Mr Adrian Maddocks
Development Manager
White Rock Wind Farm Pty Ltd

By email: adrianmaddocks@goldwindaustralia.com

Our ref: 100308-02

Dear Adrian

Re: White Rock Wind Farm Stage 2 Obstacle Lighting Specification

Please find in this correspondence advice on the obstacle lighting requirements for the White Rock Wind Farm Stage 2 planning development to satisfy and meet regulatory requirements of the Department of Planning and Environment.

1.1. Introduction

White Rock Wind Farm Pty Ltd (WRWFPL) is preparing a response to the Department of Planning and Environment to meet relevant conditions relating to wind turbine lighting.

Project Approval MP10_0160 was granted for the WRWF on 10 July 2012 and authorises the construction and operation of a wind farm with up to 119 wind turbines and associated infrastructure in the Northern Tablelands region of NSW. Stage 1 consisting of 70 WTG sites is now built and became operational on the 19 March 2018. The proposed Stage 2 is currently subject to a Modification Application (MOD 6) assessment and could consist of up to an additional 48 WTG sites.

WRWFPL engaged Aviation Projects to prepare an Aviation Impact Assessment and a review of whether aviation safety lighting is required to be installed on selected Stage 2 turbines to support a modified Stage 2 of the WRWF development (MOD 6).

1.2. Project background

The White Rock Wind Farm (the Project) site is located approximately 18 km west of Glen Innes in New South Wales.

Stage 2 (MOD 6) proposes to use a larger Goldwind GW140 turbine or equivalent model as the indicative machine specification, with a maximum blade length of 85 m and a maximum tip height of 200 m AGL.

Stage 2 (MOD 6) proposes a review of turbine spacing and the addition of new turbine sites, resulting in a revised total of up to 48 WTG sites and an overall total of up to 118 turbines.

Aviation Projects submitted the White Rock Wind Farm Aeronautical Impact Assessment (AIA) to WRWFPL in February 2018 as part of the MOD 6 application.

Aviation Projects has assessed that there will be an acceptable level of aviation safety risk associated with the potential for an aircraft collision with a wind turbine, without obstacle lighting on the turbines of the Project.

In any case, we have been asked to provide advice set out in the Scope of Work.

1.3. Scope of Work

The scope of work for this report is to address the Department of Planning and Environment and CASA's requirements and recommendations regarding aviation obstacle lighting including development of an Obstacle Lighting Layout Plan.

1.4. References

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

- Civil Aviation Safety Authority, *Manual of Standards Part 139 – Aerodromes*, version 1.14: dated January 2017;
- Department of Infrastructure and Regional Development, Australian Government, National Airport Safeguarding Framework, *Guideline D Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation, dated June 2013*;
- NSW Government, NSW Legislation, Environmental Planning and Assessment Act 1979, No 203, dated 3 April 2018;
- United States, Federal Aviation Administration, Advisory Circular AC 70/7460-1L CHG1, dated 10.08.2019; and
- other references as noted.

1.5. Client material

WRWFPL provided the following materials for the purposes of this analysis:

- White Rock Wind Farm Pty Ltd, 170629_WRWF_WTG_Elevations.xlsx, received 030717; and
- White Rock Wind Farm Pty Ltd, WRWF_S2_WTG_Layout19+48WTG.kml, received 030717.

1.6. Civil Aviation Safety Authority

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

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

Section 9.4.1 provides some general guidance on obstacle lighting:

9.4.1.2 In general, an object in the following situations would require to be provided with obstacle lighting unless CASA, in an aeronautical study, assesses it as being shielded by another lit object or that it is of no operational significance:

> *(b) outside the obstacle limitation surfaces of an aerodrome, if the object is or will be more than 110 m above ground level.*

Section 9.4.2 provides guidance on Types of Obstacle Lighting and Their Use:

9.4.2.3 Medium intensity obstacle lights are to be used either alone or in combination with low intensity lights, where:

> *(a) the object is an extensive one;*
>
> *(b) the top of the object is 45 m or more above the surrounding ground; or*
>
> *(c) CASA determines that early warning to pilots of the presence of the object is desirable.*

9.4.2.5 High intensity obstacle lights are flashing white lights used on obstacles that are in excess of 150 m in height.

1.7. CASA advice on obstacle lights

CASA has assessed the proposed the White Rock Wind Farm Modified Stage 2 (MOD 6) development modification to be a potential hazard to air navigation and has suggested to install steady red medium intensity hazard lights to mitigate this risk. The advice is as follow:

> *The proposal seeks to use larger Goldwind GW140 turbines with a maximum tip height of 200 m and an increase in total turbines to 118.*
>
> *Due to their height above ground level, CASA considers the turbines to be a potential hazard to air navigation. The risk can be suitably mitigated by the installation of steady red medium intensity hazard lights installed in accordance the NASF Guideline D – Wind Turbines, para 35 to be operational at night and at times of reduced visibility.*
>
> *ICAO recommends that: 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. (Ref ICAO Annex 14 Vol 1 para 6.2.4.4).*
>
> *NASF Guideline D – Wind Turbines, para 36 states: To minimise the visual impact on the environment, obstacle lights may be partially shielded, provided it does not compromise their operational effectiveness.*
>
> *Should such lighting be considered a negative impact on visual amenity and result in resident objection, CASA would recommend that an Aircraft Detection Lighting System (as recommended in the United States Federal Aviation Administration Advisory Circular AC 70/7460-1L CHG1 – Obstruction Marking and Lighting), be installed. Such a system would only activate the light when an aircraft is detected in the near vicinity and deactivate the light once the aircraft has passed. This would be a reasonable and feasible alternative to having the light activated from dusk to dawn and in*

low light levels during the day and would ensure aviation hazard lighting is implemented in a manner that minimises visual intrusion to surrounding residences.

In support of subpart 175.E of the Civil Aviation Safety Regulations 1998, CASA recommends that all permanent obstacles 100 m or more above ground level are reported to the Aeronautical Information Service (AIS) provider, Airservices Australia.

1.8. Department of Infrastructure and Regional Development

Department of Infrastructure and Regional Development, Australian Government, released the National Airport Safeguarding Framework, *Guideline D Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation* issued on June 2013. Guideline D sets out recommendations on wind farm turbine lighting as follows:

Obstacle lighting standards for wind turbines

35. When lighting has been recommended by CASA to reduce risk to aviation safety, medium-intensity obstacle lights should be used. Where used, lighting on wind farms should be installed:

(a) to identify the perimeter of the wind farm;

(b) respecting a maximum spacing of 900m between lights along the perimeter, unless an aeronautical study shows that a greater spacing can be used;

(d) within a wind farm, any wind turbines of significantly higher elevation are identified wherever located.

36. To minimise the visual impact on the environment, obstacle lights may be partially shielded, provided it does not compromise their operational effectiveness. Where obstacle lighting is provided, 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.

1.9. Department of Planning and Environment

The role of the NSW Department of Planning and Environment is to coordinate the planning process according to the applicable regulations, and in partnership with individual people, community groups, businesses and industry groups, other organisations, local councils, and State and Commonwealth Government agencies. The legal framework includes the Environmental Planning and Assessment Act 1979 and Environmental Planning and Assessment Regulation 2000. Development projects such as wind farms in NSW must submit a development application for approval by the Minister for Planning.

In December 2016, Department of Planning and Environment released *the Wind Energy Framework* stating the following:

Wind energy developers are required to work with the Civil Aviation Safety Authority and the Royal Australian Air Force Aeronautical Information Service and may be required to prepare an aeronautical impact assessment as part of the project.

1.10. Aircraft Detection Lighting System

The United States Federal Aviation Administration (FAA) Advisory Circular AC 70/7460-1L CHG1 – Obstruction Marking and Lighting) sets standards for marking and lighting obstructions that have been deemed to be a hazard to air navigation, stating the following:

> *14.1 Purpose.*
>
> > *Aircraft Detection Lighting Systems (ADLS) are sensor-based systems designed to detect aircraft as they approach an obstruction or group of obstructions; these systems automatically activate the appropriate obstruction lights until they are no longer needed by the aircraft. This technology reduces the impact of nighttime lighting on nearby communities and migratory birds and extends the life expectancy of obstruction lights.*
>
> *14.2 General Standards.*
>
> > *14.2.1 The system should be designed with sufficient sensors to provide complete detection coverage for aircraft that enter a three-dimensional volume of airspace, or coverage area, around the obstruction(s)…*
>
> *14.2.2 The ADLS should activate the obstruction lighting system in sufficient time to allow the lights to illuminate and synchronize to flash simultaneously prior to an aircraft penetrating the volume defined above…*

NASF Guideline D at paragraph 38 incorporates a one-paragraph discussion of the concept of 'on-demand aviation obstacle lighting systems':

> *In some circumstances, it may be feasible to install obstacle lights that are activated by aircraft in the vicinity. This involves the use of radar to detect aircraft within a defined distance that may be at risk of colliding with the wind farm. When such an aircraft is detected, the wind farm lighting is activated. This option may allow aviation safety risks to be mitigated where obstacle lighting is recommended while minimising the visual impact of the wind farm at night.*

1.11. International Civil Aviation Organization

As a contracting state to the International Civil Aviation Organization (ICAO) and signatory to the Chicago Convention on International Civil Aviation, Australia has an obligation to implement ICAO's standards and recommended practices (SARPs) as published in the various annexes to the Convention. Where these SARPs are not met, a difference must be filed.

Annex 14 to the Convention — Aerodromes, Volume 1 documents SARPs applicable to wind turbines. Paragraph 6.2.4.4 of Annex 14 provides as follows:

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

1.12. Obstacle lighting layout plan

Refer to Figure 1 for an illustration of proposed obstacle lighting layout plan.

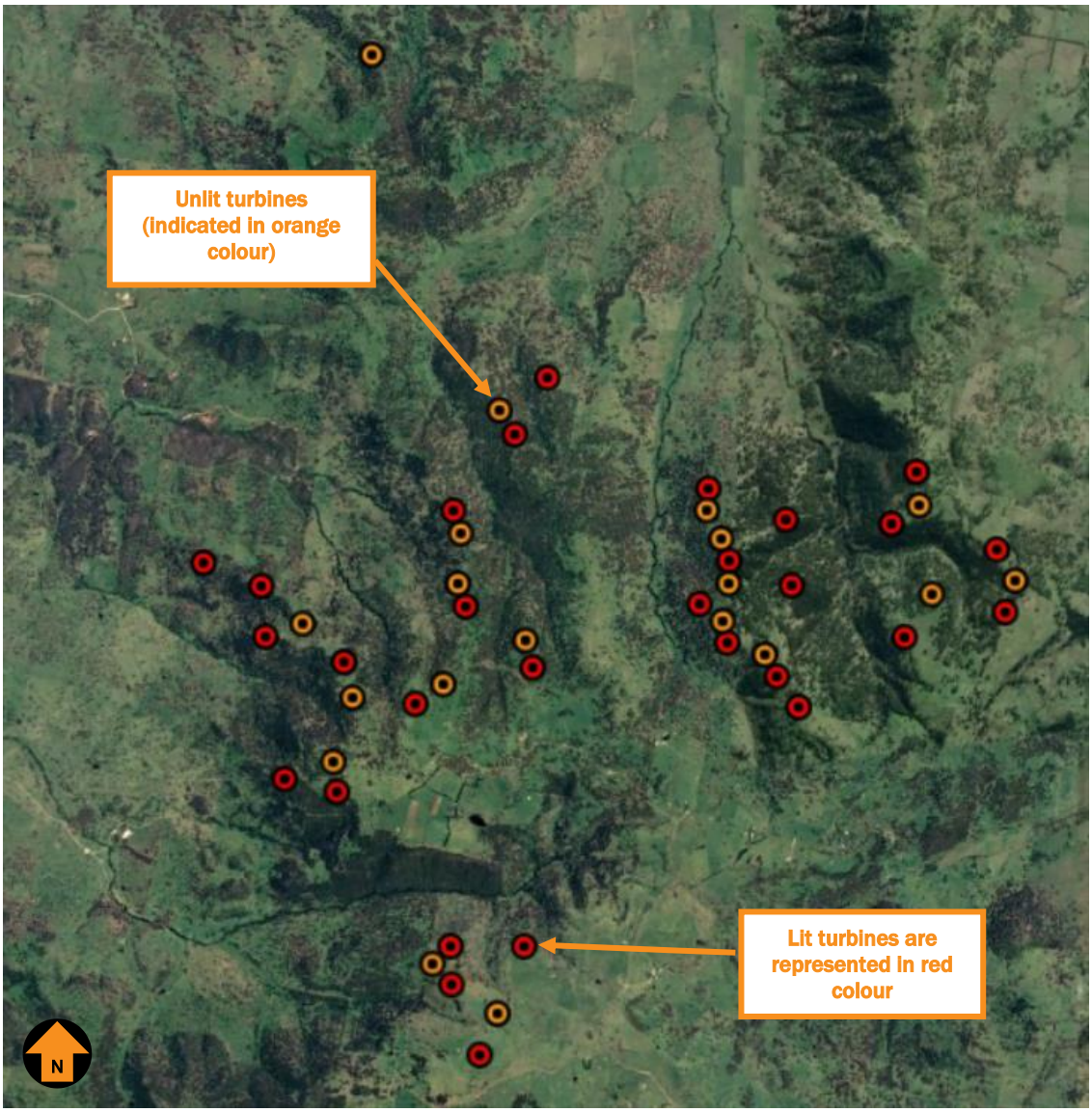


Figure 1 WRWF Stage 2 Obstacle lighting layout plan

1.13. Wind turbine 12 lighting consideration

WTG 12 is not intended to be lit as it is located within the Stage 1 wind turbines with approximately equal to or greater tip height in close proximity. There is currently no requirement to light Stage 1 turbines, and so if

WTG 12 is fitted with obstacle lighting it may lead to confusion and increased risk for aircraft flying in the immediate area given WTG 12's distance from the core cluster of Stage 2 located south and south east of Stage 1.

Figure 2 shows the location of WTG 12 relative to unlit turbines of Stage 1 of the Project.

Figure 2 Wind turbine lighting specification of WTG 12

Note: Stage 1 of the WRWF Project has no obstacle lighting installed on wind turbines.

1.14. Stage 2 lit and unlit turbines

Table 1 contains information on wind turbine that shall be lit and those that shall remain unlit.

Table 1 Stage 2 lit and unlit wind turbines

WTG ID	Lit / Unlit	WTG ID	Lit / Unlit	WTG ID	Lit / Unlit	WTG ID	Lit / Unlit	WTG ID	Lit / Unlit
12	Unlit	84	**Lit**	95	**Lit**	122	**Lit**	132	**Lit**
42	**Lit**	85	Unlit	105	**Lit**	123	Unlit	133	**Lit**
43	Unlit	86	Unlit	106	Unlit	124	Unlit	134	Unlit
45	Unlit	87	**Lit**	107	**Lit**	125	**Lit**	135	**Lit**
46	**Lit**	88	Unlit	108	**Lit**	126	**Lit**	136	Unlit
49	Unlit	89	**Lit**	114	**Lit**	127	Unlit	137	**Lit**
50	**Lit**	90	Unlit	115	Unlit	128	**Lit**	138	Unlit
66	Unlit	91	**Lit**	116	**Lit**	129	**Lit**	139	**Lit**
67	**Lit**	92	Unlit	120	**Lit**	130	**Lit**		
70	**Lit**	93	**Lit**	121	Unlit	131	**Lit**		

1.15. Obstacle light specifications

To accord with the requirements specified in MOS 139 Section 9.4.2.3 Type of Obstacle Lighting and Their Use, Section 9.4.3.4A Location of Obstacle Lights and Section 9.4.7 Characteristics of Medium Intensity Obstacle Lights, the following wind turbine light specifications apply:

- turbines should be fitted with two steady red medium intensity lights and operated at night and at times of reduced visibility;
- the downward component of obstacle lighting may be shielded to the extent:
    - no more than 5% of the nominal light intensity is emitted at or below 5° below horizontal; or
    - no light is emitted at or below 10° below horizontal.
- two lights must be provided on top of the generator housing in a way that allows at least one of the lights to be seen from every angle in azimuth;
- Characteristics of medium intensity obstacle lights as follows:
- the peak effective intensity is to be 2,000 ± 25% cd with a vertical distribution as follows:

- vertical beam spread is to be 3° minimum (beam spread is defined as the angle between two directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity);
- at -1° elevation, the intensity is to be 50% minimum and 75% maximum of lower tolerance value of the peak intensity; and
- at 0° elevation, the intensity is to be 100% minimum of the lower tolerance value of the peak intensity.

A plan showing the proposed obstacle lighting layout and specification for Stage 2 is **enclosed.**

1.16. Aircraft Detection Lighting System consideration

The ADLS is designed to mitigate the impact of night time lights by deploying a radar-based system around a wind farm, turning lights on only when low-flying aircraft are detected nearby. This system provides an alternative to a convention method of wind turbine lighting and may be considered by the Proponent for utilisation.

If you wish to clarify or discuss of the contents of this correspondence, please contact me on 0417 631 681.

Kind regards

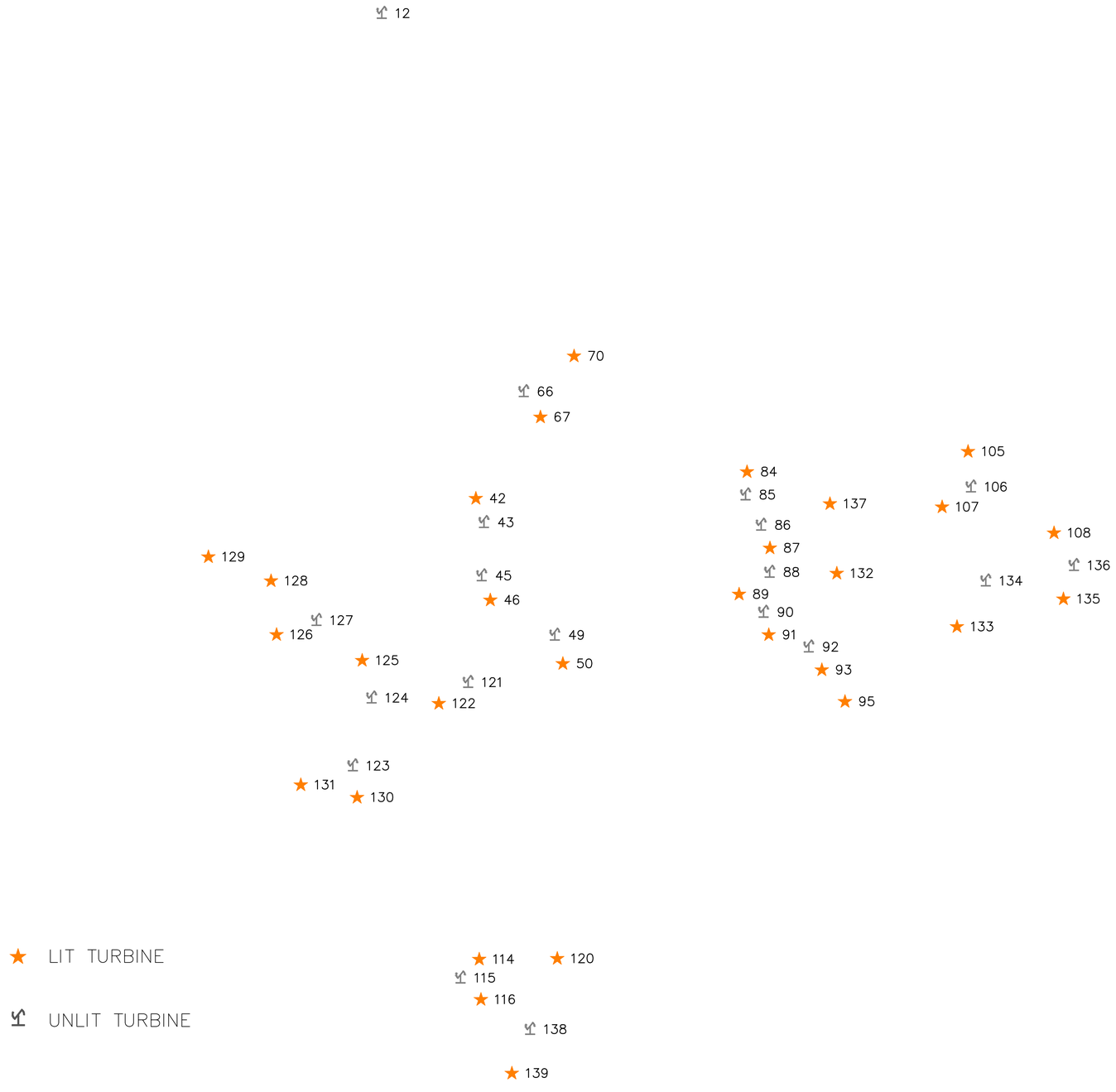
Keith Tonkin

Managing Director

30 May 2018

Enclosure: EP18034-WRWF-DWG-1000-A, Proposed Layout – Lit and Unlit Turbines, Rev B, 22 May 2018

WHITE ROCK WIND FARM
OBSTACLE LIGHTING DESIGN



★ LIT TURBINE

UNLIT TURBINE

1. Light and shielding Specification:

Light characteristics:

- 2 steady red medium intensity lights:
  - the peak effective intensity is to be 2,000 ± 25% cd with a vertical distribution as follows:
    - vertical beam spread is to be 3º minimum (beam spread is defined as the angle between two directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the peak intensity);
    - At -1º elevation, the intensity is to be 50% minimum and 75% maximum of lower tolerance value of the peak intensity; and
    - At 0º elevation, the intensity is to be 100% minimum of the lower tolerance value of the peak intensity.

Shielding:

- the downward component of obstacle lighting may be shielded to the extent:
  - no more than 5% of the nominal light intensity is emitted at or below 5º below horizontal; or
  - no light is emitted at or below 10º below horizontal.

- two lights must be provided on top of the generator housing in a way that allows at least one of the lights to be seen from every angle in azimuth.

2. References

- Civil Aviation Safety Authority, *Manual of Standards Part 139 - Aerodromes*, v1.14, 2017, Section 9.4.2.3, Section 9.4.4.4A and Section 9.4.7;
- Department of Infrastructure and Regional Development, Australian Government, National Airport Safeguarding Framework, *Guideline D Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*, 2013, paragraphs 35, 36 and 37; and
- NSW Government, NSW Legislation, Environmental Planning and Assessment Act 1979, No 203, dated 3 April 2018.

REV	DESCRIPTION	DATE
B	REVISED OBSTACLE LIGHTING PATTERN	22.05.18
A	FOR INFORMATION	16.05.18

POSITION	NAME	SIGNATURE
DRAWN	TO	
DESIGNED		
DRAFTING CHECK	AC	
DESIGN CHECK	PO	
DESIGN MGR APPROVAL	PB	
PROJECT APPROVAL		

PROJECT: AVIATION PROJECTS

AIRPORT DESIGN CONSULTANT: ACG AIRPORT CONSULTANCY GROUP — www.acgaustralia.com.au

TITLE: WHITE ROCK WIND FARM OBSTACLE LIGHT SPECIFICATION
AVIATION PROJECTS
PROPOSED LAYOUT LIT & UNLIT WIND TURBINES

DRAWING SCALE	ORIG. SIZE	DRAWING No.	REVISION
1: 30000		EP18034-WRWF-DWG-1000-A	B

FILE: O:\EP18034 - AVPROJECTS WIND FARM\10-CD\EP18034-WRWF-DWG-1000-AINEW DATA\DWG

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