RE Future

Brewster Wind Farm

Appendix J

Aeronautical Impact Assessment

December 2021

Aeronautical Impact Assessment

Brewster Wind Farm

Victoria

Client

RE Future Pty Ltd

LB00396

Final v8

20 August 2021

Version and Use Information:

Version	Date	Author(s)	Approver	Comments
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Draft v002	14 January 2021	PWW		Amendment following client feedback
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Final v2	22 January 2021	PWW		Updated Final Report
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Final v4	27 March 2021	PWW		Inclusion of Met Monitoring Mast
Final v5	20 May 2021	PWW		Updated lighting discussion
Final v6	25 May 2021	PWW		Micro-sited WTG Locations
Final v7	1 June 2021	PWW		DELWP setback locations
Final v8	20 August 2021	EVC	KS	Layout changed, additional WTG

Contents

1 Introduction

RE Future Pty Ltd has tasked Landrum & Brown Worldwide (Australia) Pty Ltd to prepare an Aeronautical Impact Assessment (AIA) for the proposed Brewster Wind Farm located between Ballarat and Beaufort, in central west Victoria.

The development consists of 7 wind turbine generators (WTG) with a maximum height of 247 m AGL for the blade tips. A meteorological Monitoring Tower, with a maximum height of 160 m AGL is located centrally on the proposed wind farm.

The highest WTG within the wind farm will be 636.14 **m AHD /** 2087.07 **ft AMSL**. **Table 1** details the location and relevant heights of each WTG. A detailed site layout plan is provided at Appendix A.

Figure 1 shows the development in relation to Ballarat and Beaufort.

Figure 1: Location (Google Earth)

WTG No	Northing	Easting	AHD (m)	AHD (ft)	WTG AGL	WTG AHD (m)	WTG AHD (ft)
1	722341.0239	5852128.316	387.98	1272.90	247	634.98	2083.27
2	721842.9638	5851468.396	386.22	1267.13	247	633.22	2077.49
3	722559.5292	5851198.646	386.80	1269.03	247	633.80	2079.40
4	722959.1727	5851849.389	389.14	1276.71	247	636.14	2087.07
5	721592.8979	5852297.922	383.95	1259.68	247	630.95	2070.05
6	721009.7574	5851317.859	380.31	1247.74	247	627.31	2058.10
7	720527.8949	5851738.734	382.85	1256.07	247	629.85	2066.44

Table 1: WTG Data (20 August 2021)

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 Inner Horizontal Surface of the OLS for these airports extend to approximately 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 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, 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);
- CFA Guidelines for Renewable Energy Installations (Feb 2019); and
- Australian Fire and Emergency Services Authorities Council (AFAC).

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

4 Assessments

4.1 OLS

All airports in this region have OLS that extent to approximately 4 km from the Aerodrome Reference Point (ARP) which is usually near the centre of the airport.

The wind farm is located 24 km from Ballarat Airport and 7 km from Beaufort aerodrome.

The Brewster Wind Farm is located outside of all OLS associated with aerodromes and does not affect any OLS.

4.2 PANS OPS Surfaces

PANS OPS surfaces associated with a 25 nm Minimum Safe Altitude (MSA) include a 5 nm buffer and therefore exist out to a maximum of 55 km (30 nm) from an airport with instrument approach procedures.

The nearest airport, with instrument approach procedures, to the wind farm is Ballarat Airport approximately 24 km east of the wind farm boundary and laterally within the 25 nm MSA segment of the PANS OPS area.

The 25 nm MSA published for Ballarat Airport is 3100 ft and has a PANS OPS buffer of 1000 ft below that of 2100 ft AHD.

As the highest WTG will have an elevation of 636.14 m / 2087.07 ft AHD, it will not infringe the PANS OPS surfaces and will be just over 1000 ft / 300 m below the lowest altitude that an IFR aircraft can be overhead the wind farm when using the 25 nm MSA.

The Brewster Wind Farm is located laterally outside of the other published instrument approaches for Ballarat Airport.

The Brewster Wind Farm will not have any impact upon any PANS OPS area or surface.

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 90 km from the boundary of the farm.

The Brewster Wind farm will not have any impact upon the performance of the Mt Macedon Secondary Surveillance Radar (SSR) 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 in the immediate vicinity of the proposed farm, the location of ADS- B receivers has not been authorised for public disclosure.

There are other wind farms in this region of Western Victoria and to L&B's knowledge, have not presented any impacts to the Mt Macedon SSR system. These radar systems send a radio signal that does not bounce back from aircraft like a Primary radar does. Their signal is interpreted by navigation equipment in the aircraft that then sends a specific signal back to the SSR receiver. It is not like a reflected signal.

Significant computer filtering is incorporated in modern primary and secondary radar systems to eliminate or significantly reduce reflections, distortions and other interference that the Air Traffic Controllers do not want to see.

This report should be provided to Airservices Australia to enable them to conduct their own assessment of any impact upon their ATC surveillance 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.

There are no navigation aids nearby to the Brewster Wind Farm.

4.5 IFR Air Route Lowest Safe Altitudes

The proposed Brewster Wind Farm will be located in Class G airspace, which is un-controlled airspace, from the ground up to the base of Class E airspace at 8,500 ft.

The only IFR air route with protection surfaces overhead the wind farm is W291 between Horsham and Avalon Airport. The Lowest Safe Altitude (LSALT) protection area for W291 is 1158 m / 3800 ft AHD, well above the maximum height of the wind farm.

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 Grid LSALT is determined by adding a tolerance above the highest obstacle or terrain within the navigation tolerances for that Air Route or Grid area. When applicable to surveyed obstacles, such as WTGs, this tolerance is 1000 ft.

The Grid LSALT area surrounding the wind farm also has a LSALT of 4800 ft and a protection surface of 3800 ft, well above the highest WTG.

The Brewster Wind Farm will not have an impact upon any IFR Air Route LSALT.

4.6 Visual Flight Operations

A variety of flight operations are conducted in the area of the proposed wind farm. 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.

Most commercial flight operations are operated under the IFR. These are protected by the PANS OPS surfaces referred to in section 4.2 and 4.5.

Other civil flight operations in the area are conducted in Visual Meteorological Conditions (VMC). Pilots are required to 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 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 in sufficient time to avoid them by prescribed vertical or lateral 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, aerodromes, mining sites and noise sensitive areas as well as hilly or mountainous terrain. Any aerial agricultural aviation activity, or low-level firefighting activity in the immediate vicinity of the wind farm, or indeed within the boundary of the wind farm, would need to be conducted only following a detailed briefing from the landowner and the wind farm operator. It is likely that the WTGs could be locked in a stationary position at short notice for emergency type flight operations.

CASA generally requires WTGs to be painted in a white or light grey colour so that they conspicuous from the surrounding terrain background, 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.

The proposed Brewster Wind Farm will add four WTGs to an area with many wind farms already operating or under construction. Pilots who regularly fly in this area are aware of all of the wind farms and itinerant pilots have sufficient information available to them to be able to consider the wind farms during their flight planning activities prior to a flight in the area, to the same extent that they would not to consider dense forest areas, high terrain and water crossings.

The proposed Brewster Wind Farm not add any additional hazard to visual flight operations in the area.

4.6.1 Aerodromes in the Vicinity of the Wind Farm

A review of aeronautical charts and published information identified one private airfield within 10 km of the farm.

The nearest is located 8 km to the southwest of the wind farm at Nerring, called Beaufort on aeronautical charts.

Aircraft conducting take-off and landing operations at Beaufort airfield are generally confined to within 3.5 km of the aerodrome to allow the pilot to keep the runway in sight and enabling them to properly judge their approach or departure to/from the runway. They will not be required to operate overhead the wind farm due to the distance of the aerodrome from the wind farm. Other wind farms shown on the aeronautical chart at Figure 4 are much closer to the aerodrome than Brewster Wind Farm.

Pilots operating at these types of airfields need to ensure that they consider local conditions and hazards to ensure that their flight is conducted to the safety standards required under Civil Aviation Regulation 92 (1) which states: *"An aircraft shall not land at, take-off from, any place, unless….(d) the place….is suitable for use as an aerodrome for the purposes of the landing and taking-off of aircraft; and, having regard to all the circumstances of the proposed landing or take-off (including the prevailing weather conditions), the aircraft can land at, or take-off from, the place in safety."*

Other local farmers may have private airfields on their property that they may use from time to time, but none have been identified.

Civil Aviation Advisory Publication (CAAP) 92-1(1), published by CASA, specifies the minimum characteristics of unlicensed airfields such as small airfields on private or public land. It specifies minimum width of runways, runway strips, approach and take-off areas and flyover areas alongside the runway. An example if shown at **Figure 2** below.

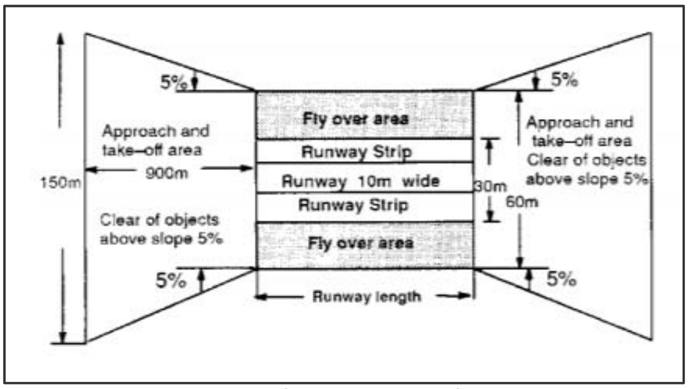

Figure 2: Typical Physical Characteristics (CAAP 92-1(1))

A potential direct physical impact of wind turbines on aviation is that of turbulence induced by the turning wind turbines up to 16 turbine diameters down-wind of the wind farm. For a WTG with a rotor diameter of 170 m planned for this farm, this potential turbulence could therefore exist up to 2.7 km from the wind farm, depending on the strength of the wind.

Figure 3, from the UK Civil Aviation Authority guidance on this subject shows that the significant portion of the turbulence is dissipated within 5 rotor diameters, which is 850 m from the 170 m diameter rotors, with any turbulence beyond that distance being returned to a similar state to that existing in the other areas around the area. Rotor speeds are in the order of 9 to 12 rpm.

"Turbulence is caused by the wake of the turbine which extends stream wise behind the blades and the tower, from a near to a far field. The dissipation of the wake and the reduction of its intensity depend on the convection, the turbulence diffusion, the topography (obstacles, terrain etc.) and the atmospheric conditions.

Although research on wind turbine wakes has been carried out, the effects of these wakes on aircraft are not yet known.

The wake of a wind turbine can be divided into a near and a far region. The near wake is the area just downstream of the rotor up to one RD, where the effect of the rotor properties, including the blade aerodynamics and geometry determine the flow field. Near wake research is mainly focused on the wind turbine's performance and the physics of power extraction. The far wake is the region beyond the near wake, where the details of the wake are less dependent on the rotor design. The main interest in this area is the wake interference with other wind turbines (e.g. in a wind farm) or passing-by aircraft (wind turbine wake encounter). Here, flow convection and turbulent diffusion are the two main mechanisms that determine the flow field.

LIDAR field measurements on a WTN250 wind turbine at East Midlands Airport, UK, indicated that statistically, the wake velocities recovered to 90% of the freestream velocity at the downstream distance of 5 RD." [1]

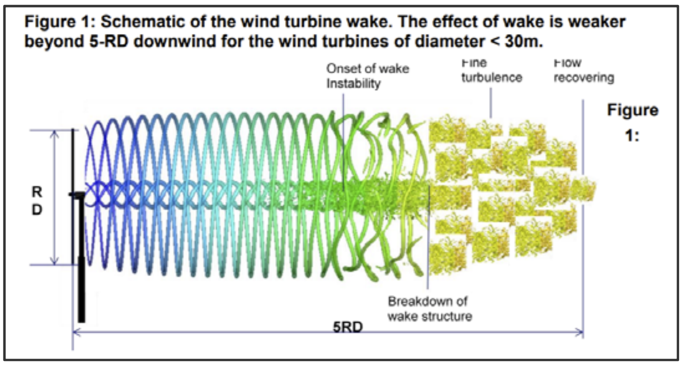

Figure 3: Schematic of WTG Wake (UK CAP 746- 2016)

There are no known airstrips within this area of possible WTG turbulence.

4.6.2 Marking and Lighting of the WTGs

Generally, CASA tends to recommend obstacle lighting for wind turbines over 150 m AGL, but the local planning authority is the determinant in each case, but they will consider CASA's recommendation. CASA is likely to recommend that the WTGs be painted in a contrasting colour to the surrounding terrain and background, so that they are conspicuous enough for pilots to identify in sufficient time to avoid them safely, should they not be aware of their presence.

The proposed Brewster Wind Farm, with WTGs higher than 150 m, is located in an area remote from regularly used airports and where low-level flight operations do not occur regularly, especially at night.

It does not infringe any OLS, so lighting will not be mandated by CASA.

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

The local planning authority will refer the proposal to CASA.

Other wind farms, as shown in **Figure 4**, are prominent in the area to the north and to the west of the proposed Brewster Wind Farm, as shown on aeronautical charts published by Airservices Australia, are not equipped with obstacle lighting.

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[1] UK CAA CAP 764 July 2016

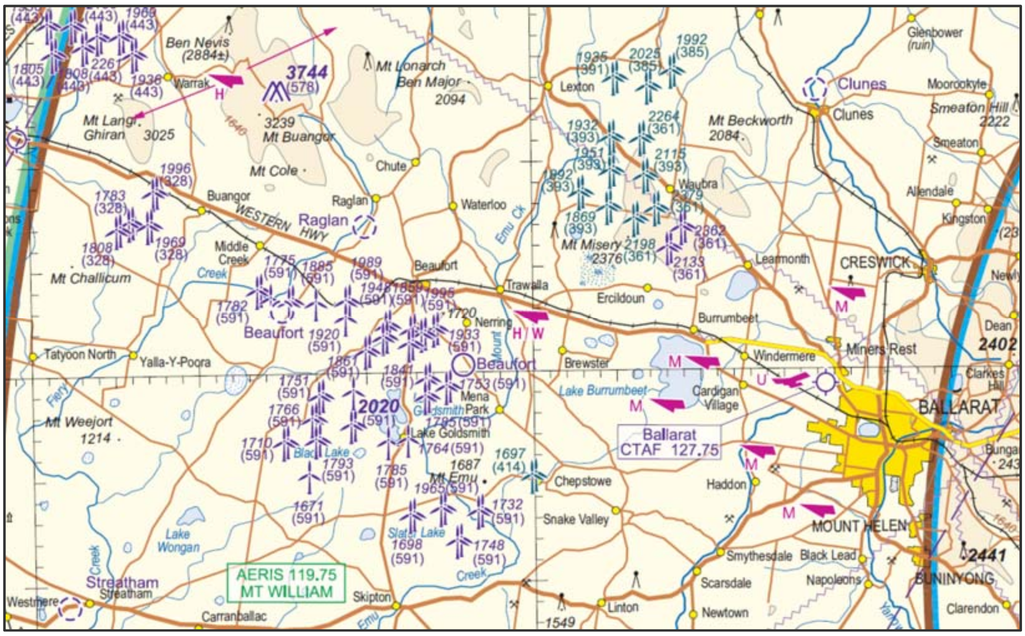


Figure 4: Melbourne Visual Navigation Chart (Airservices Australia)

4.6.3 Discussion Regarding Obstacle Lighting Requirements

The aeronautical requirements for marking and lighting of wind farms are currently undergoing review by the International Civil Aviation Organization (ICAO), the Department of Infrastructure, Regional Development and Cities (DIRDC) and CASA.

DIRDC recently issued a Discussion Paper “Safeguards for Airports and The Communities Around Them” that implies an amendment to the criteria for wind turbine reporting heights from 110m to 152m AGL being applicable to wind farms in the vicinity of aerodromes. In addition, CASA is currently reviewing its withdrawn Advisory Circular AC139-181 “Obstacle Marking and Lighting of Wind Farms”.

The outcomes of these various reviews may result in:

- Revised criteria for reporting of wind energy facilities; and
- Wind energy facilities that are in remote locations, away from aerodromes, not requiring obstacle lighting, depending on the findings of a qualitative risk assessment to be undertaken by the proponent.

While the DIRDC Discussion Paper applies specifically to within the vicinity (generally accepted as 30km) of aerodromes, CASA is also currently reviewing the requirements for marking and lighting of obstacles and hazards remote from aerodromes. CASA has informally advised the renewable energy industry that a qualitative risk assessment approach to the potential hazards, as presented by wind energy facilities, may be considered.

CASA’s current position on obstacle lighting of wind energy facilities that are remote from an aerodrome (which is the situation for the Brewster Wind Farm) is summarised as:

- CASA cannot mandate obstacle lighting for wind energy facilities that are not within the vicinity of an aerodrome;
- provision of obstacle lighting is the responsibility of the proponent;
- any associated requirements placed on proponents by planning authorities, insurers or financiers are beyond CASA’s scope;
- a wind farm proponent may have a duty of care to the aviation industry and local operators in terms of ensuring obstacles are made conspicuous; and
- obstacle marking and lighting requirements in relation to Obstacle Limitation Surfaces, etc, as specified in the CASA Manual of Standards Part 139, Chapters 8 and 9 applies.

CASR Part 139 Manual of Standards (MOS), Chapter 9, Section 9.4 indicates that for structures more than 110m AGL, the proponent should expect that obstacle lighting will be required unless there are unusual circumstances. The turbines to be installed at Brewster Wind Farm will have a maximum height of 250 m AGL. However, there have been situations where CASA has acknowledged non-provision of obstacle lighting of wind energy facilities in Australia where the turbine height exceeds just 110m AGL after taking the planning authorities requirements into consideration.

As indicated above, Australian policy, standards and recommended practices for obstacle marking and lighting of wind energy facilities are currently under review. A current proposal includes a change to the criterion height of 110m (361ft) to 152m (500ft) AGL for wind energy facilities within the vicinity of a certified or registered aerodrome.

Minimum Allowable Height for Visual Aircraft Operations

Civilian aircraft that are required to operate with constant visual contact with the land or water are authorised under the Civil Aviation Regulations to operate at a minimum height of **152 m (500ft)** above all obstacles **within 300 m** laterally of the aircraft's flight path by day only.

These operations are conducted in good weather where the visibility and cloud base requirements allow the pilot to see obstacles in sufficient time to avoid them by the required margin. The painting of wind turbines with a colour that is conspicuous to the background is generally suggested by CASA and required by the local planning authority.

Depicting the location of the wind farm on aeronautical charts allows pilots to be aware of the existence of the turbines in a particular location, allowing them to adequately plan a flight path around, above or clear of the wind farm.

Pilots conducting travel flights from one place to another generally do so at a much higher altitude than the minimum allowed due to better fuel consumption than at low-level, comfort by avoiding low level turbulence and to achieve a higher ground speed at altitude.

A higher altitude also provides pilots with a timely opportunity to consider options in the event of an engine failure or other system failure that may require an immediate landing.

The presence of a conspicuous wind farm would also provide a prominent navigation feature to help the pilot accurately determine his position and confirm their navigation accuracy.

By night, even in good weather, things change significantly. Obstacles and terrain of any kind cannot be seen and as such minimum altitude requirements for visual flight operations at night require the pilot to maintain an altitude that is at least 300 m (1000 ft) above the highest surveyed obstacle or terrain within 10 nm of his planned flight path. The publication of the wind farm on aeronautical charts provides the pilots with information that will allow them to conform to this requirement.

Pilots that are authorised to conduct daytime and nighttime flights in specially equipped and authorised IFR aircraft, are able to operate in weather conditions that do not necessarily enable them to see the ground or water, except during take-off and landing. They are required to operate on published air routes or, if not on a published air route at altitudes well above the terrain and surveyed obstacles. This altitude is called the Lowest Safe Altitude and is calculated to allow a minimum of 300 m (1000 ft) clearance above the highest obstacle or terrain within a lateral margin of their flight path dependent on the accuracy of the aircraft's navigation equipment and the qualifications of the pilot.

As noted, wind energy facilities with a maximum height of 110 m or more are required to be notified to aviation authorities for marking on aeronautical charts. These charting additions contain symbols that denote whether a wind farm is unlit or lit.

Low level operations by agricultural application aircraft and firefighting aircraft are generally conducted in good weather and following a briefing from the landowner that provides the pilot with detailed information of the location and extent of obstacle and hazards on near the property. These aircraft may operate between the wind turbines when sufficient distance is provided between them. Fire-fighting aircraft will avoid known wind turbine areas when they are obscured by smoke.

Military low flying operations by high speed fighter type aircraft, transport aircraft and helicopters in the area are conducted with a higher level of scrutiny due to the nature of the high-speed of their operation and requirement to be at very low level to effectively carry out the training or operational mission. Such flights are planned meticulously from information available in aeronautical databases, charts and Geographical Information Systems available to the military. Pilot awareness and minimum authorised heights and distances from wind farms provides an appropriate level of safety for these operations.

Local farmers may have airstrips on their property that may be close to the wind farm during take-off and landing operations but flights during nighttime or in conditions of poor visibility are not authorised or prudent.

In all of these circumstances applying obstacle lighting to wind turbines makes little or no difference to the ability of a pilot to see and avoid them, when they are located away from the area that aircraft use in the vicinity of an aerodrome, during take-off and landing operations.

In conditions of poor visibility or low cloud occasionally pilots who are confined to visual conditions are forced to operate at altitudes below the minimum altitudes to try to find a suitable place to land or find clear weather. Such operations are generally the result of poor pre-flight planning and in-flight decisions that put pilots in very hazardous situations. Whilst providing obstacle lighting may assist these pilots to identify a hazard, it is the pilot's actions that have created the hazard and not the wind farm. Many other high terrain areas are not lit in areas remote from aerodromes.

Due to the nature of flights in the area being outside controlled airspace, it is difficult to determine the frequency of local flights in the vicinity of the wind farm. It is likely however, that such flights are not frequent, but do regularly occur in the area, but not at the low level that would bring aircraft into conflict with the Brewster Wind Farm.

There are several other wind farms in Western Victoria that are not equipped with obstacle lighting.

Any wind farm that is published on aeronautical charts prior to construction of the wind farm will provide sufficient information to pilots to enable them to be aware of them and to plan their flight operation safely around or more often, above the wind farm, to the same extent that high terrain and populated areas shown on aeronautical charts is avoided by pilots conforming to the aviation rules.

In emergency situations that may require a pilot to make an immediate landing the conspicuous marking of parts of a wind farm provide sufficient visual warning to enable that pilot to avoid them in VMC.

In bad weather involving low visibility such as low cloud and fog, all obstacles and terrain are "invisible". Low intensity obstacle lighting, as recommended in the CASA and DITRDC documents, installed on any obstacle will not give pilots any additional warning of their presence in such conditions.

When wind farms were first introduced into the aviation environment, aviation authorities were concerned that they would cause a significant hazard to aviation safety. They therefore put significant mitigations into play such as marking, lighting and publication on aeronautical charts, some of which, especially low intensity lighting do not provide any additional warning of the presence of the wind farm.

Aircraft around the world have been operating around wind farms for many years without any abnormal number of incidents relating to them. To date, in Australia, there have been no reported collisions of aircraft with wind turbines. Reporting of such a collision is mandatory.

Siting wind farms outside of the area surrounding recognised aerodromes where aircraft are taking off, preparing to land or landing, further reduces the risk of a collision with a wind turbine due to the regulated requirements to remain clear of known and published terrain, populous areas and obstacles

The amenity of local residents is considered by planning authorities to a high degree and any obstacle lighting that is required on such obstacles needs to provide a definite safety benefit against the loss of local amenity.

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.

In any case Airservices Australia needs to be notified of the wind farm to allow them to publish the facility on aeronautical charts and to confirm the assessment of any impacts on air routes.

Consultation with local aviation stakeholders is strongly encouraged in the early planning stages. This consultation should include the aerodrome operators of any nearby private unlicensed aerodromes and operators of local aerial agricultural application companies.

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

5.1 Notifications

Once the final form and layout of the Brewster Wind Farm are known then the application for Development Approval can be submitted to the local planning authority. The application should include this AIA. The local planning authority will send it to CASA for their opinion. CASA do not approve or reject these projects; they merely make comment from a safety perspective to the planning authority.

Notification to Airservices Australia can be made at this time and should include this AIA. There is sufficient information within this AIA for Airservices Australia to be able to publish the wind farm on aeronautical charts.

6 CFA Guidelines for Renewable Energy Installations (Feb 2019)

Victoria's Country Fire Authority (CFA) publishes the *CFA Guidelines for Renewable Energy Installations (*February 2019*)* to provide concise guidance to organisations developing and managing wind farm and other such power resources about standard measures and processes in relation to fire safety, risk and emergency management that should be considered when designing, constructing and operating new renewable energy facilities, and upgrading existing facilities.

Part 2 of the guideline is related to CFA firefighting aircraft hazard minimization.

Where practicable, wind farm installations can be sited on open grassed areas (such as grazed paddocks). Vegetation is to be managed as per the requirements of this guideline, or as informed through a risk management process.

Wind turbines are to be located no less than 300 metres apart. This provides adequate distance for aircraft to operate around a wind farm given the appropriate weather and terrain conditions. Fire suppression aircraft operate under visual flight rules. As such, fire suppression aircraft only operate in areas where there is no smoke and can operate during the day or night.

The installation must be notified to CFA and Geoscience Australia (for inclusion in the Vertical Obstruction Database).

Adjoining property use and distances to habitable buildings must be considered in the design of wind energy installations, with regard made to turbine height and prevailing wind speeds.

Wind turbine manufacturers must provide specifications for safe operating conditions for temperature and wind speed. This information must be provided within the content of the emergency information book.

A wind farm emergency plan must include maximum operational wind speed and temperature conditions and operating procedures to limit fire risk. This information must be provided within the content of the emergency information book.

7 Australian Fire and Emergency Services Authorities Council (AFAC)

The AFAC Wind Farms and Bushfire Operations Guideline, Version 3.0 dated 25 October 2018 states the AFAC member agencies approach towards wind farms, their development and operations in relation to bushfire prevention, preparedness, response and recovery. It is also intended for wind farm developers and operators and land use planners and relevant regulators.

This section relates to the aviation component of the document.

"Windfarm developers should also be aware that meteorological monitoring towers, which are associated with pre-construction investigative activities as well as operating wind farms, are generally more likely to pose a risk to pilots as they are not easily visible structures. For these structures, developers should record these towers in the Tall Structures Database maintained by Air Services Australia (Civil Aviation Safety Authority 2018) and install warning lights or visible markers (such as orange balls) on all masts to minimise risks during aerial firefighting operations." (AFAC Wind Farm and Bushfire Operations Guideline V3.0 25 October 2018)

These recommendations are aligned with the CFA guidelines and with CASA requirements, but shutdown procedures detailed below will also need to be taken into consideration.

"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 fire-fighting personnel should assess risks posed by aerial obstacles, wake turbulence and moving blades in accordance with routine procedures." (AFAC Wind Farms and Bushfire Operations Guideline V3.0 25 October 2018)

8 Conclusion

The proposed Brewster Wind Farm development located between Ballarat and Beaufort in Victoria, with WTGs to a maximum height of 636.14 **m /** 2087.07 **ft AHD:**

- will not infringe the OLS for any airport or airstrip;
- 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 any airport or known aerodrome;
- will not infringe the PANS OPS surface of any airport;
- will not have an adverse impact upon the operation of aviation navigation aids;
- will not have an adverse impact upon any ATC Surveillance system;
- is located away from all airports and may not require obstacle lighting to be installed; and
- will provide a prominent visual navigation feature in the area.

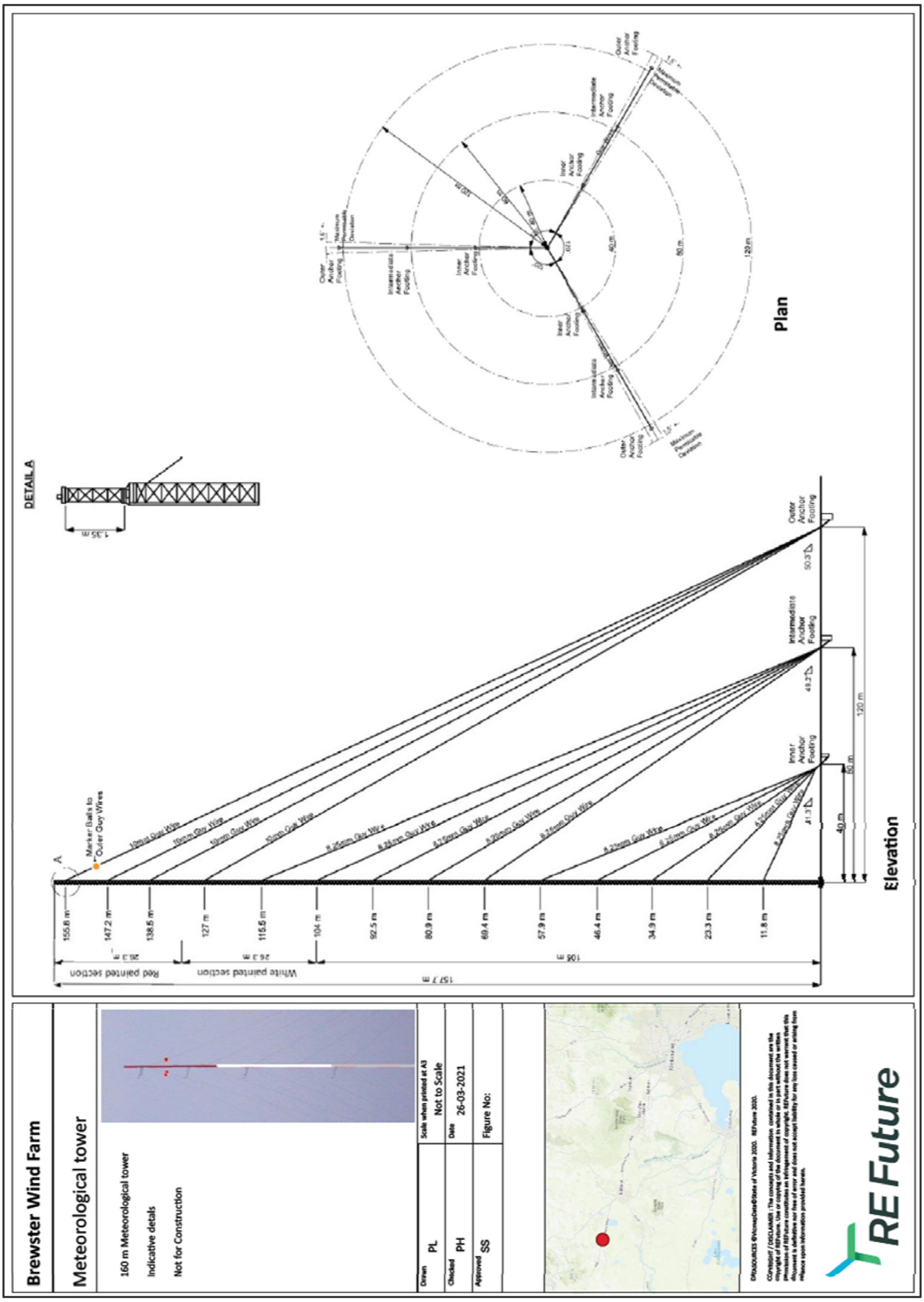
Once the development is approved, the details of the proposed wind farm should be provided to Airservices Australia to enable publication of the details of the WTGs to be included in the Aeronautical Charts, other areas of the Aeronautical Information Publication and to be included in Aeronautical Databases.

The planning authority will provide these details to CASA for comment regarding aviation safety standards.

Consultation with aviation stakeholders has been conducted with adjacent landowners and ongoing consultation will continue as recommended by NASF Guideline D and any issues identified will 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 – Detailed Site Layout Plan

Site Plan (RE Future)



Meteorological Tower (RE Future)

Appendix B – 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