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Australian Government
Civil Aviation Safety Authority

**ADVISORY CIRCULAR
AC 139.E-05 v2.0**

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

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Acknowledgement of Country

The Civil Aviation Safety Authority (CASA) respectfully acknowledges the Traditional Custodians of the lands on which our offices are located and their continuing connection to land, water and community, and pays respect to Elders past, present and emerging.

Artwork: James Baban.

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

This AC provides guidance for assessing wind farms and other tall structures to protect aviation safety. Wind farms and monitoring towers (turbine installations) and other tall structures may pose a safety risk to aviation due to their physical characteristics, size and location. Mitigation measures such as warning lights are also described, together with the notification to CASA obligation under regulation 139.165 and the reporting of objects and structures to Airservices Australia (Airservices) under Subpart 175.E of CASR.

For further information

For further information or to provide feedback on this AC, visit CASA's [contact us](#) page.

Use of artificial intelligence

Artificial intelligence (AI) tools were used to assist with the drafting, editing, summarisation, information synthesis and document structuring activities undertaken on this document. Any AI-generated content included in this document, or used as an input to the review process, has been reviewed, validated and refined by a human and has not been relied upon as a substitute for evidence gathering, analysis, findings or recommendations.

Unless specified otherwise, all subregulations, 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 National Manager, Flight Standards Branch.

Note: Changes made in the current version are not annotated. The document should be read in full.

Table 1: Status

Version	Date	Details
v2.0	October 2026	• Updated references to current legislation and standards. • Added definitions and explanatory guidance for obstacle assessment, Updated guidance on aircraft detection lighting systems. • Clarified notification obligations under Part 139 and Subpart 175.E. • Updated references from Civil Aviation Regulations to Civil Aviation Safety Regulations • Expanded guidance on protected airspace, aeronautical studies, wake turbulence and consultation requirements. • Updated guidance on obstacle marking, lighting and aircraft detection lighting systems. • Improved readability and consistency throughout the AC. • Editorial amendments and correction of terminology. • Latest CASA style template applied.
v1.1	October 2022	This is the third AC about obstacle marking and lighting of wind farms and contains editorial amendments.
v1.0	May 2021	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.

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1 Reference material

1.1 Acronyms

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

Table 2: Acronyms

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	<i>Civil Aviation Regulations 1988</i>
CASA	Civil Aviation Safety Authority
CASR	<i>Civil Aviation Safety Regulations 1998</i>
DPS	data product specification
ERSA	en route supplement Australia
IAIP	integrated aeronautical information package
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
LSALT	Lowest Safe Altitude
MOS	Manual of Standards
NASAG	National Airports Safeguarding Advisory Group
NASF	National Airports Safeguarding Framework
OLS	obstacle limitation surface
PANS-OPS	Procedures for Air Navigation Services — Aircraft Operations
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. Where definitions from the civil aviation legislation have been reproduced for ease of reference, these are identified by 'grey shading'. Should there be a discrepancy between a definition given in this AC and the civil aviation legislation, the definition in the legislation prevails.

Table 3: Definitions

Term	Definition
aircraft detection lighting system	a system that detects aircraft in the vicinity of an obstacle and activates the obstacle lighting only while an aircraft is detected. This AC also refers to it as a radar detection system.
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).
NOTAM	a notice issued by the NOTAM Office containing information or instructions concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to persons concerned with flight operations.
obstacle	all fixed (whether temporary or permanent) and mobile objects that: (a) are located on an area intended for the surface movement of aircraft; or (b) extend above a defined surface intended to protect aircraft in flight; or (c) stand outside those defined surfaces and that have been assessed as being a hazard to air navigation.
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.
prescribed airspace	airspace declared under the Airports (Protection of Airspace) Regulations 2026 in relation to a federally leased airport, within which a controlled activity must not be carried out without approval.
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

Legislation

Legislation is available on the Federal Register of Legislation website <https://www.legislation.gov.au/>

Table 4: Legislation references

Document	Title
Airports Act 1996	Airports Act 1996

Document	Title
Airports (Protection of Airspace) Regulations 2026	Airports (Protection of Airspace) Regulations 2026
Regulation 91.265 of CASR	Minimum height rules — populous areas and public gatherings
Regulation 91.267 of CASR	Minimum height rules — other areas
Regulation 91.280 of CASR	VFR flights — compliance with VMC criteria
Part 91 (General Operating and Flight Rules) Manual of Standards	Requirements for VFR flights — compliance with VMC criteria
Part 139 of CASR	Aerodromes
Part 139 (Aerodromes) 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 (NASF)	Framework D - Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation

Advisory material

CASA's advisory materials are available at <https://www.casa.gov.au/publications-and-resources/guidance-materials>

Table 5: Advisory material

Document	Title
AC 139.E-01	Reporting of tall structures

Other reference material

Table 6: Other reference material

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 wind turbine generators in the UK with a maximum blade tip height at or more than 150m above ground level
European Union Aviation Safety Agency (EASA)	EASA, Safety Impact of Wind Turbines in the Vicinity of Aerodromes and Air Routes, Report EASA.2019.CEI.14.EC021, October 2023

International Civil Aviation Organization documents

International Civil Aviation Organization (ICAO) documents are available for purchase from <http://store1.icao.int/>

Many ICAO documents are also available for reading, but not purchase or downloading, from the ICAO eLibrary (<https://elibrary.icao.int/home>).

Table 7: ICAO references

Document	Title
ICAO Annex 14 Aerodromes Vol 1	Aerodrome Design and Operations
ICAO Doc 9774	Manual on Certification of Aerodromes - Appendix 3-1 Aeronautical Study
ICAO Doc 9981	Procedures Air Navigation Services - Aerodromes (PANS-Aerodromes)

2 Introduction

2.1 General guidance

- 2.1.1 CASA advises planning authorities about the lighting and marking of wind farms, wind monitoring masts, telecommunications towers and other tall structures when such authorities are considering a proposal.
- 2.1.2 Planning authorities make the final determination whether a wind farm or a tall structure outside the vicinity of a certified aerodrome must be lit or marked, regardless of CASA's advice.

2.2 Background

- 2.2.1 All wind turbine developments and other tall structures should be assessed for risk to aviation safety. This AC complements the National Airports Safeguarding Framework (NASF), Guideline D, which explains how to assess a wind farm development and what reasonable measures can mitigate any adverse effect on aviation safety.
- 2.2.2 For the purposes of this AC, navigable airspace is the airspace above the minimum altitudes of VFR and IFR flight, including airspace required to ensure the safe take-off and landing of an aircraft. Generally, minimum altitude limits equate to 1000 ft (305 m) above ground level depending on whether the flight is over a populous or built-up area or 500 ft (152 m) in other areas.
- 2.2.3 These minimum heights are prescribed by regulations 91.265 and 91.267 of CASR. However, operations below those heights are lawful for certain activities, including aerial application, aerial mustering, survey, pipeline inspection, fire spotting and aerial firefighting, conducted under Part 138 of CASR and the associated low-level authorisations. An assessment that assumes aircraft won't be operating below 500 ft AGL will understate the risk at many rural sites.
- 2.2.4 Wind turbines, wind monitoring masts and other tall obstacles may create a collision risk. An entity proposing to introduce a hazard into navigable airspace, such as a wind farm, should mitigate the risk to airspace users so that an acceptable level of safety is maintained.
- 2.2.5 If the entity cannot achieve an acceptable level of safety, CASA may consider the risk unacceptable or provide advice on additional risk control measures.

2.2.6 Part 139 regulations

- 2.2.6.1 Part 139 of the *Civil Aviation Safety Regulations 1998 (CASR)* regulates obstacles within the vicinity of certified aerodromes. The Part 139 Manual of Standards (MOS) supports Part 139 of CASR. It defines an obstacle and sets the standards for marking and lighting of obstacles. Any wind turbine (where the height is defined to be the maximum height reached by the tip of the turbine blades), wind monitoring mast or other tall structure that penetrates an obstacle limitation surface (OLS) of an aerodrome will be assessed under Part 139 of CASR and its MOS.
- 2.2.6.2 Subpart 139.E of CASR also imposes obligations, and confers powers on CASA, that apply anywhere in Australia — irrespective of whether the object or structure is in the vicinity of a certified aerodrome.
- 2.2.6.3 Under regulation 139.165, a person must give written notice to CASA as soon as practicable after deciding to construct or erect an object or structure that will be 100 m or more above ground level, will include a qualifying emissions source, or is of a kind prescribed by the Part 139 MOS. The notice must contain the particulars prescribed by that regulation, including the location, dimensions and proposed timeframe. Contravention is a criminal offence of strict liability. Regulation 139.170 imposes a corresponding notification obligation in relation to activities that will create certain emissions sources.

- 2.2.6.4 Under regulations 139.175 and 139.180, CASA may determine in writing that an existing or proposed object, structure or emissions source is a hazard to aircraft operations. Regulation 139.185 provides for the consequences of such a determination. The Part 139 MOS prescribes the kinds of objects, structures and emissions sources that constitute a hazard to aircraft operations for the purposes of those regulations.
- 2.2.6.5 Note 2 to Chapter 1 of the Part 139 MOS provides that, for objects or structures that CASA determines are hazardous under regulations 139.175 and 139.180, CASA may recommend in writing to the person who owns, or is in occupation or control of, the object or structure that the standards in Chapter 8, Division 10 and Chapter 9, Division 4 of the MOS should be observed. This is the mechanism by which the Part 139 MOS marking and lighting standards may come to be recommended for a structure that is outside the OLS of a certified aerodrome.
- 2.2.6.6 The reporting obligation owed to CASA under regulation 139.165 is separate from, and in addition to, the provision of data to Airservices under Subpart 175.E as described in section 2.2.5 of this AC. Complying with one does not discharge the other.

2.2.7 Part 175.E regulations

- 2.2.7.1 Subpart 175.E of CASR sets standards for the quality and integrity of obstacle data used in air navigation. It applies to obstacle data published in the Integrated Aeronautical Information Package and on aeronautical charts that Airservices manages.
- 2.2.7.2 Under Part 175.E, 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 the more critical of these objects are recorded in the Airservices obstacle database and published on aeronautical charts. This Part 175.E process is separate from the notification obligation owed to CASA under regulation 139.165. The process of reporting tall structures is outlined in [AC 139.E-01 - Reporting of tall structures](#).

Note: Airservices will issue a Data Product Specification (DPS) to data owners of obstacles at or exceeding 92M (300FT) above ground level. The DPS establishes the data and information exchange protocols between the obstacle owner and Airservices as the AIS Provider for aeronautical data and information that is published in the Integrated Aeronautical Information Package (IAIP). Further information can be found at <https://www.airservicesaustralia.com>.

- 2.2.7.3 Proponents should refer tall structures and wind farms to Airservices at the concept stage so that Airservices can assess the potential effect on airspace procedures, communication, navigation and surveillance facilities, and air traffic control operations. Send referrals to Airport.Developments@AirservicesAustralia.com. Early referral is important because construction can take several years.
- 2.2.7.4 Referral should be made where the object or structure will be 30 m or more above ground level and within 30 km of a certified aerodrome, or where it will be 100 m or more above ground level anywhere in Australia. Where the object or structure will be within 15 km of a certified aerodrome, the proponent should also ask the aerodrome operator whether it will be within the aerodrome's protected airspace.

2.2.8 Risks

- 2.2.8.1 Outside the vicinity of an aerodrome, which is defined as being outside the OLS of an aerodrome, wind farms and other tall structures may be a risk to low-flying aviation operations, which can be conducted down to 500 ft above ground level (AGL) over non-populous areas. Wind monitoring masts and telecommunications towers may be hazardous because they are thin and hard to see. Wind farms can also affect the performance of communications, navigation and surveillance (CNS) equipment operated by Airservices or the Department of Defence (Defence).

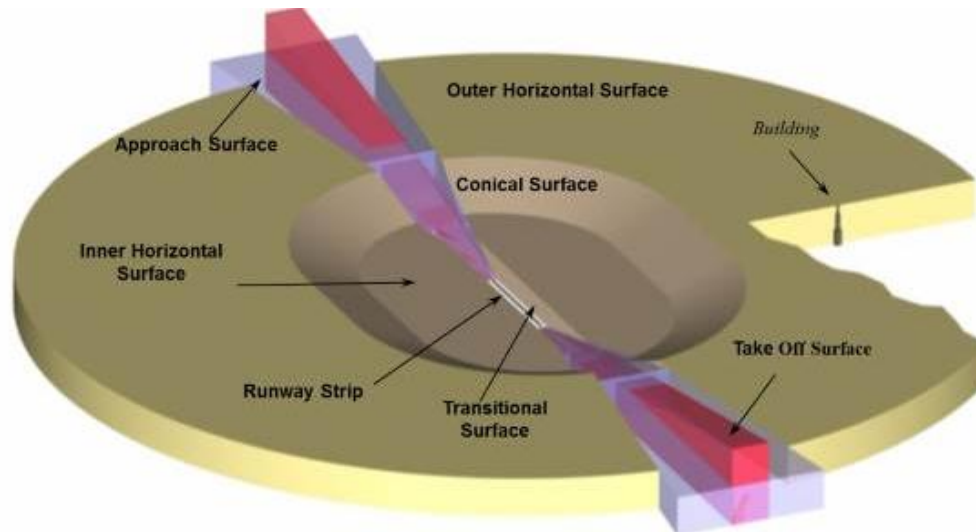


Figure 1: Typical OLS configuration

- 2.2.8.2 The dimensions of an OLS, as shown in Figure 1, vary with each aerodrome's location, physical characteristics and the function. Chapter 7 of the Part 139 MOS describes each section of an OLS and its dimensions.
- 2.2.8.3 The OLS is not the only protected airspace. Instrument flight procedure surfaces, including PANS-OPS and RNP AR surfaces protect airspace regimes that may apply to the aerodrome.
- 2.2.8.4 Contemporary modern wind turbines may be up to 300 meters (1,000 feet) AGL and may have rotor diameters exceeding 200 metres. Because wake effects can extend for many rotor diameters downwind of a turbine, planning authorities should consider the potential impact of wind turbine wake turbulence on aircraft conducting low-level operations in the vicinity of aerodromes and airstrips.

Note: Figure 2 illustrates a typical runway circuit configuration and should not be interpreted as defining a fixed turbulence-affected area. The extent of wind turbine wake effects will vary according to turbine characteristics, prevailing meteorological conditions and local terrain.

- 2.2.8.5 Studies define wake extent in terms of rotor diameters (D) rather than metres (EASA, 2023). Typical findings are:
- strongest wake effects occur within a distance downstream of approximately 5D
 - measurable wake effects often persist beyond 10D downstream
 - under some atmospheric conditions wakes may remain detectable beyond 15D-20D.
- The aviation significance is that wake extent scales with rotor diameter.
- 2.2.8.6 Until the evidence base for large modern wind turbines improves, an aeronautical study addressing wake turbulence should:
- state the rotor diameter, hub height and blade tip height of the turbines proposed, and the wake envelope adopted, together with the source relied upon for that envelope
 - where the envelope adopted differs from that given in NASF Guideline D, justify the difference by reference to published research or manufacturer data for turbines of comparable size
 - address the cumulative wake effects of adjacent wind farms, including within declared Renewable Energy Zones

- state the assessment method used and the acceptance criterion applied.

- 2.2.8.7 When assessing the location of wind turbines near an aerodrome or airstrip, planning authorities should consider the potential for wind turbine wake turbulence and disturbed airflow to affect aircraft conducting take-off, landing and circuit operations¹. Figure 2 illustrates a typical runway circuit configuration. Unless circuit operations are restricted to one side of the runway, the considerations illustrated in Figure 2 should be applied to both sides of the runway.
- 2.2.8.8 The risk from wind turbine turbulence should be mitigated to an acceptable level of safety, particularly during the critical phases of flight such as landing and taking off. Mitigation may include relocation of turbines away from the aerodrome or airstrip sensitive areas, such as the take-off and approach areas, reduction in size of the turbines in question or removal of individual turbines that may cause a turbulence hazard.
- 2.2.8.9 Marking and lighting make an obstacle conspicuous—they do not remove it, and they do not mitigate turbulence.

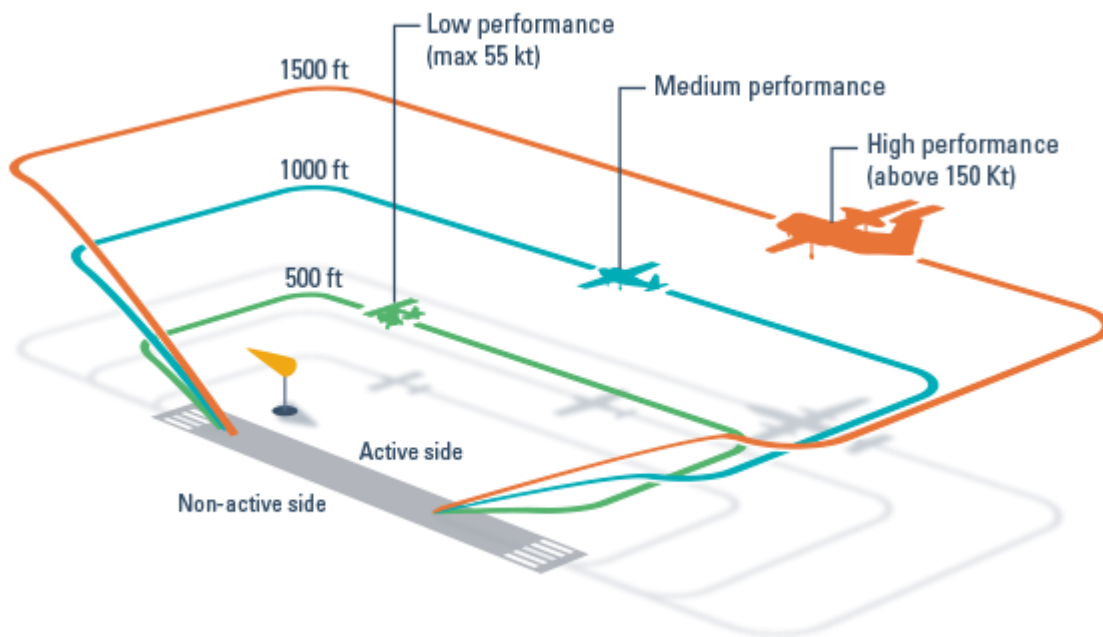


Figure 2: Typical circuit configuration

2.2.9 Additional guidance material

- 2.2.9.1 The Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts has developed a safeguarding framework of guidelines to improve safety outcomes for developments that may affect aviation safety. NASF Guideline D 'Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation' provides guidance on managing the risk to aviation safety from constructing and operating wind farms and wind monitoring masts. NASF Guideline F 'Managing the Risk of Intrusions into the Protected Airspace of Airports' also applies where the development may affect the protected airspace of an airport.

¹ See Safety Impact of Wind Turbines in the Vicinity of Aerodromes and Air Routes, EASA.2019.CEI.14.EC021, October 2023

2.3 Protected airspace and obstacles within the vicinity of a CASA Certified aerodrome

- 2.3.1 Chapter 8, Division 10 of the Part 139 MOS describes the marking of obstacles within the vicinity of an aerodrome.
- 2.3.2 Chapter 9, Division 4 of the Part 139 MOS describes the lighting of obstacles within the vicinity of an aerodrome.
- 2.3.3 The OLS is not the only airspace in the vicinity of an aerodrome to be protected in the interests of aviation safety. Before concluding that a development is 'outside the vicinity' of an aerodrome, a proponent should establish whether the object would affect any of the following:
- the OLS of a certified aerodrome, described in Chapter 7 of the MOS
 - instrument flight procedure surfaces, including PANS-OPS surfaces and RNP AR surfaces, which may extend beyond the OLS or lie below it
 - published minimum sector altitudes and lowest safe altitudes (LSALT) for an aerodrome or route
 - prescribed airspace declared under the *Airports (Protection of Airspace) Regulations 2026* in relation to a federally leased airport
 - Defence aviation areas and the airspace associated with military aerodromes.
- 2.3.4 Where a development is within prescribed airspace at a federally leased airport, erecting the structure is a controlled activity and requires approval under *the Airports (Protection of Airspace) Regulations 2026*. That approval is separate from, and additional to, any state or territory planning approval. A planning authority does not make the final decision.

Note: This AC does not describe that process; proponents should refer to NASF Guideline F and consult the airport operator.

- 2.3.5 Where the wind farm or tall structure is within 30 km of a military aerodrome, or may affect a Defence aviation area, Defence should be consulted.

2.4 Obstacles outside the vicinity of a CASA Certified aerodrome

- 2.4.1 This section describes how to assess wind farms, telecommunications towers and other tall structures outside the vicinity of a certified aerodrome, and the mitigation measures to consider.

2.4.2 Early review by proponent

- 2.4.2.1 In the early stages of planning for a wind farm or tall structures, the proponent should engage an aviation consultant to carry out an aeronautical study to determine whether the proposed development will create a risk to aviation safety. Proponents should consult relevant aviation operators early to identify and manage aviation safety risks. For example, the proposed location might be close to:
- a certified aerodrome or military aerodrome
 - a high-density VFR lane or VFR reporting point
 - an uncertified aerodrome or landing area used by the local community.
 - a private or unregistered airstrip

- low flying training area used by Defence aircraft
- an area used regularly for low level operations, including aerial application, aerial mustering, survey, pipeline inspection, fire spotting and aerial firefighting.

2.4.2.2 In identifying the aviation activity to be consulted, the proponent should search at least 30 km from the boundary of the proposed development. They should check the En Route Supplement Australia, aeronautical charts, relevant state or territory aviation and land use registers, and relevant industry associations. Many aircraft landing areas and private airstrips are unregistered and appear in no public dataset. If the proponent cannot identify an operator or landing area from those sources, they should record the searches they made so that the adequacy of the search can be assessed.

2.4.2.3 An aeronautical study identifies aviation safety risks and the need to mitigate them. The study should provide a detailed assessment of the potential impacts of the proposed development 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 or any other tall structures on any aviation activity
- conduct a risk analysis using AS/NZS ISO 31000:2018 Risk management — Guidelines as the risk management framework
- consult nearby aerodrome operators (certified and uncertified) and aircraft operators known to fly in the area, including operators carrying out low-level activities such as fire spotting and control
- record the consultation undertaken, including any objection raised and how it was addressed
- identify the protected airspace regimes that apply to the site
- state the rotor diameter, hub height and blade tip height of the turbines proposed, and the wake envelope adopted
- address any wind monitoring masts associated with the development, whether temporary or permanent
- consult with Airservices and Defence to determine whether any nearby aeronautical communications, navigation or surveillance equipment may be affected
- provide details of proposed mitigations to ensure an acceptable level of safety and an analysis of the effectiveness of each risk control measure
- recommend operating procedures/restrictions or other means to mitigate risks.

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

2.4.2.5 Cumulative effects of other wind farms near a new wind farm development should also be considered.

2.4.2.6 Mitigation should be considered in the following order: avoidance of the hazard, by siting, layout, height limitation or removal of individual turbines; reduction of the hazard; and only then making the hazard conspicuous by marking and lighting. An aeronautical study that proceeds directly to marking and lighting, without demonstrating that avoidance and reduction were considered, is incomplete.

2.4.3 Planning authority process

2.4.3.1 The proponent of a wind farm or tall structure must submit a development application to the relevant planning authority for approval. The planning authority will assess the proposal and review the detailed aeronautical study that should be provided as part of the development application.

- 2.4.3.2 The planning authority may seek advice from CASA on the risk to aviation created by the development or the proposed mitigation plan if a risk has been identified.
- 2.4.3.3 CASA is not a consent authority for a wind farm, telecommunications towers or tall structure outside the vicinity of a certified aerodrome. The decision to approve the development, and any conditions imposed on it, are matters for the relevant planning authority, informed by CASA's advice.
- 2.4.3.4 CASA holds separate statutory functions that apply to such a development wherever it is located, including the notification obligation owed to CASA under regulation 139.165 and CASA's power to determine that an object or structure is a hazard to aircraft operations under regulations 139.175 and 139.180. A development that requires no CASA approval may still attract those obligations and powers.
- 2.4.3.5 Aeronautical studies usually rely on consultants engaged by the proponent. The proponent submits their reports to the relevant planning authority, which may then refer them to CASA for advice. The reliability of consultant reports depends on the quality of data, assumptions and analysis.
- 2.4.3.6 Once a wind farm has been approved and constructed, an audit should be undertaken to confirm that the aviation safety conditions imposed by the planning authority have been implemented as constructed. Planning authorities are encouraged to impose a condition of consent specifying:
- the criteria against which conformance is assessed
 - that the audit is completed before the wind farm is energised and repeated at a stated interval afterwards
 - that the audit report is given to the planning authority and to CASA
 - that the as-constructed coordinates and heights are notified to Airservices
 - verification of the as-constructed configuration matters because the obstacle data published on aeronautical charts depends on it.

2.4.4 CASA assessment process

- 2.4.4.1 The CASA assessment process reviews identified potential airspace risks and risks to the safety of air navigation.

Step 1: Assessment of aeronautical studies

- 2.4.4.2 The assessment by CASA considers:
- location, height, and number of the wind turbines, monitoring masts or tall structures
 - terrain near the development
 - volume and type of flying operations near the development
 - proximity to aerodromes
 - protected airspace regimes applicable to the site, including instrument flight procedure surfaces
 - urban (built-up area) or rural setting
 - potential for wind turbine turbulence effects
 - ability to see the development in low visibility conditions
 - prevailing local weather conditions
 - inclusion of light management systems in the proposal - radar detection or visibility monitoring

- the cumulative effect of nearby developments
- international best practice.

Step 2: Mitigation associated with proposals impacting air navigation or aircraft safety

- 2.4.4.3 If potential risks to the safety of air navigation or aircraft safety are identified, they should be reduced to as low as reasonably practicable to achieve an acceptable level of safety using mitigation and control measures. A proponent asserting that a risk has been reduced to an acceptable level of safety should identify the controls considered, state which were adopted, and explain why any control not adopted was discounted. Examples of the measures that could be undertaken include:
- obstacle lighting and marking of the turbines
 - technology solutions, such as radar activated alerting or lighting systems
 - advice to local operators (information bulletins)
 - notification to Airservices: as-constructed obstacle database email (vod@airservicesaustralia.com)
 - NOTAM
 - advice in ERSA for nearby aerodromes
 - chart symbols
 - siting, layout or height changes that avoid the hazard
 - redesign of an affected instrument flight procedure.

Step 3: Advice

- 2.4.4.4 Finally, CASA will provide advice on the outcomes of its assessment to the relevant planning authority.

2.5 Aviation hazard lighting - international best practice

- 2.5.1 This section describes the visibility criteria that apply to VFR flight in Australia, the relevant provisions of ICAO Annex 14, Volume I, and the marking and lighting of wind turbines recommended by that Annex.
- 2.5.2 Aircraft in uncontrolled airspace may operate under visual flight rules (VFR). A pilot flying under VFR must remain clear of clouds and comply with visibility minima. Regulation 91.280 of CASR, the Part 91 Manual of Standards and the Aeronautical Information Publication (AIP) ENR 1.2 prescribe the following requirements:
- in Class G airspace below 3,000 ft above mean sea level (AMSL) or 1,000 ft AGL, whichever is the higher – remain clear of cloud with minimum visibility of 5,000 m
 - in Class G airspace below 10,000 ft AMSL, subject to the above – remain 1,000 ft vertically and 1,500 m horizontally from cloud, with minimum visibility of 5000 m.

Notes:

1. Helicopters may be permitted to operate in lower visibility. Further exemptions may apply to special cases such as military, search and rescue, medical emergency, agricultural and fire-fighting operations.
2. Regulations 157, 172 and 174, cited in earlier versions of this AC, were repealed on 2 December 2021 on the commencement of the new flight operations regulations.

- 2.5.3 ICAO Annex 14, Volume 1, addresses objects outside the OLS in Chapter 4, and the marking and lighting of obstacles in Chapter 6. In summary:
- Chapter 4, 4.6.1 recommends that objects outside the obstacle limitation surfaces which extend to a height of 100 m or more above ground level be regarded as obstacles, unless an aeronautical study shows that they are not a hazard to aeroplane operations.
 - Chapter 6, 6.1 sets out which objects are to be marked, lighted or both. Outside the obstacle limitation surfaces this is a matter for aeronautical study.
 - Chapter 6.2 and Table 6-3 specify how objects are marked and lighted and the characteristics of each type of obstacle light. Intensity is specified by light type — low, medium and high intensity — and not as a single value.
- 2.5.4 In Australia, CASA has accepted 200 candela lighting in some circumstances. Background lighting in rural and remote areas is low, so a pilot can acquire a lower intensity light far enough away to see and avoid the obstacle. A proposal relying on a reduced intensity should demonstrate:
- the background luminance at the site, measured or derived, and the basis on which it is said to be low
 - the assumed closing speed and pilot response time, and the acquisition distance required as a result
 - that the proposed intensity delivers that acquisition distance in the meteorological visibility conditions in which VFR flight is permitted at the site
 - that the reduced intensity does not compromise conspicuity for the operations most likely to be conducted in the vicinity, including low-level operations conducted below 500 ft AGL.

2.5.5 Marking and lighting of wind turbines — ICAO Annex 14

- 2.5.5.1 Annex 14, Volume I, contains provisions specific to wind turbines. These are the primary international reference for the marking and lighting of wind turbines and should be applied unless an aeronautical study supports a different treatment.
- 2.5.5.2 Annex 14, Volume I, also recommends that the rotor blades, nacelle and upper two-thirds of the supporting mast of a wind turbine be painted white, unless otherwise indicated by an aeronautical study.
- 2.5.5.3 Wind farms as extensive objects. Annex 14, Volume I, recommends that a wind farm — a group of two or more wind turbines — be regarded as an extensive object, and that the lights be installed:
- to identify the perimeter of the wind farm
 - respecting the maximum spacing between lights along the perimeter which for medium-intensity lights is a longitudinal interval not exceeding 900 m, unless a dedicated assessment shows that a greater spacing can be used
 - so that, where flashing lights are used, they flash simultaneously throughout the wind farm

- so that any wind turbines of significantly higher elevation within the wind farm are also identified
- obstacle lights may be partially shielded, provided the shielding does not compromise their operational effectiveness.

2.5.5.4 Where obstacle lighting is provided, lights should operate at night, and at times of reduced visibility.

2.5.5.5 Proponents should also establish a monitoring, reporting and maintenance procedure to ensure outages, including loss of synchronisation, are detected, reported and rectified.

2.5.6 Hazard lighting

2.5.6.1 This section describes CASA's approach to aviation hazard lighting for tall structures and to aircraft detection lighting systems for wind farms. CASA assesses each proposal on its merits.

2.5.6.2 Hazard lighting for wind farms, telecommunications towers and other tall structures is intended to alert pilots flying at low altitude to an obstacle in time to avoid it. The pilot is responsible for avoiding other traffic and obstacles under the alerted see-and-avoid principle.

2.5.6.3 Unless the wind farm or tall structure is located near an airport, it is not expected to pose a risk to regular public transport operations. The air traffic usually encountered at low altitude near a wind farm or tall structure includes light aircraft (for example, private operators, flight schools, sport aviation, agricultural, survey, and fire spotting and control) and helicopters (military, police, emergency services, survey, and fire spotting and control). Hazard lights are therefore designed to provide pilots with sufficient awareness about the presence of the structure(s), so they can avoid it. This means that the intensity of the hazard 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. The required acquisition distance depends on the speed of the aircraft and the time and manoeuvring room the pilot needs to avoid the obstacle.

2.5.6.4 Light management systems to regulate hazard 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. Permanent light shielding may also be used to reduce the impact of obstacle lighting on nearby residences. Shielding reduces the conspicuity of the light in the shielded sector and is therefore a trade-off against safety. A proposal relying on shielding should state the vertical and horizontal sectors that will remain unshielded and demonstrate that the acquisition distance preserved for aircraft approaching the obstacle from any direction from which they may reasonably be expected to approach.

2.5.6.5 A visibility meter intensity regulation system can reduce the intensity of hazard 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 hazard lights as possible and, in the case of a wind farm, at a spacing sufficient for the measured visibility to be representative of conditions across the whole of the wind farm. The proposal should state the spacing adopted and the basis for it.

2.5.6.6 A radar detection system activates the hazard lights when aircraft are detected in the vicinity of the wind farm or tall structure. The system does not require additional equipment to be carried by aircraft. CASA does not approve or certify aircraft detection lighting systems. Where CASA is satisfied that a system performs as specified, CASA may advise the manufacturer that it has no objection to the system's use in Australia. Advice of 'no objection' is not an approval, authorisation or exemption under CASR. It indicates only that CASA is not aware of a reason to object to the system.

2.5.7 Wind monitoring masts

- 2.5.7.1 Wind monitoring masts are a recognised hazard to low-level aircraft operations. They are narrow, are frequently guyed, are often unlit and unmarked, are commonly erected before a wind farm proposal is otherwise visible to the aviation community, and in several jurisdictions are exempt from planning approval because of their height or their temporary nature. An exemption from State or Territory planning approval does not affect the reporting obligation in regulation 139.165 where the mast will be 100 m or more above ground level.
- 2.5.7.2 The mast should be marked so that it is conspicuous against the terrain, and the guy wires should be marked. Marking of guy wires may include high visibility spherical markers, and flags or sleeves on the upper portions of the wires. Guidance on the marking of cables and their supporting structures is given in AS 3891.1. Air navigation — Cables and their supporting structures — Marking and safety requirements.
- 2.5.7.3 Where the height or location of the mast warrants lighting, an aeronautical study should determine the lighting. Where the mast is part of a wind farm, the lighting should be consistent with the lighting of that wind farm.
- 2.5.7.4 The proponent should notify the erection of a wind monitoring mast, and its removal, to Airservices and to the aerodrome, aircraft landing area and low-level operators. Where a mast is erected for a limited period, the notification should state that period.
- 2.5.7.5 Proponents should have regard to the guidance issued by the Aerial Application Association of Australia on the marking of wind monitoring masts, and to the operating doctrine of State and Territory emergency service aviation operators.

2.6 CASA's commitment to aviation safety

- 2.6.1 CASA assesses light management systems and lighting intensities on a case-by-case basis to determine whether they provide sufficient obstacle conspicuity and support an acceptable level of aviation safety. Assessment may consider the characteristics of the structure, surrounding environment, local aviation activities and the effectiveness of any proposed mitigations.
- 2.6.2 CASA considers the surrounding environmental setting when assessing the need for, and level of, obstacle lighting on wind farms, telecommunications towers and other tall structures. This may include consideration of reduced lighting intensities where a structure is located away from an aerodrome and in an area with low levels of background lighting. In rural and remote environments, lower ambient lighting may improve the conspicuity of aviation hazard lighting compared to more densely developed areas where competing light sources may reduce its visual prominence.