

Finnish Transport and Communications Agency / Unofficial copy

Instructions for daytime signalling of wind turbines, aircraft warning lights and the grouping of lights

Scope: Wind turbines outside the obstacle limitation surface areas of aerodromes.

NB: If not otherwise indicated by an aeronautical study or expert findings.

Lighting and signalling:

- Maximum blade tip height less than 70m
 - => no lighting
 - => daytime signalling *

- Maximum blade tip height higher than 70m (70-100 m)
 - => at night type B, low intensity red light on the body of the nacelle
 - => daytime signalling *

- Maximum blade tip height higher than 100 m (100-150 m)
 - => at night type B, medium intensity flashing red light on the body of the nacelle
 - => daytime signalling *
 - > truss lattice tower **

- Maximum blade tip height higher than 150 m
 - In daytime
 - => type B, high intensity flashing white light (100 000 cd) on the body of the nacelle (2 x 50 000 cd meets this requirement)
 - => daytime signalling*
 - > truss lattice tower **
 - In twilight
 - => Twilight setting, type B high intensity, can be used respectively on the body of the nacelle (2 x 10 000 cd meets this requirement). (AGA M3-6 table 4, Annex 14 table 6-3)
 - At night
 - => type B, high intensity flashing white light (2 000 cd), or type B, medium intensity flashing red light (2 000 cd) or type C, medium intensity, non-flashing red light (2 000 cd) on the body of the nacelle. (2 x 1 000 cd meets this requirement)

If the wind turbine tower height is 105m or more above ground level, low intensity type B obstruction lights shall be placed on the tower with intervals of no more than 52m. The lowest lights shall be placed above the level of the surrounding tree tops.

* The daytime markings of the rotor blades and the nacelle must be white.

* The daytime markings of the upper 2/3 of the tower must be white.

** White daytime markings on truss lattice towers can be substituted by low intensity, type B obstruction lights, placed on the upper 2/3 of the tower in addition to a painted red marking with a height of 6 m, placed under these lights.

The colour shades of daytime markings are:
white RAL 9003, 7035, 7038, 7047 or 9016, 9018
red RAL 3024 or 3026.

The placing of the lights, as well as the number of lights required, must be designed so that at least one light on the nacelle and two lights at tower light level are visible from all aircraft, irrespective of which direction it is coming from, without no part of the wind turbine blocking the view.

All obstruction lights on a wind farm must flash simultaneously.

IR requirements for LED lights:

If LED technology is used for wind turbines, the lighting mechanism must, in addition to visible light, radiate IR light within the wavelength area of 800-940 nm.

Intensity requirements for IR lights in relation to the vertical angle:

1. Low intensity obstruction light

Pmin 3 mW/sr, $>+5^\circ - <+90^\circ$

Pmin 25 mW/sr, $>0^\circ - <+5^\circ$

Pmax 60 mW/sr, $-90^\circ - +90^\circ$

2. Medium intensity obstruction light (includes high intensity obstruction lights at night)

Pmin 500 mW/sr, $>0^\circ - <+2^\circ$

Pmax 1 000 mW/sr, $-90^\circ - +90^\circ$

The IR light must be on continuously if the visible obstruction light does not flash. In other cases, the IR light must flash at the same rate as the visible obstruction light.

An operational lighting mechanism with LED obstruction lights without an IR light component must be replaced with a mechanism that meets the indicated requirements when the lights are being renewed, changed or repaired.

Reduction of obstruction light intensity in good visibility conditions:

The nominal intensity of the light can be reduced to 30% when visibility is more than 5,000 m and to 10% when visibility is more than 10,000 m.

Measuring the visibility conditions:

Visibility is measured with equipment, mounted on the nacelle, that is specifically designed to measure visibility and that filters the light pollution from obstruction lights when measuring visibility. On wind farms, the distance between measuring units must not be more than 1,500m. The visibility value used is the one with the lowest reading. The measuring equipment shall have an automatic function control system. In case of an interruption, or if the readings are not accurate, light intensity must be set at 100%.

Visibility measuring sensors must be calibrated once a year for land-based wind turbines and twice a year for offshore wind turbines.

Wind turbine constructors shall, when applying for permission to set up an obstacle to air navigation, present the visibility measuring equipment they plan to use. When the mechanism is taken into service, it must be inspected by an institute or company independent of the constructor. The inspection protocol must be presented to the Finnish Transport Safety Agency. For wind farms, the person responsible for applying

for permission to set up the obstacle must present a plan concerning the location of the visibility measuring equipment to the Finnish Transport Safety Agency.

Grouping obstruction lights for wind farms:

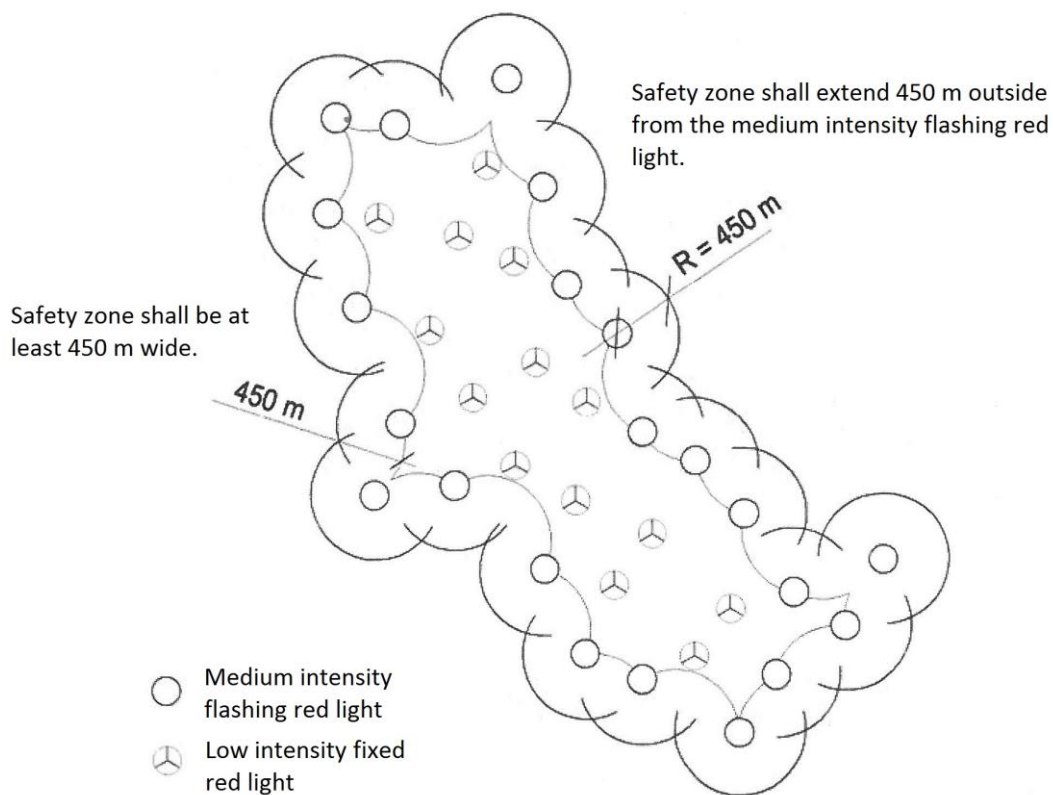
To reduce the amount of light emitted to the surrounding area, obstruction lights on wind farms can be grouped so that the edge of the farm is ringed by a perimeter of more powerful lights, the height of which is determined by the height of the wind turbines. Obstruction lights for wind turbines inside this ring can be made up of low intensity, non-flashing red lights. If one or more wind turbine is significantly taller than the other turbines on the wind farm, it must be equipped with more powerful lights.

The wind farm constructor must design a grouping plan for the lights for both the construction period and for a completed wind farm, and present it to the Finnish Transport Safety Agency together with the application for setting up the obstacle. Requirements for wind turbine obstruction lights on existing wind farms can also be changed on application in accordance with the same principle.

A The outer perimeter is made up of type B, medium intensity flashing red obstruction lights:

The highest point of drag of the wind turbine rotor blades is 100-150 m above terrain.

An arc with a radius of 450 m is drawn around the wind turbines on the perimeter of the wind farm, as shown in the diagram below. The arcs drawn around the turbines should overlap so that they form a circle around the farm. A safety zone of at least 450 metres from each wind turbine to the perimeter shall be ensured.



The outer perimeter of the safety zone shall be 450 m from the wind turbines equipped with medium intensity flashing red lights.

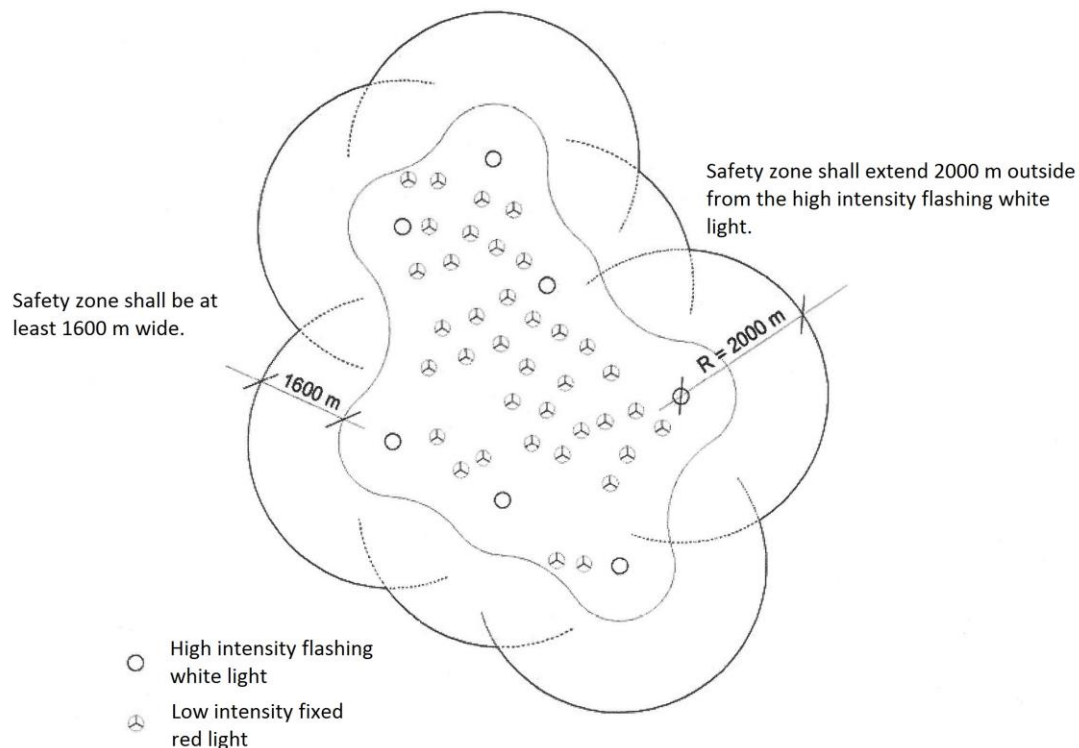
The safety zone shall be at least 450 m wide.

- Medium intensity flashing red light
- Low intensity non-flashing red light

B The outer perimeter is made up of type B, high intensity, flashing white obstruction lights:

The highest point of drag of the wind turbine rotor blades is 100-150 m above terrain.

An arc with a radius of 2,000 m is drawn around the wind turbines on the perimeter of the wind farm, as shown in the diagram below. The arcs drawn around the turbines should overlap so that they form a circle around the farm. A safety zone of at least 1,600 metres from each wind turbine to the perimeter shall be ensured.



The outer perimeter of the safety zone shall be 2,000 m from the wind turbines equipped with high intensity, flashing white lights.

The safety zone shall be at least 1,600 m wide.

- High intensity flashing white light
- Low intensity non-flashing red light