

APPENDIX 16

**Crudine Ridge Wind Farm Aeronautical Impact Assessment,
Qualitative Risk Assessment and Obstacle Lighting Review**

HART Aviation

CONFIDENTIAL

AVIATION ASSESSMENT

PROPOSED CRUDINE RIDGE WIND FARM

For



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DISTRIBUTION

Wind Prospect CWP Pty Ltd
HART Aviation Services Pty Ltd

REFERENCE

PN 11-0373

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AUDIT DATE

August 2011

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This document is confidential and intended for the sole use of Wind Prospect CWP Pty Ltd. The information and any assessments contained within are based on the information provided by Wind Prospect CWP, observations made during a visit to the proposed Crudine Ridge Wind Farm site and independent research. Because of the sampling nature and other inherent limitations of what is presented for review or seen during an inspection, there is an unavoidable risk that some material or other irregularities may remain undiscovered. The report relates to specific operations only in the vicinity of the Crudine Ridge Wind Farm and may not reflect the position at other locations, on different operations, or at some other time in the future. Notwithstanding anything contained in this Report, HART Aviation is not liable for any loss, damage or injury caused by or as a result of activities of or the negligence of a third party claiming to be relying on this Report. This Report shall not be disclosed to or used by any third party without first obtaining Wind Prospect CWP's and HART Aviation's written permission. *Revision: 2005-09-29*



1. TERMS OF REFERENCE

The objective of the Aviation Assessment is to undertake a detailed assessment of the potential aviation impacts of the proposed Crudine Ridge Wind Farm development and, where potential impacts are identified, propose options for mitigation.

The outcomes of this assessment are intended to form part of the Crudine Ridge wind farm Environmental Assessment (EA). The detailed Aviation Assessment should, therefore, meet the requirements of the Department of Planning & Infrastructure (DoPI), and Director General Requirements (DGR), additional agency requirements and be undertaken with consideration of guidelines relevant to New South Wales wind farm developments.

2. SCOPE OF CONSIDERATIONS

The **Assessment Scope** was defined as follows: -

Principal considerations: -

- An assessment of the potential impacts on aviation safety considering in particular: -
 - Aviation hazard lighting;
 - Nearby aerodromes and aircraft landing areas;
 - Defined air traffic routes;
 - Aircraft operating heights;
 - Approach and departure procedures;
 - Radar interference, communication systems and navigation aids;
 - Aerodromes within 30 km of the turbines and impacts on obstacle limitation surfaces.

General Requirements: -

- The assessment must cover the worst case and representative impact for all key issues;
- Consideration of any cumulative impacts as relevant,
 - Taking note of proposed wind farms in the locality including the proposed Ungula Wind Farm, located east of Wellington and west of Mudgee and comprising approximately 330 turbines.
- With respect to the transmission line:
 - A considered overview of the impacts along the length of the line;
 - Identify areas of potential significant impact, for further more detailed assessment;
 - In addition to detailed assessment of areas of potentially significant impact, other areas along the length of the line should be addressed in a more general manner, with a particular focus on the development of frameworks for mitigation, management and monitoring of more minor and generic environmental issues.

Additional Agency Requirements/Response: -

- Airservices Australia input (refer to Appendix 6.4);
- CASA input (refer to Appendix 6.3);
- Dept of Defence input (refer to Appendix 6.5);
- Aerial Agricultural Association of Australia input (refer to Appendix 6.6);
- Response to Airservices Australia consultation (refer to Appendix 6.4);
- Response to Dept of Defence consultation.

Minimum requirements

- Identify the nearest registered aerodromes and other airfields to the proposed wind farm site, including those located within thirty kilometres (or other relevant distance) of the proposed wind farm site and assess the risks the proposed wind farm could pose to activities at these airfields;
- Identify and assess any applicable CASA and other relevant Civil Aviation Regulations and, in particular, any regulations that relate to wind farms, obstacles and aerodromes;
- Assess the potential risks the proposed wind farm could have on relevant instrument approach procedures for the relevant region around the proposed wind farm site;
- Examine existing air routes in relation to the proposed wind farm development to determine if there would be any influence on the Lowest Safe Altitudes published for these routes;
- Identify and assess any risks the proposed wind farm development could pose, including (but not limited to):
 - Aeronautical navigation aids;
 - Air traffic services;
 - Obstacle Limitation Surfaces;
 - In consultation with RAAF, any military aircraft conducting low flying operations in the area;
 - The operation of civilian aircraft undertaking recognised low flying activities;
 - In relation to any aerial fire fighting activities that may be undertaken in the region;
 - Any rural air ambulance activities that may be undertaken in the region;
 - Any aerial agricultural and agricultural activities that may be undertaken in the region;
 - Contingency procedures and engine inoperative flight paths.
- Assess and advise on applicable Civil Aviation Regulations in regard to notification of tall structures that may present obstacles and hazards to aviation activities;
- Assess the potential cumulative impact of the construction of other approved and constructed wind farms in the region (location data to be provided);
- Assess the obstacle lighting requirements for the proposed wind farm development;

- Assess and outline any changes that would occur to the aeronautical impact and obstacle marking and lighting assessment if the tip height of the turbines were to exceed 152 metres (or any other relevant mandatory standard);
- Document any limitations associated with the aeronautical impact and obstacle marking and lighting assessment;
- Assess and discuss any other relevant matter;
- Provide recommendations to manage, mitigate or avoid any identified risks;
- Provide conclusions.

3. REVIEW OF PROPOSED CRUDINE RIDGE WIND FARM

3.1 METHODOLOGY

Consistent with the **Assessment Scope** as detailed above, HART Aviation approached the tasks using the following methodology: -

- 1) Communication with the Head of Development, Wind Prospect CWP in Newcastle to: -
 - a. discuss the aviation assessment process / methodology;
 - b. to collect all the background information and materials; and
 - c. to arrange a mutually suitable time to visit the proposed wind farm site.
- 2) Undertook an assessment investigating aircraft movements and airfields in the surrounding area, including both civil and military operations.
 - a. In addressing this element of the **Assessment Scope**, HART Aviation identified the extent to which aviation activities in the proposed wind farm area may or may not be an issue for concern, which included, inter alia: -
 - i. Review of Crudine Ridge Wind Farm detailed layout, taking particular note of:-
 1. map of area;
 2. surrounding terrain;
 3. site plan;
 4. number of wind turbines, position, and heights.
 - ii. Review of relevant aviation charts for the area concerned, including: -
 1. relevant World Aeronautical Chart (WAC);
 2. designated airspace (including Prohibited, Restricted, Danger Areas PRDs) and other airspace considerations;
 3. relevant En Route Charts (ERC);
 4. departure & arrival procedures for any aerodromes in the vicinity;
 5. relevant Visual Terminal Charts (VTC), Terminal Area Charts (TAC) and Visual Navigation Charts (VNC) if any, for the area;
 6. available airfield and airstrip guides / directories for the area; and
 7. any other matter considered relevant.
 - iii. Visit to proposed wind farm site and surrounding areas to assess issues, including: -
 1. identifying any nearby aviation related sites / airfields / Aircraft Landing Areas (ALA), etc, which may be, or may not be, evident on available maps; and

2. Identifying and assessing whether any risks the proposed wind farm development could pose on any aviation related matter, including those particular issues identified by Wind Prospect CWP in the Project Brief as detailed in Section 2 above.
- 3) Reviewed relevant aviation legislation, including: -
 - a. CASA's current position: -
 - i. recognising the withdrawal of its Advisory Circular AC 139-18(0); and
 - ii. the implications of Advisory Circular AC 139-08(0) dealing with the Reporting of Tall Structures.
 - b. Including consideration of the following guidelines: -
 - i. Auswind (2006) Best Practice Guidelines for Implementation of Wind Energy Projects in Australia;
 - ii. National Wind Farm Development Guidelines (Draft) – July 2010; and
 - iii. Draft Guidelines for Land Use Planners to Manage the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation – issued by The Department of Infrastructure and Transport National Airports Safeguarding Advisory Group on 26th July 2011.
- 4) Consultation with relevant stakeholders was to be undertaken if necessary but, after discussion with Wind Prospect CWP, this proved to be unnecessary.
- 5) A review and update of Australian and International literature regarding wind farm projects, aviation safety and aircraft safety.
- 6) An assessment of the potential cumulative impact of the construction of approved wind farms in the region using data provided by Wind Prospect CWP.
- 7) Based on the above, determine the requirements for obstacle marking and / or aviation safety lights at the proposed Crudine Ridge Wind Farm was determined and is reported later within this document.

3.2 ASSUMPTIONS, LIMITATIONS & EXCLUSIONS

No specific assumptions, limitations and exclusions exist.

The information and any assessments contained within are based on the information provided by Wind Prospect CWP, observations made during a visit to the proposed Crudine Ridge Wind Farm site and independent research.

3.3 OVERVIEW OF PROPOSED WIND FARM

The proposed Crudine Ridge Wind Farm is situated approximately 50 km south of Mudgee and 45 km north of Bathurst, New South Wales (NSW). The ridge line is of moderate-to-high elevation (890 m to 1,000 m above sea level, Australian Height Datum [AHD]). The nearest locality is Pyramul, which is located approximately 5 km to the North West along Aarons Pass and Pyramul roads.

The area concerned is a mix of heavily wooded areas, including on the ridge itself, and open properties largely used for sheep and cattle grazing with very little evidence of crop farming.



Typical terrain in the Crudine Ridge area.

The Project will comprise one of two potential design layouts; one consisting of up to 106 wind turbines and the other up to 77 wind turbines and ancillary structures, both spread over 17 different properties within the project site in the Pyramul area between Mudgee and Bathurst, with a maximum blade tip height of 160 m.

One or a combination of these layouts will be used in the construction of the project, to be determined following final turbine selection post-consent.

Consideration is also given to a 100 m micro-siting allowance and 5 m turbine height allowance, to accommodate post-consent layout changes and turbine selection.

The project will have an installed capacity of approximately 165 MW, which is dependent on the turbine model and layout selected, and in addition to the wind turbines will consist of the following associated infrastructure:

- Six metre access tracks, passing bays and hardstand areas suitable for cranes;
- Overhead and underground electrical cabling;
- Substations (a main collector substation on site, and if necessary, a switching substation near to the point of connection);
- Wind measuring masts;
- Storage compounds; and,
- Operations buildings.

In addition, an external overhead electrical interconnection lines (up to 132 kV double circuit) and associated communications cables will be installed between the main collector substation and the switching station.

The project will connect to the TransGrid 132 kV overhead transmission line 15 km east of the Crudine ridgeline.

Turbine Rotor

The turbines used for the project will be three-bladed, semi-variable speed, pitch regulated machines with rotor diameters between 74 and 126 m and a swept area of 4,300 to 12,470 square metres (m²). Typically turbines of this magnitude begin to generate energy at wind speeds in the order of 3.5 metres per second (m/s) (12.6 kilometres per hour [kph]) and shut down (for safety reasons) in wind speeds greater than 25 m/s (90 kph). Wind turbine blades are typically made from glass fibre reinforced with epoxy or plastic attached to a steel hub, and include lightning rods for the entire length of the blade. The blades typically rotate at about 12 revolutions per minute (rpm) at low wind speeds and up to 18 rpm at higher wind speeds.

Towers

The supporting structure is comprised of a reducing cylindrical steel tower fitted with an internal ladder or lift. The largest tower height under consideration is 101.5 m with an approximate diameter at the base of 4.5 m and 2.5 m at the top. However, it is important to note that the rotor diameter suitable for this wind turbine model is 101 m and, therefore, would fall within the maximum proposed blade tip height of 160 m. Similarly, the longest blade length under consideration is 63 m but it is important to note that the tower height suitable for this wind turbine is 94 m and, therefore, also falls within the maximum proposed blade tip height of 160 m. Alternative tower heights between 80 and 100 m are also under consideration but this is not exhaustive since new models and certified designs are continuing entering the market place. The tower will typically be manufactured and transported to site in three to five sections for on-site assembly.

Blade Tip

The blade tip will comprise the highest point of the wind turbine when in a vertical position. Given the turbines under consideration, a blade tip height of 160 m is considered to be the maximum. As new turbine models are regularly appearing on the market, blade tip height may vary by up to 5 m to accommodate potential changes to tower heights and blade lengths of new machines.

Monitoring Masts

There are currently two temporary wind monitoring masts installed, one 60 m mast located in the Pyramul Cluster and one 100 m mast located in the Sallys Flat Cluster, recording wind data for the project development and planning.

Up to six permanent wind monitoring masts, up to 100 m high, are proposed to be installed on-site. Locations for these masts are yet to be determined and will be influenced by the final wind turbine selection, but may include the installations of the existing temporary monitoring masts. These permanent masts will provide information for the performance monitoring of the wind turbines. The wind monitoring masts would be of a guyed, narrow lattice or tubular steel design. The image below shows both typical tubular and lattice wind monitoring mast designs.



Examples of Tubular (left) and lattice (right) wind monitoring masts.

Overhead and Underground Cables

The electrical cables from the Pyramul and Sallys Flat Clusters will comprise a mix of underground or overground cabling. Only the overground cabling is of potential interest to aviation operations.

Where feasible, an internal overhead transmission line will be used to export power from the Sallys Flat Cluster to the main collector substation. The image below shows a typical overhead line construction that could be implemented in this project.



Typical Double-circuit overhead 33 kV power line.

A double circuit 66 kV interconnection overhead transmission line may be constructed for connection between a secondary collector substation and the main collector substation. This transmission line will be up to 25 m in height comprising of two cross arms with insulators with an average span length of 200 m.

A single or double circuit 132 kV transmission line will be constructed for energy export into the grid. The 132 kV overhead transmission line will be up to 30 m in height comprising of two cross arms with insulators with an average span length of 250 m.

The location of the proposed wind farm is shown in Appendix 6.1, being an excerpt from the World Aeronautical Chart (WAC 3456 - SYDNEY).

Appendix 6.2 shows the Crudine Ridge Wind Farm Project Design with the two layouts as proposed at this stage.

3.4 SPECIFIC ISSUES

3.4.1 Airfields in the vicinity of the proposed Wind Farm.

Registered and / or Certified Aerodromes.

Bathurst Aerodrome.

The nearest Registered or Certified aerodrome is **Bathurst Aerodrome**, a Certified aerodrome which is approximately 45 km to the south of the most southern edge of the proposed Crudine Ridge Wind Farm site. This aerodrome is sufficiently far away from the proposed wind farm site such that obstacle limitation surfaces for this aerodrome would not be penetrated by any wind turbine proposed for the Crudine Ridge Wind Farm. Further, an assessment of GPS arrival procedures and NDB and RNAV (GNSS) arrival and missed approach procedures has indicated that the existence of the wind farm would not impact on those procedures in any way. (See Section 5 for list of Abbreviations used in this report.)

Mudgee Aerodrome.

The next nearest Registered or Certified aerodrome is **Mudgee Aerodrome**, a Certified aerodrome which is approximately 50 km to the north of the most northern edge of the proposed Crudine Ridge Wind Farm site. This aerodrome is sufficiently far away from the proposed wind farm site such that obstacle limitation surfaces for this aerodrome would not be penetrated by any wind turbine proposed for the Crudine Ridge Wind Farm. An assessment of GPS arrival procedures and associated missed approach procedures has indicated that the existence of the wind farm will not affect any instrument sector or circling altitude, nor any instrument approach or departure procedures at Mudgee aerodrome. Earlier advice (see Appendix 6.4) indicated to the contrary but this was subsequently reconsidered by Airservices Australia.

Other aerodromes and / or airfields.

A comprehensive search of all available documentation on airfields (including the En Route Supplement Australia [ERSA], the Aircraft Owners and Pilots Association [AOPA] National Airfield Directory and FlightAce[®] Country Airstrip Guide) identified the following airstrips in the vicinity of the proposed Crudine Ridge Wind Farm site.

These aerodromes / airfields have been listed in approximate order of distance from the proposed Crudine Ridge Wind Farm site.

Dabee Station.

Dabee Station is a private unlicensed airfield owned by the Fernside Pastoral Company.

The airfield is situated approximately 34 km east of the northern edge of the proposed Crudine Ridge Wind Farm site and approximately 20 km east of the existing high tension power lines into which the electrical output from the Crudine Ridge Wind Farm will be connected.

The airfield has two unsealed grass strips of 900 m and 1,100 m length oriented 09-27 and 15-33 respectively. Permission is required prior to use.

Operations from this airfield will not be affected by the presence of the Crudine Ridge Wind Farm.

Rylstone Aerodrome.

This aerodrome is unlicensed; the owner / operator being Rylstone Air Park.

The aerodrome is situated approximately 35 km east of the northern edge of the proposed Crudine Ridge Wind Farm site and approximately 20 km east of the existing high tension power lines into which the electrical output from the Crudine Ridge Wind Farm will be connected.

The airfield has two unsealed grass/dirt strips of 750 m length oriented 09-27 and 17-35. Permission is required prior to use.

Operations from this aerodrome are largely private. There is a microlight (gyroplane) club operating from this aerodrome.



Microlight (gyrocopters) and Clubhouse at Rylstone Aerodrome.

Operations from this airfield will not be affected by the presence of the Crudine Ridge Wind Farm.

Capertee (Bernina) and Capertee (Longridge).

These airstrips are situated approximately 36 km and 42 km south east of the Crudine Ridge Wind Farm site. Both strips are no longer maintained and are considered closed.

The only other aerodromes / airstrips identified anywhere near the proposed Crudine Ridge Wind Farm site are: -

Amyville – an unlicensed private airfield, approximately 54 km to the northwest.

Orange – a Certified Aerodrome, approximately 54 km to the southwest.

Molong – an unlicensed private airstrip, approximately 65 km to the west.

Gamboola Station - an unlicensed private airfield, approximately 69 km to the northwest.

Catombal - an unlicensed private airfield, approximately 76 km to the northwest.

Yeoval (Fairview) - an unlicensed private airfield, approximately 79 km to the northwest.

Operations from these airfields will not be affected by the presence of the Crudine Ridge Wind Farm.

In addition to the above, during the physical inspection of the site a property was identified on the eastern side of the Turondale - Crudine Road on the south eastern edge of the proposed wind farm construction area with the entrance gate identifying an “**Air Strip**”. See photos below.



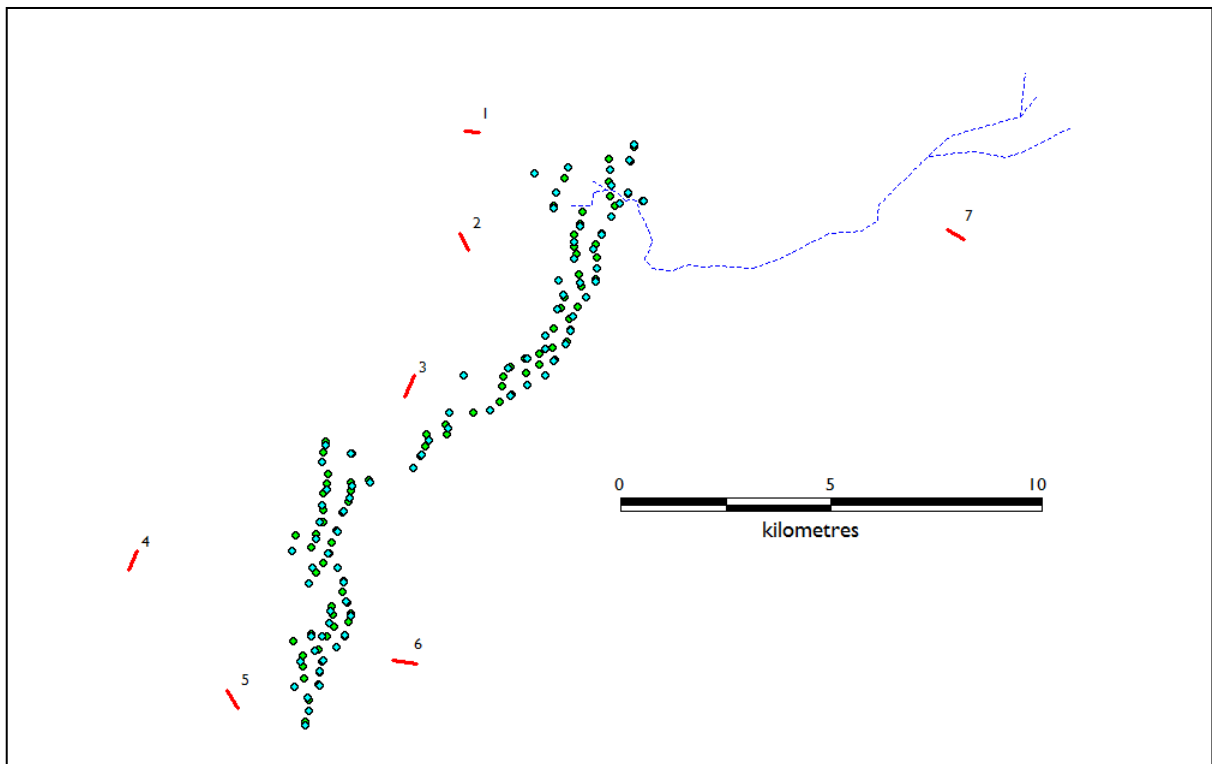
Property entrance gate.



Sign on gate.

Despite a comprehensive external visual search of the property concerned, no evidence could be found of any airstrip in the vicinity or any signs of wind socks. Further, an extensive search of current Google Earth maps showed no evidence of such an airstrip. It is considered that, if indeed such an airstrip exists, it would be for private ad hoc use only and operations from such an airstrip would not be affected by the presence of the Crudine Ridge Wind Farm, provided the presence of the wind farm was clearly published on aviation charts.

Subsequent to the physical inspection, a review of topographical maps of the project identified seven marked landing grounds and orientation as will be seen from the following figure.



Identified airstrips within the vicinity of the proposed Crudine Ridge Wind Farm.

The airstrip identified as No 6 is assessed as that on the property as identified above. It is estimated that the nearest wind turbine in the landing and take off direction of that strip would be approximately 1.3 km distant and, as such, operations from that airstrip would not be affected. This judgement has been made using the “Guidelines for Aeroplane Landing Areas” expressed in the Civil Aviation Advisory Publication (CAAP) No. 92 – 1(1) of July 1992.

All the other airstrips identified are potentially less affected by the presence of the wind farm using the same guidelines as the basis of that assessment. All are further away from the wind farm by comparison. Again, it is essential that the presence of the wind farm be clearly published on aviation charts in due course.

Apart from the above mentioned airstrips and aerodromes, HART Aviation found no evidence of any other airfield or airstrip within the confines of the proposed Crudine Ridge Wind Farm, or on the fringes of a wind farm.

3.4.2 Aviation operations – general.

Overflying air routes.

The following defined air routes have been identified as overflying in the vicinity of the Crudine Ridge Wind Farm: -

V 295 – Sydney to Dubbo. Lowest Safe Altitude (LSALT) established is 5,600 ft.

W 731 – Katoomba to Dubbo. LSALT established is 5,600 ft.

W 575 – Bathurst to Mudgee. LSALT established is 5,600 ft.

W 604 – Katoomba to Mudgee. LSALT established is 5,500 and 5,600 depending on the particular route segment.

The Civil Aviation Regulations require that, unless it is necessary for takeoff and landing, an instrument flight rules (IFR) or a Night VFR aircraft must not be flown at a height less than 1,000 ft above the

highest obstacle within a 10 nm radius of the aircraft in flight. This defines the Lowest Safe Altitude (LSALT) for any such operation and is relevant to that LSALT quoted for the above-mentioned routes.

The highest wind turbine proposed for the Crudine Ridge Wind Farm is 1,160 m (3,806 ft) AHD. This would mean that the presence of the wind farm will have no effect on the overflying air routes.

It should be noted that any aviation operations from those smaller aerodromes / airstrips identified as in the vicinity of the proposed Crudine Ridge Wind Farm site would all be under visual flight rules (VFR). Night operations and IFR operations will occur from Mudgee, Bathurst and Orange Aerodromes but these aerodromes are too far away for such operations to be adversely affected by the presence of the proposed Crudine Ridge Wind Farm.

It should be further noted that under the Civil Aviation Regulations, VFR operations, except during take off and landing, are required to maintain a minimum height above ground level (AGL) of 500 ft outside of built up areas and 1,000 ft over built up areas. In this respect, wind turbines higher than 500 ft AGL (i.e. ~ 152 m) need to be specially considered. This matter is addressed later in Section 3.4.5 a).

3.4.3 High voltage transmission lines.

An assessment of the proposed Crudine Ridge Wind Farm site identified the presence of 132 kV high voltage transmission lines running northwest – southeast about 15 km east of the proposed site. These are clearly shown in Appendices 6.1 and 6.2. It is understood that it is these lines which will be used to accept the output from the Crudine Ridge Wind Farm. Since these transmission lines are already appropriately identified on aviation charts they do not present any increased risk to aviation operations as a direct result of the establishment of the Crudine Ridge Wind Farm.

As noted in Section 3.3 above, transmission lines up to 25 m in height will be included within the wind farm complex for the transfer of electricity. Further, a single or double circuit 132 kV transmission line will be constructed for energy export into the grid. This latter line will be up to 30 m in height. With the possible exception of special low level operations (such as for aerial agricultural purposes – see Section 3.4.7 later) the presence of these lines will have no adverse effect on any aircraft operations that might occur in the area.

Prima facie, there is also no need to report the presence of these lines under current requirements. However, bearing in mind the Crudine Ridge Wind Farm will be within the Danger Area 538A (Williamstown Military Flying Training) it would be advisable to inform the Department of Defence in this respect, regardless. See also comments in Section 3.4.5 c) later.

It should be noted that some electricity providers use helicopters for live line maintenance and insulator washing and this possibility may arise for those power lines proposed to be installed associated with the proposed Crudine Ridge Wind Farm development.

For such operations the minimum clearance usually required when working between circuits is 25 m from the outside wire of one circuit to the outside wire of another circuit. This advice is based on operator experience when positioning a helicopter safely between circuits with the lines energised. It would seem appropriate for these requirements to be recognised during the design of the power line structures associated with the proposed Crudine Ridge Wind Farm.

Whilst it is understood that there is no formally established minimum setback for the wind turbines from the power lines, it would seem wise to adopt a setback figure in excess of the maximum wind turbine height to blade tips (say, 10% more) for those wind turbines close to the transmission lines. This would nominally protect against the unlikely worst case scenario should the turbine fall. Prima facie, also, such a set back as suggested above would enable helicopter live line washing operations to be undertaken, but not without the necessary due care, of course.



Washing insulators using a MD 500 helicopter.

3.4.4 Reference towers for meteorological monitoring.

There are currently two temporary wind monitoring masts installed, one 60 m mast located in the Pyramul Cluster and one 100 m mast located in the Sallys Flat Cluster, recording wind data for the project development and planning. The 60 m mast was identified during the familiarisation visit to the site as shown below.



60 m temporary wind monitoring mast as viewed from the Crudine Road.
(Note that it is difficult to see.)

The 100 m mast had not been installed at the time of the site inspection – it was due to be installed during the week of 1st August 2011. However, the location was identified.

As indicated in Section 3.3, up to six permanent wind monitoring masts, up to 100 m high, are proposed to be installed on-site. Locations for these masts are yet to be determined and will be influenced by the final wind turbine selection, but may include the installations of the existing temporary monitoring masts.

As will be observed from the photo above, reference towers can be quite difficult to see. Indeed, the 60 m temporary mast could only be identified in the first instance using binoculars. For this reason, these towers are of particular concern to any local aerial agricultural operators, if indeed there would be in the area concerned as no evidence was found of such during this assessment. Nevertheless, it is very important that advice as to the presence of these towers is readily available.

The heights of the temporary and permanent reference towers are such that these are not required to be reported to the Civil Aviation Safety Authority (CASA) under CASR 139.365, which requires CASA to be informed of structures 110m or more above ground level.

However, the Civil Aviation Advisory Publication (CAAP) 89W-2(0) "Reporting of Tall Structures" refers to Regulations requiring the reporting of tall structures defined as those structures, the top of which is above: -

- 30 m above ground level, that are within 30 km of an aerodrome; and
- 45 m above ground level elsewhere.

Note that the relevant Regulations listed in CAAP 89W-2(0), viz: 89W, X Y & Z, have since been withdrawn yet the CAAP remains active. In this circumstance, the legal basis of the CAAP is perhaps currently in question, even though the advice within, and the reasons for that advice, are sound. On querying CASA, HART Aviation was advised that resolution of this matter is part of a Regulatory update work programme but, since CAAP 89W-2(0) is an advisory document, the priority is unfortunately low. HART Aviation holds the view that the principles of the referenced CAAP should be upheld in the meantime. Refer also to additional comments Section 3.4.5 c) following.

HART Aviation has been advised that Airservices Australia, the Department of Defence, CASA, the Aerial Agriculture Association of Australia (AAAA), the Rural Fire Service, The Department of Heritage and local councils are all notified of such masts prior to installation and, once installed, Wind Prospect CWP engineers complete the online RAAF report for Vertical Obstructions. This is appropriate and commendable.

It should be noted that no evidence could be found of any collisions by aircraft with any wind turbine anywhere in the world. However, there is one recorded case of a collision of an aerial agricultural aircraft with a 197 ft (60 m) wind monitoring mast which occurred in the USA in January 2011. The pilot was killed.

3.4.5 Airspace considerations.

In assessing the potential impact on aviation operations the En Route Charts (ERC), Visual Terminal Charts (VTC), Visual Navigation Charts (VNC) and Terminal Area Charts (TAC) potentially relevant to the area concerned were studied in depth.

In addition, the Designated Airspace Handbook and the relevant World Aeronautical Chart (WAC 3456 SYDNEY) were studied for any issues of concern.

The proposed site for the Crudine Ridge Wind Farm is outside of the Sydney Airport Control Zone, the Richmond and Williamtown Aerodrome Military Control Zones and there are no other nearby control zones which are relevant in this context.

Further, the defined operating height of aircraft on designated routes over the area is such that the presence of the Crudine Ridge Wind Farm would have no effect at all. There are no aircraft traffic control issues nor is there any potential influence on any instrument approach procedures or aeronautical navigation aids.

No Prohibited or Restricted areas have been identified in the area. However, the proposed Crudine Ridge Wind Farm falls within the entire designated Danger Area D 538A set aside for Williamtown Military Flying Training. This is a risk element but probably not a critical issue and the matter is further expanded in Section 3.4.5 c) below.

No active Notices to Airmen (NOTAM), which might impact on the development of the Crudine Ridge Wind Farm were found.

HART Aviation is also of the view that the presence of the Crudine Ridge Wind Farm would be very unlikely to impact on any radar or communication links within the vicinity.

Although, with the exception of Danger Area D 538A (addressed later), no issues of concern were discovered, it is considered that there is still a continued need for consultation with CASA, Airservices and the Department of Defence and it is clear that some has already occurred. Particular comments on this follow.

a) CASA.

CASA has already been advised of the proposed Crudine Ridge Wind Farm and a copy of its response is at Appendix 6.3.

As will be seen, CASA has indicated that it has no specific authority for the obstacle marking and lighting of tall structures, including wind farms, located away from aerodromes. However, CASA has recommended that owners of structures have a duty of care to aviators and should undertake an assessment of the hazards to aviation because of the proposed development and also consult Airservices Australia and the Aerial Agricultural Association of Australia as part of the process. HART Aviation considers that Wind Prospect CWP had met its duty of care in the above respects as demonstrated by the comments within this report.

It is noted in CASA's response that reference is made to the fact that "aircraft are generally permitted to fly as low as 500 ft (152 m) above ground level, and certain operations are permitted to fly below this height." It is noted that the wind turbines proposed for use in the Crudine Ridge Wind Farm will possibly be up to 160 m in height and CASA has indicated that "this height could be a hazard to aircraft traversing the area" and recommends "that the proponent takes this into consideration when assessing their duty of care in deciding whether or not the wind farm should be obstacle lit or otherwise marked".

HART Aviation holds a similar view to that of CASA.

Whilst it is considered that the overall risk to aviation operations in the vicinity of the proposed Crudine Ridge Wind Farm is low, there are two areas where the risk to aviation operations is slightly higher than normal; viz:

- The nominal maximum turbine tip height is such that the wind turbines would extend into navigable airspace by some 25 ft; and
- Low level military jet operations may occur in the region;
 - This issue is addressed further in Section 3.4.5 c) below.

The proposed (nominal) maximum tip height for the wind turbines in the Crudine Ridge Wind Farm is 160 m (~525 ft) above ground level (AGL) i.e. more than 500 ft AGL. As such, the wind turbines would extend into navigable airspace if this maximum tip height is constructed. Note that in Section 3.3 it is noted that consideration is also given to a 100 m micro-siting allowance and 5 m turbine height allowance, to accommodate post-consent layout changes and turbine selection. This means that the maximum tip height could be up to 165 m.

What is meant by "**navigable airspace**"?

Under the Civil Aviation Regulations, aircraft undertaking VFR operations, except during take off and landing, are required to maintain a minimum height above ground level (AGL) of 500 ft outside of built up areas and 1,000 ft over built up areas. Any aircraft undertaking VFR operations outside controlled airspace is, therefore, legally entitled to operate as low as 500 feet above ground level (AGL).

The Civil Aviation Regulations further require that, unless it is necessary for takeoff and landing, an instrument flight rules (IFR) or a Night VFR aircraft operation must not be flown at a height less than 1,000 ft above the highest obstacle within a 10 nm radius of the aircraft in flight. This defines the Lowest Safe Altitude (LSALT) for any such operation which, by definition, would be higher than any wind turbine in the proposed Crudine Ridge Wind Farm development.

In principle, therefore, this defines "navigable airspace".

As mentioned, the proposed maximum tip height of the wind turbines within the proposed Crudine Ridge Wind Farm is 160 m (i.e. ~525 ft). Consequently, the risk profile for aviation operations would increase, albeit only slightly. This latter view is based on the fact that, as previously mentioned, with the exception of possible low level military jet operations, only limited civil aircraft operations are likely to occur in the vicinity of the proposed wind farm.

Nevertheless, the risk would be higher, principally because obstacles above 500 ft (~152 metres) start to penetrate navigable airspace and some aircraft operations can potentially occur in the vicinity of the wind farm. For this reason, HART Aviation is of the view that such obstacles could be adjudged as a hazard to aviation and require obstacle lighting to be installed and activated in low visibility and night conditions.

It is further considered that the installation of such obstacle lights should conform with the CASA Manual of Standards Part 139, paragraph 9.4.3A – a copy of which is attached to the CASA letter at Appendix 6.3.

It will be seen that the CASA requirements for obstacle lighting of wind farms are closely aligned to the Recommendations of the International Civil Aviation Organisation (ICAO) as detailed in Annex 14. A copy of the relevant excerpt is at Appendix 6.9 of this report.

b) Airservices Australia.

Whilst Airservices Australia works closely with CASA in respect of airspace considerations and other matters, there is value in advising them separately both in respect of the proposed Wind Farm development and the temporary reference towers. Sometimes Airservices Australia chooses, in consultation with CASA, to issue a Notice to Airmen (NOTAM) advising of associated hazards. There is also a close link between Airservices AIS and the RAAF AIS.

As indicated earlier, HART Aviation undertook a search of the Airservices Australia web site and did not discover any NOTAMs relevant to the site.

It is clear that there have already been significant exchanges of correspondence between Airservices Australia and Wind Prospect CWP regarding the proposed Crudine Ridge Wind Farm development – a copy of the principal elements of which are included at Appendix 6.4.

Airservices Australia has confirmed that the proposed Crudine Ridge Wind Farm will not impact on the performance of Precision and Non-Precision Navigational Aids, HF / VHF Communications, A-Surface Movement Guidance and Control Systems (SMGCS), Radar, Precision Runway Monitoring (PRM) or Satellite / Links.

In addition, Airservices Australia has confirmed that the proposed wind farm will not affect any instrument sector or circling altitude, nor any instrument approach or departure procedures at Mudgee, Bathurst or Orange Aerodromes. This recent advice is contrary to that previously advised after closer consideration of the matter by Airservices Australia. See Appendix 6.4.

c) Department of Defence & RAAF AIS.

Among other things, the RAAF Aeronautical Information Service (AIS) issues aviation charts defining low level operational routes used by the RAAF aircraft. These often cover low level jet aircraft operations.

HART Aviation has noted that Wind Prospect CWP has already been in communication with the Department of Defence in respect of the proposed establishment of the Crudine Ridge Wind Farm and its response is at Appendix 6.5.

The Department of Defence has indicated that “the proposed development will be outside any areas affected by Defence (Areas Control) Regulations (DCAR)”. There is, therefore, little concern in this respect.

Certainly, HART Aviation has not identified any adverse effects on primary radar (civil or military) or secondary surveillance radar which would arise as a result of the establishment of the Crudine Ridge Wind Farm.

However, the Department of Defence has confirmed the location of the wind farm will be sited wholly within Danger Area D538A, which is used for Williamstown Military Flying Training. This Danger Area was previously mentioned in Section 3.4.5 discovered during the HART Aviation independent assessment.

Danger Area D538A is not always active. When it becomes active, the aviation fraternity is advised via an Airservices Australia issued NOTAM, the operational details being provided by the Department of Defence. The vertical limits of this Danger Area are from surface to 7,500 ft – hence low level flying is potentially involved. The existence of this Danger Area does not preclude the construction of the Crudine Ridge Wind Farm, but it is essential that the details of the positions and heights of each wind turbine within the wind farm, and the wind monitoring masts (both temporary and permanent) are advised to the Department of Defence so appropriate flight planning can be made to avoid these. The Department of Defence has emphasised this in its response.

Consequently, HART Aviation is of the view that there will be no adverse Defence-related operational issues which will impact adversely on the development of the Crudine Ridge Wind Farm.

Note that it is the RAAF AIS which keeps and manages a central aeronautical data base of tall structures, including those reported in accordance with the requirements detailed within the CAAP 89W-2(0), mentioned in Section 3.4.4 above. This data base is made available for use by other mapping agencies and the RAAF AIS liaises closely with Airservices' AIS in this respect.

3.4.6 Aerial fire fighting activities

Some concern is often raised about the potential adverse impact on the possible need for aerial fire fighting services, should such be needed in the vicinity of wind farms.

Aerial fire fighting activities can be separated into two elements – those using helicopters and those using fixed wing aircraft.

HART Aviation is of the opinion that any operations of fixed wing aircraft for fire fighting purposes within the confines of the proposed Crudine Ridge Wind Farm would be hazardous and are not recommended. This is a position held in respect of all wind farms. Indeed, the area on which the Crudine Ridge Wind Farm is planned to be located has few open spaces making it not conducive to fixed wing aircraft operations anyway.

The operation of helicopters within the confines of the Crudine Ridge Wind Farm is perhaps possible.

It is also possible that aerial fire fighting could be undertaken above the level of the wind turbines (i.e., above 500 ft), but dropping water or retardant from this height would reduce the fire fighting effectiveness. This is a matter for the expert fire fighting operators to assess.

The position in respect of the proposed Crudine Ridge Wind Farm is no different from any other wind farm.

Helicopter or fixed wing aircraft operations within the confines of any wind farm and below the top of the wind turbines are potentially hazardous and not recommended.

3.4.7 Aerial agricultural operations

As indicated earlier, the area concerned is a mix of heavily wooded areas, including on the ridge itself, and open properties largely used for sheep and cattle grazing with very little evidence crop farming.

HART Aviation considers that the likelihood of any aerial agricultural operations occurring in this region is remote, but such cannot be completely discounted.

Whilst it is not unusual for temporary aerial agricultural airstrips to appear overnight and be established on existing farm land, it was observed that there are only limited available flat areas suitable for such temporary airstrips and little if any apparent need for aerial agricultural operations in the area.

The Aerial Agricultural Association of Australia (AAAA) holds the view that wind farms and their pre-construction wind monitoring towers are a direct threat to aviation safety and especially aerial application. A copy of the AAAA policy with respect to wind farms is attached at Appendix 6.6.

It should be noted that aerial application includes not only spraying but also seeding and the spreading of fertilisers.

From the perspective of the AAAA, there are two quite distinct issues arising from Wind Farms that affect aerial application: -

- safety of the aircraft and pilot; and
- economic impact on aerial applications.

Aerial agricultural operations generally occur between 20 – 30 m from the ground. There is no doubt, therefore, that any objects that penetrate the airspace above 20 – 30 m will impact on aerial agricultural operations and will need to be taken into account in planning to undertake such operations.

HART Aviation agrees that the presence of wind turbines will adversely impact the ability of aerial agricultural operators to safely undertake aerial spraying, seeding or fertilising within the confines of a wind farm. As it is for fire fighting activities, this position in respect of the proposed Crudine Ridge Wind Farm is no different from that for any other wind farm.

However, the safety issue can be addressed by “seeing and avoiding” the wind turbines or, preferably in HART Aviation’s view, not undertaking any aerial agricultural operations within the confines of a wind farm and amongst the wind turbines. The latter action would address any concerns with respect to the safety of the operation. It needs to be recognised, though, that any aerial agricultural operations undertaken within the confines of a wind farm would be constrained to ensure avoidance of the wind turbines and any cessation of any such operations would have the potential to decrease the productivity of, not only the agricultural operator, but also the land owner. A cessation of any aerial agricultural spraying, seeding or fertilising would mean the land owner would need to resort to such action by ground operational modes, which no doubt could be as effective but probably be more time consuming and perhaps even more expensive. It will certainly reduce the revenue for the aerial agricultural operators and, in HART Aviation’s view this is a prime reason for the AAAA’s opposition to wind farms in general – the issues being largely “commercial” as opposed to “safety” per se.

In summary, aerial spraying, seeding or fertilising operations be they by helicopter or fixed wing aircraft, within the confines of any wind farm and below the top of the wind turbines are potentially hazardous and not recommended. In any event, such operations within the precincts of the Crudine Ridge Wind Farm development are considered unlikely to be an issue.

3.4.8 Rural air ambulance services

It has been suggested that the presence of wind farms may impact on the ability for rural air ambulance services to operate in the region.

Certainly, the existence of wind turbines has the potential to limit the flexibility of operations of helicopter ambulance services within the confines of a wind farm and there is little that can be done about that. This is a common factor for all wind farms.

For fixed wing air ambulance operations it is an issue which is not considered relevant to the proposed Crudine Ridge Wind Farm. Such services do not exist within the confines of the proposed wind farm site now and the presence of the wind farm will not change that position. In the event that an air ambulance operation is required, it is probable that Bathurst or Mudgee Aerodromes would be used and the transfer of any patients arranged either via helicopter or road transport to and from there. This option is available now and will not change with the construction of the Crudine Ridge Wind Farm.

3.4.9 Contingency procedures and engine inoperative flight paths

These issues are not considered relevant in respect of the proposed Crudine Ridge Wind Farm.

In the event of an engine failure, aerial agricultural aircraft and any other single engine aircraft would force land in the nearest suitable field. This is standard practice.

Helicopters would auto-rotate down to the nearest available field. This is also standard practice.

No twin engine aircraft are likely to be operated in the vicinity of the proposed Crudine Ridge Wind Farm site at all.

In the event of an engine failure occurring to any twin engine aircraft which operate to and from, such as, Bathurst or Mudgee Aerodromes, a return to the particular aerodrome would be the most likely action. The presence of the Crudine Ridge Wind Farm would not place any constraints on such operations.

3.4.10 Wind Farm layout issues

a) Effect of variable wind turbine positions

HART Aviation has noted that Wind Prospect CWP is considering at least two alternatives for the position of wind turbines within the confines of the proposed Crudine Ridge Wind Farm site. See Appendix 6.2.

HART Aviation is of the view that the actual positions of the wind turbines within the proposed Crudine Ridge Wind Farm site boundaries will have little, if any, effect on the low risk profile associated with aviation operations in the vicinity.

b) Cumulative impact of Wind Farms in region

There is a proposed Ungula Wind Farm to be developed north of the Crudine Ridge Wind Farm site between the townships of Mudgee and Wellington. See Appendix 6.7.

The Ungula Wind Farm is a larger development, believed to be for up to 330 wind turbines.

Whilst clearly the Ungula Wind Farm needs to be assessed in its own right from an aviation risk perspective to ensure that no special aspects are present, HART Aviation is of the view that the cumulative effect of the presence of Ungula Wind Farm and the Crudine Ridge Wind Farm would have little, if any, effect on the overall risk profile to aviation operations in the area concerned. The Ungula Wind farm is sufficiently remote from the Crudine Ridge Wind Farm site for its existence to be irrelevant in the context of the aviation risks.

Prima facie, it is considered likely that the Ungula Wind Farm has a greater potential for impact on operations from Mudgee Aerodrome and, perhaps Wellington and Gulgong Airstrips also. However, these are matters which can be considered in isolation from the Crudine Ridge Wind Farm assessment.

Whilst the two wind farms are some 40 km apart, there is a possibility that the very large number of wind turbines (estimated as 450+) which may very well end up being present in the wider area may very well have the reverse effect.

It is an essential risk mitigation requirement that all wind farms be identified on all aeronautical maps. The very size of the overall development in the area may very well increase the overall awareness of the presence of the wind farms / wind turbines reducing the risk of operators not knowing of the existence of the developments.

3.4.11 Comment on current State and National guidelines

In the context of this study, HART Aviation considered the implications of existing State and National guidelines, in particular the following: -

a) *Auswind (2006) Best Practice Guidelines for Implementation of Wind Energy Projects to Australia.*

These are considered excellent, quite comprehensive general planning guidelines.

The clauses relevant to aviation are quoted below, with associated comments.

3.1.2.7 Aircraft safety

Proponents should assess potential for aircraft safety issues by noting the proximity of the site to any major airports, aerodromes or landing strips. Proponents should contact the Civil Aviation Safety Authority (CASA), Air Services Australia and the authorities responsible for the operation of such facilities in the vicinity of the proposed site. Advice should be sought on contacting agricultural aviators who may operate in the area.

In addition, proponents should obtain advice from landowners on any farming related uses of aircraft such as aerial spraying or mustering. In such cases, the district aerodrome supervisor should be contacted for advice on the potential impact of a wind energy development on these activities.

3.1.2.8 Restricted areas

Research should be carried out to determine whether any restrictions may apply to the development of a wind farm in the proximity of security areas, such as military installations and telecommunications installations.

This is good general advice and is endorsed. An associated Appendix 5 deals in more depth with Aircraft Safety issues, which are largely replicated within this report. HART Aviation has no fundamental disagreement with the above principles and those within the referenced Appendix 5. However, elements of the Appendix 5 are subject to change as CASA establishes its formal policy in respect of Wind Farms and the need or otherwise for obstacle lighting.

3.2.1.4 Other agencies

The Royal Australian Air Force (RAAF) maintains a database of tall structures for structures over 20 metres in height. Proponents should provide the Royal Australian Air Force Aeronautical Information Service with the timing, description and location details of any monitoring masts exceeding 20 metres.

Structures such as wind monitoring masts in the vicinity of an airfield or flight area may cause a safety hazard. It is recommended that the proponent contact the Civil Aviation Safety Authority (CASA) to maximise aircraft safety. Where structures exceed 110 metres above ground level, proponents are required to consult with CASA irrespective of location. The proponent should consult with CASA again once the wind farm design details are finalised. Further discussion of CASA consulting requirements is provided in ► Appendix 5. Air Services Australia also undertake assessments, often following referral from CASA, and require specific details from proponents to conduct those assessments. Proponents should contact Air Services Australia for further information www.airservicesaustralia.com.

Consultation should continue with the rural fire service, both regional and local, throughout the feasibility stage to work towards agreed fire response actions and keep the group informed of proposed locations for the wind development. Further discussion regarding consultation with the rural fire service is contained in ► Appendix 10.

The above is consistent with the HART Aviation advice within this report.

b) National Wind Farm Development Guidelines (Draft) - July 2010.

These quite comprehensive guidelines (208 pages) place considerable emphasis on the planning processes and have much detail on specific environmental and ecological issues.

The area covering aircraft safety (copied below) will be seen as rather shallow.

3.7 Aircraft safety

The issue

Wind farms inherently involve the construction of tall structures (towers plus blades) that have potential to impact on the safety of low flying commercial, private and defence aircraft. In this respect, wind farms are similar to tall buildings, communications towers and other tall engineered structures. They differ by virtue that they are generally located in areas remote from other tall structures, and are generally deployed along ridgelines (further exacerbating the potential impacts) and they involve components moving through shared airspace. Thus, the primary impact of a wind farm is the potential safety risk it may pose to aircraft operating at low levels (below 350 metres above ground level) in vicinity of the wind farm.

The movement of the turbine blades and the materials and size of the turbines may also interfere with radio communications and aircraft and meteorological radar. These potential impacts would need to be considered when selecting a site and in designing a layout for the site.

The reference to aircraft operating at low levels (below 350 metres above ground level) is noted. As indicated elsewhere in this report, outside of built up areas, aircraft can legally operate down as low as 152 m (i.e., 500 ft) AGL.

Guidance notes

The physical intrusion of towers and blades into the airspace used by aircraft is addressed by the Civil Aviation Safety Authority (CASA) guidelines, which are currently under review. The CASA guidelines, once finalised, may indicate that night lighting should be installed on some or all turbines within the wind farm. This, in turn, may pose a visual impact that will need to be considered in the landscape assessment and in the birds and bats assessment. The proponent should also ensure that key aviation bodies are consulted with during the planning and development of the project, particularly CASA, Air Services Australia and the Department of Defence.

Aircraft safety related assessments are particularly important where major airports, aerodromes or landing strips are nearby, or if farmers in the area utilise aircraft for crop-dusting, mustering or other purposes. There is also a need to ensure that structures are reported so that they may be depicted on aeronautical charts. CASA Advisory Circular AC 139-08(0) - *Reporting of Tall Structures* provides details of when and how this is to be done.

The above mentioned authorities should be contacted in the project feasibility stage.

The potential to affect radio communications and radar services is addressed as part of the assessment of electromagnetic interference (see Section 3.6). Section 4 and Appendices C and G show at what stage during the planning process aircraft safety (including night lighting) should be addressed.

HART Aviation has no disagreement with the guidance notes above. The need for consultation with the relevant parties is clear. This is consistent with the HART Aviation advice within this report.

c) Draft Guidelines for Land Use Planners to Manage the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation – issued by The Department of Infrastructure and Transport National Airports Safeguarding Advisory Group on 26th July 2011.

Before commenting on the above guidelines it is thought necessary to summarise the background to the current regulatory position in Australia and to the development of these guidelines.

The Civil Aviation Safety Authority (CASA) powers in respect of the control of obstacles in and around aerodromes flow from the Civil Aviation Regulations 1988 (CAR), Part 9, Subpart 95, which provides for the marking or removal of hazardous objects within the obstacle limitation surfaces (OLS) of any aerodrome.

Civil Aviation Safety Regulation 1998 (CASR) Subpart 139.E covers the specific definitions of hazardous objects and the reporting requirements.

In summary, CASR 139.E requires: -

1. Aerodrome operators to monitor the surrounding airspace for any object that might infringe the OLS and to notify CASA;
2. Any person who proposes to construct any structure which will be 110 m or more AGL to inform CASA; and
3. CASA may determine whether the proposed structure(s) will be a hazardous object because of its location, height or lack of marking or lighting.

Detailed aerodrome design requirements are within the CASA Manual of Standards Part 139 – Aerodromes. Chapter 7 covers the detailed requirements for Obstacle Restriction and Limitation.

In support of the above regulations, CASA issued two Advisory Circulars; viz:

- AC 139-08(0) “Reporting of Tall Structures” April 2005; and
- AC 139-18(0) “Obstacle Marking and Lighting of Wind Farms” December 2005.

There is no doubt that CASA has the necessary regulatory powers to control the marking and removal of hazardous objects in and around aerodromes and for the reporting of tall structures. However, there is some question as to CASA’s powers to insist on marking and / or lighting of obstacles outside the immediate area of an aerodrome. Further, the approach by CASA expressed within the AC 139-18(0) raised concerns amongst the Wind Farm industry. This was particularly raised in those cases where independent expert aviation advice recommended that marking and lighting was not needed because of low risks, yet CASA recommended to the contrary and noted that failure to follow the CASA advice would mean that the proponent of the Wind Farm would be “responsible for creating the hazard to aircraft safety and may be liable for their actions”.

As a consequence, in mid 2008, CASA withdrew Advisory Circular AC139-18(0) and initiated an internal review process to look at how Wind Farms located near aerodromes are assessed and regulated. CASA selected a consultant to undertake this review, which was initiated in late July 2009. The aims were to undertake an appropriate safety study into the risk to aviation posed by wind farms and for the outcome of that study to be used as a basis for developing a new set of guidelines. This review process is understood to have included appropriate consultation with the aviation industry and other stakeholders. Further, the review was to look at all obstacles, including wind turbines and included a review of the latest regulatory position amongst other authorities throughout the world, including the UK CAA, EASA, USA FAA, Transport Canada and CAA NZ. The ICAO position was also to be part of considerations.

HART Aviation understands that the CASA review was completed in late 2009, but the outcome was withheld pending the issue of the Australian Government’s National Aviation Policy White Paper. This White Paper was released on 16th December 2009 but nothing further was immediately forthcoming.

Instead, in July 2006 CASA established a rule change Project AS 06/07 titled “Assessment of windfarms and plumes”, subsequently changed in August 2006 to “Assessment of obstacles including wind turbines and exhaust plumes”. The only apparent outcome from this Project was a change to the Manual of Standards MOS 139 to include a reference that any obstacle lights for wind farms should conform with paragraph 9.4.3A – previously mentioned and a copy of which is attached at Appendix 6.3.

Project AS 06/07 was officially closed by CASA on 1st March 2011, indicating that it had been "overtaken by events" and referring to the fact that the Department of Infrastructure and Transport (the policy-making Department overseeing the functions of CASA) was addressing the impact of wind farms on aviation which they raised in the paper "Safeguards for Airports and the Communities around them". Following this, on 26th July 2011, the Department of Infrastructure and Transport issued for comment draft "Guidelines for Land Use Planners to Manage the Risk of Wind Turbines as Physical Obstacles to Air Navigation". A copy of these guidelines is attached at Appendix 6.8.

In reviewing these draft guidelines it is apparent that little new advice is forthcoming. Much of the guidelines are a repeat of the current regulatory position held by CASA in respect to its ability to control obstacles outside the immediate vicinity of an aerodrome. It also confirms the current reporting requirements in respect of obstacles. All of these issues are covered elsewhere in this report.

However, there are certain features within the guidelines which bear emphasising and commenting upon. In particular: -

Background Information Para 21.

21. Aircraft operating en route to and from aerodromes will be unlikely to be at an altitude which would necessitate obstacle lighting, except in the cases of structures which are only marginally clear of aerodrome Obstacle Limitation Surfaces (OLS), laterally or vertically. CASA has a general policy of discouraging tall structures within or close to an aerodrome OLS.

HART Aviation supports this view.

Guidelines Para 17.

17. Experience has shown that the white colour universally adopted for wind turbines installed so far in Australia, satisfies the requirements for daytime visibility.

HART Aviation supports this view.

Guidelines Paras 22 to 24.

22. CASA strongly discourages the siting of wind turbines in the vicinity of an aerodrome, as these tall structures can pose serious hazards to aircraft taking-off and landing .
23. Where a proposed wind turbine has to be located such that it will penetrate the OLS of an aerodrome, and it is determined by CASA that it will require obstacle lighting, the top lights are required to be arranged so as to mark the highest point reached by the rotating blades. The need to mark the highest point is necessary because aircraft conducting the take-off and landing phases of flight will be close to the ground and providing obstacle lights at only approximately 2/3 of the maximum height of the turbine could lead pilots into a false sense of vertical separation.
24. As it is not practicable to install obstacle lights at the tip of the blades, these lights may be located on a separate supporting structure adjacent to the wind turbine, at a height that corresponds to the highest point of the rotating blade of the turbine.

HART Aviation strongly supports these comments.

Guidelines Para 25.

25. CASA can accept the construction of wind turbines or wind farms that are not in the vicinity of an aerodrome, provided they do not pose a hazard to aviation, or where the risk to aircraft safety has been minimised by the provision of approved lighting and/or marking.

HART Aviation agrees that approved lighting and/or marking will reduce the risk hazard to aviation operations where such is deemed necessary.

Guidelines Para 32.

32. Obstacle lights should operate at night, and at times of reduced visibility. All obstacle lights on a wind farm should be turned on simultaneously and off simultaneously.

HART Aviation agrees that where obstacle lights are deemed to be necessary to reduce the risk to aviation operations, then such should not only operate at night but also in cases of reduced visibility.

Guidelines Para 34.

34. Before developing a wind farm, it is common for masts or towers to be erected for anemometers and other meteorological sensing instruments to evaluate the suitability or otherwise of a site. Even where these structures are below the mandatory notification height of 110m, they are difficult to see from the air due to their slender construction and guy wires. This is a particular problem for aerial agriculture. Wind farm proponents are encouraged to take appropriate steps to minimize such hazards, particularly in areas where aerial agriculture is likely to occur.

HART Aviation strongly supports this view. Experience has confirmed that monitoring masts are very difficult to see and it is essential that aviation operators, particularly those within the aerial agriculture industry, are informed of the existence and position of such masts.

Guidelines Para 39.

39. CASA's regulatory regime for obstacle lighting provides an appropriate level of safety for normal aircraft operations. Certain flying operations, by their nature, involve lower than normal flying, for example aerial agricultural spraying, aerial mustering, power line inspection, helicopter operations including search and rescue, some sports aviation, and some military training. Pilots conducting such operations require special training and are required to take obstacles into account when planning and conducting low flying operations. Wind farm operators should check if proposed wind turbines will be located near areas where low flying operations are likely to be conducted, and if so, consider their duty of care to such activities.

HART Aviation considers that Wind Prospect CWP has clearly recognised its duty of care in seeking an independent assessment of the aviation issues in respect of the proposed Crudine Ridge Wind Farm.

General comments: -

Whilst the Guidelines issued are largely a re-statement of the current regulatory scene, HART Aviation considers that these are a good summary of the situation as it exists today and provides adequate guidelines for wind farm developers.

Whilst to a large degree the responsibility for decision making regarding the need or otherwise for obstacle lighting outside the immediate vicinity of aerodromes is placed on the wind farm developer using the somewhat ill defined "duty of care" tag, HART Aviation feels that there is sufficient guidance existing to enable a wind farm developer to substantiate that such duty of care has been discharged appropriately.

Further, HART Aviation considers that in all elements of the design of the Crudine Ridge Wind Farm, Wind Prospect CWP has met, and is meeting, its duty of care obligations not only in informing and seeking advice from CASA, Airservices Australia and the Department of Defence, but also in seeking an independent assessment of the aviation risk issues relevant to the site.

Nothing to date has been seen which is inconsistent with any of the elements of the aforementioned standards and guidelines.

3.4.12 Obstacle lighting needs

In assessing the proposed Crudine Ridge Wind Farm, HART Aviation is of the view that, if wind turbines with a tip height of 160 m (~525 ft) are proposed to be used, then obstacle lights are necessary to minimise the risk to aviation operators in the region. Further, such lights should be medium density lights installed in a manner consistent with the requirements of the CASA Manual of Standards 139 as mentioned in Section 3.4.5 a) above.

If the tip height of the wind turbines were to be limited to no more than 152 m (~499 ft), then HART Aviation considers that the risk to aviation operations in the vicinity of the Crudine Ridge Wind Farm is sufficiently low such that obstacle lights are not required for the wind turbines.

4 SUMMARY COMMENTS

The following comments and recommendations are made, *issues considered of particular importance being highlighted in bold italics*: -

- Airfields in the vicinity.
 - The nearest Registered or Certified aerodrome is **Bathurst Aerodrome**, a Certified aerodrome which is approximately 45 km to the south of the most southern edge of the proposed Crudine Ridge Wind Farm site. Operations from this airfield will not be affected by the presence of the Wind Farm;
 - The next nearest Registered or Certified aerodrome is **Mudgee Aerodrome**, a Certified aerodrome which is approximately 50 km to the north of the most northern edge of the proposed Crudine Ridge Wind Farm site. Operations from this airfield will not be affected by the presence of the Wind Farm;
 - There is one private unlicensed airstrip (Dabee Station) and one unlicensed aerodrome (Rylstone) respectively 34 km and 35 km to the east of the Crudine Ridge Wind Farm site. Operations from these airfields will not be affected by the presence of the Wind Farm;
 - All other identified airfields are over 54 km distant from the Crudine Ridge Wind Farm site and operations from these airfields will not be affected by the presence of the Wind Farm.
- Aviation operations – general.
 - No defined air routes over the Crudine Ridge Wind Farm site will be affected by the presence of the wind farm;
 - All night VFR and IFR operations should be clear of any wind turbines;
 - ***Wind turbines which have a tip height greater than 152 m (~500 ft) may impact on VFR operations in the vicinity and require special consideration regarding the risk.***
- High voltage transmission lines.
 - High voltage transmission lines exist some 15 km east of the proposed site. These transmission lines are already appropriately identified on aviation charts they do not present any increased risk to aviation operations as a direct result of the establishment of the Crudine Ridge Wind Farm;
 - 25 m and 30 m high transmission lines are proposed to be installed within the boundaries of the wind farm site and for connection to the existing 132 kV grid. With the possible exception of special low level operations (such as for aerial agricultural purposes) the presence of these lines will have no adverse effect on any aircraft operations that might occur in the area;
 - It would seem wise to adopt a set back figure in excess of the maximum wind turbine height to blade tips (say, 10% more) for those wind turbines close to the transmission lines.
 - If required, helicopter live line maintenance and insulator washing programmes for the high voltage transmission lines may be subject to constraints where the transmission

lines cross the wind farm site. However, whether or not such operations could be undertaken would be an operational decision for the particular operator.

- Reference towers for meteorological monitoring.
 - There are currently two temporary wind monitoring masts installed and up to six permanent wind monitoring masts proposed;
 - Traditionally, such **wind monitoring masts are difficult to see**;
 - The height of the temporary and permanent reference towers are such that these are not required to be reported to the Civil Aviation Safety Authority (CASA) under CASR 139.365. However, **reporting is advisable in accordance with the Civil Aviation Advisory Publication (CAAP) 89W-2(0)**;
 - It is understood that Wind Prospect CWP has advised the RAAF AIS of the existence of the temporary reference towers in accordance with the procedures mentioned in the referenced CAAP.
 - Such reporting should continue in respect of any future masts.
- Airspace considerations.
 - General
 - The proposed site for the Crudine Ridge Wind Farm does not impact on any airport control zone;
 - Further, the defined operating height of aircraft on designated routes over the area is such that the presence of the Wind Farm would have no effect at all;
 - No Prohibited or Restricted areas have been identified in the area. However, the proposed **Crudine Ridge Wind Farm falls within the entire designated Danger Area D 538A set aside for Williamtown Military Flying Training**;
 - No active Notices to Airmen (NOTAM), which might impact on the development of the Wind Farm, were found;
 - The presence of the Crudine Ridge Wind Farm is very unlikely to impact on any radar or communication links within the vicinity;
 - **There is a continued need for consultation with CASA, Airservices and the Department of Defence** and it is clear that some has already occurred.
 - CASA.
 - CASA has no specific authority for the obstacle marking and lighting of tall structures, including wind farms, located away from aerodromes;
 - CASA has recommended that owners of structures have a duty of care to aviators and should undertake an assessment of the hazards to aviation because of the proposed development and also consult Airservices Australia and the Aerial Agricultural Association of Australia as part of the process. HART Aviation considers that Wind Prospect CWP had met its duty of care in the above respects;
 - Whilst it is considered that the overall risk to aviation operations in the vicinity of the proposed Crudine Ridge Wind Farm is low; **there are two areas where the risk to aviation operations is slightly higher than normal; viz:**
 - **The nominal maximum turbine tip height proposed is such that the wind turbines would extend into navigable airspace by some 25 ft, and**
 - **Low level military jet operations may occur in the region.**
 - **HART Aviation is of the view that such obstacles could be adjudged as a hazard to aviation and require obstacle lighting to be installed and activated in low visibility and night conditions;**
 - **Obstacle lights should conform with the CASA Manual of Standards Part 139, paragraph 9.4.3A.**
 - Airservices.
 - Whilst Airservices Australia works closely with CASA in respect of airspace considerations and other matters, **there is value in advising Airservices Australia separately both in respect of the proposed Wind Farm**

development and the temporary reference towers in the event they wish to issue a Notice to Airmen (NOTAM) advising of associated hazards.

There is also a close link between Airservices AIS and the RAAF AIS;

- HART Aviation did not discover any NOTAMs relevant to the site;
 - The proposed Crudine Ridge Wind Farm will not impact on the performance of Precision and Non-Precision Navigational Aids, HF / VHF Communications, A-Surface Movement Guidance and Control Systems (SMGCS), Radar, Precision Runway Monitoring (PRM) or Satellite / Links;
 - The proposed wind farm will not affect any instrument sector or circling altitude, nor any instrument approach or departure procedures at Mudgee, Bathurst or Orange Aerodromes.
- Department of Defence & RAAF AIS.
 - The proposed development will be outside any areas affected by Defence (Areas Control) Regulations (DCAR);
 - Primary radar (civil or military) or secondary surveillance radar will not be affected as a result of the establishment of the Crudine Ridge Wind Farm;
 - The location of ***the Wind Farm will be sited wholly within Danger Area D538A, which is used for Williamstown Military Flying Training;***
 - Danger Area D538A is not always active.
 - When it becomes active, the aviation fraternity is advised via an Airservices Australia issued NOTAM.
 - The vertical limits of this Danger Area are from surface to 7,500 ft – hence low level flying is potentially involved.
 - The existence of this Danger Area does not preclude the construction of the Crudine Ridge Wind Farm, but ***it is essential that the details of the positions and heights of each wind turbine within the wind farm, and the wind monitoring masts (both temporary and permanent) are advised to the Department of Defence so appropriate flight planning can be made to avoid these.***
 - ***The RAAF AIS should also be advised on the proposed Crudine Ridge Wind Farm development in addition to the presence of and the temporary wind monitoring mast.***
- Aerial fire fighting activities.
 - Helicopter or fixed wing aircraft operations within the confines of any wind farm and below the top of the wind turbines are potentially hazardous and not recommended;
 - The position in respect of the proposed Crudine Ridge Wind Farm is no different from any other wind farm. Helicopter or fixed wing aircraft operations within the confines of any wind farm and below the top of the wind turbines are potentially hazardous and not recommended;
 - It is possible that aerial fire fighting could be undertaken above the level of the wind turbines, but dropping water or retardant from this height would reduce the effectiveness. This is a matter for the expert fire fighting operators.
 - Aerial agricultural operations.
 - The likelihood of any aerial agricultural operations occurring in the region of the proposed Crudine Ridge Wind Farm is remote, but such cannot be completely discounted;
 - Aerial spraying, seeding or fertilising operations, be they by helicopter or fixed wing aircraft, within the confines of any wind farm and below the top of the wind turbines are potentially hazardous and not recommended;
 - The situation in respect of the proposed Crudine Ridge Wind Farm is no different from that for any other Wind Farm.

- Rural air ambulance services.
 - The existence of wind turbines has the potential to limit the flexibility of operations of helicopter ambulance services within the confines of the Crudine Ridge Wind Farm and there is little that can be done about that. This is a common factor for all wind farms;
 - Otherwise, the proposed Crudine Ridge Wind Farm will have little effect on the provision of rural air services currently available in the region.
- Contingency procedures and engine inoperative flight paths.
 - Any such procedures will not be affected by the presence of the Crudine Ridge Wind Farm.
- Wind Farm layout issues.
 - Effect of variable wind turbine positions.
 - The actual positions of the wind turbines within the proposed Crudine Ridge Wind Farm site boundaries will have little, if any, effect on the low risk profile associated with aviation operations in the vicinity.
 - Cumulative impact of Wind Farms in region.
 - The cumulative effect of the presence of Uungula Wind Farm and the Crudine Ridge Wind Farm would have little, if any, effect on the overall risk profile to aviation operations in the area concerned.
 - The Uungula Wind farm is sufficiently remote from the Crudine Ridge Wind Farm site for its existence to be irrelevant in the context of the aviation risks.
- Comment on current State and National guidelines.
 - The assessed standards / guidelines, in principle, cover the aviation related issues and the development of the Crudine Ridge Wind Farm has been quite consistent with those standards / guidelines.
- **Obstacle lighting needs.**
 - ***If wind turbines with a tip height of 160 m (~525 ft) are proposed to be used, then obstacle lights are considered to be necessary to minimise the risk to aviation operators in the region;***
 - ***Any such lights should be medium density lights installed in a manner consistent with the requirements of the CASA Manual of Standards 139.***
 - ***If the tip height of the wind turbines were to be limited to no more than 152 m (~499 ft), then the risk to aviation operations in the vicinity of the Crudine Ridge Wind Farm is considered to be sufficiently low such that obstacle lights are not required for the wind turbines.***

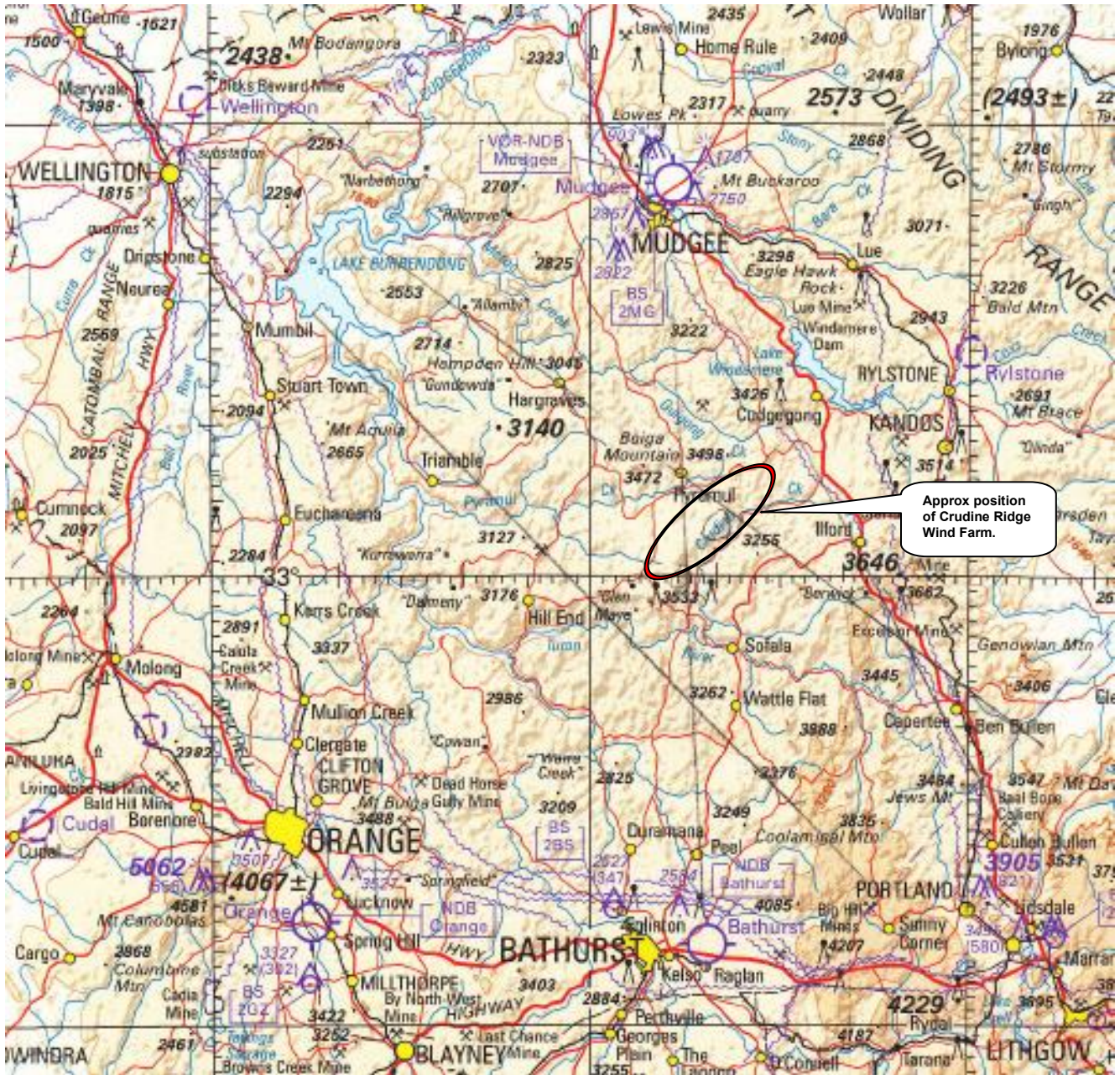
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5 ABBREVIATIONS USED IN THIS REPORT

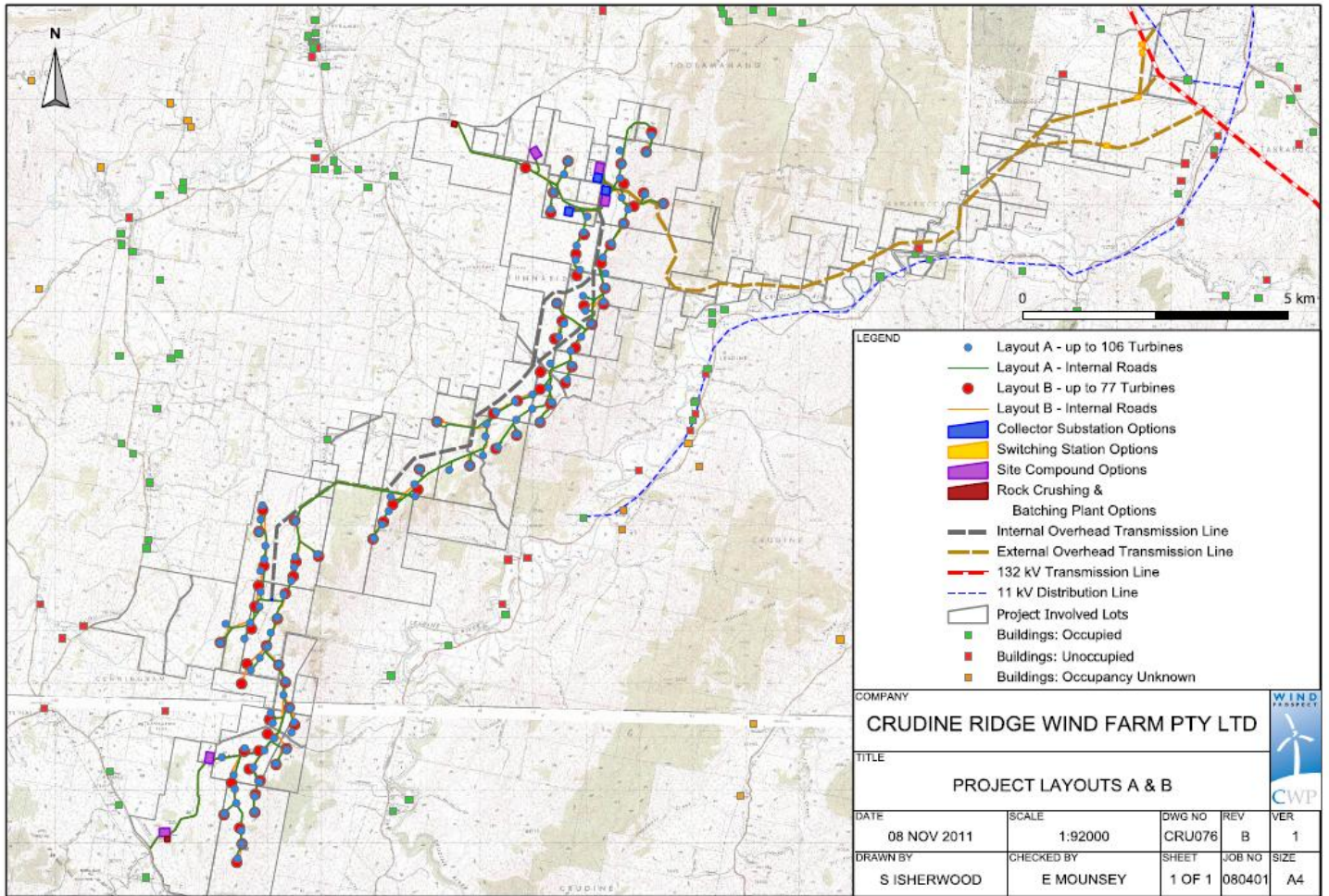
AAAA	Aerial Agricultural Association of Australia	kph	Kilometres per hour
AC	Advisory Circular	kV	Kilovolts
AGL	Above Ground Level	LSALT	Lowest Safe Altitude
AHD	Australian Height Datum	m	Metre
AIS	Aeronautical Information Services	m/s	Metres per second
ALA	Authorised Landing Area	MD	McDonnell Douglas
AOPA	Aircraft Owners and Pilots Association of Australia	MOS	Manual of Standards
CAA	Civil Aviation Authority	MW	Mega Watt
CAAP	Civil Aviation Advisory Publication	NDB	Non Directional Radio Beacon
CAR	Civil Aviation Regulation	nm	Nautical Mile
CASA	Civil Aviation Safety Authority (Australia)	NOTAM	Notice to Airmen
CASR	Civil Aviation Safety Regulation	NZ	New Zealand
CWP	Continental Wind Partners	OLS	Obstacle Limitation Surfaces
DCAR	Defence (Areas Control) Regulations	PRD	Prohibited, Restricted, Danger areas
DGR	Director General Requirements	PRM	Precision Runway Monitor[ing]
DoPI	Department of Planning & Infrastructure	RAAF	Royal Australian Air Force
EA	Environmental Assessment	RNAV	Area Navigation
EASA	European Aviation Safety Agency	rpm	Revolutions per minute
ERC	En Route Chart	SMGCS	Surface Movement Guidance and Control System
ERSA	En Route Supplement Australia	TAC	Terminal Area Chart
FAA	Federal Aviation Administration	UK	United Kingdom
ft	Feet	USA	United States of America
GNSS	Global Navigation Satellite System	VFR	Visual Flight Rules
GPS	Global Positioning System	VHF	Very High Frequency
ICAO	International Civil Aviation Organisation	VNC	Visual Navigation Chart
IFR	Instrument Flight Rules	VTC	Visual Terminal Chart
HF	High Frequency	WAC	World Aeronautical Chart
km	Kilometre		

6 APPENDICES



6.1 EXCERPT FROM WAC 3456 – SYDNEY



6.2 CRUDINE RIDGE WIND FARM – PROJECT DESIGN WITH TWO LAYOUTS



6.3 CASA RESPONSE RE PROPOSED CRUDINE RIDGE WIND FARM

 <p>Australian Government Civil Aviation Safety Authority</p> <p>AIRSPACE AND AERODROME REGULATION File Ref: G111/322</p>	 PCU021411
<p>1 April 2011</p>	
<p>Manager - Energy Infrastructure Projects Department of Planning GPO Box 39 SYDNEY NSW 2001</p> <p>Attention: Ms Anna Timbrell</p>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> <p>Department of Planning Received</p> <p>06 APR 2011</p> <p>Scanning Room</p> </div>
<p>Dear Ms Timbrell</p> <p>Crudine Ridge Wind Farm, between Bathurst and Mudgee - Environmental Assessment</p> <p>Thank you for your letter addressed to our Mr Jones dated 18 February 2011 concerning the proposed Crudine Ridge Wind Farm.</p> <p>CASA notes that aviation safety issues have not been dealt with in the Crudine Ridge Wind Farm Preliminary Environmental Assessment dated February 2011 and that consultation on aircraft safety will be incorporated into the planning stages of the development.</p> <p>At this time, CASA has no specific authority to require action for the obstacle marking and lighting of tall structures, including Wind Farms, located away from aerodromes. CASA can not impose a requirement for the provision of obstacle lights, nor can we comment on the location or design of tall structures that are located away from the vicinity of an aerodrome.</p> <p>Notwithstanding CASA's regulatory authority, owners of structures which could be hazardous to aviation have a duty of care to aviators. The proponent should undertake, at least, the following consultation to assess the potential hazard posed to aviation by the proposed development.</p> <ol style="list-style-type: none"> 1. Identify any aerodrome within 30 km of the boundaries of the proposed wind farm and consult with the aerodrome operator to determine any impact on Obstacle Limitation Surfaces at such aerodromes. Penetration of these surfaces is likely to pose a hazard to normal aviation operations at the aerodrome. 	
<p>GPO Box 2005 Canberra ACT 2601 Telephone 131 757 Canberra, Brisbane, Darwin, Cairns, Townsville, Tamworth, Bankstown, Mascot, Moorabbin, Melbourne, Adelaide, Perth</p>	

2. Consult with Airservices Australia to have them assess any potential impact on instrument approach procedures at aerodromes, navigational aids, communications facilities or surveillance facilities.
3. Contact the Aerial Agriculture Association of Australia (02 6241 2100 - Mr Phil Hurst) to advise him of the proposal and gain comment on the potential hazards to aerial application and related operations in the area.

Aircraft are generally permitted to fly as low as 500 ft, (152 m) above ground level, and certain operations are permitted to fly below this height. The Preliminary Environmental Assessment indicated that the proposed turbines could exceed this height, with rotor diameters up to 120 m, and hub heights up to 100 m, resulting in maximum blade tip heights of approximately 160 m above ground. Turbines of this height could be a hazard to aircraft traversing the area. It is recommended that the proponent take this into consideration when assessing their duty of care in deciding whether or not the wind farm should be obstacle lit or other wise marked.

If the proponent chooses to provide obstacle lighting to indicate the presence of this Wind Farm at night, to ensure consistency and avoid any confusion to pilots, the obstacle lighting installation should conform with our Manual Of Standards Part 139, paragraph 9.4.3.4A. Our Manual of Standards is available on our Web Site, http://casa.gov.au/wcmswr/_assets/main/rules/1998casr/139/139mfull.pdf

Any requirements placed on developers by planning authorities, insurers, or financiers, are beyond CASA's control.

Thank you for the opportunity to provide comment on the aviation safety aspects of this proposed project.

Yours sincerely



Malcolm McGregor
Manager, Airways and Aerodromes
Airspace and Aerodromes Regulation

EXCERPT FROM CASA MANUAL OF STANDARDS Part 139 re Obstacle Lighting for Wind Farms

9.4.3.4A In the case of a wind farm whose wind turbines must have obstacle lighting, medium intensity lights are to be installed as follows:

- (a) if any part of the wind turbine, including the rotating blades, penetrates the obstacle limitation surface (OLS) of an aerodrome, top lights must mark the highest point reached by the rotating blades:

Note: Because it is not practicable to install obstacle lights at the tip of the blades, these lights may be located on a separate structure, adjacent to the wind turbine, at a height that corresponds to the highest point of the rotating blade of the turbine.

- (b) if the rotating blades do not penetrate the OLS, the top lights must be placed on top of the generator housing;
- (c) obstacle lights must be provided on a sufficient number of individual wind turbines to indicate the general definition and extent of the wind farm, with intervals between lit turbines not exceeding 900 m;
- (d) all of the obstacle lights on a wind farm must be synchronised to flash simultaneously;
- (e) the downward component of obstacle lighting may be shielded to the extent mentioned in either or both of the following sub-subparagraphs:
- (i) so that no more than 5% of the nominal light intensity is emitted at or below 5° below horizontal;
- (ii) so that no light is emitted at or below 10° below horizontal;
- (f) to prevent obstacle light shielding by the rotating blades, 2 lights must be provided on top of the generator housing in a way that allows at least 1 of the lights to be seen from every angle in azimuth.

6.4 SUMMARY OF EXCHANGES WITH AIRSERVICES AUSTRALIA RE PROPOSED CRUDINE RIDGE WIND FARM

From: Tattam, Steve [<mailto:steve.tattam@airservicesaustralia.com>]
Sent: Thursday, 28 April 2011 4:41 PM
To: Ed Mounsey
Subject: Crudine Ridge Wind Farm - (Airservices assessment ref: NSW-WF-023)

Dear Ed,

I refer to your request for Airservices Australia to assess the proposed development of the Crudine Ridge Wind Farm (Airservices assessment ref: NSW-WF-023).

At a maximum height of 1,160m (3808 FT) AHD, select turbines proposed at this wind farm will affect the SECTOR A GPS ARRIVAL and SECTOR B GPS ARRIVAL procedures at Mudgee aerodrome.

At a maximum height of 1158m (3799FT) AHD turbines located at the proposed wind farm will not affect any procedures at Mudgee, Bathurst or Orange aerodromes.

If applicable to the airport, no assessment was conducted in relation to any other procedures made available by another Part 173 Certified Designer.

This proposed wind farm will not impact the performance of Precision/Non-Precision Nav Aids, HF/VHF Comms, A-SMGCS, Radar, PRM or Satellite/Links.

Regards,

Steve Tattam

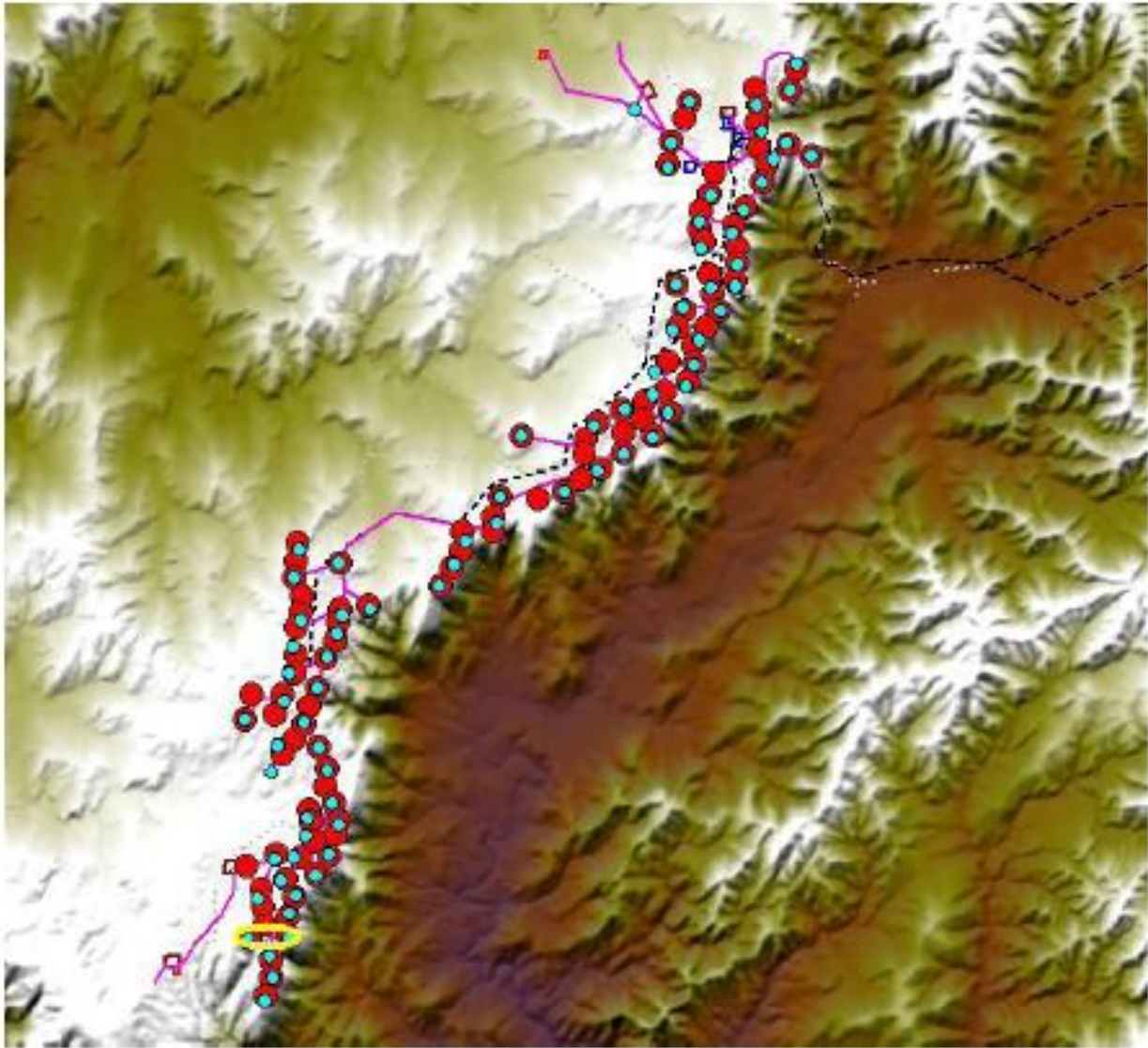
Airport Relations & Development Manager
Airservices Australia
E-mail: steve.tattam@airservicesaustralia.com

From: Ed Mounsey [<mailto:ed.mounsey@wpcwp.com.au>]
Sent: Thursday, 28 April 2011 5:07 PM
To: Tattam, Steve
Subject: RE: Crudine Ridge Wind Farm - (Airservices assessment ref: NSW-WF-023)

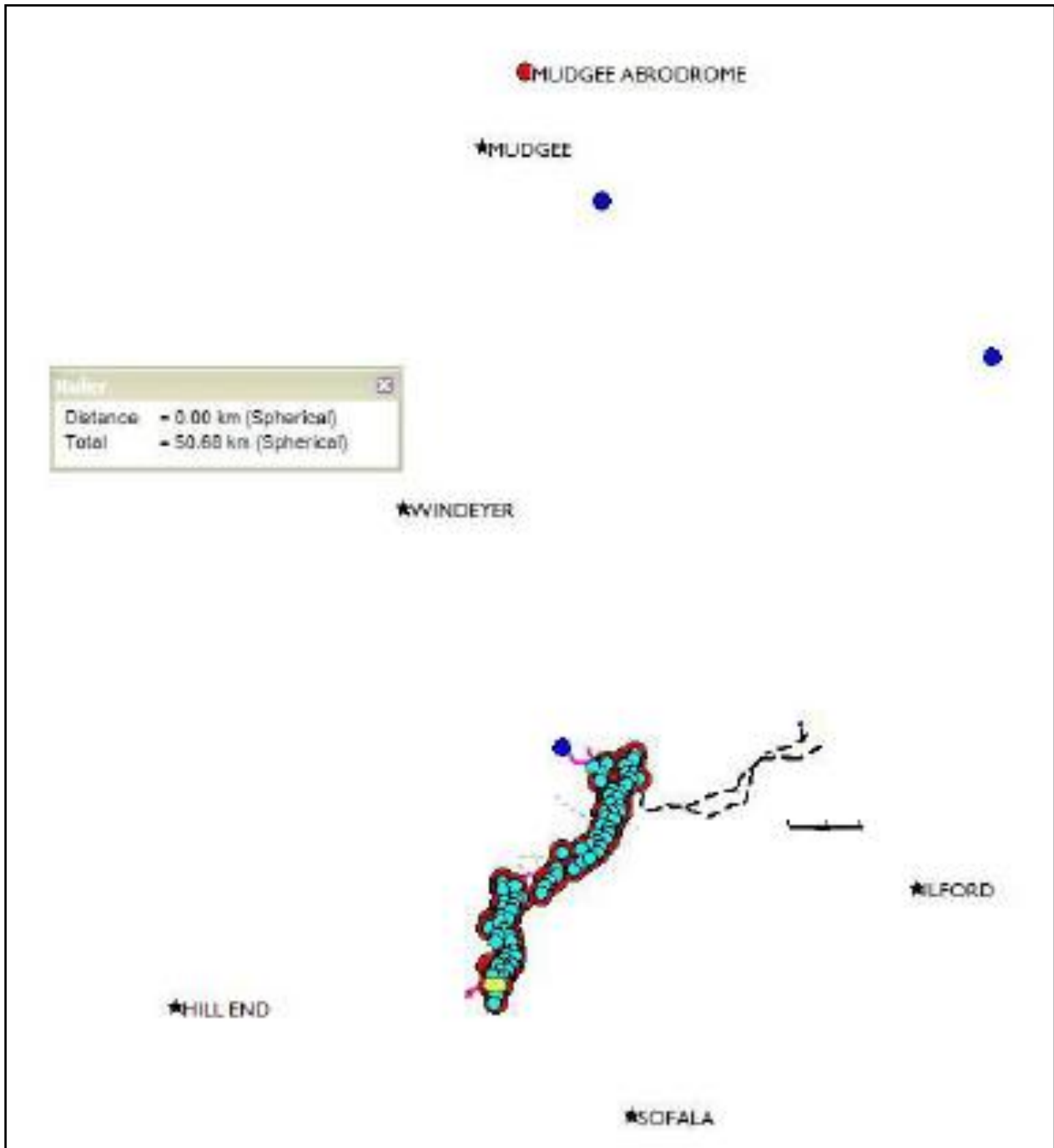
Steve

Refer to the attached. Only two turbine locations within each layout exceed the 1,158 AHD limit. I therefore see no issue with defining this as a ceiling height beyond which no part of a wind turbine will protrude in the Statement of Commitments – would you consider this an acceptable conclusion?

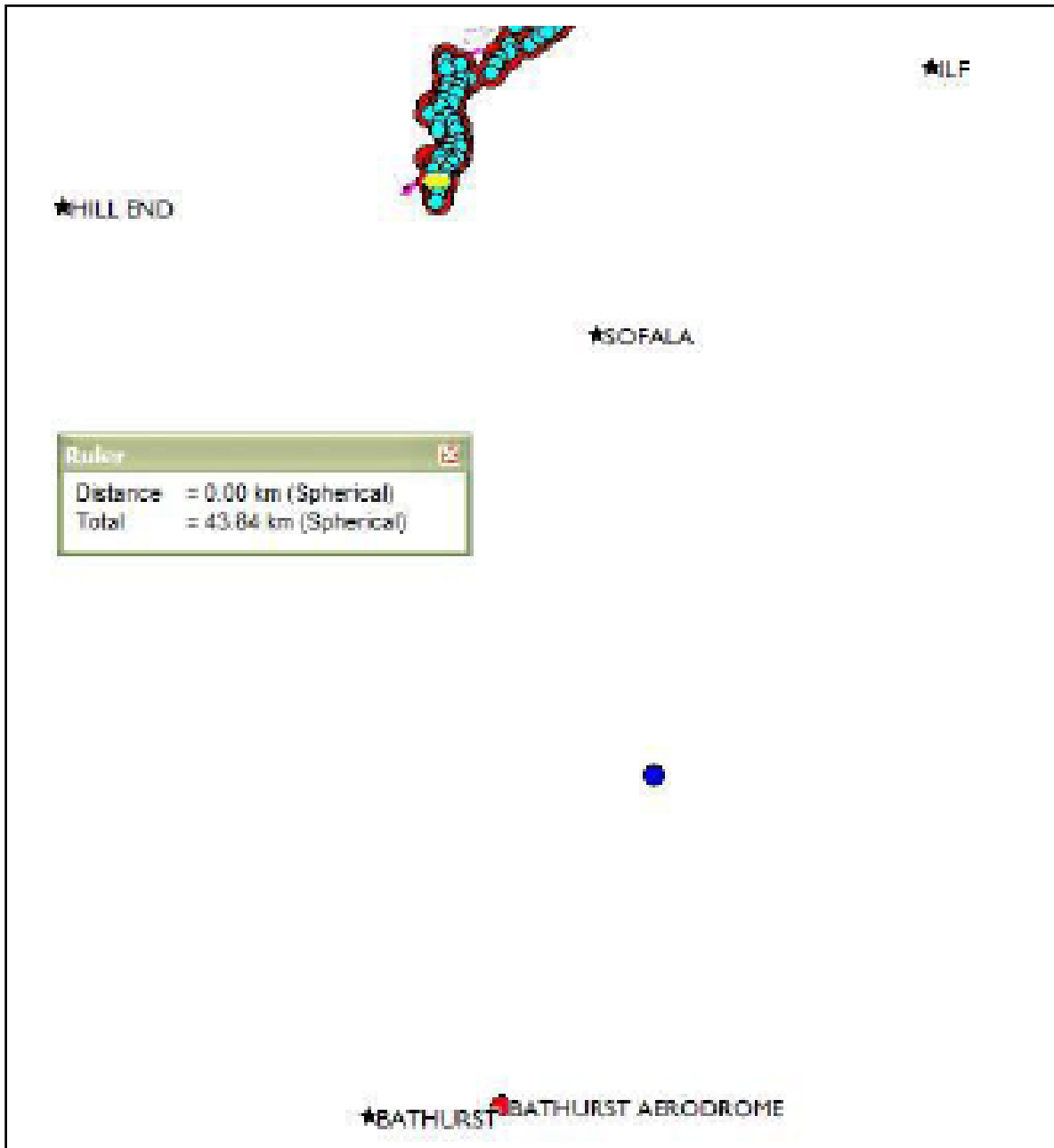
Further to this, Map 1 below shows the location of these two turbine locations (highlighted by a yellow boundary) at the southern end of the site. Map 2 provides the distance of these turbines to the Mudgee Aerodrome as over 50km and Map 3 shows Bathurst Aerodrome to be over 43km.



Map 1



Map 2



Map 3

From: Tattam, Steve [steve.tattam@AirservicesAustralia.com]
 Sent: Monday, 2 May 2011 4:04 PM
 To: Ed Mounsey
 Subject: RE: Crudine Ridge Wind Farm - (Airservices assessment ref: NSW-WF-023)

Hi Ed,

I do consider this matter to be an acceptable conclusion (assessment completed) as long as no turbine blade tip at the top of rotation exceeds 1158m AHD within the bounded area you provided Airservices Australia for assessment as part the Crudine Ridge Wind Farm proposal.

Steve Tattam

Aviation Relations Manager
 Airservices Australia
 E-mail: steve.tattam@airservicesaustralia.com

Copy of email advice received by Mel Dunn, HART Aviation, from Airservices Australia, 10th August 2011.

As we just discussed on the phone, the following advice is Airservices Australia's (Airservices) updated assessment for Crudine Ridge Wind Farm – (Airservices Assessment Reference NSW-WF-023)

Airservices originally assessed this wind farm proposal using broad data (i.e. a single maximum height and the perimeter of the whole wind farm area) which identified an impact on the GPS arrivals for Mudgee Aerodrome. As an impact was identified, Airservices has since received specific coordinates and heights and have found that two turbines are just outside the protection areas and do not have any effect on these GPS arrival procedures after a more accurate assessment.

For your background information, the design criteria that are required to follow for DME or GPS arrival procedures (YMDG GPS ARRIVAL SECTOR C and SECTOR D) is written in the CASA Manual of Standards Part 173 (MOS 173). The criteria require that the GPS arrival procedure protection area includes a navigation fix tolerance. The navigation fix tolerance applicable to these procedures at or beyond 25nm is 2nm. Thus, the total protection area is actually 27nm from the navigation aid for the GPS arrival procedures. The majority of the wind farm is within 27nm, so Airservices initial advice based on the previously mentioned perimeter of the wind farm and the ceiling of 1158m AHD (3799ft) is still correct for the majority of the wind farm.

The YMDG 25nm MSA is not affected because it is covered by different criteria, being ICAO PANS-OPS. However, the protection area extends out to 30nm from MDG VOR or MDG NDB with the critical altitude being 1163m (3816ft) AHD, thus the entire wind farm is contained within the MSA protection area.

Upon review the two turbines exceeding 1158m AHD are outside the GPS arrival assessment areas by approximately 144m. So they are positioned greater than 27nm from either MDG VOR or MDG NDB. Provided that the final location of these turbines is not at or within 27nm of MDG VOR or MDG NDB than at their current height AHD they will not affect these GPS arrival procedures.

These are the two turbines that are now ok and do not affect our procedures.

MGA 94 Zone 55				
X	Y	AHD (m)	max turbine height	max height
743287	6343698	1000	160	1160
743869	6343744	999.9	160	1159.9

Please find below the updated assessment of this proposal:

I refer to the application for "Crudine Ridge Wind Farm" proposal. With respect to ICAO PANS-OPS procedures promulgated by Airservices, at a height of 1158m (3799ft) AHD the proposed wind farm will not affect any instrument sector or circling altitude, nor any instrument approach or departure procedures at Mudgee aerodrome.

The two turbines located at 1 (Easting 743287, Northing 6343698, 1160m (3806ft) AHD) and 2 (Easting 743869, Northing 6343744, 1159.9m (3806ft) AHD) with respect to ICAO PANS-OPS procedures promulgated by Airservices, will not affect any instrument sector or circling altitude, nor any instrument approach or departure procedures at Mudgee aerodrome.

This assessment is only based on the most recent data received and may be rendered null and void should any variation occur to the turbine layout.

Regards,

Steve Tattam

Aviation Relations Manager
Corporate & International Affairs | Airservices Australia
Ph 02 6268 4891 | Mob 0409 319 139 | Email steve.tattam@airservicesaustralia.com

6.5 DEPARTMENT OF DEFENCE RESPONSE TO PROPOSED CRUDINE RIDGE WIND FARM

Australian Government
Department of Defence
Defence Support Group

2004/1044160/7
LPSI/OUT/77/2011

Mr Ed Mounsey
Wind Prospect CWP
PO Box 1708
NEWCASTLE NSW 2300

Dear Mr Mounsey

PROPOSED CRUDINE RIDGE WIND FARM NSW

Thank you for your email dated 21 March 2011 advising that Wind Prospect CWP is proposing to construct a wind farm to be located approximately 45km to the south of Mudgee and 45km to the north of Bathurst in NSW. There are two potential layouts ranging from 77 to 106 wind turbines. The maximum wind turbine blade tip height will be up to 160m above ground level (AGL).

The wind farm will be connected into the existing electricity transmission lines via a new easement approx 13km long in which a 132kV power line will need to be constructed. The wind turbines will extend over a 16km span along the Crudine Ridge. The individual turbine positions are located on land with above mean sea level (AMSL) elevations ranging from approx 890m AMSL to 1000m AMSL. Defence notes that Wind Monitoring Masts may have already been installed on the site or may be installed in the future. The guyed wind monitoring masts are tall with a small horizontal profile making them difficult to see.

The Department of Defence has assessed the proposal for any possible impact on the safety of military flying operations and possible interference to Defence communications and radars.

The Department advises the proposed development will be outside any areas affected by the Defence (Areas Control) Regulations (DACR). The DACR control the height of objects (both man-made structures and vegetation) and to an extent the purpose for which they may be used within approximately 15km radius of Defence airfields.

However, the location of the wind farm will be sited wholly within Danger Area D538A which is used for Williamtown Military Flying Training. For reference, the published military flying training areas which may include low level flying are depicted as Danger area and Restricted area airspace on aeronautical charts published by Airservices Australia (AsA).

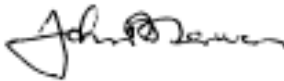
There is an ongoing need to obtain and maintain accurate information about tall structures. The risk posed by a tall structure to aircraft safety can be minimised if information on the tall structure is conveyed to pilots so that they can fly at a safe margin above the structure. The RAAF Aeronautical Information Service (RAAF AIS) in Melbourne is responsible for recording the location and height of tall structures. The information is held in a central database managed by RAAF AIS and relates to the erection, extension or dismantling of tall structures the top of which is:

- a. 30 metres or more above ground level - within 30 kilometres of an aerodrome,
or
- b. 45 metres or more above ground level elsewhere.

The proposed wind farm, wind monitoring masts and the electricity transmission line towers will meet the above definition of tall structure. RAAF AIS has requested that the proponent supply them with location and height details once final design positions are known and before construction commences. After construction is complete, the Department of Defence requests that Wind Prospect CWP provide RAAF AIS with "as constructed" details. RAAF AIS has a web site with a Vertical Obstruction Report Form at www.raafais.gov.au/obstr_form.htm which can be used to enter the location and height details of tall structures.

Defence has assessed the wind farm project and advises of no objection to the proposal. My point of contact for this matter is Mr Gary Lee on telephone (02) 6266 8187.

Yours sincerely



John Kerwan
Director External Land Planning
BP3-1-A052
Department of Defence
CANBERRA ACT 2600

19 May 2011

For Information:
Regional Director DS Northern NSW
RAAF Base Williamtown ABXO
RAAF Base Williamtown BSM

6.6 AERIAL AGRICULTURAL ASSOCIATION OF AUSTRALIA WIND FARM POLICY



March 2011

Introduction

Windfarms and their pre-construction wind monitoring towers are a direct threat to aviation safety – and especially aerial application. They also pose an economic threat to the industry where the costs of windfarm development—including those of compensation for loss of income—are externalized onto other sectors such as aerial application.

AAAA has developed this policy so as to inform regulators, asset developers and operators alike of the need for action on their part to fulfill their duty of care to Australia's aerial applicators.

AAAA Windfarm Policy

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

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

1. consulted honestly and in detail with local aerial application operators
2. sought and received an independent aerial application expert opinion on the safety and economic impacts of the proposed development
3. clearly and fairly identified that there will be no short or long term impact on the aerial application industry from either safety or economic perspectives and
4. if there is an identified impact on local aerial application operators, provided a legally binding agreement for compensation over a fair period of years for loss of income to the aerial operators affected.
5. Adequately marked any wind infrastructure and advised pilots of its presence .

AAAA believes that the above processes should also apply for all windfarms that have already been approved or erected, especially the establishment of long-term (for the life of the windfarm or until it is removed, whichever is the

longest) binding compensation arrangements for affected aerial application companies.

While it is not AAAA policy to provide specific comment on particular development proposals due to resource limitations, AAAA notes that windfarms can have far-reaching footprints that can remove significant amounts of land from treatment for a considerable distance from the windfarm boundary.

Operational implications of each development will vary enormously depending on the site, the positioning of the turbines, orientation of affected paddocks relative to the turbines, the type of aerial application taking place, the aircraft used, the pilot's experience, the meteorological conditions, the site elevation, the position of any airstrip relative to the turbines and a range of other variables.

However, it is clearly unacceptable that one industry can impose significant safety threats on another, longer established industry with impunity.

AAAA believes that:

- All wind monitoring towers—including guy wires—must be clearly marked to assist pilots to see them
- All wind turbines, wind monitoring towers and associated infrastructure must be required to be removed when no longer in use. A mandatory bond should be levied on all developments to ensure the site can be remediated.

<p>Recommendations to Government</p> <p>Meratorium & National Policy AAAA recommends to all Governments the establishment of a moratorium on windfarm developments until a national COAG policy on wind-farms is established that requires the following to be considered before approval:</p> <ul style="list-style-type: none"> • Competing land uses for the particular site. • Priority for existing long-term land-uses. • Economic and safety impacts on contracting industries such as aerial application, including the broader implications for thresholds of sustainability for contractors. • Independent life cycle analysis of windfarms and their overall environmental impact. • Impact on aviation safety. • Impact on bushfire preparedness and aerial firefighting. • Impact on visual pollution / amenity/ tourism. • Other sources of sustainable energy. <p>Transparency AAAA recommends that any 'special' or 'fast-track' planning processes established for wind-farm developments be removed. All windfarm developments should be subject to the full planning processes and community consultation in each State and Territory, including appeal of decisions.</p> <p>Governments should require public disclosure on a register of payments to landholders made before approval of the windfarm. This will allow other landholders and contractors to be aware of developments.</p> <p>Aviation Safety AAAA recommends that government provide better information to all windfarm developers on their responsibilities for aviation safety, including raising the duty of care requirements established under <i>Sheather v Country Energy</i> (NSW Court of Appeals) for owners of assets that pose a known threat to aviation activities to provide for suitable marking and other safety initiatives.</p> <p>The Commonwealth should establish a head of power to consider and regulate windfarm developments to protect aviation safety. This should include mandatory marking and notification of wind infrastructure and the power to veto proposed developments where they interfere with aviation safety.</p> <p>CASA should set a much lower than previously used height trigger for notification of tall structure developments - down to 50 feet in an area of known aerial application activity—or by using a</p>	<p>risk assessment based approach.</p> <p>CASA should work with Airservices Australia and any other relevant agencies to ensure that completed windfarms are included on suitable aviation mapping including WAC charts and topographic maps.</p> <p>CASA should develop a national tall structures web database that is accessible in real time by all low-level aviation pilots and which captures all wind-monitoring towers as well as completed windfarms. The database should also capture other tall structures such as radio masts etc.</p> <p>Background CASA does not have a clear head of power or a pathway for windfarm developers to ensure the risks their developments are posing are appropriately managed so as to protect legitimate activities of low-level aviation operators.</p> <p>In particular, previous CASA efforts to address this issue by requiring marking and lighting of certain towers above a certain height and within a certain distance of an airport misses the main risk to aviation and this is the wind monitoring towers as they are frequently lower than the height trigger, but still a threat to legitimate low-level aviation.</p> <p>Wind monitoring towers are very tall in relation to aerial application operations, are erected within very short timeframes, are extremely difficult for any pilot to identify from the aircraft and are often not notified to aviation users because of the lack of a Government-mandated notification system and the desire of the developers to keep their positions a secret because of commercial issues.</p> <p>There are two quite distinct issues arising from windfarms that affect aerial application:</p> <ul style="list-style-type: none"> • safety of the aircraft and pilot and • economic impact on aerial applicators. <p>Safety Impacts AAAA's view is that the case of <i>Sheather v Country Energy</i> (NSW Court of Appeals) clearly established that anyone with infrastructure posing a threat to aviation must consider the risks that infrastructure poses to aviation safety and respond appropriately through marking or other measures to safeguard aviation operations.</p> <p>This precedent is of critical relevance to wind-farm developers although not apparently widely known to them or acted upon.</p>
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<p>Economic Impacts</p> <p>Safety is not the only consideration that is imposing additional risk and consequences on the aerial application industry.</p> <p>The placement of wind farms in areas of highly productive agricultural land is leading to reductions in treatment areas of aerial application companies with no compensation for this externalization of costs by wind farm developers.</p> <p>For example, placement of a wind farm may affect flight lines and application height or even whether the application can be conducted at all - leading directly to either an increase in cost or a reduction in income - and sometimes both - for aerial application operators.</p> <p>As windfarm developments increase in number and scale of footprints, the threshold of non-viability of aerial application in an area may be reached where it is simply not economic to base an aircraft there. In a highly seasonal industry such as aerial application, operations may already be close to this threshold and windfarm footprints may compromise the availability of a critical service.</p> <p>The need to manage spray applications to ensure they are safe may mean that pest outbreaks such as locusts may not be able to be effectively controlled. Windfarms may create significant gaps in large scale treatment plans—leading to a breakdown of an overall campaign against locusts, cereal rust, noxious weeds or other pests with massive economic implications for farmers and the economy.</p> <p>In particular, AAAA is concerned that not enough consideration is being given through the State planning approval processes to the impacts of windfarms on productive agricultural land and the aerial application industry, remembering that it may not only be the land footprint where the windfarm is sited, but also land surrounding that for some kilometers where aircraft may have to maneuver to conduct aerial application.</p> <p>At the very least, windfarm developers should be required to pay compensation to aerial applicators where it can be reasonably established that there will be an economic impact imposed on the aerial application company by the wind farm developer.</p> <p>Operational impacts</p> <p>The following potential impacts on aerial application should be considered by all windfarm developers:</p>	<ul style="list-style-type: none"> ▪ positioning of wind farms may affect local aerial application operations, depending on the particular site. ▪ impacts could vary from affecting flight lines to treatment height and accuracy, maneuvering areas and possibly take-off and landing splays if an airfield is nearby (see for example, CASA CAAP 92-1 for agricultural air-strips – www.casa.gov.au – search for CAAP 92-1.) ▪ it may not be the land or farm that the wind farm is to be situated on that will be affected. Neighbouring farms, especially any with borders close to the windfarm site, may suffer significant impacts by imposed limits on the manoeuvring areas of aerial application aircraft. ▪ a key impact may not be the turbines themselves, but the positioning of any powerline that would lead from the windfarm substation back to the grid, or any other above ground powerline that would be put in to support the development. Any sections of above ground cable should be adequately marked. ▪ economic impacts could include increased costs due to longer flight times required to maneuver heavily laden aircraft around wind towers, a loss of accuracy due to being required to fly higher for safety reasons, an increase in liability due to the reduction in accuracy, or the complete loss of application jobs due to the landholder not wanting the area covered by windfarms to be treated.
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AAAA Activities to date

AAAA has done a lot of work to make it easier to mark guy wires and powerlines – including on wind monitoring towers – through amendment of the national standard on marking of wires so as to use a marker developed by Country Energy (NSW) with the cooperation of AAAA.

There is now little practical reason why wind towers and especially wind monitoring towers should not to be clearly marked.

In addition, AAAA has attempted to provide relevant information to developers through the Wind Energy Association, but this process/ advice is voluntary and consequently will not provide coverage of all developers.

AAAA also passes on information to members that has been provided to it by wind farm developers on the physical location of wind monitoring towers. However, only a few developers provide this information and again there is little doubt that many towers are going up unmarked and unknown until hopefully spotted by pilots during pre-application inspections.

More comprehensive safeguards must include a mandatory national system of communication of the position of all wind monitoring towers and the inclusion of this on a national database accessible by low level pilots.

This is a very real issue for topdressing and fire-bombing operations - as wind monitoring increases, so does the threat to legal aviation activities.

AAAA Windfarm Notification Process

AAAA tries to assist aviation safety by advising those of our members on our email lists of the position of wind monitoring towers and also wind turbines when they are under construction and finally constructed, if advised by windfarm developers.

Windfarm developers are encouraged to provide these details (in lats and longs by email to AAAA) so that AAAA can pass them on to those members.

AAAA provides this facility on the basis of it being information of a general nature only and the understanding that the information, for a range of reasons (including email failure, not all members being covered by email, or non-use by members, or operational shortcomings) will not provide any guarantees of aviation safety.

**FURTHER INFORMATION**

If you would like more information on the vital and responsible role the aerial application industry plays:

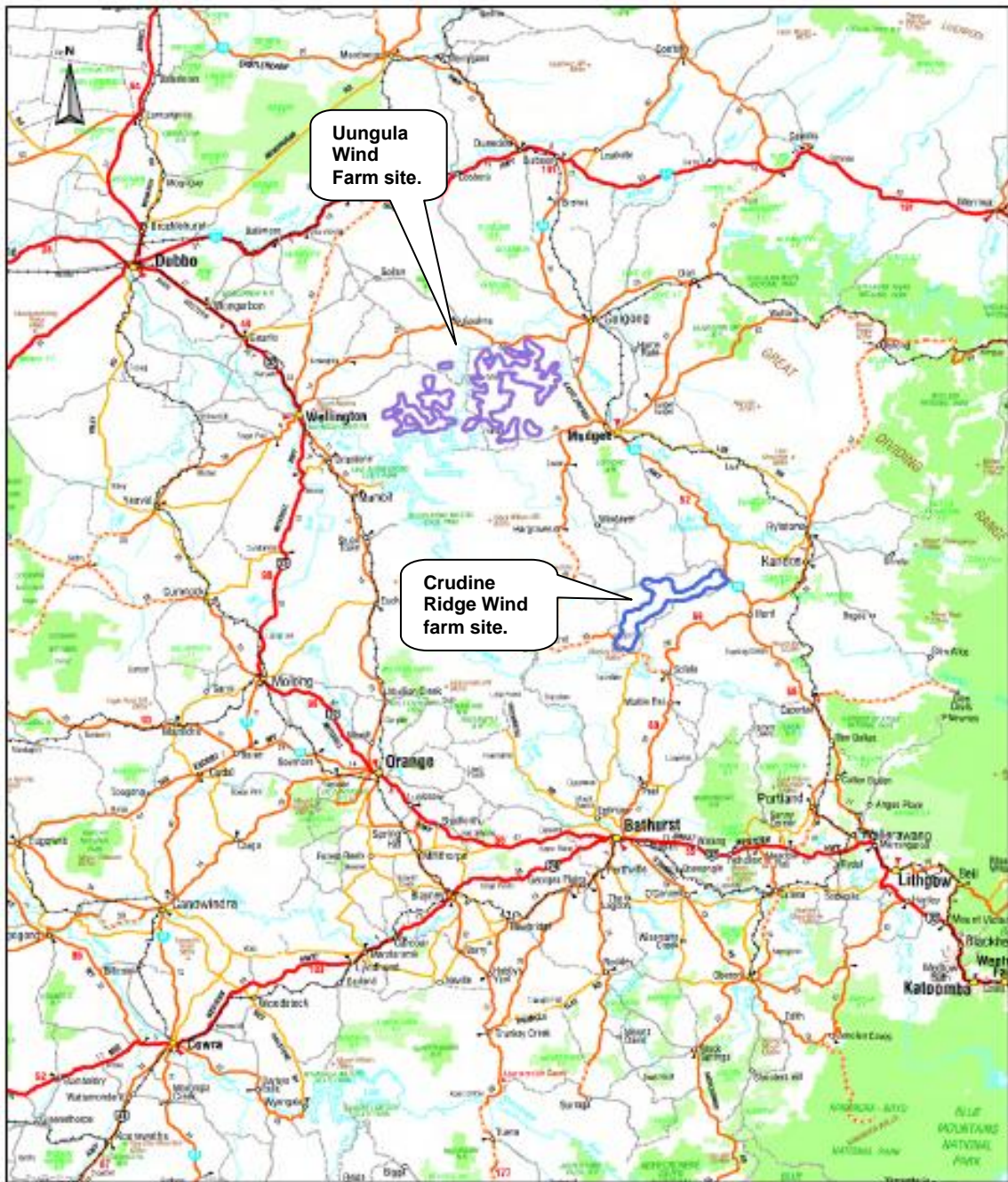
www.aerialag.com.au

**Or contact us on:
02 6241 2100 ph.**

phil@aerialag.com.au

**AAAA
PO BOX 353
Mitchell ACT 2911**

6.7 PROXIMITY OF UUNGULA WIND FARM TO CRUDINE RIDGE WIND FARM



LEGEND 	COMPANY CRUDINE RIDGE WIND FARM PTY LTD				
	TITLE PROXIMITY OF UUNGULA WIND FARM TO CRUDINE RIDGE WIND FARM				
SCALE BAR 	DATE 20 JUL 2011	SCALE 1:758200	DWG NO CRU046	REV A	VER 1
	DRAWN BY S ISHERWOOD	CHECKED BY E MOUNSEY	SHEET 1 OF 1	JOB NO 080401	SIZE A3

6.8 DRAFT GUIDELINES FOR LAND USE PLANNERS TO MANAGE THE RISK OF WIND TURBINE FARMS AS PHYSICAL OBSTACLES TO AIR NAVIGATION.

NATIONAL AIRPORTS
SAFEGUARDING ADVISORY GROUP

GUIDELINES FOR LAND USE PLANNERS TO MANAGE THE RISK OF WIND TURBINE FARMS AS PHYSICAL OBSTACLES TO AIR NAVIGATION

BACKGROUND INFORMATION FOR USERS OF THE GUIDELINES

OBJECTIVE

1. These guidelines are designed to assist state and local governments, airport operators and developers of wind turbine farm operations to jointly address the risk to civil aviation arising from the development, presence and use of wind turbine farms.
2. The guidelines are intended to provide certainty to proponents of wind farms and planning authorities about the acceptability of proposed wind turbine installations from an aviation perspective. While the Commonwealth leased airports are already protected from risk posed by wind turbine farms in the vicinity by the provisions of the *Airports Act 1996* and the *Airports (Protection of Airspace) Regulations 1996*, smaller airports currently do not have similar levels of protection.
3. Implementation of the guidelines will have the additional benefit of being applicable in areas away from airports to address the risk posed by wind turbine farms to air navigation in those areas.
4. Adoption of the guidelines will help ensure that aviation safety agencies are provided with an opportunity to examine and address at the planning stage the risk to aviation safety that proposed wind turbine farms may pose. This will enable the use of wind energy to continue to grow, while protecting aviation safety.
5. These guidelines will complement the proposed National Wind Farm Development Guidelines. This document has been drafted by the Council of Australian Government (COAG) Environment and Heritage Protection Council to address the inconsistent approaches between jurisdictions towards the assessment of wind farm developments.

GENERAL

6. There has been a rapid growth in the number of wind turbines farms in Australia. This trend is likely to continue given the pressure to move to sustainable energy sources. Wind turbine farms are among the most cost effective of renewable energy options and can produce electricity at costs comparable to traditional coal fired power stations if externalities are taken into account.
7. From the aviation perspective, wind turbine farms can:
 - be a physical obstacle to flight operations; and
 - affect the performance of communications, navigation and surveillance equipment operated by Defence and Airservices Australia (Airservices).

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Wind turbine farms

Wind turbine farms - physical obstacles to flight operations

8. Tall man-made structures, such as wind turbine farms and meteorological towers, have the potential to be obstructions to flight operations. Governments recognize the importance of mitigating the risks of low flying aircraft colliding with tall, man-made structures.
9. Aircraft at risk would include agricultural aviation aircraft, other general aviation aircraft and Defence aircraft conducting low-level flying manoeuvres.
10. Apart from flight safety issues, the risk of collision raises other possibilities such as:
 - injury or loss of life;
 - disruption to utility services, such as production of electricity;
 - replacement and repair costs of wind turbines/associated equipment affected by a collision; and
 - liability issues for the wind turbine farm operator and for regulatory authorities.
11. It is important that wind turbine farms are assessed for their potential to be an obstacle to flight operations and that necessary mitigation measures are implemented.

Wind turbine farms – impact on integrity of communications, navigation and surveillance equipment

12. Concerns have been raised about the potential for wind turbine farms to affect the integrity of communications, navigation and surveillance equipment (CNS) such as radar and navigation aids, including instrument landing systems. There are two issues that give rise to these concerns: the structure of the wind turbine itself and the rotation of the wind turbine blades. All tall structures, including tall buildings have the potential to create electromagnetic interference. The rotation of the blades of wind turbine farms exacerbates the potential for electromagnetic interference.
13. There is therefore a need for wind turbine farms to be assessed for potential impacts on CNS equipment operated by Defence and Airservices. Currently, Airservices assesses wind farm proposals for potential impact on its CNS equipment and on approach, departure and en-route procedures. Airservices will develop guidance material for determining whether the physical presence of a building (including wind farms) may have an adverse effect on the availability or quality of CNS signals.
14. These guidelines will address the infringement of critical and sensitive surfaces and unacceptable interference to facility performance. When the guidance is finalised, it will be added to the draft guidelines.

REGULATORY PROVISIONS RELATING TO WIND TURBINES AND WIND FARMS

15. Leased federal airports are protected from tall structures in the vicinity of airports based on standards established by the International Civil Aviation Organization (ICAO). This legislation, the Airports (Protection of Airspace) Regulations 1996, made under the *Airports Act 1996*, can be used to ensure wind farms hazardous to aviation are not erected in the vicinity of leased federal airports. This legislation is administered by the Australian Government Department of Infrastructure and Transport.
16. The ICAO standards form the basis of 'prescribed airspace' legislation whereby airspace surrounding an airport is regulated to ensure that obstacles to safe air transport are not

Wind turbine farms

built. However, this legislation is by definition only applicable to prescribed airspace in the vicinity of federal airports.

17. The Aeronautical Information Service of the Royal Australian Air Force (RAAF AIS) also has a requirement that all tall structures meeting the following criteria should be reported to it:
 - 30 metres or more above ground level for structures within 30km of an aerodrome; or
 - 45 metres or more above ground level for structures located elsewhere.
18. Until quite recently wind turbines have been treated as any other obstacle by ICAO. In 2009, ICAO issued an amendment to Annex 14 (Aerodromes) specifically dealing with the marking and lighting of wind turbines. In summary, ICAO has recommended the need for lighting of wind turbines if determined to be an obstacle.
19. ICAO Contracting States which are signatories to the Convention on International Civil Aviation are obliged to implement ICAO Standards unless they lodge a formal difference.
20. Annex 14 (Aerodromes) includes a provision for an aeronautical study as to the need, or otherwise, for marking and/or lighting. This is consistent with provisions in Australia for risk-based assessments of potential hazards to aviation safety.
21. Aircraft operating en route to and from aerodromes will be unlikely to be at an altitude which would necessitate obstacle lighting, except in the cases of structures which are only marginally clear of aerodrome Obstacle Limitation Surfaces (OLS), laterally or vertically. CASA has a general policy of discouraging tall structures within or close to an aerodrome OLS.

NATIONAL AIRPORTS
SAFEGUARDING ADVISORY GROUP

**GUIDELINES FOR LAND USE PLANNERS TO MANAGE THE
RISK OF WIND TURBINE FARMS AS PHYSICAL OBSTACLES
TO AIR NAVIGATION**

THE GUIDELINES

INTRODUCTION

1. Wind turbine farms can be hazardous to aviation as they are tall structures. They can also affect the performance of Communications, Navigation and Surveillance equipment operated by Airservices Australia and Defence.
2. These guidelines provide general information and advice to:
 - (a) proponents of wind farms (including single wind turbines); and
 - (b) planning authorities with jurisdiction over the approval of such structures.
3. These guidelines also provide specific advice on measures to reduce the hazard, and how to implement them.

GENERAL

4. The guidelines apply to:
 - (a) a single wind turbine, or
 - (b) a group of wind turbines, referred to as a wind farm, which may be spread over a relatively large area.
5. The height of a wind turbine is defined as the maximum height reached by the tip of the turbine blades at their highest point above ground level.
6. Wind turbines pose a particular practical problem in that their highest point is not a fixed structure to which obstacle lights can be attached. The highest fixed part of the turbine where lights can conveniently be located is the top of the generator housing, also known as the nacelle, and this is typically of the order of 2/3 of the maximum height of the turbine.
7. The marking and lighting described in this document addresses aviation requirements only. For offshore wind farms, in addition to these requirements, separate lighting and marking may be required for the safety of marine navigation.

NOTIFYING CASA OF A WIND FARM PROPOSAL

8. Prior to approaching the local planning authority for approval of a proposal to construct a wind turbine or wind turbine farm, the proponent should notify the Civil Aviation Safety Authority (CASA). However, this requirement does not apply if the top of the structure (including the turbine blade) is less than 110 metres above ground level.
9. Proponents and local planning authorities should note that airport operators are required to notify CASA if an operator becomes aware of any development or proposed construction

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Wind turbine farms

near the aerodrome that is likely to create an obstacle to aviation, or if an object will infringe the obstacle limitation surfaces (OLS) of an aerodrome.

Note: *Obstacle limitation surfaces are a complex of virtual surfaces associated with an aerodrome. They vary depending on number and orientation of runways, and the instrument-approach type of the runway(s). Some surfaces can extend to 15 km from an aerodrome. Aerodrome operators can provide details for their particular aerodrome.*

10. Any individual wind turbine, or a wind farm where any turbine in the group will be 110 metres or more above ground level should be notified to CASA.
11. Where a proposed wind turbine or a wind farm is to be located in the vicinity of an aerodrome (within 15km), the proponent of the project should contact the relevant aerodrome operator in the first instance, to ascertain whether the proposal will infringe the aerodrome's OLS. If the proposed height of the wind turbines will penetrate the OLS and the proponent still wishes to pursue the wind farm project at the selected site, then the aerodrome operator is required to notify CASA of this proposal.
12. Where the height of a proposed wind turbine or wind farm is going to be 110m or more above the ground level, the proponent of the project should notify CASA. This should be done through the nearest CASA Regional or Field Office. Location and contact details of CASA Aerodrome Inspectors may be obtained by calling CASA on 131757.
13. CASA may determine that a proposed structure will be a hazardous object because of its location, height or lack of marking or lighting. Depending on the assessment, CASA will advise the proponent whether the proposed wind farm will be determined as:
 - (a) a hazardous object, but that the risks to aircraft safety would be reduced by the provision of approved lighting and/or marking; or
 - (b) a hazardous object that CASA believes should not be built, either in the location and/or to the height proposed.
14. Proponents of wind farms where a turbine penetrates an OLS, and/or exceeds 110m above ground level, should expect that CASA will recommend appropriate obstacle lighting and marking to reduce the hazard to aviation.

MARKING OF WIND TURBINES

15. During the day, large wind turbines are sufficiently conspicuous due to their shape and size, provided the colour of the turbine is of a contrasting colour to the background.
16. Accordingly, unless the colour of the turbine is likely to blend in with the background, the characteristic obstacle marking colours and/or patterns, detailed in the Manual of Standards for Part 139 of the *Civil Aviation Safety Regulations (MOS Part 139)*, are not required.
17. Experience has shown that the white colour universally adopted for wind turbines installed so far in Australia, satisfies the requirements for daytime visibility.
18. A relatively small area on the back of each blade near the rotor hub may be treated with a different colour or surface treatment, to reduce reflection from the blades of light from the obstacle lights, without compromising the daytime visibility of the overall turbine.

Wind turbine farms

LIGHTING OF WIND TURBINES

19. The normal standard for obstacle lighting requires lights to be located as close as practicable to the top of the objects, and at other locations so as to indicate the general definition and extent of the objects.
20. For a wind turbine, the highest point is the tip of a rotating blade, presenting a practical problem with placement of lights and meeting the standard. The highest fixed part of the turbine where lights can conveniently be located is the top of the generator housing.
21. In balancing the risks and providing a practical solution, CASA has adopted a measured approach by treating the turbines differently, depending on whether they are located close to an aerodrome or some distance away.

LIGHTING OF WIND TURBINES IN THE VICINITY OF AN AERODROME

22. CASA strongly discourages the siting of wind turbines in the vicinity of an aerodrome, as these tall structures can pose serious hazards to aircraft taking-off and landing.
23. Where a proposed wind turbine has to be located such that it will penetrate the OLS of an aerodrome, and it is determined by CASA that it will require obstacle lighting, the top lights are required to be arranged so as to mark the highest point reached by the rotating blades. The need to mark the highest point is necessary because aircraft conducting the take-off and landing phases of flight will be close to the ground and providing obstacle lights at only approximately 2/3 of the maximum height of the turbine could lead pilots into a false sense of vertical separation.
24. As it is not practicable to install obstacle lights at the tip of the blades, these lights may be located on a separate supporting structure adjacent to the wind turbine, at a height that corresponds to the highest point of the rotating blade of the turbine.

LIGHTING OF WIND TURBINES NOT IN THE VICINITY OF AN AERODROME, WITH A HEIGHT OF 110m OR MORE

25. CASA can accept the construction of wind turbines or wind farms that are not in the vicinity of an aerodrome, provided they do not pose a hazard to aviation, or where the risk to aircraft safety has been minimised by the provision of approved lighting and/or marking.
26. Where a proposed wind turbine is to be located away from the vicinity of an aerodrome, and CASA recommends that obstacle lighting is required, the obstacle lights should be placed on top of the generator housing.

OBSTACLE LIGHTING STANDARDS FOR WIND TURBINES

27. In the case of a single wind turbine:
 - (a) two flashing red medium intensity obstacle lights should be provided;
 - (b) the light fixtures should be mounted sufficiently above the surface of the nacelle so that the lights are not obscured by the rotor hub, and at a horizontal separation to ensure an unobstructed view of at least one of the lights by a pilot approaching from any direction;
 - (c) both lights should flash simultaneously; and
 - (d) the characteristics of the obstacle lights should be in accordance with the standards for the Medium Intensity Obstacle Lights published in MOS Part 139.
28. In the case of a wind farm, sufficient individual wind turbines should be lighted to indicate the extent of the group of turbines:

Wind turbine farms

- (a) the interval between obstacle lighted turbines should not exceed 900m, which is the current standard for an extensive object or a group of closely spaced objects;
 - (b) in addition, the most prominent (highest for the terrain) turbine(s) should be lighted, if not included amongst the turbines lighted in accordance with (a) above; and
 - (c) the lighting of individual turbines should be in accordance with 8.1 above.
29. When CASA determines that a wind farm requires obstacle lighting, all turbines in the farm should be included in the consideration as to which ones should be lighted. For example, turbines that have a height of less than 110m above ground level may in fact extend higher into the sky than turbines that are greater than 110m in height, if the shorter turbines are located on higher ground than the taller turbines.

Note: *A group of close spaced obstacles is effectively an extensive obstacle. It is accepted practice, worldwide, to indicate extensive obstacles by lights spaced at longitudinal intervals not exceeding 900m, to indicate the general definition and extent of the extensive obstacle.*

A pilot approaching an extensive obstacle will see an array of several obstacle lights in his field of view, indicating the extent of the obstacle. An appropriate evasive manoeuvre would be to either fly over, or around the extent of the obstacle.

If a pilot sees two widely spaced obstacle lights, that indicates two separate obstacles, separated by that distance. An appropriate evasive manoeuvre in such a circumstance could be to fly between the widely spaced obstacle lights. In the case of a wind farm, if a pilot was to fly between two widely spaced obstacle lights, and there were un-lit and therefore inconspicuous turbines between the lighted ones, that would pose a real hazard to the pilot.

The spacing of turbines in a wind farm is unlikely to be such that obstacle lights can be placed on them and at the same time be longitudinally spaced at regular 900m intervals. To reduce the hazard to aviation, CASA advocates a conservative approach in the provision of obstacle lights, with longitudinal distances less than 900m being a safer alternative to longitudinal distances slightly greater than 900m.

After a wind farm proponent has designed the obstacle lighting arrangement to indicate the general definition and extent of the wind farm, they should submit a scaled map showing the proposed lighting to CASA, for endorsement.

30. To minimise visual impact on the environment, obstacle lights may be partially shielded, provided it does not compromise their operational effectiveness.
- (a) Shielding may be provided to restrict the downward component of light to either, or both, of the following:
 - (i) such that no more than 5% of the nominal intensity is emitted at or below 5° below horizontal; and
 - (ii) such that no light is emitted at or below 10° below horizontal.
 - (b) Where two lights are mounted on a nacelle, dynamic shielding or light extinction of one light at a time, for the period that a blade is passing in front of the light, is permissible provided that at all times at least one light can be seen, without interruption, from every angle in azimuth.
31. All obstacle lights on a wind farm should be synchronised so that they flash simultaneously.

Wind turbine farms

Note: *The synchronization function can be accomplished through various means, such as, but not necessarily limited to, radio frequency devices, hard-wired control cables, or independently mounted global positioning system synchronizer units.*

32. Obstacle lights should operate at night, and at times of reduced visibility. All obstacle lights on a wind farm should be turned on simultaneously and off simultaneously.
33. Where obstacle lighting is provided, proponents should establish a monitoring, reporting and maintenance procedure to ensure outages, including loss of synchronisation, are detected, reported and rectified. This would include making an arrangement for a recognised responsible person from the wind farm to notify the relevant CASA office, so that CASA can advise pilots of light outages.

MARKING AND LIGHTING BEFORE AND DURING CONSTRUCTION

34. Before developing a wind farm, it is common for masts or towers to be erected for anemometers and other meteorological sensing instruments to evaluate the suitability or otherwise of a site. Even where these structures are below the mandatory notification height of 110m, they are difficult to see from the air due to their slender construction and guy wires. This is a particular problem for aerial agriculture. Wind farm proponents are encouraged to take appropriate steps to minimize such hazards, particularly in areas where aerial agriculture is likely to occur.
35. If wind turbines in a wind farm are to be erected progressively, obstacle lighting should be progressively installed to indicate the extent of the group so far installed. This may require the provision of temporary obstacle lighting on turbines that will not require lighting in the completed farm.
36. During construction of wind turbines, equipment such as cranes can also pose a hazard to aviation. This equipment should also be appropriately obstacle marked and lighted.

REPORTING OF WIND TURBINES LESS THAN 110m IN HEIGHT

37. There is no requirement for CASA to be notified if a proposed wind turbine is less than 110 m in height and does not infringe the OLS of an aerodrome. However, being tall structures, they may still need to be included in the national database of tall structures maintained by the Royal Australian Air Force. Information on reporting of tall structures may be found in an advisory circular issued by CASA ' AC 139-08(0) Reporting of Tall Structures.

ENVIRONMENTAL CONCERNS WITH OBSTACLE LIGHTS ON WIND TURBINES

38. Concerns have been raised that the obstacle lights may be visually unacceptable to humans. It should be noted that obstacle lighting has been in use on buildings and structures for a very long time, and has been accepted in Australia and around the world. It is possible that some of the visual amenity criticism of obstacle lighting on wind turbines may stem from a concern about the wind turbine itself, rather than the lights. In any case, correct alignment, and if necessary, appropriate shielding of the light fittings should minimise the visual impact of the obstacle lighting on adjacent areas.

Wind turbine farms

VOLUNTARY PROVISION OF OBSTACLE LIGHTS

39. CASA's regulatory regime for obstacle lighting provides an appropriate level of safety for normal aircraft operations. Certain flying operations, by their nature, involve lower than normal flying, for example aerial agricultural spraying, aerial mustering, power line inspection, helicopter operations including search and rescue, some sports aviation, and some military training. Pilots conducting such operations require special training and are required to take obstacles into account when planning and conducting low flying operations. Wind farm operators should check if proposed wind turbines will be located near areas where low flying operations are likely to be conducted, and if so, consider their duty of care to such activities.
40. If a wind farm operator chooses to provide obstacle lighting even though CASA has not recommended lighting, it is recommended that the owner follow the standards for lighting contained in these guidelines. This will ensure pilots will recognise and correctly interpret the visual warning provided, and provide low flying pilots with a last line of defence against inadvertent collision.

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6.9 EXCERPT FROM ICAO ANNEX 14 RE WIND FARM LIGHTING

4.3 Objects outside the obstacle limitation surfaces

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

4.3.2 **Recommendation.**— *In areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 150 m or more above ground elevation should be regarded as obstacles, unless a special aeronautical study indicates that they do not constitute a hazard to aeroplanes.*

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

6.4 Wind turbines

6.4.1 A wind turbine shall be marked and/or lighted if it is determined to be an obstacle.

Note.— *See 4.3.1 and 4.3.2.*

Markings

6.4.2 **Recommendation.**— *The rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines should be painted white, unless otherwise indicated by an aeronautical study.*

Lighting

6.4.3 **Recommendation.**— *When lighting is deemed necessary, medium-intensity obstacle lights should be used. In the case of a wind farm, i.e. a group of two or more wind turbines, it should be regarded as an extensive object and the lights should be installed:*

- a) *to identify the perimeter of the wind farm;*
- b) *respecting the maximum spacing, in accordance with 6.3.14, between the lights along the perimeter, unless a dedicated assessment shows that a greater spacing can be used;*
- c) *so that, where flashing lights are used, they flash simultaneously; and*
- d) *so that, within a wind farm, any wind turbines of significantly higher elevation are also identified wherever they are located.*

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

6.10 REFERENCES

1. Auswind (2006) Best Practice Guidelines for Implementation of Wind Energy Projects to Australia.
2. Aviation Plan in respect to the interaction between wind turbines and aviation interests. UK Govt. URN 09/545; 30 September 2005.
3. CAA UK Civil Aviation Publication CAP 764 "CAA Policy and Guidelines on Wind Turbines" February 2009.
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