- a description of the visibility of the development
- photomontages of the project and associated transmission lines taken from:
  - potentially affected residences (including approved but not yet developed dwellings or subdivisions with residential rights) within 2 km of a proposed wind turbine or other associated infrastructure (note that the number of photomontages may be reduced in less sensitive landscapes such as industrial areas),
  - urban settlements, and
  - significant public view points including roads, lookout points and walkways.
- identification of the zone of visual influence of the wind farm (no less than 10km)
- a description of the significance of the landscape values and character in a local and regional context
- a description of community and stakeholder values of the local and regional visual amenity and quality and perceptions of the project based on surveys and consultation.
- assessment of cumulative impacts on the landscape and any cumulative visual impacts from transmission line infrastructure and any surrounding approved or operational wind farms in the locality

Mitigating landscape and visual amenity impacts

The feasibility, effectiveness and reliability of proposed mitigation measures should be assessed. The extent of any residual impacts left over after mitigation measures have been implemented should also be described. Examples of mitigation measure that proponents can use to reduce the visual impact of a proposed wind farm include:

- where possible, locate turbines:
  - away from areas with high scenic values
  - away from areas with high visibility from local residents
- select turbines that :
  - look the same, have the same height and rotate the same way
  - are off-white or grey colouring
- minimise the removal of vegetation
- plant vegetation to provide a visual screen
- reduce impacts of night and obstacle lighting by
  - limiting lighting on towers to that required for safe operation and aviation safety and
  - use of lighting design which minimises glare
- underground electricity wires where practicable
- use alternative transmission line pole designs to minimise visual impact.

Appendix B – Civil Aviation Safety Authority Advisory Circular AC139-18(0) July 2007 (Withdrawn)

Australian Government
Civil Aviation Safety Authority

Advisory Circular

AC 139-18(0) SEPTEMBER 2004

OBSTACLE MARKING AND LIGHTING OF WIND FARMS

CONTENTS

1. REFERENCES

- CASR Part 139, Subpart 139.E, and in particular
  - ◊ 139.365 Structures 110 metres or more above ground level.
  - ◊ 139.370 Hazardous objects etc.
- MOS-Part 139 Chapter 7 – Obstacle Restrictions and Limitations.
- MOS-Part 139 Section 8.10 – Obstacle Marking.
- MOS-Part 139 Section 9.4 – Obstacle Lighting.

2. PURPOSE

This Advisory Circular (AC) provides general information and advice on the obstacle marking and lighting of Wind Farms (including single wind turbines), where CASA has determined that the wind farm is, or will be, a hazardous object to aviation.

3. STATUS OF THIS AC

This is the first AC to be issued on this subject.

Advisory Circulars are intended to provide recommendations and guidance to illustrate a means but not necessarily the only means of complying with the Regulations, or to explain certain regulatory requirements by providing interpretative and explanatory material.

Where an AC is referred to in a 'Note' below the regulation, the AC remains as guidance material.

ACs should always be read in conjunction with the referenced regulations

4. GENERAL

4.1 This AC applies specifically to horizontal-axis wind turbines, which are the only type installed, or known to be proposed for installation, in Australia, at the date of issue of this document.

4.2 This AC applies 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.

4.3 The height of a wind turbine is defined to be the maximum height reached by the tip of the turbine blades.

4.4 Australian standards and recommended practices for the marking and lighting of obstacles and objects assessed as being hazardous to aviation, are consistent with international standards and recommended practices as published by the International Civil Aviation Organisation (ICAO) in Annex 14 Volume 1 (Aerodrome Design and Operations). The general requirements are:

(a) marking is used to make objects conspicuous to pilots, by day.

(b) lighting is used to make objects conspicuous to pilots, by night;

(c) lights are 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.

4.5 Wind turbines pose a particular practical problem in that their highest point is not a fixed structure, and therefore lights can not be appropriately located. The highest fixed part of the turbine where lights can conveniently be located is the top of the generator housing, sometimes known as the nacelle, and this is typically of the order of 2/3 the maximum height of the turbine.

4.6 ICAO has not yet published standards and recommended practices specifically suited to wind turbines. The advice in this document has been derived by allowing some variations to standards and recommended practices to accommodate the specific practical difficulties associated with wind turbines and wind farms, and taking into consideration the practices of some overseas countries.

5. WIND TURBINES IN THE VICINITY OF AN AERODROME

5.1 CASA strongly discourages the siting of wind turbines in the vicinity of an aerodrome.

5.2 A wind turbine located sufficiently close to an aerodrome so that it penetrates an obstacle limitation surface (OLS) of the aerodrome, is defined by MOS-Part 139 Section 7.1, to be an obstacle.

5.3 If the aerodrome is to be used at night, an obstacle that penetrates an OLS should be lighted, in accordance with MOS-Part 139 Section 9.4. The top lights are required to be arranged so as to at least indicate the points or edges of the object highest above the obstacle limitation surface. For a wind turbine, these lights may be located on a separate supporting structure adjacent to the wind turbine, to overcome the difficulty associated with the highest point of the obstacle being the (moving) blades of the turbine.

Note: Obstacle limitation surfaces are a complex of imaginary 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.

6. WIND TURBINES WITH A HEIGHT OF 110 m OR MORE

6.1 CASR 139.365 requires a person proposing to construct a building or structure, the top of which will be 110 m or more above ground level, to inform CASA of that intention and the proposed height and location of the proposed building or structure.

6.2 CASA will conduct an aeronautical study to determine if the wind turbine will be a hazardous object to aviation, in accordance with CASR 139.370.

6.3 If, as a result of the aeronautical study CASA finds that a proposed wind turbine will penetrate an OLS of an aerodrome, the proposal will be dealt with in accordance with 5 above.

6.4 The aeronautical study may find that even though the proposed wind turbine will not penetrate any OLS of an aerodrome, it will be a hazardous object to aviation.

6.5 The hazard that an object poses to aviation can be reduced by indicating its presence by appropriate marking and/or lighting.

Note: The marking and/or lighting does not necessarily reduce operating limitations which may be imposed by an obstacle or hazardous object.

6.6 The advice, in 7 and 8 below, on marking and lighting of wind turbines, should be suitable for wind turbines that do not penetrate an OLS, in most cases. However, because of the variations in configurations and layout of turbines in wind farms, the aeronautical study may indicate that a variation to that advice would be appropriate for a particular wind farm. In such a case, CASA may offer suggestions for variations to the normal advice provided in 7 and 8 below.

7. MARKING OF WIND TURBINES

7.1 Experience with wind turbines installed to date, indicates that they are sufficiently conspicuous by day, due to their shape, size, and colour.

7.2 Wind turbines that are of basically a single colour, and visually conspicuous against the prevailing background, do not require to be painted in obstacle marking colours and/or patterns.

8. LIGHTING OF WIND TURBINES

8.1 In the case of a single wind turbine:

(a) two flashing red medium intensity obstacle lights should be mounted on top of the generator housing;

(b) the light fixtures should be mounted 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 MOS-Part 139 subsection 9.4.7.

8.2 In the case of a wind farm, sufficient individual wind turbines should be lighted to indicate the extent of the group of turbines:

(a) the interval between obstacle lights should not be less than the current extensive object standard of 900 metres, and at a distance that minimises the number of lighted wind turbine generators without diminishing appropriate aviation safety;

(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.

*Note**:*** *There is an overseas proposal that all lighting provided at a wind farm should flash simultaneously. This proposal is still to be validated and accepted. It is suggested that wind farm operators bear in mind that the simultaneous flashing of all lights at a wind farm could become accepted practice some time in the future.*

8.3 On completion of the project, CASA may choose to conduct a flight check to determine the adequacy of the obstacle lighting. This may result in a change (either more or fewer) to the number of obstacle lights required, to ensure the development remains conspicuous.

8.4 Where obstacle lighting is to be provided, it is recommended a monitoring, reporting and maintenance procedure be put in place to ensure outages are reported through the NOTAM system and repairs are implemented.

Bill McIntyre
Executive Manager
Aviation Safety Standards

Appendix C – Andrew Homewood, curriculum vitae

GREEN BEAN DESIGN *landscape architects* PO Box 3178 Austral NSW 2179 - Mobile 0430 599 995

GREEN BEAN DESIGN *landscape architects*

CURRICULUM VITAE

Andrew Homewood Grad Dip LM, BSc (Dual Hons), Dip Hort - Registered Landscape Architect, AILA

Areas of Expertise

Landscape/urban design
Landscape management
Landscape and visual impact assessment
Independent verification
Landscape photography

Academic

Post Graduate Diploma Landscape Management (Sheffield University 1996)
BSc (Dual Hons) Landscape Architecture and Archaeology (Sheffield University 1994)
National Diploma Amenity Horticulture (Writtle College 1986)

Green Bean Design (GBD) is an experienced landscape architectural consultancy specialising in landscape and visual impact assessment. As an independent consultancy GBD provide professional advice to a range of commercial and government clients involved in large infrastructure project development.

GBD owner and Principal Landscape Architect Andrew Homewood is a Registered Landscape Architect and member of the Australian Institute of Landscape Architects and the Environmental Institute of Australia and New Zealand.

Andrew has over 20 years continuous employment in landscape consultancy and has completed numerous landscape and visual impact assessments for a range of large scale and State significant infrastructure and renewable energy projects, including wind energy and solar power developments. Green Bean Design has been commissioned for over 20 wind energy projects across New South Wales, Victoria, South Australia, Queensland and Tasmania.

CURRICULUM VITAE

Andrew Homewood Grad Dip LM, BSc (Dual Hons), Dip Hort - Registered Landscape Architect, AILA

Selected Project Experience — ***Landscape and Visual Impact Assessment***

Wind and Solar Farms

BP Moree Solar Power Station, Status: Approved

LVIA for the Solar Flagship Moree Solar Farm site in northern New South Wales.

Boco Rock Wind Farm EA, (Wind Prospect CWP Pty Ltd) Status: Approved

LVIA for the proposed construction of up to 125 wind turbine generators in the NSW Southern Tablelands Monaro sub region, including coordination for supply of photomontage, ZVI and flicker assessment.

Sapphire Wind Farm EA (Wind Prospect CWP Pty Ltd) Status: Approved

LVIA for the proposed construction of up to 174 wind turbine generators in the NSW New England region, including coordination for supply of photomontage, ZVI and flicker assessment.

Silverton Wind Farm EA Stages 1 & 2 (Epuron Pty Ltd) Status: Approved

LVIA for a 1000MW wind farm at Silverton in the Unincorporated Area of western NSW, for up to 600 wind turbines including a 25km length of 220kV transmission line between the wind farm and Broken Hill.

Conroy's Gap Wind Farm (Epuron Pty Ltd) Status: Approved

LVIA for a DA modification for additional wind turbines to an approved development located in the southern highlands NSW.

Collector Wind Farm EA, (RACL Australia Pty Ltd) Status: Approved

LVIA for the proposed construction of up to 68 wind turbines adjoining the operation Cullerin wind farm project including a detailed cumulative impact assessment.

Mount Emerald Wind Farm (RACL Australia Pty Ltd)

LVIA for the proposed construction of up to 75 wind turbines located in the Atherton Tablelands Far North Queensland.

Bango Wind Farm (Wind Prospect CWP Pty Ltd)

LVIA for the proposed construction of up to 100 wind turbines located in the southern highlands NSW.

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Liverpool Range Wind Farm Stage 1 (Epuron Pty Ltd)

LVIA for the proposed construction of up to 200 wind turbines located in the Warrumbungle and Upper Hunter Shire Councils approximately 370 km north of Sydney, and a 60 km length of 330 kV line connecting to the Ulan mine site.

Rye Park Wind Farm, (Epuron Pty Ltd)

LVIA for the proposed construction of up to 120 wind turbines adjoining multiple wind farm sites in the New South Wales southern highlands.

Deepwater Wind Farm (Epuron Pty Ltd)

LVIA for the proposed construction of up to 7 wind turbines at Deepwater in north NSW.

Port Kembla Wind Farm (Epuron Pty Ltd)

LVIA for the proposed construction of up to 7 wind turbines within the Port Kembla industrial facility at Wollongong.

Eden Wind Farm, (Epuron Pty Ltd)

LVIA for the proposed construction of up to 7 wind turbines within the SEFE woodchip facility on the south coast of New South Wales.

Paling Yards Wind Farm EA, (Union Fenosa Pty Ltd)

LVIA for the proposed construction of up to 59 wind turbines including night lighting, cumulative impact assessment, detailed field assessment for shadow flicker and preparation of photomontages.

Willatook Wind Farm EES Referral, (Wind Prospect WA Pty Ltd)

Preliminary LVIA for the proposed construction of up to 190 wind turbines within Moyne Shire Council (Victoria) including a detailed cumulative impact assessment, photomontage location selection and community consultation.

White Rock Wind Farm EA, (Epuron Pty Ltd)

LVIA for the proposed construction of up to 100 wind turbines adjoining the proposed Sapphire and approved Glen Innes wind farm projects including a detailed cumulative impact assessment, photomontage

CURRICULUM VITAE

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location selection and community consultation.

Crookwell 3 Wind Farm EA, (Union Fenosa Wind Australia)

LVIA for the proposed construction of up to 35 wind turbines adjoining the approved Crookwell 2 wind farm development including a detailed cumulative impact and night time lighting assessment.

Granville Harbour Wind Farm, (Westcoast Wind)

LVIA for the proposed construction of up to 33 wind turbines in north west Tasmania.

Professional History

Green Bean Design, Principal Landscape Architect 2006 – to date

URS Australia Pty Ltd, Practice Leader Landscape Architecture 2005 – 2006

URS Australia Pty Ltd, Associate Landscape Architect 2003-2005

URS Australia Pty Ltd, Senior Landscape Architect, 2002 – 2003

URS Australia Pty Ltd, Landscape Planner, 2001-2002

URS, Contract Landscape Architect, 2000-2001

Blacktown City Council, Contract Landscape Planner, 2000-2001

Knox & Partners Pty Ltd, Landscape Architect, 1996-2000

Brown & Associates, Landscape Architect, 1996

Philip Parker & Associates, Graduate Landscape Architect, 1994-1995
Rendel & Branch, Landscape Assistant, 1989-1991

National Trust, Horticulturalist, 1987-1988

English Nature, Species Protection Warden, 1985-1986

Essex Wildlife Trust, Botanist, 1984-1985

Royal Society for the Protection of Birds, Voluntary Warden, 1983-1984