Australian Government
Civil Aviation Safety Authority

ADVISORY CIRCULAR
AC 139.E-05 v1.0

Obstacles (wind farms) outside the vicinity of a CASA certified aerodrome

Date	January 2021
Project number	AS 14/24
File ref	D18/451336

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.

Advisory Circulars should always be read in conjunction with the relevant regulations.

Audience

This advisory circular (AC) applies to:

- persons involved in the design, construction and operation of wind farms and monitoring masts
- proponents of wind farms and wind monitoring masts
- planning authorities
- aerodrome and aircraft landing area operators
- the Civil Aviation Safety Authority (CASA).

Purpose

Wind turbine installations (wind farms and monitoring towers) may pose a safety risk to aviation due to their physical characteristics, size and their location. The purpose of this AC is to provide guidance on matters that should be considered when assessing a wind turbine development so that all necessary measures can be taken to protect aviation safety. Mitigation measures such as warning lights, and reporting of tall structures that are at least 100m AGL, are also prescribed.

For further information

For further information, contact CASA's Air Navigation, Airspace and Aerodromes Branch (telephone 131 757 or email Airspace.Protection@casa.gov.au).

Unless specified otherwise, all sub regulations, regulations, divisions, subparts, and parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

Status

This version of the AC is approved by the Manager, Flight Standards Branch.

Version	Date	Details
v1.0	January 2020	This is the second AC about obstacle marking and lighting of wind farms which replaces the AC that was withdrawn from circulation.
(0)	September 2004	This was the first AC about obstacle marking and lighting of wind farms. This AC was withdrawn from circulation in 2009.

Contents

1 Reference material

1.1 Acronyms

The acronyms and abbreviations used in this AC are listed in the table below.

Acronym	Description
AC	advisory circular
AGL	above ground level
AIP	aeronautical information publication
ALA	aircraft landing area
ALARP	as low as reasonably practicable
ALoS	acceptable level of safety
AMSL	above mean sea level
CAR	*Civil Aviation Regulations 1988*
CASA	Civil Aviation Safety Authority
CASR	*Civil Aviation Safety Regulations 1998*
ERSA	en route supplement Australia
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
LSALT	Lowest Safe Altitude
MOS	Manual of Standards
NASAG	National Airports Safeguarding Advisory Group
NOTAM	notice to airmen
OLS	obstacle limitation surface
RPT	regular public transport
VFR	visual flight rules

1.2 Definitions

Terms that have specific meaning within this AC are defined in the table below.

Term	Definition
navigable airspace	The airspace above the minimum altitudes of flight, including airspace required to ensure the safety for the take-off and landing of an aircraft. (prescribed by the Civil Aviation Regulations 1988)

Term	Definition
obstacle limitation surface (OLS)	A series of planes associated with each runway at an aerodrome that defines the desirable limits to which objects may project into the airspace around the aerodrome so that aircraft operations at the aerodrome may be conducted safely.
outside the vicinity of an aerodrome	For the purposes of this AC, outside the vicinity of an aerodrome is outside the limits of the obstacle limitation surface (OLS) of a CASA certified aerodrome
vicinity of an aerodrome	For the purposes of this AC, the vicinity of an aerodrome is within the limits of the obstacle limitation surface (OLS)

1.3 References

Regulations

Regulations are available on the Federal Register of Legislation website https://www.legislation.gov.au/

Document	Title
Regulation 157 of the Civil Aviation Regulations 1988 (CAR)	Low Flying
Regulation 172 of the Civil Aviation Regulations 1988 (CAR)	Flight visibility and distance from cloud
Regulation 174 of the Civil Aviation Regulations 1988 (CAR)	Determination of visibility for VFR flights
Part 139 of CASR	Aerodromes
Part 139 Manual of Standards	Part 139 (Aerodromes) Manual of Standards
Subpart 175.E of CASR	Aeronautical information management - objects and structures that affect aviation safety
National Airports Safeguarding Advisory Group (NASAG) Guideline D	Managing the Risk to Aviation Safety of Wind Turbine Installations (Wind Farms)/Wind Monitoring Towers
ICAO Annex 14 Aerodromes Vol 1, Chapter 6	Aerodrome Design and Operations
ICAO Doc 9774 A3-1	Aeronautical Study

Advisory material

CASA's advisory circulars are available at http://www.casa.gov.au/AC

CASA's Civil Aviation Advisory Publications are available at http://www.casa.gov.au/CAAP

Document	Title
UK Civil Aviation Authority (CAA) Advisory Publication (CAP) 764	CAA Policy and Guidelines on Wind Turbines
UK CAA Policy Statement	Lighting of onshore wine turbine generators in the UK with a maximum blade tip height at or more than 150m above ground level
FAA AC 70/7460-1L	Obstruction Marking and Lighting

2 Wind farm guidance

2.1 Background

2.1.1 All wind turbine developments should be assessed to determine whether they pose a risk to aviation safety. This AC augments the information in the National Aerodromes Safety Advisory Group (NASAG) Guideline D and provides additional guidance on the assessment of wind turbine developments and for establishing what reasonable measures may be put in place to mitigate any adverse effect the wind farm development may pose to aviation safety.

2.1.2 As prescribed by the *Civil Aviation Regulations 1988 (CAR)*, navigable airspace is the airspace above the minimum altitudes of VFR and IFR flight, including airspace required to ensure the safety for the take-off and landing of an aircraft. Generally, the minimum altitude limits equate to 500 ft (152 m) or 1 000 ft (305 m) above ground level depending on the situation i.e. whether or not the flying is over a populous area. The presence of wind turbines or wind monitoring masts may create a risk to the safety of flight. Anyone that is introducing a hazard to navigable airspace, such as a wind farm, must mitigate the risk of the hazard on airspace users to ensure an acceptable level of safety.

2.1.3 If the entity is unable to achieve an acceptable level of safety using risk mitigators CASA may deem the risk as unacceptable or provide guidance on additional risk control measures.

2.1.4 Part 139 regulations

2.1.4.1 Part 139 of the *Civil Aviation Safety Regulations 1998 (CASR)*, regulates obstacles within the vicinity of certified aerodromes. This is supported by the Part 139 Manual of Standards (MOS) which provides the definition of an obstacle as well as the standards for marking and lighting of an obstacle. Any wind turbine (where the height is defined to be the maximum height reached by the tip of the turbine blades) or wind monitoring mast that penetrates an Obstacle Limitation Surface (OLS) of an aerodrome will be dealt with in accordance with the provisions of Part 139 of CASR and the MOS.

2.1.5 Part 175.E regulations

2.1.5.1 Subpart 175.E of CASR specifies standards and legislative requirements for the quality and integrity of data and information used in air navigation. Specifically, information published in the Integrated Aeronautical Information Package, on aeronautical charts and contained within aeronautical navigation databases that Airservices Australia manages.

2.1.5.2 Under Part 175.E of CASR, Airservices may request information about an object or structure anywhere in Australia to confirm ownership, geographic location, dimensions and whether the structure or object is marked or lit. This includes a requirement to report any structure that is at least 100 m in height above ground level, which ensures these objects are recorded in the Airservices Australia obstacle database and published on aeronautical charts.

2.1.6 Risks

2.1.6.1 Outside the vicinity of an aerodrome, which is defined as being outside the OLS of an aerodrome, wind farms may constitute a risk to low-flying aviation operations which may be conducted down to 500 ft AGL over non-populous areas. Additionally, wind monitoring masts erected in anticipation of, or in association with, wind farms can also be hazardous to aviation, given their low visibility. Wind farms can also affect the performance of communications, navigation and surveillance (CNS) equipment operated by Airservices Australia or the Department of Defence.

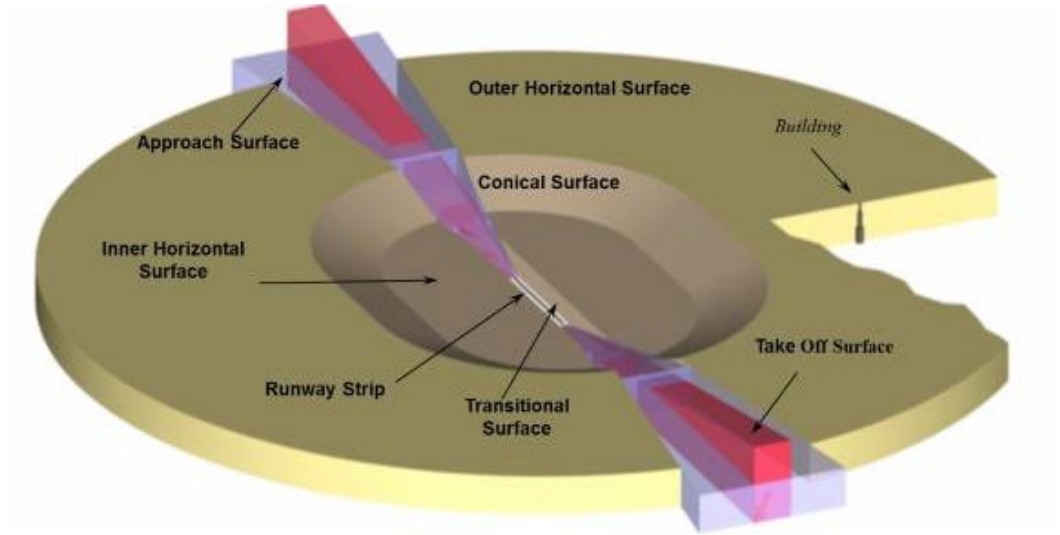

Figure 1 - Typical OLS configuration

2.1.6.2 The dimensions of the OLS as displayed in Figure 1 varies with each aerodrome location, the aerodrome physical characteristics and the aerodromes function. The detailed description and dimensions of each section of the OLS can be found in the Part 139 MOS, Chapter 7.

2.1.6.3 The dimensions of the recommended OLS for non-certified aerodromes is contained in the Civil Aviation Advisory Publication (CAAP) 92-1 - Guidelines for aeroplane landing areas available on the CASA webpage. <https://www.casa.gov.au>

2.1.6.4 The height of the wind turbines and the associated turbulence may impact lighter aircraft, such as those operated by sport and general aviation, more than larger aircraft. Research on the study of the turbulence effects from wind turbines and associated wake velocities downstream has been conducted by UK CAA and University of Liverpool research <http://publicapps.caa.co.uk/docs/33/CAP764%20Issue6%20FINAL%20Feb.pdf> When considering associated turbine effects, the study identifies that for wind turbines of less than 30 m Rotor Diameter (RD) the wake vortices will impact aircraft located up to 5 RD downwind and 2 RD vertically.

2.1.6.5 Planning authorities should consider wake vortices when assessing the location of wind turbines in proximity to an aerodrome, any airstrip and associated circuit patterns. The risk to the safety of air navigation from wind turbine turbulence should be mitigated to

an acceptable level of safety particularly during critical phases of flight such as landing and taking off.

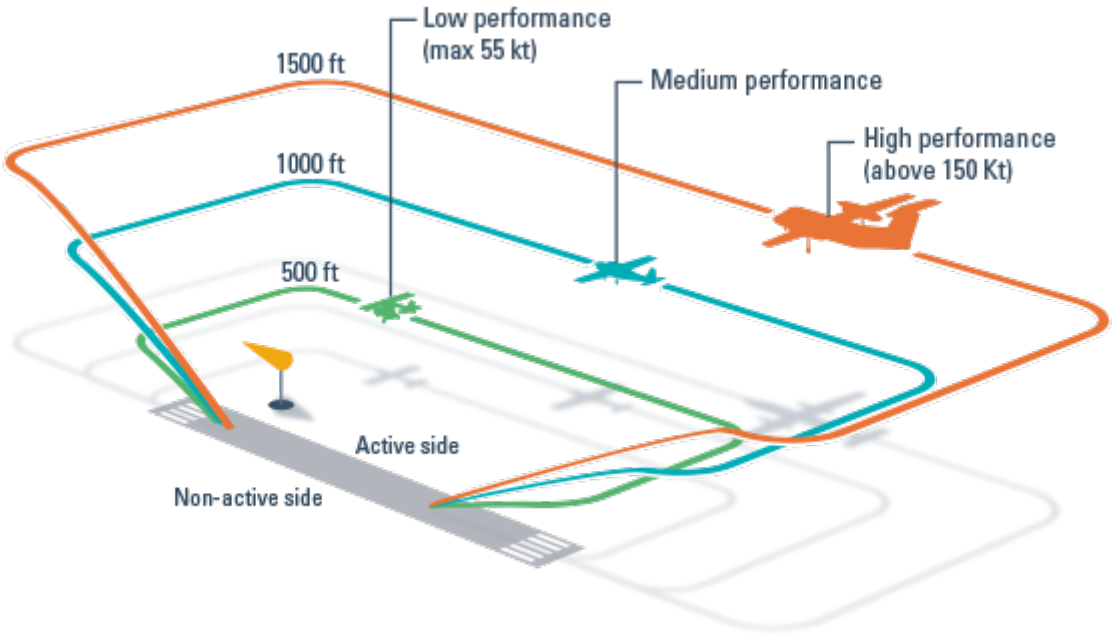

Figure 2 - Typical circuit configuration

2.1.7 Guidelines

2.1.7.1 The Department of Infrastructure, Transport, Regional Development and Communications has developed a safeguarding framework that contains guidelines to improve safety outcomes in relation to developments which may impact on navigation of flight (aviation safety). Specifically, NASAG Guideline D '*Managing the risk to aviation safety of wind turbine installations (wind farms) / wind monitoring towers*' <https://infrastructure.gov.au/aviation/environmental/airport_safeguarding/nasf/files/4.1.3_Guideline_D_Wind_Turbines.pdf> provides information on managing the risk to aviation safety presented by the construction and operation of wind farms and wind monitoring masts.

2.2 Obstacles within the vicinity of a CASA Certified aerodrome

2.2.1.1 Mitigation for obstacles within the vicinity of an aerodrome is described within the Part 139 MOS, Chapter 8, Division 10.

2.3 Obstacles outside the vicinity of a CASA Certified aerodrome

2.3.1.1 The methodology for assessment of wind farms that are located outside the vicinity of a certified aerodrome and recommended mitigation measures for consideration are described below.

2.3.2 Early review by proponent

2.3.2.1 In the early stages of planning for a wind farm, it is recommended that a wind farm proponent engages an aviation consultant to conduct an aeronautical study to determine if the proposed wind farm location will create a risk to aviation safety. For example, the proposed location might be situated close to a high-density VFR lane or a VFR reporting point.

2.3.3 An aeronautical study will identify any aviation safety risks, and the need for mitigation of those risks. The study should provide a detailed assessment of the potential impacts of the wind farm on aviation activities and demonstrate how an acceptable level of aviation safety can be maintained. The aeronautical study should:

- assess the impact of the wind farm on any aviation activity
- conduct a risk analysis using a likelihood and consequence process
- consult with nearby aerodrome operators and aircraft operators known to fly in the area
- provide details of proposed mitigation to ensure an acceptable the level of safety analysis of the effectiveness of each risk control measure
- recommend operating procedures/restrictions or other means to mitigate risks.

2.3.4 All proposed mitigation measures should be assessed to demonstrate they are adequate to reduce risks to an acceptable level.

2.3.5 Cumulative effects of other wind farms in close proximity should also be considered.

2.3.6 Planning authority process

2.3.6.1 A proponent of a wind farm is required to submit a development application to the relevant planning authority for approval. The planning authority will assess the proposal and review the provided aeronautical study.

2.3.6.2 The planning authority may seek advice from CASA on the risk to aviation created by the wind farm or the proposed mitigation plan if a risk has been identified.

2.3.6.3 CASA will review the development application and aeronautical study using the airspace risk assessment process described at 2.3.7 and provide advice to the planning authority. CASA has no authority or powers in relation to a wind farm approval outside the vicinity of a certified aerodrome but advice from CASA will inform the planning authority in regard to any decisions or conditions on any approval the planning authority might place on a wind farm.

2.3.7 CASA airspace risk assessment process

2.3.7.1 The CASA airspace risk assessment process identifies potential airspace risks or risks to the safety of air navigation and it is a five-step process.

2.3.7.2 The risk assessment will be assessed in accordance with the risk assessment methodology, as found in AS/NZS ISO 31000:2018 Risk Management - Principles and Guidelines.

Step 1 Preliminary assessment

2.3.7.3 The preliminary assessment by CASA considers:

- location, height, and number of the wind turbines / monitoring masts
- terrain in the vicinity of the wind turbines
- volume and type of flying operations in the area
- potential for aircraft to operate in the vicinity of the wind farm
- proximity to aerodromes and aircraft landing areas (ALA)
- urban (built up area) or rural setting
- wind turbine turbulence effect
- effect on communication, navigation, and surveillance
- visible range of wind turbines / monitoring masts in low visibility conditions.

Step 2 Stakeholder engagement

2.3.7.4 CASA will engage with aviation stakeholders to inform the airspace risk assessment. For example, local flying schools to understand the type of flying operations being conducted in the vicinity of the proposed wind farm. Any proposal which requires adjustment to instrument procedures or airspace minima for a nearby certified aerodrome need to be supported by the aerodrome operator and Airservices Australia.

Step 3 Risk assessment

2.3.7.5 CASA will conduct an airspace risk assessment that will identify any potential hazards and assess the likelihood and consequence of any risk. The risk assessment will also consider and assess risk control measures.

Step 4 Mitigating the impact of the proposal

If potential risks to the safety of air navigation or aircraft safety are identified, these should be reduced to As Low As Reasonably Practicable (ALARP) to achieve an Acceptable Level of Safety (ALoS) using mitigation and control measures. Examples of such measures are:

a. obstacle lighting and marking of the turbines
b. future technology solutions, such as radar activated alerting/lighting systems
c. advice to local operators (information bulletins)
d. notification to Airservices Australia - obstacle database email (vod@airservicesaustralia.com)
e. Notice to Airmen (NOTAM)

f. Advice in En Route Supplement Australia (ERSA) (particularly in ERSA entries for nearby aerodromes)
g. Chart symbols.

Step 5 Advice and recommendations

2.3.7.6 Finally, CASA will provide advice on the outcomes of the airspace risk assessment to the relevant planning authority. CASA does not provide advice directly to a proponent or a consultant.

2.4 Obstacle visibility requirements

2.4.1 Aircraft in uncontrolled airspace may operate under visual flight rules (VFR), which requires the pilot to remain clear of clouds and to adhere to visibility minima. CAR 172 and CAR 174 and the Aeronautical Information Publication (AIP) ENR 1.2 prescribe the requirements:

- in Class G airspace below 3000 ft Above Mean Sea Level (AMSL) or 1000 ft AGL (whichever is the higher) – clear of cloud with minimum visibility of 5000 m.
- in Class G airspace below 10 000 ft AMSL (subject to the above) – 1000 ft vertically and 1500 m horizontally from cloud and 5000 m visibility.

Note: Helicopters may be permitted to operate in lower visibility and that further exemptions may apply to special cases such as military, search and rescue, medical emergency, agricultural and fire-fighting operations.

2.4.2 Obstacles penetrating this airspace (which starts at the minimum flight altitude of 500 ft (152.4 m) above ground level) outside of a built-up area, are recommended by ICAO to be equipped with 2000 candela medium intensity obstacle lights in ICAO Annex 14, Vol 1, Chapter 6.2.

2.4.3 ICAO's 2000 candela medium intensity obstacle lighting satisfies the 5000 m VFR visibility requirements, according to practical exercises undertaken by the FAA and documented in AC 70/7460-1L (FAA, 2015).

Table 1: Light Visible Distances from FAA AC70/7460-1L

Time Period	Meteorological Visibility (m)	Distance (m)	Intensity (Candelas)
Night	4800	4700	1,500 (+/- 25%)
		4900	2,000 (+/- 25%) (ICAO medium intensity light)
		2200	32

2.5 Wind farm hazard lighting

2.5.1 Obstacle lighting for wind farms (and other tall structures) is intended to alert pilots, flying at low altitude, to the presence of an obstacle allowing them sufficient awareness

to safely navigate around or avoid it. The pilot is responsible for avoiding other traffic and obstacles based on the alerted see-and-avoid principle.

2.5.2 Unless the wind farm is located near an airport, wind turbines are not expected to pose a risk to regular public transport operations. The kind of air traffic that is usually encountered at low altitude in the vicinity of a wind farm includes light aircraft (private operators, flight schools, sport aviation, agricultural, survey) and helicopters (military, police, medical emergency services, survey). Obstacle lights are therefore designed to provide pilots with sufficient awareness about the presence of the wind farm, so they can avoid it. This means that the intensity of the obstacle lights should be such that the acquisition distance is sufficient for the pilot to recognise the danger, take evasive action and avoid the obstacle by a safe margin in all visibility conditions. This outcome considers the potential speed of an aircraft to determine the distance by which the pilot must become aware of the hazard to have enough time and manoeuvrability to avoid it.

2.5.3 If CASA's obstacle or wind farm assessment recommends a need for obstacle lighting to mitigate the risk to aviation activities, CASA will consider a light management system or plan submitted by the proponent to meet the requirement.

2.5.4 Light management systems to regulate obstacle lights and their intensity are acceptable options in Australia. The two primary options are the use of visibility meters to reduce light intensity during high visibility conditions and the use of a radar detection system to allow the lights to activate when an aircraft is in the vicinity of the wind farm. Permanent light shielding is also an option to reduce impact on residences within six kilometres of the installation.

2.5.5 A visibility meter intensity regulation system can reduce the intensity of obstacle lights depending on the level of visibility determined by the sensors. Visibility meters detect real time visibility conditions and are mounted as near to the obstacle lights as possible and in the case of wind farms, on turbines every 1.5 km.

2.5.6 A radar detection system activates the obstacle lights when aircraft are detected in the vicinity of the wind farm. The system does not require additional equipment to be carried by aircraft. CASA does not approve radar detection systems, but provides advice of 'no objections' to the system manufacturers if an FAA Technical Note concludes that the system “performed according to the manufacturer’s specifications and met the performance requirements identified in AC 70/7460-1L".

2.6 CASA's commitment to aviation safety

2.6.1 CASA will consider the lighting intensity management and systems that achieve an acceptable level of compliance on a case by case basis during assessment.

2.6.2 A CASA determination will consider the environmental setting when determining the need and level of lighting required on a wind farm. This may include consideration of lower lighting intensities for obstacles away from an aerodrome. The backlighting of some locations is almost non-existent, meaning the risk of an aviation obstacle light being compromised by background lighting from towns or cities is lower than would

otherwise apply in a built-up residential area. CASA can provide advice on the recommended number of obstacle lights, their intensity and pattern.

2.6.3 Planning authorities

2.6.3.1 CASA advice about lighting of wind farms is provided in a submission to a planning authority that is considering a wind farm proposal.

2.6.3.2 Regardless of CASA advice, planning authorities make the final determination via conditions of consent as to whether a wind farm or tall structure not in the vicinity of a CASA regulated aerodrome will require lighting or marking.