

## Navigation In The Vicinity of Offshore Renewable Energy Installations

### Introduction

The United Kingdom Maritime and Coastguard Agency has recently published a Marine Guidance Note; MGN 372 (M+F) for the attention of, amongst others, Shipowners, Masters and Ships Officers, concerning the factors to be taken into account when planning a passage and navigating in the vicinity of Offshore Renewable Energy Installations, (OREIs). OREIs comprise Wind Turbines, Wave Energy Converters (WECs) and Tidal Energy Converters (TECs).

The guidance contained within the MGN is principally concerned with the renewable energy installations that are, or are to be situated around the coast of the United Kingdom, however, some of the advice contained within the document is referenced to International Association of Lighthouse Authorities (IALA) Recommendation O-117 on 'The Marking of Offshore Wind Farms', Recommendation O-131 on 'The Marking of Offshore Wave and Tidal Energy Devices' and IALA Recommendation O-114 on 'Recommendations on the Marking of Offshore Structures'. Therefore some of the information given within the MGN will be applicable in other countries with OREIs that are members of IALA.

By far the most common type of OREI at present is the wind turbine. With many commercial turbines in operation, these may be sited individually, or as part of a wind farm; the latter may be extensive, with some having a coverage area approaching 100 nautical square miles. Large wind farms may have an offshore transformer station present; this will be similar in appearance to a small oilfield offshore production platform. When a transformer station is present submarine cables will lead from each turbine to the transformer station, from where power



will be exported to shore via an export cable. The wind farms may have irregular shapes and may well be located close together.

At present WEC and TEC development is at an early stage and only test sites exist around the UK at present, however the world's first wave farm site has recently commenced operation off the Portuguese coast.

It has to be borne in mind that OREIs are a fairly recent development and many of the technologies involved are in their infancy; therefore the guidance given is of a general nature and will no doubt be expanded as experience of the location, operation and peculiarities associated with OREIs is gained as time passes. Information available on navigation charts and in Sailing Directions should be studied and it is planned that the next edition of 'The Mariners Handbook' (NP100) will contain further information on OREIs.

### Charting of OREIs

Information on the location of the various types of OREIs will be found on navigational charts, and updated as necessary by Admiralty Notices to Mariners. Any urgent information regarding OREIs will be promulgated by navigational warnings. Mariners need to be aware of the symbols and markings on charts associated with OREIs and details of the symbols in use can be found in Admiralty chart 5011. Wind turbines on land will, dependent on chart scale, either be marked as single turbines, or if the scale of the chart does not permit this, then as a field marked with a black maritime limit and a wind turbine symbol. Offshore, again dependent on the scale of the chart, wind turbines may be individually charted or again marked as a field with a black maritime limit depicting the extremity of the field, or, if a restriction on entry exists then with a magenta field limit with an appropriate

legend. If a turbine is lit it will have a light star, magenta light flare and a description of the light characteristic. Where vessels may navigate close to a wind turbine there may also be information next to the wind turbine symbol advising the clearance from Mean High Water Spring to the bottom of the arc swept by the blades, in UK waters this is to be at least 22m.

Dependent on chart scale submarine cables may be shown, or it may be marked as a cable area.

For subsurface WECs or TECs these will be charted as a danger circle with an appropriate legend, such as 'Turbine'. The depth over the device to chart datum, where known, may be shown in the danger circle along with the appropriate symbol depicting safe clearance depth, or, for example, if the depth was obtained by wire sweep. If part of a device is above the surface and marked/lit, then the appropriate symbol will be used, such as isolated danger mark beacon with light star, magenta light flare and light characteristic, along with an appropriate legend placed next to the symbol. If due to the scale of the chart it is not possible to depict the individual units then an appropriate legend, such as 'Underwater Turbines' with a black maritime limit will depict the extent of the field, as for wind turbines. If a restriction exists then the magenta area limit with a suitable legend such as 'Entry Restricted' will be used.



## Wind Turbines

Wind turbines encountered around the UK typically comprise of a foundation below sea level, then a yellow section which will be at least 15m high measured from highest astronomical tide, at the top of which will be a platform. Above this will be the turbine tower which will typically

be 70-80 metres in height. At the top of the turbine tower will be a nacelle containing the generator, and attached to this will be either 2 or 3 blades which can measure over 60m in length. The components of the wind turbine above the yellow section are usually painted matt grey. In other areas wind turbines may be encountered that are marked with horizontal yellow bands of not less than 2 metres in height and separation, and in some cases retro-reflective tape may be fitted.

The total height of a wind turbine can be up to 150m; therefore, theoretically, an observer with a height of eye of 3m would be able to see the tips of the blades at 28 miles, and the top of the tower structure at 20 miles, in clear visibility.

## Wind Farm Navigational Marks

During construction wind farm extremities are generally marked with standard cardinal marks, and in areas of high traffic density guard vessels may also be employed. Once operational the wind farm will be marked in line with IALA Recommendation O-117, 'Marking of Offshore Wind Farms'. Any aid to navigation fitted on a wind turbine will be fitted below the lowest point of the arc of rotation of the turbine blades, and at a height above highest astronomical tide of not less than 6m or more than 15m, being typically at the top of the yellow section of the mast.

A wind farm will be marked such that the wind turbine on a corner of a square or rectangular wind farm, or at a significant point on an irregularly shaped wind farm, will be designated a Significant Peripheral Structure (SPS). Each SPS should be fitted with lights that are visible from all directions in the horizontal plane, and the lights on a structure should be synchronised to show a yellow 'special mark' light characteristic with a range of not less than 5 nautical miles. It may be found that the lights on all the SPSs within a field are synchronised. SPSs are designated and situated such that the distance between them does not exceed 3 nautical miles.

Between SPSs there may also be Intermediate Peripheral Structures (IPSS)

situated not more than 2 nautical miles from SPSs, these will be fitted with lights that are visible from all directions in the horizontal plane, again, as for an SPS, synchronised on each structure. These lights will be 'special mark' lights, but they will have a distinctly different flash characteristic from that shown by the SPSs, and with a minimum range of 2 nautical miles.

The provision of additional aids to navigation over and above the IALA recommendations is at the discretion of the field operator, and it may be found that either all structures within a field, or all structures on the periphery of the field are lit, or that racons, which may have morse letter 'U' or radar reflectors have been fitted. In some instances it may be found that the field is fitted with AIS. Sound signals may be fitted for restricted visibility and IALA recommend that the typical range of such a sound signal be not less than 2 nautical miles.

Individual wind turbines that are not part of a wind farm will be marked in accordance with IALA Recommendation O-114 on the Marking of Offshore Structures. Transformer stations situated within or adjacent to a wind farm should be similarly lit. These structures will have synchronised white lights flashing morse 'U' such that at least one light is visible from any direction in the horizontal plane, with a maximum period of 15 seconds. Such structures will also be fitted with sound signals situated such that they are audible to vessels approaching from any direction. These will sound morse code 'U' every 30 seconds and be audible in all directions to at least 2 nautical miles, and will be activated when the visibility is less than 2 nautical miles.

Some wind farms may also have permanent cardinal marks situated adjacent to them. For full details of the lights and aids to navigation fitted a particular wind farm or wind turbine, the largest scale navigational chart for the area should be consulted.

Around the UK wind turbines are marked with unique alphanumeric identifiers, of such a size that they are visible from 150m, and at night these are discretely lit by downlighters so as to be visible from the same distance. Situated on top of the generator units are red aviation warning



lights and these may possibly be visible to surface craft, care has to be taken that these are not mistaken for red sidelights, and when seen through the rotating turbine blades they will appear to be flashing.

In some instances vessels and barges engaged in wind farm construction may have the ability to jack-up the body of the barge or vessel whilst on location to provide a stable platform for construction work. Mariners must be aware that these vessels and barges, when afloat, will be lit in line with the requirements of the Collision Regulations. However, when such a vessel is jacked-up she will be lit in line with the requirement of IALA Recommendation O-114 on the Marking of Offshore Structures. The marking and navigational aids associated with such structures will be as previously described above for isolated wind turbines.

### Passage Planning and Navigation in the Vicinity of Wind Farms

By their nature wind turbines are generally situated in relatively shallow water such as shoals or sand banks, therefore naturally restricting the ability of many vessels to navigate in their vicinity due to the limited depth of water available.

Wind turbines are generally spaced around 500m apart; however, they are spaced so as to best make use of the available wind whilst ensuring that interference from surrounding turbines is minimal. Therefore, generally the larger the diameter of the blades, the greater the distance between turbines.

There is some evidence that in areas of strong tides or currents scouring of the seabed in way of a turbine base structure may occur, leading to significant deposits of seabed material in other locations. Vessels navigating in the vicinity of wind turbines will have to bear this in mind, especially when proceeding with limited under keel clearance.

The structure may obstruct tidal or current streams locally creating eddies; however, these will only be very close to the structures and therefore should not be a concern to vessels on passage in or around a wind farm.

Vessels engaged in servicing/maintaining the wind turbines may be encountered in or around a wind farm, and some of these may be quite small and be obscured by turbine masts, therefore mariners must ensure they keep a good lookout whilst navigating in the vicinity.

When wind farms are located adjacent to the coastline, shore aids to navigation may become obscured due to the wind farm structures. Mariners should be particularly

aware of this and ensure that all aids to navigation, and in particular shore lights whose characteristics may be masked or blurred by the wind farm structures, are positively identified prior to being used to ascertain the vessels position at night.

Dependent on the scale of the navigational chart, or when a transformer station is present, it may be the case that not all submarine cables associated with the wind farm are charted, therefore vessels should only anchor in the vicinity in the case of an emergency as the probability of fouling the anchor and causing damage to submarine cable is high.

Trials conducted to assess the impact on various ship navigation and communication systems when vessels are navigating in or around wind farms has shown that there is minimal impact on VHF, GPS, mobile phones and AIS. UHF and microwave systems were found to suffer the usual interference experienced when structures are in the line of transmission.

Radar returns from wind farms were found to be quite strong, however, at close range, starting at about 1.5 nautical miles, it was found that wind farms may produce multiple echoes, reflected echoes and side lobe echoes which could be masking real radar targets. The deterioration of the radar picture progresses as a vessel closes with the wind farm. The size of the radar target echo increases close to a turbine with consequential degradation of target definition and bearing discrimination. These effects were found with both 3cm (X-band) and 10cm (S-band) radars. Vessels with poorly sited radar antenna may enhance these effects. Although these effects can, to some degree, be suppressed by use of the radar controls, care must be taken that genuine targets with a small radar signature, such as buoys, service craft or GRP pleasure craft, are not also suppressed. It must be remembered that radar performance is an important factor to be borne in mind when deciding upon a safe speed under Rule 6 of the collision regulations, and if the radar picture is degraded then the speed should be adjusted accordingly and a good lookout in accordance with Rule 5 maintained. Therefore, based on the above, it would be prudent for vessels

when engaged in passage planning to lay off courses at least 2 nautical miles clear of wind farms.

### Wave Energy Converters and Tidal Energy Converters

These devices, of which there are many different designs being developed, may be either sub-surface or on the sea surface, either fixed in position or on a mooring allowing a range of movement with the tidal flow or current stream.

The most common type of WEC is the attenuator, which consists of a series of interconnected tubes which float on the surface and ride the waves parallel to the wave / swell direction. TECs consist of sub-sea turbines which may have either exposed or enclosed turbine blades.

These devices may be attached to the seabed in a number of ways. They may physically sit on the seabed as a gravity based structure, remaining in place due to the weight of the object itself, or they may be mounted on piles driven into the seabed to hold the device in place. Devices may be moored to the seabed on a wire or chain, and the mooring may be of such a length to allow a degree of movement for the device, or it may be a rigid mooring allowing minimal movement. Some devices have fins designed such that the stream of water passing over them produces downforce to keep the device in position.

### Navigational Marks around WECs and TECs

Marking of WECs and TECs should be in accordance with IALA Recommendation O-131, 'The Marking of Offshore Wave and Tidal Energy Devices'.

Individual WECs and TECs which extend above the surface should be painted yellow, but may not necessarily be fitted with lights, however when lights are fitted they are yellow lights flashing with sufficiently different light characteristics from any buoys around the field extremity, with a range of at least 2 nautical miles.. An area containing a number of either WECs or TEC should be marked around its

extremity with appropriate navigation buoys with corresponding lights, with a nominal range of at least 5 nautical miles, and topmarks; these should be visible from all directions of approach. Usually the buoys deployed will consist of cardinal marks at the northerly, southerly, easterly and westerly extremities of the field, however, if the field is quite extensive, there may be the need to deploy additional lateral or special marks between the cardinal marks. When additional buoys are deployed they should be positioned such that the distance between two buoys marking a field boundary does not exceed 3 nautical miles. In addition, retro reflective material, racons and AIS may be used.

If a single WEC or TEC extends just above the surface it should be marked as an isolated danger mark, being black with red horizontal bands and lit accordingly. If a single WEC or TEC is below the surface and is considered a hazard to navigation it should be marked with a special mark yellow buoy with a flashing yellow light with a range of at least 5 nautical miles. Mariners must bear in mind that many TECs are equipped with exposed fast moving turbine blades.

Mariners have to also be aware, that due to the nature of the tidal stream in locations where WECs or TECs may be located, surface marker buoys may not be visible at all states of the tide.

### Restricted Areas around OREIs

During construction of OREI sites around the UK a temporary safety exclusion zone may be established, and guard vessels employed to patrol the area, these guard vessels may actually be fishing vessels employed in this role. Details of these zones will be promulgated by Admiralty Notices to Mariners and Navigational Warnings. Vessels planning a passage in the vicinity of such a zone are advised to give it a wide berth.

Offshore structures such as oil production platforms have a 500m safety zone; however it is expected that wind turbines will be given a 50m safety zone, and due to the scale of charts this may not be shown. For developments including WECs or TECs the establishment of safety zones

is yet to be addressed as only test sites exist around the UK at present, but it may be that due to the nature of units they may be protected by the establishment of a restricted safety zone.

The full text of the MCA Marine Guidance Note MGN 372 (M+F) 'Offshore Renewable Energy Installations (OREIs): Guidance to Mariners Operating in the Vicinity of UK OREIs' can be found at [www.mcga.gov.uk/c4mca/mgn372.pdf](http://www.mcga.gov.uk/c4mca/mgn372.pdf)

Further information on the 'Marking of Offshore Wind Farms', 'The Marking of Offshore Wave and Tidal Energy Devices' and 'Recommendation on the Marking of Offshore Structures' can be found on the International Association of Lighthouse Authorities website at [www.iala-aism.org/](http://www.iala-aism.org/)



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