



Advisory Circular

AC 139-18(0)

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OBSTACLE MARKING AND LIGHTING OF WIND FARMS

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1. REFERENCES

- 1 • Civil Aviation Safety Regulations 1998 (CASR) Part 139, Subpart 139.E.
- 1 • Manual of Standards (MOS) Part 139.

2. PURPOSE

- 2 **2.1** Being tall structures, wind turbines can be hazardous objects to aviation.
- 3 **2.2** This Advisory Circular (AC) provides general information and advice to:
 - 4 (a) proponents of wind farms (including single wind turbines), and
 - 4 (b) planning authorities with jurisdiction over the approval of such structures.
- 4 **2.3** This AC also provides specific advice on measures to reduce the hazard, and how to implement them.

3. STATUS OF THIS AC

- 6 **3.1** This is the first AC to be issued on this subject.

Advisory Circulars are intended to provide advice 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 informative, 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 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.

4.2 The height of a wind turbine is defined to be the maximum height reached by the tip of the turbine blades above ground level.

4.3 Wind turbines pose a particular practical problem in that their highest point is not a fixed structure, and therefore obstacle 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, also known as the nacelle, and this is typically of the order of 2/3 the maximum height of the turbine.

4.4 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.

5. NOTIFYING CASA OF A WIND FARM PROPOSAL

5.1 Under the Civil Aviation Safety Regulations 1998 (CASR) Part 139, the Civil Aviation Safety Authority (CASA) must be notified:

- (a) by an aerodrome operator, if it becomes aware of any development or proposed construction near the aerodrome that is likely to create an obstacle, or if an object will infringe the obstacle limitation surfaces (OLS) of an aerodrome; or
- (b) by a person who proposes to construct a building or structure the top of which will be 110 metres or more above ground level.

***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.*

5.2 An individual wind turbine, or a wind farm where any turbine in the group meets the above criteria, must be notified to CASA.

5.3 Where a wind turbine or a wind farm is proposed 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.

5.4 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 is required by regulation 139.365 of the CASRs to notify CASA. This should be done through the nearest CASA Regional or Field Office. Location and contact details of CASA Aerodrome Inspectors may be found on CASA's website: <http://casa.gov.au/aerodromes/contacts.htm>.

5.5 Under CASR Part 139, Subpart E, 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:

- (a) as a hazardous object, but that the risks to aircraft safety would be reduced by the provision of approved lighting and/or marking, or
- (b) as a hazardous object, that CASA believes should not be built either in the location and/or to the height proposed.

5.6 The hazard determination is a notice to recipients that if CASA's advice is not followed, they are responsible for creating a hazard to aircraft safety and may be implicated in the liability for a resultant accident. When such a determination is made, it will be directed not only to the proponent of the wind farm, but also to any authorities whose approval is required for the construction.

5.7 Proponents of wind farms where a turbine penetrates an OLS, and/or exceeds 110m above ground level, should expect that CASA will require appropriate obstacle lighting and marking to reduce the hazard to aviation, unless the circumstances at a particular wind farm are very unusual.

6. MARKING OF WIND TURBINES

6.1 CASA has determined that by 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.

6.2 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 MOS Part 139, are not required.

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

6.4 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 conspicuity of the overall turbine.

7. LIGHTING OF WIND TURBINES

7.1 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.

7.2 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.

7.3 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 from it.

8. LIGHTING OF WIND TURBINES IN THE VICINITY OF AN AERODROME

8.1 CASA strongly discourages the siting of wind turbines in the vicinity of an aerodrome, as these tall structures can pose serious hazards to aircraft conducting take-off and landing operations.

8.2 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.

8.3 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 is corresponding to the highest point of the rotating blade of the turbine.

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

9.1 CASA does not oppose 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.

9.2 Where a proposed wind turbine is located not in the vicinity of an aerodrome, and CASA has determined that obstacle lighting is required, the obstacle lights may be placed on top of the generator housing.

10. OBSTACLE LIGHTING STANDARDS FOR WIND TURBINES

10.1 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 Characteristics of Medium Intensity Obstacle Lights in MOS Part 139, chapter 9. See <http://casa.gov.au/rules/1998casr/139/139m09.pdf>

10.2 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 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 10.1 above.

10.3 When it has been determined 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.

10.4 To minimise visual impact on the environment, some shielding of the obstacle lights is permitted, 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.
 - (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 providing that at all time at least one light can be seen, without interruption, from every angle in azimuth.

10.5 All obstacle lights on a wind farm are to be synchronised so that they flash simultaneously.

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.*

10.6 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.

10.7 Where obstacle lighting is provided, it is necessary to 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 initiate NOTAM action to advise pilots of light outages.

11. MARKING AND LIGHTING BEFORE AND DURING CONSTRUCTION

11.1 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.

11.2 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.

11.3 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.

12. REPORTING OF WIND TURBINES LESS THAN 110m IN HEIGHT

12.1 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 AC 139-08(0) Reporting of Tall Structures: <http://casa.gov.au/rules/1998casr/139/139c08.pdf>.

13. ENVIRONMENTAL CONCERNS WITH OBSTACLE LIGHTS ON WIND TURBINES

13.1 There have been concerns 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 the rest of the world. It is possible that some of the visual amenity criticism of obstacle lighting on wind turbines may be an expression of the real concern with 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.

14. VOLUNTARY PROVISION OF OBSTACLE LIGHTS

14.1 CASA's regulatory regime for obstacle lighting provides an appropriate level of safety for normal aircraft operations. Certain flying operations, by their fundamental nature, involves 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. Such operations are beyond the normal. These pilots 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.

14.2 If a wind farm operator chooses to provide obstacle lighting, of his own volition, the owner should follow the standards for lighting contained in this AC. 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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