13. Aeronautical Assessment

Aeronautical Impact Assessment

Wimmera Plains Energy Facility
Western Victoria

Client

BayWa r.e. Projects Australia Pty Ltd

LB00351

Final V3

27 April 2020

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Final V2	Update with overhead power line	PWW	24 January 2020	
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Contents

1 Introduction

BayWa r.e. Projects Australia Pty Ltd has tasked Landrum & Brown Worldwide (Australia) Pty Ltd to prepare an Aeronautical Impact Assessment (AIA) for the proposed Wimmera Plains Energy Facility approximately 8 km north east of Horsham Airport and 24 km south west of Warracknabeal Airport in western Victoria.

The development consists of 54 wind turbine generators (WTG) with a maximum height of 250 m AGL for the blade tips.

Powerlines up to a maximum height of 42 m AGL will connect the wind farm energy to the existing power grid within the boundary of the wind farm.

Terrain within the boundary of the proposed energy facility varies from 135 m to 143 m therefore the maximum heights of the blade tips for the WTGs varies between 385 m to 393 m Above Mean Sea Level (AMSL).

Figure 1 shows the development in relation to Horsham Airport.

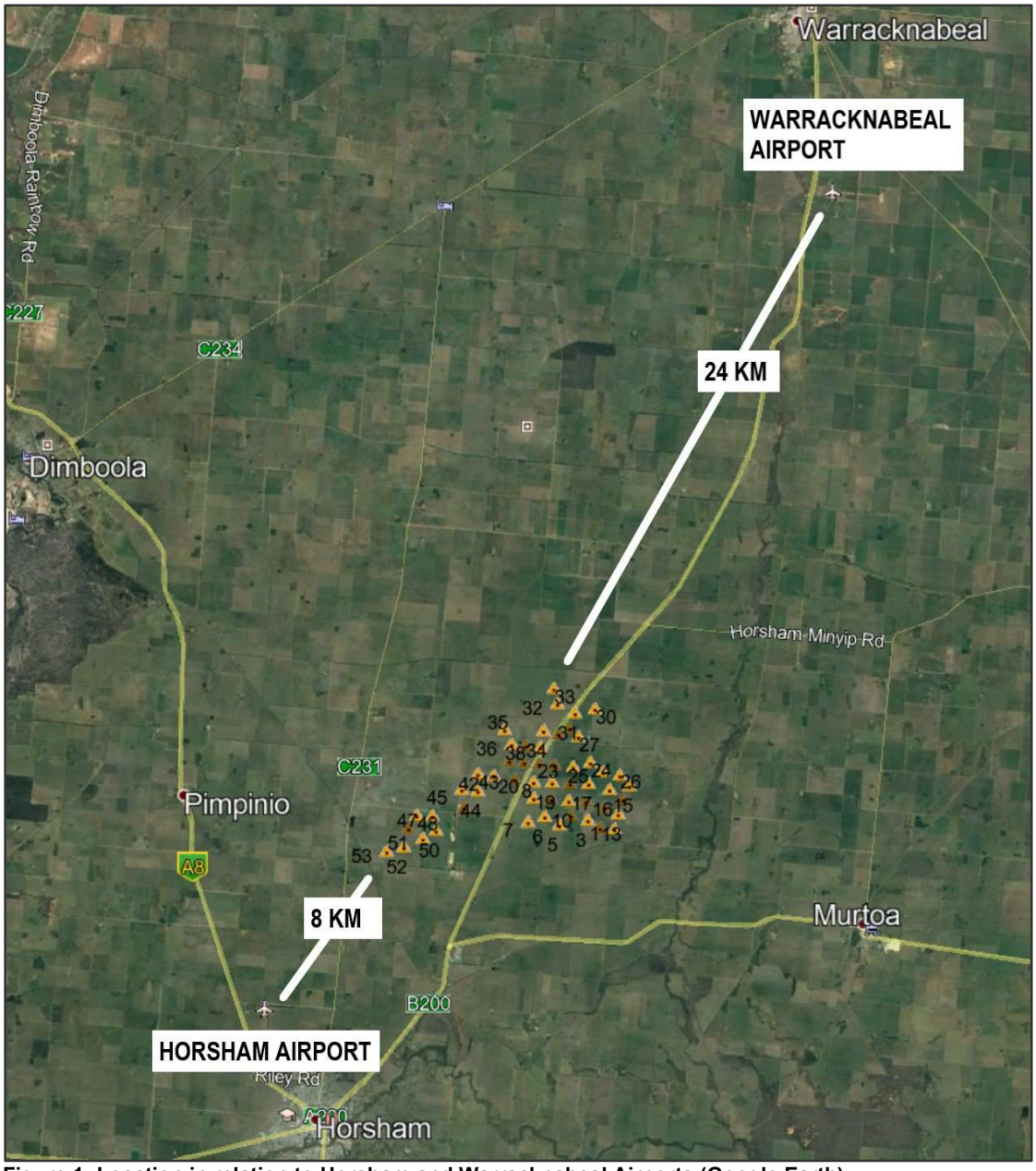

Figure 1: Location in relation to Horsham and Warracknabeal Airports (Google Earth)

2 Airport Airspace

Airports that cater for aircraft that can operate under the Instrument Flight Rules (IFR) are surrounded by a set of Obstacle Limitation Surfaces (OLS) and PANS OPS (Procedures for Air Navigation Services – Aircraft Operations) surfaces that are designed to protect aircraft operations from colliding with obstacles and/or terrain during the critical take-off and landing phases of flight.

The OLS are conceptual surfaces associated with runways that are designed to protect aircraft operations from unrestricted obstacle growth. Obstacles that infringe the OLS may be considered as "hazardous" and CASA may direct that they be lit or marked to make them conspicuous so that pilots can identify them and take appropriate action to avoid them. They would also need to be shown on Aeronautical Charts to assist pilots at the pre-flight planning stages so that they are aware of the obstacle environment around the airport.

The OLS at Horsham and Warracknabeal comprises the following:

- inner horizontal surface (IHS);
- approach surface;
- inner approach surface;
- transitional surface;
- inner transitional surface;
- baulked landing surface; and
- take-off climb surface.

The Inner Horizontal Surface of the OLS for these airports extend to 4 km from the airport's Aerodrome Reference Point (ARP). Infringements of the IHS component of the OLS may be approved subject to a detailed aeronautical study that shows that there is not impact to flight safety or the regularity of flight operations at the airport.

The PANS OPS surfaces are designed beneath instrument approach and departure flight paths to and from a runway with a prescribed minimum obstacle clearance above the obstacles or terrain. They provide an obstacle free flight path to enable safe and efficient aircraft operations in Instrument Meteorological Conditions (IMC). Some PANS OPS surfaces exist up to 54 km from the particular airport.

Infringement of most of the PANS OPS surfaces are generally not supported by the aviation authorities.

3 Assessment Methodology

In preparing aeronautical impact assessments associated with airport safeguarding and protection, it is necessary to observe the requirements of the relevant aviation authorities including:

- The Department of Infrastructure, Regional Development and Cities (DIRDC);
- The Civil Aviation Safety Authority of Australia (CASA);
- Airservices Australia (ASA);
- Airport Operators; and
- Department of Defence where appropriate.

Relevant Acts and Regulations applicable to developments near airports and air traffic routes were referenced during this assessment.

The major relevant documents include:

- Civil Aviation Safety Regulation (CASR) Part 139 Manual of Standards – Aerodromes;
- Aeronautical Information Publication (AIP) – including currently published Departure and Approach Procedures (DAP), Enroute Supplement (ERSA) and Enroute (ENR) charts;
- Airservices Australia's Airways Engineering Instructions – ATC Radar and Aviation Navigation Aid Building Restricted Areas and Siting Guidance (BRA);
- National Airports Safeguarding Framework (NASF) Guideline D – Managing the Risk to Aviation Safety of Wind Turbine Installations/ Wind Monitoring Towers;
- International Civil Aviation Organisation (ICAO) DOC 8168 Procedures for Air Navigation – Aircraft Operations (PANS OPS).

A Glossary of Aeronautical Terms and Abbreviations is shown at Appendix A.

4 Assessments

4.1 OLS

Horsham and Warracknabeal airports have OLS that extent to 4 km from the Aerodrome Reference Point (ARP) which is usually near the centre of the airport.

The energy facility is located outside of all OLS associated with airports in the vicinity.

The OLS associated with Horsham Airport and Warracknabeal Airport are not affected by the proposed development.

4.2 PANS OPS Surfaces

The PANS OPS surfaces associated with Horsham and Warracknabeal Airports were assessed for this proposed development.

A detailed assessment of Horsham Airport's PANS OPS surfaces determined that the range of heights determined by the terrain and WTGs the Wimmera Plains Energy Facility will infringe the PANS OPS surface related to the 10 nm Minimum Safe Altitude (MSA) by between 63 and 90 ft (20 – 30 m). The 10nm MSA is 2200 ft AHD with a PANS OPS protection surface 1000 ft beneath that, at 1200 ft. The range of heights of the WTGs is between 1263 and 1290 ft AHD.

A 100 ft increase to the 10 nm MSA to make it coincident with the 25 nm MSA of 2300 ft is not likely to affect aircraft operations due to the commencement altitudes for the two instrument approach procedures being at 2400 ft and 4000 ft. Aircraft conducting either instrument approach procedure will not descent to 2200 ft prior to commencing the approach.

For IFR aircraft that are arriving at Horsham in weather conditions where a cloud base between 2200 ft and 2400 ft exists requires an instrument approach to be commenced, in order to be able to descend below 2200 ft and obtain visual contact with the aerodrome, a 100 ft increase in the 10 nm MSA will not impact upon their operations or ability to land at Horsham.

Airservices Australia are responsible for the design and publication of the instrument approach procedures and would need to be asked if an increase to the 10 nm MSA can be approved and carried out. CASA would also need to be involved to approve the possible change.

A detailed assessment of Warracknabeal Airport's PANS OPS surfaces revealed that the PANS OPS surfaces are not infringed.

The proposed energy facility at a maximum height of 293 m AMSL:

- will infringe the 10 nm MSA of the Horsham Airport PANS OPS surfaces; and
- will not infringe the PANS OPS surfaces of Warracknabeal Airport.

An increase of 100 ft to the 10 nm MSA will also align it with the LSALT for air route W291 from Nhill to Horsham. (see 4.5 below)

An application to Airservices Australia, which will be referred to CASA, will need to be made to request an increase to the Horsham 10 nm MSA of 100 ft to be coincident with the Horsham 25 nm MSA of 2300 ft.

Note: aviation systems use feet for altitude measurements. Conversion to metres and then back to feet can lead to errors.

4.3 ATC Surveillance System Performance

Buildings and/or terrain that infringe radar clearance planes have the potential to cause signal shadows in areas where ATC need to provide a surveillance information or advisory service to aircraft.

The nearest ATC surveillance radar system is located at Mount Macedon, more than 200 km from the boundary of the energy facility.

The energy facility will not have any impact upon the performance of the Mt Macedon surveillance radar system.

Airservices Australia has installed Automatic Dependent Surveillance – Broadcast (ADS-B) receivers throughout Australia to enhance the provision of ATC services. Wind Turbine Generators are unlikely to impact on the operation of the ADS-B system due to the nature of the ADS-B system.

While it is unlikely that an ADS-B receiver is located in the immediate vicinity of the proposed energy facility, the location of ADS- B receivers has not been authorised for public disclosure.

This report should be provided to Airservices Australia to enable them to conduct their own assessment of any impact upon their ADS-B systems.

4.4 Navigation Aid Performance

Airservices Australia's Building Restricted Areas (BRA) describes a sensitive zone that exists to a radius of 3000 m from the navigation aid antenna sites.

The nearest navigation aid to the boundary of the energy facility is located at Hamilton Airport, approximately 110 km south of Horsham.

The development site is located outside of all BRA for all navigation aids in the Sydney area and therefore will not have an impact upon their operation.

4.5 IFR Air Route Lowest Safe Altitudes

Three IFR Air Routes exist within the vicinity of the proposed energy facility.

Each segment of an air route has a Lowest Safe Altitude (LSALT) published that provides pilots with information about the lowest altitude that they can fly, along that air route, that provides statutory clearance above obstacles and terrain.

A Grid LSALT is also published within a 1-degree latitude and longitude grid for IFR aircraft that are not operating on a published air route.

Each LSALT is determined by adding a tolerance above the highest obstacle or terrain within the navigation tolerances for that LSALT.

When applicable to surveyed obstacles, such as WTGs, this tolerance is 1000 ft.

Table 2 presents the LSALTs for each route and shows any infringements of these LSALTs.

IFR Air Route	LSALT (ft)	LSALT Protection Surface (ft)	Result – WTG Max Elevation 1290 ft
W291 Horsham to Nhill	2300	1300	10 ft Clearance
W414 Horsham to Warracknabeal	2600	1600	310 ft Clearance
V223 BURRA WPT to Horsham	4700	3700	2410 ft Clearance
Grid LSALT	3900	2900	1610 ft Clearance

Table 2 – IFR Air Routes

The IFR air route LSALTs with navigation tolerances above the energy facility and the relevant Grid LSALT are not infringed by the proposed energy facility with a WTG located on the highest ground.

Figure 2 shows these Air Routes (black) and the Grid LSALTs (green)

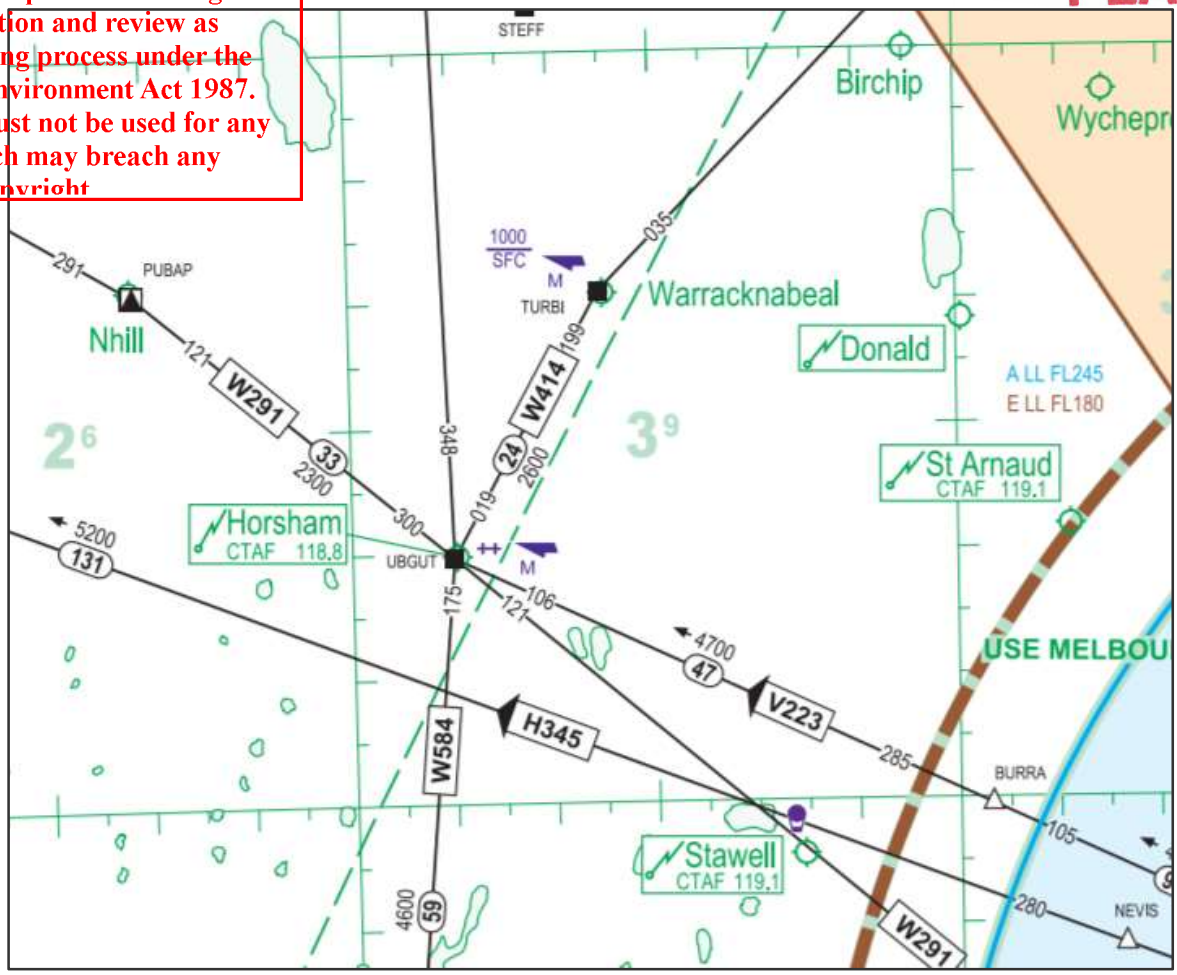

Figure 2 – IFR Air Routes (Source – Airservices Australia AIP Effective 7 November 2019)

4.6 Visual Flight Operations

A variety of flight operations are conducted in the area of the proposed energy facility. They include:

- Regular light aircraft and helicopter recreational and training flights;
- Commercial flight operations including:
  - Aerial spraying on agricultural properties (Crop Dusting);
  - Aerial Fire Fighting operations;
  - Medivac type helicopter flight operations
- Regular glider flying from/to Horsham airport; and
- Occasional low-level military flights.

Some commercial flight operations will be operated under the IFR. These are protected by the PANS OPS surfaces referred to in section 4.2.

The majority of civil flight operations in the area are conducted in Visual Meteorological Conditions (VMC) by day in which pilots navigate by visual reference to ground or water features in conditions where the flight visibility is at least 5 km, and they are able to remain 300 m distance beneath cloud. They must also maintain at least 152 m clearance above all terrain and obstacles within 600 m laterally of the aircraft, unless taking off or landing. These conditions allow pilots to identify obstacles and terrain along their intended flight paths and therefore avoid them by prescribed margins.

Military low-level flight operations and aerial spraying flight operations are conducted by highly trained pilots who carry out extensive pre-flight planning and briefing which includes obstacles such as power lines, wind farms, airfields, mining sites and noise sensitive areas as well as hilly or mountainous terrain. They would also consider the possible turbulence created by the WTGs which can exist for up to 2 km downwind of an energy facility.

CASA generally requires WTGs to be painted in a white or light grey colour so that they stand out from the surrounding terrain, thereby providing pilots with the best chance to observe them and remain clear of them.

A cluster of WTGs also provides a good navigation reference that assists pilots to establish their position by reference to the highly visible WTGs.

4.6.1 Horsham Airport Operations

Horsham Airport's runways do not point directly toward the proposed energy facility. Aircraft taking off are required to maintain the runway heading until at least 500 ft above the runway before turning in the required direction to remain in the circuit area at Horsham. Aircraft that are departing Horsham for other destinations may maintain runway heading until 1500 ft before turning onto their required track. At this point they are above the energy facility.

Aircraft that are landing or conducting circuit training at Horsham Airport are required to be aligned with the runway that they are landing on by at 500 ft above the runway. They would normally remain within 2 to 3 kms of the runway at approximately 1000 ft above ground when conducting circuit training operations.

Aircraft that are conducting an instrument approach would be aligned with the particular runway, and well clear of the energy facility, before going below the height of the WTGs.

The energy facility located 8 km north of the airport and any turbulence created by the WTGs, would be unlikely to have an adverse impact upon take-off and landing operations at Horsham Airport.

4.6.2 Warracknabeal Airport Operations

Warracknabeal Airport is approximately 24 km north east of the proposed energy facility. Aircraft taking off and landing would not be affected by it.

4.6.3 Other Airfields in the Vicinity

A review of aeronautical charts and published information did not identify any other airfields within 10 km of the energy facility. Local farmers may have private runways on their property that they may use from time to time.

4.6.4 Marking and Lighting of the WTGs

The proposed energy facility, with WTGs higher than 150 m, is located between two airports at which regular flight operations occur. They are both equipped with appropriate lighting to cater for night flying operations.

During the day, large WTGs are sufficiently conspicuous due to their shape and size, provided the colour is contrasting with the background. The rotor blades, nacelle and upper 2/3 of the mast should be painted white.

Due to the energy facility's location in close proximity to Horsham airport it is likely that CASA will require the fitting of appropriate obstacle lighting to enough turbines that can delineate the extent of the energy facility at night. This lighting can be provided with shielding that only permits the obstacle lights to be seen from above, therefore alleviating local population concerns regarding distracting lighting.

4.6.5 Mitigations

Public consultation with local landowners should be conducted to allow anyone with a private runway on their property to determine any adverse impact upon flight operations at their private runway.

Consultation with aviation stakeholders should be conducted to identify potential issues.

Publication of the location of the energy facility along with the height of the WTGs, combined with the conspicuous colouring of them, would enable all aircraft operating in VMC to see and avoid them. They are unlikely to cause an adverse hazard.

5 NASF Guideline D Aspects

The NASF Guideline D 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 wind monitoring towers.

When WTGs with a maximum height over 150 m above ground level are built within 30 kms of a certified or registered aerodrome, CASA and Airservices Australia should be notified. If the WTGs are within 30 kms of a military aerodrome, Defence should be notified.

Consultation with local aviation stakeholders is strongly encouraged in the early planning stages. This consultation should include the aerodrome operators of Horsham Aerodrome, Warracknabeal Aerodrome, any nearby private unlicenced airfields and operators of local agricultural companies.

If CASA determines that the proposal will create a hazard and should not be built, planning authorities should not approve the proposal.

The complete document is available on-line at:

https://www.infrastructure.gov.au/aviation/environmental/airport_safeguarding/nasf/files/4.1.3_Guideline_D_Wind_Turbines.pdf

6 Conclusion

The proposed Wimmera Plains Energy Facility development located to the north east of Horsham Airport with WTGs to a maximum height of 393 m AMSL:

- will not infringe the OLS for Horsham Airport or Warracknabeal Airports;
- will not infringe the LSALT protection surfaces of any IFR air route or Grid LSALT;
- will not have an adverse impact upon take-off and landing operations at Horsham Airport or Warracknabeal Airport;
- will infringe the PANS OPS surface of Horsham Airport related to the 10 nm MSA but a minor increase of 100 ft to this MSA will eliminate the infringement;
- will not infringe the PANS OPS surfaces for Warracknabeal Airport or any other airport;
- will not have an adverse impact upon the operation of aviation navigation aids;
- will not have an adverse impact upon any ATC radar clearance Surveillance system;
- will provide a prominent visual navigation feature in the area.

Details of the proposed energy facility should be provided to Airservices Australia to enable publication of the details of the WTGs to be included in the Aeronautical Charts, other areas of the Aeronautical Information Publication and to be included in Aeronautical Databases.

A specific application to Airservices Australia and CASA should be made to request the increase to the 10 nm MSA.

Consultation with aviation stakeholders is recommended by NASF Guideline D and any issues identified should be subject to analysis and detailed aviation risk assessment that addresses issues raised and provides mitigations that would reduce the risk to aircraft safety.

Appendix A – Glossary of Aeronautical Terms and Abbreviations

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

LSALT (Lowest Safe Altitudes) are published for each low level air route segment. Their purpose is to allow pilots of aircraft that suffer a system failure to descend to the LSALT to ensure terrain or obstacle clearance in IMC where the pilot cannot see the terrain or obstacles due to cloud or poor visibility conditions. It is an altitude

that is at least 1,000 feet above any obstacle or terrain within a defined safety buffer region around a particular route that a pilot might fly.

MDA (Minimum Descent Altitude) is the lowest altitude that can be used during a non-precision approach in IMC. Flight below the MDA reduces the clearance above obstacles and is not permitted in IMC.

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

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

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

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

PANS OPS (Procedures for Air Navigation Services - Aircraft Operations) is an Air Traffic Control term denominating rules for designing instrument approach and departure procedures. Such procedures are used to allow aircraft to land and take off under Instrument Meteorological Conditions (IMC) or Instrument Flight Rules (IFR). ICAO document 8168-OPS/611 (volumes 1 and 2) outlines the principles for airspace protection and procedure design which all ICAO signatory states must adhere to. The regulatory material surrounding PANS OPS may vary from country to country.

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

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

Radar Terrain Clearance Chart (RTCC) is a chart that provides air traffic controllers with the lowest usable altitude that they can vector an aircraft using prescribed surveillance procedures within controlled airspace. There is a protection surface below this usable altitude which is shown in airport master plans.

Regulations (Civil Aviation Safety Regulations)

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

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

Abbreviations

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

Abbreviation	Meaning
AC	Advisory Circular (document support CAR 1998)
ACFT	Aircraft
AD	Aerodrome
ADS-B	Automatic Dependent Surveillance - Broadcast
AHD	Australian Height Datum
AIP	Aeronautical Information Publication
Airports Act	Airports Act 1996, as amended
AIS	Aeronautical Information Service
ALT	Altitude
AMSL	Above Mean Sea Level
APARs	Airports (Protection of Airspace) Regulations, 1996 as amended
ARP	Aerodrome Reference Point
AsA	Airservices Australia
ATC	Air Traffic Control(ler)
ATM	Air Traffic Management
BARO-VNAV	Barometric Vertical Navigation
BRA	Building Restricted Area
CAO	Civil Aviation Order
CAR	Civil Aviation Regulation
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
Cat	Category
DAP	Departure and Approach Procedures (charts published by AsA)
DER	Departure End of (the) Runway
DME	Distance Measuring Equipment
Doc nn	ICAO Document Number nn
DIT	Department of Infrastructure and Transport. (Formerly Dept. of Infrastructure, Transport, Regional Development and Local Government and Department of Transport and Regional Services (DoTARS))
DOTARS	See DIT above
ELEV	Elevation (above mean sea level)
ENE	East North East
ERSA	Enroute Supplement Australia
FAF	Final Approach Fix

Abbreviation	Meaning
FAP	Final Approach Point
FAS	Final Approach Surface of a BARO-VNAV approach
ft	feet
GBAS	Ground Based Augmentation System (satellite precision landing system)
GNSS	Global Navigation Satellite System
GP	Glide Path
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organisation
IHS	Inner Horizontal Surface, an Obstacle Limitation Surface
ILS	Instrument Landing System
ISA	International Standard Atmosphere
km	kilometres
kt	Knot (one nautical mile per hour)
LAT	Latitude
LLZ	Localizer
LONG	Longitude
LNAV	Lateral Navigation criteria
m	metres
MAPt	Missed Approach Point
MDA	Minimum Descent Altitude
MGA94	Map Grid Australia 1994
MOC	Minimum Obstacle Clearance
MOS	Manual of Standards, published by CASA
MSA	Minimum Sector Altitude
MVA	Minimum Vector Altitude
NASAG	National Airports Safeguarding Advisory Group
NDB	Non Directional Beacon
NE	North East
NM	Nautical Mile (= 1.852 km)
nnDME	Distance from the DME (in nautical miles)
NNE	North North East
NOTAM	NOtice to AirMen
OAS	Obstacle Assessment Surface
OCA	Obstacle Clearance Altitude
OCH	Obstacle Clearance Height
OHS	Outer Horizontal Surface
OIS	Obstacle Identification Surface

Abbreviation	Meaning
OLS	Obstacle Limitation Surface
PANS OPS	Procedures for Air Navigation Services – Aircraft Operations, ICAO Doc 8168
PBN	Performance Based Navigation
PRM	Precision Runway Monitor
QNH	An altimeter setting relative to height above mean sea level
REF	Reference
RL	Relative Level
RNAV	aRea NAVigation
RNP	Required Navigation Performance
RPA	Rules and Practices for Aerodromes — replaced by the MOS Part 139 — Aerodromes
RPT	Regular Public Transport
RTCC	Radar Terrain Clearance Chart
RWY	Runway
SFC	Surface
SID	Standard Instrument Departure
SOC	Start Of Climb
STAR	STandard ARrival
SGHAT	Solar Glare Hazard Analysis Tool
TAR	Terminal Approach Radar
TAS	True Air Speed
THR	Threshold (Runway)
TNA	Turn Altitude
TODA	Take-Off Distance Available
VNAV	Vertical Navigation criteria
V_n	aircraft critical Velocity reference
VOR	Very high frequency Omni directional Range
WAC	World Aeronautical Chart