments including regional and local planning schemes and strategies.

The position statement supersedes Planning Bulletin 67 Guidelines for Wind Farm Development (2004).

Section 5.3.1 *Community consultation* and Section 5.3.5 *Public and aviation safety* are relevant to this AIA and are extracted below:

> ***Section 5.3.1 Community consultation***
>
> *Early consultation with the community and stakeholders by the proponents is encouraged to ensure that the proposal is compatible with existing land uses on and near the site. The local government should be consulted with respect to the community consultation program. Relevant stakeholders may include:*
>
> - *Air Services Australia*
> - *Australian Wind Alliance*
> - *Civil Aviation Safety Authority*
>
> ***5.3.5 Public and aviation safety***
>
> *Proponents of wind turbine proposals should refer to the National Airports Safeguarding Framework (NASF) Guideline D: Managing the Risk to Aviation Safety of Wind Turbine Installation (Wind Farms) / Wind Monitoring Towers to determine any potential aviation safety risks and possible mitigation measures.*
>
> *Any potential aviation safety risks identified require consultation with Civil Aviation Safety Authority (CASA), Air Services Australia and/or the Commonwealth Department of Defence.*

The position paper defines renewable energy facility as premises used to generate energy from a renewable energy source and includes any building or other structure used in, or relating to, the generation of energy by a renewable resource. It does not include renewable energy electricity generation where the energy produced principally supplies a domestic and/or business premises and any on selling to the grid is secondary.

It is considered that the intent of the Position Paper is met through the completion of this aviation impact assessment, including consultation with key aviation stakeholder and reference to (NASF) Guideline D and other specific requirements for Airservices Australia and CASA.

3.2. National Airports Safeguarding Framework

The National Airports Safeguarding Advisory Group (NASAG) was established by Commonwealth Department of Infrastructure and Transport to develop a national land use planning framework called the National Airports Safeguarding Framework (NASF). The purpose of the NASF is to enhance the current and future safety, viability, and growth of aviation operations at Australian airports through:

- the implementation of best practice in relation to land use assessment and decision making in the vicinity of airports
- assurance of community safety and amenity near airports
- better understanding and recognition of aviation safety requirements and aircraft noise impacts in land use and related planning decisions
- the provision of greater certainty and clarity for developers and landowners
- improvements to regulatory certainty and efficiency
- the publication and dissemination of information on best practice in land use and related planning that supports the safe and efficient operation of airports.

NASF Guideline D: *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers*, provides guidance to State/Territory and local government decision makers, airport operators and developers of wind farms to jointly address the risk to civil aviation arising from the development, presence and use of wind farms and WMTs.

The methodology for preparing the risk assessment is contained in the NASF Guideline D *Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*.

The risk assessment will have regard to all potential aviation activities within the vicinity of the Project site including recreation, commercial, civil (including for agricultural purposes) and military operations.

NASF Guideline D strongly encourages consultation with aviation stakeholders in the early stages of wind farm development planning, including with aerodrome owners and operators, regional aircraft operators and CASA and Airservices.

3.3. Aircraft operations at non-controlled aerodromes

Advisory Circulars (ACs) provide advice and guidance from CASA to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements. Advisory Circular (AC) 91-10 v1.1 *Operations in the vicinity of non-controlled aerodromes* provides guidance for pilots flying at or in the vicinity of non-controlled aerodromes, with respect to CASR 91.

A conventional circuit pattern and heights are provided in AC 91-10 v1.1. The standard circuit consists of a series of flight paths known as *legs* when departing, arrival or when conducting circuit practice. Illustrations of the standard aerodrome traffic circuit procedures provided in AC 91-10 v1.1. are shown in Figure 3 and Figure 4.

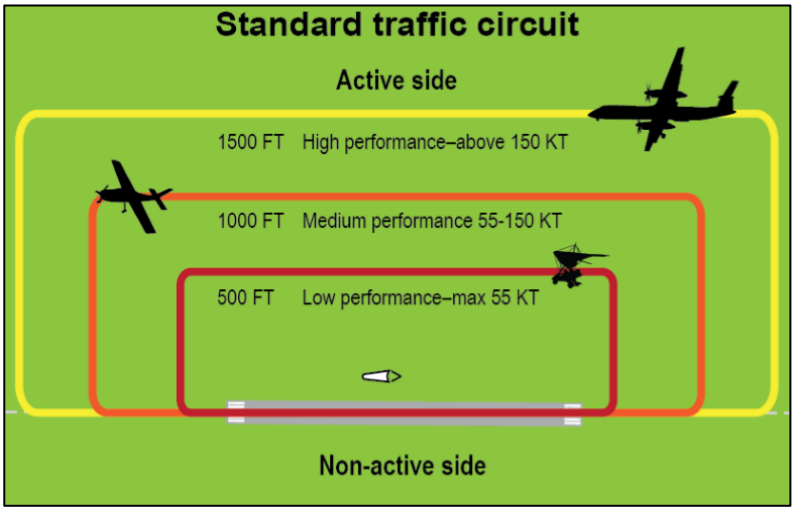


Figure 3 Lateral and vertical separation in the standard aerodrome traffic circuit

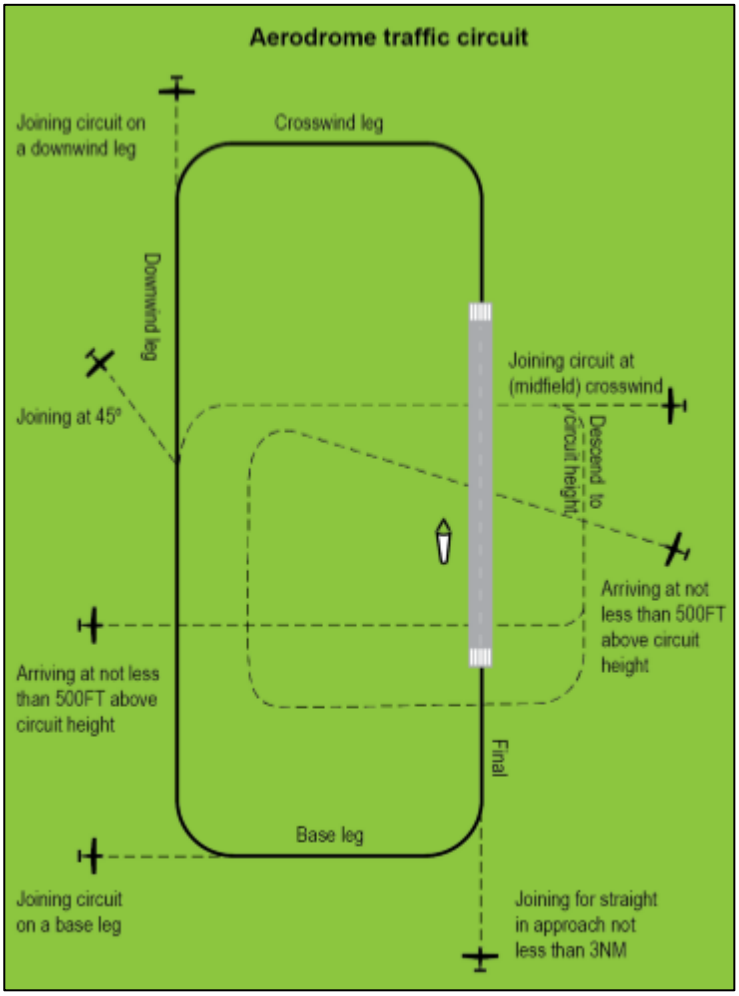


Figure 4 Aerodrome standard traffic circuit, showing arrival and joining procedures

AC 91-10 v1.1. paragraph 7.10 makes reference to a distance that is "normally" well outside the circuit area and where no traffic conflict exists, which is at least 3 nm (5556 m). The paragraph is copied below:

> *7.10 Departing the circuit area*
>
> *7.10.1 Aircraft should depart the aerodrome circuit area by extending one of the standard circuit legs or climbing to depart overhead. However, the aircraft should not execute a turn to fly against the circuit direction unless the aircraft is well outside the circuit area and no traffic conflict exists. This will normally be at least 3 NM from the departure end of the runway, but may be less for aircraft with high climb performance. In all cases, the distance should be based on the pilot's awareness of traffic and the ability of the aircraft to climb above and clear of the circuit area.*

3.4. Rules of flight

3.4.1. Flight under Day Visual Flight Rules (VFR)

According to Aeronautical Information Publication (AIP) the meteorological conditions required for visual flight in the applicable (Class G) airspace at or below 3000 ft AMSL or 1000 ft AGL whichever is the higher are: 5000 m visibility, clear of clouds and in sight of ground or water.

Civil Aviation Safety Regulation (1998) 91.267 (Minimum height rules—other areas) prescribes the minimum height for flight. Generally speaking, and unless otherwise approved, aircraft are restricted to a minimum height of 500 ft AGL above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas, and 1000 ft AGL over built up areas (within a horizontal radius of 600 m of the point on the ground or water immediately below the aeroplane).

These height restrictions do not apply if through stress of weather or any other unavoidable cause it is essential that a lower height be maintained.

Flight below these height restrictions is also permitted in certain other circumstances.

3.4.2. Night VFR

With respect to flight under the VFR at night, Civil Aviation Safety Regulations (1998) 91.277 requires that the pilot in command of an aircraft flying VFR at night must not fly below the following heights (unless during take-off and landing operations, within 3 nm of an aerodrome, or with an air traffic control clearance):

a) *the published lowest safe altitude for the route or route segment (if any);*

b) *the minimum sector altitude published in the authorised aeronautical information for the flight (if any);*

c) *the lowest safe altitude for the route or route segment;*

d) *1,000 ft above the highest obstacle on the ground or water within 10 nautical miles ahead of, and to either side of, the aircraft at that point on the route or route segment;*

e) *the lowest altitude for the route or route segment calculated in accordance with a method prescribed by the Part 91 Manual of Standards for the purposes of this paragraph.*

3.4.3. Instrument Flight Rules (IFR) (Day or night)

According to CASR 91, flight under the instrument flight rules (IFR) requires an aircraft to be operated at a height clear of obstacles that is calculated according to an approved method.

3.5. Aircraft operator characteristics

Aircraft operations in the vicinity of the Project area may include private, air transport, flight training and aerial work operations. High-capacity air transport operations will also occur at Southern Cross aerodrome associated with chartered aircraft servicing nearby mining operations.

There may be some aerial application and aerial firefighting operations conducted in the vicinity of the Project Area.

Air transport operations are generally conducted under the instrument flying rules (IFR), while aerial work and private and recreational activities are likely to be conducted under visual flying rules (VFR).

Operations conducted under VFR are required to remain in visual meteorological conditions (VMC) (at least 5,000 m horizontal visibility at a similar height of the wind turbines) and clear of the highest point of the terrain by 500 ft vertical distance and 300 m horizontal distance. In visual meteorological conditions (VMC), the wind turbines will likely be sufficiently conspicuous to allow adequate time for pilots to avoid the obstacles. VFR operators will most likely avoid the Project Area once wind turbines are erected.

IFR and Night VFR (which are required to conform to IFR applicable altitude requirements) aircraft operations are addressed in Section 6.

3.6. Private operations

Private operations are generally conducted under day or night VFR, with some IFR. Flight under day VFR is conducted above 500 ft AGL.

There is likely to be private operations conducted in the vicinity of the Project, associated with approach and departure procedures from Southern Cross aerodrome.

3.7. Military operations

There may be some high-speed low-level military jet aircraft and helicopter operations conducted in the area.

Refer to Section 5 for Department of Defence consultation.

3.8. Aerial application operations

Aerial application operations including such activities as fertiliser, pest and crop spraying are generally conducted under day VFR below 500 ft AGL; usually between 6.5 ft (2 m) and 100 ft (30.5 m) AGL.

The standard response from the Aerial Application Association of Australia in relation to wind farms has been included in Section 3.12 (below) for reference. Objections to windfarms are generally related to large scale wind farm projects in active areas of agriculture located in the vicinity of aerial agriculture operations.

There may be aerial application operations associated with fertiliser, pest and crop spraying in the area.

3.9. Aerial Application Association of Australia (AAAA)

In previous consultation with the AAAA, Aviation Projects has been directed to the AAAA Windfarm Policy (dated March 2011) which states in part:

As a result of the overwhelming safety and economic impact of wind farms and supporting infrastructure on the sector, AAAA opposes all wind farm developments in areas of agricultural production or elevated bushfire risk.

In other areas, AAAA is also opposed to wind farm developments unless the developer is able to clearly demonstrate they have:

1. consulted honestly and in detail with local aerial application operators;

2. sought and received an independent aerial application expert opinion on the safety and economic impacts of the proposed development;

3. clearly and fairly identified that there will be no short or long term impact on the aerial application industry from either safety or economic perspectives;

4. if there is an identified impact on local aerial application operators, provided a legally binding agreement for compensation over a fair period of years for loss of income to the aerial operators affected; and

5. adequately marked any wind farm infrastructure and advised pilots of its presence.

AAAA had developed National Windfarm Operating Protocols (adopted May 2014). These protocols note the following comments:

At the development stage, AAAA remains strongly opposed to all windfarms that are proposed to be built on agricultural land or land that is likely to be affected by bushfire. These areas are of critical safety importance to legitimate and legal low-level operations, such as those encountered during crop protection, pasture fertilisation or firebombing operations.

However, AAAA realises that some wind farm proposals may be approved in areas where aerial application takes place. In those circumstances, AAAA has developed the following national operational protocols to support a consistent approach to aerial application where windfarms are in the operational vicinity.

The protocols list considerations for developers during the design/build stage and the operational stage, for pilots/aircraft operators during aircraft operations and discusses economic compensation. NASF Guideline D is included in the Protocols document as Appendix 1, and AAAA Aerial Application Pilots Manual – excerpts on planning are provided as Appendix II.

This AIA has been prepared in consideration of the National Windfarm Operating Protocols, noting there are no known aerial application operations associated with fertiliser, pest and crop spraying in the area.

3.10. Local aerial application operators

Aerial application operators consulted in previous studies undertaken by Aviation Projects have stated that a wind farm would, in all likelihood, prevent aerial agricultural operations in that particular area, but that properties adjacent to the wind farm would have to be assessed on an individual basis.

Aerial application operators generally align their positions with the AAAA policies.

Based on previous studies undertaken by Aviation Projects, and subject to the results of consultation with AAAA and any further consultation with local aerial application operators, it is reasonable to conclude that safe aerial application operations would still be possible on properties within the Project site and neighbouring the Project site, by implementing recommendations provided in this report.

The use of helicopters enables aerial application operations to be conducted in closer proximity to obstacles than would be possible with fixed wing aircraft due to their greater manoeuvrability.

It is possible that fixed wing aerial agriculture operations will be conducted in the vicinity of the Project.

3.11. Aeromedical services – Royal Flying Doctor Service

Royal Flying Doctor Service (RFDS) and other emergency services operations are generally conducted under the IFR, except when arriving/departing a destination that is not serviced by instrument approach aids or procedures.

RFDS WA also operates 2 Heli-Med Service EC145 helicopters from their Jandakot airport base, which may also operate directly to/from Southern Cross aerodrome.

Most emergency aviation services organisations have formal risk management programs to assess the risks associated with their operations and implement applicable treatments to ensure an acceptable level of safety can be maintained.

Refer to Section 5 for Royal Flying Doctor Service consultation.

3.12. Aerial firefighting

Aerial firefighting operations (firebombing in particular) are conducted under Day VFR, sometimes below 500 ft AGL. Under certain conditions visibility may be reduced/limited by smoke/haze.

Most aerial firefighting organisations have formal risk management programs to assess the risks associated with their operations and implement applicable treatments to ensure an acceptable level of safety can be maintained. For example, pilots require specific training and approvals, additional equipment is installed in the aircraft, and special procedures are developed.

The Australasian Fire and Emergency Services Council (AFAC) has developed a national position on wind farms, their development and operations in relation to bushfire prevention, preparedness, response and recovery, set out in the document titled *Wind Farms and Bushfire Operations*, version 3.0, dated 25 October 2018.

Of specific interest in this document is the section extracted verbatim from under the 'Response' heading, copied below:

> *Wind farm operators should be responsible for ensuring that the relevant emergency protocols and plans are properly executed in an emergency event. During an emergency, operators need to react quickly to ensure they can assist and intervene in accordance with their planned procedures.*
>
> *The developer or operator should ensure that:*
>
> - *liaison with the relevant fire and land management agencies is ongoing and effective*
> - *access is available to the wind farm site by emergency services response for on-ground firefighting operations*
> - *wind turbines are shut down immediately during emergency operations – where possible, blades should be stopped in the 'Y' or 'rabbit ear' position, as this positioning allows for the maximum airspace for aircraft to manoeuvre underneath the blades and removes one of the blades as a potential obstacle.*
>
> *Aerial personnel should assess risks posed by aerial obstacles, wake turbulence and moving blades in accordance with routine procedures.*

4. INTERNAL CONTEXT

4.1. Wind farm description

The Southern Cross Wind Farm will comprise of a maximum of 10 WTGs at 240 m AGL tip height, together with associated infrastructure.

The Project is located approximately 12 km southeast of the town of Southern Cross, and approximately 10 km (3.6 nm) southeast of Southern Cross aerodrome.

The Project will be located on rural cropping and pastoral land.

The main permanent wind farm components of the proposed Project will include the following:

- A maximum of 10 WTGs with a maximum tip height of 240 m AGL
- transformer
- hard standing areas for WTG construction
- overhead cabling and unground cabling as required (linking WTGs to site sub-station)
- access roads to WTG sites

Figure 5, Figure 6 and Figure 7 shows the general nature of the Project area. These locations are generally representative of the nature of Project area for all proposed WTG sites.

Figure 5 Northeast Project area

Figure 6 Central Project area

Figure 7 Western Project area

4.2. Grid transmission

The configuration of the grid transmission and distribution equipment is still under investigation and not specified for this assessment. It is anticipated that underground cables will be used for connection between the WTGs and the grid. An overhead transmission line exists in the Project Area already.

Figure 8 shows the nature of the existing overhead transmission line travelling east-west located in the Central part of the Project Area.

Figure 8 Transmission line located in central Project Area

5. CONSULTATION

The following list of stakeholders were identified as requiring consultation:

- Airservices Australia
- Royal Flying Doctor Service
- Department of Defence
- Shire of Yilgarn
- Aerodrome Management Services
- Regional aircraft operators

Details and results of the consultation activities are provided in Table 3.

Table 3 Stakeholder consultation details

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
Airservices Australia	19 September 2023			
Civil Aviation Safety Authority	Email sent 15 September 2023	18 September 2023 – David Russell, aerodrome inspector	*In regard to the wind farm proposal below, the aerodromes inspector team wouldn't be involved in the process as there is no impact on the OLS. The notification from the proponent will go directly to the airspace protection team within CASA and they are the team that would give out any general advice (if any) re wind farm projects. Their email is Airspace.Protection@casa.gov.au*	The proponent of the wind farm will need to report the Project to CASA in accordance with CASR Part 139.165.
Royal Flying Doctor Service	19 September 2023			
Shire of Yilgarn	19 September 2023 (online meeting)			
Aerodrome Management Services	19 September 2023 (online meeting)		Potential impact of Project on future expansion of YSCR to accommodate larger aircraft (understood to be an upgrade to runway 09/27). If the DA is submitted prior to receiving feedback from Airservices and CASA, the	Obstacle lighting not mandatory. CASA may provide recommendation. Risk assessment in this study conducted, and supports nil obstacle lighting on the Project with controls implemented.

Agency/Contact	*Activity/Date*	*Response/ Date*	*Issues Raised During Consultation*	*Action Proposed*
			Shire won't know if obstacle lighting is required and should become a development condition.	
Department of Defence	19 September 2023 (online meeting)			
Regional aircraft operators				

6. AVIATION IMPACT STATEMENT

6.1. Overview

The NASF Guideline D: *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers* provides information to proponents and planning authorities to help identify any potential safety risks posed by WTG and wind monitoring installations from an aviation perspective.

Potential safety risks include (but are not limited to) impacts on flight procedures and aviation communications, navigation, and surveillance (CNS) facilities which require assessment by Airservices Australia.

To facilitate these assessments all wind farm proposals submitted to Airservices Australia must include an Aviation Impact Statement (AIS).

This analysis considered the aeronautical impact of the WTGs on the following:

- The operation of nearby certified aerodromes
- The operation of nearby aircraft landing areas (uncertified aerodromes)
- Grid and air route LSALTS
- Airspace protection
- Aviation facilities
- Radar installations
- Local aircraft operations.

6.2. Nearby certified aerodromes

The area of 30 nm (56 km) from a certified airport's aerodrome reference point (ARP) is used to identify possible constraints from the Project.

The 30 nm radius represents the 25 nm minimum sector altitude (MSA) for aerodromes with terminal instrument flight procedures. The 25 nm MSA minimum altitude is determined by assessing obstacles within 30 nm of the reference point.

The Project Area is located within 30 nm (55.56 km) of Southern Cross aerodrome. There are no other certified aerodromes within 30 nm of the Project.

6.3. Nearby aircraft landing areas (ALAs)

As a guide, an area of interest within a 3 nm radius of an aircraft landing area (ALA – uncertified aerodrome) is used to assess potential impacts of proposed developments on aircraft operations at or within the vicinity of the ALA.

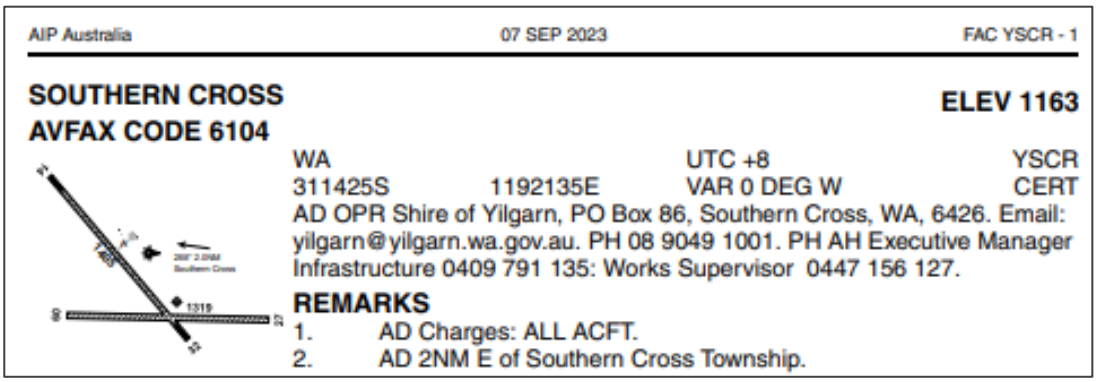
A search on OzRunways, which sources its data from Airservices Australia (AIP) and Aircraft Owners and Pilots Association (AOPA) Australia Airfield Directory, did not identify any verified ALAs within 3nm from the Project. The aeronautical data provided by OzRunways is approved under CASA CASR Part 175.

6.4. Southern Cross aerodrome (YSCR)

Southern Cross aerodrome (YSCR) is a certified aerodrome located approximately 5 nm northwest of the Project Area boundary (to the threshold of runway 32), owned and operated by the Shire of Yilgarn.

A check of Aeronautical Information Package (AIP) via the Airservices Australia website showed that Southern Cross aerodrome is served by non-precision instrument flight procedures (source: AsA, effective 07 September 2023).

Figure 9 shows an excerpt of the published operating profile for Southern Cross Aerodrome (Source: Airservices Australia)



AIP Australia 07 SEP 2023 FAC YSCR - 1

SOUTHERN CROSS **ELEV 1163**
AVFAX CODE 6104

WA UTC +8 YSCR
311425S 1192135E VAR 0 DEG W CERT
AD OPR Shire of Yilgarn, PO Box 86, Southern Cross, WA, 6426. Email: yilgarn@yilgarn.wa.gov.au. PH 08 9049 1001. PH AH Executive Manager Infrastructure 0409 791 135: Works Supervisor 0447 156 127.

REMARKS
1. AD Charges: ALL ACFT.
2. AD 2NM E of Southern Cross Township.

Figure 9 Southern Cross aerodrome published information.

The Project site is located within the lateral limits of the:

- 25 nm Minimum Safe Altitude (MSA) segment
- 10 nm MSA segment
- Intermediate approach segment of the RNP S instrument approach procedure
- Missed approach segment of the RNP N instrument approach procedure.

6.4.1. Instrument Approach Procedures

There are two instrument approach procedures published for YSCR:

- RNP N
- RNP S.

6.4.2. 25 nm MSA

The 25 nm MSA encompasses an area within a radius of 30 nm from the reference point, in this case the Aerodrome Reference Point (ARP) at YSCR.

It provides IFR pilots with a known safe altitude that they can descend to in conditions where they cannot necessarily see the ground due to cloud or rain, etc, as they position the aircraft to commence an instrument approach to allow them to see the runway at an appropriate safe point prior to landing visually.

The 25 nm MSA determines the altitude at which IFR aircraft commence an instrument approach and also determines the minimum holding altitude for each approach.

The minimum altitude within the 25 nm MSA is determined by adding the appropriate Minimum Obstacle Clearance (MOC) buffer of 984 ft to the highest obstacle within the 30 nm radius area.

The minimum altitude published for the 25 nm MSA is 2900 ft AMSL with a PANS-OPS surface of 1916 ft AMSL.

The WTGs are located within the lateral limits of the 25 nm MSA.

The highest WTG #1 has a maximum height of 2224.41 ft AMSL and therefore infringes the 25 nm MSA by 308.41 ft, necessitating an increase to the 25 nm MSA minimum altitude by 400 ft to 3300 ft AMSL. Subsequent adjustments to all of the instrument approach procedures would also need to be made to ensure consistency with the 25 nm MSA.

An increase to the minimum altitude for the 25 nm MSA by 400 ft would not cause an adverse impact to IFR operations at YSCR due to the distance between the point where the aircraft intercept the final approach path (5nm from Runway 08 threshold) and the Initial approach fix at 15 nm from the Runway 32 threshold.

6.4.3. 10 nm MSA

The 10 nm MSA encompasses an area within a radius of 15 nm from the reference point, in this case the Aerodrome Reference Point (ARP) at YSCR. The minimum altitude within the 10 nm MSA is determined by adding the appropriate Minimum Obstacle Clearance (MOC) buffer of 984 ft to the highest obstacle within the 15 nm radius area.

The minimum altitude published for the 10 nm MSA is 2800 ft AMSL with a PANS-OPS surface of 1816 ft AMSL.

WTG #1, at a height of 2224.41 ft AMSL will infringe the 10 nm MSA PANS-OPS surface by 408.41 ft necessitating an increase to the 10 nm PANS-OPS surface by 500 ft, subsequently increasing the minimum altitude to 3300 ft, commensurate with the 25 nm MSA.

The majority of the WTGs are located within the 10 nm MSA area. The 10 nm MSA has no relevance to the RNAV approaches at YSCR.

It is relevant to departure planning for IFR aircraft but a 400 ft increase would not create an adverse impact.

An increase to the minimum altitude for the 10 nm MSA to 3300 ft AMSL would not create an adverse impact to IFR aircraft operations at YSCR.

6.4.4. RNP S

The WTGs are located within the Intermediate Approach Segment of the RNP S instrument approach procedure. This segment has a minimum altitude of 2700 ft and a PANS-OPS surface of 2208 ft AMSL. WTG #1 infringes this PANS-OPS surface by 16.41 ft necessitating an increase of 100 ft to accommodate the wind farm. An increase to the minimum altitude to 2800 ft will not affect the flight path gradient.

Alternatively, WTG#1 could be moved to lower terrain to ensure that it has a maximum height lower than 2208 ft (673 m) AMSL.

Increases to the minimum holding altitude, approach commencement altitude and final missed approach altitude will not create an adverse impact to this procedure as the final approach descent gradient is not affected.

6.4.5. RNP N

The WTGs are located in the Missed Approach Segment of the RNP N instrument approach procedure.

None of the WTGs infringe the PANS-OPS surface.

Increases to the minimum holding altitude, approach commencement altitude and final missed approach altitude will not create an adverse impact to this procedure as the final approach descent gradient is not affected.

6.4.6. IFR Circling Areas

The instrument approach procedures are available for aircraft up to and including Performance Category C. The protection surface is applicable within 7.85 km (4.2 nm) of each runway end. It is understood that air transport operators may utilise the RNP-N and RNP-S procedures and circle to land on runway 09/27.

The Project is located approximately 10 km from the nearest runway end and therefore the Project does not have an impact on the IFR Circling Areas.

Figure 10 shows the relevant Instrument Approach Segment boundaries.

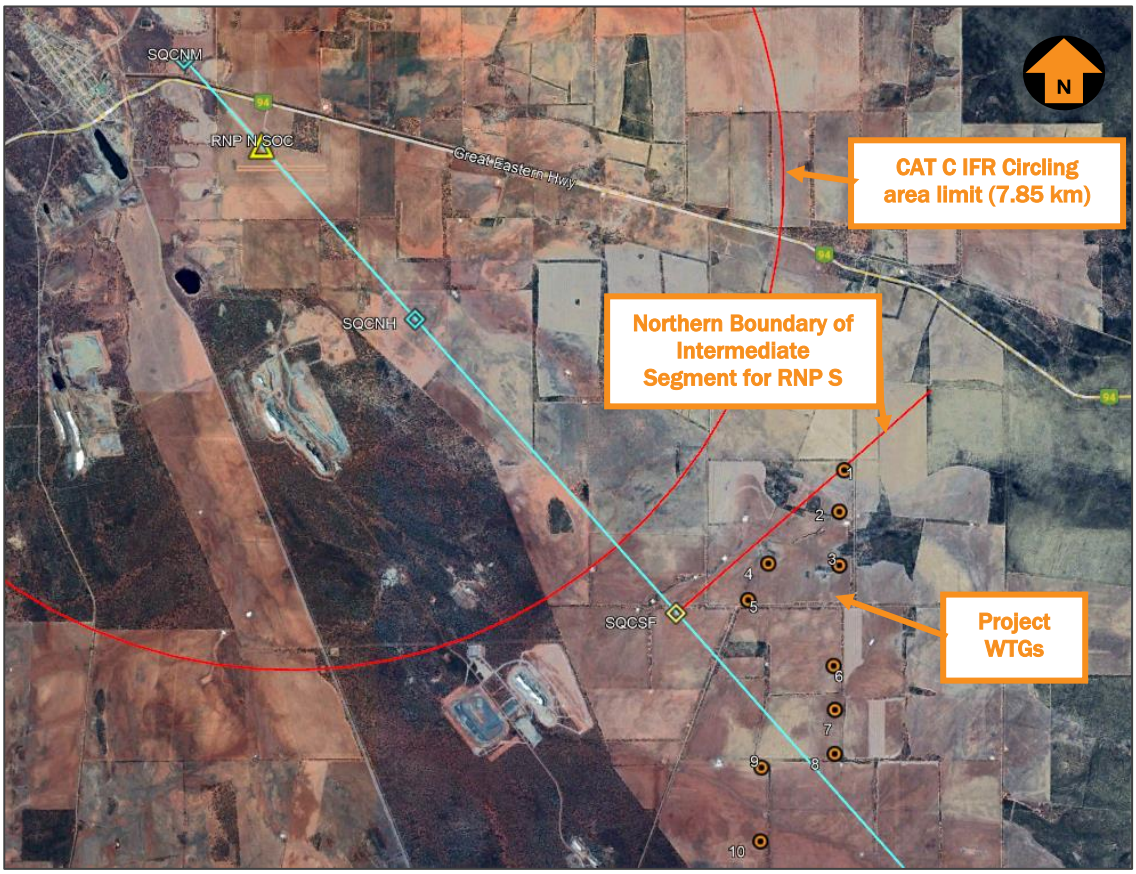


Figure 10 YSCR Instrument Approach data

Summary – impact to YSCR terminal instrument flight procedures

The Project will result in an impact to the terminal instrument flight procedures established at YSCR. Airservices Australia will technically evaluate the impact to the procedures, which will be initiated as part of the consultation process of this aviation impact assessment.

The impacts caused to the procedures by the Project is not anticipated to cause any adverse operational impacts to aircraft as the final approach descent gradient is not affected, and the overall efficacy and effectiveness of the procedures is not considered to be impacted.

The permission of the aerodrome operator will be required prior to Airservices Australia making any amendments to the procedures following their review.

6.4.7. Obstacle Limitation Surfaces (OLS)

An obstacle limitation surface must be established at certified aerodromes in accordance with the specifications in Part 139 MOS 2019.

The OLS at Southern Cross aerodrome comprise of:

- Inner Horizontal Surface (IHS) within a radius of 3.5 km from each runway strip end and 45 m above the airport's reference elevation datum. This surface is not infringed by the Project.
- Conical Surface from the edge of the IHS rising at 5% to 60 m above the IHS, a distance of 1200 m from the outer edge of the IHS. This surface is not infringed by the Project.
- An Approach Surface of various gradients and a horizontal section for Runway 32 Code 1 runway. The total length of the Approach Surface is 2500 m from the inner edge, which is located 60 m before the landing threshold. There are no WTGs proposed within the Approach Surface for Runway 32.
- A Take-off Climb Surface rising at 5% to 1600 m from near the runway end for runway 14/32. There are no WTGs proposed within the Take-Off Climb Surface for Runway 32.
- A Transitional Surface parallel to the runway which is not relevant to this assessment.

Figure 11 shows the typical OLS (Source: CASR Part 139 Manual of Standards). The Outer Horizontal Surface is not relevant to this assessment.

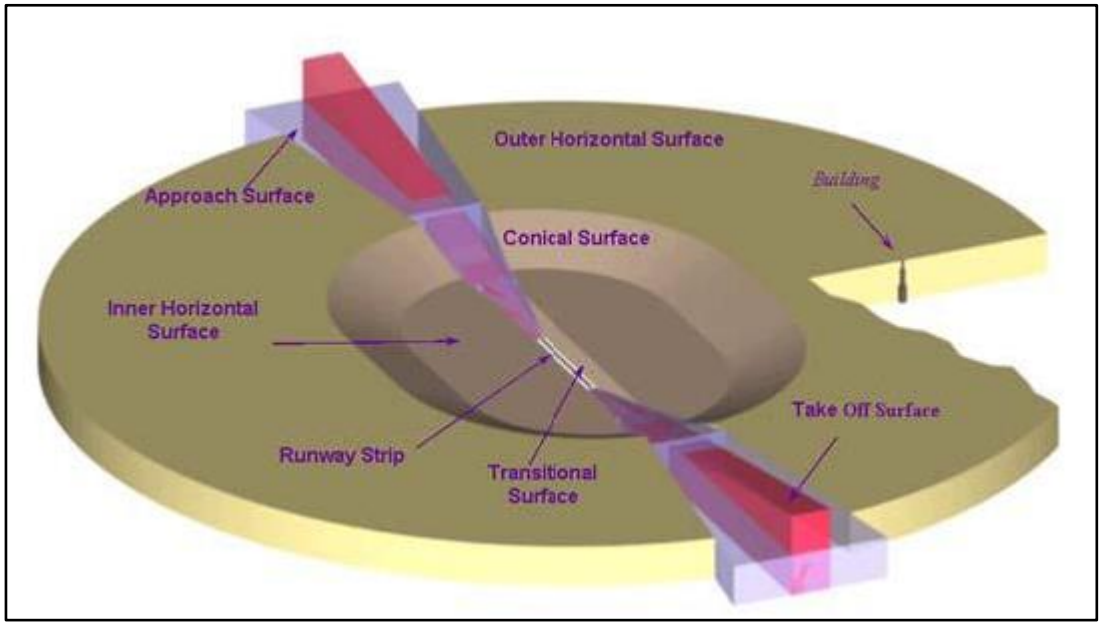


Figure 11 Typical OLS

The Project does not infringe the OLS at Southern Cross aerodrome.

6.4.8. Potential future operations Southern Cross aerodrome

It is understood the Shire of Yilgarn are investigating options to facilitate the operation of larger aircraft to the aerodrome, primarily associated with high-capacity air transport operations for nearby mining operations. These options may include:

- Lengthening, widening, strengthening and sealing of runway 09/27
- Implementing terminal instrument flight procedures to runway 09/27
- Upgrading runway 09/27 to a code 3 runway

The nearest WTG is located more than 9,300 m from the boundary of Southern Cross aerodrome. The Project would not affect the potential upgrade of runway 09/27 to facilitate larger aircraft in the proposed configuration. The Project would be located clear of the obstacle limitation surface for an upgrade to runway 09/27 (as a code 3, instrument non-precision runway), and the implementation of runway aligned terminal instrument flight procedures would not be prevented by the Project as the WTGs would be clear of the final, intermediate and missed approach segment protection areas for runway 09/27 procedures.

6.5. Wake turbulence impacts

NASF Guideline D states that turbulence created by the rotating blades may be noticeable up to 16 rotor diameters from the turbine. Although the impact of the turbulence on aircraft in the vicinity is relatively unknown, it is accepted that there may be risk to aircraft operating within the 16-rotor blade diameter of the turbine. Light aircraft are most susceptible to impacts of wake turbulence. International studies have indicated that wake turbulence impacts beyond 10 times the rotor diameter are only expected to be minor.

Based on a maximum rotor diameter of 180 m, a distance of 2880 m is the maximum distance where wake turbulence impacts may be experienced by aircraft downwind of a WTG, based on the NASF guidance.

The NASF Guideline D turbulence figure is based on United Kingdom (UK) Civil Aviation Authority (CAA) Civil Aviation Publication (CAP) 764 – CAA Policy and Guidelines on Wind Turbines, which in turn is based on *"research activity or modelling and studying the wake characteristics…..using computational fluid dynamics techniques, wind tunnel tests and on site LIDAR measurements."*

This CAP recognises that the extent of the turbulence diminishes to less than 10% of what exists immediately behind the turbine within 5 rotor diameters (RD). This study was based on a 30 m diameter turbine.

A study by the European Academy of Wind Energy, - *Do Wind Turbines Pose Roll Hazards to Light Aircraft,* 2018, used large-eddy simulations (LES) to assess wind-generated roll hazards to small aircraft from the wake of a utility-scale wind turbine – a GE 1.5 MW turbine with three bladed rotor of 77 m in diameter and a hub height of 80 m. A typical aircraft was used in the study, which was a Cessna 172.

This study is considered a simple method for quantifying turbine-wake-induced roll hazards on general aviation aircraft. The assessment criteria are based on *the maximum rolling moment that the aileron on a typical aircraft can generate to counteract a moment induced by the wake field."*

This study determined:

- Turbine wakes tend to diffuse more rapidly in convective conditions as the mechanical mixing of the air erodes the wake (Baker and Walker 1984, Magnusson and Smedman 1994, Mirocha et al., 2015)
- The worst case for longer-persisting wakes exists in stable atmospheric conditions (Bodini et al., 2018)
- 99.99% of all calculations exist within the low hazard threshold

- No moments reached the high hazard threshold
- In stable conditions the largest roll hazards occur most frequently about 5 D downwind of the turbine
- All of the peak hazards are located in the high-shear zone at the edge of the wake between 3 and 7 D downwind from the turbine
- Normal control inputs by pilots when first noticing the roll movement will alleviate the wake impact.

The data and conclusions contained in the above study indicates that any turbulence downwind of a turbine is significantly decreased beyond approximately 7 rotor diameters.

Aviation Projects considers that a conservative distance of 10 rotor diameters would contain any effects from downwind turbulence from the WTGs.

There are no aerodromes within 1800 m of any WTG.

6.6. Air routes and LSALT

MOS 173 requires that the published lowest safe altitude (LSALT), for a particular airspace grid or air route, provides a minimum of 1000 ft clearance above the controlling (highest) obstacle within the relevant airspace grid or air route tolerances.

Grid LSALTs are specified for grid squares formed by the parallels and meridians at 1° intervals for low-level charts and 2° intervals for the high-level chart applicable to the Project Area.

The proposed WTGs are located in a grid identified in the EnRoute Chart – Low. (ERCL 8)

The Project Area is located within a Grid with an LSALT of 3000 ft and associated protection surface of 2000 ft AMSL.

At a maximum height of 2224.41 ft AMSL the highest WTG will infringe this protection surface by 224.41 ft necessitating an increase to the Grid LSALT of 300 ft to 3300 ft AMSL. All WTGs infringe the 2000 ft protection surface.

An increase to the Grid LSALT should not create an adverse impact to flight operations in the area.

Figure 12 provides the low-level air routes and grid LSALTs in proximity to the Project site (source: ERC Low National, Yilgarn).

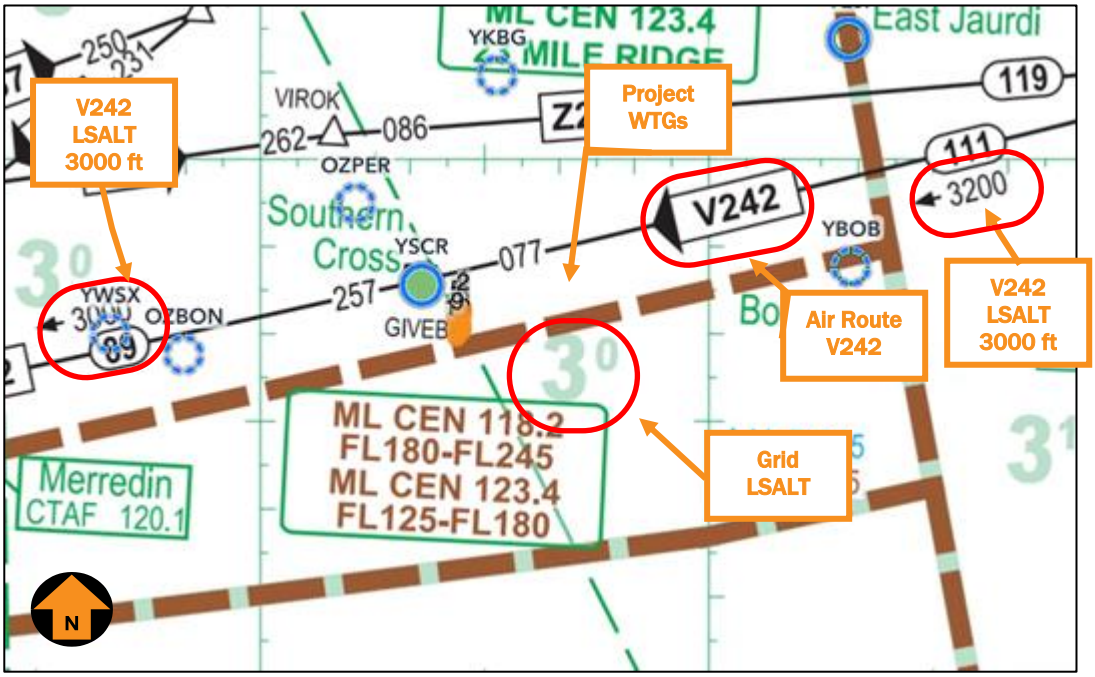


Figure 12 Grid and Enroute LSALT details

One air route overlies the Project: V242 with a LSALT to the east of GIVEB waypoint of 3200 ft AMSL and 3000 ft AMSL to the west of GIVEB.

At a maximum height of 2224.41 ft AMSL the highest WTG will infringe this protection surface by 224.41 ft necessitating an increase to the LSALT of 300 ft to 3300 ft AMSL. All WTGs infringe the 2000 ft protection surface.

An impact analysis of the LSALTs applicable to the Project Area is provided in Table 4.

Table 4 LSALT analysis

Air route	*Waypoint pair*	*LSALT (ft AMSL)*	*Protection surface (ft AMSL)*	*Impact on airspace design*	*Potential solution*	*Impact on aircraft ops*
V242	YPKG - GIVEB	3200	2200	24.41 ft infringement	Raise LSALT to 3300 ft AMSL	No adverse impact
V242	GIVEB - KELLA	3000	2000	224.41 ft infringement	Raise LSALT to 3300 ft AMSL	No adverse impact
Grid LSALT	N/A	3000	2000	224.41 ft infringement	Raise Grid LSALT to 3300 ft.	No adverse impact

Airservices Australia will amend the established grid LSALTs' once notified of the planned construction of the WTGs.

6.7. Airspace Protection

The Project site is located outside controlled airspace (wholly within Class G airspace) and is not located in any Prohibited or Restricted areas.

The Project will not impact controlled airspace.

6.8. Aviation facilities – Communication, Navigation and Surveillance Systems (CNS)

NASF Guideline G (Protection Aviation Facilities - Communication, Navigation and Surveillance (CNS)) and Part 139 MOS 2019 specify the area where development of buildings and structures has the potential to cause unacceptable interference to CNS facilities.

There are no aviation CNS located in the vicinity of any WTGs, and the Project will not penetrate any protection areas associated with CNS facilities as specified in Part 139 MOS 2019 and the National Airports Safeguarding Framework.

6.9. ATC Surveillance Radar

Airservices Australia currently requires an assessment of the potential for wind turbine generators to affect radar line of sight.

With respect to aviation radar facilities, the closest radar is the Kalamunda Route Surveillance Radar (RSR) which is located approximately 176 nm (324 km) west-southwest of the nearest proposed WTG. The Perth Primary Surveillance Radar (PSR) is located approximately 180 nm (334 km) west-southwest of the nearest proposed WTG.

The Project is located outside the stated range for these ATC radar facilities. (90 nm for the PSR and 250 nm for the RSR)

Note: Route Surveillance Radar (RSR) and Secondary Surveillance Radar (SSR) are similar radar system.

EUROCONTROL guidelines for assessing the potential impact on wind turbines on radar surveillance sensors stipulate the following assessment requirements:

Primary Surveillance Radar (PSR)

- Zone 1 0-500 m: Not permitted
- Zone 2 500 m – 15 km: Detailed assessment
- Zone 3: Further than 15 km but within maximum instrumented range and in radar line of sight: Simple assessment
- Zone 4: Anywhere within maximum instrumented range but not in radar line of sight or outside the maximum instrumented range: No assessment

Secondary Surveillance Radar (SSR)

- Zone 1: 0-500 m: Not permitted
- Zone 2 500 m – 16 km but within maximum instrumented range and in radar line of sight: Detailed assessment
- Zone 4: Further than 16 km or not in radar line of sight: No assessment

(Zone 3 is not established for secondary surveillance radar)

Due to the distance and intervening terrain between the Project Area and the radar facilities, the proposed Project is not anticipated to affect any radar facility. A simple assessment of the Perth Primary Surveillance Radar may be required by Airservices Australia, however due to the distance and terrain profile between the radar facility and the Project area, there is no impact anticipated.

Airservices Australia will review the potential impact of the Project on these radar facilities once notified of the Project.

6.10. Consultation

An appropriate and justified level of consultation was undertaken with relevant parties. Refer to **Section 5** for details of the stakeholders and a summary of the consultation.

6.11. AIS Summary

Based on the Project WTG layout and maximum blade tip height of up to 240 m AGL, the blade tip elevation of the highest WTG associated with both proposed WTG configurations, will not exceed 678 m AHD (2224.41 ft AMSL) and:

- will not infringe Southern Cross aerodrome's obstacle limitation surfaces
- infringes the PANS-OPS surfaces of Southern Cross aerodrome and will require amendments to both instrument approach procedures
- the infringements to the YSCR PANS-OPS surfaces will not create an impact to the existing flight paths
- will require an increase to the LSALT for air route V242
- will require an increase to the Grid LSALT
- will not have an impact on operational airspace
- is wholly contained within Class G airspace
- is outside the clearance zones associated with civil aviation navigation aids and communication facilities.

6.12. Assessment recommendations

Based on the information contained within this section and the analysis conducted, the following recommendations are made:

- Consultation should be undertaken with Airservices Australia to assess potential impacts of the Project (undertaken during this assessment)
- Consult with the Southern Cross aerodrome to determine if there will be potential safety issues for aircraft operations to the aerodrome if the Project was developed (undertaken during this assessment) and to seek approval for the amendments to the instrument approach procedures
- Department of Defence should be consulted to identify any potential impacts from the Project on military operations.

An appropriate and justified level of consultation was undertaken with relevant parties. Refer to **Section 5** for details of the stakeholders and a summary of the consultation.

7. HAZARD LIGHTING AND MARKING

Based on the risk assessment set out in Section 9 it is concluded that aviation lighting is not required for WTGs but should be considered to be installed electively as an additional safety measure.

For completeness, relevant lighting standards and guidelines are summarised in **Annexure 3.**

8. ACCIDENT STATISTICS

This section establishes the external context to ensure that stakeholders and their objectives are considered when developing risk management criteria, and that externally generated threats and opportunities are properly taken into account.

8.1. General aviation operations

The general aviation (GA) activity group is considered by the Australian Transport Safety Bureau (ATSB) to be all flying activities that do not involve commercial air transport (activity group), which includes scheduled (RPT) and non-scheduled (charter) passenger and freight type. It may involve Australian civil (VH–) registered aircraft, or aircraft registered outside of Australia. General aviation/recreational encompasses:

- Aerial work (activity type). Includes activity subtypes: agricultural mustering, agricultural spreading/spraying, other agricultural flying, photography, policing, firefighting, construction – sling loads, other construction, search and rescue, observation and patrol, power/pipeline surveying, other surveying, advertising, and other aerial work.
- Own business travel (activity type).
- Instructional flying (activity type). Includes activity subtypes: solo and dual flying training, and other instructional flying.
- Sport and pleasure flying (activity type). Includes activity subtypes: pleasure and personal transport, glider towing, aerobatics, community service flights, parachute dropping, and other sport and pleasure flying.
- Other general aviation flying (activity type). Includes activity subtypes: test flights, ferry flights and other flying.

8.2. ATSB occurrence taxonomy

The ATSB uses a taxonomy of occurrence sub-type. Of specific relevance to the subject assessment are terms associated with **terrain collision**. Definitions sourced from the ATSB website are provided below:

- **Collision with terrain**: Occurrences involving a collision between an airborne aircraft and the ground or water, where the flight crew were aware of the terrain prior to the collision.
- **Controlled flight into terrain (CFIT):** Occurrences where a serviceable aircraft, under flight crew control, is inadvertently flown into terrain, obstacles, or water without either sufficient or timely awareness by the flight crew to prevent the event.
- **Ground strike:** Occurrences where a part of the aircraft drags on, or strikes, the ground or water while the aircraft is in flight, or during take-off or landing.
- **Wirestrike:** Occurrences where an aircraft strikes a wire, such as a powerline, telephone wire, or guy wire, during normal operations.

8.3. National aviation occurrence statistics 2010-2019

The Australian Transport Safety Bureau (ATSB) recently published a summary of aviation occurrence statistics for the period 2010-2019 (AR-2020-014, Final - 29 April 2020).

According to the report, there were no fatalities in high or low capacity RPT operations during the period 2010-2019. In 2019, 220 aircraft were involved in accidents in Australia, and a further 154 aircraft involved in serious incidents (an incident with a high probability of becoming an accident). In 2019 there were 35 fatalities from 22 fatal accidents**.** There have been no fatalities in scheduled commercial air transport in Australia since 2005.

Of the 326 fatalities recorded in the 10-year period, almost two thirds (175 or 53.68%) occurred in the general aviation segment. On average, there were 1.51 fatalities per aircraft associated with a fatality in this segment. The fatalities to aircraft ratio ranges from 1.09 to 177:1. Whilst it can be inferred from the data that the majority of fatal accidents are single person fatalities, it is reasonable to assert that the worst credible effect of an aircraft accident in the general aviation category will be multiple fatalities.

A breakdown of aircraft and fatalities by general aviation sub-categories is provided in Table 5 (source: ATSB).

Table 5 Number of fatalities by General Aviation sub-category – 2010 to 2019

Sub-category	*Aircraft assoc. with fatality*	*Fatalities*	*Fatalities to aircraft ratio*
Aerial work	37	44	1.18:1
Instructional flying	11	19	1.72:1
Own business travel	3	5	1.6:1
Sport and pleasure flying	53	94	1.77:1
Other general aviation flying	11	12	1.09:1
Totals	115	174	1.51:1

Figure 13 refers to Fatal Accident Rate by operation type per million departures over the 6-year period (source: ATSB). Note the rates presented are not the full year range of the study (2010–2019). This was due to the availability of exposure data (departures and hours flown) which was only available between these years. According to the ATSB report, the number of fatal accidents per million departures for GA aircraft over the 6-year reporting period ranged between 6.6 in 2014 and 4.9 in 2019.

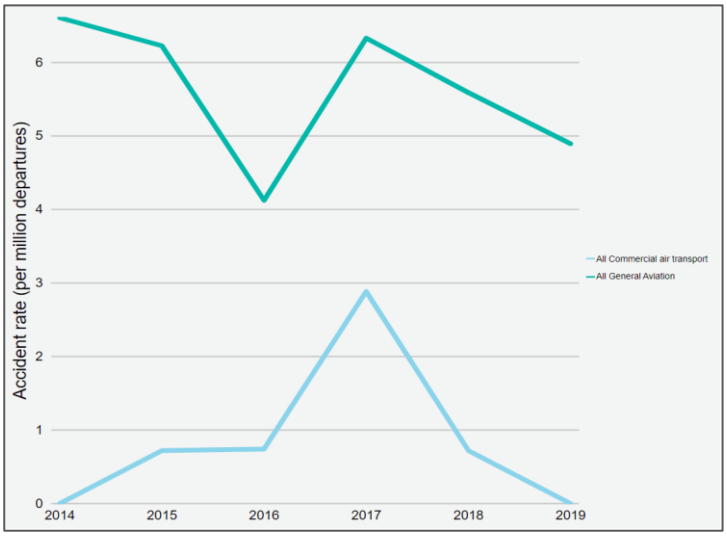


Figure 13 Fatal Accident Rate (per million departures) by Operation Type

In 2018, there were 9 fatal accidents and 9 fatalities involving GA aircraft, resulting in a rate of 5.6 fatal accidents per million departures and 7.7 fatal accidents per million hours flown.

In 2019, there were 1,760,000 landings, and 1,320,000 hours flown by VH-registered general aviation aircraft in Australia, with 8 fatal accidents and 17 fatalities. Based on these results, in 2019 there were 4.9 fatal accidents per million departures and 6.4 fatal accidents per million hours flown. A summary of fatal accidents from 2010-2019 by GA sub-category is provided in Table 6 (source: ATSB).

Table 6 Fatal accidents by GA sub-category – 2010 -2019

Sub-category	*Fatal accidents*	*Fatalities*
Agricultural spreading/spraying	13	13
Agricultural mustering	11	12
Other agricultural	1	1
Survey and photographic	5	10
Search and rescue	2	2
Firefighting	2	2
Other aerial work	3	4
Instructional flying	11	19
Own business travel	3	5
Sport and pleasure flying	53	94
Other general aviation flying	11	12
Total	**115**	**174**

Over the 10-year period, no aircraft collided with a WTG or a WMT in Australia.

Of the 20,529 incidents, serious incidents and accidents in GA operations in the 10-year period, 1,404 (6.83%) were terrain collisions.

The underlying fatality rate for GA operations discussed above is considered tolerable within Australia's regulatory and social context.

8.4. Worldwide accidents involving wind farms

Worldwide since aviation accident statistics have been recorded, there have been a total of 4 aviation accidents involving a wind farm (i.e. where WTGs were erected). To provide some perspective on the likelihood of a VFR aircraft colliding with a WTG, a summary of the 4 accidents and the relevant factors applicable to this assessment is incorporated in this section.

Based on the statistics set out in the Global Wind Energy Council (GWEC) report 2016, there were 341,320 WTGs operating around the world at the end of 2016. In 2019, approximately 60.4 GW of wind power had been installed worldwide.

Based on the Australia's Clean Energy Council statistics there were 102 wind farms in Australia at the end of 2019. Aviation Projects has researched public sources of information, accessible via the world wide web,

regarding aviation safety occurrences associated with wind farms. Occurrence information published by Australia, Canada, Europe (Belgium, Denmark, France, Germany, Norway, Sweden and The Netherlands), New Zealand, the United Kingdom and the United States of America was reviewed.

The 4 recorded aviation accidents involving a wind farm are summarised as follows:

- One accident, which resulted in 2 fatalities, occurred in Palm Springs in 2001. This accident involved a wind farm but was not caused by the wind farm. The cause of the accident was the inflight separation of the majority of the right canard and all of the right elevator resulting from a failure of the builder to balance the elevators per the kit manufacturer's instructions. The accident occurred above a wind farm, and the aircraft struck a WTG on its descent and therefore the cause of the accident was not attributable to the wind farm and not applicable to this AIA.
- Two accidents involving collision with a WTG were during the day, as follows:
    - One accident occurred in Melle, Germany in 2017 as the result of a collision with a WTG mounted on a steel lattice tower at a very low altitude during the day with good visibility and no cloud. The accident resulted in one fatality. If the tower was solid and painted white, as is standard on contemporary wind farms, then it more than likely would have been more visible than if it were to be equipped with an obstacle light which in all likelihood would not have been operating during daylight with good visibility conditions.
    - One accident occurred in Plouguin, France in 2008 when the pilot decided to descend below cloud in an attempt to find the destination aerodrome. The aircraft was flying in conditions of significantly reduced horizontal visibility in fog where the top of the WTGs were obscured by cloud. The WTGs became visible too late for avoidance manoeuvring and the aircraft made contact with two WTGs. The aircraft was damaged but landed safely. No fatalities were recorded.
    - In both of the above cases, it is difficult to conclude that obstacle lighting would have prevented the accidents.
- One fatal accident, near Highmore, South Dakota in 2014 occurred at night in Instrument Meteorological Conditions (IMC).

There is one other accident mentioned in a database compiled by an anti-wind farm lobby group (wind-watch.org), which suggests a Cessna 182 collided with a WTG near Baraboo, Wisconsin, on 29 July 2000. The NTSB database records details of an accident involving a Cessna 182 that occurred on 28 July 2000 in the same area. For this particular accident, NTSB found that the probable cause of the accident was VFR flight into IMC encountered by the pilot and exceeding the design limits of the aircraft. A factor was flight to a destination alternate not performed by the pilot. No mention in the NTSB database is made of WTGs or a wind farm.

A summary of the 4 accidents is provided in Table 7.

Table 7 Summary of accidents involving collision with a WTG

ID	Description	Date	Location	Fatalities	Flight rules	WTG height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
1	Diamond DA320-A1 D-EJAR Collided with a WTG approximately 20 m above the ground, during the day in good visibility. The mast was grey steel lattice, rather than white, although the blades were painted in white and red bands.	02 Feb 2017	Melle, Germany	1	Day VFR No cloud and good visibility	Not specified	Not specified	Not specified	Not applicable

ID	Description	Date	Location	Fatalities	Flight rules	WTG height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
2	The Piper PA-32R-300, N8700E, was destroyed during an impact with the blades of a WTG, at night in IMC. The wind farm was not marked on either sectional chart covering the accident location; however, the pilot was reportedly aware of the presence of the wind farm.	27 Apr 2014	10 miles south of Highmore, South Dakota	4	Night IMC Low cloud and rain	420 ft AGL overall	Fitted but reportedly not operational on the WTG that was struck	The NTSB determined the probable cause(s) of this accident to be the pilot's decision to continue the flight into known deteriorating weather conditions at a low altitude and his subsequent failure to remain clear of an unlit WTG. Contributing to the accident was the inoperative obstacle light on the WTG, which prevented the pilot from visually identifying the WTG.	An operational obstacle light may have prevented the accident.

ID	Description	Date	Location	Fatalities	Flight rules	WTG height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
3	Beechcraft B55 The pilot was attempting to remain in VMC by descending the aircraft through a break in the clouds. The pilot, distracted by trying to visually locate the aerodrome, flew into an area of known presence of WTGs. After sighting the WTGs he was unable to avoid them. The tip of the left wing struck the first WTG blade, followed by the tip of the right wing striking the blade of a second WTG. The pilot was able to maintain control of the aircraft and landed safely.	04 Apr 2008	Plouguin, France	0	Day VFR The weather in the area of the WTGs had deteriorated to an overcast of stratus cloud, with a base between 100 ft to 350 ft and tops of 500 ft.	328 ft AGL hub height, 393 ft AGL overall	Not specified	This pilot reported having been distracted by a troubling personal matter which he had learned of before departing for the flight. The wind farm was annotated on aeronautical charts.	Not applicable

ID	Description	Date	Location	Fatalities	Flight rules	WTG height	Obstacle lighting	Cause of accident	Relevant to obstacle lighting at night
4	VariEze N25063 The aircraft collided with a WTG following in-flight separation of the majority of the right canard and all of the right elevator.	20 July 2001	Palm Springs, USA	2	Day VFR	N/A	N/A	The failure of the builder to balance the elevators per the kit manufacturer's instructions. The cause of this accident is not attributable to the wind farm.	Not applicable

9. RISK ASSESSMENT

A risk management framework is comprised of likelihood and consequence descriptors, a matrix used to derive a level of risk, and actions required of management according to the level of risk.

The risk assessment framework used by Aviation Projects and risk event description is provided in **Annexure 4.**

9.1. Risk Identification

The primary risk being assessed is that of aviation safety associated with the height and location of WTGs and likely WMTs proposed by the Project in relation to Southern Cross aerodrome, and for regional aviation operations. The risk of collision with the Project WMT is not included in this assessment as it has already been installed with marking and lighting as recommended in a separate assessment and as approved in separate development application by the Shire of Yilgarn.

Based on an extensive review of accident statistics data (see summary in Section 8 above) and analysis of the potential impact of the Project on aviation operations, 4 identified risk events related to aviation safety or potential visual impact, and are listed as follows:

1. potential for an aircraft to collide with a WTG, controlled flight into terrain (CFIT) (related to aviation safety).
2. potential for a pilot to initiate manoeuvring in order to avoid colliding with a WTG resulting in collision with terrain (related to aviation safety).
3. potential for the hazards associated with the Project to invoke operational limitations or procedures on operating crew (related to aviation safety).
4. Potential effect of obstacle lighting on neighbours (related to potential visual impact).

It should be noted that according to guidance provided by the Commonwealth Department of Infrastructure and Regional Development, and in line with generally accepted practice, the risk to be assessed should primarily be associated with passenger transport services.

The four risk events identified here are assessed in detail in the following section.

9.2. Risk Analysis, Evaluation and Treatment

For the purpose of considering applicable consequences, the concept of worst credible effect has been used. Untreated risk is first evaluated, then, if the resulting level of risk is unacceptable, further treatments are identified to reduce the residual level of risk to an acceptable level.

A summary of the level of risk associated with the Project, under the proposed treatment regime, with specific consideration of the effect of obstacle lighting, is provided in Table 8 through to Table 11.

Table 8 Aircraft collision with wind turbine generator (WTG)

Risk ID:	1. Aircraft collision with wind turbine generator (WTG) (CFIT)

Discussion

An aircraft collision with a WTG would result in harm to people and damage to property. Property could include the aircraft itself, as well as the WTG.

There have been 4 reported occurrences worldwide of aircraft collisions with a component of a WTG structure since the year 2000 as discussed in Section 8. These reports show a range of situations where pilots were conducting various flying operations at low level and in the vicinity of wind farms in both IMC and VMC. No reports of aircraft collisions with wind farms in Australia have been found.

In consideration of the circumstances that would lead to a collision with a WTG:

- GA VFR aircraft are likely to operate in the vicinity of the Project Area associated with arrival and departure procedures from Southern Cross aerodrome
- RFDS aircraft are likely to operate in the vicinity of the aerodrome, including at night, while conducting visual approach and departure procedures from Southern Cross aerodrome
- Aircraft operations at night at Southern Cross aerodrome are likely to be limited only to emergency services aircraft with the provision of runway lighting only provided for emergency use
- There is a very small chance that a pilot, suffering the stress of weather, will continue into poor weather conditions (contrary to the rules of flight) rather than divert away from it, is not aware of the wind farm, will not consider it or will not be able to accurately navigate around it.
- If the aircraft was flown through the wind farm, there is still a very small chance that it would hit a WTG.

Refer to the discussion of worldwide accidents in Section 8.

There are no known aerial application operations conducted at night in the vicinity of the Project site.

If a proposed object or structure is identified as likely to be an obstacle, details of the relevant proposal must be referred to CASA for CASA to determine, in writing:

(a) whether the object or structure will be a hazard to aircraft operations

(b) whether it requires an obstacle light that is essential for the safety of aircraft operations

The Project site is clear of the obstacle limitation surfaces (OLS) of any aerodrome.

Consequence

If an aircraft collided with a WTG, the worst credible effect would be multiple fatalities and damage beyond repair. This would be a Catastrophic consequence.

Consequence	Catastrophic

Untreated Likelihood

There have been 4 reports of aircraft collisions with WTGs worldwide, which have resulted in a range of consequences, where aircraft occupants sustained minor injury in some cases and fatal injuries in others (see Section 8). Similarly, aircraft damage sustained ranged from minor to catastrophic. One of these accidents resulted from structural failure of the aircraft before the collision with the WTG. Only two relevant accidents occurred during the day, and only one resulted in a single fatality. It is assessed that collision with a WTG

resulting in multiple fatalities and damage beyond repair is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.	
Untreated Likelihood	Possible

Current Treatments (without lighting)

- The Project site is clear of the obstacle limitation surfaces (OLS) of any certified aerodrome.
- Aircraft flying at night are required to maintain at least the established LSALT with at least 1000 ft clearance over the highest obstacle except within 3 nm of the aerodrome during landing and take-off operations. There is no proposed WTG located within 3 nm of any point of Southern Cross aerodrome's runways
- Aircraft are restricted to a minimum height of 500 ft (152.4 m) AGL above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas. The proposed WTGs will be a maximum of 240 m (787.4 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 87.6 m (287.4 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).
- Aircraft approaching Southern Cross aerodrome from the southeast would likely approach over the Project Area currently, prior to joining a circuit to land in the selected direction. Development of the WTGs may require aircraft to track around the WTGs while approaching from the southeast to land at the aerodrome, noting that aircraft could overfly the WTGs and join a circuit pattern for YSCR
- In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, the minimum visibility of 5,000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs.
- The WTGs are typically coloured white so they should be visible to pilots during the day.
- The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of all WTGs can be noted on aeronautical maps and charts.
- Because the Project WTGs are proposed to be above 100 m AGL, there is a statutory requirement to report the WTGs to CASA and notified to Airservices Australia prior to construction. CASA will review the Project for potential hazards to aircraft operations and may recommend the use of obstacle lighting.

Level of Risk

The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8 (Unacceptable).

Current Level of Risk	8 - Unacceptable

Risk Decision

A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.

Risk Decision	Unacceptable

Recommended Treatments

The following treatments which can be implemented which will provide an acceptable level of safety:

• Details of the Project should be communicated to local and regional aircraft operators (refer to **Section 5**) prior to construction to heighten their awareness of its location and so that they can plan their operations accordingly (regional aircraft operators will be consulted with during this aviation impact assessment). • WTGs will be published by Airservices Australia in applicable aeronautical publications.
Residual Risk With the implementation of the Recommended Treatments listed above, the likelihood of an aircraft collision with a WTG resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 - Tolerable**. The level of risk with the implementation of the Recommended Treatments is considered **As Low As Reasonably Practicable (ALARP).** **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a Project WTG without obstacle lighting on the WTGs.**

Residual Risk	7 - Tolerable

Table 9 Harsh manoeuvring leading to controlled flight into terrain

Risk ID:	**2. Harsh manoeuvring leads to controlled flight into terrain (CFIT)**

Discussion

An aircraft colliding with terrain as a result of manoeuvring to avoid colliding with a WTG would result in harm to people and damage to property.

There are a few ground collision accidents resulting from manoeuvring to avoid wind farms, but none in Australia, and all were during the day.

The Project is clear of the OLS of any aerodrome.

Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built up areas. The proposed WTGs will be a maximum of 240 m (787.4 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 87.6 m (287.4 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).

Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs.

Aircraft are restricted to a minimum height of 304.8 m (1000 ft) above obstacles within 10 nm of the aircraft in visual flight at night and potentially even higher during instrument flight (day or night).

Aircraft authorised to intentionally fly below 152.4 m (500 ft) AGL (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.

Assumed risk treatments

- The WTGs are typically coloured white so they should be visible during the day.
- The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of WTGs can be noted on aeronautical maps and charts.
- Since the WTGs will be higher than 100 m AGL, there is a statutory requirement to report the WTG to CASA.

Consequence

If an aircraft collided with terrain, the worst credible effect would be multiple fatalities and damage beyond repair. This would be a Catastrophic consequence.

Consequence	Catastrophic

Untreated Likelihood

There are a few ground collision accidents resulting from manoeuvring to avoid WTGs, but none in Australia, and all were during the day (see Section 8). It is assessed that a ground collision accident following manoeuvring to avoid a WTG is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.

Untreated Likelihood	Possible

Current Treatments (without lighting)

- The Project site is clear of the obstacle limitation surfaces (OLS) of any aerodrome.
- Aircraft operations are likely to occur in the vicinity of the Project Area including RFDS aircraft arriving and departing at night.
- Aircraft are restricted to a minimum height of 152.4 m (500 ft) above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas.
- Aircraft flying at night are required to maintain at least the established LSALT with at least 1000 ft clearance over the highest obstacle except within 3 nm of the aerodrome during landing and take-off operations
- The proposed WTGs will be a maximum of 240 m (787.4 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 87.6 m (287.4 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft).
- Nevertheless, the minimum visibility of 5000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs.
- Aircraft authorised to intentionally fly below 152.4 m AGL (500 ft) (day) or below safety height (night) are operated in accordance with procedures developed as an outcome of thorough risk management activities.
- The WTGs are typically coloured white, typical of most WTGs operational in Australia, so they should be visible during the day.
- The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of wind farms can be noted on aeronautical maps and charts.
- Since the WTGs will be higher than 100 m AGL, there is a statutory requirement to report the WTGs to CASA.

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Level of Risk

The level of risk associated with a Possible likelihood of a Catastrophic consequence is 8.

Current Level of Risk	8 – Unacceptable

Risk Decision

A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.

Risk Decision	Unacceptable

Recommended Treatments

The following treatments which can be implemented which will provide an acceptable level of safety:

- Details of the Project should be communicated to local and regional aircraft operators (refer to Section 5) prior to construction to heighten their awareness of its location and so that they can plan their

operations accordingly (regional aircraft operators will be consulted with during this aviation impact assessment). • Ensure details of the Project WTGs have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators prior to construction.
Residual Risk With the implementation of the Recommended Treatments listed above, the likelihood of an aircraft collision with a WTG resulting in multiple fatalities and damage beyond repair will be **Unlikely**, and the consequence remains **Catastrophic**, resulting in an overall risk level of **7 - Tolerable**. The level of risk with the implementation of the Recommended Treatments is considered **As Low As Reasonably Practicable (ALARP).** **It is our assessment that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a Project WTG without obstacle lighting on the WTGs.**

Residual Risk	7 - Tolerable

Table 10 Effect of the Project on operating crew

Risk ID:	**3. Effect of the Project on operating crew**
Discussion Introduction or imposition of additional operating procedures or limitations can affect an aircraft's operating crew. There are no known aerial application operations conducted at night in the vicinity of the Project site. Some aircraft operations in the vicinity of the Project Area are possible at night, primarily associated with RFDS aircraft operating to and from Southern Cross aerodrome at night. Day VFR operations in the vicinity of the Project may occur.	
Consequence The worst credible effect a wind farm could have on flight crew would be the imposition of operational limitations, and in some cases, the potential for use of emergency procedures. This would be a Minor consequence.	
Consequence	Minor
Untreated Likelihood The imposition of operational limitations is unlikely to occur, but possible (has occurred rarely), which is classified as Possible.	
Untreated Likelihood	Possible
Current Treatments (without lighting) • The Project site is clear of the obstacle limitation surfaces (OLS) of any certified aerodrome. • There are no WTGs proposed to be located within 3 nm of the Southern Cross aerodrome. • Aircraft flying at night are required to maintain at least the established LSALT with at least 1000 ft clearance over the highest obstacle except within 3 nm of the aerodrome during landing and take-off operations • Aircraft are restricted to a minimum height of 500 ft (152.4 m) AGL above the highest point of the terrain and any object on it within a radius of 300 m in visual flight during the day when not in the vicinity of built-up areas. The proposed WTGs will be a maximum of 240 m (787.4 ft) at the top of the blade tip. The rotor blade at its maximum height will be approximately 87.6 m (287.4 ft) above aircraft flying at the minimum altitude of 152.4 m AGL (500 ft). • Aircraft approaching Southern Cross aerodrome from the southeast would likely approach over the Project Area currently, prior to joining a circuit to land in the selected direction. Development of the WTGs would likely require aircraft to track around the WTGs while approaching from the southeast to land at the aerodrome, noting that aircraft could overfly the WTGs and join a circuit pattern for YSCR • In the event that descending cloud forces an aircraft lower than 500 ft (152.4 m) AGL, the minimum visibility of 5,000 m required for visual flight during the day should provide adequate time for pilots to observe and manoeuvre their aircraft clear of WTGs.	

- The WTGs are typically coloured white so they should be visible to pilots during the day.
- The 'as constructed' details of WTGs are required to be notified to Airservices Australia so that the location and height of all WTGs can be noted on aeronautical maps and charts.
- Because the Project WTGs are proposed to be above 100 m AGL, there is a statutory requirement to report the WTGs to CASA and notified to Airservices Australia prior to construction. CASA will review the Project for potential hazards to aircraft operations and may recommend the use of obstacle lighting.

Level of Risk

The level of risk associated with a Possible likelihood of a Minor consequence is 5.

Current Level of Risk	5 - Tolerable

Risk Decision

A risk level of 5 is classified as Tolerable: Treatment action possibly required to achieve ALARP - conduct cost/benefit analysis. Relevant manager to consider for appropriate action.

Risk Decision	Accept, conduct cost benefit analysis

Recommended Treatments

The following treatment, which can be implemented at little cost, will provide an additional margin of safety:

- Ensure details of the Project WTGs have been communicated to Airservices Australia, and local and regional aerodrome and aircraft operators prior to construction.

Residual Risk

Notwithstanding the current level of risk is considered **Tolerable,** the additional Recommended Treatments listed above will enhance aviation safety. The likelihood remains **Possible**, and consequence remains **Minor**. In the circumstances, the risk level of 5 is considered **ALARP.**

It is our assessment that there is an acceptable level of aviation safety risk associated with the potential for operational limitations to affect aircraft operating crew, without obstacle lighting on the Project WTGs. However, the use of obstacle lighting may be considered as an additional safety measure.

Residual Risk	5 – Tolerable

Table 11 Effect of obstacle lighting on neighbours

Risk ID:	***4.*** **Effect of obstacle lighting on neighbours**

Discussion

This scenario discusses the consequential impact of a decision to install obstacle lighting on the wind farm.

Installation and operation of obstacle lighting on WTGs can have an effect on neighbours' visual amenity and enjoyment, specifically at night and in good visibility conditions.

If a proposed object or structure will be 100 m AGL or more, details of the relevant proposal must be referred to CASA for CASA to determine, in writing:

(a) whether the object or structure will be a hazard to aircraft operations

(b) whether it requires an obstacle light that is essential for the safety of aircraft operations.

In general, objects outside an OLS and above 100 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.

Consequence

The worst credible effect of obstacle lighting specifically at night in good visibility conditions would be:

- Moderate site impact, minimal local impact, important consideration at local or regional level, possible long-term cumulative effect. Not likely to be decision making issues. Design and mitigation measures may ameliorate some consequences.

This would be a Moderate consequence.

Consequence	Moderate

Untreated Likelihood

The likelihood of moderate site impact, minimal local impact is Almost certain - the event is likely to occur many times (has occurred frequently).

Untreated Likelihood	Almost certain

Current Treatments

If the WTGs will be higher than 150 m (492 ft) AGL, they must be regarded as obstacles unless CASA assess otherwise. In general, objects outside an OLS and above 100 m would require obstacle lighting unless CASA, in an aeronautical study, assesses it is shielded by another lit object or it is of no operational significance.

Level of Risk

The level of risk associated with an Almost certain likelihood of a Moderate consequence is 8.

Current Level of Risk	8 - Unacceptable

Risk Decision

A risk level of 8 is classified as Unacceptable: Immediate action required by either treating or avoiding risk. Refer to executive management.

Risk Decision	Unacceptable

Recommended Treatments

Not installing obstacle lighting would completely remove the source of the impact.

As per the above safety risk assessment, the provision of lighting for the WTGs is not considered necessary to provide an acceptable level of safety.

If CASA or a planning authority decide that obstacle lighting is required there are impact reduction measures that can be implemented to reduce the impact of lighting on surrounding neighbours, including:

- reducing the number of WTGs with obstacle lights
- specifying an obstacle light that minimises light intensity at ground level
- specifying an obstacle light that matches light intensity to meteorological visibility
- mitigating light glare from obstacle lighting through measures such as baffling.

These measures are designed to optimise the benefit of the obstacle lights to pilots while minimising the visual impact to residents within and around the Project site.

Consideration may be given to activating the obstacle lighting via a pilot activated lighting system.

An option is to consider using Aircraft Detection Lighting Systems (referred in the United States Federal Aviation Administration Advisory Circular AC70/7460-1L CHG1 – *Obstruction Marking and Lighting*). Such a system would only activate the lights when an aircraft is detected in the near vicinity and deactivate the lighting once the aircraft has passed. This technology reduces the impact of night lighting on nearby communities and migratory birds and extends the life expectancy of obstruction lights.

Residual Risk

Not installing obstacle lights would clearly be an acceptable outcome to those potentially affected by visual impact.

If lighting is required, consideration of visual impact in the lighting design should enable installation of lighting that reduces the impact to neighbours.

The likelihood of a **Moderate** consequence remains **Likely**, with a resulting risk level of **7 – Tolerable**.

It is our assessment that visual impact from obstacle lights can be negated if they are not installed. If obstacle lights are to be installed, they can be designed so that there is an acceptable risk of visual impact to neighbours.

Residual Risk	**7 - Tolerable**

10. CONCLUSIONS

The key conclusions of this AIA are summarised as follows:

10.1. Project description

The Project will comprise the following:

- up to a maximum of 10 WTGs with a maximum overall height (tip height) of up to 240 m AGL
- the highest WGT has a ground elevation of 438 m AHD and an overall height of 678 m AHD (2224.41 ft AMSL)
- Associated high voltage equipment and transmission infrastructure including connection to the existing overhead transmission line located within the Project Area

The Project is located within the Shire of Yilgarn LGA.

10.2. Aviation Impact Statement

Based on the Project WTG layout and maximum blade tip height of up to 240 m AGL, the blade tip elevation of the highest WTG associated with both proposed WTG configurations, will not exceed 678 m AHD (2224.41 ft AMSL) and:

- will not infringe Southern Cross aerodrome's obstacle limitation surfaces (for the current and potential future upgrade of runway 09/27)
- infringes the PANS-OPS surfaces of Southern Cross aerodrome and will require amendments to both instrument approach procedures
- the infringements to the YSCR PANS-OPS surfaces will not create an impact to the existing flight paths and minimum descent altitude
- will require an increase to the LSALT for air route V242
- will require an increase to the Grid LSALT
- will not have an impact on operational airspace
- is wholly contained within Class G airspace
- is outside the clearance zones associated with civil aviation navigation aids and communication facilities.

10.3. ALA analysis summary

There are no uncertified aerodromes (ALA) within 3 nm of the Project WTGs.

10.4. Aircraft operator characteristics

Aircraft operators flying in vicinity of the Project will be mostly those aircraft operating to and from Southern Cross aerodrome. Aerial firefighting and aerial application operations may be possible in the vicinity of the Project Area.

Aircraft operating to YSCR will be mostly day-time operations, and those aircraft operating at night are anticipated to be operating under the IFR.

There are air transport operations that would be conducted in the vicinity of the Project Area. The Project is not anticipated to affect the normal operation of air transport aircraft.

10.5. Hazard marking and lighting

The following conclusions apply to hazard marking and lighting:

- With respect to CASR Part 139 Division 139.E.1 Notifying potential hazards 139.165, the proposed WTGs must be reported to CASA.
- CASA will review the proposed WTG development and make a recommendation for obstacle lighting if required.
- With respect to marking of WTGs, a white colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents. WTGs must be marked in accordance with Part 139 MOS 2019 Chapter 8 Division 10 section 8.110

10.6. Summary of risks

A summary of the level of residual risk associated with the Project with the Recommended Treatments implemented, is provided in Table 12.

Table 12 Summary of Residual Risks

Identified Risk	*Consequence*	*Likelihood*	*Risk*	*Actions Required*
Aircraft collision with wind turbine generator (WTG)	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Consider installing obstacle lights as additional safety measure, primarily associated with night operations at Southern Cross aerodrome. Communicate details of the Project WTGs to local and regional operators.
Avoidance manoeuvring leads to ground collision	Catastrophic	Unlikely	7	**Acceptable without obstacle lighting (ALARP).** Consider installing obstacle lights as additional safety measure, primarily associated with night operations at Southern Cross aerodrome. Communicate details of the Project WTGs to local and regional operators.
Effect on crew	Minor	Possible	5	**Acceptable without obstacle lighting (ALARP)** Consider installing obstacle lights as additional safety measure, primarily associated with night operations at Southern Cross aerodrome. Communicate details of the Project WTGs to local and regional operators.
Visual impact from obstacle lights	Moderate	Likely	7	Acceptable without obstacle lighting (zero risk of visual impact from obstacle lighting). If lights are installed, design to minimise impact.

11. RECOMMENDATIONS

Recommended actions resulting from the conduct of this assessment are provided below.

Notification and reporting

1. Details of WTGs exceeding 100 m AGL must be reported to CASA *as soon as practicable after forming the intention to construct or erect the proposed object or structure,* in accordance with CASR Part 139.165(1)(2).

2. 'As constructed' details of WTG coordinates and elevation should be provided to Airservices Australia, by submitting the form at this webpage: https://www.airservicesaustralia.com/wp-content/uploads/ATS-FORM-0085_Vertical_Obstruction_Data_Form.pdf to the following email address: vod@airservicesaustralia.com

3. Any obstacles above 100 m AGL (including temporary construction equipment) should be reported to Airservices Australia NOTAM office until they are incorporated in published operational documents. With respect to crane operations during the construction of the Project, a notification to the NOTAM office may include, for example, the following details:

    a. The planned operational timeframe and maximum height of the crane; and

    b. Either the general area within which the crane will operate and/or the planned route with timelines that crane operations will follow.

4. Details of the wind farm should be provided to local and regional aircraft operators prior to construction in order for them to consider the potential impact of the wind farm on their operations.

5. To facilitate the flight planning of aerial application operators, details of the Project, including the 'as constructed' location and height information of WTGs, WMTs and overhead transmission lines should be provided to landowners so that, when asked for hazard information on their property, the landowner may provide the aerial application pilot with all relevant information

Marking of WTGs

6. The rotor blades, nacelle and the supporting mast of the WTGs should be painted white, typical of most WTGs operational in Australia. No additional marking measures are required for WTGs.

Lighting of WTGs

7. CASA will determine whether obstacle lighting is recommended for the WTGs. It is not a formal requirement to light the WTGs.

Micrositing

8. The potential micrositing of the WTGs has been considered in the assessment with the estimate of the overall maximum height being based on the highest ground level within 100 m of the nominal WTG and WMT positions. Providing the micrositing is within 100 m of the WTGs and WMTs is likely to not result in a change in the maximum overall blade tip height of the Project. No further assessment is likely to be required from micrositing and the conclusions of this AIA would remain the same.

Overhead transmission line

9. Details of overhead transmission lines has not been specified for this assessment. An existing transmission line runs through the Project Area already.

Triggers for review

10. Triggers for review of this risk assessment are provided for consideration:

a. prior to construction to ensure the regulatory framework has not changed

b. following any significant changes to the context in which the assessment was prepared, including the regulatory framework

c. following any near miss, incident or accident associated with operations considered in this risk assessment.

ANNEXURES

1. References
2. Definitions
3. CASA regulatory requirements – Lighting and Marking
4. Risk Framework

ANNEXURE 1 – REFERENCES

References used or consulted in the preparation of this report include:

- Airservices Australia, Aeronautical Information Package; including AIP Book, Departure and Approach Procedures and En Route Supplement Australia dated 7 September 2023
- Airservices Australia, Designated Airspace Handbook, effective 15 June 2023
- Western Australia Government, Department of Planning, Lands and Heritage, Position Statement: Renewable energy facilities, March 2020
- Civil Aviation Safety Authority, Civil Aviation Safety Regulations 1998 (CASR)
    - Advisory Circular (AC) 91-10 v1.1: *Operations in the vicinity of non-controlled aerodromes*, dated November 2021
    - Advisory Circular 139.E-01 v1.0—*Reporting of Tall Structures*, dated December 2021
    - Advisory Circular (AC) 139.E-05 v1.1 *Obstacles (including wind farms) outside the vicinity of a CASA certified aerodrome*, October 2022
    - CASR Part 139 Manual of Standards (Aerodromes) 2019, dated 13 August 2020
    - CASR Part 173 Manual of Standards – *Standards Applicable to Instrument Flight Procedure Design*, version 1.5, dated March 2016
- Department of Infrastructure and Regional Development, Australian Government, National Airport Safeguarding Framework, Guideline D *Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers* dated July 2012
- International Civil Aviation Organization (ICAO) Doc 8168 Procedures for Air Navigation Services—Aircraft Operations (PANS-OPS)
- ICAO Standards and Recommended Practices, Annex 14—Aerodromes
- OzRunways, aeronautical navigation charts extracts, dated September 2023
- Standards Australia, ISO 31000:2018 *Risk management – Guidelines*

ANNEXURE 2 – DEFINITIONS

Term	*Definition*
Aerial Agricultural Operator	Specialist pilot and/or company who are required to have a commercial pilot's licence, an agricultural rating and a chemical distributor's licence
Aerodrome	A defined area on land or water (including any buildings, installations, and equipment) intended to be used either wholly or in part for the arrival, departure, and surface movement of aircraft.
Aerodrome facilities	Physical things at an aerodrome which could include: a. the physical characteristics of any movement area including runways, taxiways, taxilanes, shoulders, aprons, primary and secondary parking positions, runway strips and taxiway strips; b. infrastructure, structures, equipment, earthing points, cables, lighting, signage, markings, visual approach slope indicators.
Aerodrome reference point (ARP)	The designated geographical location of an aerodrome.
Aeronautical Information Publication (AIP)	Details of regulations, procedures, and other information pertinent to the operation of aircraft
Aeronautical Information Publication En-route Supplement Australia (AIP ERSA)	Contains information vital for planning a flight and for the pilot in flight as well as pictorial presentations of all licensed aerodromes
Civil Aviation Safety Regulations 1998 (CASR)	Contain the mandatory requirements in relation to airworthiness, operational, licensing, enforcement.
Instrument meteorological conditions (IMC)	Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, less than the minimum specified for visual meteorological conditions.
Manual of Standards (MOS)	The means CASA uses in meeting its responsibilities under the Act for promulgating aviation safety standards
National Airports Safeguarding Framework (NASF)	The Framework has the objective of developing a consistent and effective national framework to safeguard both airports and communities from inappropriate on and off airport developments.
Obstacles	All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.

Term	*Definition*
Runway	A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.
Runway strip	A defined area including the runway and stopway, if provided, intended: a. to reduce the risk of damage to aircraft running off a runway; and b. to protect aircraft flying over it during take-off or landing operations.
Safety Management System	A systematic approach to managing safety, including organisational structures, accountabilities, policies and procedures.

ANNEXURE 3 – CASA REGULATORY REQUIREMENTS – LIGHTING AND MARKING

In considering the need for aviation hazard lighting and marking, the applicable regulatory context was determined.

The Civil Aviation Safety Authority (CASA) regulates aviation activities in Australia. Applicable requirements include the Civil Aviation Regulations 1988 (CAR), Civil Aviation Safety Regulations 1998 (CASR) and associated Manual of Standards (MOS) and other guidance material. Relevant provisions are outlined in further detail in the following section.

Civil Aviation Safety Regulations 1998, Part 139—Aerodromes

CASR 139.165 requires the owner of a structure (or proponents of a structure) that will be 100 m or more above ground level to inform CASA. This must be given in written notice and contain information on the proposal, the height and location(s) of the object(s) and the proposed timeframe for construction. This is to allow CASA to assess the effect of the structure on aircraft operations and determine whether the structure will be hazardous to aircraft operations.

Manual of Standards Part 139—Aerodromes

Chapter 9 sets out the standards applicable to Visual Aids Provided by Aerodrome Lighting.

Section 9.30 provides guidance on Types of Obstacle Lighting and Their Use:

1. *The following types of obstacle lights must be used, in accordance with this MOS, to light hazardous obstacles:*
    a. *low-intensity;*
    b. *medium-intensity;*
    c. *high-intensity;*
    d. *a combination of low, medium or high-intensity.*
2. *Low-intensity obstacle lights:*
    a. *are steady red lights; and*
    b. *must be used on non-extensive objects or structures whose height above the surrounding ground is less than 45 m.*
3. *Medium-intensity obstacle lights must be:*
    a. *flashing white lights; or*
    b. *flashing red lights; or*
    c. *steady red lights.*

    Note CASA recommends the use of flashing red medium-intensity obstacle lights.

4. *Medium-intensity obstacle lights must be used if:*
    a. *the object or structure is an extensive one; or*

b. *the top of the object or structure is at least 45 m but not more than 150 m above the surrounding ground; or*

c. *CASA determines in writing that early warning to pilots of the presence of the object or structure is desirable in the interests of aviation safety.*

Note For example, a group of trees or buildings is regarded as an extensive object.

5. *For subsection (4), low-intensity and medium-intensity obstacle lights may be used in combination.*

6. *High-intensity obstacle lights:*

   a. *must be used on objects or structures whose height exceeds 150 m; and*

   b. *must be flashing white lights.*

7. *Despite paragraph (6) (b), a medium-intensity flashing red light may be used if necessary, to avoid an adverse environmental impact on the local community.*

Sections 9.31 (8) and (9) provide guidance on obstacle lighting specific to wind farms:

8. *Subject to subsection (9), for wind turbines in a wind farm, medium-intensity obstacle lights must:*

   a. *mark the highest point reached by the rotating blades; and*

   b. *be provided on a sufficient number of individual wind turbines to indicate the general definition and extent of the wind farm, but such that intervals between lit turbines do not exceed 900 m; and*

   c. *all be synchronised to flash simultaneously; and*

   d. *be seen from every angle in azimuth.*

   Note: This is to prevent obstacle light shielding by the rotating blades of a wind turbine and may require more than 1 obstacle light to be fitted.

9. *If it is physically impossible to light the rotating blades of a wind turbine:*

   a. *the obstacle lights must be placed on top of the generator housing; and*

   b. *a note must be published in the AIP-ERSA indicating that the obstacle lights are not at the highest position on the wind turbines.*

10. *If the top of an object or structure is more than 45 m above:*

    a. *the surrounding ground (ground level); or*

    b. *the top of the tallest nearby building (building level); then the top lights must be medium-intensity lights, and additional low-intensity lights must be:*

    c. *provided at lower levels to indicate the full height of the structure; and*

    d. *spaced as equally as possible between the top lights and the ground level or building level, but not so as to exceed 45 m between lights.*

Advisory Circular 139.E-01 v1.0—Reporting of Tall Structures

In Advisory Circular (AC) 139.E-01 v1.0—Reporting of Tall Structures, CASA provides guidance to those

authorities and persons involved in the planning, approval, erection, extension or dismantling of tall structures so that they may understand the vital nature of the information they provide.

Airservices Australia has been assigned the task of maintaining a database of tall structures. RAAF and Airservices Australia require information on structures which are:

a) 30 metres or more above ground level—within 30 kilometres of an aerodrome; or

b) 45 metres or more above ground level elsewhere for the RAAF, or

c) 30 m or more above ground level elsewhere for Airservices Australia.

The purpose of notifying Airservices Australia of these structures is to enable their details to be provided in aeronautical information databases and maps/charts etc used by pilots, so that the obstacles can be avoided.

The proposed WTGs must be reported to Airservices Australia. This action should occur once the final layout after micrositing is confirmed and prior to construction.

International Civil Aviation Organisation

Australia, as a contracting State to the International Civil Aviation Organisation (ICAO) and signatory to the Chicago Convention on International Civil Aviation (the Convention), has an obligation to implement ICAO's standards and recommended practices (SARPs) as published in the various annexes to the Convention.

Annex 14 to the Convention — *Aerodromes, Volume 1,* Section 6.2.4 provides SARPs for the obstacle lighting and marking of WTGs, which is copied below:

> *6.2.4 Wind turbines*
>
> *6.2.4.1 A wind turbine shall be marked and/or lighted if it is determined to be an obstacle.*
>
> *Note 1. — Additional lighting or markings may be provided where in the opinion of the State such lighting or markings are deemed necessary.*
>
> *Note 2. — See 4.3.1 and 4.3.2*
>
> *Markings*
>
> *6.2.4.2 Recommendation. — The rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines should be painted white, unless otherwise indicated by an aeronautical study.*
>
> *Lighting*
>
> *6.2.4.3 Recommendation. — When lighting is deemed necessary, in the case of a wind farm, i.e. a group of two or more wind turbines, the wind farm should be regarded as an extensive object and the lights should be installed:*
>
> > *a) to identify the perimeter of the wind farm;*
> >
> > *b) respecting the maximum spacing, in accordance with 6.2.3.15, between the lights along the perimeter, unless a dedicated assessment shows that a greater spacing can be used;*
> >
> > *c) so that, where flashing lights are used, they flash simultaneously throughout the wind farm;*
> >
> > *d) so that, within a wind farm, any wind turbines of significantly higher elevation are also identified wherever they are located; and*
> >
> > *e) at locations prescribed in a), b) and d), respecting the following criteria:*

i) for wind turbines of less than 150 m in overall height (hub height plus vertical blade height), medium-intensity lighting on the nacelle should be provided;

ii) for wind turbines from 150 m to 315 m in overall height, in addition to the medium-intensity light installed on the nacelle, a second light serving as an alternate should be provided in case of failure of the operating light. The lights should be installed to assure that the output of either light is not blocked by the other; and

iii) in addition, for wind turbines from 150 m to 315 m in overall height, an intermediate level at half the nacelle height of at least three low-intensity Type E lights, as specified in 6.2.1.3, should be provided. If an aeronautical study shows that low-intensity Type E lights are not suitable, low-intensity Type A or B lights may be used.

Note. — The above 6.2.4.3 e) does not address wind turbines of more than 315 m of overall height. For such wind turbines, additional marking and lighting may be required as determined by an aeronautical study.

6.2.4.4 Recommendation. — The obstacle lights should be installed on the nacelle in such a manner as to provide an unobstructed view for aircraft approaching from any direction.

6.2.4.5 Recommendation. — Where lighting is deemed necessary for a single wind turbine or short line of wind turbines, the installation should be in accordance with 6.2.4.3 e) or as determined by an aeronautical study.

As referenced in Section 6.2.4.3(e)(iii), Section 6.2.1.3 is copied below:

6.2.1.3 The number and arrangement of low-, medium- or high-intensity obstacle lights at each level to be marked shall be such that the object is indicated from every angle in azimuth. Where a light is shielded in any direction by another part of the object, or by an adjacent object, additional lights shall be provided on that adjacent object or the part of the object that is shielding the light, in such a way as to retain the general definition of the object to be lighted. If the shielded light does not contribute to the definition of the object to be lighted, it may be omitted.

As referenced in Section 6.2.4.3(b), Section 6.2.3.15 is copied below:

6.2.3.15 Where lights are applied to display the general definition of an extensive object or a group of closely spaced objects, and

a) low-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 45 m; and

b) medium-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 900 m.

Section 4.3 Objects outside the OLS states the following:

4.3.1 Recommendation.— Arrangements should be made to enable the appropriate authority to be consulted concerning proposed construction beyond the limits of the obstacle limitation surfaces that extend above a height established by that authority, in order to permit an aeronautical study of the effect of such construction on the operation of aeroplanes.

4.3.2 Recommendation. — In areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 150 m or more above ground elevation should be regarded

as obstacles, unless a special aeronautical study indicates that they do not constitute a hazard to aeroplanes.

Note. — This study may have regard to the nature of operations concerned and may distinguish between day and night operations.

ICAO Doc 9774 Manual on Certification *of Airports* defines an aeronautical study as:

An aeronautical study is a study of an aeronautical problem to identify potential solutions and select a solution that is acceptable without degrading safety.

Light characteristics

If obstacle lighting is required, installed lights should be designed according to the criteria set out in the applicable regulatory material and taking CASA's recommendations into consideration in the case that CASA has reviewed this risk assessment and provided recommendations.

The characteristics of the obstacle lights should be in accordance with the applicable standards in Part 139 MOS 2019.

The characteristics of low and medium intensity obstacle lights specified in Part 139 MOS 2019, Chapter 9, are provided below.

Part 139 MOS 2019 Chapter 9 Division 4 – Obstacle Lighting section 9.32 outlines Characteristics of Low Intensity Obstacle Lights.

1. *Low-intensity obstacle lights must have the following:*
    a. *fixed lights showing red;*
    b. *a horizontal beam spread that results in 360-degree coverage around the obstacle;*
    c. *a minimum intensity of 100 candela (cd);*
    d. *a vertical beam spread (to 50% of peak intensity) of 10 degrees;*
    e. *a vertical distribution with 50 cd minimum at +6 degrees and +10 degrees above the horizontal;*
    f. *not less than 10 cd at all elevation angles between –3 degrees and +90 degrees above the horizontal.*

    Note: The intensity requirement in paragraph (c) may be met using a double-bodied light fitting. CASA recommends that double-bodied light fittings, if used, should be orientated so that they show the maximum illuminated surface towards the predominant, or more critical, direction of aircraft approach.

2. *To indicate the following:*
    a. *taxiway obstacles;*
    b. *unserviceable areas of the movement area; low-intensity obstacle lights must have a peak intensity of at least 10 cd.*

Part 139 MOS 2019 Chapter 9 Division 4 – Obstacle Lighting section 9.33 outlines Characteristics of Medium Intensity Obstacle Lights.

1. *Medium-intensity obstacle lights must:*

a. *be visible in all directions in azimuth; and*

b. *if flashing — have a flash frequency of between 20 and 60 flashes per minute.*

2. *The peak effective intensity of medium-intensity obstacle lights must be 2 000 ☐ 25% cd with a vertical distribution as follows:*

a. *for vertical beam spread — a minimum of 3 degrees;*

b. *at -1-degree elevation — a minimum of 50% of the lower tolerance value of the peak intensity;*

c. *at 0 degrees elevation — a minimum of 100% of the lower tolerance value of the peak intensity.*

3. *For subsection (2), vertical beam spread means the angle between 2 directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity.*

4. *If, instead of obstacle marking, a flashing white light is used during the day to indicate temporary obstacles in the vicinity of an aerodrome, the peak effective intensity of the light must be increased to 20 000 ± 25% cd when the background luminance is 50 cd/m^2 or greater.*

Visual impact of night lighting

Annex 14 Section 6.2.4 and Part 139 MOS 2019 Chapter 9.31 (8)(9) are specifically intended for WTGs and recommends that medium intensity lighting is installed.

Generally accepted considerations regarding minimisation of visual impact are provided below for consideration in this aeronautical study:

- To minimise the visual impact on the environment, some shielding of the obstacle lights is permitted, provided it does not compromise their operational effectiveness;
- Shielding may be provided to restrict the downward component of light to either, or both, of the following:
    - such that no more than 5% of the nominal intensity is emitted at or below 5 degrees below horizontal; and
    - such that no light is emitted at or below 10 degrees below horizontal;
- If a light would be shielded in any direction by an adjacent object or structure, the light so shielded may be omitted, provided that such additional lights are used as are necessary to retain the general definition of the object or structure.
- If flashing obstacle lighting is required, all obstacle lights on a wind farm should be synchronised so that they flash simultaneously; and
- A relatively small area on the back of each blade near the rotor hub may be treated with a different colour or surface treatment, to reduce reflection from the rotor blades of light from the obstacle lights, without compromising the daytime visibility of the overall WTG.

Marking of WTGs

ICAO Annex 14 Vol 1 Section 6.2.4.2 recommends that the rotor blades, nacelle and upper 2/3 of the supporting mast of the WTGs should be painted a shade of white, unless otherwise indicated by an aeronautical study.

It is generally accepted that a shade of white colour will provide sufficient contrast with the surrounding environment to maintain an acceptable level of safety while lowering visual impact to the neighbouring residents.

Overhead transmission lines

Overhead transmission lines and/or supporting poles that are located where they could adversely affect aerial application operations should be identified in consultation with local aerial application operators and marked in accordance with Part 139 MOS 2019.

The Project will utilise the existing distribution network comprising of overhead power lines and poles approximately 15 m AGL. The marking specifications referenced are not considered applicable.

ANNEXURE 4 – RISK FRAMEWORK

A risk management framework is comprised of likelihood and consequence descriptors, a matrix used to derive a level of risk, and actions required of management according to the level of risk.

The risk assessment framework used by Aviation Projects has been developed in consideration of ISO 31000:2018 *Risk management—Guidelines* and the guidance provided by CASA in its Safety Management System (SMS) for Aviation guidance material, which is aligned with the guidance provided by the International Civil Aviation Organization (ICAO) in Doc 9589 *Safety Management Manual*, Third Edition, 2013. Doc 9589 is intended to provide States (including Australia) with guidance on the development and implementation of a State Safety Programme (SSP), in accordance with the International SARPs, and is therefore adopted as the primary reference for aviation safety risk management in the context of the subject assessment.

Section 2.1 of the ICAO Doc 9589 *The concept of safety* defines safety as follows [author's underlining]:

> *2.1.1 Within the context of aviation, safety is "the state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management."*

Likelihood

Likelihood is defined in ISO 31000:2018 as the chance of something happening. Likelihood descriptors used in this report are as indicated in Table 1.

Table 1 Likelihood Descriptors

No	*Descriptor*	*Description*
1	Rare	It is almost inconceivable that this event will occur
2	Unlikely	The event is very unlikely to occur (not known to have occurred)
3	Possible	The event is unlikely to occur, but possible (has occurred rarely)
4	Likely	The event is likely to occur sometimes (has occurred infrequently)
5	Almost certain	The event is likely to occur many times (has occurred frequently)

Consequence

Consequence is defined as the outcome of an event affecting objectives, which in this case is the safe and efficient operation of aircraft, and the visual amenity and enjoyment of local residents.

Consequence descriptors used in this report are as indicated in Table 2.

Table 2 Consequence Descriptors

No	Descriptor	People Safety	Property/Equipment	Effect on Crew	Environment
1	Insignificant	Minor injury – first aid treatment	Superficial damage	Nuisance	No effects or effects below level of perception
2	Minor	Significant injury – outpatient treatment	Moderate repairable damage – property still performs intended functions	Operations limitation imposed. Emergency procedures used.	Minimal site impact – easily controlled. Effects raised as local issues, unlikely to influence decision making. May enhance design and mitigation measures.
3	Moderate	Serious injury - hospitalisation	Major repairable damage – property performs intended functions with some short-term rectifications	Significant reduction in safety margins. Reduced capability of aircraft/crew to cope with conditions. High workload/stress on crew. Critical incident stress on crew.	Moderate site impact, minimal local impact, and important consideration at local or regional level, possible long-term cumulative effect. Not likely to be decision making issues. Design and mitigation measures may ameliorate some consequences.
4	Major	Permanent injury	Major damage rendering property ineffective in achieving design functions without major repairs	Large reduction in safety margins. Crew workload increased to point of performance decrement. Serious injury to small number of occupants. Intense critical incident stress.	High site impact, moderate local impact, important consideration at state level. Minor long-term cumulative effect. Design and mitigation measures unlikely to remove all effects.
5	Catastrophic	Multiple Fatalities	Damaged beyond repair	Conditions preventing continued safe flight and landing. Multiple deaths with loss of aircraft	Catastrophic site impact, high local impact, national importance. Serious long-term cumulative effect. Mitigation measures unlikely to remove effects.

Risk matrix

The risk matrix, which correlates likelihood and consequence to determine a level of risk, used in this report is shown in Table 3.

Table 3 Risk Matrix

		CONSEQUENCE				
		INSIGNIFICANT 1	MINOR 2	MODERATE 3	MAJOR 4	CATASTROPHIC
LIKELIHOOD	ALMOST CERTAIN 5	6	7	8	9	10
	LIKELY 4	5	6	7	8	9
	POSSIBLE 3	4	5	6	7	8
	UNLIKELY 2	3	4	5	6	7
	RARE 1	2	3	4	5	6

Actions required

Actions required according to the derived level of risk are shown in Table 4.

Table 4 Actions Required

8-10	**Unacceptable Risk**	Immediate action required by either treating or avoiding risk. Refer to executive management.
5-7	**Tolerable Risk**	Treatment action possibly required to achieve As Low As Reasonably Practicable (ALARP) - conduct cost/benefit analysis. Relevant manager to consider for appropriate action.
0-4/5	**Broadly Acceptable Risk**	Managed by routine procedures, and can be accepted with no action.

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