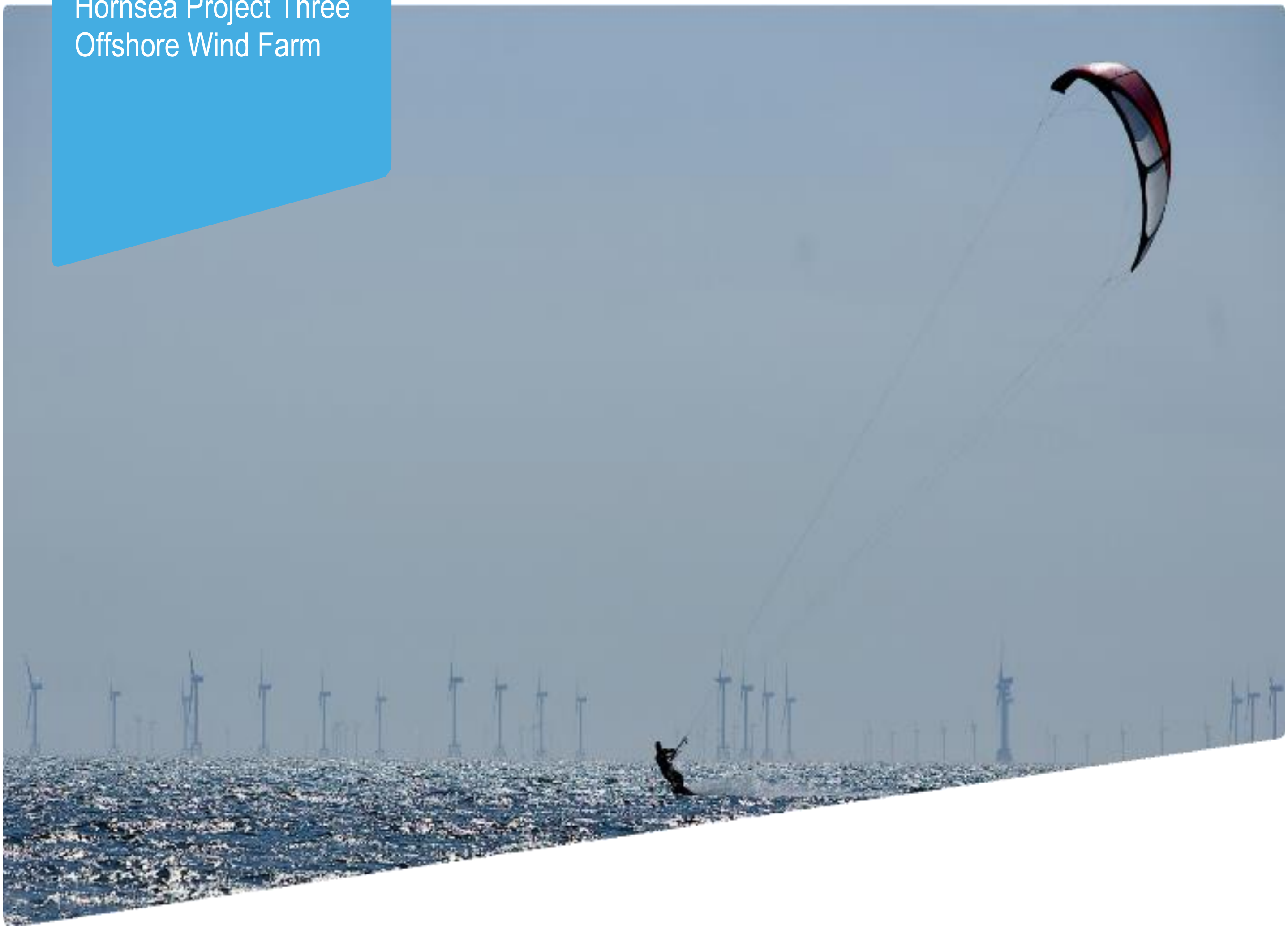
Hornsea Project Three
Offshore Wind Farm



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Offshore Wind Farm

Appendix 13 to Deadline I Submission – Racon and AIS Review

J6A Platform Technical Note

Date: 7th November 2018

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Acronyms

Acronym	Definition
AIS	Automatic Identification System
ASL	Above Sea Level
AtoN	Aid to Navigation
CPA	Closest Point of Approach
DCO	Development Consent Order
Db	Decibel
EIA	Environmental Impact Assessment
GHz	Gigahertz
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IMO	International Maritime Organisation
LAT	Lowest Astronomical Tide
MMSI	Maritime Mobile Service Identity
nm	Nautical Miles (1 nm=1,852 meters)
NRA	Navigational Risk Assessment
Racon	Radar Beacon
REWS	Radar Early Warning System
RCS	Radar Cross Section
SNS	Southern North Sea
SOLAS	Safety of Life at Sea
TSS	Traffic Separation Scheme
UKCA	United Kingdom Continental Shelf
VHF	Very High Frequency
W	Watts

1. Introduction

1.1 This document has been produced in response to consultation between Ørsted Hornsea Project Three UK (Ltd) (the Applicant) and Spirit Energy Resources Ltd. (hereafter referred to as Spirit Energy). During this consultation, Spirit Energy provided new information in regard to the Radar Early Warning System (REWS) assessments undertaken in the Environmental Statement produced by the Applicant as part of the Development Consent Order (DCO) application for the Hornsea Three offshore wind farm on the Spirit Energy operated J6A platform.

1.2 The information provided by Centrica (subsequently Spirit Energy) during the preparation of the Environmental Statement was that the J6A platform had a REWS system. The Hornsea Three Environmental Impact Assessment assessed the potential effect of Hornsea Three alone (paragraph 11.11.2.67 of Volume 2, Chapter 11: Infrastructure and Other Users of the Environmental Statement (APP-071) and in combination with other projects and plans on the J6A platform REWS (paragraph 11.13.3.50 of Volume 2, Chapter 11: Infrastructure and Other Users of the Environmental Statement). The assessment was informed by a technical report prepared by Manchester University (Volume 5, Annex 11.1: Radar Early Warning System Technical Report of the Environmental Statement (APP-119)).

1.3 This information has been superseded by new information provided by Spirit Energy, in that the J6A platform has a Racon and AIS and not a REWS. This note updates the assessments considering this new information.

1.4 It should be noted that whilst the Hornsea Three Environmental Statement also assessed the potential effect of Hornsea Three on vessel routes, and the subsequent effect of the route deviations on Closest Point of Approach (CPA) and Time to CPA alarms on the REWS on oil and gas platforms (paragraph 11.11.2.79 of Volume 2, Chapter 11: Infrastructure and Other Users of the Environmental Statement), this assessment did not include the J6A Platform (as explained in paragraph 11.11.2.81 of Volume 2, Chapter 11: Infrastructure and Other Users of the Environmental Statement) and so has not been affected by the new information provided by Spirit Energy.

1.5 This report is set out as follows:

- Section 2: introduces the technical review of the Racon and AIS hardware on the J6A platform.
- Section 3: identifies the location of the J6A platform and Hornsea Three
- Section 4: discusses the potential effect of Hornsea Three turbines on the J6A Platform Racon.
- Section 5: discusses the potential effect of Hornsea Three turbines on the J6A platform AIS.
- Section 6: presents the potential effect of Hornsea Three on the J6A Racon and AIS and provides a summary of the implications on the assessment conclusions (in EIA terms) for the following impact (in regard to the J6A platform) in Volume 2, Chapter 11: Infrastructure and Other Users of the Environmental Statement.

2. Overview of the technical assessment on the Racon and AIS hardware on the J6A platform

2.1 Concerns have been expressed by Spirit Energy with respect to the potential impacts of Hornsea Three on the Racon and AIS hardware on the J6A platform. The concerns are around the continued efficacy of these systems due to potential shadowing which may result from the turbines. This Technical Note describes the Racon and AIS systems in use on J6A and addresses the potential impacts based on modelling expertise, experience and knowledge drawn from other systems in use around other offshore wind farms on the UKCS.

2.2 Appendix A details the distances at which vessels would be expected to see a Racon.

3. Location of J6A & Hornsea Three

Overview

3.1

3.2 Figure 3.1 presents an overview of the J6A platform relative to the Hornsea Three array area.

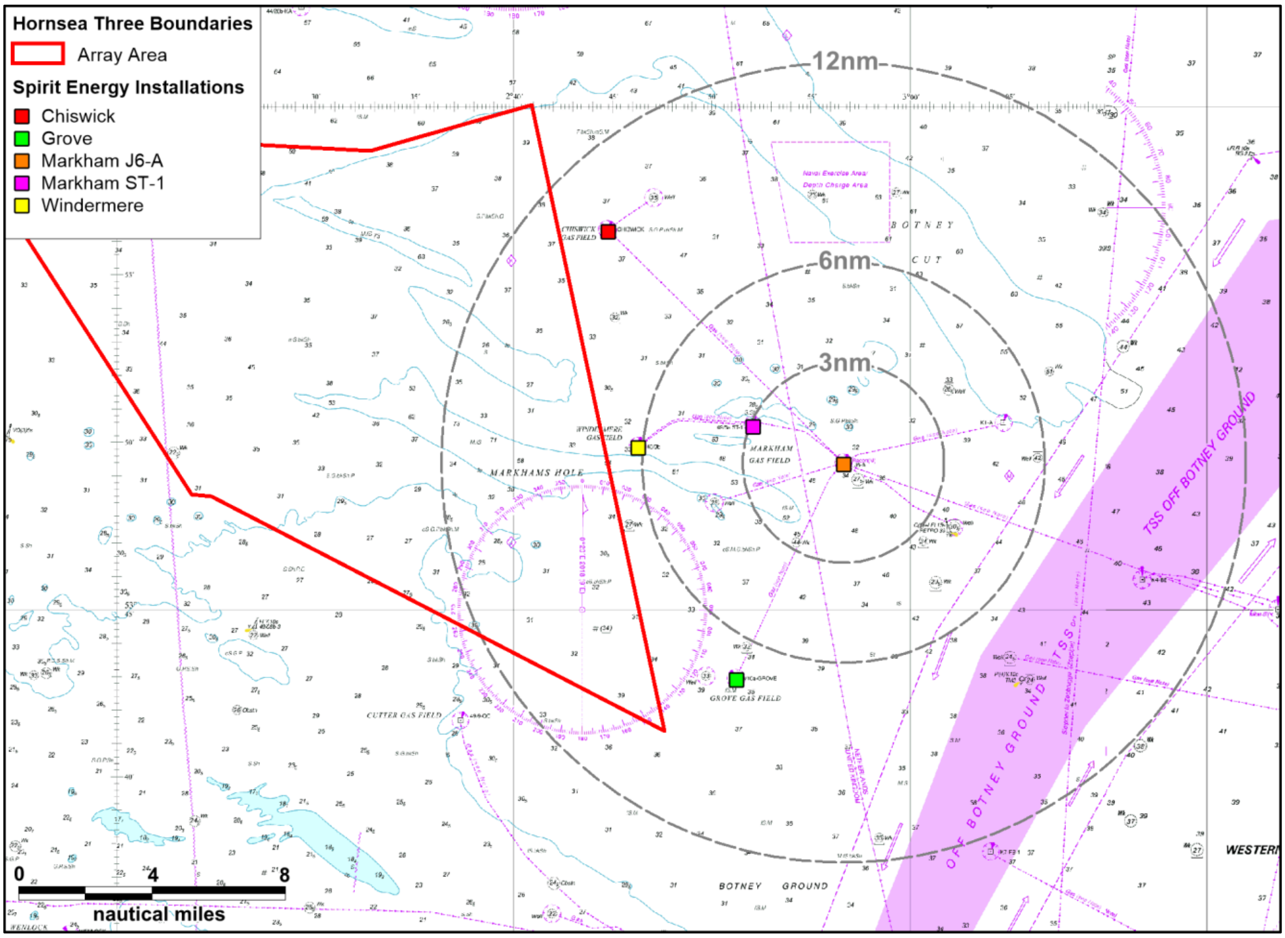

Figure 3.1 Overview of Markham Gas Field and Hornsea Three

3.3 It can be seen that the minimum distance between Hornsea Three array area and the J6A platform is 6.9 nm. This is a key distance in terms of reviewing the minimum separation of the Racon (Section 4) and AIS (Section 5) equipment installed on the J6A platform from the nearest potential Hornsea Three turbines.

Traffic Overview

3.4 Figure 3.2 presents AIS survey data (26 days summer and 14 days winter) while Figure 3.3 and Figure 3.4 present overviews of the shipping routes in the vicinity of the Hornsea Three array area, pre- and post- construction. Details of the shipping data presented below are provided in Volume 5, Annex 7.1: Navigational Risk Assessment of the Environmental Statement (APP-112) which includes descriptions on each shipping route within 10 nm of the Hornsea Three array area. The shipping routes in the figures are numbered to correspond with the descriptions presented in the Navigational Risk Assessment (NRA).

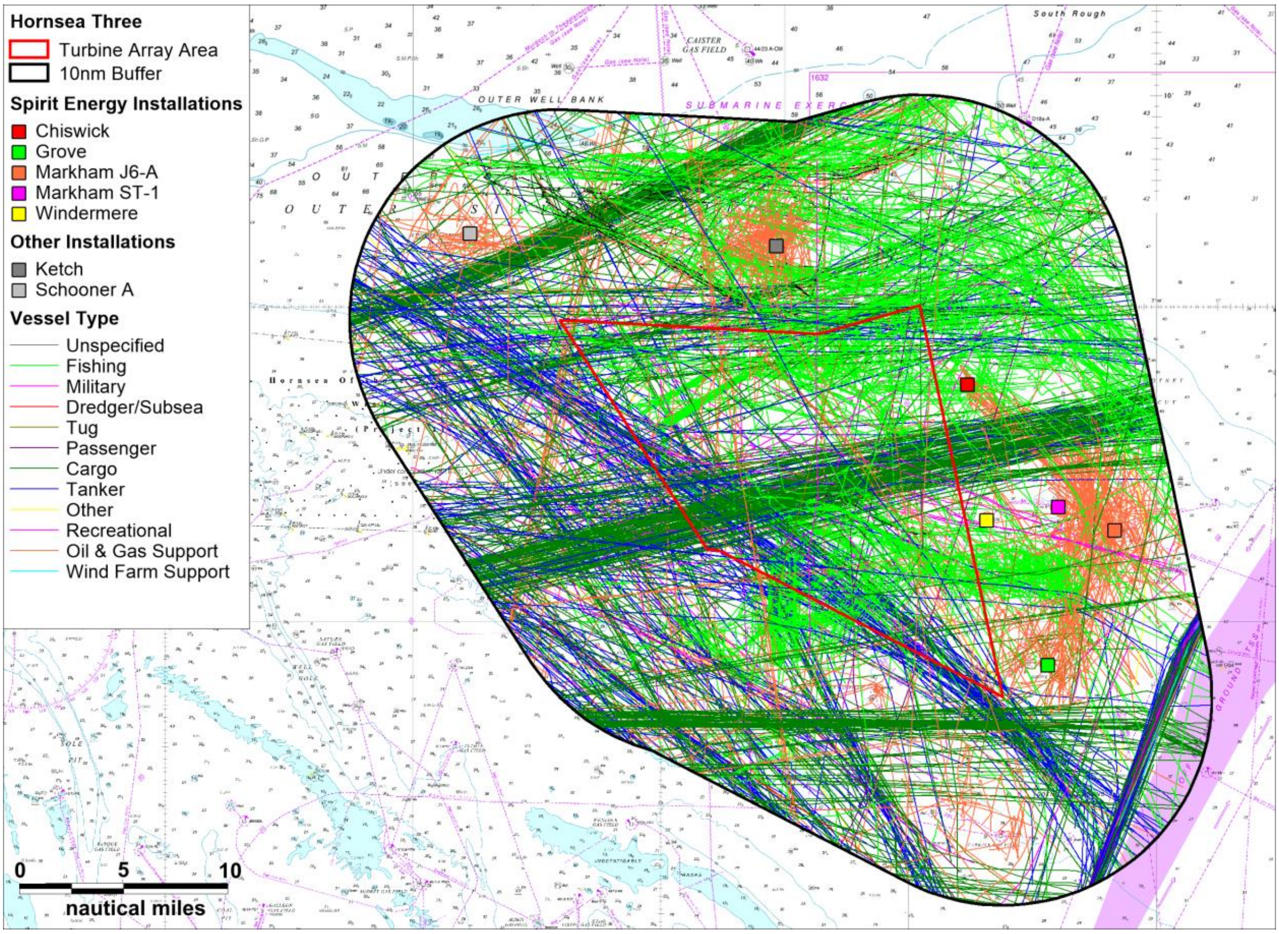

Figure 3.2 AIS Data for Hornsea Three array area

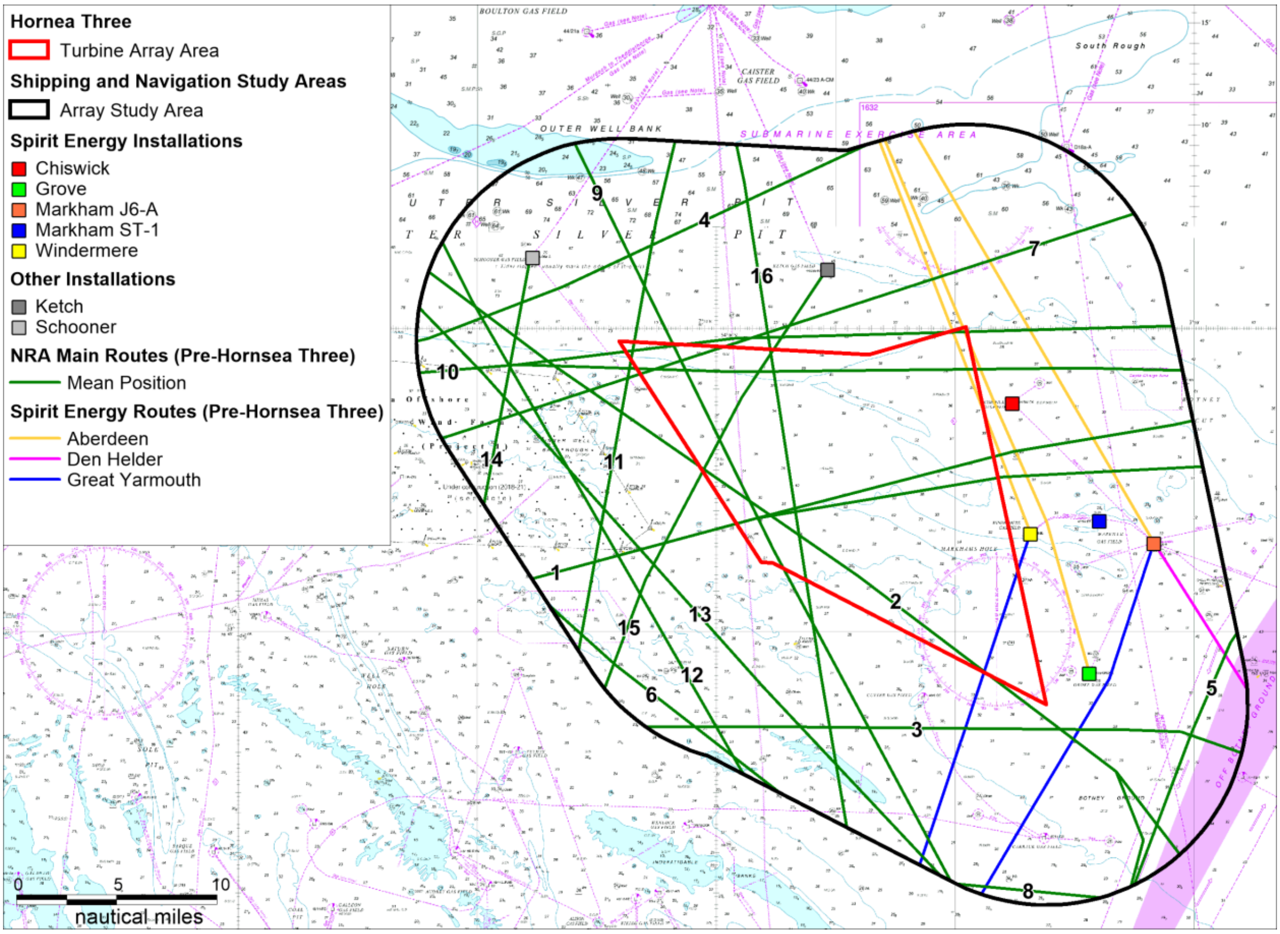

Figure 3.3 Pre-construction Shipping Routes

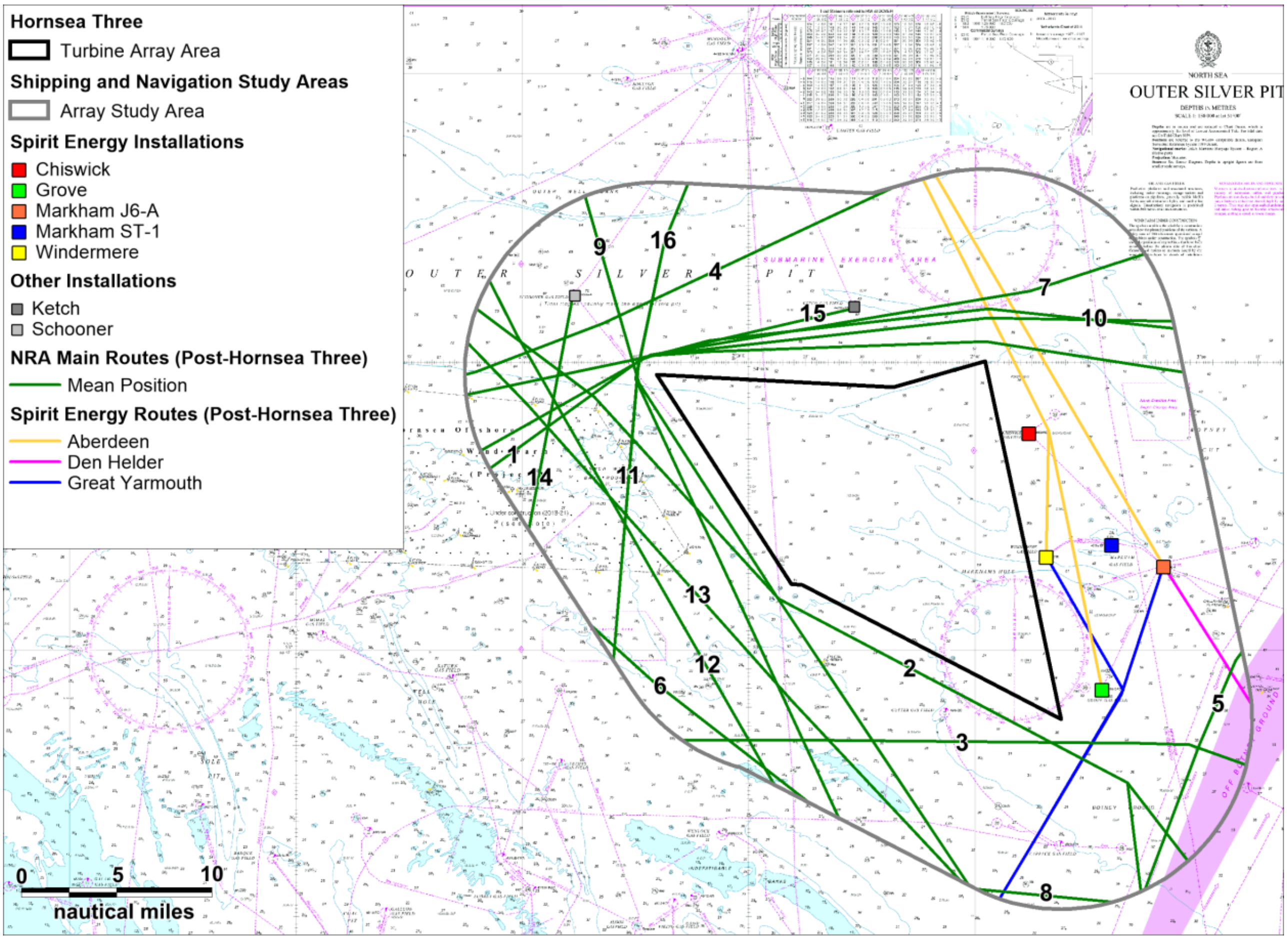

Figure 3.4 Post-construction Shipping Routes (Predicted)

3.5 Three commercial routes pass in proximity to the Spirit Energy assets. Details of these routes are as follows:

- Route No. 1 - Cargo vessel and DFDS Seaways ferry route between Immingham and Cuxhaven passing between the Chiswick and Windermere/Markham ST-1/Markham J6A platforms. An average of approximately three to four vessels per day use this route which splits on approach to the Off Botney Ground Traffic Separation Scheme (TSS).
- Route No. 3 - Cargo vessel and DFDS Seaways ferry route between Immingham and Cuxhaven passing south of the Grove platform. An average of approximately one to two vessels per day use this route.
- Route No. 10 - Cargo vessel and tanker route between Immingham and German ports passing north of the Chiswick platform. An average of one vessel per day uses this route which splits on approach to the Off Botney Ground TSS.

3.6 Once Hornsea Three is constructed, it can be seen in Figure 3.4 that it acts as a screen for the Spirit Energy assets from passing commercial traffic, as shipping routes will avoid passing through the array area. East/west traffic will, on average, pass further from the J6A platform.

3.7 Offshore shipping routes to/ from the Spirit Energy assets are likely to be minimally impacted when Hornsea Three is constructed due to approaching the platforms from the north or south.

3.8 Further details on the commercial shipping and Spirit Energy offshore routes in the vicinity of Hornsea Three can be found in the Volume 5, Annex 7.1: Navigational Risk Assessment of the Environmental Statement.

4. Racon Review and Modelling

Overview of Racon

4.1 A radar beacon (otherwise known as a Racon) is a radar responder which is commonly used to mark maritime navigational hazards. The Racon responds to a radar pulse received from a vessel by transmitting a signal on the same frequency which shows as a Morse code symbol on the vessel's radar screen, providing range, bearing and identification information. This is illustrated in Figure 4.1. The use of Racons for purposes other than as aids to navigation is prohibited. They are commonly used to mark the following:

- Lighthouse and navigation buoys;
- Navigable spans under bridges;
- Positions on inconspicuous coastlines;
- Offshore wind farms;
- Offshore oil & gas platforms and other offshore structures;
- Temporary, new & uncharted hazards; and
- Leading line.

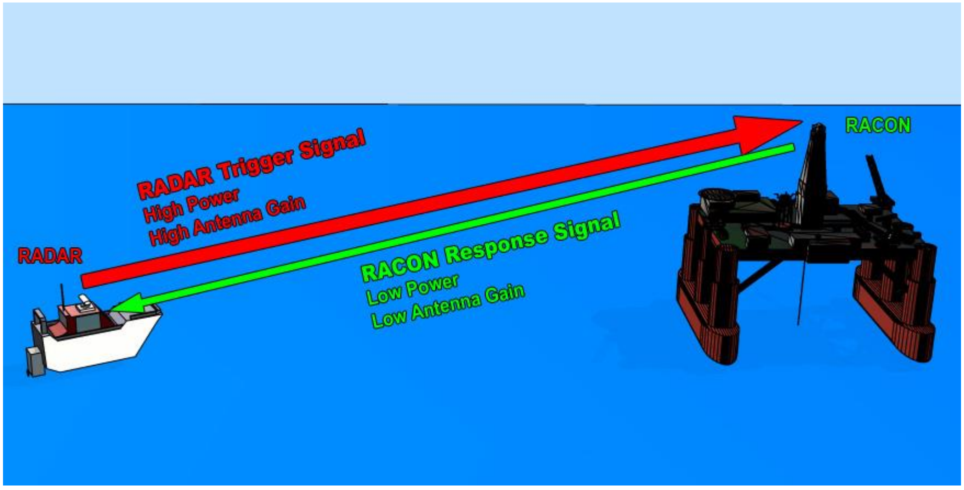

Figure 4.1 The interaction between radar and Racon systems

4.2 Modern Racons are ‘frequency-agile’ meaning they are able to respond on the same frequency on which a radar pulse is detected. They usually operate on both X and S bands. The International Maritime Organisation (IMO) Safety of Life at Sea (SOLAS) Chapter V Regulation 19 requires 9 GHz (X band) radar on all ships of 300 gross tonnage and upwards and passenger ships irrespective of size. In addition, all ships of 3,000 gross tonnage and upwards are required to have a 3 GHz (S band) radar (unless a second 9 GHz radar is considered appropriate by the Administration). IMO MSC79 resolution 192(79) removed the requirement for S band radar to trigger Racons from 1 July 2008. The Racon only issues a radar response if the received radar signal is above a given threshold. If the received signal is above that threshold the Racon would issue an Omni-directional response at a pre-set power setting -typically, between 1 – 5 W depending on application and location of the Racon. In most cases it is suitable to assume that a Racon system is operating at 1 or 2 W transmitter power.

4.3 A Racon is generally considered to be a supplementary aid to navigation (AtoN) installed at sites that would also be marked with a light. It is important to note that although they are likely to reduce the risk of collision, they do not act as an anti-collision system for structures such as offshore platforms.

4.4 It is noted that since the further development of AIS, newer offshore installations which may have previously been marked using a Racon are now more commonly marked with an AIS AtoN. These include the recently marked Viking Installations currently undergoing decommissioning in the SNS. They are either marked by physical AtoNs or virtual AtoNs, the latter being where there is no physical AtoN present at the location but an AtoN marker appears on the display transmitted from a nearby physical AtoN unit. An example of a virtual AtoN is a subsea asset being marked by a physical AtoN on a nearby offshore surface platform (i.e. the subsea location appears as a diamond on screen despite having no physical AtoN).

J6A Racon Characteristics

4.5 The frequency-agile Racon installed on the J6A platform complies with specifications set by the IALA and IMO. Table 4.1 presents the key characteristics of this Racon.

Table 4.1 J6A Racon Characteristics

Characteristics		J6A Racon	
		X band	S band
Physical	Dimensions (L x W x H)	379 x 268 x 856 mm	
	Weight	30 kg	
	Operating Temp. Range	-20˚C to +40˚C	
Performance	Reception	X and S independent	
	Detected Pulse Widths	50 – 2000 nsec	
	Response Delay	670 and <700 nsec	

Characteristics		J6A Racon	
		X band	S band
	Frequency Response Accuracy	+/- 1.5 MHz if pulse width >200 nsec +/- 3.5 MHz if pulse width <200 nsec	
	Frequency Range	9300-9500 MHz	2900-3100 MHz
	Receiver Sensitivity	-40dBm (adjustable)	-35dBm (adjustable)
	Transmission Power	1.0W (min)	1.0W (min)
System design, control and monitoring	Antenna Polarisation	Vertical	Vertical & Horizontal
	Antenna Gain (pan)	+/- 2dB	Over 360˚
	Antenna Gain (tilt)	+/- 3dB	Over 15˚

4.6 The J6A Racon has a programmable duty cycle that allows it to be active from between 0 and 60 seconds and idle from between 0 and 60 seconds. The programmed cycle can vary however, in the UK, an example of a standard duty cycle used is 20 seconds in which the Racon will respond to radar signals, followed by 40 seconds when it will not (e.g., the Racon is on for 20 seconds and off for 40 seconds). This is to avoid the Racon response masking any important radar targets behind the beacon.

Racon Operation

4.7 This section presents a review of the average distances at which vessels are expected to see the return from the Marine Radar Beacon (Racon) installed on the Markham J6A platform in calm conditions (i.e. wave height 0 m). Different vessel types with radars located at various heights above sea level (ASL) have been summarised. It is noted that these are approximate values only and various factors can influence the range at which vessels detect the Racon.

4.8 The following maximum ranges are approximate guidelines at which vessels detect Racon. All calculations provided are for X band radar as IMO MSC79 removed requirement for S band radars to trigger Racons. It is noted that S-band radars will most likely only be carried by large vessels (above 3,0000 gross tonnes) such as cargo vessels and tanker. The Racon parameters used in the following examples are given below:

- Power: 1 W
- Antenna Gain: 4.5 dBi
- Receiver Sensitivity: -40 dBm

4.9 The Racon installed on the J6A platform (X and S band) has similar parameters with a transmitter power of 1 watt and receiver sensitivity of -40 dBm (adjustable) for X band radar. The antenna gain is +/- 2 dB (pan) and +/- 3 dB (tilt). The height above sea level of the Racon installed on the Markham J6A platform is unknown, however the helideck is approximately 34 m above sea level (LAT) based on the information available; therefore an example of 30 m ASL was used for ranges was presented below.

4.10 One of the key parameters that needs to be considered when studying the Racon performance is the antenna gain pattern and the transmitter power of the Racon system. The antenna gain and the transmitter power are relatively small compared to that of a radar system. Therefore, the signal emitted from the Racon will experience significant attenuation and will quickly diminish in amplitude as it propagates through space. This will limit the detection range of the Racon signal for radar systems with smaller antennas (lower gain).

4.11 The gain refers to how much of the energy leaving the antenna is focused into a particular direction. Therefore, higher gain is accompanied by a narrower beam width. Higher gain and narrow beams are desirable for long-range detection and tracking ranges, as well as accurate direction measurement. The antenna gain of the Racon on J6A is less than provided in the example and thus detection ranges may be slightly less than presented here however, it also covers a larger area than that covered in the example Racon (i.e. beam width is larger). A summary of detection ranges for Racons is presented in Table 4.2. These ranges were calculated using computer programs by IALA (2005).

Table 4.2 Summary of Maximum Detection Ranges

Vessel Type	**Power of Radar on Vessel (kW)1**	**Height of Radar (m) ASL**	**Approximate Maximum Detection Ranges (nm)[2]**	
			Racon Height of 30 m ASL	Racon Height of 40 m ASL
Pleasure/Small Craft	4	1A - 3	8.8	10
		1B - 6	10.4	12
Small Commercial	10	2A - 5	12.8	14.1
		2B - 10	14.6	15.2
Large Commercial	25	3A - 15	18	20
		3B - 35	22	24

[1] Typical power outputs of radars installed on vessels
[2] See Appendix A for maximum detection ranges if calculated for a 6 dB loss in performance.

Factors Affecting Distances

4.12 Various factors affect the range at which vessels detect Racons. These are given below:

- Propagation characteristics of the atmosphere
- Fading due to multi-path interference
- Blind arcs
- Racon tracking accuracy

4.13 Precipitation, temperature and humidity all have the capability of influencing the performance of radar/Racon, particularly at distances greater than 10 nm. Effective detection range of Racon will be reduced by the presence of clutter between the radar and Racon.

4.14 Self-interference of the radar signal at the Racon caused by reflection of the signal on the sea surface (when sea is calm) can cause multi-path fading. This gives “fade zones” in which the Racon may not be triggered however this will seldom persist on the radar of a moving vessel because the distance between the radar and Racon will usually be changing.

4.15 Blind arcs are areas in which signals / echoes cannot be received, or their strength is affected, due to an obstruction. They are influenced by the vessel’s superstructure (mast) and siting of the radar antenna.

4.16 Some error in frequency tracking can be expected as the (automated) process of adjusting the Racon transmission frequency to match the radar frequency is not always exact. Therefore, Racon signal strength may be degraded.

4.17 Some of the potential issues specifically associated with the presence of wind farms are the shadowing and the multiple reflection of radar/Racon signals within the wind farm.

Radar and Racon Shadowing

4.18 As with other communication systems, the presence of physical obstruction to the signal will cause blockage and shadowing regions behind the object. Radio shadowing is the reduction of the signal intensity behind the object (shadow region) which causes the radar/Racon system to have reduced performance in detecting the desired signals effectively in the affected regions.

4.19 Racon systems operate at S or X band which have small wavelengths in comparison to the wind turbine dimensions. Having a small ratio between the wavelength and the dimension of the blocking object would make the shadowing region more severe as it would reduce the diffraction effects around the object causing deep shadowing regions. When assessing the impact of wind farms on radars operating at X-band, it is generally acceptable to assume optical shadowing as an indicative measure of the maximum design scenario of shadowing effects. In reality, the shadowing effects generated by wind farms are expected to show less severe effects due to the diffraction of the radar signals around the tower and the support structure.

4.20 Racons operate cooperatively with nearby radar systems. Therefore, unlike a conventional radar system where the transmitter and the receiver are collocated, having two spatially separated transceivers would suffer from two distinct shadow regions as shown in Figure 4.2 and Figure 4.3. Thus, the effect of turbine shadowing on both the radar and the Racon should be considered.

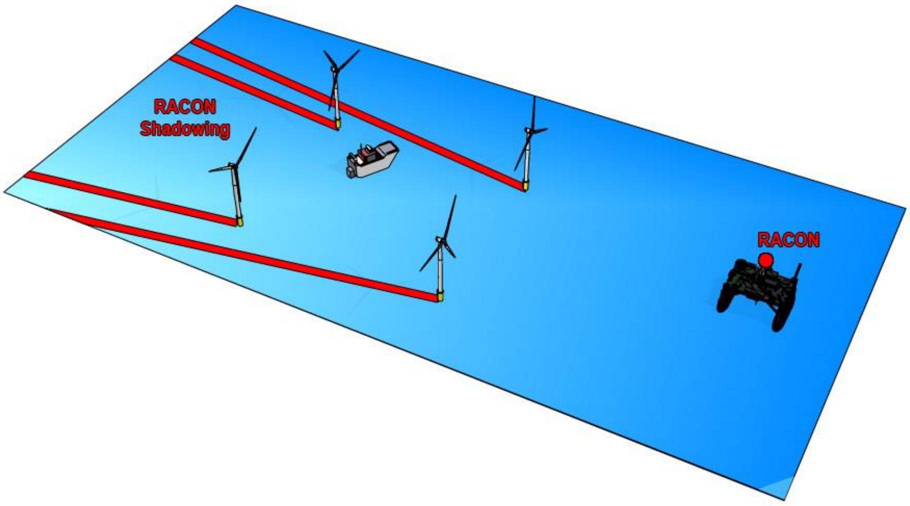

Figure 4.2 Shadowing of the Racon (response) signal due to turbines

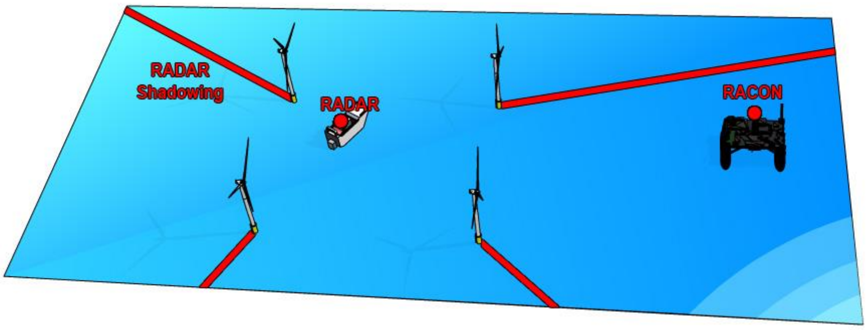

Figure 4.3 Shadowing of the radar (trigger) signal due to turbines

Shadowing effects for the J6A platform

4.21 The J6A platform is equipped with a Racon system that operates at both S and X bands. The range between the closest turbine and the J6A platform is approximately 6.9 nm, which is expected to produce narrow shadowing regions for the Racon. The width of the shadows for the radar will be dependent on the range between the radar and the turbine –close ranges are expected to generate wider shadowing sectors. However, although the presence of turbines is expected to generate Racon shadowing as well as shadowing regions for radars operating near or within the wind farm, the effects of the shadows are expected to be transient and Racon detections should recover for moving vessels. Experienced radar operators should be able to interpret the radar returns successfully and be able to locate the source of the Racon signal without much disturbance -as it is common to have intermittent Racon positioning as part of the Racon operation (e.g., the Racon can be on for 20 seconds and off for 40 seconds; see Section 3). While the Racon is in the 'on' state, it provides positioning aid of the assets by displaying a Morse code on the radar screen that extends over a few nautical miles behind the asset. When the Racon is in its 'off' state, it provides opportunity for the navigating vessels to detect objects located behind the assets (by effectively switching off the Morse code on the radar display). Therefore, having transient losses of the Racon signal due to the shadowing can be considered to be of negligible effect on the functionality of the Racon.

Multiple reflections

4.22 When operating traditional marine navigational radars, the effects of multiple reflections of the radar signals can be observed when the radar is operating close to large reflective objects. The radar signal would reflect from the large object and travel towards other targets in the region generating additional paths for the signal to travel along -which in turn generates multiple accounts for the same targets (as known ghost targets). In theory, this can also occur for a cooperative system such as the Racon. However, it is worth noting that the severity of the multiple reflections and the appearance of ghost targets are largely dependent on the range between the radar and the turbine (R1) as well as the range between the Racon and the turbine (R2) -as illustrated in Figure 4.4. A reference for similar interaction with Marine Navigational radar is: BWEA (2007).

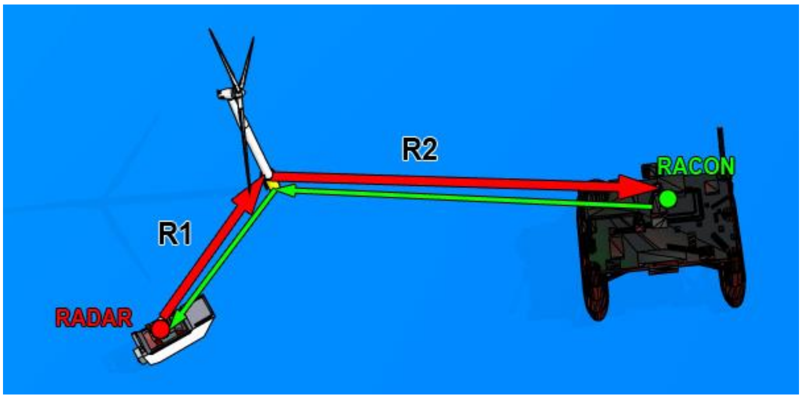

Figure 4.4 Conditions for the appearance of ghost targets due to multiple reflections

4.23 The conditions for the appearance of multiple accounts of the Racon signal are:

- The successful detection of the radar trigger signal at the Racon site through the reflected path (shown in red in Figure 4.4). This condition is likely to occur if the vessel is operating at close ranges from the turbines. The highly reflective surfaces of the turbine will reflect a large portion of the radar signal towards other objects nearby -such as the Racon receiver.
- The successful detection of the Racon response signal at the radar site through the reflected path (shown in green in Figure 4.4). The multiple reflection of the response signal is considered to be less likely and of less significance. This is due to the lower power transmitted from the Racon in a less directional manner. It is expected that the Racon signal will experience significant attenuation as it reaches the reflecting object. After reflection off the turbine and further propagation, the signal is likely to fall under the detection threshold of the radar and will not be registered as a viable return. Therefore, this type of multiple reflection is not expected to cause interference with navigational radars operating near a wind farm unless operating very close to a turbine.

Modelling the Potential Impact of Multiple Reflections on the J6A platform

4.24 In order to investigate this, the bi-static radar cross-section (RCS) of the turbine must be approximated to compute the radar/ Racon signal reflected towards the Racon /radar from the turbine. The bi-static RCS of a turbine is a highly complex parameter and is largely dependent on the size and geometry of the turbine -as well as the range of the turbine from the source and receiving points. In this study, the bistatic RCS of the turbine was approximated using a simplified model of the cylindrical tower only at far field distances. Far field distance refers to the range between the radar and the scattering object where the scattering patterns becomes “mature”. Depending on the size of the target and the radar frequency, this distance can extend to a few meters or up to tens of km’s. In the case of turbines (which are large in comparison to the radar wavelengths) the far field distance is approximated to be around 30 – 90 km’s away from the radar.

4.25 As the tower is known to be the largest contributor to the overall turbine scattering profile (BAE Systems, 2009), this assumption is deemed to be acceptable for studying and approximating the appearance of ghost targets.

4.26 As shown previously in Table 4.2, the Racon operation and detection range is also dictated by the type of radar. To investigate the likelihood of the appearance of multiple Racon responses on different types of vessels, the models were utilised to simulate a large commercial vessel with a radar height of 35 m (vessel 3B in the table) and a small commercial vessel with a radar height of 10 m (2B). The models were initially run by varying R1 and R2 independently to establish the possibility of multiple reflections occurring. Figure 4.5 and Figure 4.6 show the regions where multiple reflections would occur in red for a large vessel and a small vessel respectively.

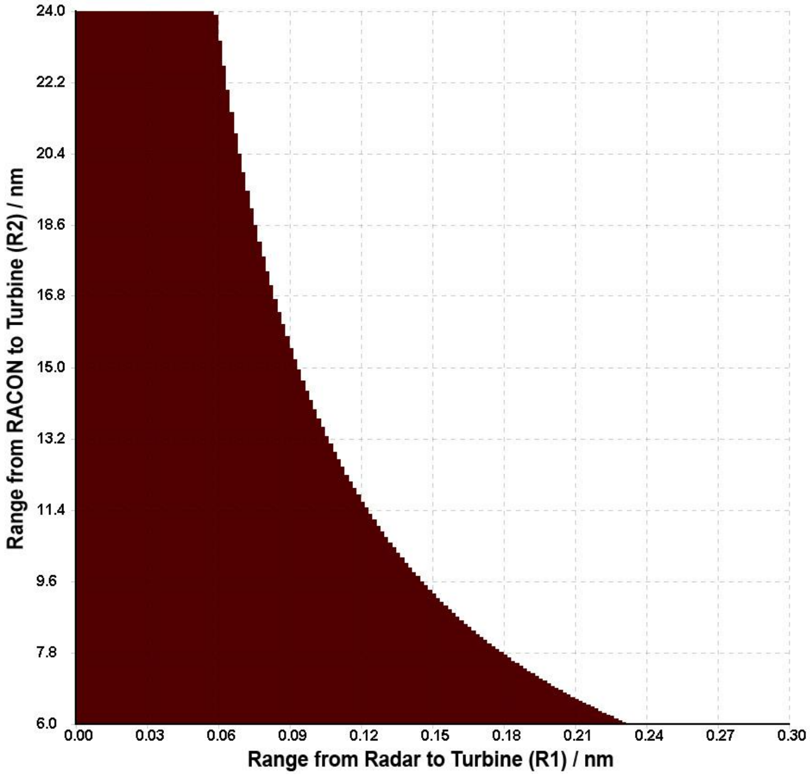

Figure 4.5 The region where multiple Racon responses would be recorded for a Large Commercial vessel with a radar height of 35 m ASL (Power = 25Kw, Antenna Gain = 31dB)

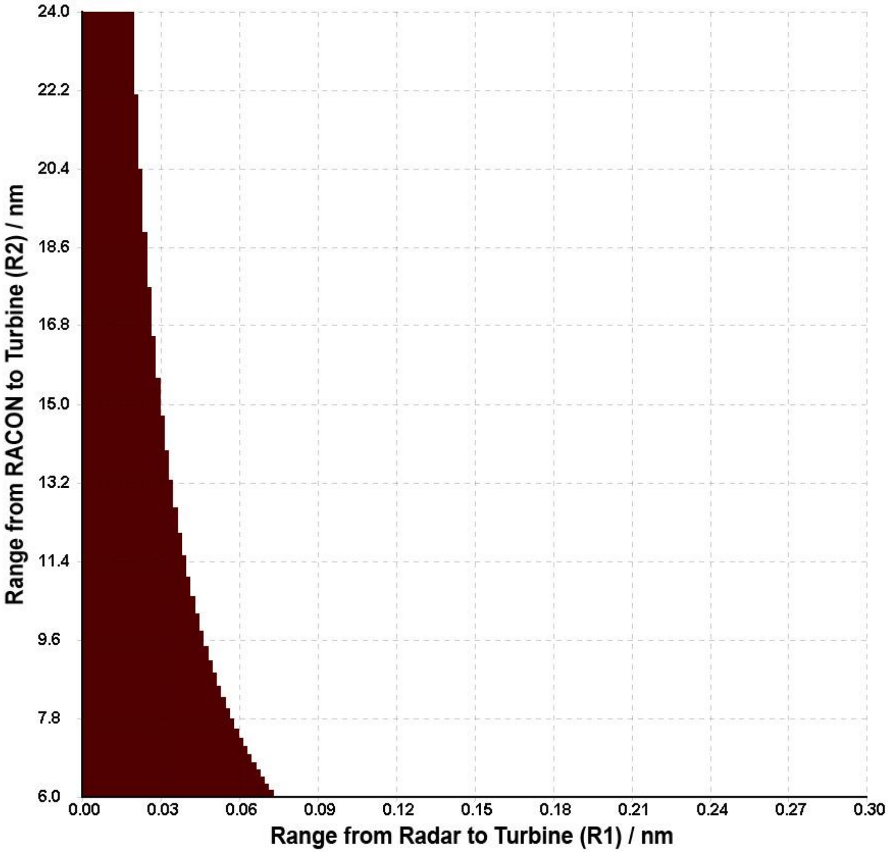

Figure 4.6 The region where multiple Racon responses would be recorded for a Small Commercial vessel with a radar height of 10 m ASL (Power = 10Kw, Antenna Gain = 25dB)

4.27 As the nearest turbine to the J6A platform is approximately 6.9 nm, the appearance of multiple reflections would occur at approximately 0.19 nm (or 350 m) away from the turbine for the case of the large vessel and 0.08 nm (150 m) for the smaller commercial vessel. The effect of multiple reflections quickly diminishes for turbines that are located further away for the platform. This can be seen in Figure 4.7 and Figure 4.8 whereby the regions of multiple reflections are shown around each turbine in red for the large and the small vessel respectively.

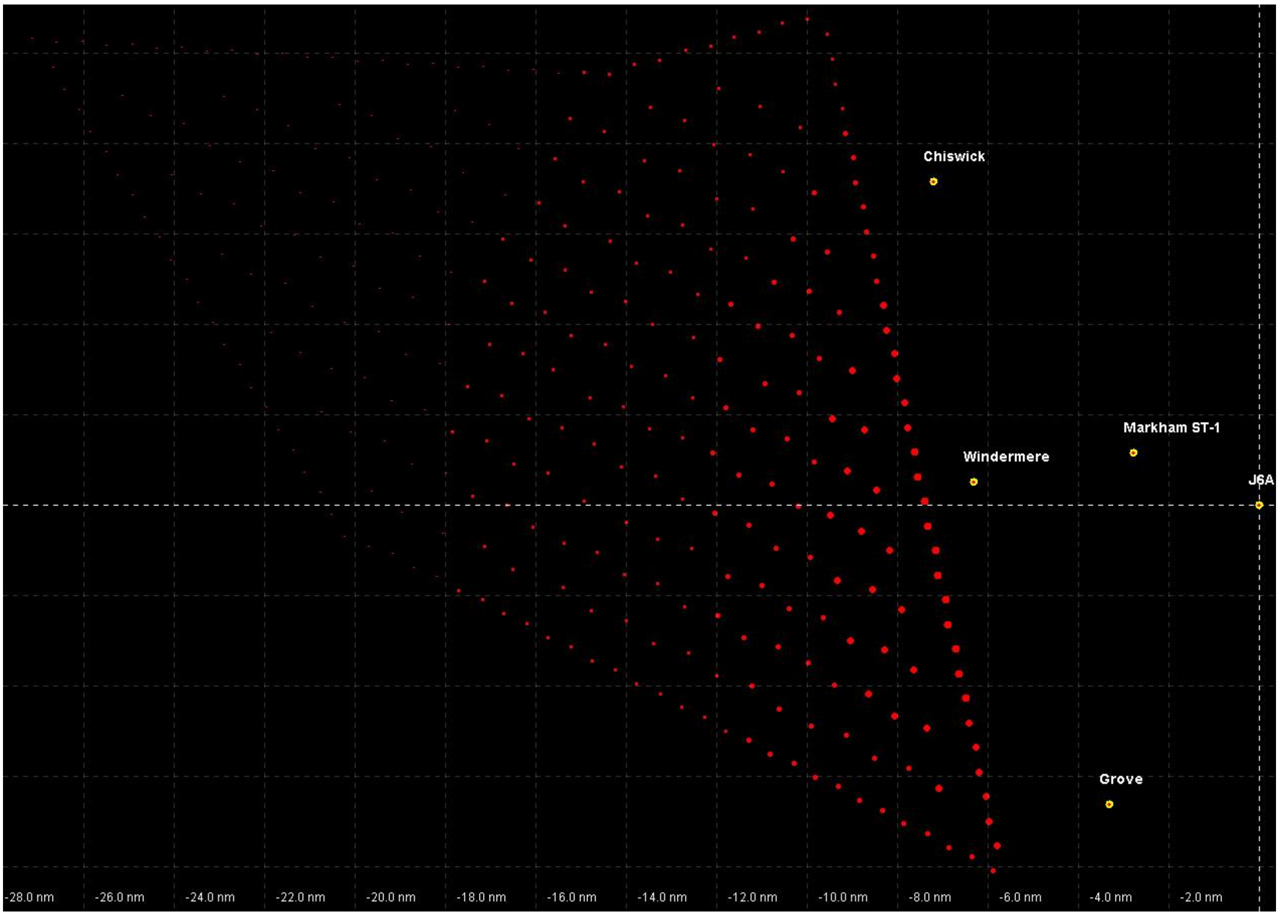

Figure 4.7 Modelling results of the region of multiple Racon responses within Hornsea Three array area for Large Commercial vessel with a radar height of 35 m ASL (Power = 25Kw, Antenna Gain = 31dB)

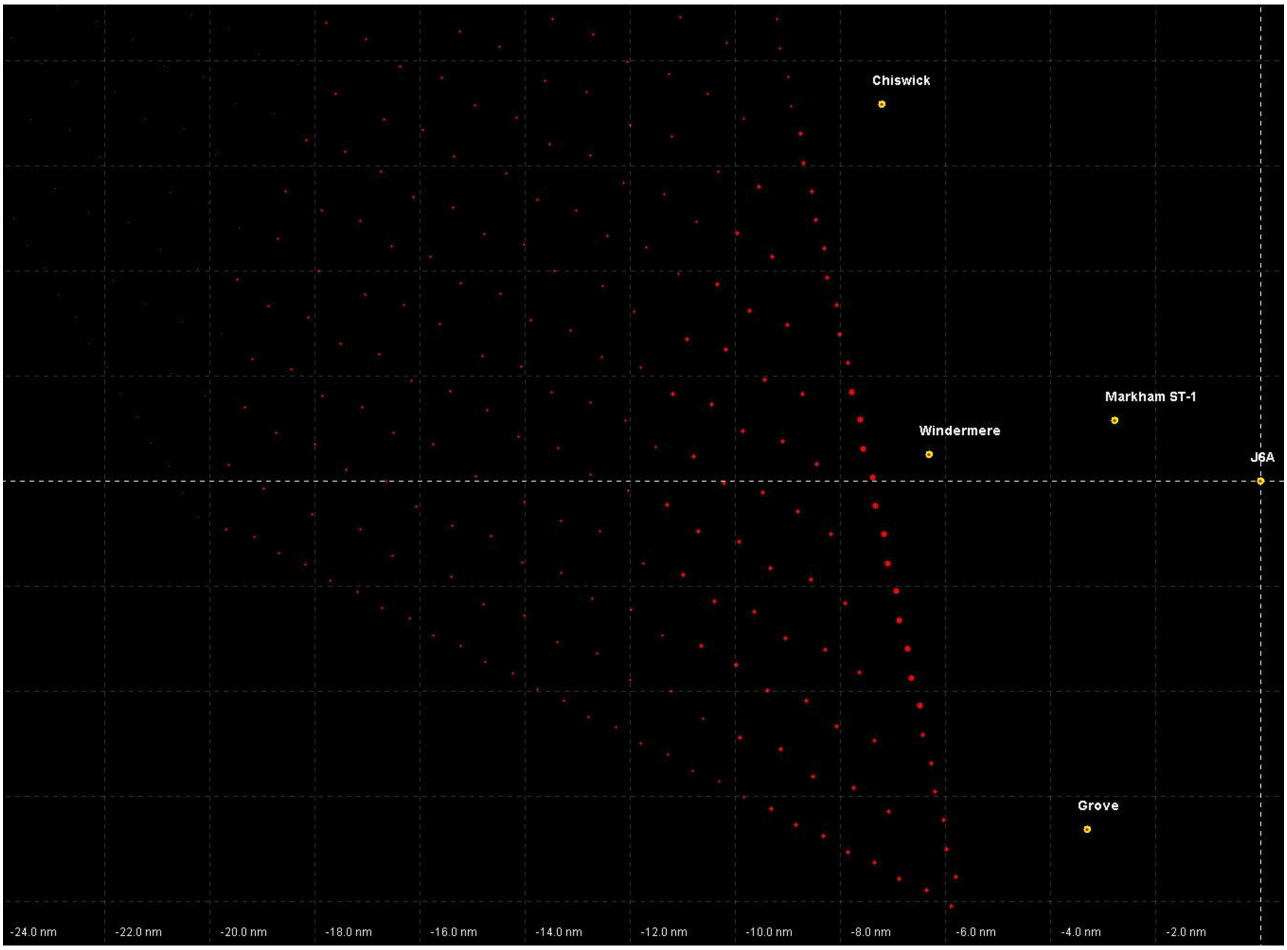

Figure 4.8 Modelling results of the region of multiple Racon responses within Hornsea Three array area for a Small Commercial vessel with a radar height of 10 m ASL (Power = 10Kw, Antenna Gain = 25dB)

4.28 The results show that the potential impact of multiple reflections of the Racon signal within the Hornsea Three array area is likely to be localised within a small radius around each turbine. The turbines closest to the J6A platform may cause interference with the Racon signal if the vessel is operating less than 500 m away from the turbine. However, even in such cases, due to the large separation distance between the turbines in the proposed Hornsea Three layout, it is unlikely that the radar would register more than one false Racon response at a time. This is because it is not possible for a vessel to be within 500 m from more than one turbine at any given time. Experienced radar operators would still be able to navigate through the array area without the Racon multiple reflections causing any issues. The results of the modelling are also in line with the experience of mariners operating near wind farms and other Racon systems as shown in the next subsection.

Examples of Other Racons Adjacent to Offshore Wind Farms

4.29 This section presents an overview of examples of Racons around other existing operational wind farms on the UKCS. It is noted that most of the Racons are located on buoys as opposed to offshore installations.

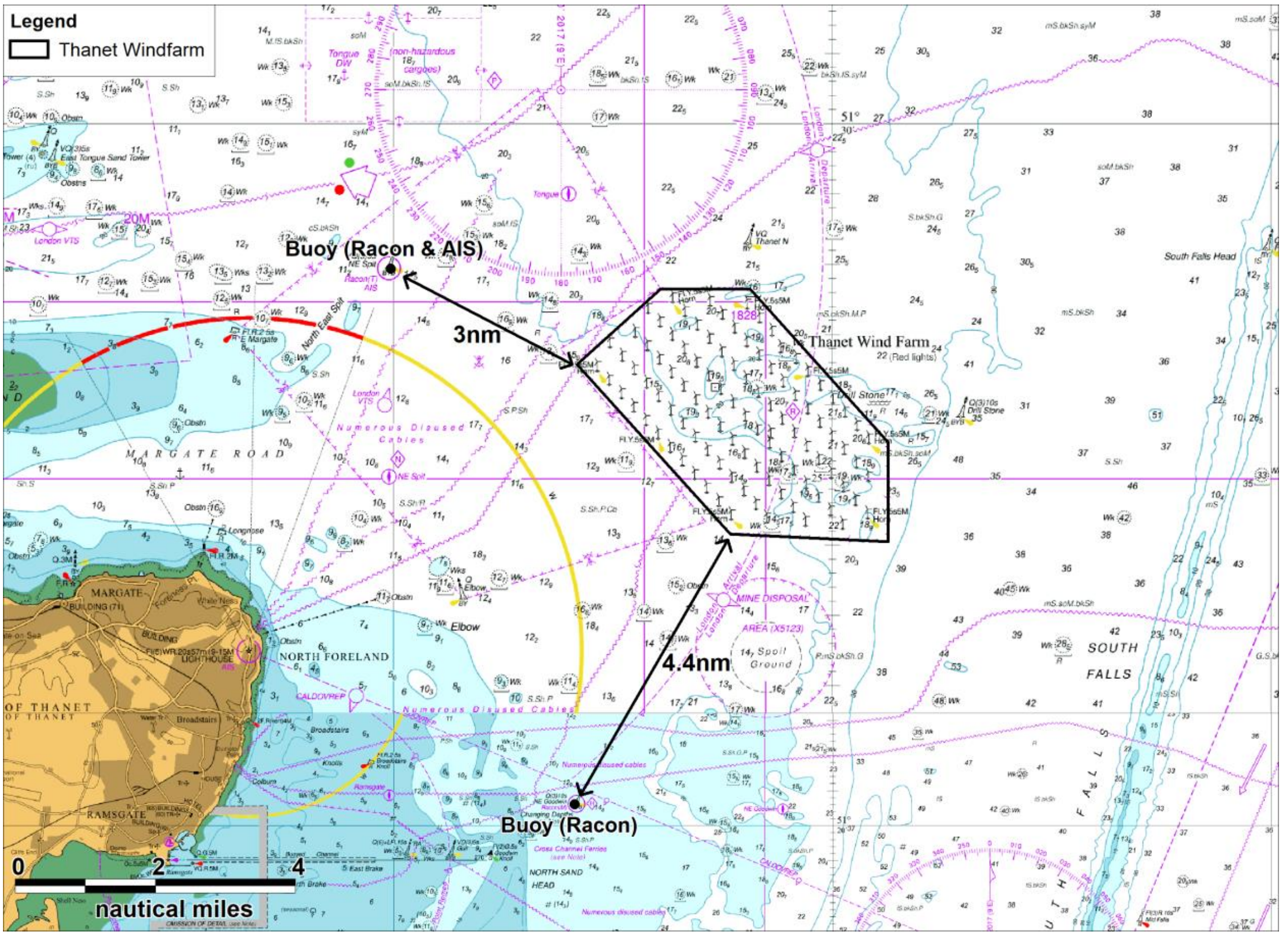

Figure 4.9 Overview of Racons near Thanet Wind Farm

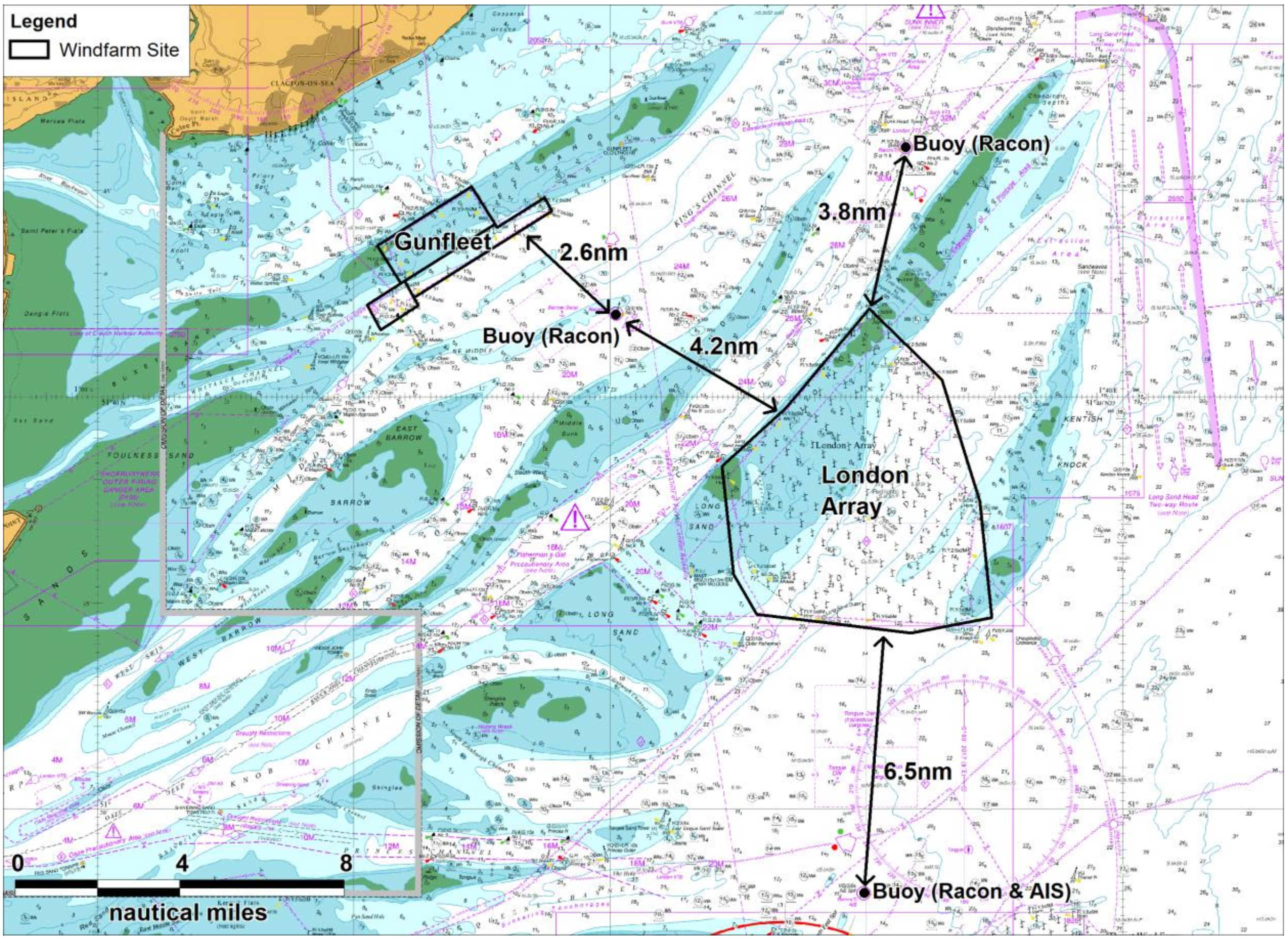

Figure 4.10 Overview of Racons near London Array and Gunfleet Wind Farms

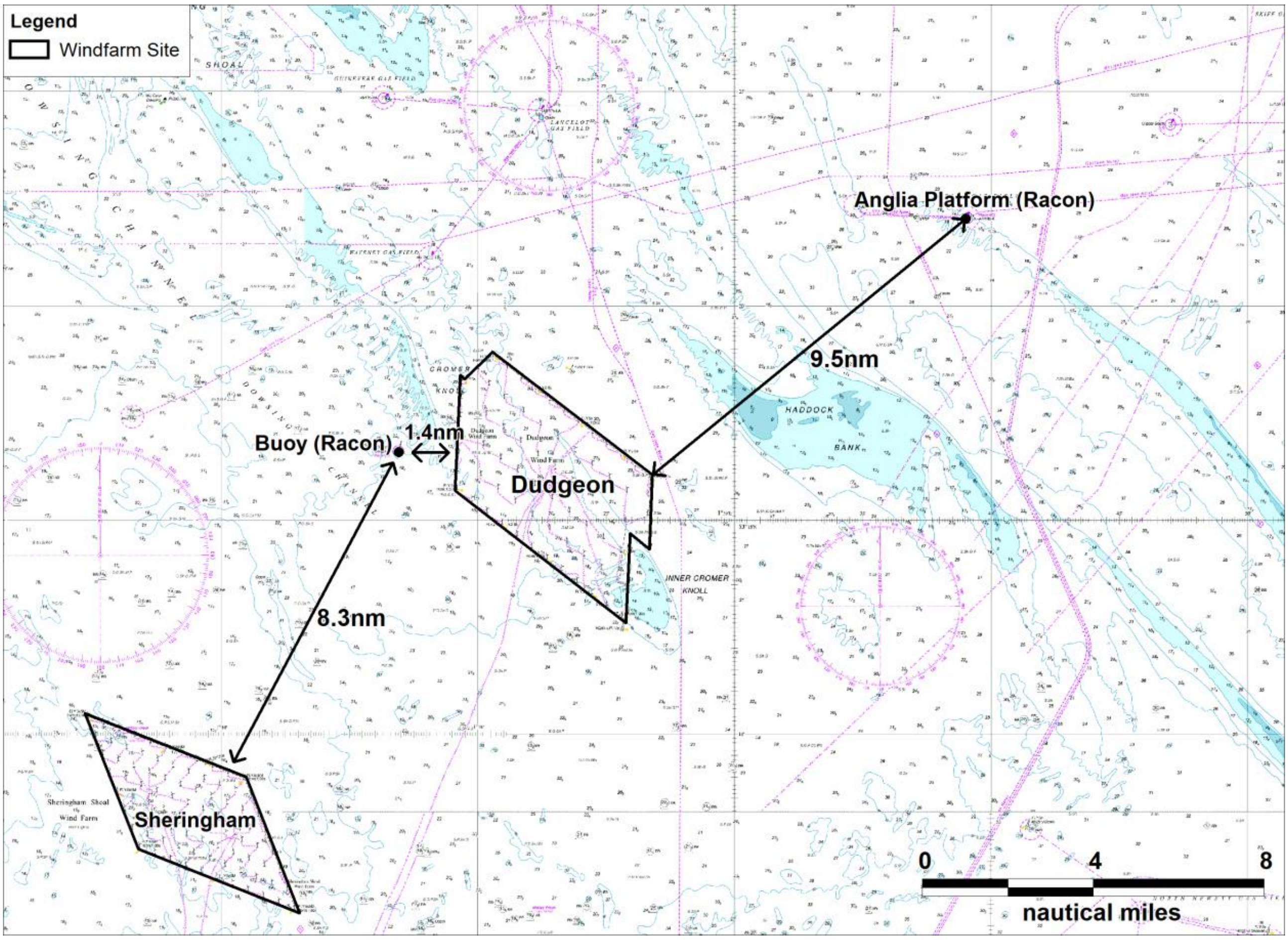

Figure 4.11 Overview of Racons near Dudgeon and Sheringham Wind Farms

4.30 Table 4.3 presents a list of all wind farms within 10 nm of a Racon and Figure 4.12 presents a graph of the ranges of Racons from nearby wind Farms. It is noted that these Racons are located on either buoys, lightships or oil and gas platforms.

Table 4.3 List of Wind Farms with Nearby Racons

Wind Farm	Distance to Racon (nm)	Type of Installation
Aberdeen	3.1	Buoy
Barrow	3.4	Buoy with AIS
Burbo Bank	1.9	Lightship
Dudgeon	1.4	Buoy
Dudgeon	9.5	Platform
Galloper	4.5	Buoy
Galloper	6.8	Lightship with AIS
Greater Gabbard	2.3	Buoy
Greater Gabbard	3.7	Lightship with AIS

Wind Farm	Distance to Racon (nm)	Type of Installation
Greater Gabbard	9.6	Buoy
Gunfleet	2.6	Buoy
Gwynt y mor	6.1	Buoy
Gwynt y mor	8.4	Platform
Humber Gateway	0.8	Lightship with AIS
Humber Gateway	2.8	Lightship
Humber Gateway	5.9	Buoy with AIS
Lincs	5.0	Buoy
Lincs	4.6	Buoy
London Array	3.8	Buoy
London Array	4.2	Buoy
London Array	6.5	Buoy with AIS
Lynn	4.5	Buoy
Race Bank	6.9	Buoy
Rhyl Flats	4.7	Buoy
Scroby Sands	6.5	Buoy
Sheringham	8.3	Buoy
Tees	1.7	Buoy
Thanet	3.0	Buoy with AIS
Thanet	4.4	Buoy
West of Duddon Sands	6.7	Buoy with AIS

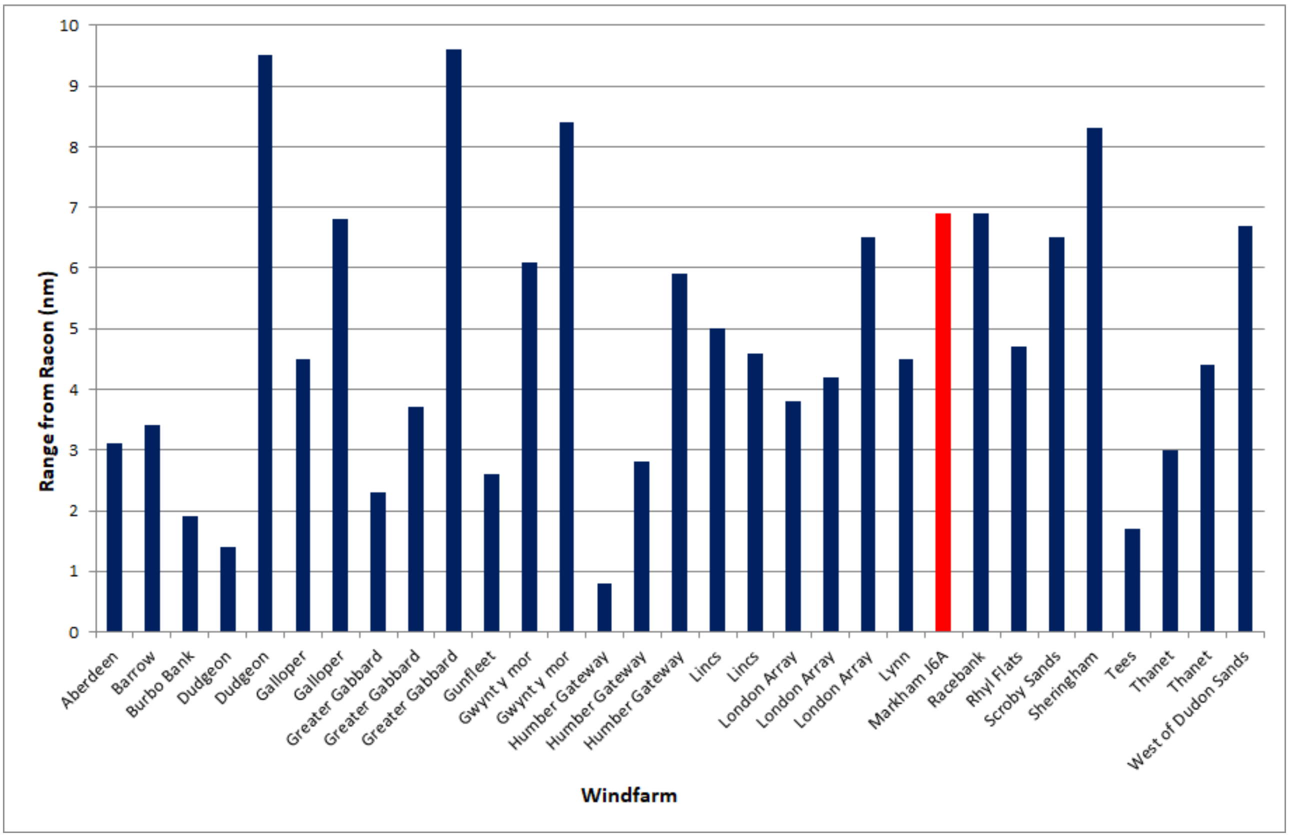

Figure 4.12 Racon Range from Nearby Wind Farms including Markham J6A

Impacts of Hornsea Three Turbines on J6A Racon

4.31 This note has presented a summary of distances at which vessels can detect Racon installed on platforms such as the Markham J6A platform.

4.32 Overall, the factors that have the most significant effect on the range include the power output of the radar, height of the Racon ASL and the height of the radar ASL. Small craft can be detected in ranges of approximately 9 nm to 12 nm if conditions are favourable, small commercial vessels in ranges between 13 nm and 15 nm, and large commercial vessels in ranges 18 nm to 24 nm. It is noted that the Racon range will be reduced in poor weather conditions.

4.33 It was shown above that a number of Racons were positioned near to existing wind farms. Currently no known issues are noted with the Racons listed above due to the nearby wind farms locations.

4.34 Two masters of various vessels that operated at wind farms with nearby Racons were consulted; these vessels perform guard duty and survey operations at a number of windfarms. In-line with the modelling results, the masters of the vessels reported that no issues were noted and the vessel radars were picking up the Racons at a normal distance. The vessel radars operated without issues when near to the windfarm and Racon, with no shadowing regions reported by the vessel masters.

5. AIS Review

AIS Overview

Introduction

5.1 AIS is a VHF based technology which was created as a tool for collision avoidance and means of automatic data exchange both ship-to-ship and ship-to-shore. Complete deployment of AIS to Safety of Life at Sea (SOLAS) class vessels was required by 31 December 2004 under SOLAS Chapter V.

5.2 SOLAS requires Class A AIS to be fitted onboard all ships of 300 gross tonnage and upwards engaged on international voyages, cargo ships of 500 gross tonnage and upwards not engaged on international voyages and all passenger ships irrespective of size.

5.3 Class A AIS is now also required to be carried by fishing vessels of 15 m length and over under EU Directive, EU (2009).

5.4 AIS can also be used to mark AtoN such as buoys, lightships, wind turbines and offshore platforms. AIS AtoNs can either be a physical installation on the structure or virtual (synthetic) where they are broadcast from a nearby source.

AIS Classes and Data Format

5.5 There are two classes of AIS system; A and B, each of which broadcast slightly different data.

5.6 The main information transmitted by ships using Class A and B is given below:

- fixed or static information, which is entered into the AIS on installation and need only be changed if the ship changes its name or undergoes a major conversion from one ship type to another;
- dynamic information, which, apart from 'Navigational status' information, is automatically updated from the ship sensors connected to AIS; and
- voyage-related information, which might need to be manually entered and updated during the voyage (this is only broadcast on Class A).

5.7 The most important message for collision avoidance is the dynamic information that includes the ship's "User ID" (the MMSI) for identification, the position from the ship's GPS, speed over ground, course over ground, rate of turn, and several additional parameters.

5.8 The position updates for Class A systems range from every two seconds to every three minutes depending on vessel speed and status, as detailed below.

- Three minutes for a vessel at anchor (speed of less than 3 knots);
- Ten seconds for a vessel on transit (speed less than 14 knots);
- Four seconds for a vessel on transit and changing course;
- Six seconds for a vessel on transit (speed between 14 and 23 knots); and
- Two seconds for a vessel on transit (speed greater than 23 knots) or changing course (speed greater than 14 knots).

5.9 Class B AIS was specified as a less expensive alternative to Class A to be used by smaller, non-SOLAS vessels such as fishing vessels below 15 m and recreational vessels. The data broadcast is slightly reduced but it still contains the main information that is required for collision risk management. The main differences are as follows:

- Class B has a reporting rate less than Class A (e.g., every 30 seconds if speed over the ground is greater than 2 knots, or every 3 minutes for slower vessels).
- Class B does not transmit the vessel's IMO number, call sign, ETA, destination or navigational status.

5.10 Class B is only required to receive, not transmit, text safety messages.

5.11 Buoys, lightships and offshore platforms can be marked by AIS as AtoNs instead of as a standard vessel. This is achieved by either having an AIS transmitter installed on the structure or having the structure marked by a virtual AIS AtoN position. The virtual AIS AtoN is broadcast from a nearby AIS transmitter (within VHF range); therefore no physical electronics are required to be installed on the structure.

5.12 AIS AtoN locations are broadcast as Message #21; these messages contain the position of the installation, aid type, name and Maritime Mobile Service Identity (MMSI). AtoN messages are broadcast every 3 minutes and will be displayed on electronic navigational systems as a diamond shape rather than a standard vessel shape (triangle).

5.13 Figure 5.1 and Figure 5.2 present examples of the type of information broadcast by a Class A AIS system used on vessels and an AtoN Message #21 used to mark structures such as buoys and platforms.

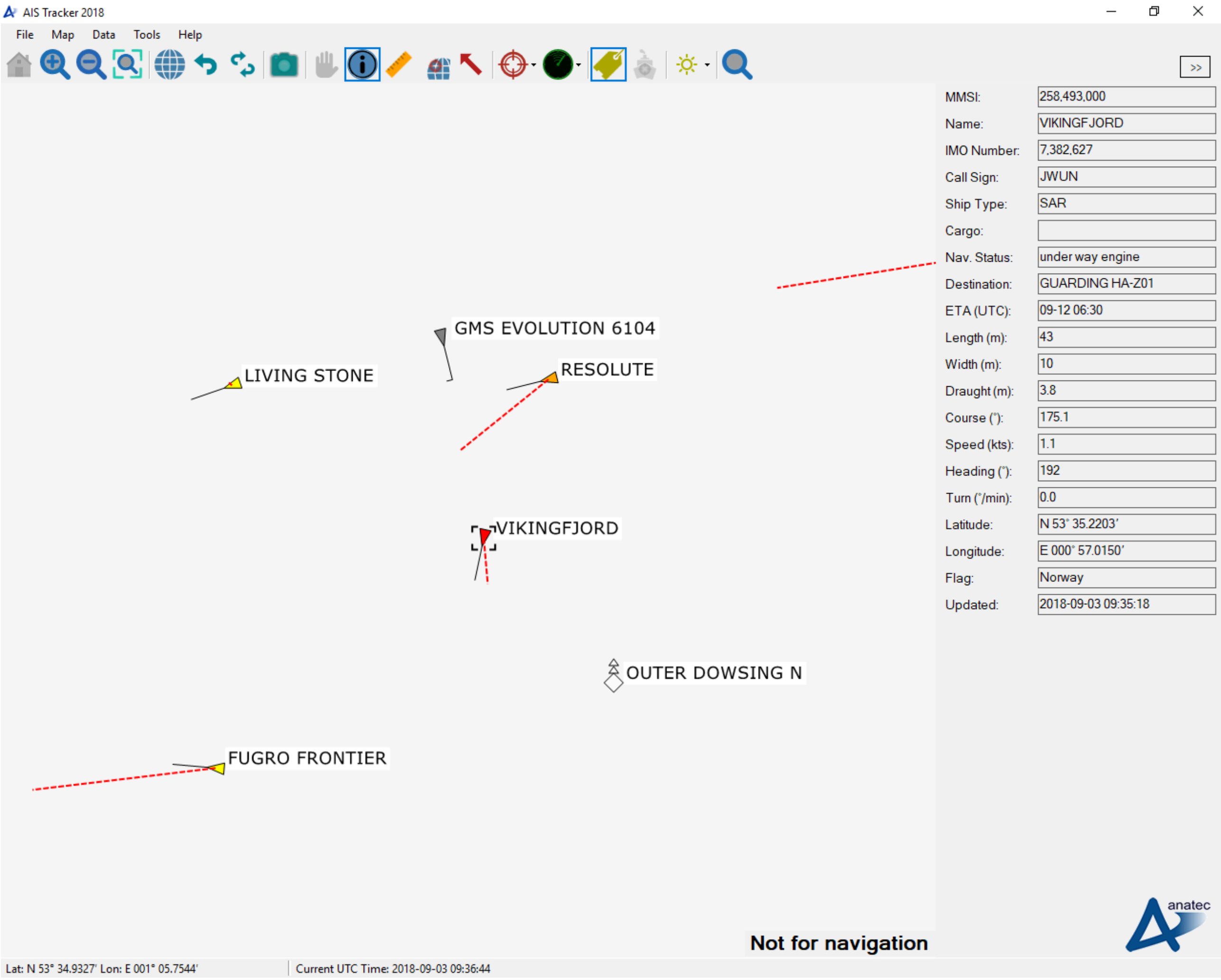

Figure 5.1 Type of Symbol and Information Broadcast by Class A AIS System (Vessel)

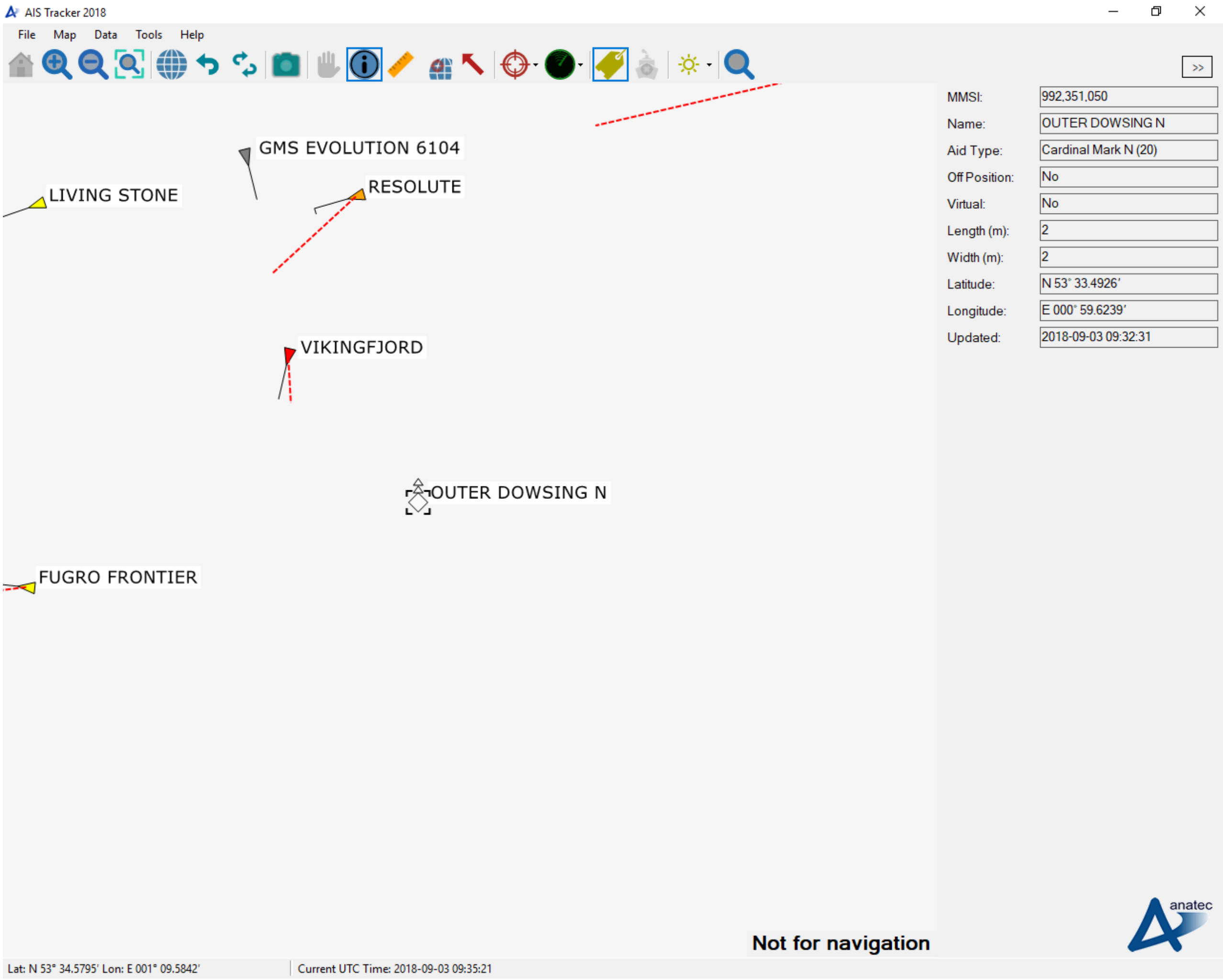

Figure 5.2 Type of Symbol and Information Broadcast by AtoN System (Buoy)

AIS on J6A

5.14 The J6A platform has been broadcasting its position on AIS using a standard vessel based system (Class A) as opposed to an AIS AtoN which is more commonly used to mark offshore platforms in the North Sea. This system marks the platform as a stationary vessel using the MMSI 245849000 on vessels' navigational equipment.

5.15 Based on the J6A Platform being stationary, positional updates will be broadcast every 3 minutes. However, it is noted that nearby offshore survey data for the general area showed that the platform was not recorded at all times. This could indicate that broadcast range is poor or the platform does not broadcast all the time.

Factors Impacting AIS Performance

5.16 Various factors impact the range at which vessels detect/broadcast AIS messages. These are given below:

- Atmospheric conditions (weather)
- Height of AIS Antenna (Line of Sight)
- Location of AIS Antenna
- Power (Watts)
- Radio shadowing due to obstruction of line-of-sight

5.17 Precipitation, temperature and humidity all have the capability of influencing the range of AIS, particularly at distances greater than 10 nm. Effective range of AIS will be reduced during low pressure weather conditions.

5.18 The line of sight that the vessel / structure will have an impact on the range for detection/ broadcast as the AIS messages are broadcast using VHF radio waves. VHF range is typically the line of sight (taking into account curvature of the earth), therefore, higher antennas will tend to have a greater range. This means larger vessels tend to detect other vessels at greater distances due to the AIS antennas height.

5.19 The position of the AIS antenna can also affect the range. Any blockages in the line of sight will reduce the range in the direction of the blockage. This could include the coastline or metal structures on an offshore platform partly blocking the antenna in a certain direction.

5.20 Another factor that affects the performance of an AIS system is the transmit power (Watts), Class A systems will typically use a 12.5 W system while Class B systems will typically use lower power. Using a lower power will result in a reduction in the range of messages transmitted from the vessel.

5.21 As with many radio frequency communication systems, the presence of physical obstruction to the line of sight may reduce the effectiveness of the system. The radio shadows caused by terrain features or other large objects may limit the coverage of the AIS or reduce the power received in the shadow region. However, it is worth noting that since the AIS is operating at VHF, the radio waves will experience diffraction around the blocking objects reducing the shadow region.

Experience of AIS Near Wind Farms

5.22 In 2004, the MCA and QinetiQ conducted trials (MGN 372) at the North Hoyle wind farm (QinetiQ and MCA, 2004) to determine any impact of wind turbines on marine communications and navigations systems. The results from the full report, available from the MCA (Volume 5, Annex 7.1: Navigational Risk Assessment of the Environmental Statement), are summarised below. The trials indicated that there is minimal impact on VHF radio, Global Positioning Systems (GPS) receivers, cellular telephones and AIS. UHF and other microwave systems suffered from the normal masking effect when turbines were in the line of the transmissions.

5.23 In theory, the effects of radio shadowing due the presence of turbines may affect the AIS performance at very close ranges to the turbines. However, since the wavelength of the AIS signal is approximately 1.8 m, the shadowing due to the turbine tower and the support structure is expected to recover within a few hundred metres due to the diffraction of the radio waves around the turbine. Additionally, due to the movement of the vessels, the effect of the shadowing will be transient and is expected to be restored as the vessel moves within or behind the wind farm. The effect of shadowing on vessel-to-vessel communication is often expected to be reduced even further due to the movement of both vessels in and out of the shadow regions making the loss shorter.

5.24 The effects of shadowing on AIS due to the presence of wind farms has been investigated further by Anatec by reviewing in-house AIS data of vessels operating near and within wind farms. Anatec have reviewed the effect of wind farms on AIS broadcasts received by a coastal AIS unit and a vessel based AIS unit.

5.25 The data showed that AIS was received for the surrounding area in the vicinity of the wind farm with no visible impact on the range of the AIS messages received. This included vessels operating within and behind the wind farm.

5.26 Figure 5.3 and Figure 5.4 presented below are from a coastal receiver in the vicinity of the Sheringham Shoal Offshore Wind Farm.

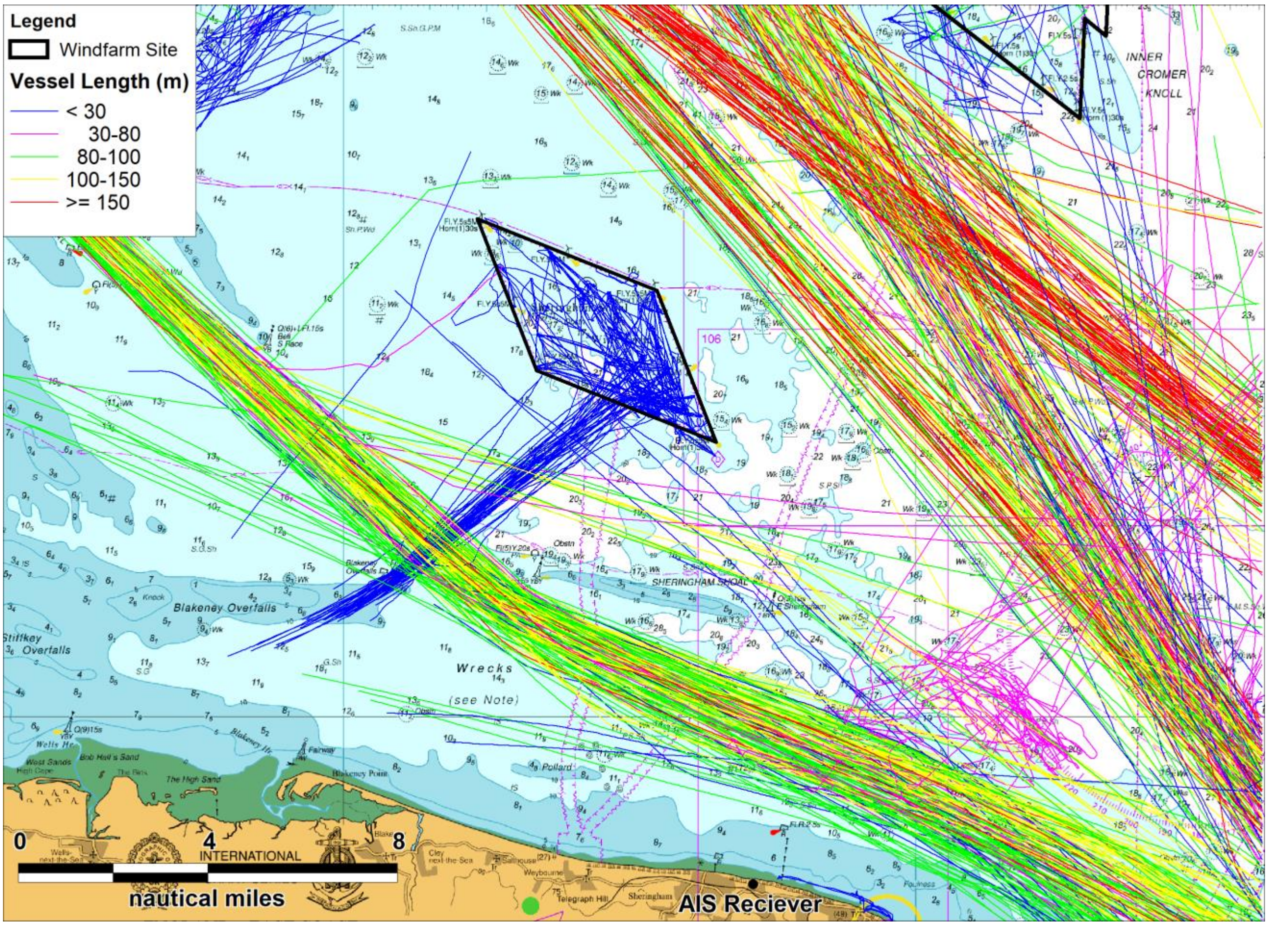

Figure 5.3 Overview of AIS Data by Length around Sheringham Wind farm (1 week)

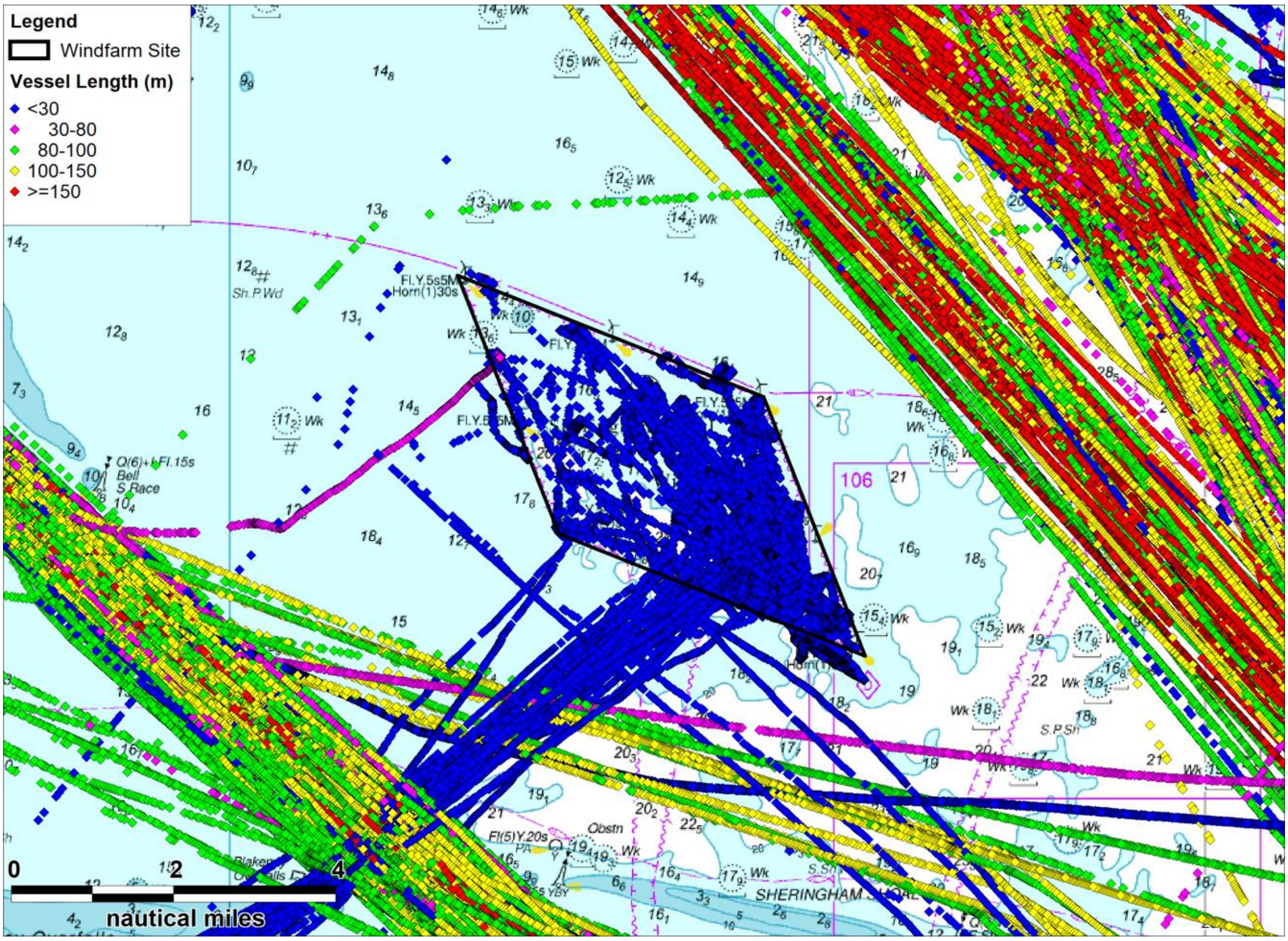

Figure 5.4 Overview of AIS Data Points by Length in Vicinity of the Sheringham Wind Farm (1 week)

5.27 As it can be seen, vessels were tracked to the north of the Sheringham Shoal Offshore Wind Farm from the coastal receiver located 9.5 nm from the wind farm boundary. The AIS coverage was limited to the west due to the coastal features blocking the line of sight. Vessels operating within the wind farm boundary were tracked by the coastal receiver with regular vessel position reports received for the small support vessels.

5.28 Figure 5.5 and Figure 5.6 present AIS data from a vessel operating in the vicinity of the Thanet Wind Farm.

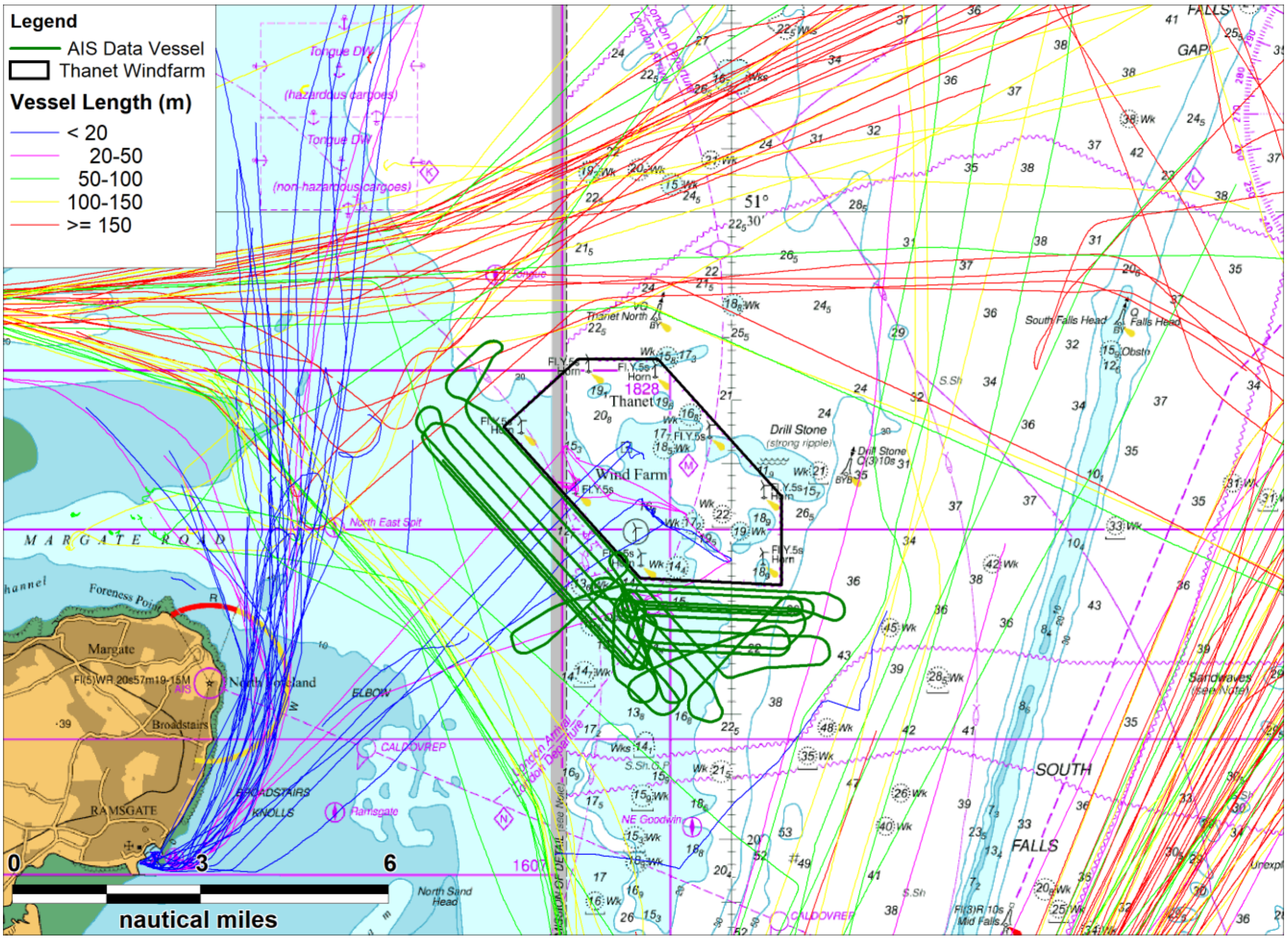

Figure 5.5 Overview of AIS Data by Length around Thanet Wind Farm (1 Day)

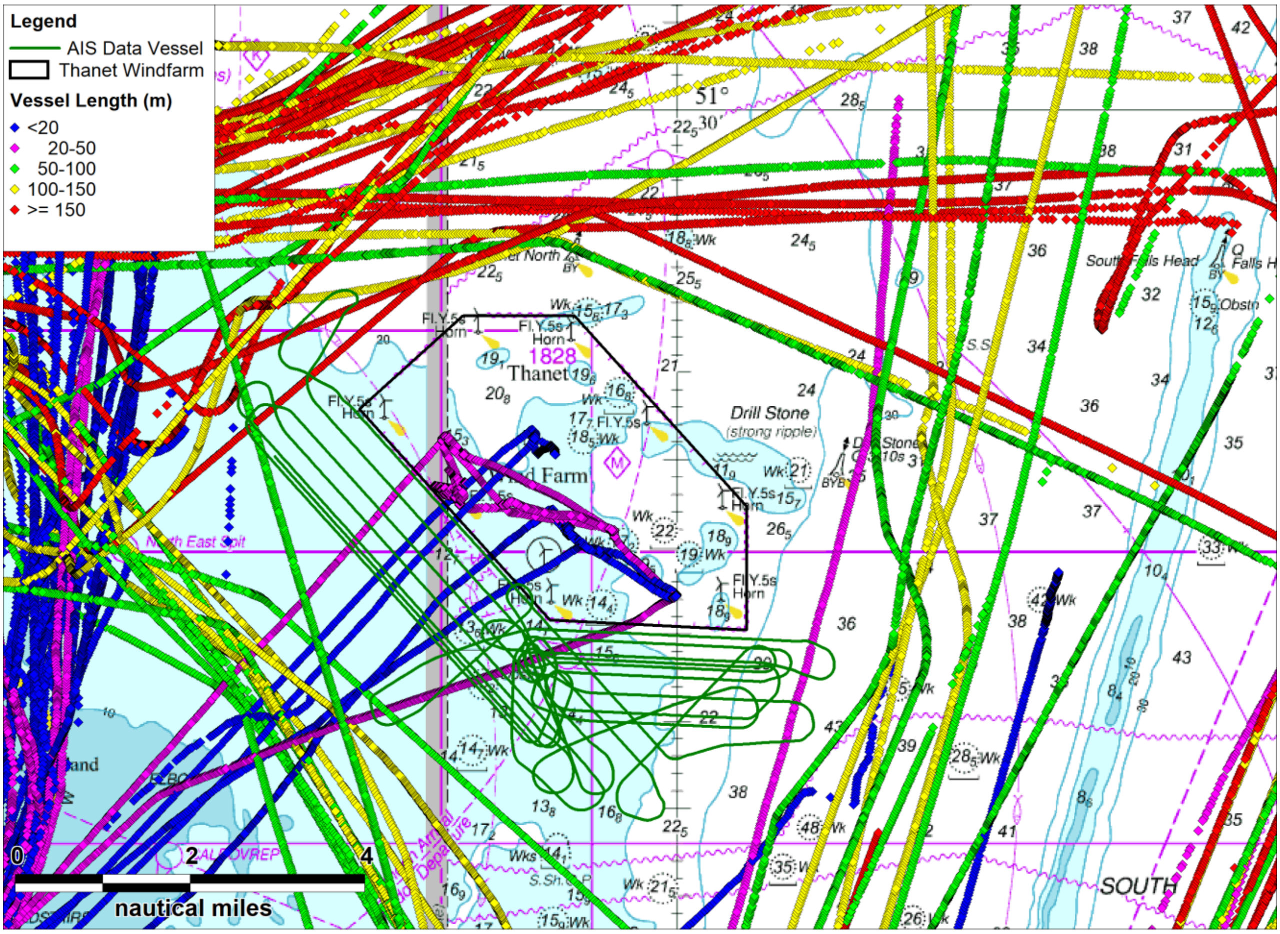

Figure 5.6 Overview of AIS Data Points by Length in Vicinity of the Thanet Wind Farm (1 Day)

5.29 As it can be seen, the vessel collecting the AIS data was operating close to the Thanet Wind Farm boundary. The AIS unit was still able to receive messages from the passing traffic to the north of the wind farm even though the position of the vessel was shielded by turbine locations. The vessel was also able to record the movements of vessels operating within the wind farm.

5.30 There is currently no reported reduction in performance of AIS around wind farms.

AIS Conclusions

5.31 This section presented information on the types of AIS carried by vessels and used to mark navigational features such as platforms. The impact on AIS from wind farm turbines was also presented.

5.32 The effects of radio shadowing due to the presence of turbines is unlikely to affect passing vessels AIS as they operate using VHF. The AIS may get affected if a vessel was within close range (less than 200 m) of the turbines but should recover when the vessel has moved away from the turbines. Therefore, as passing vessels are not likely to pass within the Hornsea Three array area limits, the AIS for these vessels should operate as normal.

5.33 Two masters of vessels experienced in operating at windfarms were consulted; these vessels have performed guard duties and survey operations at a number of operational and under construction windfarms in the East Irish Sea and North Sea. No issues were noted with the vessels' AIS systems when recording vessels on the other side of the wind farms or when vessels were working within the wind farm limits. The vessel masters noted no reduction in range of AIS when operating in close vicinity of the windfarms.

6. Potential effect of Hornsea Three on the J6A Racon and AIS

6.1 The preceding sections of this document have provided an updated assessment to account for new information provided by Spirit Energy, in that the J6A platform has a Racon and AIS system and not a REWS. This section provides a summary of the implications on the assessment conclusions (in EIA terms) for the following impact (specifically in regard to the J6A platform) in Volume 2, Chapter 11: Infrastructure and Other Users of the Environmental Statement:

The presence of new wind turbines in previously open sea areas may cause interference with the performance of the REWS located on oil and gas platforms.

6.2 The physical presence of wind turbines has the potential to interfere with the performance of Racons and AIS hardware, due to potential shadowing and multiple returns (Racon) and shadowing (AIS). These systems are sometimes used by oil and gas operators to identify the location of their platform to marine vessels. The Racon is generally considered a supplementary aid to navigation installed at sites that would already have standard markings including lights (as in the case with the J6A platform) but it is important to note that although Racon are likely to reduce the risk of collision, they do not act as an anti-collision system for offshore platforms.

6.3 It is noted that since the further development of AIS, newer offshore installations which may have previously been marked using a Racon are now more commonly marked with an AIS AtoN. AIS is a VHF based technology which was created as a tool for collision avoidance and means of automatic data exchange both ship-to-ship and ship-to-shore and can be used to mark structures such as offshore platforms.

6.4 The J6A platform operated by Spirit Energy, located at a distance of 6.9 nm from the Hornsea Three array area, has both a Racon and AIS hardware. The J6A platform has been broadcasting its position on AIS using a standard vessel-based system (Class A) as opposed to an AIS AtoN which is more commonly used to mark offshore platforms in the North Sea. This system marks the platform as a stationary vessel. Based on the J6A Platform being stationary, positional updates will be broadcast every 3 minutes. However, it is noted that nearby offshore survey data for the general area showed that the platform was not recorded at all times. This could indicate that the broadcast range is poor, or the platform does not broadcast all the time.

6.5 Modelling and assessment was carried out on the effect of Hornsea Three on the J6A platform Racon and AIS hardware as presented in Section 2 to Section 6 above. The results are summarised below.

6.6 The technical note has presented a summary of distances at which vessels can detect Racon installed on platforms such as the Markham J6A platform (Section 4). Overall, the factors that have the most significant effect on the range include the power output of the radar, height of the Racon ASL and the height of the radar ASL. Small craft can be detected in ranges of approximately 9 nm to 12 nm if conditions are favourable, small commercial vessels in ranges between 13 nm and 15 nm, and large commercial vessels in ranges 18 nm to 24 nm.

6.7 The range between the closest turbine and the J6A platform is approximately 6.9 nm, which is expected to produce narrow shadowing regions for the Racon. The width of the shadows for the radar will be dependent on the range between the radar and the turbine – close ranges are expected to generate wider shadowing sectors. However, although the presence of turbines is expected to generate Racon shadowing as well as shadowing regions for radars operating near or within the wind farm, the effects of the shadows are expected to be transient and Racon detections should recover for moving vessels. Experienced radar operators should be able to interpret the radar returns successfully and be able to locate the source of the Racon signal without much disturbance. While the Racon is in the ‘on’ state, it provides positioning aid of the assets by displaying a Morse code on the radar screen that extends over a few nautical miles behind the asset. When the Racon is in its ‘off’ state, it provides an opportunity for the navigating vessels to detect objects located behind the assets (by effectively switching off the Morse code on the radar display). Therefore, having transient losses of the Racon signal due to the shadowing can be considered to be of negligible effect on the functionality of the Racon.

6.8 The potential impact of multiple reflections of the Racon signal within the Hornsea Three array area is likely to be localised within a small radius around each turbine. The turbines closest to the J6A platform may cause interference with the Racon signal if the vessel is operating less than 500 m away from the turbine. However, even in such cases, due to the large separation distance between the turbines in the proposed Hornsea Three layout, it is unlikely that the radar would register more than one false Racon response at a time. This is because for Hornsea Three, it is not possible that a vessel would be within 500 m from more than one turbine at any given time. Experienced radar operators would still be able to navigate through the array area without the Racon multiple reflections causing any issues.

6.9 A number of Racons are positioned near to existing offshore wind farms (see Section 4). Currently no known issues are noted with these Racons due to the nearby offshore wind farms.

6.10 Masters of vessels that operated at wind farms with nearby Racons were consulted. These vessels perform guard duty and survey operations at a number of windfarms. Consistent with the modelling results, the masters of the vessels reported that no issues were noted and the vessel radars were picking up the Racons at a normal distance. The vessel radars operated without issues when near to the windfarm and Racon signals were received with no shadowing regions being reported by the vessel masters.

6.11 The results of the technical assessment on the AIS hardware on the J6A platform are presented in Section 5. The effects of radio shadowing due to the presence of turbines is unlikely to affect passing vessels AIS as they operate using VHF. The AIS may be affected if a vessel was within close range (less than 200 m) of the turbines but should recover when the vessel has moved away from the turbines. Therefore, as passing vessels are not likely to pass within the Hornsea Three array area limits, the AIS for these vessels should operate as normal.

6.12 Masters of vessels that operated at windfarms were consulted; these vessels perform guard duty and survey operations at a number of wind farms. No issues were noted with the vessel AIS when recording vessels on the other side of the wind farms or when vessels were working within the wind farm limits. The vessel masters noted no reduction in AIS range when operating within the vicinity of the windfarms.

6.13 The relevant impact assessment within the Environmental Statement (Volume 2, Chapter 11: Infrastructure and Other Users of the Environmental Statement) concluded an effect of minor adverse significance from Hornsea Three on the J6A REWS (which is not significant in EIA terms).

6.14 Based on the assessment presented in this technical note, the magnitude of impact of Hornsea Three on the Racon and AIS system present on the J6A platform is considered to be negligible. The sensitivity of the Racon and AIS hardware is considered to be high. The effect will, therefore, be of minor adverse significance which is not significant in EIA terms. This is the same significance of effect as predicted in the Application.

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