Attachment K : Aviation assessment and memo

REHBEIN Airport Consulting

23 April, 2015
Our File Ref: M15055AL001
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Attention: Stephen Crowe

RE: IMPACT TO AVIATION ACTIVITIES - INCREASE TO WIND TURBINE ELEVATION

REHBEIN Airport Consulting has been requested to consider the likely impacts of Westwind Energy's plan to increase the blade tip heights of the wind turbines proposed for the Lal Lal wind farm from 130m AGL to 161m AGL.

In 2007 REHBEIN Airport Consulting produced an aeronautical assessment on behalf of Westwind Energy which was successfully approved by the DoT. A lighting plan was also issued by CASA for the proposed 130m AGL wind turbine generators. Since the previous report was issued in 2007, legislation has changed and therefore a separate assessment of the now proposed 161m AGL wind turbines acknowledging the current regulations has been undertaken. This letter is based on the findings of previous aeronautical assessments undertaken in 2007 (Ref: A0788AR001) and 2015 (Ref: M15055AR001Rev1) and should be read in conjunction with those assessments.

Airspace around the nearest aerodromes to the Lal Lal wind farm is considerably distant from the proposed Lal Lal wind farm and thus an increase in turbine elevation would be insignificant.

Radar and navaid performance at Ballarat and Yarrowee will not be impacted by Westwind Energy's proposal to increase the turbine height given their distances from the Lal Lal wind farm.

IFR and VFR routes LSALTS will not be influenced by the change in wind turbine generator elevation. Because of the mix of civil aviation activities conducted in the areas to the North and North West of Melbourne Control Zone it is highly unlikely that Military Low Jet Routes will be proposed in the Lal Lal region and therefore should not be affected by an increase in the elevation of the wind turbine generators.

There are no restricted flying areas and aviation sports activities within the vicinity of the Lal Lal region and therefore will not be impacted by the proposed wind farm.

Yours faithfully
For and on behalf of
LAMBERT & REHBEIN (SEQ) PTY LTD

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REHBEIN AIRPORT CONSULTING

DATE 17 March, 2015

CONTACT BEN HARGREAVES

Lal Lal Wind Farm - Aeronautical Assessment

For Westwind Energy

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Document Control Page

Revision	Date	Description	Author	Signature	Verifier	Signature	Approver	Signature
0	17/03/15	DRAFT	JFO		NBO		BJH	
1	8/04/15	FINAL	JFO		NBO		BJH	

1.0 EXECUTIVE SUMMARY

Westwind Energy Pty Ltd is proposing to locate wind generator towers in the Lal Lal region of Victoria. Two sites have been identified for consideration, one site near the town of Elaine and one site near the town of Yendon. The proposed Elaine site is approximately 30kms to the South East of Ballarat airport, 48kms to the North West of Avalon airport and 73kms to the west of Melbourne airport. The Yendon site is approximately 20kms to the East South East of Ballarat airport, 58kms to the North West of Avalon Airport and 71kms to the West of Melbourne Airport.

The blade tips of the largest turbine are 161m Above Ground Level (AGL). As the proposed wind turbines will be greater than 110m AGL, they must be reported to the Civil Aviation Safety Authority (CASA) for assessment of the risk they may pose to civil aircraft operations. The Australian Defence Force (ADF) (Defence) also has an interest in assessing tall structures and it can be expected that CASA in its assessment will consider the impact upon military flying operations and if required, advice from Defence will be sought.

This study considered in detail the likely impact of the location, height and blade rotation of the proposed wind turbines on the nearest aerodromes; air navigation and air traffic management services; transiting air routes; designated airspace such as Danger, Restricted or Prohibited areas; any other aviation activity; and electromagnetic interference (EMI) with airborne radio.

The study concluded that the proposed wind farm will not impact upon aircraft operations to registered or certified aerodromes such as Ballarat, Avalon or Melbourne Airport or the uncertified aerodromes within used for recreational aviation activities. Nor is the wind farm considered likely to interfere with radio or navigation aid performance. Flights operating under the VFR should not be affected by the proposed wind farm as these flights are required to be conducted at a minimum height of 500ft above ground level outside populous areas and will therefore be well above the level of the turbines. The structures will be sufficiently conspicuous by day, and at night local en route lowest safe altitudes (LSALTs) will provide clearance required for flights under the Instrument Flight Rules (IFR) and night operations under the Night VFR.

Low level flying operations such as agricultural aerial spreading and spraying operations or power transmission line inspections may be affected on the downwind side of the turbines over land on which the turbines are directly positioned, or over portions of some adjoining properties that are sited downwind from the turbines. This is due to wind shear, turbulence and downdrafts in the wake of the turbine rotors presenting a critical hazard to aircraft such as agricultural aircraft operating at low level and high weights during application of chemicals and seeding. However, agricultural spraying operations are normally conducted at very low levels and often require calm or very light wind conditions of less than 8 knots (15km/h).

Aerial agricultural operations and hang gliding activities do not operate in the vicinity of the wind farm, therefore the risk to civil aviation activities, if any, that the wind farm may pose is considered

to be negligible. However, as with any reported tall structure that may pose a risk, regardless of its likelihood, the position of the proposed wind farm should be shown on appropriate air navigation charts to assist pilots operating in the region. Additionally, CASA may direct or the proponent may identify a need to illuminate the proposed structures in order to highlight the development to the flying community.

In 2007 REHBEIN Airport Consulting produced an aeronautical assessment on behalf of Westwind Energy which was successfully approved by the DoT. A lighting plan was also issued by CASA for the proposed 130m AGL wind turbine generators. Since the previous report was issued in 2007, legislation has changed and therefore a separate assessment of the now proposed 161m AGL wind turbines acknowledging the current regulations has been undertaken.

2.0 INTRODUCTION

Westwind Energy Pty Ltd is proposing to locate wind generator towers in the Lal Lal region of Victoria. Two sites have been identified for consideration, one site near the town of Elaine and one site near the town of Yendon. The proposed Elaine site is approximately 30kms to the South East of Ballarat airport, 48kms to the North West of Avalon airport and 73kms to the west of Melbourne airport. The Yendon site is approximately 20kms to the East South East of Ballarat airport, 58kms to the North West of Avalon Airport and 71kms to the West of Melbourne Airport.

The proposed Elaine site is approximately 8kms to the East North East, and the Yendon site approximately 20kms to the North East of the proposed Mt Mercer wind farm which has previously been assessed for impact upon aeronautical operations.

The Lal Lal wind farm will consist of 60 wind turbine generators (WTG) in total with the blade tips of the largest turbine 161m Above Ground Level (AGL). As the proposed wind turbines will be greater than 110m AGL, they must be reported to the Civil Aviation Safety Authority (CASA) for assessment of the risk they may pose to civil aircraft operations. The Australian Defence Force (ADF) (Defence) also has an interest in assessing tall structures and it can be expected that CASA in its assessment will consider the impact upon military flying operations and if required, advice from Defence will be sought.

This report outlines the assessment of the rules and regulations associated with the development of wind farms, as well as identify the potential risks to aviation activities within the vicinity of the Lal Lal Region.

3.0 LEGISLATIVE BACKGROUND

Under the provisions of the *Civil Aviation Act 1998,* the *Civil Aviation Regulations* or the *Civil Aviation Safety Regulations,* CASA is not empowered to approve or oppose the erection of structures on or near an aerodrome. If deemed necessary, CASA has limited power to order the removal of an object which is classified as an obstruction or hazardous to aircraft operations within 3000m of an aerodrome (CAR 95).

CASR Part 139.E promulgates the requirements to be met in relation to obstacles and hazards. CASR 139.365 requires the proponent of a proposed structure *"…the top of which will be 110m or more above ground level…"* to notify CASA of their intention and to provide the proposed height and location of the building or structure.

In accordance with CASR 139.370 CASA may determine that an obstacle, building or structure is, or will be hazardous to aircraft operations after conducting an aeronautical assessment. If the proposed obstacle, building or structure is deemed to be hazardous to aircraft operations CASA may direct the proponent to light or mark the hazard in accordance with the *Manual of Standards (MOS) - Part 139 Aerodromes*. With respect to the lighting of wind farms CASA formerly provided guidance material in Advisory Circular AC 139-18(0) *Obstacle Marking and Lighting of Wind Farms,* however, this has subsequently been withdrawn. Other means of providing lighting and / or marking can be proposed to CASA such as those detailed in advice from European agencies and the International Civil Aviation Organisation (ICAO).

Following a 2009 risk review of man-made objects located away from regulated aerodromes CASA is contemplating the development of a regulatory framework similar to that of the United States Federal Aviation Administration for marking and lighting of obstacles. The United States regulations define obstacles as buildings, objects and structures of 150m or more in height. In conjunction with rulemaking activity, CASA intends to review regulations on reporting of tall structures and will consider reviewing the withdrawn Advisory Circular 139-18(0) on lighting of wind turbines to refer to lighting requirements for structures 150m or more above ground level. Guidance material is normally released with new regulations in a process that may require up to two years to complete. However, guidance contained in withdrawn AC 139-18(0) on lighting of wind turbines to fulfil duty of care obligations continues to be relevant.

National Airports Safeguarding Framework (NASF) Guidelines D outlines the proponent of wind turbines *"over 150m above ground level to be built within 30km of a certified or registered aerodrome…"* should notify CASA and Airservices.

CASA may determine that a particular activity is dangerous to aircraft operations and declare the area encompassing the activity a danger zone.

If a wind turbine is found to penetrate prescribed airspace surrounding an airport, it will be defined as an obstacle and shall be dealt with in accordance with the requirements set out in Chapters 7, 8

and 9 of the *Manual of Standards (MOS) – Part 139 Aerodromes*. If the aerodrome is used for night operations lighting of the obstacle must be in accordance with the provisions of the Chapter 9 of the MOS.

The legislative instruments protecting civil aircraft safety can be assumed to replicate the interests of Defence aircraft operations and as such input from Defence could be expected if the proposed activity has a potential impact on military flying operations. CASA may liaise with Defence Aeronautical Information Service (AIS) as that organisation maintains the tall structure database on behalf of the aviation community. NASF Guidelines D outlines *"if a windfarm is within 30km of a military aerodrome…"* the proponent should notify Defence.

Likewise Airservices Australia, the provider of Air Traffic Control and Air Navigation services has an interest in assessing proposed tall structures to ensure there is no impact upon the performance of ground based navigation aids and radar facilities. A desktop analysis has been undertaken to assess the impact the proposed wind farm may have on Surveillance Sensors.

4.0 METHODOLOGY

In carrying out the assessment REHBEIN Airport Consulting has considered the likely impact of the location, height and blade rotation of the proposed wind turbines on:

- The nearest aerodromes and:
  - the types of flying activities conducted there;
  - their airspace protection requirements established by the Obstacle Limitation Surfaces (OLS);
  - any existing aircraft instrument procedures published in the Aeronautical Information Publication – Departure and Approach Procedures (AIP-DAP); and
  - prescribed airspace;
- Air navigation and air traffic management services including:
  - radar; and
  - ground based navigation aids;
- Transiting air routes, including:
  - routes used by civil pilots operating under IFR;
  - routes used by civil pilots operating under VFR; and
  - routes used by military aircraft;
- Designated Airspace such as Danger, Restricted or Prohibited areas;
- Any other aviation activity; and
- Electromagnetic interference (EMI) with airborne radio.

5.0 IDENTIFIED ISSUES

Each individual stakeholder will have differing concerns regarding a proposed development. Below is a breakdown of the stakeholder issues REHBEIN Airport Consulting has identified which are addressed in this aeronautical assessment:

5.1 CIVIL & MILITARY AIRCRAFT PILOTS

REHBEIN Airport Consulting has considered the effect of the proposed wind farm on aircraft transiting the region, arriving and departing from local aerodromes and on aircraft flying instrument approaches into Ballarat aerodrome. This consideration has addressed both VFR and IFR operations.

5.2 AIRPORT OPERATORS

REHBEIN Airport Consulting has assessed the aerodromes in close proximity to the proposed wind farms such as Ballarat, Lethbridge Airpark and Fiskville ALA. An assessment of the types of flying activities conducted at each aerodrome has been undertaken, and airspace protection has been considered along with the instrument flight procedures into Ballarat airport.

5.3 AIRSERVICES AUSTRALIA

REHBEIN Airport Consulting has undertaken an assessment of the impact of the proposed wind farms on the performance on both ground based navigation aids and radar facilities.

5.4 OTHER AVIATION ACTIVITIES

5.4.1 AERIAL APPLICATION

REHBEIN Airport Consulting has undertaken an assessment of the likely type of agricultural activities conducted in the area of the proposed wind farm and the impact of the turbines on aerial agricultural operations.

5.4.2 RECREATIONAL AVIATION

Given the proximity to the Lethbridge Airpark and a number of other Aeroplane Landing Areas (ALAs) consideration has been given to the effect upon recreational aviators operating in the region.

6.0 POTENTIAL RISKS TO AVIATION ACTIVITIES

As with any proposed obstacle, building or structure, wind turbines must be assessed for any potential hazard/risk to aircraft operations.

6.1 AIRSPACE AROUND AERODROMES

There are two key airspace surfaces which may be relevant dependent on the category of operations into the aerodrome.

6.1.1 OBSTACLE LIMITATION SURFACE (OLS)

The OLS is a set of imaginary surfaces associated with an aerodrome. They define the volume of airspace that should ideally be kept free from obstacles in order to minimise the danger to aircraft during an entirely visual approach or during the final visual segment of an instrument approach procedure. These surfaces are of a permanent nature and comprise the reference datum which defines an obstacle. Anything above the vertical limits of the OLS is regarded as an obstacle. Obstacles are reported so that CASA can determine if they are “hazardous” and therefore need to be marked and/or lit to ensure they are prominently identified.

Airspace requirements will depend on the nature and scale of activities at an aerodrome but could extend to a radius of 15 km. The OLS also need to be considered in relation to both current and future aerodrome developments and activities.

Wind turbines may be acceptable in these areas covered by the OLS but will need to be assessed in relation to critical manoeuvres such as the approach to land and possible low level missed approaches, and a reduced power take-off following an engine failure.

6.1.2 PANS-OPS SURFACES

Airspace associated with aircraft instrument approach and departure procedures is defined by the PANS-OPS surfaces for an aerodrome. These surfaces are ascertained in accordance with the procedures in the International Civil Aviation Organisation (ICAO) *Procedures for Air Navigation Services - Aircraft Operations* (Doc 8168, PANS-OPS).

The PANS-OPS surfaces are intended to safeguard an aircraft from collision with obstacles when the pilot is flying by reference to instruments. The designer of an instrument procedure determines the lateral extent of areas needed for an aircraft to execute a particular manoeuvre. The designer then applies minimum obstacle clearance to structures, terrain and vegetation within that area to determine the lowest altitude at which the manoeuvre can be safely executed. As a result, PANS-OPS surfaces cannot be infringed in any circumstances.

These airspace requirements will depend on the nature and scale of activities at an aerodrome but could determine the acceptable obstacle heights to a radius of 10 - 20 km from the aerodrome.

6.2 RADAR

Primary radar works by radiating electromagnetic energy and detecting a return signal from reflecting objects. Comparison of the return signal with the original transmission provides information such as the direction and range of the target from the radar site. ATC radars are designed to filter returns from stationary objects to avoid moving targets, primarily aircraft, being obscured by radar clutter. Other than this means of differentiating between stationary and moving targets, primary radar cannot tell the type of object and has no means of determining the height of the object.

SSR emits radio frequency (RF) interrogation messages that trigger automatic responses from a "transponder" on board an aircraft. The transponder reports aircraft identification and altitude.

The blades of a wind turbine may be detected if within the coverage and line of sight of primary radar. A grouping of blades will return intermittent reflections that create the impression of a moving target. Since the primary radar gives no height information, reflections from wind turbine blades may cause an air traffic controller to divert aircraft which may be in the vicinity of the wind farm within primary radar coverage regardless of their flight level.

The turning blades may also reflect or deflect the primary radar signals and prevent aircraft flying in their "shadow" from being detected. In this case the co-located SSR would also detect the aircraft but even then the reflection of SSR transmissions in some instances could cause the aircraft to be wrongly identified or its position to be inaccurately shown on ATC radar.

Weather radar can similarly be affected and this too impacts on flight safety which relies on accurate forecasting of major weather events and wind shear at higher altitudes.

6.3 NAVIGATION AIDS

Ground based navaids could suffer from similar reflection and deflection effects as with radar. The effect of this may be that an aircraft is not tracking accurately towards the navaid on the designated air route. This false tracking can cause the aircraft to deviate too far from the intended flight track and expose it to obstacles which infringe upon the clearances defined in the design of the particular flight procedure in instrument conditions. Similarly, visually navigated aircraft may track erroneously due to a conflict of navigation data available from maps and navigation aids.

Line of sight principles again apply but this type of facility will normally be protected by preventing new structures if they will extend above an elevation angle of 1° as seen from the navaid site.

This means that on level ground a 161m high wind turbine could be safely located at around 9.2km from the navaid site.

6.4 VISUAL & INSTRUMENT FLIGHT RULES

6.4.1 INSTRUMENT FLIGHT RULES (IFR)

Aircraft operating under IFR are navigated by reference to cockpit instruments which process data from aircraft systems, ground-based navaids or satellites. All regular public transport (RPT) jet aircraft operating into or between major Australian cities operate only in controlled airspace and under IFR.

In contrast, jet, turboprop or piston engine regional RPT aircraft travelling to or from a regional city may operate route sectors outside controlled airspace (OCTA) and even under VFR.

Charter and business aircraft may operate in controlled airspace under IFR or VFR, or OCTA under VFR or IFR. General aviation training aircraft are most likely to operate under VFR. Military aircraft may operate anywhere and may be flying at very low levels.

Aircraft operating under IFR may do so either OCTA or within controlled airspace. If flying below 10,000 ft pilots must select, or will be assigned, cruising altitudes which are multiples of 1,000 ft – odd thousands if their track is 0°-179°M and even thousands if their track is 180° - 359°M. IFR traffic must select or be assigned to a designated air route depicted on air navigation charts.

Since IFR pilots may be relying solely on cockpit instruments and have no outside visual reference, a lowest safe altitude (LSALT) is published for each air route. It is determined by adding 1,000 ft minimum vertical clearance to the highest terrain or known structure enroute.

It is conceivable that a new wind farm, if located on prominent terrain, may require an increase in LSALT for a particular air route.

6.5 VISUAL FLIGHT RULES (VFR)

Aircraft operating under VFR may do so only in visual meteorological conditions (VMC) defined as an average range of visibility of 5,000m forward of the cockpit, horizontal cloud clearance of 1,500 m and vertical cloud clearance of 1,000 ft.

VFR traffic is most likely to operate OCTA but may fly in controlled airspace without reference to ATC at altitudes below 10,000 ft. VFR pilots may fly a designated air route in which case they must select altitudes which are multiples of 500 ft - odd thousands plus 500 ft if their track is 0° - 179°M and even thousands plus 500 ft if their track is 180° - 359°M. This rule ensures there should be a minimum 500 ft separation between IFR and VFR traffic using the same air route.

The minimum statutory height for VFR flight is 500ft above ground level or clear of obstacles in non-populous areas. Night VFR pilots must fly at or above the LSALT for that route.

Night VFR pilots must use either a published LSALT for the area or if on a dead reckoning (DR) track then a calculated LSALT taking into account any point within 10 NM of the nominated track.

VFR traffic in daylight hours is not confined to air routes and these aircraft may operate anywhere provided they do so in VMC and observe the same rules for selecting their cruising altitude.

In these conditions wind farms should be easily visible and have no impact on VFR flying activity.

6.6 MILITARY LOW FLYING

Military pilots must conduct low level flying training so that the skill becomes second nature. Low level flying exercises are carried out by military aircraft from a number of defence airfields. Routes at or below 5,000 ft AGL used by military jet aircraft for low level, high speed navigation or terrain following exercise are designated as Military Low Jet Routes (MLJR).

Routes are planned to avoid controlled airspace, civil restricted areas and danger areas, civil aerodromes by at least 5 NM laterally and 4000 ft vertically, and Common Traffic Advisory Frequency – Radio (CTAF-R) airspace unless aircraft are equipped with the appropriate radio frequency.

A small number of MLJR are notified in the Aeronautical Information Publication – EnRoute Supplement Australia (AIP-ERSA) and are permanently activated. In all other instances routes and duration of MLJR operations are advised by the Notice to Airmen (NOTAM) system.

This policy means that MLJRs are more flexible and new installations such as wind farms would be considered by the Australian Defence Force (ADF) when planning low level flight.

Given the close proximity to the City of Ballarat and the number of small towns surrounding the proposed wind farms it would be unlikely that military low flying would take place in the Lal Lal region. It would be reasonable to assume that due to the lower density of settlement to the west of Ballarat this would be more suited to low level flight training than the region to the east south east of Ballarat.

6.7 DESIGNATED AIRSPACE

Special use airspace, extending to varying heights, is defined on air navigation charts and identified as P (Prohibited), R (Restricted) or D (Danger). For safety reasons flight into this airspace may be prohibited or restricted or the airspace may be designated as a danger area to warn pilots to take additional care.

Wind turbines will not be permitted within prohibited or restricted areas as these are usually set aside for military training, weapons firing or security sensitive structures.

Danger areas will usually relate to mining or quarrying sites, chimneys or stacks with high velocity or high temperature discharges, special aviation activities such as aerobatic training and the like. While pilots may elect to avoid these areas there is no restriction on entry.

Wind turbines may not be compatible with some activities conducted within a designated Danger Area but, more importantly, CASA may elect to designate a Danger Area around a wind farm in order to alert pilots to avoid low altitude flying.

6.8 OTHER AVIATION ACTIVITIES

Aerial agricultural operations may be affected by the presence of wind turbines depending on the spacing between turbines and cluster orientation. Turbulence produced by the rotors can present a hazard to agricultural aircraft conducting operations at very low levels, particularly when manoeuvring at high weights. The vortices may persist for a considerable distance downwind from the rotors and may cause an upset that is extremely hazardous to a heavily loaded agricultural aircraft operating at low level. Overseas studies[1] suggest that the plume behind a wind turbine can persist for distances of at least six times the rotor diameter. The turbine type has not yet been finalised by the client, but the expected worse case would be a rotor diameter of 122m. For a 122m rotor the distance could be 732m or greater. The extraction of wind energy by a turbine causes a velocity deficit in the air flow behind the turbine, producing significant shear between the free stream wind and the turbine wake. The wake exhibits rotational flow at the blade rate and can contain turbulent high speed flows when the turbine is operating at maximum power. However, because aerial spraying and spreading operations are conducted in calm wind conditions when the turbine blades are stationary, agricultural aircraft are unlikely to encounter hazardous turbulence generated by wind turbines when operating near them.

Special use areas for hang-gliding, parachuting or radio controlled model aircraft flying are marked by symbols on air navigation charts. Although these do not usually justify the designation of a Danger Area the symbol serves to alert pilots to over-fly these sites at a safe height. Since a wind farm shares low level airspace it could seriously curtail these types of recreational activities. Wind farms are now being indicated on charts by a symbol in the same manner.

6.9 ELECTROMAGNETIC INTERFERENCE WITH AIRBORNE RADIO

Large scale power generation activities may cause electromagnetic interference (EMI) with on-board radio communication equipment of aircraft overflying and/or flying in the vicinity of the wind farm.

The available literature indicates that this effect may be considered negligible because of the standards which apply to wind turbine construction. Wind turbines have been installed worldwide with very few instances of EMI being recorded.

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[1] L.J Vermeer, J.N. Sorenson, A Cresp, *Wind Turbine Wake Aerodynamics,* Progress in Airspace Sciences 39 (2003).

Hand M, Simms D, Finger L, Jager D, Coteril J, Schreck S, Larwood S *Unsteady aerodynamics experiments phase VI: Wind tunnel test configuration and available data campaigns.* Technical Report BREL/TP-500-29955, NREL (December 2001).

Wind Turbine Wakes – Control and Vortex Shedding by Davide Medici. Technical Reports from KTH Mechanics Royal Institute (2004)

7.0 AERONAUTICAL RISK ANALYSES

Having considered the potential risks to aviation activities as outlined in Section 6.0 as part of an overall analysis of the proposed wind farms, the following risk assessments are detailed.

7.1 AERODROMES

The proposed Elaine wind farm is planned to be positioned approximately 30kms to the South East of Ballarat airport, 73kms to the west of Melbourne airport and 48kms to the North West of Avalon airport. Therefore under NASF Guideline D outlined in Section 3.0, the proponent should notify CASA and Airservices of a windfarm consisting of turbines greater than 150m AGL that are within 30km of a certified or registered aerodrome.

The proposed Yendon site is planned to be positioned approximately 20kms to the East South East of Ballarat airport, 71kms to the West of Melbourne airport and 58kms to the North West of Avalon airport.

Given the distances from Avalon and Melbourne airports analysis of any impact on operations to or from either of these airports is not necessary. Avalon control zone does not extend beyond 12 NM from Avalon aerodrome and Melbourne controlled airspace lower levels in the area of the proposed wind farm are well above the planned heights for the wind turbines. Lower level airspace in the Lal Lal region is classified Class G and is not controlled (i.e. not subject to Air Traffic Control clearances/separation), though ATC may provide a Flight Information Service (FIS) if resources allow. VFR aircraft operating at low level around the Ballarat region are not required to maintain radio contact below 5,000ft or operate with a serviceable transponder Outside Controlled Airspace (OCTA) below 10,000ft.

Local Aeroplane Landing Areas (ALAs) include Lethbridge and Fiskville.

7.1.1 BALLARAT

Ballarat aerodrome is approximately 20km from the proposed Yendon wind farm and approximately 30km from the proposed Elaine section. Ballarat airport is normally available only to aircraft below 5,700kg MTOW. Aircraft with MTOW in excess of 5,700kg require prior permission to operate at Ballarat aerodrome so the majority of the traffic will be light aircraft. Because the sealed runways are respectively only 1265m and 1245m in length, the largest aircraft likely to operate into the aerodrome without special approval are twin engine commuter aircraft such as the Beechcraft Kingair, Piper Cheyenne or the De Havilland Twin Otter.

Since the greatest possible extent of any OLS for any aerodrome is 15km there will be no penetration of the Ballarat OLS by either the proposed Elaine or Yendon wind farms.

The Instrument approach procedures into Ballarat are effectively all contained within +/-15º of north south tracks reference the Ballarat NDB (Non Directional Beacon). The Runway 18 RNAV approach has an inbound track of 163º and a missed approach track of 178º. The Runway 36

RNAV approach has an inbound track and missed approach track of 357º. The circling NDB approach has an outbound track of 184º, and inbound and missed approach tracks of 349º. Given that both proposed wind farms are to the east south east of Ballarat aerodrome at a distance of 20km and 30km respectively there will be no impact on any of the Ballarat instrument flight procedures.

The 25 NM Minimum Sector Altitude (MSA) for aircraft operating to the East of Ballarat is 4000ft (2567ft above aerodrome elevation) and the 10 NM MSA is 3700ft (2267ft above aerodrome elevation) from all directions reference the Ballarat NDB. Given that the spot heights provided to REHBEIN Airport Consulting for the proposed Yendon wind farm indicate a maximum ground level of 542m (1779ft) and in the Elaine region 430m (1411ft), it can be calculated that if the Yendon wind turbines were the critical obstacle the Minimum Sector Altitude (MSA) would be: 1779ft (ground level) plus 427ft (turbine height 161m) plus 1000ft – 3206ft. The current 25 NM and 10 NM MSA as stated above indicates that there are higher obstacles in the region thus indicating that the proposed wind turbines will have no effect on MSA.

7.1.2 LETHBRIDGE AND FISKVILLE

The proposed Elaine wind farm will be located approximately 17km from the Lethbridge Airpark. Given the traffic operating to/from Lethbridge would be operating under VFR during daylight hours the Elaine wind farm would be appropriately visible to transiting traffic operating to or from the Lethbridge Airpark. If an OLS was prepared for the Lethbridge Airpark neither of the proposed wind farms would penetrate this airspace.

The Yendon wind farm will be located approximately 15km from the Fiskville aerodrome. Again, given that the traffic operating to/from Fiskville will be operating under VFR during daylight hours the Yendon wind farm will be appropriately visible to transiting traffic. Similarly, if an OLS was prepared for Fiskville neither of the proposed wind farms would penetrate this airspace.

Investigation of all other marked airfields in the region indicates that there is no known aerodrome within 13km of either of the proposed wind farms.

Consultation with the aerodrome operators and users of the Lethbridge Airpark and Fiskville ALA should be undertaken to ensure the proposed wind farms do not adversely affect the safe operation of aircraft from the airfield.

7.2 RADAR & NAVAIDS

7.2.1 RADAR

The closest radar facility to the proposed Lal Lal wind farm is associated with Melbourne airport and located at Mount Macedon. This radar antenna is approximately 56km to the north east of the proposed Yendon wind farm and approximately 65km north east of the proposed Elaine wind farm. Melbourne Airport Terminal Area Radar (TAR) located at Gellibrand Hill and Melbourne Airport Radar, are approximately 74km south east of the proposed Yendon wind farm and 79km south

east of the proposed Elaine wind farm site. There is also military radar located at East Sale however its exact location is presently unknown pending a response from Defence. Conservatively, the East Sale radar is assumed to be approximately 278km from development site based on the assumption that the facility will be located within the East Sale area.

The impact the Lal Lal wind farm will have on radar facilities has been assessed with consideration to the Eurocontrol Guidelines on *How to Assess the Potential Impact of Wind Turbines on Surveillance Sensors* as required by Airservices Australia for its review of Aviation Impact Statements.

The Mount Macedon Enroute Radar facility sensor comprises of a PSR and a SSR. The antenna height of the radar facilities are 1047m AHD at Mount Macedon. The Melbourne Airport radar facilities antenna height is 133.8m AHD with a maximum instrumented range of 250NM. The Melbourne Terminal Area Radar at Gellibrand Hill sensor comprises of a PSR and a SSR. The antenna height of the PSR sensor is 223m AHD and the SSR sensor is 226m AHD.

The Eurocontrol guidelines divide the area between the PSR or SSR radar antennae and the maximum instrumented range of the radar (60NM for PSR and 250NM for SSR) into zones based on distance from the antennae. Assessment requirements are less complex as distance from the radar antennae increases or the amount of the Wind Turbine Generator (WTG) that is in line of sight of the antennae reduces.

The assessment criteria for PSR outlined in the Eurocontrol guidelines are described in Table 1.

Table 1: PSR Assessment Criteria for Wind Farms

Zone	Zone 1	Zone 2	Zone 3	Zone 4
Description	0 – 500m	500m – 15km and in radar line of sight	Further than 15km but within maximum instrumented range and in radar line of sight	Anywhere within maximum instrumented range but not in radar line of sight or outside the maximum instrumented range
Assessment Requirements	Safeguarding	Detailed Assessment	Simple Assessment	No Assessment

The assessment criteria for SSR outlined in the Eurocontrol guidelines are described in Table 2.

Table 2: SSR Assessment Criteria for Wind Farms

Zone	Zone 1	Zone 2	Zone 4

Description	0 – 500m	500m – 16km but within the maximum instrumented range and in radar line of sight	Further than 16km or not in radar line of sight
Assessment Requirements	Safeguarding	Detailed Assessment	No Assessment

The Primary Surveillance Radars located at Mount Macedon, Gellibrand Hill and East Sale have a maximum instrument range of 111km (60Nm). Since the proposed development site is within 111kms of the Mount Macedon Enroute Radar and Gellibrand Hill TAR but not in radar line of site no further assessment is required under the Eurocontrol guidelines. The development site is outside maximum instrumented range of the East Sale military radar.

The Melbourne TAR at Gellibrand Hill consists of an SSR radar antenna with a maximum instrumented range of 250Nm (463km). In the case of the Secondary Surveillance Radars the development site is situated within the maximum instrument range of the facilities however, is beyond 16km. Based on the Eurocontrol assessment criteria this would position the site in Zone 4. In this case no further assessment is required.

Considering the terrain and distance between the Gellibrand Hill TAR at Melbourne Airport from the proposed wind farm sites in the Lal Lal Region it would be highly unlikely that shielding of primary radar returns would occur. Given that there is overlap of SSR from the Mount Macedon and Melbourne airport facilities there should be no impact upon SSR in the Lal Lal region. Also it should be noted that given the lower level of controlled airspace is 8,500ft in the Lal Lal region, there is no requirement to provide SSR coverage below this level because VFR aircraft operating OCTA are not required to carry and operate transponders.

7.2.2 NAVAIDS

Given the 1º slope from the navaid position above which obstructions can potentially interfere with navigation aid (navaid) signals a 161m high structure (wind turbine in this case) must be a minimum of 9.2km from the navaid facility on level ground.

The Ballarat NDB at Ballarat Airport is the nearest navaid to the Yendon windfarm located 24.6km and at a bearing of 301 degrees magnetic from the windfarm. The Yarrowee VOR is the nearest navaid to the Elaine windfarm located 20.9km and at a bearing of 275 degrees magnetic from the windfarm.

Given the distances from the proposed wind farms to the nearest navaids at Ballarat and Yarrowee, there should be no adverse effects on navaid performance from the wind turbines.

7.3 TRANSITING AIR ROUTES

7.3.1 IFR AIR ROUTES

A number of IFR routes pass over the Yarrowee VOR. An analysis of these routes has revealed Lowest Safe Altitudes (LSALT) in the range of 2,900 ft up to 4,700 ft. As was outlined in Section 6.1.1 the Yendon wind farm will have a critical turbine height that would dictate a LSALT of 3206 ft. Airway W291 (2 way low-level domestic route) has published LSALTs of 3,000 ft and 2,900 ft between Avalon and Yarrowee. As per the data provided by Westwind Energy, the highest land elevation in the Elaine Turbine cluster is 430.1m. With the addition of the 161m turbine and blade height this would give a maximum height of 591.1m (1,838ft) AMSL for the highest turbine. This would suggest that the turbines will not be a critical obstacle as the LSALT for the sector closest to Yarrowee on airway W291 is 3,000ft. The critical obstacle on this sector of the airway is approximately 2,000ft AMSL. The Yendon wind farm will not impact upon the use of airway W291 because the Yendon site is well to the north of the Avalon-Yarrowee track. IFR aircraft operating on this track are adequately protected by the published route LSALTs.

All other airways transiting via the Yarowee navaids or the Ballarat NDB that will pass over or close to the proposed wind farms have LSALT's of at least 3,500ft.

Neither of the proposed wind farms at Yendon or Elaine will affect current published LSALT's.

7.3.2 VFR AIR ROUTES

There are no published VFR routes for aircraft operating in the Lal Lal Windfarm region. As the proposed wind farm will be sufficiently conspicuous during daylight operations, as indicated in CASA Advisory Circular AC 139-08(0) there would be no requirement for specific marking of the wind turbines as there will be no impact on VFR aircraft operating in the area.

Aircraft operating under the Night Visual Flight Rules (Night VFR) are required to fly at or above the route LSALT for the flight planned track. LSALTs are similar for Night VFR and IFR aircraft as outlined in Section 6.3.1.

Despite the remoteness of the wind farm from aerodromes likely to be used for Night VFR operations, the structures still exceed 150m in height, therefore CASA may direct or the proponent may identify a need to illuminate the proposed structures in order to highlight the development to the flying community. The lighting should be operated in a manner consistent with a general duty of care towards aviation, such as during the period 30 minutes before and after sunrise and sunset, and during conditions of reduced visibility caused by smoke, dust or haze. In doing so the proponent may partially discharge their duty of care to protect night flying operations.

7.3.3 MILITARY LOW FLYING OPERATIONS

Because of the mix of civil aviation activities conducted in the areas to the North and North West of the Melbourne CTR it is highly unlikely that MLJRs will be proposed in this area.

7.4 RESTRICTED AREAS

There are no published Danger (D), Prohibited (P) or Restricted (R) zones in the region.

7.5 OTHER AVIATION ACTIVITY

Symbols on navigation charts show that hang gliding and model aeroplane activities occur to the West of Ballarat. To the south there is an area close to the Rokewood ALA that indicates hang gliding and winched or auto towed aviation activity.

These activities should not be adversely affected by the proposal as they are remote from the proposed wind farm site.

8.0 CONCLUSIONS AND RECOMMENDATIONS

CASA currently allows fixed structures up to 110m AGL without marking, lighting or advice to the aviation industry. These structures could be located anywhere and be any shape, size, colour or number. In this instance Westwind Energy proposes structures that are substantially higher at 161m above ground level, concentrated in a defined area, conspicuous because of their shape and colour and unlikely, on the basis of this preliminary investigation, to pose a hazard to aviation.

It would be a prudent move to have discussions with local aerodrome operators (Fiskville and Lethbridge) to gain an understanding of their current usage and future plans for development and expansion of their airports that focus on recreational flying activities.

The proposed wind farms will not impact upon aircraft operations to/from Ballarat, Avalon or Melbourne nor interfere with radio or navigation aid performance.

Analysis undertaken by REHBEIN Airport Consulting indicates that there will be no impact upon IFR traffic operating to Ballarat or transiting the area with reference to the Ballarat or Yarowee navaids. Further investigation of the impact upon IFR operations will most likely not be required.

Traffic operating under the VFR will not be affected by the proposed wind farms as the structures will be sufficiently conspicuous by day and at night local LSALTs will provide clearance well in excess of the minimum required for night VFR operations.

It would also be prudent to confirm whether Airservices Australia has any concerns about the impact of the proposed Wind Farms upon Radar and Radio performance in the region although investigation undertaken by REHBEIN Airport Consulting suggest the impact, if any, will not be of operational significance.

Analysis suggests that there will be no impact upon the safety of recreational aviation activities in the region. A prudent measure may be for Westwind Energy to confirm that their proposal does not impact on recreational aviation activities undertaken in the area near the Rokewood ALA by consulting relevant national associations/federations. In this assessment REHBEIN Airport Consulting has relied on the location of such activities being accurately depicted on navigation charts.

In this case all the safeguards imposed by CASA to ensure tall structures including wind turbines do not constitute a hazard to the safety of civil aircraft operations in Australia are satisfied and the risk to civil aviation activities, if any, that this wind farm may pose is trivial.

As with any reported tall structure that may pose any risk, regardless of its triviality, it would seem sufficient to indicate the position of the proposed wind farms on appropriate air navigation charts to assist pilots operating in the region and to provide lighting as deemed acceptable to CASA.

Subject to the results of a risk assessment to be undertaken by Westwind Energy, hazard lighting may need to be installed on sufficient turbines to define the extremities of the proposed wind farm site to discharge duty of care obligations to aviation operators.

If lighting is deemed necessary then it should be in accordance with CASA MOS Part 139, Chapter 9, Section 9.4 and be operated in a manner consistent with a general duty of care towards aviation, such as during the period 30 minutes before and after sunrise and sunset, and during conditions of reduced visibility caused by smoke, dust or haze.

Revisions to associated guidance material are likely to include reissue of CASA Advisory Circular AC139-18(0), *Obstacle Marking and Lighting of Wind Farms* updated to incorporate advice on providing obstacle lighting for structures 150m or more above ground level. Timing for this advice at this stage is unknown.

In 2007 REHBEIN Airport Consulting produced an aeronautical assessment on behalf of Westwind Energy which was successfully approved by the DoT. A lighting plan was also issued by CASA for the proposed 130m AGL wind turbine generators. Since the previous report was issued in 2007, legislation has changed and therefore a separate assessment of the now proposed 161m AGL wind turbines acknowledging the current regulations has been undertaken.

9.0 ABBREVIATIONS

AC	Advisory Circular
AGL	Above Ground Level
AIP-DAP	Aeronautical Information Publication – Departure and Approach Procedures
AIP-ERSA	Aeronautical Information Publication – En route Supplement Australia
AIS	Aeronautical Information Service
ALA	Aeroplane Landing Area
AMSL	Above Mean Sea Level
ATC	Air Traffic Control
CAR	Civil Aviation Regulations
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulations
CTAF	Common Traffic Advisory Frequency
CTR	Control Zone
EMI	Electromagnetic Interference
IFR	Instrument Flight Rules
LSALT	Lowest Safe Altitude
MLJR	Military Low Jet Routes
MOS	Manual of Standards
Navaids	Navigation aids
NDB	Non Directional Beacon
NM	Nautical Miles
NOTAM	Notice to Airmen
OCTA	Outside Controlled Airspace
OLS	Obstacle Limitation Surfaces
PANS-OPS	Procedures for Air Navigation Services – Aircraft Operations
RF	Radio Frequency
RPT	Regular Public Transport
SSR	Secondary Surveillance Radar
TAR	Terminal Area Radar
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VOR	VHF Omni Directional Range

10.0 GLOSSARY OF TERMS

Advisory Circular (AC): Advisory documents issued by CASA suggesting preferred methods for complying with the CASR. The advice contained in the AC is meant to be read in conjunction with the CASR and Manual of Standards.

Aeronautical information publication (AIP): A publication issued by or with the authority of a State and containing aeronautical information of a lasting nature essential to air navigation. The AIP for Australia and its Territories is published under Section 8 of the *Air Services Act 1995.*

Aeronautical information service (AIS): A service provided by AA to collect, collate, edit and publish aeronautical information.

Air route: The navigable airspace between two points and the terrain beneath such airspace identified, to the extent necessary, for application of flight rules.

Air traffic control (ATC): A service established by Airservices Australia pursuant to section 8 of the *Air Services Act 1995*. ATC functions are chiefly to prevent collisions between aircraft (and on the manoeuvring area, between aircraft and obstructions), and to expedite and maintain an orderly flow of air traffic.

Civil Aviation Regulations (CAR): Regulations made by the Governor-General under the *Civil Aviation Act 1988*.

Civil Aviation Safety Regulations (CASR): Regulations made by the Governor-General under the *Civil Aviation Act 1988*.

Common traffic advisory frequency (CTAF): A frequency for pilots to exchange traffic information while operating to or from an airport without an operating control tower, or within a designated area.

Controlled airspace: Airspace of defined dimensions within which ATC service is provided to controlled flights. A control area or control zone.

Danger area: An airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times.

Departure and approach procedures (DAP): An aeronautical information publication (AIP-DAP) which contains aerodrome/landing charts, instrument approach and landing procedures, standard instrument departures, DME or GPS arrivals and noise abatement procedures.

En route Supplement Australia (ERSA): This AIP supplement (AIP-ERSA) is a joint military/civil publication containing the aerodrome and facility directory for military aerodromes and civil public aerodromes. ERSA contains aerodrome diagrams (ADDGM) and other information such as physical characteristics, visual ground aids, aeronautical lights, MBZ and CTAF boundaries.

General aviation (GA): All civil aviation operations other than RPT operations.

IFR operation: An operation conducted in accordance with the Instrument Flight Rules prescribed in Part XII of the Civil Aviation Regulations. These operations (landings and take-offs at an airport) are made in periods of inclement weather and poor visibility and under these conditions, positive control on approach and climb-out is maintained by the use of electronic navigational aids.

Instrument approach procedure: A series of pre-determined manoeuvres by reference to flight instruments with specified protection from obstacles from the initial approach fix, or where applicable, from the beginning of a defined arrival route, to a point from which a landing can be completed and thereafter, if a landing is not completed, to a position at which holding or en-route clearance criteria apply. The approved procedure to be followed by aircraft in letting down from cruising level and landing at an aerodrome.

Instrument flight rules (IFR): A set of rules, as outlined in Part XII of the CAR, governing the conduct of flight under instrument meteorological conditions (IMC). See also "IFR operation".

Instrument meteorological conditions (IMC): Meteorological conditions expressed in terms of visibility, distance from cloud and ceiling less than minima specified for visual meteorological conditions (VMC).

Lowest safe altitude (LSALT): The lowest altitude that will provide safe terrain clearance at a given place.

Nautical mile (NM): A length of 1 852 metres.

Navigation aid (navaid): A ground based or airborne facility or equipment relying primarily on the transmission/reception of radio or radar signals to provide information used to determine the location of an aircraft. Navaids are designed to be used either for en-route navigation or to assist in approach and landing in reduced visibility conditions.

Non-directional beacon (NDB): A ground radio station emitting continuous signals and providing an omni-directional radiating pattern which is used in conjunction with airborne ADF equipment to provide directional guidance to aircraft.

Notice To Airmen (NOTAM): A notice containing information 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. NOTAM are published under Section 8 of the *Air Services Act 1995*.

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 which extend above a defined surface intended to protect aircraft in flight. See also "obstacle limitation surfaces (OLS)".

Obstacle lights: Lights mounted on or adjacent to obstacles or potential hazards to aircraft moving on the ground or in the navigable airspace, for the purpose of indicating the obstructions or hazards by night.

Obstacle limitation surfaces (OLS): A series of planes associated with each runway of an airport, or the airport itself, which define the desirable limits to which objects may project into the airspace around the airport. Objects penetrating an OLS are defined as obstacles and may need to be marked and/or lit in accordance with CASA requirements.

PANS-OPS (Procedures for Air Navigation Services - Aircraft Operations) criteria: The ICAO specification for obstacle assessment or identification and allowances for minimum obstacle clearance used in the design of each stage of an instrument departure or approach procedure.

Primary radar: A radar system which uses reflected radio signals.

Prohibited area: An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited.

Radar: A radio detection device which provides information on range, azimuth and/or elevation of objects.

Regular public transport (RPT): The transport of persons generally, or cargo for persons generally, for hire or reward in accordance with fixed schedules and to and from fixed terminals over specific routes.

Restricted area: An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions.

Route: A way to be taken in flying from a departure to a destination airport, specified in terms of track and distance for each route segment.

Secondary surveillance radar (SSR): A system of secondary radar using ground transmitters/receivers (interrogators) and airborne transponders.

Terminal area radar (TAR): A high definition radar used for air traffic control purposes in the terminal area.

VHF omni-directional radio range (VOR): A VHF radio navigation aid which provides a continuous indication of bearing from the selected VOR ground station. It provides 360 degree radial tracks to the beacon corresponding to the points of the magnetic compass and which may selected at one degree intervals by the pilot.

Visual flight rules (VFR): Rules of flight to permit operations on a see and be seen basis in visual meteorological conditions (VMC). These rules are prescribed in Part XII of the CAR.

Visual meteorological conditions (VMC): Meteorological conditions in which the flight visibility and distances from cloud during a flight are equal to, or greater than the applicable distances determined by the (Civil Aviation Safety Authority) under CAR 172(2).