Offshore Wind Farm Helicopter Search and Rescue Trials Undertaken at the North Hoyle Wind Farm

Report of helicopter SAR trials undertaken with Royal Air Force Valley 'C' Flight 22 Squadron on March 22nd 2005

Report written for the Maritime and Coastguard Agency by Colin Brown, MCA Contract MSA 10/6/239, May 2005

Report of the trials undertaken on March 22nd 2005 by the Maritime and Coastguard Agency and C Flight 22 Squadron Royal Air Force, RAF Valley, Anglesey

This work was carried out by the MCA, with funding from Shipping Policy Division of the Department for Transport, in co-operation with C Flight, 2 Squadron of the Royal Air Force.

This report was compiled and written under contract MSA 10/6/239 by :

Captain Colin Brown,
MCA Consultant,
'The Moorings',
Riverside Cottages,
Forder,
Saltash,
Cornwall PL12 4QS,
United Kingdom

e-mail : CCandCGBrown@aol.com

RAF report by:

Sqdn Ldr J.M. Stanley,
Officer Commanding C Flight 22 Squadron,
Royal Air Force Valley,
Holyhead,
Isle of Anglesey LL65 3NY,
United Kingdom

Requests for further information should be sought from :

Captain J.P. Collins,
Head, Navigation Safety Branch,
The Maritime and Coastguard Agency,
Spring Place,
105 Commercial Road,
Southampton,
Hampshire SO151EG,
United Kingdom

Cover photo by Colin Brown

Executive Summary

These trials follow on from those undertaken by the Maritime and Coastguard Agency in conjunction with QinetiQ and Npower Renewables at the North Hoyle offshore wind farm in July 2004 [1]. These had been carried out at North Hoyle with the co-operation of Npower since, at that time, it was the only large area offshore wind farm in United Kingdom waters.

No critical assessment of search activities within and close to offshore wind farms had previously been carried out and the trials indicated that marine and shore-based radar systems would suffer some adverse effects when in their proximity. However no experimentation involving aircraft systems was made at that time.

Therefore, in co-operation with C Flight, 22 Squadron, RAF Valley, it was suggested that trials involving search and rescue helicopters should be carried out. These took place on March 22nd 2005, using a Sea King Mark lll aircraft.

The results indicated that :

- Radio communications from and to the aircraft operated satisfactorily, as also did its VHF homing system.
- Vessels, turbines and personnel in the wind farm were clearly identifiable on the aircraft's thermal imaging system when operating in dry weather conditions.
- No compass deviation was experienced.

However, there could be limitations on the use of helicopters in offshore wind farms, due to :

- Significant radar side lobe returns from structures, limiting target detection when vessels were within 100 metres of turbines.
- The current inability of some wind farms operators to remotely lock turbine blades in rotation and in yaw.
- Limitations in approach distances from turbines in clear weather.
- Inability to effect surface rescues within wind farms in restricted visibility.
- Limitations of helicopters as radar search platforms if the wind farm was large and had irregularly spaced turbines.
- Limitations in the use of thermal imaging in conditions of mist or precipitation.
- Tracking, by vessel or shore-based marine radar, of helicopter movements within wind farms was generally poor.
- Increase of aircraft power requirements downwind of the wind farm.

Other factors which the previous trials had identified for further assessment were :

- The potential for reflected radar signals from turbines triggering RACONS. This was currently under investigation by Trinity House Lighthouse Service.
- The effects of offshore wind farms on short range radio systems. OFCOM had been offered participation in the trials, but did not wish to do so at that time.

[1] " Results of the electromagnetic investigations and assessments of marine radar, communications and position fixing systems undertaken at the North Hoyle wind farm by QinetiQ and the Maritime and Coastguard Agency" MCA Report MNA 53/10/366 of 15.11.04

Acknowledgments :

A number of individuals, companies and organisations took part in these trials.

The most vital contribution was of course that of ‘C’ Flight, 22 Squadron, Royal Air Force, Valley, Anglesey, under the command of Squadron Leader J.M.Stanley

Amongst others, the project manager and the Maritime and Coastguard Agency would particularly like to record their appreciation for the contributions of the following :

Broken Hill Proprietary Billiton Ltd.,

The Environment Agency, Buckley

NPower Renewables Ltd and the crew of “Celtic Wind”

Trinity House Lighthouse Service

The Royal National Lifeboat Institution

Paul Frost, 2nd Mechanic of the Rhyl Lifeboat Station

Carl Davies, skipper of “Lady Gwen II”

and

HM Coastguard, MRSC Holyhead, Anglesey.

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Abbreviations and acronyms :

ALB	All weather lifeboat
AIS	Automatic Identification Systems
ARPA	Automatic radar plotting aid
BHP	Broken Hill Proprietary (Billiton)
dB	Decibels
DSC	Digital Selective Calling
DTI	Department of Trade and Industry
DfT	Department for Transport
FLIR	Forward looking Infra Red
FM	Frequency Modulated
GLA	General Lighthouse Authorities
GPS	Global Positioning System
ISPS	International Ship and Port Facility Security Code
IMO	International Maritime Organisation
ILB	Inshore lifeboat
IRH	Inshore rescue hovercraft
KHz	Kilohertz (radio frequencies)
MCA	Maritime and Coastguard Agency
MDHB	Mersey Docks and Harbour Board
MGN	Marine Guidance Note
MRSC	Maritime Rescue Sub-Centre
Mhz	Megahertz (radio frequencies)
MV	Motor Vessel
NFFO	National Federation of Fishermens Organisations
n.m.	Nautical mile (1852 metres)
OREI	Offshore Renewable Energy Installation
RACON	Radar Beacon
RAF	Royal Air Force
RIB	Rigid Inflatable Boat
RNLI	Royal National Lifeboat Institution
RYA	Royal Yachting Association
SAR	Search and Rescue
SOLAS	Safety of Life at Sea
THLS	Trinity House Lighthouse Service
TI	Thermal Imaging
TV	Television
UHF	Ultra High Frequency
UK	United Kingdom
µsecs	Microseconds
VHF	Very High Frequency
VTS	Vessel Traffic Services
WTG	Wind Turbine Generator

photo by Colin Brown

Fig 1 : North Hoyle Offshore Wind Farm from Gwaenysgor

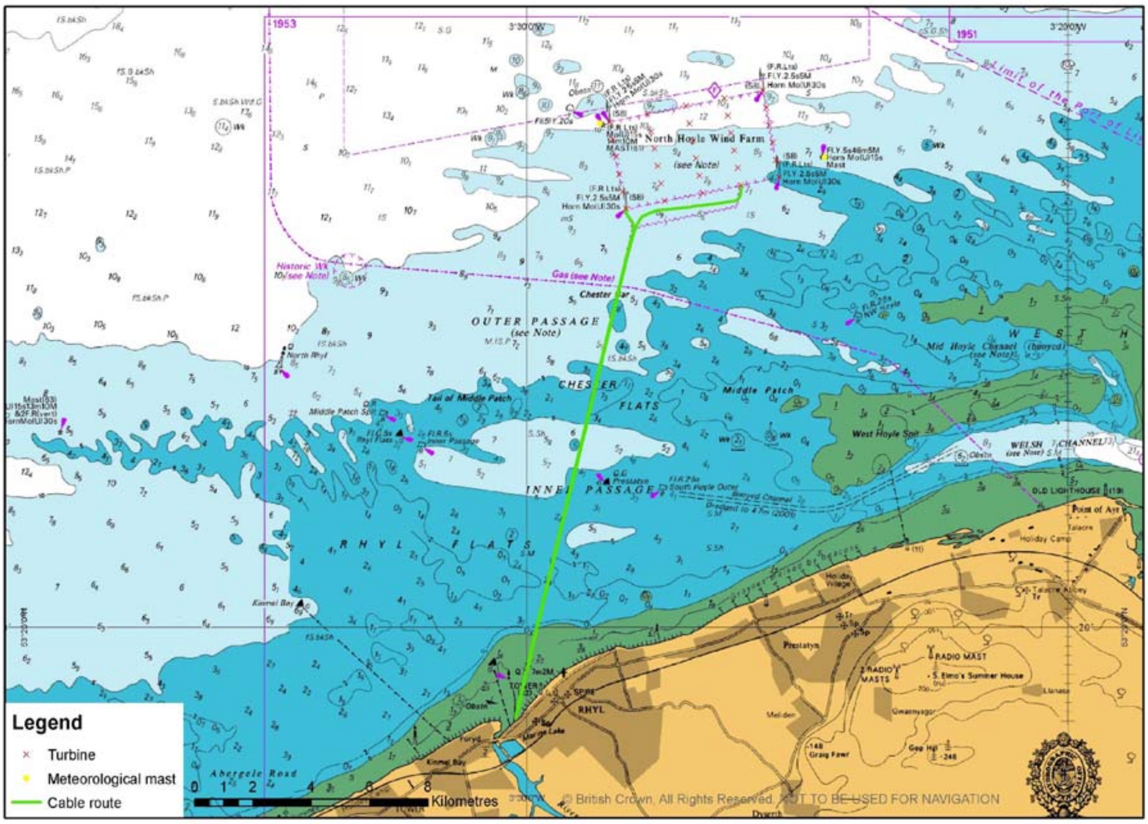


Fig 2 : Charted details of North Hoyle
(diagram courtesy of Npower Renewables)

North Hoyle Offshore Wind Farm

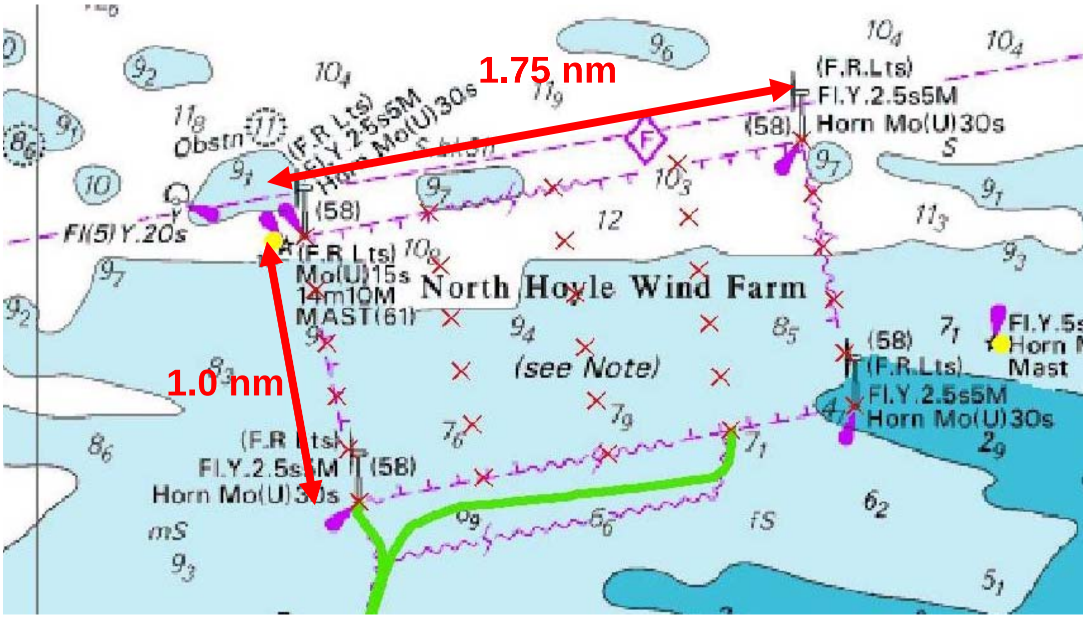


Fig 3 : 30 turbines within an area approximately 1.0 X 1.75 n.m. (1.8 X3.2 km)

1 Introduction :

The Maritime and Coastguard Agency (MCA) has responsibility, on behalf of the Department for Transport of the UK Government, for the safety of navigation under the International Convention for the Safety of Life at Sea (SOLAS), for the direction and co-ordination of search and rescue operations and for the prevention of marine pollution. Offshore wind farm installations are new to the United Kingdom and comparatively so to other countries' waters. The installations are large in area and in the number and size of their structures. However, at the few sites where wind farms had been constructed little detailed practical research on their effect on marine safety had yet been undertaken.

Experience with other types of offshore structure and the results of desktop studies indicated that offshore wind farm structures might have the potential to interfere with marine systems such as shipborne, shorebased and airborne radar.

The original proposed research was intended to obtain scientific and practical operational data on various navigation and communications systems' performance within and in the vicinity of offshore wind farms. In particular, any degradation of the performance of systems was to be determined, quantified and, where considered necessary, cost effective solutions recommended.

Offshore wind farms, consented under Round 1 and proposed under Round 2, cover large areas of open water and hence present hazards to navigation. A number of them are considered to be close to or encroach into waters where there is a high density of shipping movements or be close to waters used by fishing vessels and recreational craft. Their positions are necessarily those which are exposed to weather conditions which could affect the navigation of vessels, particularly small craft. Their locations are, for technical reasons, often in relatively shallow waters near shoals, and therefore in close proximity to restricted waters used by small craft, shipping inshore gaining access to ports or to those waters providing a more sheltered passage required in inclement weather and sea conditions. Tidal streams of varying sets and rates pass through all wind farm sites. Some sites are within port limits and some lie within Vessel Traffic System (VTS) operational limits.

Port authorities and VTS operators require effective detection, identification and tracking of vessels navigating in their areas so as to be able to organise traffic or provide traffic information and navigational assistance services to vessels operating within port approaches or prescribed routing schemes to meet their statutory responsibilities in respect of the safety of navigation. The importance of effective detection and identification is further emphasised by the implementation of the International Ship and Port Facility Security (ISPS) Code from 1 July 2004.

Emergency services such as Royal National Lifeboat Institution (RNLI) vessels, HM Coastguard and RAF helicopters require the ability to rapidly detect and react to maritime casualties.

All of the foregoing require consistent and effective radio communications systems.

Failure of any radar, navigation or communication system could give rise to increased risks to safety or lead to marine casualties and reduce the effectiveness of emergency service operations.

These data will be used to inform mariners, the shipping and ports industries, the General Lighthouse Authorities, the National Federation of Fishermen's Organisations, the emergency services, the Royal Yachting Association, wind farm developers and all other interested parties, of the extent of any system limitations, any consequent increased risks and, where necessary, recommendations as to how these should be mitigated.

This outcome may also be used to inform the consents process of offshore wind farm applications.

The original trials were carried out at the North Hoyle wind farm on various days between July 20th and August 11th 2004 but, for reason of other commitments, these trials were unable to include search and rescue helicopters.

2 Radar cross section of turbines

photo by Colin Brown

Fig 4 : North Hoyle Vestas turbine

The wind turbine generators (WTG) are very large structures in the vertical plane and significantly so in the horizontal plane. Although the towers are cylindrical, their diameter of about 5 metres and height above the water – around 70 metres - is such that they have a comparatively large reflecting surface area. This is compounded by the reflecting surfaces of the platforms, ladders and other structural features of the towers, an average total of about 80 square metres at any time and from any direction. The three bladed rotors have a total reflecting area of around 200 square metres when their plane is at right angles to the direction of the radar scanner, and around half that when in line with it. The nacelle and boss have reflecting areas of up to 16 square metres. Thus in the vertical plane the North Hoyle WTGs, similar to most other types, may from a particular direction have a radar reflecting area of around 300 square metres.

3 Report of the original trials

As was noted in the trials report of November 2004 *(ref. 1)* , the WTGs produced radar side lobe, reflected and multiple spurious echo effects with blind and shadow sectors. The effect was that other turbines and vessels in these areas may not be detected and displayed. Additionally, the strong response of the WTGs when nearby, and with their close spacing, appeared to produce saturation areas in which targets were not detected, particularly if radar receiver gain was reduced to cancel side lobe and other spurious echoes.

4 Helicopter search and rescue trials

The foregoing effects were determined using only ship-borne and shore-based marine radar systems. These included those carried in the Rhyl and Hoylake Mersey Class RNLI lifeboats.

However the RAF, RN and HM Coastguard all contribute greatly to search and rescue operations at sea and therefore it was considered necessary to assess representative systems used in helicopters. It was originally hoped that this could be done during the trials periods in July and August 2004 but, for operational reasons, it was not possible and arrangements were made to do this on 22nd March 2005.

The aircraft carrying out the trials was a Sea King Mark lll of C Flight, 22 Squadron, Royal Air Force, of RAF Valley, Anglesey, in whose operational area the North Hoyle wind farm lies. A number of other consented Round 1 and proposed Round 2 wind farms will also be in RAF Valley's area of responsibility when constructed.

photo by Colin Brown

Fig 5 : Mk lll Sea King of C Flight , 22 Squadron, used in the trials
Pilot Sqdn Ldr J.M. Stanley, Officer Commanding

5 The aircraft's SAR systems

Fig 6 : port side of aircraft

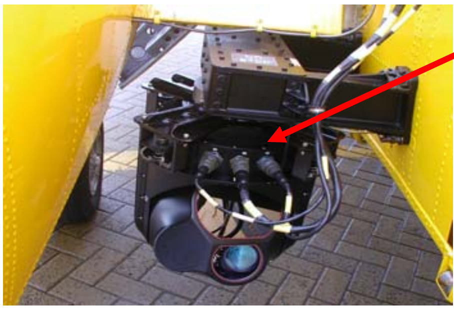


Fig 7 : TV and TI camera housing

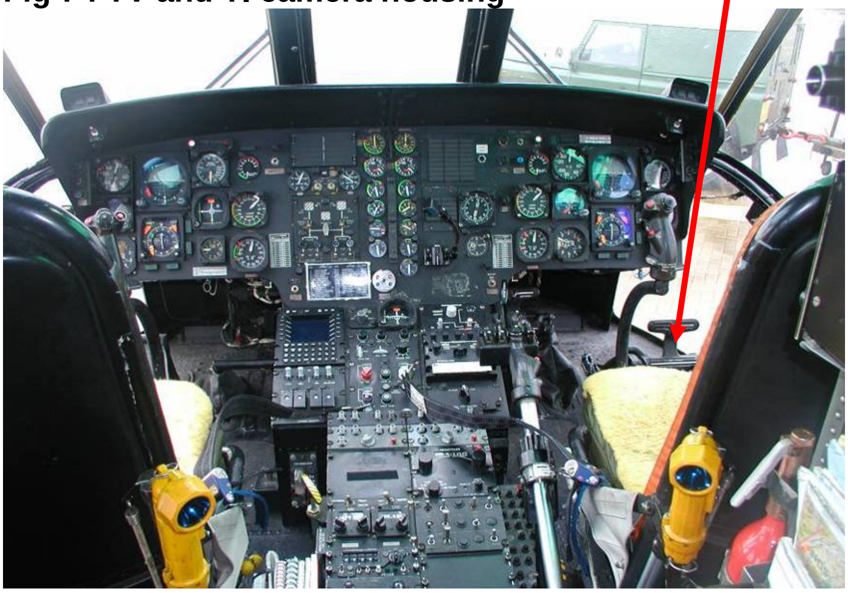
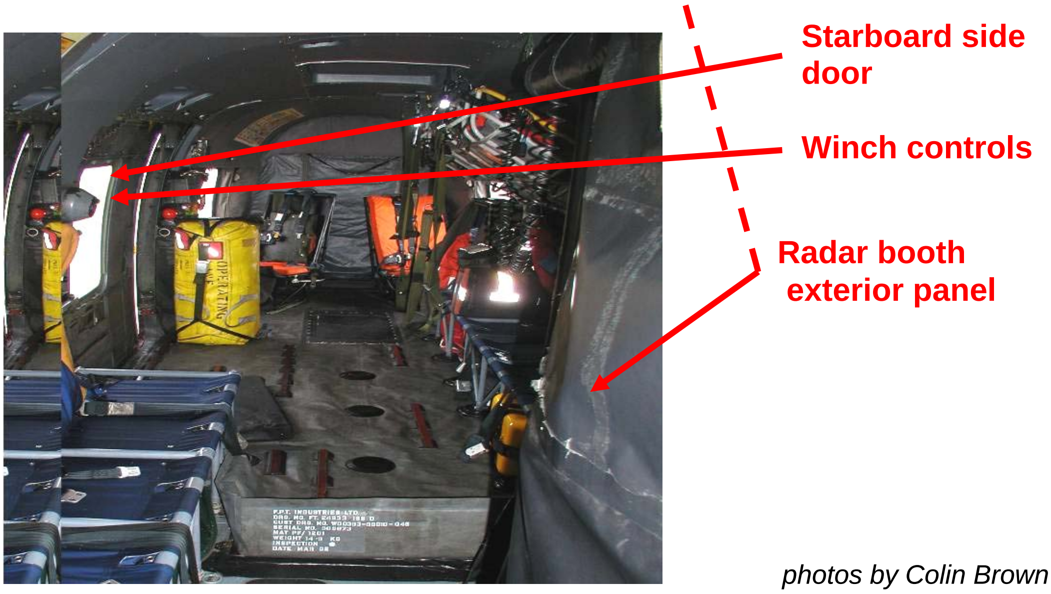


Fig 8 : Cockpit

photos by Colin Brown

Fig 9 : Radar observer's booth, port side



photos by Colin Brown

Fig 10 : Cabin interior

6 General details

The majority of the aircraft systems relating to search and rescue are described in Squadron Leader J.M. Stanley's report (Section 9)

Radar details not included in that section are :

Operational frequency - 9240 MHz
Pulse length - 0.5 microsec
Beam width (in azimuth) - 4°
Beam width (in elevation)- 5°
Blind arcs - 30° ahead & approx 4° astern
(due to to gearboxes and engines)

The aircraft operates with a crew of four :

Two pilots (Captain and co-pilot), a medically qualified winchman and a radar / winch operator

Note : Section 12 of Squadron Leader Stanley's report on page **16** explains that the radar operator doubles as the rescue hoist operator.
As can be seen from figures 8, 9 & 10, the radar console will not be visible from the rescue hoist position or from the cockpit – i.e. once the rescue hoist is in operation the pilots are radar blind.

7 Vessels used in trials

photo by Jim Paton, Holyhead MRSC

This chartered recreational fishing vessel, with MCA communications operators on board, was used mainly for testing ship to helicopter and ship to shore communications systems.

Fig 11 : "Lady Gwen II"

Fig 12 " Celtic Wind" *(photo courtesy of Npower Renewables*

The vessel which provided the major trials target was the NPower Renewables' service vessel "Celtic Wind" which was undertaking various tasks, including taking service personnel off turbines, during the course of the trials.

This vessel, about the same size as a Mersey Class RNLI lifeboat, was very suitable for this purpose.

8 Report of the Officer Commanding C Flight, 22 Squadron :

C FLIGHT 22 SQUADRON
ROYAL AIR FORCE
Royal Air Force Valley
Holyhead
Isle of Anglesey LL65 3NY

Tel: 01407 762241 ext 7249 RAFTN: 95581 ext 7249

Fax: 01407 762241 ext 7385 RAFTN: 95581 ext 7385

See Distribution

Your Reference:
Our Reference: 22C/209/Ops
Date: 5 April 2005

(Comment by Colin Brown)

INTRODUCTION

1. On 22 Mar 05 an informal trial examining Sea King HAR.3 radar performance in relation to offshore wind farms was carried out on behalf of the MCA. The MSS-modified aircraft carried out the trial at the North Hoyle wind farm, which is situated approx 5nm NNW of Rhyl. North Hoyle (fig 1) contains 30 turbines in a regular grid of 6 rows and 5 columns, with the rows orientated approx ENE / WSW. The rows and columns are spaced approx 300m and 700m apart respectively.

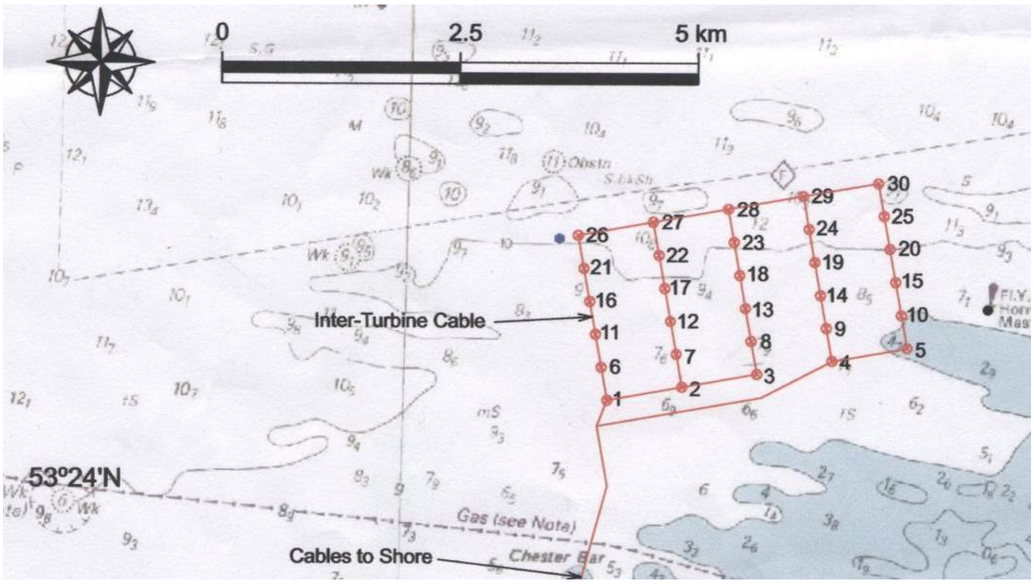


Fig 1 – North Hoyle Offshore Windfarm

2. Weather conditions for the trial were broken medium-level cloud, nil precipitation, wind southerly at 20 kts and sea state 3. Although a small fishing vessel had been chartered for use as a target, its arrival at the wind farm was delayed; fortuitously, the wind farm workboat ('Celtic Wind', similar in size to a Mersey-class lifeboat) was present and was used as a target for the majority of the trial. The aircraft operating crew was a standard SAR crew with no formal trials experience.

RESULTS

3. Sea King Radar Performance. Side lobe returns were found to extend approximately 100m to either side of each turbine, with the sidelobe depth estimated at less than 50m. The target, which was moving between the turbines within the wind farm, was tracked from the aircraft positioned in the 50 ft hover between 0.25 and 0.5 nm clear of the sides of the wind farm.

These results are consistent with those found during the MCA / QinetiQ trials of July and August 2004 (ref. 1) and would be expected with respect to the Sea King's comparatively wide horizontal beam width. See also figure 28

4. The target could be tracked to a distance of approximately 100m from each turbine. Beyond this point the target could be recognised at a slightly closer range to the turbine, but only if it had been previously identified at a greater separation and radar processing continuously adjusted. In summary, the minimum radar detection range from a turbine is estimated to be 100m. **Possession of a chart of the wind farm layout is considered to be extremely desirable to allow the radar operator to accurately interpret radar returns.**

As with marine radar systems, detection of vessels close to turbines, ie. at distances less than 100m, is difficult even at short range. Large scale plans of wind farm layouts will be necessary for all emergency service activities as will the short range marking and lighting of individual turbines

5. Thermal Imager Performance. The RAF Sea King is equipped with an externally-mounted FLIR Systems Inc STAR-Q infra-red and TV camera assembly. As the infra-red camera cannot 'see' through airborne moisture, it would be of very limited use in fog, drizzle or rain. It would, however, perform well in haze (dry airborne particulates). The target vessel was easily located within the wind farm complex, and workmen on turbine ladders and work platforms were clearly identified at a range of approximately 1 nm.

See figures 17 to 21. In restricted visibility, and in the absence of voice communications where casualties might report positions within the marked turbines configuration, radar would be the major means of casualty detection

6. Homer Performance. The Sea King radio homer system utilises the lateral displacement of a vertical bar on an instrument to indicate the sense of a target relative to the aircraft heading (ie left, right or directly ahead / astern). A 'spoking' direction indicator is not fitted. With both the aircraft and the target vessel inside the wind farm, at a range of approximately 1 nm, the homer system performed accurately on FM Ch 67 with no apparent degradation.

In the previous trials, RNLI lifeboat VHF Direction Finding equipment had been found to operate satisfactorily within the wind farm, except when very close [<50m] from turbines

7. VHF FM Radio Performance. Radio checks were carried out in the 50 ft hover on FM Ch 0 to both Holyhead and Liverpool Coastguards, with the aircraft laterally displaced from the wind farm by approximately 0.3 nm. The aircraft was positioned to place the entire wind farm complex between the aircraft and the relevant land-based aerial. (Checks were carried out to Holyhead CG from east of turbine 25, and to Liverpool from west of turbine 16.) Comms were very clear in both cases, with no apparent degradation of performance.

Communications with the MCA operators on board " Lady Gwen II" were also fully satisfactory

8. Compass Performance. With the aircraft situated inside the wind farm, no deviation was apparent on any compass system.

9. Aircraft Power Requirement. The power requirement rose from approximately 70% matched torques when hovering at 50 ft in clear air to just below 80% matched torques when hovering at 50 ft in the lee of the wind farm, at approximately 0.3 nm from the turbines. No noticeable increase in turbulence was encountered.

See reference [2] and also reference [3]

HELICOPTER RESCUE FROM WINDFARM TURBINES

10. At North Hoyle, the turbine blades cannot be remotely braked. Instead, they can be remotely feathered, then manually locked in an upright-Y configuration from within the 'pod' at the top of the upright shaft to allow helicopter winching access. If, however, the blades are feathered but not manually locked, they may still rotate slowly (as was observed during the trial). Unless the blades can be confirmed as having been manually locked, therefore, **helicopter rescue from a wind turbine would be extremely, if not prohibitively, hazardous**.

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[2] "Research initiatives for improving the safety of offshore helicopter operations" BMT Fluid Mechanics and CAA, 2004

[3] " The Effect of Wind Turbine Wakes on Wind-Driven Craft" by: CD Ziesler, 2001

See Fig 22 illustrating the configuration required for an MCA compliant active safety management system. Annex 4 of MCA's MGN 275 [4] explains these and is attached to this report as an Annex

SURFACE RESCUE WITHIN A WINDFARM

11. Visual Conditions. In good visibility, a helicopter could be safely flown into a regularly-spaced wind farm complex. Rescue from the surface could obviously only be carried out, however, if the target was sufficiently clear of the turbines for the rotating blades not to pose a hazard. The pilot's judgement would be the deciding factor in this issue, although it is considered that a helicopter could not safely be positioned laterally from the turbine within a range equal to the span of the turbine blades. **Launching a surface rescue vessel in all cases would be appropriate.**

See comment following the next section

12. Fog. While a Sea King could be safely (albeit slowly) navigated down the wider lanes at North Hoyle in poor visibility under internal radar control, in order to effect a surface rescue the radar operator must leave the radar console to operate the rescue hoist. In conditions of poor visibility this situation would result in the helicopter crew being unable to maintain a safe separation from the turbines. In foggy conditions, therefore, a helicopter would not be able to safely effect a surface rescue within a wind farm and would best be employed as a radar search platform outside the wind farm. **Surface vessels should be used to effect a rescue in fog**.

Offshore wind farms, particularly the proposed Round 2 sites, can be a considerable distance offshore. Therefore passage times for surface craft may be a significant factor. Figures 13 and 14 respectively indicate the positions of the proposed wind farm sites and the position of RNLI stations with the types of lifeboat stationed at each

13. Radar Searching. While it would be possible for the helicopter radar operator to verbally direct a rescue vessel onto the target, the most efficient method would seem to be to relate the target's position to a specific turbine and allow the surface vessel to proceed to that location, eg '300m south of turbine 18'. Clearly, this would require the radar operator to have a reference copy of the wind farm plan. Interpretation of an extensive and irregularly-spaced wind farm complex would be extremely challenging, even with an accurate plan available.

Turbines which are irregularly spaced, either by design to reduce visual seascape effect from ashore [see figure 28] or because of geological problems during installation, would cause the above search method to be difficult

[4] Marine Guidance Note 275 (M) " Proposed UK Offshore Renewable Energy Installations – Guidance on Navigational Safety Issues" MCA July 2004

Original Signed

J M STANLEY
Squadron Leader
Officer Commanding

Distribution:

Port Liaison Manager, HQ Southampton Coastguard (Simon Gooder)
Colin Brown, Dept of Transport Marine Consultant (via email)
Holyhead Coastguard (Jim Paton)

Copy to:
OC 22 Sqn
OC HSU
OC 202 Sqn
OC ARCC(K)

9 Rescue by surface vessels in conjunction with helicopters

Two factors may affect the ability of surface craft to effect rescues from both turbine structures and the sea areas within and close to offshore wind farms.

i) Rescues from structures

The ability of vessel crews other than the wind farm's own surface vessels to effect rescues from wind farm structures may be limited by their training and equipment.

With respect to North Hoyle a limited number of the Rhyl lifeboat station crew have received training on the means of boarding turbines, safety points that can be used for lowering casualties from platforms and in the use of fall arrest harnesses. Such harnesses would be supplied to the Rhyl lifeboat by Npower Renewables. [5]

It may be necessary to establish a national policy for equipping and training lifeboat crews and a meeting of interested parties, called by the RNLI, will be held shortly.

ii) Passage times from RNLI stations to offshore wind farms

The following two figures illustrate the positions of both Round 1 and Round 2 offshore wind farm proposals and the relative positions of RNLI stations.

If it is necessary to launch an RNLI vessel to effect a rescue from within or close to a wind farm then the passage time from launch to arrival at the SAR site may be significant, some required passage distances being in excess of 20 nautical miles. The type, class and speeds of lifeboats available at given stations may also be relevant in this respect.

In the latter figure the abbreviations ALB, ILB and IRH indicate respectively, "All weather lifeboat", "Inshore lifeboat" and " Inshore rescue hovercraft"

[5] Minutes of the meeting held between the RNLI and Npower Reneweables on March 23rd 2005 at Rhyl Lifeboat Station.

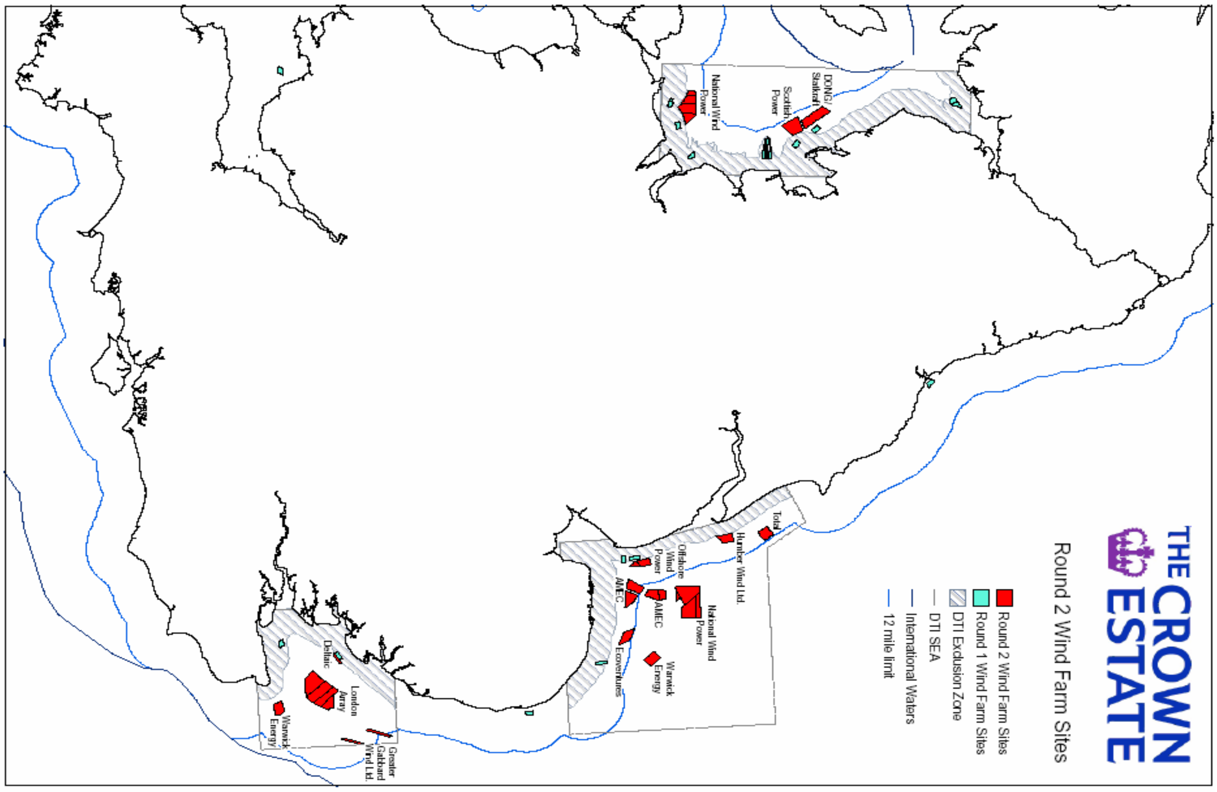


Fig 13 : Round 1 and Round 2 offshore wind farm proposals
(Diagram courtesy of Crown Estates)

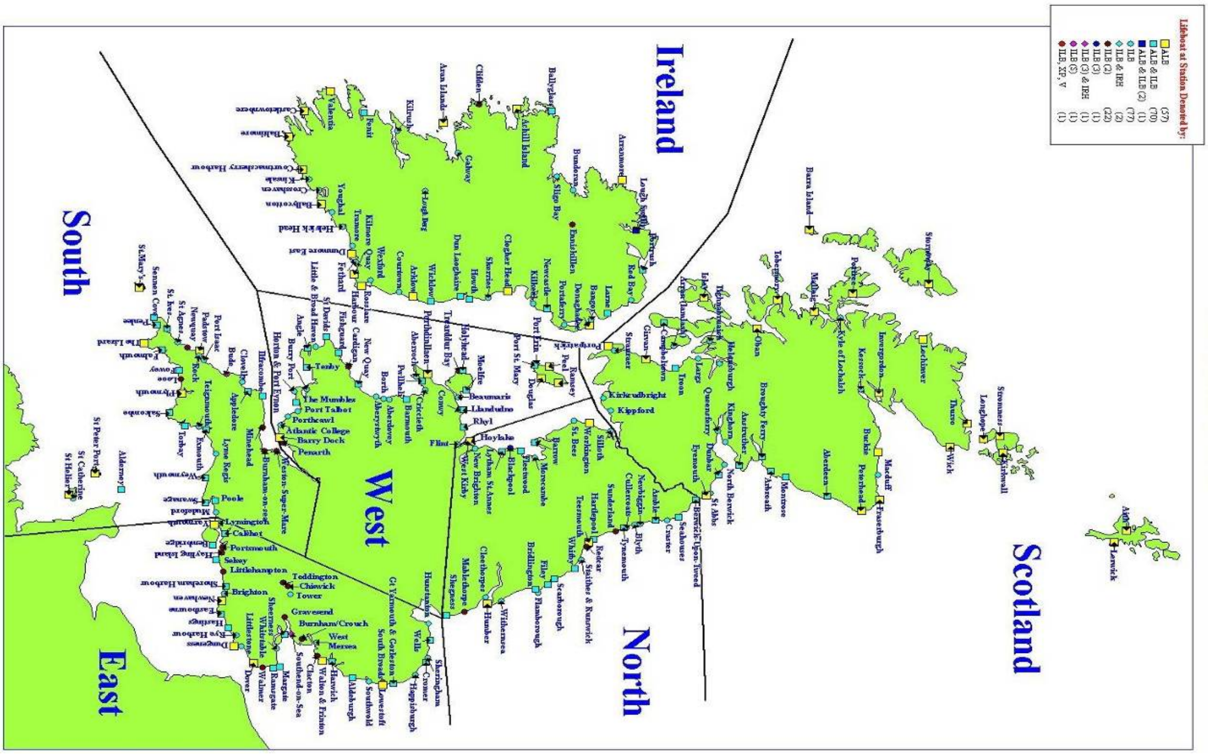


Fig 14 : RNLI lifeboat stations
(Diagram courtesy of the RNLI)

10 Training of lifeboat crews

(See section 10)

photo by Colin Brown

Fig 15 : Rhyl lifeboat " Lill Cunningham"

Fig 16 : Training of Rhyl Lifeboat crew by Npower personnel

(Photos courtesy of Paul Frost, 2nd Mechanic, Rhyl lifeboat)

11 Thermal imaging within the wind farm

Fig 17 : Thermal image of wind farm with "Celtic Wind" near turbines

(Courtesy of C Flight)

Fig 18 :

Thermal images of "Celtic Wind" and "Lady Gwen ll"

(Courtesy of C Flight)

Fig 19 :

Thermal image of "Lady Gwen lll", of similar size to a Mersey Class RNLI lifeboat
(Courtesy of C Flight)

Fig 20 :
Person being evacuated by fall arrest harness to "Celtic Wind"

Still frame from TV camera

(Courtesy of C Flight)

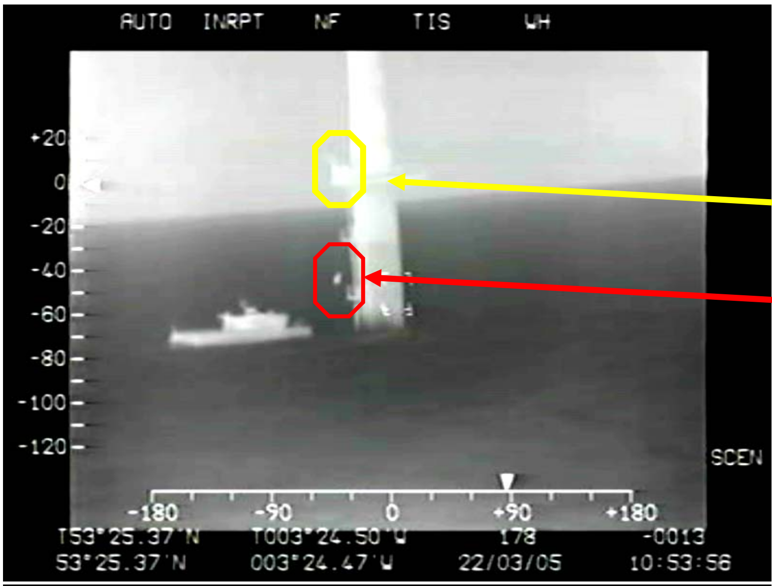


Fig 21 :
Thermal image of personnel on platform

Personnel on platform

Person being evacuated from turbine

(Courtesy of C Flight)

The images indicate that thermal imaging at night would be capable of identifying turbines, vessels and persons within the wind farm, providing that the atmosphere was dry.

Its use would, however, be very limited in mist, fog, or precipitation of any kind.

12 Rotor control during SAR operations close to a turbine

Fig 22:

Rotor configuration specified by MGN 275 (M), Annex 4.

Photo courtesy of Bonus turbines, Denmark

MCA's Marine Guidance note 275 (M) (Ref. 3) specifies that rotors should be capable of being to be locked in a required configuration, normally the above "Y" configuration, by remote signal from ashore. This will allow access to the nacelle top and, under the nacelle, closer proximity to the base of the turbine.

Helicopter pilots would need to be assured that the rotor blades were fully locked in both rotation and yaw before approaching a turbine.

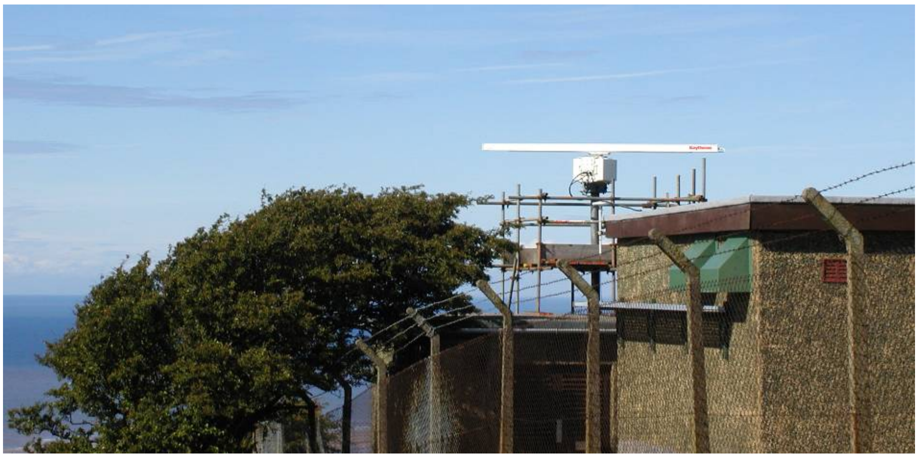
13 Shore radar observations of the helicopter trials

During the trials, observations of the helicopter movements were made using the two shore –based radars which were also set up for the original trials.

Fig 23 : Environment Agency Radar *photo courtesy of the Environment Agency*

Radar mounted in Ford Transit van and positioned as required

Fig 24 : BHP Billiton radar at Gwaenysgor



photos by Colin Brown

Fig 25 : Gwaenysgor radar site (approx. 5.2 nm from the wind farm)

The mobile Environment Agency radar (Bridgemaster 250 series) was initially stationed on the seafront at Prestatyn, approximately 6 metres above sea level and 4 n.m. from the wind farm boundary. From this position the Sea King helicopter could be identified by radar when on the near side of the wind farm, but could not when within the wind farm site.

From this position the vehicle was taken to a position close to the BHP Billiton radar site, approximately 200 metres above sea level and 5.2 n.m. from the wind farm boundary, when both radars were used to observe the helicopter trials.

The positions of the radars were as indicated on the following chartlet.

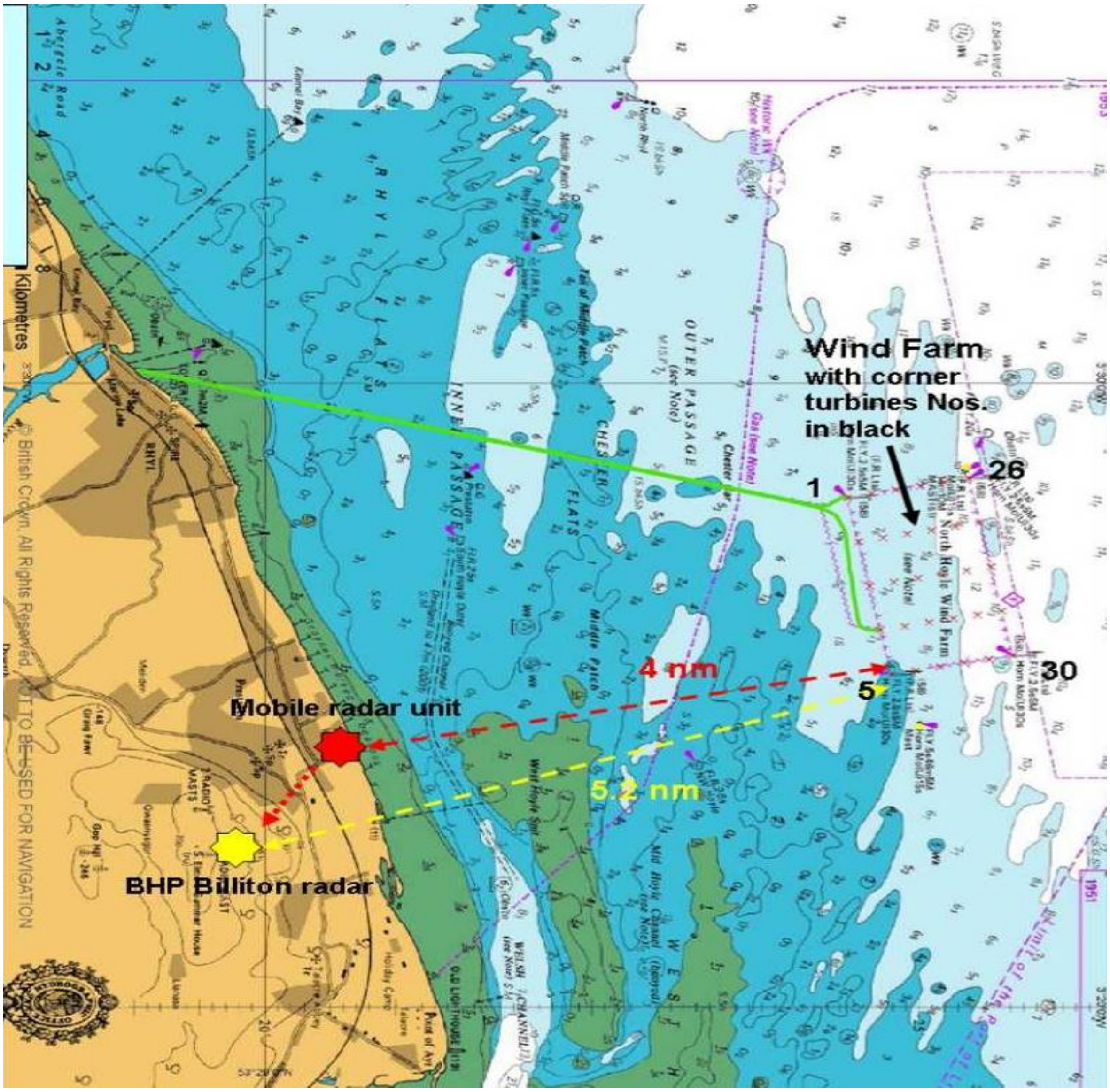


Fig 26 : Positions of the mobile radar and the BHP Billiton radar head

14 Results of the radar observations

The following photograph shows the radar display with the helicopter response outside the wind farm boundary, close to number 1 turbine, at the Southwest corner of the site. In this position it is clearly identified.

However it could not be successfully tracked within the wind farm by either of the two radars used by the MCA, or by the Anatec radar which was also at Gwaenysgor carrying out a vessel traffic survey.

The radar display shows the strong return from the structures, the returned echoes of each turbine being displayed in azimuth in an arc approximately 800 metres in length and 100 metres in depth. The helicopter response was considerably less than those of the turbines and automatic tracking was not able to lock on to this target.

This supports the findings of the first trials undertaken at North Hoyle *(Ref 1)*

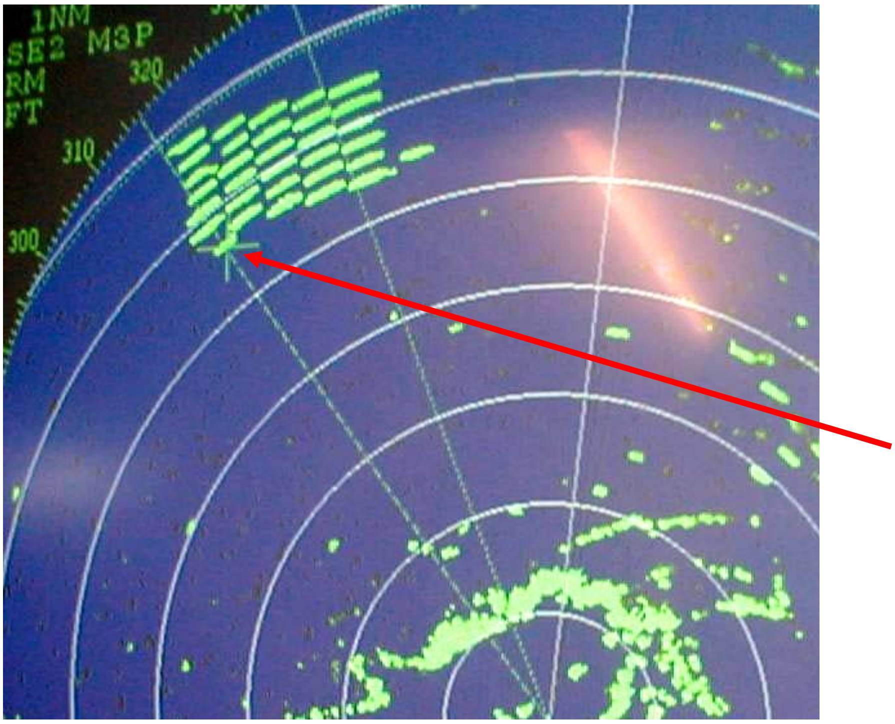


Fig 27 :

Radar display from Gwaenysgor

Helicopter echo is identified by the green cross

photo by Jim Paton Holyhead MRSC

15 Configurations of wind farm layouts

Section 13 of Sqdn Ldr Stanley's report (Section 8, page 16) refers to potential problems in using radar near to wind farms whose layout is not linear. This should be a consideration in the design of sites, whose choice of configurations may be based on a number of factors.

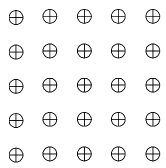
The designs below have, as their major consideration, the visual impact of wind farms ("Seascape") when viewed from ashore.

The random configuration (layout number 6) would cause the greatest problems for helicopter radar searches and probably also for visual searches.

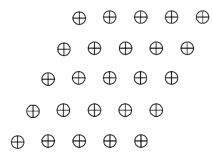
Fig 28 : Seascape Impact Assessment, suggested wind farm layouts to minimise visual impacts from ashore [6]

(1) Linear (Plan view)

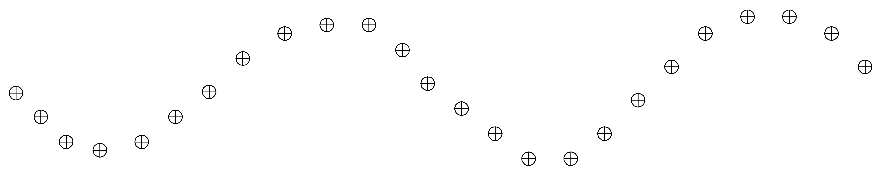
(2) Basic grid (Plan view)



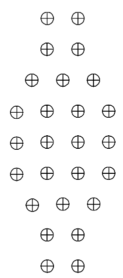
(3) Offset grid (Plan view)



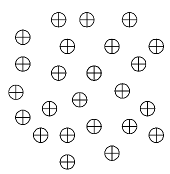
(4) **Arced (Plan view)**



(5) Feathered grid (Plan view)



(6) Random (Plan view)



Note : These have been arranged in terms of increasing difficulty for helicopter radar searches.

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[6] **Draft Seascape Impact Assessment, Guidance for wind farm developers, DTI 2005**

References :

1 *" Results of the electromagnetic investigations and assessments of marine radar, communications and position fixing systems undertaken at the North Hoyle wind farm by QinetiQ and the Maritime and Coastguard Agency"* MCA Report MNA 53/10/366 C. Brown & M.Howard 15.11.04

2 "Research initiatives for improving the safety of offshore helicopter operations" Rowe S.J.,BMT Fluid Mechanics and Howson D. CAA, 2004

3 *"The Effect of Wind Turbine Wakes on Wind-Driven Craft"* by CD Ziesler, 2001 for Powergen PLC Project PT/01/BD1076M

4 Marine Guidance Note 275 (M) *" Proposed UK Offshore Renewable Energy Installations – Guidance on Navigational Safety Issues",* Maritime & Coastguard Agency, July 2004

5 Minutes of the meeting held between the RNLI and Npower Reneweables on March 23rd 2005 at Rhyl Lifeboat Station.

6 "*Seascape Impact Assessment, Guidance for wind farm developers"*, (draft only) Department of Trade and Industry, 2005

Annex

Taken from Marine Guidance Note 275 (M) " Proposed UK Offshore Renewable Energy Installations – Guidance on Navigational Safety Issues" MCA July 2004

"Annex 4 - Standards and procedures for wind turbine generator shutdown in the event of a search and rescue, counter pollution or salvage incident in or around a wind farm.

1. Design Requirements

The wind farm should be designed and constructed to satisfy the following design requirements for emergency rotor shut-down in the event of a search and rescue (SAR), counter pollution or salvage operation in or around a wind farm:

i. All wind turbine generators (WTGs) will be marked with clearly visible unique identification characters. The identification characters shall each be illuminated by a low-intensity light visible from a vessel thus enabling the structure to be detected at a suitable distance to avoid a collision with it. The size of the identification characters in combination with the lighting should be such that, under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer, stationed 3 metres above sea levels, and at a distance of at least 150 metres from the turbine. It is recommended that lighting for this purpose be hooded or baffled so as to avoid unnecessary light pollution or confusion with navigation marks. (Precise dimensions to be determined by the height of lights and necessary range of visibility of the identification numbers).

ii. All WTGs should be equipped with control mechanisms that can be operated from the Central Control Room of the wind farm.

iii. Throughout the design process for a wind farm, appropriate assessments and methods for safe shutdown should be established and agreed, through consultation with MCA and other emergency support services.

iv. The WTG control mechanisms should allow the Control Room Operator to fix and maintain the position of the WTG blades as determined by the Maritime Rescue Co-ordination Centre or Maritime Rescue Sub Centre (MRCC/SC).

v. Nacelle hatches should be capable of being opened from the outside. This will allow rescuers (e.g. helicopter winch-man) to gain access to the tower *if tower occupants are unable to assist and when sea-borne approach is not possible.*

vi. Access ladders, although designed for entry by trained personnel using specialised equipment and procedures for turbine maintenance in calm weather, could conceivably be used, in an emergency situation, to provide refuge on the turbine structure for distressed mariners. This scenario should therefore be considered when identifying the optimum position of such ladders and take into account the prevailing wind, wave and tidal conditions.

2. Operational Requirements

i. The Central Control Room should be manned 24 hours a day.
ii. The Central Control Room operator should have a chart indicating the GPS position and unique identification numbers of each of the WTGs in the wind farm.
iii. All MRCC/SCs will be advised of the contact telephone number of the Central Control Room.
iv. All MRCC/SCs will have a chart indicating the GPS position and unique identification number of each of the WTGs in all wind farms.

3. Operational Procedures

i. Upon receiving a distress call or other emergency alert from a vessel which is concerned about a possible collision with a WTG or is already close to or within the wind farm, the MRCC/SC will establish the position of the vessel and the identification numbers of any WTGs which are visible to the vessel. The position of the vessel and identification numbers of the WTGs will be passed immediately to the Central Control Room by the MRCC/SC.

ii. The control room operator should immediately initiate the shut-down procedure for those WTGs as requested by the MRCC/SC, and maintain the WTG in the appropriate shut-down position, again as requested by the MRCC/SC, until receiving notification from the MRCC/SC that it is safe to restart the WTG.

iii. Communication and shutdown procedures should be tested satisfactorily at least twice a year "