Summary of IEA R&D Wind – 46th Topical Expert Meeting on

**OBSTACLE MARKING OF WIND TURBINES**

October 2005, Stockholm, Sweden

**Background**

Wind turbines need obstacle warning aids to help the crew of airplanes, helicopters and ships to avoid collisions with the turbines. So far, the organizations performing the logistics of applying for building permits, site preparation and erection of wind turbines have generally handled each such activity as an isolated event. Thus, obstacle warning lights or markings have been applied as seen fit for the particular wind turbine or group of turbines.

Obstacle markings have to be visible for aviators and seamen, this is obvious, but may be an annoyance to the public dwelling in the neighbourhood. This will put demands on the functioning and intensity of the system. For example: an unsynchronized blinking of light may have an adverse effect on the public acceptance of a wind farm.

Two international organisations, ICAO\(^1\) and IALA\(^2\) work with recommendations for marking of wind turbines. ICAO is currently working on producing requirements specifically for marking and lighting wind turbines but have not yet completed these deliberations. The ICAO requirements for marking and lighting obstacles apply to all obstacles including wind turbines at present. But, there is still not a unifying agreement on the aviation warning marking lights.

From a few meetings in Sweden on this topic it appears that the present sea markings, for fixed obstacles, will be accepted in their present IALA forms without modifications.

**Participants/Presentations**

A total of eight participants attended this meeting with representatives from Denmark, Ireland and Sweden. The participants represented both maritime and aviation interests as well as manufacturers and developers.

Five presentations were given on the following topics:

1. Proposed rules for aviation marking in Sweden
2. Aviation Marking of Wind Turbines - in a Danish Perspective
3. IALA Recommendation O-117 on the Marking of Offshore Wind Farms
4. Offshore Wind Farms Conspicuity Requirements
5. Proposed lighting configuration for wind turbines

**Discussion**

The two different recommendations from ICAO and IALA, for obstacle marking were discussed and evaluated. It was concluded that aviation marking recommendations are far more demanding than the corresponding rules for maritime markings. However, the aviation recommendation does not cover every detail in how the actual marking is to be implemented.

All participants agreed that a holistic approach must be applied in this area, where many interests have to be dealt with.

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\(^1\) International Civil Aviation Organization, www.icao.org

\(^2\) The International Association of Marine Aids to Navigation and Lighthouse Authorities, www.iala-aism.org/web/index.html
The holistic approach should include:

- Safety
- Public acceptance
- Cost within reason
- International standards and harmonization

Structures considered to be an obstacle are associated with two categories of information:

1. Indication on a map and database showing position, extent and elevation above sea level as well as over ground
2. Lighting and painted marking

Adequate promulgation (Category number 1) is the main means to announce the presence of an obstacle. All pilots and seamen should make themselves aware of the most up to date information. Because of this it is of the utmost importance that relevant data on all obstacles, including windturbines, are kept updated in Aviation Information Publications (AIP) and Notices to Mariners (NtM). The visual marking is only to inform about the presence of an obstacle that already should be known. The Irish participant emphasized that the role of marking is to give visual information to aviators and seamen, in addition to what they already are supposed to know. This caused the remark that, if written information were to be considered sufficient, no markings whatsoever would be needed. The comments reflect the interest to go to the fundamental basics of markings.

A discussion was held on ways to mark wind turbines in order to try to find an outline of how the rules should be implemented in real world turbines. E.g. any new rules should preferably apply to new turbines only, thus allowing older turbines to retain their old markings (unless these old markings can be suspected to invite a collision hazard).

**Aviation**

Attached to this document, in Appendix B, is table 6-3 from ICAO “characteristics of obstacle lights”, which summarizes the light requirements for obstacles.

**Single turbines**

Light if the wind turbine is an obstacle. For guidance as to what is defined as an obstacle see ICAO Annex 14 volume 1. H below denotes highest point, to top of blade spin. If it is not an obstacle no lighting is needed, (only in case of offshore turbines, wind turbines onshore will normally require obstacle lighting as the majority will be above 90m in height). Note that even if the highest point (blade in its uppermost position) is higher than 150 m, the nacelle is rarely at that height. Only in those cases that the nacelle-top is higher than the 150 m the light should be visible slightly below the horizon. All lights should be visible 360 degrees in azimuth.

Given the present ICAO regulations the following is proposed if the object is considered an obstacle. All lighting shall be on the nacelle, thus not on the highest point. Definitions on intensity levels can be found Appendix B of this document.

- **H < 90m (100)** No marking or lighting if offshore, low intensity (LI) fixed red obstacle lighting may be required if onshore.
- **90 (100) < H< 150** Onshore: Low intensity steady red light, normally not visible below the horizon (except at tower bending and low clouds). Medium intensity (MI) fixed red lights may be required in certain circumstances near aerodromes. Offshore: high intensity type A flashing white light. Normally not visible below the horizon. Vertical beam spread should be 3 degrees up and zero down.
H > 150 High intensity (HI) type A flashing white light. Not visible below the horizon if the nacelle-top is at 150 m or lower. Vertical beam spread should be 3 degrees up and zero down.

Wind Farms
Light if the wind turbine is an obstacle. For guidance as to what is defined as an obstacle see ICAO Annex 14 volume 1.

General principles:
• A small wind farm, (onshore), say <10, may be lit on one of the highest points (nacelle), depending on the shape of the farm (minimum number of lights consistent with safety). For offshore windfarms light the peripheral turbines and suitable significant points!
• Large wind farm: Clearly indicate the periphery and significant points, based on a 3 nautical mile visibility. The other turbines do not have to be lit.

Some attendants noted that in no case does it seem necessary to use lights of medium intensity. The reason is that the high intensity light varies between 200 000 Cd at daytime, to 20 000 Cd at twilight conditions and 2 000 Cd at night, while the medium intensity light has an intensity of 2 000 Cd in all conditions. As the high intensity light is white it is believed to be less offensive to the public than the red from the medium intensity light. However, the cost if lighting equipment is however higher for the HI lights.

An Alternative Marking Option
One Swedish proposal was to adopt a principal that the wind turbine markings be specific to wind turbines and other structures where the highest point, such as the upper tip of a blade, can not be lit. The simple idea behind this proposal can be understood if e.g. an emergency pick-up mission for a pilot of an ambulance helicopter is considered. If markings on top of fixed objects and wind turbines are the same, in low visibility this pilot will have to assume that all lights are markings on wind turbines! Therefore he must pass above the light with a generous margin for a rotor radius. This may force him either to ascend into low clouds or go around the obstacle at a “safe” rotor radial distance + a margin. Indiscriminate obstacle lighting thus eliminates the option to pass close and above future fixed obstacles in marginal visibility circumstances. A discriminating light for non-fixed obstacles would preserve this option. However, the group, gathered at the 46th Topical Expert Meeting, voted down this proposal.

Maritime
Maritime marking according to IALA O-117 was considered to be relevant, see also documentation O-117 in presentation No4.

Miscellaneous
Below are a number of items commonly agreed on, regarding aviation lighting:
• Blade tip lights are considered to be too complicated and visually polluting. All lighting should be located on the nacelle
• White is more acceptable than red
• All flashing lights are to be synchronized if possible
• As little as possible should be seen below the horizontal plane. Under normal circumstances this means that no light is visible from the ground
• All wind turbines should have as light a colour as possible, preferably white
• Along with lights there could be one or more systems giving additional safety. Such systems include:
  - Up-to-date flight maps
  - Transponders
  - Radar-reflectors
  - Paint schemes
• New marking rules should only apply to new turbines

**Other information**

Preliminary Danish plans for lighting offshore below 150m are as follows:
• Outline of perimeter with medium intensity lighting
• Rest of turbine with low intensity lighting

Price examples of lighting devices.

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<tr>
<td>LI</td>
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<tr>
<td>MI</td>
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<td>HI</td>
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**Information obtained after the meeting**

UK Aviation Authority has implemented recommendations for lighting wind turbines in territorial waters. The lighting principle states that the wind turbines on the periphery of a wind farm need to be fitted with at least steady red medium intensity light. The other turbines do not need to be lighted. The text describing the lighting principle is attached to this document in Appendix A. (Editor’s note: “Territorial waters” must certainly even include waters in the UK economic zone.)

**Continuation**

The intention of the group is to continue informing about these topics. An E-mail list of interested people is anticipated and will be set up by the Operating agent.

**References**


**Definitions/Links**

• IALA = The International Association of Marine Aids to Navigation and Lighthouse Authorities, www.iala-aism.org/web/index.html
• ICAO = International Civil Aviation Organization, www.icao.org/
Appendix A

The following information was obtained from Smailes Baggy\(^3\) (MarkS.Smailes@dap.caa.co.uk) after the meeting.

“Given the lack of international guidance, the UK has developed a statutory (legal) requirement to light offshore wind turbines. Article 134 of the UK Air Navigation Order, which came into effect during January of this year (editors comment, 2005), requires that turbines of 60m or more must be lit. A copy of the article is attached.”

\(^3\) UK Civil Aviation Authority, Directorate of Airspace Policy
List of participants

IEA R&D Wind Annex XI, Topical Expert Meeting
OBSTACLE MARGING OF WIND TURBINES
6th of October 2005

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