**EXTRACT FROM THE PAPER *"ASSESSMENT OF THE NAVIGATIONAL IMPACT OF OFFSHORE WIND FARMS"* PRESENTED BY COLIN BROWN, MASTER MARINER, OFFSHORE WIND FARM ADVISOR TO THE MCA AT TRINITY HOUSE'S *COLLISION RISK MANAGEMENT SEMINAR* ON 4 NOVEMBER 2003.**

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## 4.0 Problems to be Resolved

There are a number of marine safety problems which may be unique to offshore wind farms.

### 4.1 Marine systems in general

Offshore wind farms structures may induce unwanted effects and errors into a variety of communication, position fixing and radar systems. In the original Environmental Statements submitted to MCA such effects were either not addressed or misunderstood.

The reflection and shadowing of electromagnetic signals has been determined by QinetiQ ( previously known as the Defence Evaluation Research Agency, DERA) to have the potential of affecting marine radar, VHF communications and, to a lesser extent, positioning systems, particularly those of small vessels inside wind farm sites and close to the towers. There appears to have been some confusion by developers with the study commissioned by DTI and undertaken by QinetiQ with respect to military and civil aviation systems. However, this study has little or no relevance to the effect on marine systems.

QinetiQ state that, although some generic effects are noted, there are site-specific aspects which should be assessed by experts.

### 4.2 VHF Communications

Since the effectiveness of an Emergency Management System will be fully dependent on communications, any attenuation or shadowing of VHF communications signals may be critical.

VHF communication is, by far, the major means of alerting other craft and rescue services to dangers and vessels in distress, and will include, in the future, messages to and from HM Coastguard used to instigate Active Safety Management Systems ( see Section 5.1) In addition VHF is the medium on which the Universal Automatic Identification System (UAIS) data is carried.

Research undertaken indicates that there may be a potential impairment of a vessel's transmitted signal to and from wind farm sites. Of great importance is the attenuation which has found to exist close to and on the far side of turbine towers relative to transceivers, since this is the area in which small vessels are most likely to be in difficulty and requiring assistance. The research has indicated, for example, at a range of 50 metres from an average turbine tower, a loss of VHF signal strength of between –3dB and – 6dB, i.e. a loss of between 50% and 75%.

An attenuation of 12 dB ( a factor of 16) for a vessel 10 metres from a tower could easily render its distress calls ineffective, and indications appear to be that transmissions from closer to the tower could be even more affected. Research shows that these effects would be cumulative, in both rate and effective arc of attenuation, when two or more towers are in line along the transmission path.

Whether communication from and to vessels in distress can be effected therefore depends on the distance of the vessel from the tower and the relative positions of the two transceivers, but may be impossible in parts of the wind farm.

#### 4.2.1 VHF direction finding

Royal National Lifeboat Institution (RNLI) vessels use VHF Direction Finding (VHFDF) equipment extensively when engaged in search and rescue operations, so that whilst in VHF communication with a casualty or potential casualty, its direction and, possibly, position can be determined.

VHFDF may not be possible in the above circumstances.

### 4.3 Marine radar

With respect to turbines themselves, the vertical extent of their steel towers, coupled with the large vertical beam width ( around 30 degrees) of marine radar systems, will generally return strong echoes to vessels operating in the area and therefore will provide positive indications of the wind farm's presence. There are however some disadvantages to this, including the false triggering of Radar Beacons ( Racons) within a kilometre of a turbine.

The same research indicates similar signal attenuation in marine radar with a cumulative effect when a number of turbines are in the same line, and a widening with range of the attenuated cross-range path.

Thus the signal strength losses incurred in shadow areas behind single or multiple turbine towers may render target vessels undetectable in these areas. The probability of detecting other vessels and casualties within a wind farm is also affected by the beam width and pulse lengths available to the detecting radar.

#### 4.3.1 Beam width and bearing discrimination

The small vessels which may enter offshore wind farm sites are likely to be fitted with fairly low powered radars with scanner sizes ranging from 18 inches to – for the RNLI search and rescue vessels – a maximum of 4 feet. Such radar makes in use include Raytheon, Koden/Simrad, Foruno, etc., the larger RNLI lifeboats being fitted with Bridgemaster 2 systems.

Average nominal horizontal beam widths for these scanners are around 2 degrees to the 3 dB (half power) points but the smaller scanners have beam widths of 3.9 degrees. This relatively low directional quality not only increases the spread and relative power of side lobe propagation in small vessels, which may result in false echoes, but also reduces bearing discrimination.

*(The size of the echo from small targets displayed on radar varies as the beam width of the radar system, being approximately equal to the range of the target in metres multiplied by the tangent of beam width)*

For example, a vessel at one end of a small wind farm, with a radar having a 2 degree beam width, would display the echo of a tower at the farm's far end (say at a range of 3 nautical miles) as being 194 metres across. For a vessel close to a turbine at this range to be discriminated from the tower itself, i.e. to produce a larger echo than the turbine itself, it would have to be more than 194 metres in length if at right angles to the transmitted signal.

The distances at which the cross-range resolution would equal the average separation of turbines ( 450 metres), ie. the distance at which two or more turbines would be displayed on radar as a single fused echo, would be, respectively for the two typical radars,6.9 and 3.6 nautical miles.

#### 4.3.2 Range discrimination

Down range minimum resolutions ( range discrimination) for radars depend on the length of the transmitted pulse in time - which itself determines transmitted power to some extent – and these vary from 12 metres for the better systems, when at short pulse length, to 125 metres for the least expensive. Targets at lesser separation than the range discrimination of the pulse length in use will be displayed on radar as a single fused echo rather than indicating the presence of two or more targets.

#### 4.3.3 Combined effects

*Both of the above have the effect of reducing the range and bearing discrimination in which target vessels, for collision avoidance or search and rescue purposes, can be differentiated from other echoes such as the turbine structures.*

#### 4.3.4 Probability of detecting vessels in the wind farm area.

For all the foregoing reasons, any of the small sized vessel types expected to be found operating close to or within the wind farm area would only be detected by radar if :

**a)** when close to a turbine tower the vessel dimensions were considerably greater than the range and bearing discrimination of the radar in use (unlikely with small vessels)

**b)** it was such a distance from the turbine tower that it lay outside the above discriminations , was not in the same direction as the search vessel’s track, nor within a cumulative tower signal attenuation sector.

The notification and detection of casualties in good time is a critical factor in search and rescue activities, hence the reason for turbine identification in all conditions, coupled with an active safety management system (ASMS), as described in section 5.1.

### 4.4 Turbine heights and clearances

Turbines in each proposed development are of around 75 m nacelle height above mean sea level and with rotor diameters of 100 m, such that the maximum height of the swept out rotor discs will be around 125 m above mean sea level. The generators within the nacelles will each produce up to 4 Megawatts of power and will thus be of considerable size, potentially up to 500 tonnes in weight.

Minimum clearance between the lower sweep of the rotor and sea level is of interest, particularly to craft which could find themselves driven against the towers, since individual blades can weigh up to six tonnes and with rotational blade tip speeds of up to 300 km / hour.

Therefore, with respect to recreational craft, the Royal Yachting Association voices concerns over the minimal clearance between the lower edge of the disc swept out by the rotor blades and the highest, extreme condition, sea level. RYA point out that sailing vessels in difficulty near or within the wind farm might have difficulty in anchoring in such comparatively deep water and would be unable to keep clear of the turbine towers.

Their viewpoint is that :

> *"…… in the form of percentage of the UK boating fleet, we can see the percentage of recreational yachts at risk from different rotor clearance heights. ……a clearance height of 18 meters will put 12% of the national fleet at risk from rotor height collision. This position is unacceptable. There are a variety of engineering solutions that have been put forward by developers and the clearance height varies on these. However, it would appear that a clearance of 22 meters is also possible in engineering terms, which would put 4 % of the national fleet at risk, a more acceptable level of risk in the eyes of the RYA. This height has already been specified as a minimum clearance height in several of the wind farms consented in the first phase."*

### 4.5 Other concerns

These include the possibility of siltation, deposition of sediment or scouring created by the structures such as to affect the navigable depth of water or the uncovering of buried onshore cables. Cable burial depths in relation to the types of vessel likely to anchor, and corresponding anchor penetration depths in the relevant seabed type, have been calculated in few applications.

Sailing vessels may also be affected by the wind masking, turbulence or sheer effects created around offshore wind farm structures.

## 5.0 Measures to Assist Search & Rescue Operations

### 5.1 Agreement with developers

Agreement has now been reached with the majority of current offshore wind farm developers that :

**1)** a minimum safe (air) clearance shall be maintained between sea level conditions at mean high water springs (MHWS) and the turbine blades that is suitable for all vessels involved in current maritime traffic flows and operations in the wind farm sea area and is, in all cases, not less than 18 metres.

**2)** an active safety management system (ASMS) should be put into operation such that blade rotation can be stopped very rapidly at the request of HM Coastguard, with the blades coming to rest in a “Y” configuration or as otherwise required by Emergency Towing Vessel (ETV), helicopter or lifeboat operations.

**3)** all turbines should be uniquely marked and lit at night and in reduced visibility such that :

**i)** A vessel 150 metres from the turbine ( ie. twice a potential zero VHF communications range) should be able to see the tower, read its markings, and indicate its position to Emergency Services, before such communications are lost.

**ii)** The light or lights should also illuminate the turbine access ladder for use as refuge in emergency.

**iii)** The lights and marks should not be able to be confused with the navigation lighting and marking required by Trinity House Lighthouse Service, nor interfere with their visibility.

**iv)** The lights should not interfere with night vision or the ability to detect other vessels within the wind farm.

**v)** Safety lighting should not be visible from ashore.

Developers are rightly concerned that unauthorised persons – even with 50 metre safety zones – may board the turbines. However, the possibility of making these secure from vandalism, whilst still providing a small platform on which seafarers in distress would be able to take refuge, is being considered.

## 5.2 Scenarios

The following are potential scenarios :

*Drifting vessel and potential collision with turbines*
*Collision with turbine by vessel underway*
*Vessel in trouble close to a wind farm*
*Vessel in trouble within a wind farm*
*Person(s) in the water within a wind farm*
*Person(s) having sought refuge on a turbine tower*
*Maintenance staff in trouble on or inside a turbine*

### 5.2.1 Search and Rescue (SAR) Response

The response to SAR incidents in or around wind farms should be undertaken by specialist SAR assets only, eg. SAR helicopters, RNLI Lifeboats and Emergency Towing Vessels (ETVs).The risks will generally be too great to deploy non-specialist SAR units within a wind farm environment. As with a UK SAR response to incidents within the offshore industry where a shutdown is necessary, there will be no liability on MCA for any cessation of operations or loss of revenue.

### 5.2.2 Counter Pollution Response

It is likely that any counter pollution operations involving spraying aircraft in or around a wind farm will require the shut down of the entire wind farm.

### 5.2.3 Salvage Response

MCA would be guided by the salvors regarding turbine shutdown in the event of a salvage operation in or around a wind farm.

# 6.0 Reducing Casualty Risks

## 6.1 Site and individual turbine marking

International recommendations for the day and night marking of wind farms have been promulgated by IALA and applied by Trinity House Lighthouse Service, Northern Lighthouse Board and the Irish Commissioner of Lights. These are minimum recommendations and can be adjusted by national authorities as required.

There is some playoff between the desire to keep the wind farms from spoiling sea views from ashore, particularly in tourist areas, and the necessity to prevent vessels from colliding with the turbine towers. Although there is no international requirement to have all individual turbines marked, MCA and others have made recommendations that each tower should have a unique mark, painted where it can be easily seen and lit at night.

A further recommendation is that such short range lights on each tower should illuminate both the mark and the access ladder for temporary refuge.

## 6.2 Promulgation of navigation and safety information

**1)** The United Kingdom Hydrographic Office will promulgate site development information in Notices to Mariners, will show wind farm sites on Admiralty charts and will include some data in the relevant Sailing Directions, however this will largely consist of positional and development timing information and therefore instruction, advice and guidance should be promulgated by other means.

**2)** Merchant Shipping Notices (MSN), Marine Guidance Notes (MGN) and Marine Information Notes (MIN) for both merchant vessels (M) and fishing vessels (F) may, if required, be produced by the Maritime and Coastguard Agency in co-operation with the site developers.

**3)** For those vessels who are not required to access any of the foregoing information – largely fishing vessels under 12 metres in length and all recreational craft - consideration should be given to producing site navigation information, possibly in both electronic and hard copy form, and promulgated by the most appropriate means

Hard copies of this could be distributed to all potential user organisations within the area and contact details, such as a web site, made available for distribution both nationally and internationally. This might also be done in conjunction with other wind farm developers in the area, explaining such details as the layout of the sites, marking by day and night, the rise and fall of tide within the sites, clearance under the rotors or any platforms and the set and rate of the tidal stream within its general proximity, etc..

**4)** Where short term changes of any kind occur, such as in the construction and decommissioning phases, these should be promulgated in good time and in co-

operation with the United Kingdom Hydrographic Office and the Maritime & Coastguard Agency, in addition to any local port notices.

This particularly applies to any temporary exclusion zones which may be necessary to establish during construction, operation or decommissioning.

**5)** Information to mariners should include advice on procedures to follow should vessels run into difficulty within or near to the wind farm site. Such procedures should be formulated after consultation with HM Coastguard, nearby port authorities, the Royal National Lifeboat Institution, etc.

Particular attention should be paid to potential problems affecting recreational craft which may be low powered, have inexperienced crew and persons with limited physical abilities aboard. The effect of turbine wind wake on sailing craft should be monitored and any potential problems made known.

### 6.3 Mutual agreements

Agreement for the emergency shut down of offshore wind farm turbines in the event of a search and rescue, counter pollution or salvage incident in or around a wind farm was developed at a meeting of SAR experts from the MCA (SAR Branch), CAA, MoD, Bristow and RNLI. The RYA and British Wind Energy Association were also present at the meeting which was called at the behest of CAA who were concerned about the use of SAR helicopters in and around Wind Farms.

### 6.4 Contingency arrangements

Contingency arrangements should be determined in consultation with all relevant authorities and organisations including those detailed under the *"National Contingency Plan for Marine Pollution from Shipping and Offshore Installations"*, MCA January 2000, or subsequent legislation.

### 6.5 Command & Control

It is important that certain lessons learned from the early days of the offshore oil and gas industry are recalled to avoid making the same mistakes when confronted with emergencies in and around Wind Farms. The importance of reporting emergencies immediately to the MCA is stressed so that rescue and other emergency assets ashore can be mobilised quickly.

Should a wind farm control centre become aware of a maritime emergency it should immediately inform the appropriate Maritime Rescue Co-ordination Centre (MRCC) or Maritime Rescue Sub Centre (MRSC) and the latter should assume responsibility for the incident liaising with the control centre as necessary particularly where turbine shutdown might be required. Similarly, when a MRCC or MRSC becomes aware of an incident in or around a Wind Farm or one that threatens a Wind Farm then the MRCC or MRSC will make the control centre aware of the incident and asking for the shutdown of a turbine or turbines where necessary.

It is important therefore that clear lines of communication are in place between MRCC/SCs and Wind Farm Control Centres and an equally robust control mechanism is in place between the Control Centre and the turbines themselves.

## 6.6 The use of "Clearways"

The view of many navigation practitioners is that the “Shipping Clearways” adopted for Offshore Oil development should be applied equally to offshore wind developments.

As an example, Trinity House's own opinion is that :

> *"We have previously stated in this response our view that the “Shipping Clearways” in relation to the Offshore Oil Industry should apply equally to the Offshore Wind Industry and development within these clearways should not be permitted. Neither should development be permitted in channels marked by ourselves (or by port or harbour authorities) for navigation purposes. The aim should always be to reduce the risk to the minimum possible and marine marking requirements are specified by ourselves accordingly. From our experience of marking wrecks and maintaining our own aids to navigation, it remains, in our opinion, inevitable that, despite all the measures taken, collisions will occur between shipping and windfarm structures. Clearly navigational risk assessments should form part of the overall environmental assessment, however, we strongly agree with the view that current risk models for assessing navigational risks are theoretical and do not necessarily reflect reality."*

## 6.7 The REZ and "Safety Zones"

Planned legislation on offshore renewable energy resources was unveiled by the DTI at a seminar held in their conference centre on October 3rd 2003. This described a renewable energy zone (REZ) similar in function and size to the exclusive economic zone (EEZ) and the extension of both criminal and civil laws to that zone.

Article 60 of the United Nations Conference on the Law of the Sea (UNCLOS) will allow the DTI to establish *"safety zones"* within all UK waters up to REZ limits. These may consist of areas around individual installations or, if they are closely spaced, over whole installation areas.

Such provisions, which may also include prescribed restrictions on various vessel types and activities within the safety zone, may be applied retrospectively to projects which have already received consent.

However, the question of how, and by whom, safety zones will be enforced remains to be resolved.

Once the provisions are developed with justifications, MCA may wish to present them to the International Maritime Organisation (IMO) with the aim of getting international agreement for procedures in the siting offshore wind farms and managing the risks to navigation. Comparisons have already been made with the safety zones existing around offshore oil and gas installations, but no such system is so far recognised internationally for wind farms.

# 7.0 Other information

## 7.1 “Future Offshore”

The Department for Trade and Industry published a consultation document “Future Offshore” in November 2002 in which it set out a proposed strategic framework to underpin major expansion of the offshore wind industry.

Its themes covered the lease arrangements, a strategic environmental assessment of three proposed regions ( the North West, Greater Wash and Thames Estuary), in which offshore renewable energy exploitation would be encouraged, and other issues, including changes to the consents process and to the legal framework for future developments. MCA were not consulted during the scoping or production of this document, but along with other stakeholders were invited to comment.

The document can be found on the DTI website :

**www.dti.gov.uk/energy/leg_and_reg/consents/future_offshore**

## 7.2 Strategic Environmental Assessment

The Strategic Environmental Assessment (SEA) is a fundamental part of the “Future Offshore” strategy plan and has significant implications for navigation and maritime safety both within and beyond current territorial waters, to which offshore wind farms are expected to extend in the near future. DTI employed the environmental management consultants BMT Cordah Ltd. to co-ordinate the Strategic Environmental Assessment and its first phase to consider the three strategic focus areas mentioned in the preceding section, i.e. the Thames, the Wash and the North West.

Details of the Strategic Environmental Assessment can also be found via the DTI website or at:

**www.og.dti.gov.uk/offshore-wind-sea**

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