Hornsea Project Four: Environmental Statement

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A4.4.9 Safety Justification for Single Line of Orientation Layout

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Hornsea Project Four Offshore Wind Farm – Safety Justification for Single Line of Orientation Layout

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Abbreviations Table

Abbreviation	Definition
°	Degree
AEZ	Archaeological Exclusion Zone
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
ALB	All-Weather Lifeboat
BBC	British Broadcasting Company
BOWL	Beatrice Offshore Windfarm Ltd
CAA	Civil Aviation Authority
CD	Chart Datum
CHIRP	Confidential Human Factors Reporting Programme
COLREGS	Convention on International Regulations for Preventing Collisions at Sea
CTV	Crew Transfer Vessel
DCO	Development Consent Order
DfT	Department for Transport
EASA	European Aviation Safety Agency
EIA	Environmental Impact Assessment
EO	Electro-Optical
ES	Environmental Statement
EU	European Union
FRB	Fast Rescue Boat
FSA	Formal Safety Assessment
HMCG	Her Majesty's Coastguard
HRA	Helicopter Refuge Area
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IMCA	International Marine Contractors Association
IMO	International Maritime Organization

Abbreviation	Definition
km	Kilometres
km/h	Kilometres per Hour
Km^2	Square kilometres
kt	Knots
LAT	Lowest Astronomical Tide
m	Metre
m/s^2	Metres per Second Squared
MAIB	Marine Accident Investigation Branch
MCA	Maritime and Coastguard Agency
MDS	Maximum Design Scenario
MGN	Marine Guidance Note
MHCC	Marine and Helicopter Coordination Centre
MMO	Marine Management Organisation
MOD	Ministry of Defence
MSL	Mean Sea Level
nm	Nautical Mile
Nm^2	Square Nautical Miles
NRA	Navigational Risk Assessment
OOW	Officer on Watch
OREI	Offshore Renewable Energy Installation
PEIR	Preliminary Environmental Information Report
RAF	Royal Air Force
RNLI	Royal National Lifeboat Institution
SAR	Search and Rescue
SERA	Standardised European Rules of the Air
SLoO	Single Line of Orientation
SOLAS	Safety of Life at Sea
SOV	Service Operations Vessel
UK	United Kingdom

Abbreviation	Definition
UKHO	United Kingdom Hydrographic Office
UKMPG	United Kingdom Major Ports Group
US	United States
WSI	Written Scheme of Investigation
WTG	Wind Turbine Generator

1 Introduction

1. Hornsea Project Four Offshore Wind Farm, hereafter referred to as Hornsea Four, is an offshore wind farm being developed within the Former Hornsea Zone and is currently applying for a Development Consent Order (DCO). As part of the application process for a DCO a Navigational Risk Assessment (NRA) (see **Volume 5, Annex 7.1: Navigational Risk Assessment**) has been produced which identifies the shipping and navigation impacts associated with the project.

2. Layout Principles (see Section 2.4 and **Volume A4, Annex 4.7: Layout Principles**) have been produced and agreed with the Maritime and Coastguard Agency (MCA) and Trinity House for Hornsea Four and have driven the layout refinement process. Principle 3 details requirements regarding Search and Rescue (SAR) lanes and, specifically that these SAR lanes "*shall be parallel to turbine rows on a minimum one line of orientation subject to a safety justification*' therefore allowing for the development of a layout containing a Single Line of Orientation (SLoO).

3. An array layout containing a SLoO is being proposed for Hornsea Four therefore this document has been produced to provide the safety justification for the layout and to demonstrate that, as per Marine Guidance Note (MGN) 654, *"the risks to navigation and SAR associated with the proposed layout have been reduced to As Low as Reasonably Practicable (ALARP)."*

1.1 Background

4. Guidance provided in the MCA's MGN 654 states "*Where a project proposed one line of orientation, this should be discussed with MCA and a safety justification must be prepared to support this reduction and submitted to the MCA for consideration*". Using this guidance (and its predecessor MGN 543) as a basis, the Applicant has been assessing layouts and layout strategies throughout the Environmental Impact Assessment (EIA) process. Following the Preliminary Environmental Impact Assessment Report (PEIR), and responses received as part of the Section 42 consultation, the Applicant, in consultation with the MCA and Trinity House, developed a set of Layout Principles (see Section 2.4) to:

- Provide a framework for post consent layout approval; and
- Serve as a Commitment in the NRA and the Environmental Statement (ES).

5. Additionally, the MCA have provided guidance specifically for Hornsea Four, agreed during consultation (see Section 2.5), detailing the issues to be addressed within this safety justification.

1.2 General Guidance

6. The following key guidance documents have been used to inform this safety justification in line with the guidance used to inform the Hornsea Four NRA:

- *MGN 654 Safety of Navigation Offshore Renewable Energy Installations (OREIs) and Annexes – Guidance on United Kingdom (UK) Navigational Practice, Safety and Emergency Response* (MCA, 2021); and
- *Revised Guidelines for Formal Safety Assessment (FSA) – Maritime Safety Council-MEPC.2/Circ.12/Rev.2* (International Maritime Organization (IMO), 2018).

7. Although not referenced by any guidance documents, the MCA have noted during Hornsea Three and other confidential examinations that geotechnical constraints may be used to aid the justification for a SLoO, i.e., if it can be demonstrated that it is not technically possible to apply two lines of orientation.

8. As demonstrated in Sections 4 and 6, this safety justification has been built upon the safety of both surface craft and SAR aircraft noting that Annex 5 of MGN 654 indicates that both should be considered when designing a layout.

1.3 Hornsea Four Specific Guidance

9. In addition to the guidance listed in Section 1.2, the MCA has provided specific guidance for Hornsea Four detailing what should be addressed within this safety justification; the points from this guidance are listed below:

- Draw out the relevant aspects of the NRA to support one line with regards to risk;
- Incorporate the results of any surveys undertaken to date with regards to seabed conditions and other constraints leading to support for the need for just one line of orientation in the layout design;
- Any additional lines of orientation or area where you could, or have, achieved improvements in the layout, which may not be consistent across the whole area; and
- Consideration of the impact on SAR with just one line of orientation.

2 Project Description

2.1 Site Location

10. The Hornsea Four array area is located in the Southern North Sea approximately 37 nautical miles (nm) east off the UK coast, at Flamborough Head, East Riding of Yorkshire. The Hornsea Four array area covers an area of approximately 136 square nautical miles (nm^2) (468 square kilometres (km^2)) with water depths within the Hornsea Four array area ranging between approximately 32 metres (m) below Chart Datum (CD) to more than 60 m below CD, as shown in Figure 2.1.

2.2 Array Layout

11. A final layout for the Hornsea Four array area cannot be defined until the post-consent stage, as ground conditions have not yet been fully investigated and therefore viable locations for installations of structures have not yet been confirmed. Subsequently, a realist worst case layout, also used in the NRA, is considered throughout this safety justification. Figure 2.1 presents the indicative layout and contains the following structures:

- 180 Wind Turbine Generators (WTGs);
- Six offshore transformer substations;
- Three offshore High Voltage Direct Current (HVDC) convertor substations; and
- One accommodation platform.

12. It is noted that the indicative layout represents the Maximum Design Scenario (MDS) for shipping and navigation since it includes the maximum number of structures within the array area. Table 2.1 and Table 2.2 present the key MDS parameters for the structures contained in the indicative layout.

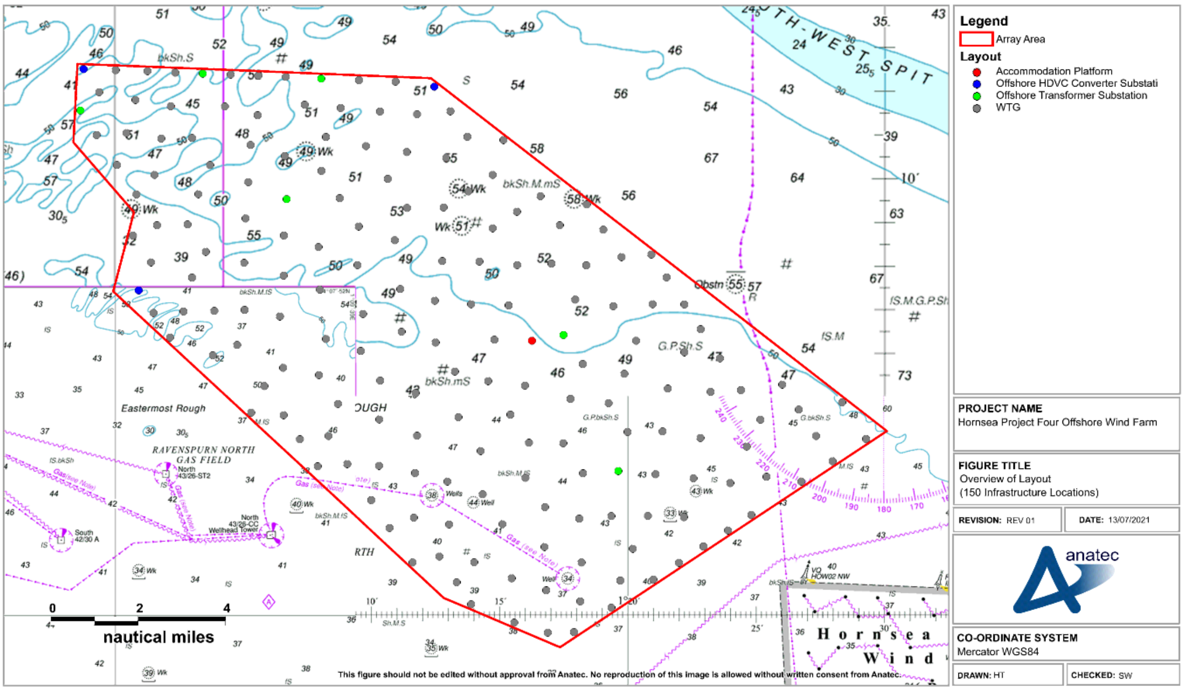

Figure 2.1 Overview of indicative layout

Table 2.1 MDS for WTGs

Parameter	Specification for Layout
Foundation type	Piled jacket (WTG-type) / suction caisson jacket (WTG-type)
Dimensions at sea surface (dependent upon water depth, geology, and WTG type)	37.6 m sided equilateral triangle
Hub height	217.5 m
Maximum blade tip height (above Lowest Astronomical Tide (LAT))	370 m
Minimum blade tip height (above LAT)	42.43 m (40 m above Mean Sea Level (MSL))
Maximum rotor blade diameter	305 m

Table 2.2 MDS for other array area infrastructure

Structure	Number	Maximum Sea Surface Dimensions (m)
Offshore transformer substation	6	80×80
Offshore HVDC converter substation	3	150×150
Accommodation platform	1	60×60

2.3 Vessel Movements

13. During each phase of Hornsea Four a number of various project vessels will transit to and from Hornsea Four and undertake activities within the Hornsea Four array area. Table 2.3 outlines the indicative vessel numbers for construction activities, noting that further detail is provided within the NRA.

Table 2.3 Indicative Vessel Numbers per Construction Activity

Construction Activity	Number of Vessels	Number of Return Trips
WTG foundations	77	2,880
WTGs	38	900
Substation foundations (including accommodation platform)	18	180
Substation installation (including offshore accommodation platform	18	270
Inter array and interconnector cables	18	1,488
Export cables	24	408

14. During the operational phase, an indicative 1,433 return trips per year is assumed to be a worst case for shipping and navigation over an anticipated 35-year operational life for Hornsea Four.

2.4 Layout Principles

15. Table 2.4 presents the Hornsea Four ES Layout Principles.

Table 2.4 Layout Principles

Principle Number	Principle Description
Principle 1	All surface infrastructure shall be located within the Hornsea Four array area. No blade overfly or structural overhang is permitted outside of the Hornsea Four array area. The minimum distance from the centre of the WTGs to the Hornsea Four Order Limits is 150 m.
Principle 2	A minimum spacing of 810 m shall be maintained between the centre points of all surface infrastructure.

Principle Number	Principle Description
Principle 3	The layout shall include SAR access lanes to facilitate SAR asset access. These lanes shall be parallel to turbine rows on a minimum one line of orientation subject to a safety justification (for surface navigation and SAR) within the Hornsea Four array area and shall satisfy the minimum width of 500 m required by MGN 654 (MCA, 2021).
Principle 4	As per MGN 654, SAR access lanes shall allow a SAR asset to enter and exit the Hornsea Four array area on a consistent heading and without coming within a 250 m radius of any Hornsea Four surface infrastructure.
Principle 5	Dense boundaries are permitted around the Hornsea Four array area and shall comply with Principles 1, 2, 3 and 4.
Principle 6	If micro-siting WTGs, surface infrastructure may be positioned up to 50 m from the centre defining a turbine row. This is a maximum distance and any micro-siting required shall be included within this parameter and comply with Principles 1, 2, 3, and 4. Should geological constraints prevent a structure from being positioned within 50 m of the line defining a turbine row then the distance may be increased up to 150 m subject to agreement with the Marine Management Organisation (MMO), in consultation with Trinity House and the MCA. WTG positioning will comply with Principles 1, 2, 3, and 4.
Principle 7	Perimeter type boundaries around the Hornsea Four array area may be arranged in a curved line where required to manage the interrelationship with existing or proposed offshore infrastructure from third parties. This is subject to the degree of curvature being agreed with the MMO in consultation with Trinity House and the MCA. WTG positioning will comply with Principles 1, 2, 3, and 4.
Principle 8	As per MGN 654, Helicopter Refuge Areas (HRAs) shall be included within the Hornsea Four array area where SAR access lanes exceed circa 10 nm length and shall be perpendicular to the SAR access lanes. The width of the HRA shall be a minimum 1 nm measured from the centre point of surrounding infrastructure to centre point of surrounding infrastructure and with the length covering the extent of the Hornsea Four array area.
Principle 9	The minimum separation distance between the Hornsea Four array area and Hornsea Two Offshore Wind Farm array area will be no less than 2.2 nm as measured from the centre-point of WTGs.

2.5 Other Offshore Wind Farms within the Former Hornsea Zone

16. There are three other Offshore Wind Farms located in proximity to Hornsea Four and, therefore, considered relevant from a SAR perspective. Figure 2.2 presents the locations of these developments. Following this, Table 2.5 summarises the

approximate distances and status (at the time of writing) for each of these developments.

17. Hornsea Project One and Hornsea Project Two are adjacent developments and, therefore, as per the requirements of MGN 654 Annex 5, the lines of orientation for these two sites allow continuous passage through both wind farms. However, the size of the gap between Hornsea Four and Hornsea Project Two is considered large enough for a helicopter to re-orientate itself and therefore, it is not necessary for the final layout for Hornsea Four to continue the same line of orientation from Hornsea Project Two, as per consultation feedback from MCA (see 26th February 2020 entry in Table 3.1).

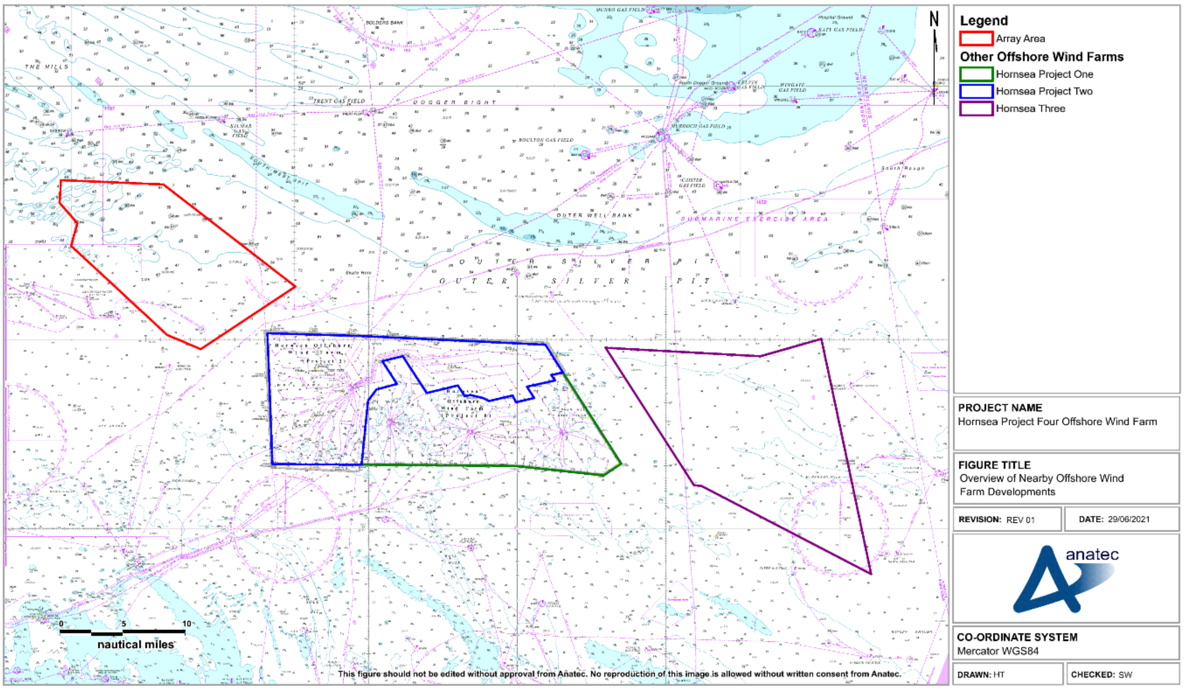

Figure 2.2 Overview of nearby offshore wind farm developments

Table 2.5 Summary of nearby offshore wind farm developments

Development	Distance from Hornsea Four[1] (nm)	Status
Hornsea Project One	9.1	Fully commissioned
Hornsea Project Two	1.9	Under construction
Hornsea Three	25	Consented

[1] Measured from Hornsea Four Order Limits to relevant site boundary.

3 Consultation

18. Table 3.1 presents a summary of the consultation to date pertaining to a layout containing SLoO.

Table 3.1 Consultation Summary

Consultee (Date)	Summary	Where Addressed within this Safety Justification
MCA (26th November 2018)	The proximity of Hornsea Four to other offshore wind farms will also need to be fully considered, with an appropriate assessment of the distances between OREI boundaries and shipping routes as per MGN 543 (now superseded by MGN 654). MCA would also welcome early discussion on the lighting and marking arrangements.	Other offshore wind farms located in proximity to Hornsea Four are considered throughout and, specifically, in Section 2.5.
DFDS Seaways (2nd April 2019)	No DFDS Seaways vessels intend to pass through Hornsea Project One where construction is ongoing, and no concerns have been raised. Even with a large spacing between structures DFDS Seaways vessels would not transit through the array.	Marine traffic is considered in Section 4.
VISNED (16th July 2019)	Entering the array, whether to fish or transit, is based on individual skipper's perception of risk. Fishermen are likely to follow the features of the seabed, and if not available, then follows any rows of WTGs.	Fishing vessels at Hornsea Four are considered in Section 4. Fishing vessels are also analysed at existing developments in Section 5. The risks of a layout containing a SLoO to fishing vessels are also considered in Section 9.
MCA (23rd September 2019)	The inclusion of a SLoO in the layout and continuation of the layout design from Hornsea Project One and Hornsea Project Two will require further discussion. Additionally, for the SLoO a detailed safety justification will be required for both surface navigation and SAR capability.	This document provides the safety justification required for Hornsea Project Four.
UK Chamber of Shipping (23rd September 2019)	The inclusion of a SLoO in the layout is a concern and it should be ensured that the MCA and Trinity House are content with the safety justification.	This document provides the safety justification required for Hornsea Project Four including specific points raised by the MCA and Trinity House (Section 1.3).
United Kingdom Major Ports Group (UKMPG) (25th September 2019)	Raised concerns regarding the possible practical constraints on access to the developed area for SAR resources.	SAR is considered within Sections 6, and 7.

Consultee (Date)	Summary	Where Addressed within this Safety Justification
DFDS Seaways (5th November 2019)	Inclusion of a navigation corridor can deal with the re-routeing concerns and is DFDS Seaways' preferred method for mitigating the commercial impact.	As this is a commercial issue it is not considered within this safety justification however re-routeing is considered within the Marine Traffic section within **Volume A2, Chapter 7: Shipping and Navigation**. However, it is noted that the layout now contains a gap between Hornsea Four and Hornsea Project Two which aligns generally with DFDS Seaways' main routes post construction of Hornsea Project Two as shown in Section 15 of **Volume A2, Chapter 7: Shipping and Navigation**, and this has been considered throughout from a safety perspective.
UK Chamber of Shipping (7th November 2019)	UK Chamber of Shipping queried if a safety justification would be prepared for the layout.	This report details the safety justification for the layout.
Danish Shipping (7th November 2019)	Noted they were reliant on MGN 543 (now superseded by MGN 654) to provide guidance and ensure that the project was compliant.	Section 1.2 lists the guidance considered within this safety justification including MGN 654 and its Annexes.
Sea Cargo (12th November 2019)	The Immingham-Tanager route used by Sea-Cargo would not be affected. The Immingham-Esbjerg route would be affected and require a deviation with north and south alternatives suggested; noting that vessels would not consider making passage internally through the array.	Internal navigation at existing arrays is considered in Section 5.
MCA and Trinity House (25th November 2019)	Trinity House queried the 150 m micro-siting within the Layout Principles.	Micro-siting will only be used if required due to geophysical constraints (see Section 8) and would not compromise the 500 m minimum width required for the SAR lanes as required by Layout Principle 3.
	The use of an HRA was discussed.	An HRA has been incorporated into the layout used within this safety justification (see Section 7).

Consultee (Date)	Summary	Where Addressed within this Safety Justification
	MCA noted that the safety justification is a bespoke document which: ▪ Draw out the relevant aspects of the NRA to support one line with regards to risk; ▪ Incorporate the results of any surveys undertaken to date with regards to seabed conditions and other constraints leading to support for the need for just one line of orientation in the layout design; ▪ Any additional lines of orientation or area where you could, or have, achieved improvements in the layout, which may not be consistent across the whole area; and ▪ Consideration of the impact on SAR with just one line of orientation.	Section 1.3 presents a summary of the specific guidance provided for Hornsea Four. The experience of internal navigation at existing arrays and passage planning are presented in Section 5. SAR at offshore wind farms including the historical incidents at Hornsea Four are presented in Section 6. Other constraints present within the array area are presented in Section 8. The impacts relevant for a SLoO have been considered in Section 9.
MCA and Trinity House (25th November 2019)	There is a strong preference to discontinue the layout set by Hornsea Project One and Hornsea Project Two by use of an HRA.	SAR lanes are presented in Section 7 noting that since this discussion a gap between Hornsea Four and Hornsea Project Two has been incorporated.
MCA and Trinity House (26th February 2020)	MCA noted that a gap between Hornsea Four and Hornsea Project Two would allow Hornsea Four to not be constrained to the same line of orientation as Hornsea Project One and Two.	SAR lanes are presented in Section 7.
MCA (28th May 2020)	Supportive of the gap between Hornsea Four and Hornsea Project Two both in terms of its benefit for vessels and SAR helicopter operations since it provides a HRA.	Acknowledged in Section 7.

4 Marine Traffic

4.1 Data Sources

19. The NRA includes a baseline review of the vessel traffic with a minimum 10 nm buffer of the Hornsea Four array area (the 'study area'). The dataset analysed consisted of a combined dataset of 28 days consisting of the following periods:

- 25th July to 7th August 2020 (14 days summer); and
- 24th February to 10th March 2021 (14 days winter).

20. Vessel traffic data for the winter period was collected from the *Karima* survey vessel located at the Hornsea Four array area and incorporates visual observations and Radar data in addition to AIS data. Vessel traffic data for the summer period consists of Automatic Identification System (AIS) data only, noting that additional data for summer was collected in July 2021 and is presented as a validation exercise in the NRA. With this additional dataset considered, the vessel traffic baseline satisfies the requirements set out in MGN 654, with the MCA consulted on the approach in February 2021.

4.1.1 Overview

21. Figure 4.1 and Figure 4.2 present the vessels, excluding temporary traffic (such as survey vessels), recorded intersecting the Hornsea Four array area during summer and winter, respectively.

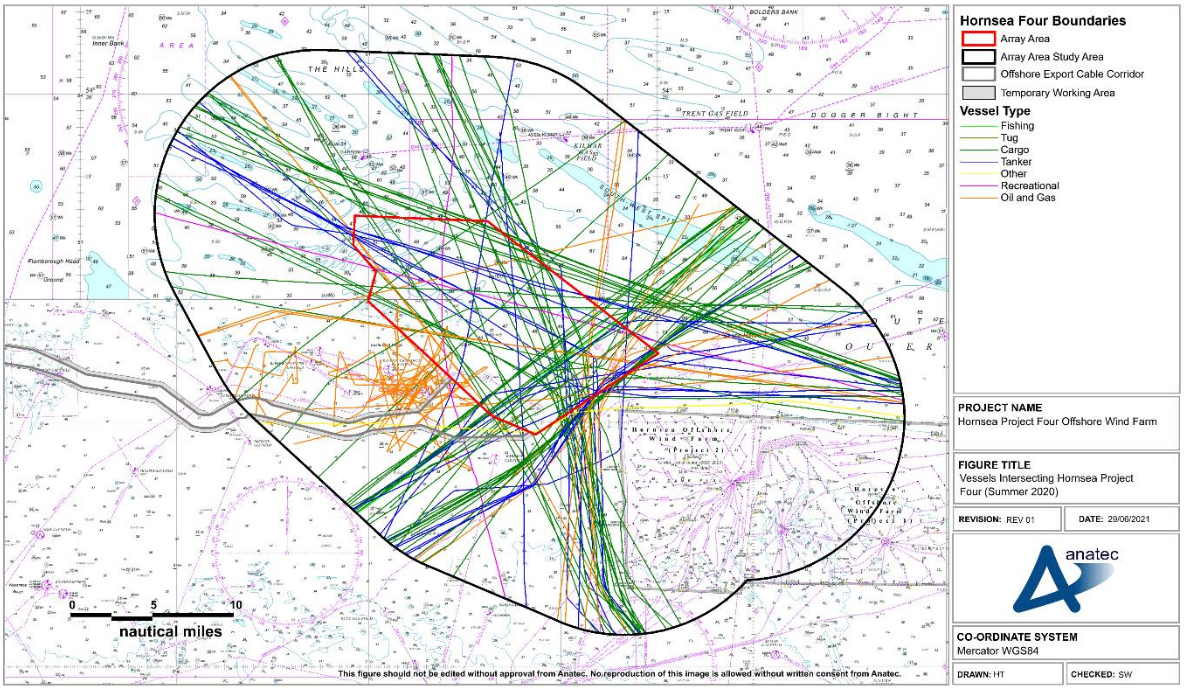

Figure 4.1 Vessels intersecting Hornsea Four (summer 2020)

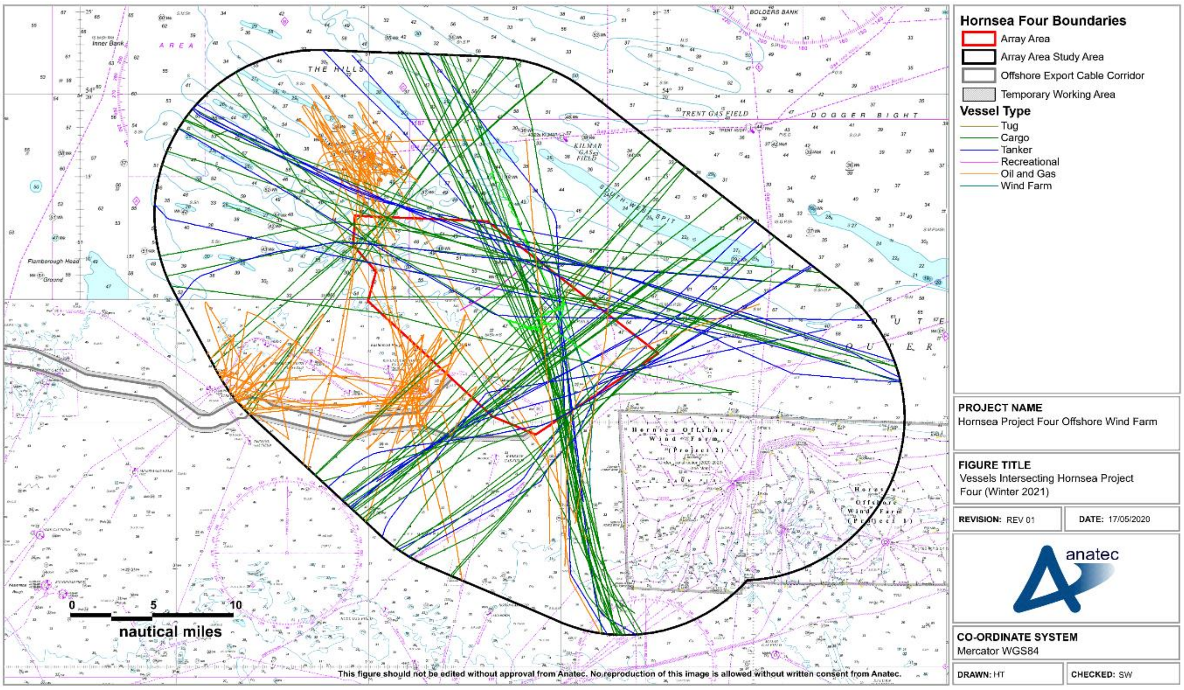

Figure 4.2 Vessels intersecting Hornsea Four (winter 2021)

22. During the summer survey period there was an average of seven unique vessels intersecting the Hornsea Four array area per day, with these vessels representing 14% of the traffic within the study area. The main types of vessels identified within the array area during the summer survey period were cargo vessels (56%), tankers

(21%), and oil and gas vessels (18%). Two recreational vessels and one fishing vessel were also recorded within the array area during the summer survey period.

23. During the winter survey period there was also an average of seven unique vessels intersecting the Hornsea Four array area per day, with these vessels representing 40% of the traffic within the array area study area. The main types of vessels identified in the array area during the winter survey period were cargo vessels (60%), tankers (18%), and oil and gas vessels (17%). One recreational vessel and two fishing vessels were recorded within the array area during the winter survey period.

4.1.2 Commercial Vessels

24. Although a number of commercial vessels were recorded during both survey periods within the array area, commercial operators indicated during consultation[2] that the vessels they operated would not intentionally enter the array and no regular route by these operators would plan to transit through the array.

4.1.3 Recreational Vessels

25. Figure 4.3 presents the recreational vessels recorded within the study area throughout the survey periods.

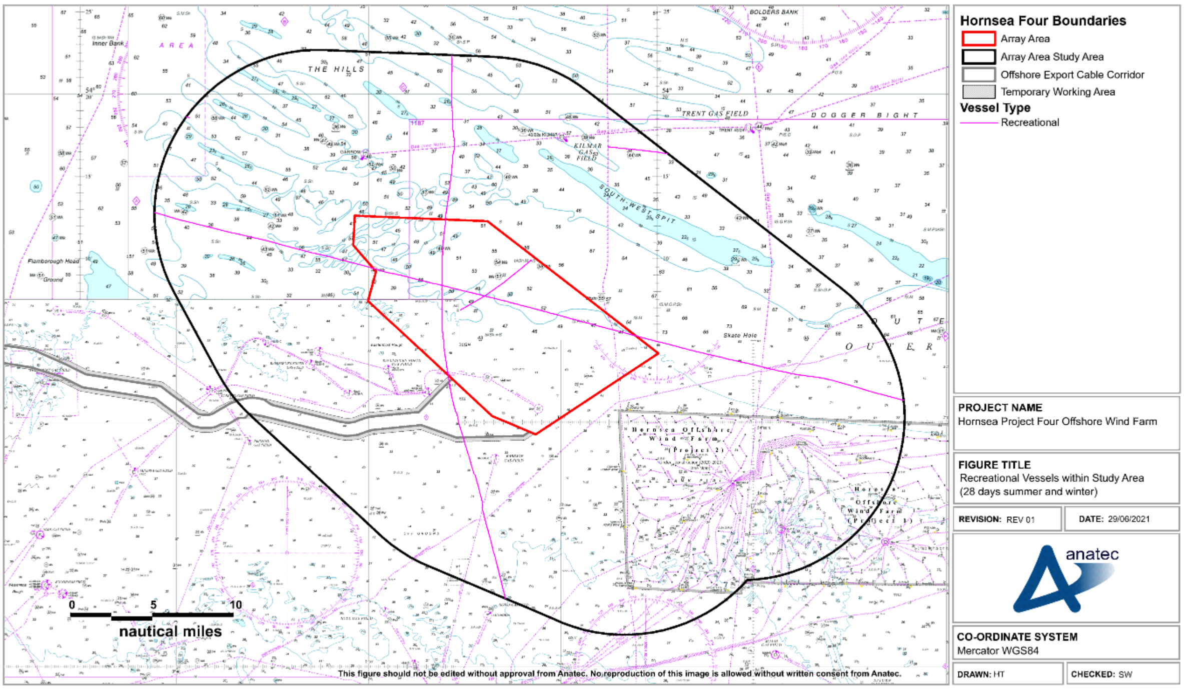

Figure 4.3 Recreational vessels within study area (28 days summer and winter)

[2] Regular Operators were identified from the vessel traffic surveys and only DFDS Seaways and Sea-Cargo provided feedback relevant to internal navigation within the array. The full list of Regular Operators identified is provided in Section 14 of **Volume A5, Annex 7.1: Navigational Risk Assessment**.

26. A limited volume of recreational traffic was identified throughout both survey periods with three recreational vessels identified during the summer survey period, and one recorded in the winter period. It is noted that the summer 2020 data presented within Figure 4.3 is AIS only and therefore could underrepresent non-AIS recreational activity within the study area. However, similar low level recreational activity was also recorded during the summer 2019 survey which also contained non-AIS traffic. The limited amount of recreational activity is likely due to the large distance Hornsea Four is located offshore. Therefore, it is expected that the recreational users that may choose to transit internally within the wind farm will be experienced, well-equipped mariners and, hence, less likely to require assistance as a result of human error.

4.1.4 Commercial Fishing Vessels

27. Figure 4.4 presents the commercial fishing vessels recorded within the study area throughout the survey periods.

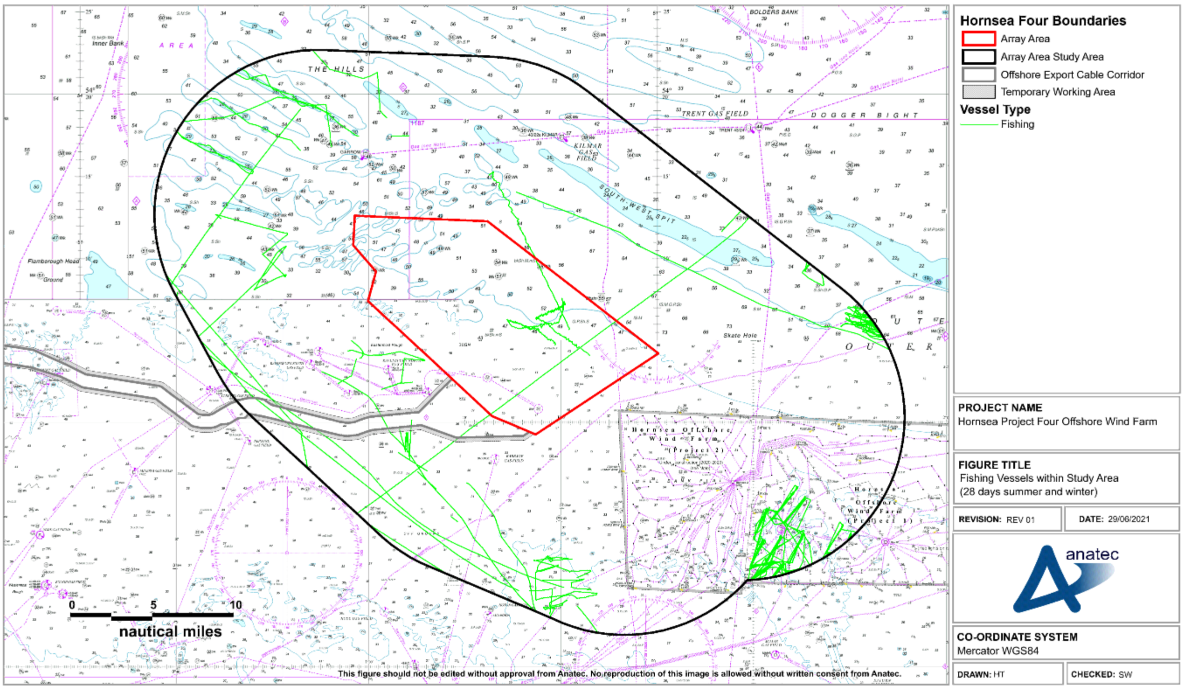

Figure 4.4 Commercial fishing vessels within study area (summer and winter)

28. An average of two unique commercial fishing vessels per day were recorded in the study area throughout the summer survey period compared to less than one per day during the winter survey period. Behavioural assessment of the commercial fishing vessels recorded within the array area indicated that these vessels were both actively fishing and transiting. The main gear types identified in the study area were potters/whelkers (54%) and twin trawlers (20%).

4.2 Traffic Density at Hornsea Developments

29. Table 4.1 summarises the density of vessel traffic recorded on AIS, visual and Radar during the NRA vessel traffic surveys undertaken for each of the Hornsea developments, noting that the data for each NRA was approved by the MCA.

Table 4.1 Traffic density within each of the Hornsea development array areas

Development	Surface Area of Array Area (nm^2)	Year(s) of Data Collection	Average Unique Vessels per Day Within Array Area			Traffic Density (Daily Vessels per nm^2)
			Summer	Winter	All	
Hornsea Project One	118	2011	12	13	12	0.10
Hornsea Project Two	134	2012	12	12	12	0.09
Hornsea Three	202	2016	15	13	14	0.07
Hornsea Four	136	2019	11	7	9	0.07
Hornsea Four	136	2021	9	7	8	0.06

30. The traffic density at all of the Hornsea developments are relatively similar with the lowest density present at Hornsea Four, noting that Hornsea Project One, Hornsea Project Two and Hornsea Three[3] have previously had layouts containing a SLoO agreed.

31. It is noted that the requirement for all fishing vessels of length greater than 15 m (Annex II of European Union (EU) Directive 2002/59/EC) was active when the data for Hornsea Four and Hornsea Three was collected whereas this was not the case during the Hornsea Project One and Hornsea Project Two data collections. Therefore, the vessel density at Hornsea Project One and Hornsea Project Two was potentially higher than the values presented in Table 4.1.

32. Although experience and knowledge of navigation by SAR assets within Offshore Wind Farms is increasing, the Applicant understands that precedence should not be set with respect to the number of lines of orientation in a layout. However, the vessel density at Hornsea Four is comparable to other developments within the Hornsea Zone which have also had layouts with a SLoO consented; therefore it is considered reasonable together with the other information presented within this safety justification for the layout of Hornsea Four to also be consented with a SLoO.

[3] An indicative layout for Hornsea Three with a SLoO was agreed as part of the examination process.

4.2.1 Anchoring Activity within Array Area

33. As part of the vessel traffic analysis undertaken in the NRA, an assessment was undertaken to identify anchoring activity within the study area. Vessels were deemed to be at anchor if they broadcast an "*at anchor*" status or the vessel was transiting at a speed of less than one knot (kt) for more than 30 minutes.

34. One vessel was identified as being at anchor within the study area, this was a bulk carrier anchored approximately 1.7 nm east of the Hornsea Four array area.

5 Internal Navigation at Existing Arrays

35. This section presents 12 months of AIS data covering 2019 from within existing wind farm arrays to demonstrate the current behaviour of vessels internally within arrays. It should be noted that vessels less than 15 m length overall are not legally required to carry AIS; therefore there may be additional vessels internally within the arrays not represented in the AIS data. To ensure the focus is on third-party vessels, wind farm related vessels have been removed from each of the figures presented in this section.

5.1 Passage Planning

36. Safety of Life at Sea (SOLAS) Chapter V (IMO, 1974) requires all vessels proceeding to sea to undertake a voyage (passage) plan. As with standard marine practice, SOLAS does not indicate any specific course or passing distance but instead indicates required good practice, such as taking due regard of your vessel and the conditions before proceeding to sea.

37. Regulation 34 of SOLAS specifically states that prior to proceeding to sea, the master of any vessel shall ensure that the intended voyage has been planned using the appropriate nautical charts and nautical publications for the area concerned, taking into account the guidelines and recommendations relevant to a flag state or maritime administration. This includes identifying a route which considers routeing systems, sea room, navigational hazards (such as offshore wind farms), and weather conditions.

38. The implementation of SOLAS and general good seamanship means that any vessel transiting through a wind farm array should plan accordingly including ensuring awareness of the structure locations and ongoing operations through Notifications to Mariners (for example).

39. As with any passage plan, the shortest safe route is often the most desirable. However, transiting between locations on a direct course (straight line) is seldom possible. Therefore, vessels will define a series of waypoints or markers to navigate between two points (these could be ports, fishing locations, anchoring locations or offshore structures for example). To achieve the desired track a vessel will have to steer a course to take account of tidal and weather conditions, as well as their chosen propulsion method to make manoeuvres as per the requirements of the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS). There is no regulation as to how often a vessel alters course or how many waypoints are in its journey passage plan.

40. When transiting through an array, it is a reasonable assumption that vessels again consider their start and finish points making alterations as required to navigate safely and efficiently through the array. There is no evidence to suggest that vessels will always follow a defined row or column and then alter outside of the array to continue

their journey. Instead, they are observed to choose a passage through an array that takes origin and terminus locations into consideration, which may involve altering course at optional points including within the array or transiting diagonally across rows or columns.

41. Some vessels, such as fishing vessels, may also navigate according to specific operations (e.g., fishing operations or fish movements). In such cases, the vessels are likely using defined waypoints such as structure positions (lights and marks), buoys or other markers to guide them, rather than rows and columns of structures.

5.2 Existing Arrays

5.2.1 London Array

42. London Array Offshore Wind Farm has been operational since 2013 and was consented within a busy and seasonal area for small craft. A specific buoyed navigational channel (through Foulger’s Gat) was designed in the position of an existing preferred route, although it does not form part of either of the primary lines of orientation in the array layout. The minimum turbine spacing at London Array is approximately 550 m. Twelve months of AIS data was collected whilst London Array was operational during 2019.

43. Figure 5.1 presents all the vessel tracks recorded internally within London Array throughout the 12-month period. The vast majority of vessels within London Array were recreational vessels and fishing vessels. A tug and an oil and gas vessel were also detected transiting through, noting that these tracks break within the array. A Royal National Lifeboat Institution (RNLI) lifeboat was also detected entering the array on two occasions.

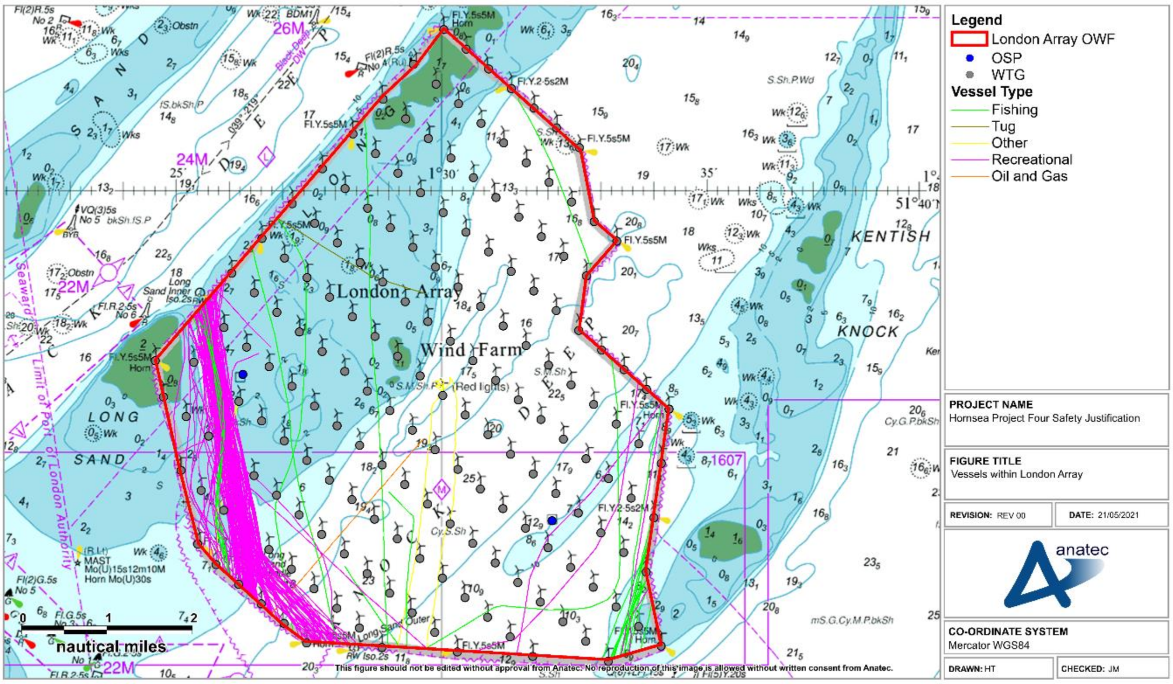

Figure 5.1 Vessels within London Array (2019)

44. During 2019, 138 recreational transits were recorded within London Array, the majority of which used a significant portion of Foulger's Gat to navigate through the array. Four recreational vessels transited without using Foulger's Gat, and not necessarily using any of the available lines of orientation. Furthermore, these transits were not necessarily in straight lines with vessels opting to deploy additional waypoints within the array.

45. There were 25 unique fishing vessels recorded within London Array, the majority of which broadcast a navigational status of "*not defined*". The other vessels recorded broadcast a navigational status of "*under way using engine*" and "*engaged in fishing*". A behavioural assessment confirmed that the majority of the "*not defined*" vessels were in transit. The majority of fishing vessels did not transit using Foulger's Gat or any of the available lines of orientation and some could be seen to set a waypoint within the array.

5.2.2 Beatrice Offshore Windfarm Ltd.

46. Beatrice Offshore Windfarm Ltd. (BOWL) is located within the Moray Firth and has been operational since 2018 noting that the Moray East Offshore Wind Farm, currently under construction, is located adjacent to BOWL. The minimum turbine spacing at BOWL is approximately 940m.

47. Figure 5.2 presents all the vessel tracks recorded internally within BOWL throughout the 12-month period. The majority of the traffic within BOWL were fishing vessels with a small number of recreational vessels.

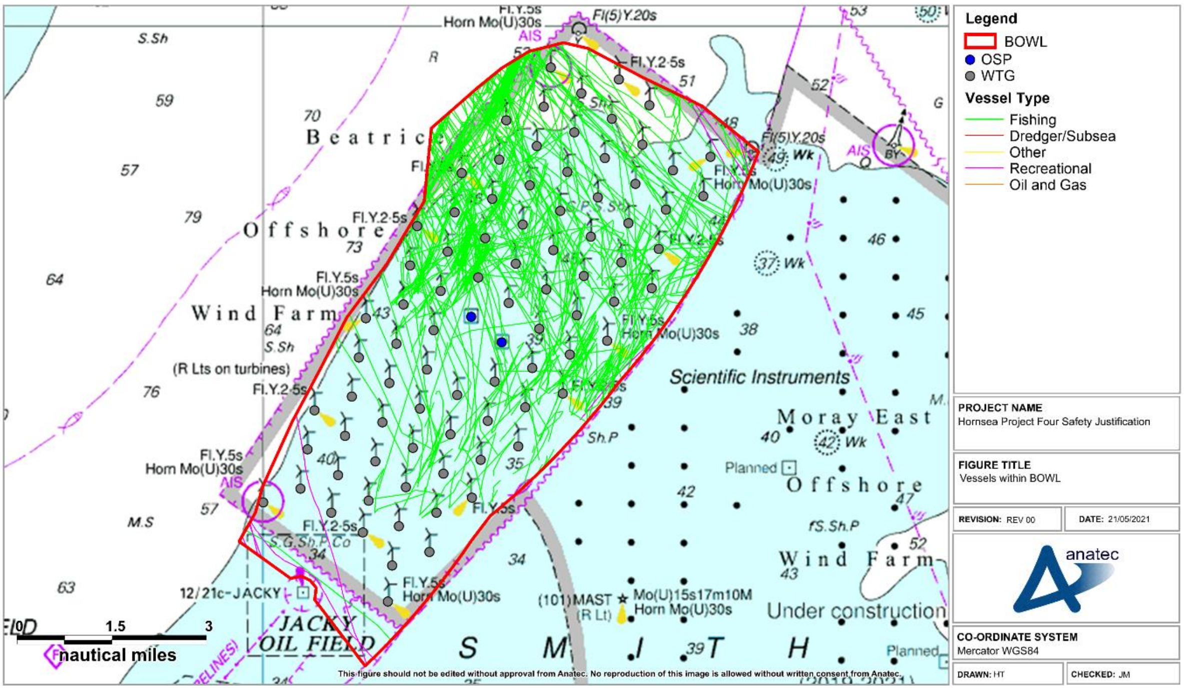

Figure 5.2 Vessels within BOWL (2019)

48. During 2019, 10 different fishing vessels were recorded within BOWL, including one fishing vessel regularly entering the array. The majority of the fishing vessels entering the array did not utilise any of the lines of orientation present when transiting with a significant number of these vessels deploying a waypoint within the array. A number of vessels were also actively engaging in fishing within the array, identified primarily based on a behavioural assessment.

5.2.3 Thanet

49. Thanet Offshore Wind Farm has been operational since 2010 and is located off the east coast of Kent. The minimum turbine spacing at Thanet Offshore Wind Farm is approximately 900m.

50. Figure 5.3 presents all the vessel tracks recorded internally within Thanet Offshore Wind Farm throughout the 12-month period. The majority of the traffic within Thanet were fishing vessels with recreational vessels also noted.

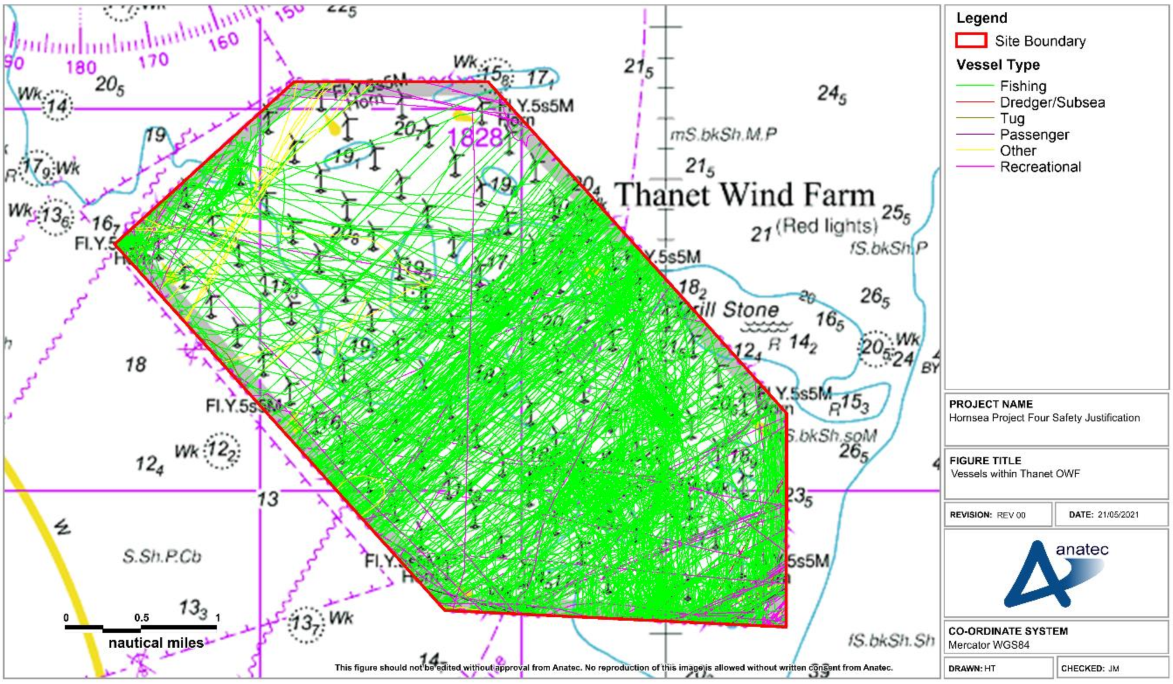

Figure 5.3 Traffic within Thanet (2019)

51. During 2019, there was an average of one fishing vessel per day and one recreational vessel every five days recorded within Thanet. The recreational vessels typically transited the array using a line of orientation. Fishing vessels were recorded both transiting and actively engaged in fishing (based on a behavioural assessment) within the array. Fishing vessels in transit generally transited through the wind farm in a straight line, but not necessarily using the lines of orientation of the wind farm.

5.2.4 Rampion

52. Rampion Offshore Wind Farm has been operational since 2018 and is located in the English Channel south of Brighton. The minimum turbine spacing at Rampion Offshore Wind Farm is 670m.

53. Figure 5.4 presents all the vessel tracks recorded internally within Rampion Offshore Wind Farm throughout the 12-month period. The majority of the traffic within Rampion were fishing vessels with recreational vessels also noted.

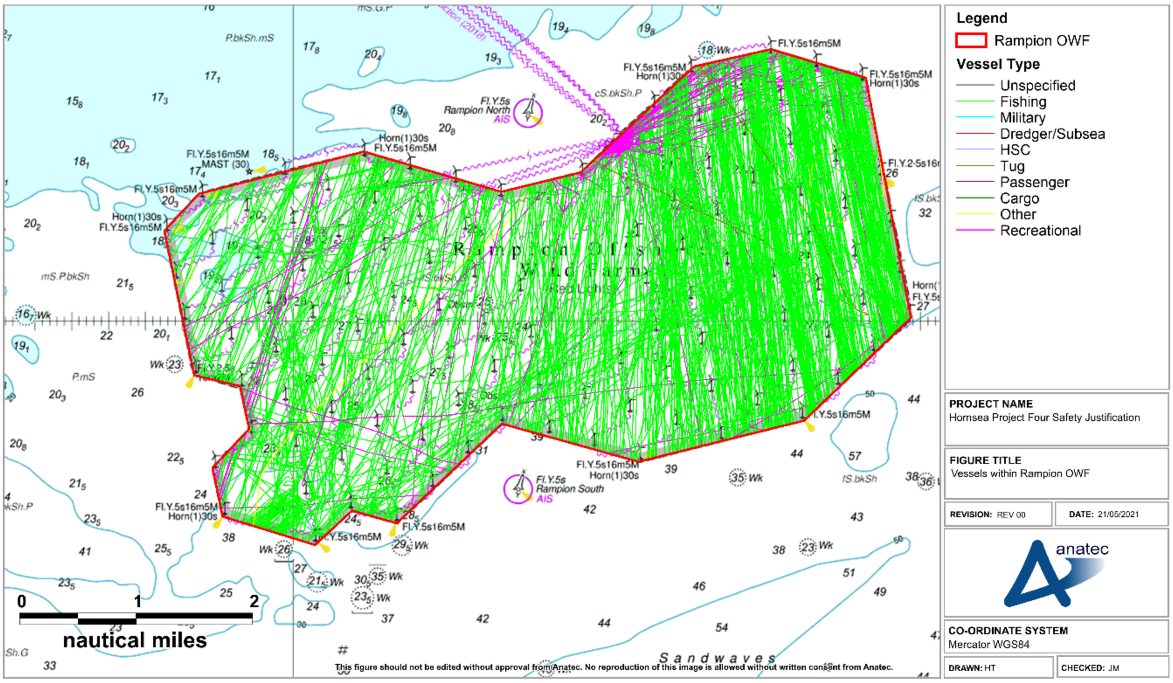

Figure 5.4 Vessels within Rampion Offshore Wind Farm 2019

54. During 2019, 52 unique recreational vessel transits were recorded within Rampion Offshore Wind Farm, some of which transited more than once. The majority of the recreational vessels did not transit using a line of orientation.

55. There was an average of between one and two unique fishing vessels per day recorded within Rampion Offshore Wind Farm. Fishing vessels tracks were indicative of both fishing vessels in transit and actively engaged in fishing (based on behavioural assessment and AIS destinations). Fishing vessels sometimes did not transit using any line of orientation and were observed deploying waypoints within the array. The passage of fishing vessels (in terms of heading) was principally dictated by the location of the port they were headed to/from (typically Shoreham).

5.2.5 Summary of Vessel Behaviour at Existing Arrays

56. The examples at existing offshore wind farms presented above give an indication of the types of vessels that transit through existing arrays and the routes they take through the arrays. Points of note regarding internal navigation within arrays include:

- Commercial shipping vessels avoid entering arrays. This is in agreement with numerous consultations undertaken for various offshore wind farms and post wind farm construction traffic monitoring reports;
- Most vessels that transit through offshore wind farms are small craft (recreational or fishing vessels);

- Vessels that transit through offshore wind farms often do not use the available lines of orientation within the array. Further, a number of vessels deploy waypoints within the array itself; and
- Some fishing vessels engage in fishing activities within existing offshore wind farms.

57. Although it is agreed that a grid layout does allow for straight transits following rows and columns of the grid to be undertaken, data from operational offshore wind farms indicates that this is not the only method of transit used, nor that it decreases the risk associated with vessels navigating internally within the array, noting to date there has only been one UK incident associated with a third-party vessel navigating internally within a wind farm array (see Section 6.7.2).

58. Therefore, it cannot be assumed that vessels that choose to navigate internally within Hornsea Four will do so using any line of orientation. Furthermore, as Hornsea Four will have a greater spacing between WTGs in comparison to the majority of the pre-existing sites, this should allow vessels that choose to deploy waypoints within the array to have more sea room available to safely place these waypoints between WTGs.

6 Search and Rescue at Offshore Wind Farms

59. No current experience, at the time of writing, exists with SAR aviation operations in UK offshore wind farms. Currently, two trials have been conducted; the first trial (Section 6.2) was conducted over Loch Ness to determine the turning radius of helicopters under various conditions. The second trial (Section 6.3) was conducted whilst Hornsea Project One was under construction to determine the most effective way to conduct a search within a large array.

60. Extensive technical assessments[4] were undertaken on the impact of Hornsea Three on the ability of SAR helicopters to undertake operations within the array area, led by Mark Prior, SAR Helicopter Specialist. Noting the similarities between Hornsea Four and Hornsea Three (distance offshore, proposed implementation of a SLoO, sea area of project, internal spacing (noting Hornsea Four's greater spacing)), many of the conclusions from these technical assessments are considered relevant to Hornsea Four.

6.1 Mark Prior Biography

61. Mark Prior is a highly experienced aviation professional with a wide range of expertise in certification, safety analysis, investigation, operations, technical issues, and regulations. Mark has over 38 years' experience as a pilot, initially in the Royal Air Force (RAF), then as a licensed civil pilot with concurrently 25 years of experience as an Experimental Test Pilot. Since 2003, Mark has been an industry representative on a number of rule-making, operational and research groups including working at the forefront of SAR within offshore wind farms.

6.2 Turning within the Array

62. The MCA provided data from a trial conducted by their SAR helicopter contractor over Loch Ness, Scotland to Orsted for the Hornsea Three safety justification for a SLoO. It should be noted that the following concerns were raised at the time:

- An image provided seemed to show turns at an inconsistent angle of bank as the orbits were not round, despite it being stated that the turns were flown in zero wind; and
- The diameters of the turns are not being measured accurately.

63. Two diagrams were provided later by the MCA showing turning performance during a second trial. The conditions the turns were performed in, and the resultant radius required for the turn are summarised in Table 6.1, noting that the angle quoted for the wind is to the right of the tracks. All radii quoted for the turns agreed with Orsted's calculations at the time.

[4] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-000582-HOW03_6.5.7.1_Volume%205%20-%207.1%20-%20Navigational%20Risk%20Assessment.pdf

Table 6.1 Parameters and results from Loch Ness SAR trials

Wind Speed (kt)	Angle of Wind (Degrees (°))	Angle of Turn (°)	Radius of Turn
40	30	180	0.12 nm (230 m)
40	90	180	0.10 nm (190 m)

64. Meteorological ocean data, also used within the NRA, from a meteorological mast located at the nearby Hornsea Project One, indicates that the proportion of the wind at speeds greater than 40 kt when the visibility is below 1,000m (i.e. very poor) is low. Seven years of data from Hornsea Project One, sampled at 10-minute intervals, indicated a probability of 0.0166% of strong winds and poor visibility occurring concurrently. This is supported by data from the J6A platform, adjacent to Hornsea Three, where one year of data showed no occurrences of windspeeds above 30 kt and visibility below 1,000m.

65. The visibility present is also an important factor to the safe operations of helicopters. The European Aviation Safety Agency (EASA) Part Standardised European Rules of the Air (SERA) is used for guidance as to the speeds flown against visibility. Although an advisory airspeed is provided, this is really the ground speed, as that determines the closure rate with obstacles. Table 6.2 gives the recommended speeds for differing levels of visibility. As can be seen in Table 6.2, the advisory speed decreases as the visibility decreases therefore turns performed in lower visibilities will have smaller turning radii.

Table 6.2 EASA Part SERA recommended speeds

Visibility (m)	Advisory Speed (kt)	Time to cover "visible distance" at "advisory speed" (seconds)
800	50	31
1,500	100	29
2,000	120	32

6.3 Flying Within a Large Array

66. A trial was undertaken at Hornsea Project One in May 2019 while it was under construction, specifically to identify any problems that could arise from a SLoO and to identify potential general mitigation measures.

67. A concern that was raised by multiple SAR crews was that in poor conditions (i.e., those conditions where the visibility is low and cloud base is low) transition through the array could become difficult and as a result of the crew focussing on flying an

ineffective search may occur. However, this could be partially mitigated, as referenced in the report, if communication is maintained with other assets (project vessels and/or Marine and Helicopter Coordination Centre (MHCC)) then this would assist routeing through the wind farm, hence making the search more effective. It is intended that Hornsea Four will use the same MHCC as Hornsea Project One and Hornsea Project Two. This will further assist crews, as communication would not have to be switched to a different MHCC when flying from one array to another.

68. Another point was raised that the safest and, potentially, an effective way to search for a person would be to search from above the array noting this would require the cloud coverage to be higher than the maximum blade tip height above LAT which is 370 m at Hornsea Four.

69. Figure 6.1 presents data from 2018 at Hornsea Four when the cloud base is less than 500 m, whilst the visibility is also less than 1000 m.

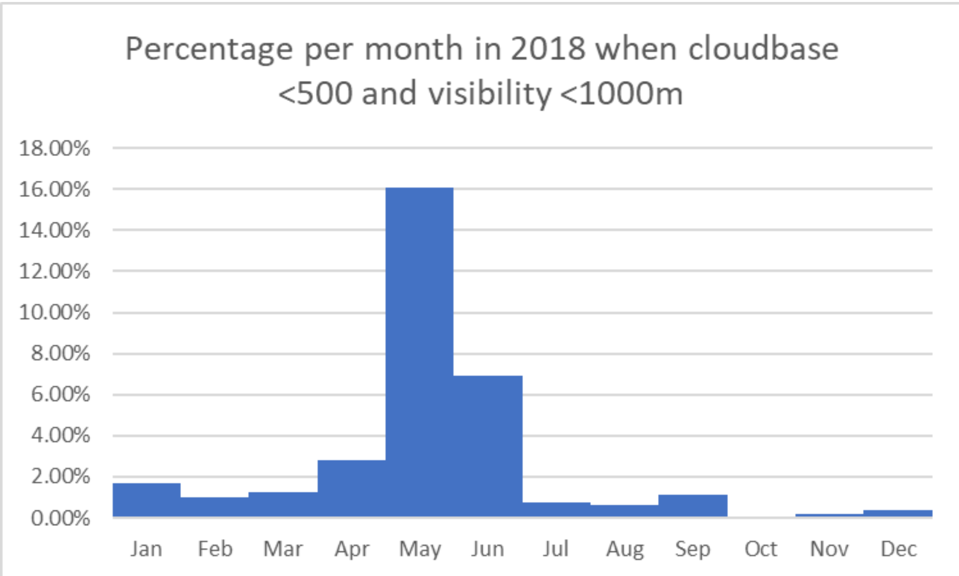

Figure 6.1 Percentage per month when cloud base was less than 500 m and visibility was less than 1000 m (2018)

70. Figure 6.1 shows that there is only a small proportion across the entire year when the cloud base is below 500 m and visibility is less than 1000 m, indicating that a search from above the array would not be viable. Therefore, if an incident were to occur the weather conditions are likely to permit a helicopter to search from above the array safely. It is noted that if a rescue were required following such a search then the helicopter would have to enter the array, i.e. be at the same altitude as the structures within the wind farm.

6.4 SAR Helicopter Response Times

71. The closest SAR helicopter base to Hornsea Four is Humberside Airport. This base is operated by Bristow Helicopters on the behalf of the MCA, using two Sikorsky S92A SAR helicopter.

72. UK helicopter SAR crews are typically at 15 minutes notice to launch during the day and 45 minutes at night. The distance from Humberside Airport to the nearest point of the Hornsea Four array area is approximately 58 nm and the typical speed of an S92A is 143 kts, so the expected time on scene for a SAR helicopter in the area would be:

- Day: 15 minutes + ((58/143) × 60) = **39 minutes**; and
- Night: 45 minutes + ((58/143) × 60) = **69 minutes**.

73. Based on the expected time it would take for a SAR helicopter to arrive on-scene and the number of project vessels both at Hornsea Four and the neighbouring Hornsea developments, it is likely that the search for the missing person would be at a developed stage once the SAR helicopter arrives, particularly due to the longer launch time at night.

6.5 Fixed Wing Assets

74. The RAF has recently (February 2021) (flightglobal, 2021) received the fifth of nine P8-A Poseidon Maritime Patrol Aircraft with a further four to be received. These aircraft will be based at the RAF base at Lossiemouth approximately 253 nm from the north western side of Hornsea Four. The maximum speed of a P8-A Poseidon Maritime Patrol Aircraft is 907 kilometres per hour (km/h); therefore it will take the aircraft approximately 31 minutes to arrive at Hornsea Four. The aircraft has a suite of highly sophisticated sensors, a high-speed search speed (approximately 440 kt) and would search above the structures within the array. Due to these fixed wing assets searching above the array their search effectiveness would not be affected by a SLoO layout. It is noted that these aircraft would not have the capability to rescue a person or help a vessel in distress but would be able to identify its location for other assets to assist.

75. Furthermore, the MCA have dedicated King Air assets equipped with SAR and Electro-Optical (EO) devices based at Doncaster Airport which could be the first asset on-scene in the event of an incident.

6.6 Minimum Spacing

76. Table 6.3 presents the minimum spacing at a number of the larger operational, under construction and consented offshore wind farms in the UK. It is noted that the minimum spacing at offshore wind farms has, generally, been increasing since 2003 as demonstrated in Figure 6.2. Minimum spacing values are based on distances

obtained from United Kingdom Hydrographic Office (UKHO) Admiralty Charts, or if not available the values submitted within the respective NRA.

Table 6.3 Minimum spacing at UK offshore wind farm developments

Development	Minimum Turbine Spacing (m)	Increase in Minimum Turbine Spacing at Hornsea Four (%)
Hornsea Project One	878	20
Hornsea Project Two	924	16
East Anglia One	675	39
Walney Extension	737	33
London Array	650	41
Hornsea Three	1,000	9
Hornsea Four	1,100[5]	-

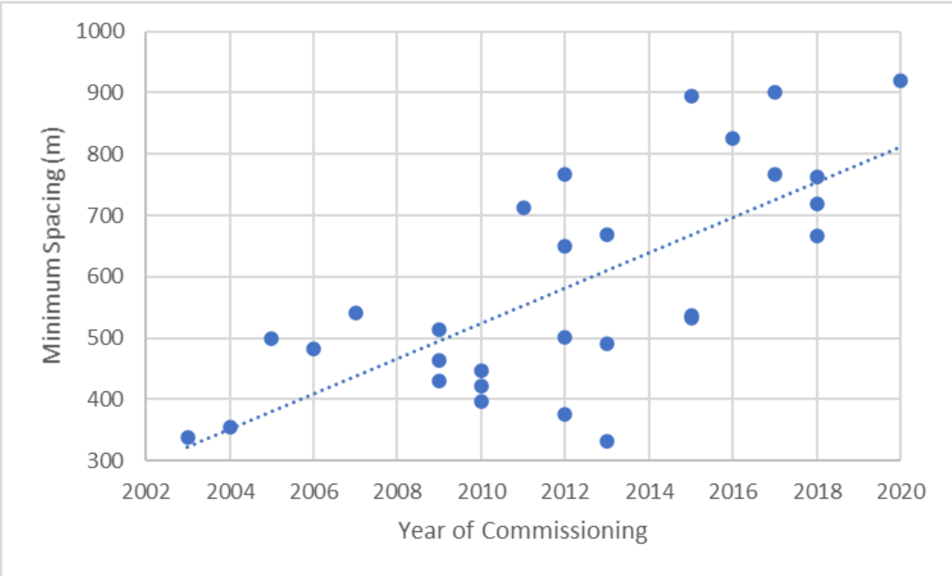

Figure 6.2 Minimum spacing at commissioned UK offshore wind farms (where available)

77. Hornsea Four will have a larger minimum spacing than any operational or under construction offshore wind farm to date. This greater minimum spacing should increase the safety for vessels transiting through the array whilst not using the SLoO

[5] The minimum spacing for Hornsea Four is 810 m, as set out in **Volume A4, Annex 4.7: Layout Principles**. The 1,110 m spacing refers to the spacing of the indicative layout (Figure 2.1) of which this safety justification is based upon.

as has been observed to occur regularly at existing offshore wind farms (see Section 5).

6.7 Historical Incidents

6.7.1 Hornsea Four

78. The NRA considers historical data from three sources:

- Marine Accident Investigation Branch (MAIB) incident data from (2010 to 2019);
- RNLI incident data (2010 to 2019); and
- Department for Transport (DfT) UK civilian SAR helicopter taskings (April 2015 to March 2020).

79. No incidents responded to by the RNLI were recorded in the study area, which reflects that the RNLI primarily respond to incidents closer to shore.

80. The MAIB incident data indicated 11 unique incidents that occurred within the study area with one of these occurring within the array area itself. The most common incident types within the study area were "*accidents to person*" and "*machinery failure*". These incidents are presented in Figure 6.3, colour-coded by incident type.

81. A total of 22 SAR helicopter taskings were undertaken within the study area, none of which occurred within the array area itself. These incidents are presented in Figure 6.4, colour-coded by tasking outcome. Most of the taskings involved a *"Rescue/Recovery"* (91%) with the majority (86%) completed.

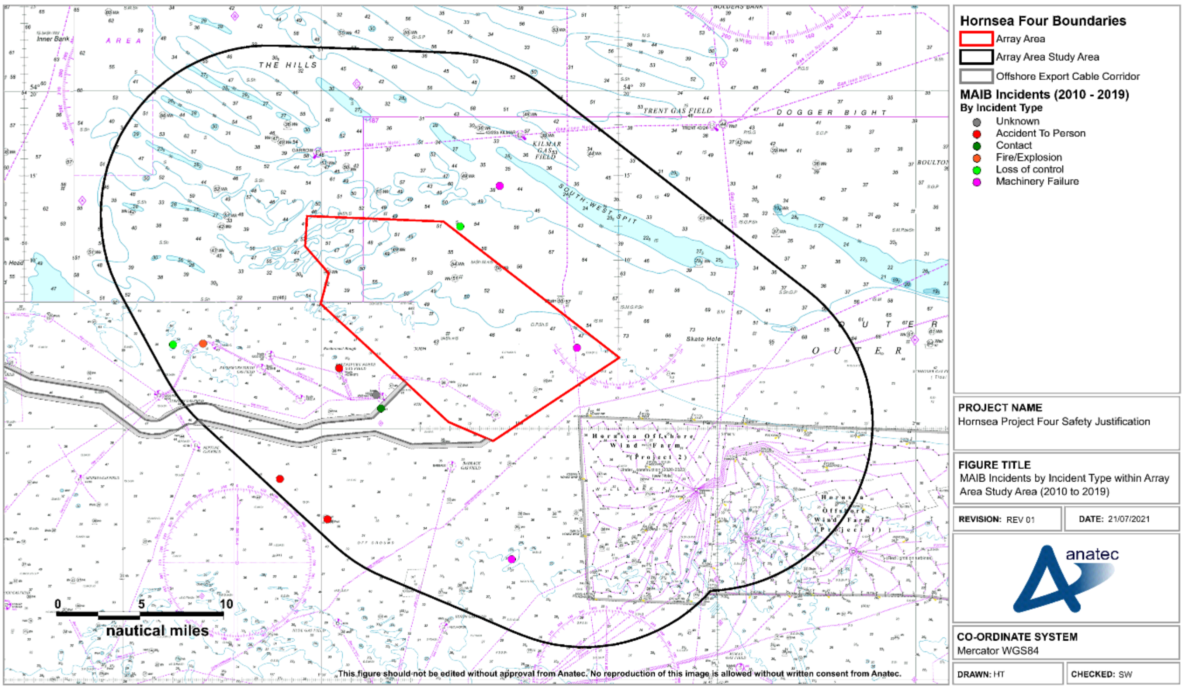

Figure 6.3 MAIB Incidents by Incident Type within Array Area Study Area (2010 – 2019)

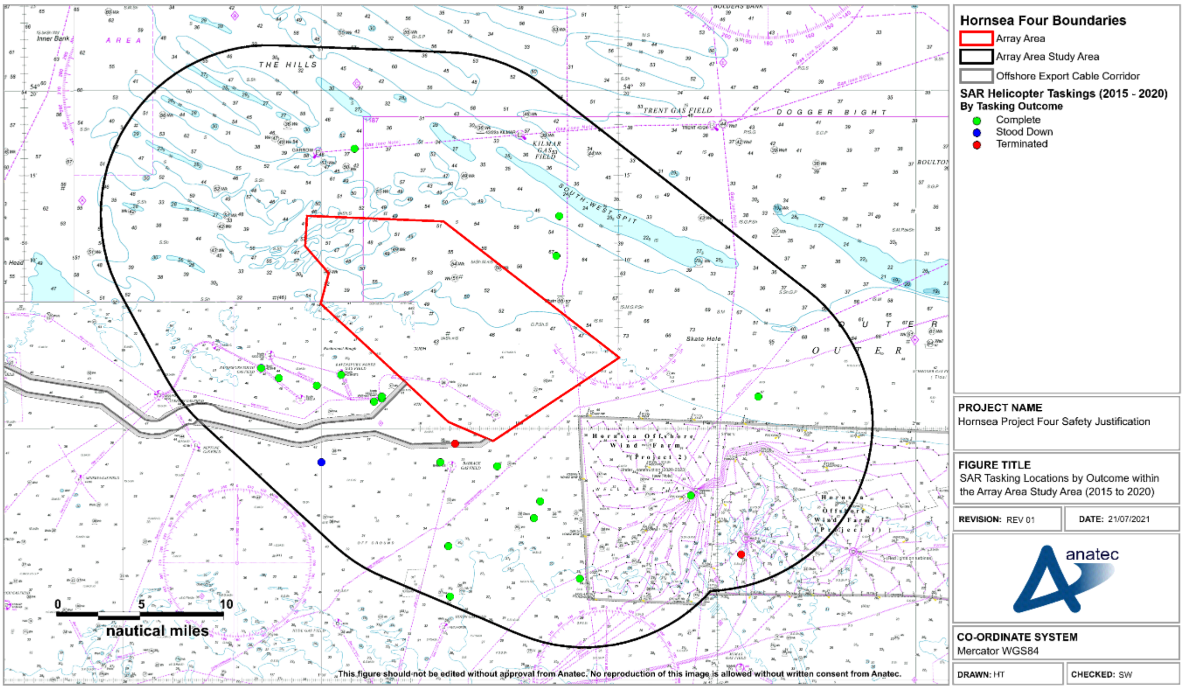

Figure 6.4 SAR Tasking Locations by Outcome within the Array Area (2015 to 2020)

82. The incident that occurred within the array area involved a general cargo vessel experiencing a main engine turbo charger failure in 2011. The vessel was able to reach the pilot station of her next port without assistance.

6.7.2 Other Wind Farms

83. As of July 2021, there are 39 fully commissioned and operational Offshore Wind Farms in the UK with these developments consisting of 16,200 fully operational WTG years. As of July 2021, there have been nine reported[6] allision incidents between a vessel and a WTG with all but one involving a service vessel for the development and the errant vessel under power rather than drifting. Therefore, there have been an average of 1,800 years per WTG allision incident in the UK, noting that this is a conservative calculation given that only operational WTG hours have been included (whereas allision incidents counted include non-operational WTGs). A summary of the historical collision and allision incidents involving UK Offshore Wind Farm developments is presented in Table 6.4.

[6] Reported to an accident investigation branch or an anonymous reporting service. Unconfirmed incidents have not been considered noting that to date only one further alleged incident has been rumoured but there is no evidence to confirm.

Table 6.4 Summary of historical collision and allision incidents involving UK offshore wind farms developments

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage*	Harm to Persons	Source
Project	Allision – project vessel with WTG	7th August 2005	A vessel involved with the installation of WTGs underestimated the effect of the current and allided with the base of a WTG whilst manoeuvring alongside it. Minor damage was sustained to a gangway on the vessel, the WTG tower, and a WTG blade.	Minor damage to gangway on the vessel	None	MAIB
Project	Allision – project vessel with WTG	29th September 2006	When approaching a WTG, an offshore services vessel was struck by the tip of a WTG blade which was rotating rather than secured in a fixed position.	None	None	MAIB
Project	Allision – project vessel with disused pile	8th February 2010	The Skipper on-board a work boat slipped their hand on the throttle controls whilst in proximity to a disused pile. There was insufficient time to correct the error and the vessel struck the pile. A passenger moving around the interior of the vessel was thrown off his feet. Although not known at the time, the passenger was later diagnosed with back injuries. No serious damage was caused to the vessel.	Minor	Injury	MAIB
Project	Collision – third party vessel with project vessel	23rd April 2011	A third-party catamaran was hit by a project guard vessel within a harbour.	Moderate	None	MAIB
Project	Allision – project vessel with WTG	18th November 2011	The Officer of the Watch (OOW) on-board a cable-laying vessel fell asleep and woke to find the vessel inside a wind farm. He attempted to manoeuvre the vessel out of the wind farm on autopilot but the settings did not allow a quick turn and the vessel struck the foundations of a partially completed WTG. The vessel suffered two hull breaches.	Major	None	MAIB

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage*	Harm to Persons	Source
Project	Collision – project vessel with service vessel	2nd June 2012	A Crew Transfer Vessel (CTV) became lodged under the boat landing equipment of a flotel. Nine persons were safely evacuated and transferred to a nearby vessel before being brought back into port.	Moderate	None	UK Confidential Human Factors Incident Reporting Programme (CHIRP)
Project	Allision – project vessel with WTG	20th October 2012	The OOW misjudged the distance from a WTG monopile and made contact with the vessel’s stern resulting in minor damage.	Minor	None	MAIB
Project	Allision – project vessel with buoy	21st November 2012	A wind farm passenger transfer catamaran struck a buoy at high speed whilst supporting operation for an offshore wind farm. The vessel was abandoned by the crew of 12 with the vessel having been holed, causing extensive flooding. There were however no injuries. It was found that the Master had unknowingly altered the vessel’s course and had not been formally assessed to determine his suitability for the role.	Major	None	MAIB
Project	Allision – project vessel with WTG	21st November 2012	A work boat allided with the unlit transition piece of a WTG at moderate speed. The impact caused all five persons on-board to be forced out of their seats. The vessel was able to proceed to port unassisted with no water ingress incurred, although there was some structural damage. It was found that the vessel’s Master had relied too heavily on visual cues and there had been insufficient training with navigation equipment. The WTG transition piece had been reported as unlit although the defect reporting system had failed to promulgate a navigation warning.	Moderate	None	MAIB

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage*	Harm to Persons	Source
Project	Allision – project vessel with WTG	1st July 2013	After disembarking passengers at an offshore substation, a service vessel's jets were disengaged, but the vessel jet drive suffered a failure which resulted in an allision with a WTG foundation. The vessel suffered some damage whereas the WTG foundation was not damaged.	Minor	None	International Marine Contractors Association (IMCA) Safety Flash
Project	Allision – project vessel with WTG	14th August 2014	A standby safety vessel allided with a WTG pile and consequently leaked marine gas oil and a surface sheen trailed from the vessel. Under its own power the vessel moved away from environmentally sensitive areas until the leak was stopped.	Minor with pollution	None	UK CHIRP
Third party	Allision – fishing vessel with WTG	26th May 2016	A crew member on-board a fishing vessel left the autopilot on, resulting in an allision with a WTG. A lifeboat attended the incident.	Moderate	Injury	Web search (RNLI, 2016)
Project	Allision – project vessel with WTG	16th January 2020	A project vessel servicing a number of WTGs allided with a WTG whilst transiting back to port resulting in a member of the crew coming into contact with the railings. The vessel proceeded unaided back to port where the man was subsequently taken to hospital to obtain doctors' advice.	None	Injury	Web search (Vessel Tracker, 2020)

6.8 SOLAS Obligations

84. Annex 5 of MGN 654 includes the following:

"International practice for SAR response to persons in distress at sea includes alerting and notifying the nearest vessel(s) (this includes small vessels e.g., fishing vessels and leisure craft) to an incident location and asking them to render assistance in accordance with SOLAS (IMO, 1974) regulations."

85. In the case of an incident internally within the Hornsea Four array area, a passing vessel may be obliged to navigate through the structures to render assistance in accordance SOLAS (IMO, 1974) obligations. In such case two lines of orientations may be helpful for larger vessels navigating the array area. However, there is anticipated to be approximately 1,433 return trips per year by operation and maintenance vessels with a number of these vessels being CTVs which are small and, hence, could comfortably navigate internally within the array as demonstrated by the behaviour of smaller vessels at existing arrays (see Section 5). Furthermore, the neighbouring Hornsea Project One and Hornsea Project Two have (or will have) on-site vessels during the operational phase which could render assistance with some of these also comprising of CTVs.

86. Additionally, there are a number of oil and gas platforms located in proximity to the Hornsea Four array area which, based on the vessel traffic survey data (see Section 15 of **Volume A5, Annex 7.1: Navigational Risk Assessment**), regularly have affiliated support vessels. These include platforms associated with the Ravenspurn, Babbage, Garrow, and Kilmar gas fields in addition to others further afield. Although, these vessels are third-party vessels, if they were required to enter the array under SOLAS obligations they have highly trained crews with experience of operating in proximity to surface infrastructure. Therefore, it is anticipated that such vessels would not have significant difficulties navigating within the array to render assistance if required.

87. Table 6.5 presents details of incidents which have occurred where a vessel associated with a nearby offshore wind farm has rendered assistance. It is noted that the initial cause of these incidents is not related to the offshore wind farm in question.

Table 6.5 Summary of historical incidents responded to by vessels associated with UK offshore wind farm developments

Incident Type	Date	Related Development	Description of Incident	Source
Capsize	21st June 2018	Walney Offshore Wind Farm	Following the capsize of a trimaran Her Majesty's Coastguard (HMCG) Holyhead issued a mayday relay broadcast requesting any vessels in the area assist. A support vessel for Walney arrived just in time to recover two persons from the water. Due to adverse conditions, the two persons were winched onboard a Coastguard helicopter and taken to shore.	Web search (4C Offshore, 2018)
Capsize	5th November 2018	Race Bank Offshore Wind Farm	A fishing vessel capsized after losing electrical power resulting in two fishermen in the water. A Belgian military helicopter spotted the casualties and dropped a life raft to assist before guiding the RNLI to the location. A vessel operating at the nearby Race Bank was also reported to have helped with the rescue.	Web search (British Broadcasting Corporation (BBC), 2018)
Vessel in trouble	15th May 2019	London Array Offshore Wind Farm	A yacht encountering difficulties in the Thames Estuary sought shelter by tying up to an offshore wind turbine. The alarm was raised by a wind farm support vessel which came across the secured yacht. The support vessel contacted the Coastguard who tasked Margate's RNLI All-Weather Lifeboat (ALB) to assist but while on passage to the casualty position the yacht suffered further damage including the loss of its single mast. At one stage the person aboard the yacht entered the water, but was recovered by the wind farm support vessel. With concern of the effects of cold water immersion the Coastguard instructed the support vessel to return to Ramsgate and seek medical assistance for the yacht's occupant.	Web search (The Isle of Thanet News, 2019)
Drifting	7th July 2019	Gwynt y Môr Offshore Wind Farm	A wind farm support vessel responded to an 'all-ships' broadcast from the Coastguard to help four people stranded on a broken down speedboat following a day of fishing south east off North Wales. The vessel went to the speedboat's aid to prevent it drifting into the Gwynt y Môr array, according to the Rhyl RNLI, and later towed the boat back towards Rhyl where it met the ALB about 10 kilometres (km) north of the harbour. The lifeboat took over the tow and brought the casualties aboard.	Web search (Renews, 2019)

Incident Type	Date	Related Development	Description of Incident	Source
Machinery failure	28th September 2019	Race Bank Offshore Wind Farm	A nearby fishing vessel lost all engine and electrical power and launched flares. The guard vessel and Service Operation Vessel (SOV) for Race Bank both immediately offered assistance until the MCA's arrival on-scene.	Internal daily progress report received by Anatec
Vessel in trouble	13th December 2019	Race Bank Offshore Wind Farm	A vessel passing Race Bank got into difficulty and the guard vessel for Race Bank was requested to assist. Once control of the situation was established, the Humber Coastguard requested that the guard vessel tow the casualty vessel into Grimsby.	Internal daily progress report received by Anatec
Search	21st May 2020	Walney Offshore Wind Farm	The guard vessel for Walney was contacted by HMCG Holyhead in the early hours of the morning reporting a red flare sighted at the wind farm. The vessel proceeded to undertake a search but did not find anything to report.	Internal daily progress report received by Anatec
Aircraft crash	15th June 2020	Hornsea Project One	A United States (US) jet operating out of RAF Lakenheath in Suffolk crashed into the North Sea during a routine training flight, approximately 74 km off the coast. Following a mayday call, the RNLI launched lifeboats from Bridlington and Scarborough and the Coastguard launched a helicopter from Humberside. A CTV and SOV for the construction of Hornsea Project One headed to the area to assist in the search for the missing pilot. The pilot was later found but was deceased.	Web search (4C Offshore, 2020)
Fire/ explosion	15th December 2020	Dudgeon Offshore Wind Farm	The crew of the SOV for Dudgeon, in cooperation with the developer's medic and technicians, rescued seven fishermen in distress near the wind farm. The fishing vessel experienced explosions on board, and all seven fishermen were "*seriously injured*". The SOV deployed its Fast Rescue Boat (FRB) and started evacuating the fishing vessel. Meanwhile, the SOV's remaining crew prepared to receive the injured.	Web search (Offshore WIND, 2020)

6.9 Summary and Conclusion

88. Given the anticipated vessel support available at Hornsea Four and the neighbouring developments (see Section 6.8) and the approximate helicopter response times (see Section 6.4) it is highly probable that a vessel associated with a nearby development would be the first to render assistance in the case of an incident internally within the array noting that the frequency of historical incidents in proximity to the Hornsea Four array area is relatively low (see Section 6.7). Therefore, it is extremely unlikely that a third-party vessel would be required to enter the array area under any SOLAS obligations as first responder.

89. Based on the trials undertaken to date (see Sections 6.2 and 6.3) and the large minimum spacing that will be present at Hornsea Four compared to other operational developments (see Section 6.6), it is considered that should a helicopters, be required, to enter Hornsea Four it will be able to safely enter the array and perform a search safely and effectively. Furthermore, the larger spacing at Hornsea Four compared to other operational developments should further increase the safety for vessels transiting through the array area therefore reducing the chance of an incident occurring which requires a SAR.

7 SAR Access Lanes and HRA

90. Annex 5 to MGN 654 states that a SAR access lane is an area within which, "*there shall be no OREIs, or other structures, in the wind farm or on the boundary that present an obstacle or risk to SAR helicopters flying along*". The purpose of a SAR access lane is to ensure that "*a SAR helicopter can fly from one side of a wind farm to the other*". Furthermore, "*the lanes also provide safer and more predictable paths through a wind farm for surface rescue vessels*". Where a number of SAR lanes of consistent bearing can be identified within a site, these are referred to as a 'line of orientation'.

91. The final layout for Hornsea Four will maintain a SLoO throughout the array, in line with Layout Principle 3. As per Layout Principle 8, Hornsea Four will provide an HRA that is perpendicular to the SAR access lanes within the site, given that the length of the SAR access lanes is greater than 10 nm. This also ensures compliance with MGN 654. As required by the Layout Principles and MGN 654, the HRA will be a minimum width of 1 nm (measured tip-to-tip) and will be completely free of surface infrastructure. Figure 7.1 presents the SAR access lanes and general HRA concept for the indicative layout assessed in the NRA, noting that this layout is considered the MDS for shipping and navigation.

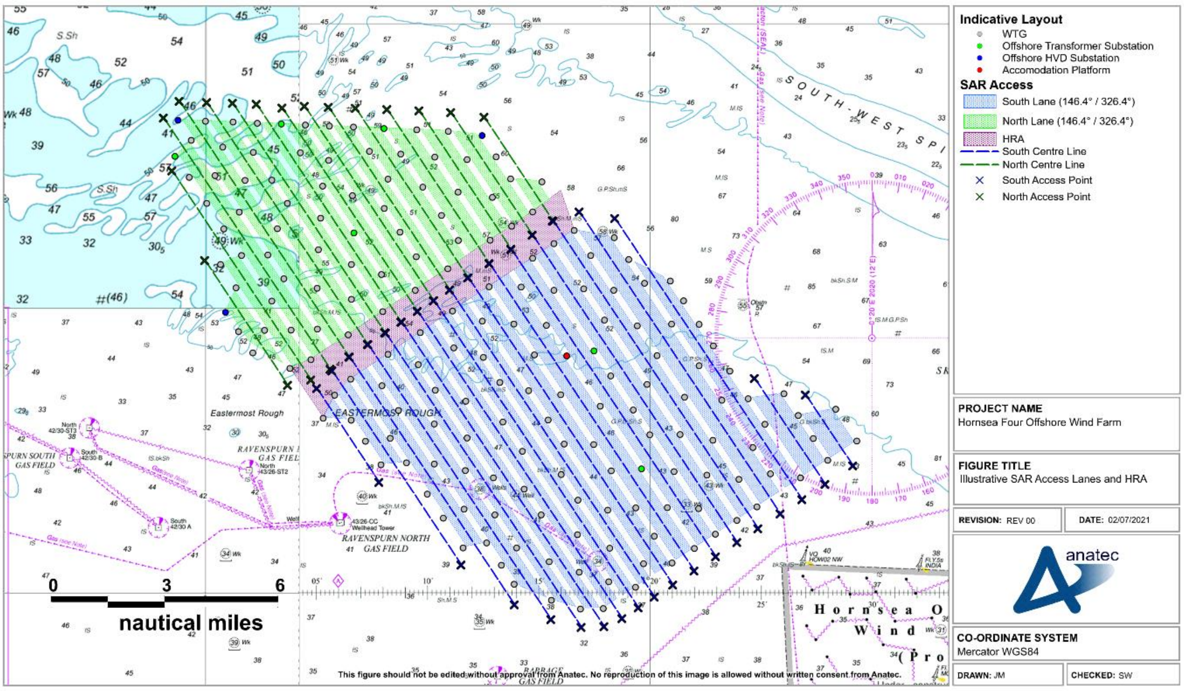

Figure 7.1 Illustrative SAR access lanes and HRA

92. It is noted that on a cumulative level, the gap between Hornsea Four and Hornsea Project Two serves as an additional HRA between the two developments, as per the MCA's comments at the second Hazard Workshop in May 2020 (see 28th May entry in Table 3.1).

8 Constraints on Layout

8.1 Wake Loss

93. Numerous studies have demonstrated that wake loss across an array can lead to a significant loss in energy generation. While wake losses constitute one of the primary sources of production loss in offshore wind farms, it is possible to partially mitigate these losses through optimised layout and wind farm design.

94. The primary mitigation is to increase the distance between WTGs in the prevailing wind direction, thus allowing wake recovery. This mitigation method is not possible to implement to a great degree in a fixed grid layout. However, a SLoO layout would allow for this mitigation to be implemented. While the distance between the rows of WTGs would be fixed, with the exception of for micro-siting or due to geological constraints, as described by Layout Principle 6, it is possible to offset the WTGs in alternating positions, thus increasing the distance between two WTGs in the prevailing wind direction whilst maintaining a distance of 50 m from the centre line of the row (micro-siting). This offers the Applicant a method to optimise electricity production within the parameters set out by the Layout Principles.

8.2 Ground Conditions

95. Detailed geophysical and geotechnical investigations are typically undertaken post financial decision due to the large costs involved. Ground investigations undertaken at previous nearby developments and specifically the neighbouring Hornsea Project Two, have shown that glacial features historically present in this area of the southern North Sea have led to higher than expected spread and density of boulders (clearing boulders complicates site preparation and costs).

96. The inherent flexibility of a SLoO layout would, should any similar glacial features be present, greatly mitigate the need to clear wider area of boulders and thus reduces the extent of interaction with the seabed. This is reflected in Principle 6 which allows for a distance of up to 150 m to be considered for positioning structures in the case of geological constraints, subject to agreement with the MMO, in consultation with the MCA and Trinity House.

8.3 Water Depths

97. The water depths within the Hornsea Four array area are between 32 and 60 m below CD. There are limited engineering challenges installing structures and particularly foundations within the shallower waters. However, these engineering challenges generally increase as the water depths increase. The option of a layout containing a SLoO allows for the flexibility, where possible within the Layout Principles, to avoid areas with greater water depths and, hence, avoid the risk of pile refusal.

8.4 Environmental Constraints

98. A number of environmental constraints are present within the Hornsea Four array area including considerations of marine mammals, ornithology and shipping and navigation. In particular, in order to reduce the impact of the project on ornithology and commercial shipping routeing, portions of the Hornsea Four array area have been removed entirely as shown in Figure 8.1.

99. Other seabed areas have been avoided, where possible, to further reduce the impact on various environmental receptors, therefore reducing the available installation space for structures. Use of a layout containing a SLoO would partially mitigate against this loss of site.

8.5 Archaeological Constraints

100. There are 18 known wrecks located within the Hornsea Four order limits and further pre-construction geophysical and geotechnical surveys will be undertaken to identify any additional features of archaeological interest. Depending on the importance of such features, as is required to be agreed with Historic England and the MMO through the Archaeological Written Scheme of Investigation (WSI) Offshore, Archaeological Exclusion Zones (AEZ) will be implemented around a feature where infrastructure or construction activity will be excluded. The AEZs would include the entirety of the features in addition to a 50 m buffer surrounding it.

101. These archaeological features, both known and unknown, represent a further constraint on the situating of structures and hence the overall layout.

8.6 Other Infrastructure

102. In the Hornsea Four array area there are two pre-existing pipelines. The areas encompassing these pipelines and within 1,000m of the pipelines have been excluded for the situation of any structures.

8.7 Site Refinement

103. As a result of consultation and consideration of other users[7], including those listed above, the Hornsea Four array area has been reduced from the original 846 km^2 at scoping stage to 467 km^2 for the DCO application, as presented in Figure 8.1. Therefore, the area where infrastructure can be situated has been significantly reduced (by approximately 45% from the scoping stage) to accommodate external constraints, thus reducing the overall layout options. The ability to incorporate a layout containing a SLoO would serve as an effective means to mitigate the reduction of the Hornsea Four array area due to the considerations given to other users, including shipping and navigation interests.

[7] Including, but not limited to, commercial vessel operators, environmental groups and statutory stakeholders.

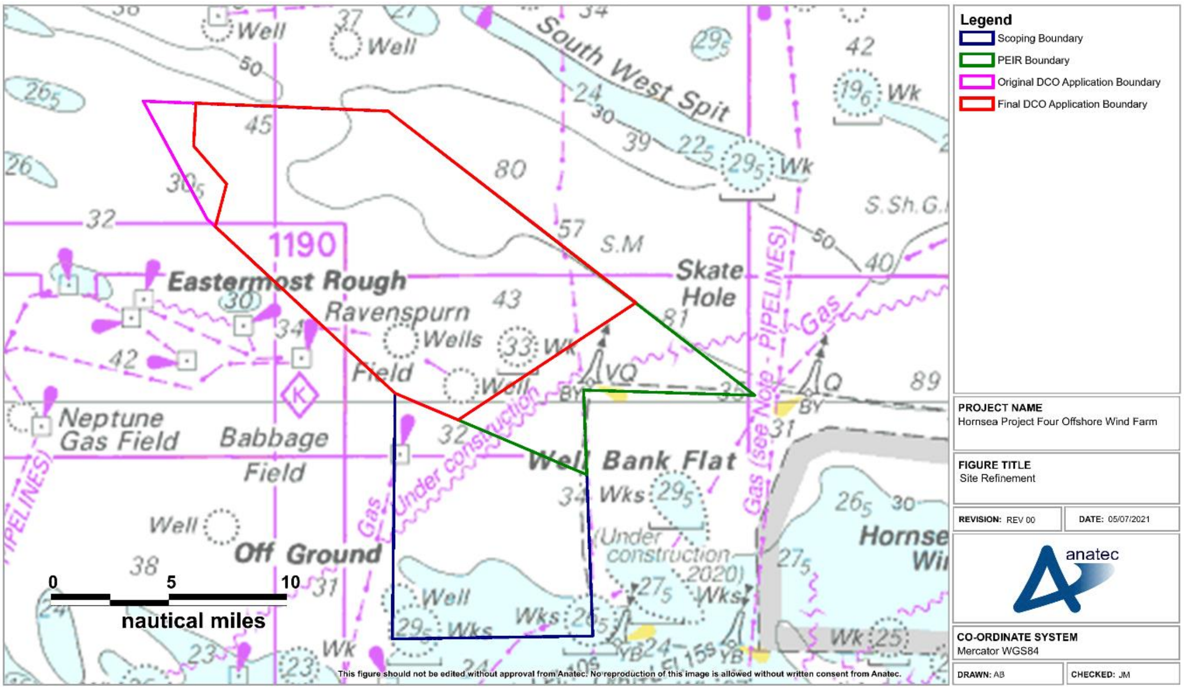

Figure 8.1 Site Refinement

9 Impact Assessment

9.1 Assessment Methodology

104. The shipping and navigation impacts scoped into **Volume A2, Chapter 7: Shipping and Navigation** have been assessed using the FSA process (IMO, 2018), as required by the MCA methodology (MCA, 2021). Under FSA each impact is assigned a frequency and severity ranking as defined in Table 9.1 and Table 9.2, respectively. These rankings are then used to determine the overall significance of each impact via a tolerability matrix as defined in Table 9.3.

Table 9.1 Severity of consequence ranking definitions

Rank	Description	Definition			
		People	Property	Environment	Business
1	Negligible	No perceptible impact	No perceptible impact	No perceptible impact	No perceptible impact
2	Minor	Slight injury(s)	Minor damage to property, i.e., superficial damage	Tier 1 local assistance required	Minor reputational impacts – limited to users
3	Moderate	Multiple minor or single serious injury	Damage not critical to operations	Tier 2 limited external assistance required	Local reputational impacts
4	Serious	Multiple serious injuries or single fatality	Damage resulting in critical impact on operations	Tier 2 regional assistance required	National reputational impacts
5	Major	More than one fatality	Total loss of property	Tier 3 national assistance required	International reputational impacts

Table 9.2 Frequency of occurrence ranking definitions

Rank	Description	Definition
1	Negligible	<1 occurrence per 10,000 years
2	Extremely unlikely	1 per 100 to 10,000 years
3	Remote	1 per 10 to 100 years
4	Reasonably probable	1 per 1 to 10 years
5	Frequent	Yearly

Table 9.3 Tolerability Matrix and Risk Rankings

Severity of Consequence	5					
	4					
	3					
	2					
	1					
		1	2	3	4	5
		Frequency of occurrence				

	Unacceptable (high risk)
	Tolerable (intermediate risk)
	Broadly Acceptable (low risk)

9.2 Commitments Included as Part of Hornsea Four

105. **Volume A2, Chapter 7: Shipping and Navigation** includes the full list of commitments adopted as part of Hornsea Four to bring shipping and navigation risks to an ALARP level. The following commitments are considered relevant to the case that a SLoO is sufficient for Hornsea Four:

- Advance warning and accurate location details of construction, maintenance and decommissioning operations, associated Safety Zones and advisory passing distances will be given via Notifications to Mariners and Kingfisher Bulletins (Co89).
- Aids to navigation (marking and lighting) will be deployed in accordance with the latest relevant available standard industry guidance and as advised by Trinity House, MCA, Civil Aviation Authority (CAA) and Ministry of Defence (MoD) as appropriate. This will include a buoyed construction area around the array area and the High Voltage Alternating Current (HVAC) booster station in consultation with Trinity House (Co93).
- The UKHO will be notified of both the commencement (within two weeks), progress and completion of offshore construction works (within two weeks) to allow marking of all installed infrastructure on nautical charts (Co 94).
- The project commits to agree layout principles with the MMO, in consultation with the MCA and Trinity House (Co96).
- Monitoring and annual reporting of vessel traffic for the duration of the construction period (Co98).
- Hornsea Four will ensure compliance with MGN 654 where appropriate (Co99).

- Safety Zones of up to 500 m will be applied during construction, maintenance and decommissioning phases. Where defined by risk assessment, guard vessels will also be used to ensure adherence with Safety Zones or advisory passing distances, as defined by risk assessment to mitigate impacts which pose a risk to surface navigation during construction, maintenance and decommissioning phases (Co139).
- Hornsea Four vessels will comply with MGN 372 (Merchant and Fishing) OREIs: Guidance to Mariners Operating in the Vicinity of UK OREIs (MCA, 2008) or the latest relevant available guidance where appropriate (Co177).
- Hornsea Four will ensure marine coordination with the MHCC (Co179).

9.3 Impact from Environmental Statement

106. **Volume A2, Chapter 7: Shipping and Navigation** included an assessment of two impacts where the inclusion of a SLoO is considered relevant to the impact under consideration, namely internal allision risk (operation and maintenance phase) and emergency response capability (all phases). The following subsections replicate the commentary provided in **Volume A2, Chapter 7: Shipping and Navigation**, noting that the magnitude of impact, sensitivity of receptor and significance of effect conclusions provided for internal allision risk are the overall conclusions determined for allision risk as a whole (including external to the array).

107. Much of the evidence outlined in the preceding sections is used in the following subsections. The additional evidence, in particular the SAR operations work undertaken by Mark Prior, shows agreement with the impact assessment's findings.

9.3.1 Internal Allision Risk (Operation and Maintenance Phase)

108. Based on consultation feedback from Regular Operators and past experience it is not considered likely that larger commercial vessels will navigate within the array; the predominant users are expected to be smaller craft such as recreational vessels and fishing vessels. The level of small craft within the area is very low and is not expected to increase significantly in a future case scenario.

109. The annual vessel to structure collision frequency for commercial fishing vessels is estimated to be 4.42×10^{-2}, corresponding to a collision return period of approximately one in 23 years. This is a low frequency when compared to other allision assessments carried out on developments in UK waters. Additionally, the model does not assume the magnitude of any allision incident, and as noted above the consequences of any impact are also likely to be low.

110. The SLoO included in the array layout will assist with safe internal navigation, noting that historical data shows that vessels transiting through offshore wind farms tend to do so in straight lines between waypoints but not necessarily following any designated line of orientation (i.e. a specific row or column); instead they will often take the shortest route. This is supported by consultation with fishing stakeholders which indicated that fishermen are first and foremost likely to follow the features of

the seabed before taking into consideration the layout of wind farm structures (see consultation undertaken as part of **Volume A2, Chapter 6: Commercial Fisheries**.

111. As with any passage, movements within the array will depend upon the prevailing conditions and vessels are expected to passage plan accordingly in line with Chapter V of SOLAS (IMO 1974). Given the distance offshore it is anticipated that any small craft choosing to navigate internally within the array will be well equipped and experienced.

112. During periods of major maintenance, Safety Zones will be applied for around active maintenance areas to ensure that those vessels that choose to navigate through the array are aware of safe passing distances. It is noted that the minimum spacing of 810 m should be sufficient for small craft to make safe passage within the array. Also, should a vessel navigate directly between Hornsea Four and Hornsea Project One and/or Hornsea Project Two, there should be no additional internal allision risk given that the minimum spacing at Hornsea Project One and Hornsea Project Two is also at least 810 m and those developments also incorporate a single line orientation in their respective layouts.

113. Overall this effect is predicted to be of local spatial extent, medium-term duration, continuous throughout the operational phase and not reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **minor**.

114. The receptor is deemed to be generally not vulnerable, have good recoverability and low value. The sensitivity of the receptor is therefore, considered to be **low**.

115. Overall, it is predicted that the sensitivity of the receptor is considered to be **low** and the magnitude is deemed to be **minor**. The effect could be either **neutral** or **slight** (which are both not significant in EIA terms), however given the variable level of damage that a vessel may sustain from an allision impact, the effect is considered to be of **slight** significance, which is not significant in EIA terms (and broadly acceptable under FSA).

9.3.2 Emergency Response Capability (Construction Phase)

116. The construction of Hornsea Four, including the increased presence of vessels and personnel within the Hornsea Four array area may impact upon the ability of emergency responders to respond to incidents. The MDS for vessel movements during the construction phase is up to eight construction vessels within a given 5 km^2 area with approximately three or four 5 km^2 areas at any given time with up to 6,126 return trips per year.

117. From recent SAR helicopter taskings data, the frequency of SAR operations in proximity to the Hornsea Four array area is moderate, although the majority of incidents occurred land side of the Hornsea Four array area and none occurred within the Hornsea Four array area itself. The frequency of SAR helicopter taskings is not

expected to change markedly given the self-help capabilities and emergency response which will be provided by Hornsea Four.

118. Further details pertaining to SAR helicopter taskings in proximity to Hornsea Four and details pertaining to the location of emergency response resources are provided in Section 13 of **Volume A5, Annex 7.1: Navigational Risk Assessment**. Given the large area covered by emergency responders the extent of the impact is considered to be on a national level.

119. Given the increased presence of vessels and personnel on site during the construction phase there will be a small increase in the likelihood (frequency) of an incident occurring, which could diminish the overall ability of the current level of emergency response provision, including pollution response. In such a scenario the consequences could be high or very high.

120. However, under national and international law, the operators of Hornsea Four will be required to comply with the existing emergency response requirements of SOLAS (IMO 1974) as well as give consideration to other response groups within the area (MCA). Owing to the increased level of activity relating to Hornsea Four there would be expected to be some increased demands on SAR facilities within the area; however this would likely be mitigated by the presence of new on site resources (associated with the construction activities) that will be able to respond in an emergency (either related to Hornsea Four or a third party) under SOLAS obligations. Therefore, the likelihood of emergency response capability being compromised is considered to be low, even with the increased likelihood of an incident occurring.

121. Overall this impact is predicted to be of national spatial extent, short-term duration, intermittent and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **minor**.

122. The receptor is deemed to be somewhat vulnerable, have very good recoverability and high value. The sensitivity of the receptor is therefore, considered to be **medium**.

123. Overall, it is predicted that the sensitivity of the receptor is considered to be **medium** and the magnitude is deemed to be **minor**. The effect could be either **slight** or **moderate**, however given the positive effect the presence of new on site resources will have the effect is considered to be of **slight** significance, which is not significant in EIA terms (and broadly acceptable under FSA).

9.3.3 Emergency Response Capability (Operation and Maintenance Phase)

124. The operation and maintenance of Hornsea Four may impact upon the ability of emergency responders to respond to incidents. The MDS for vessel movements during the operational phase is up to 1,433 return trips per year.

125. Given that vessel, aircraft and personnel numbers will be significantly reduced during the operational phase (compared to the construction phase) there are not

anticipated to be any significant impacts on emergency response resources during the operation and maintenance phase given that all offshore operations will have their own self-help capability as part of their emergency response plans.

126. It is of note that Hornsea Four on site facilities will have beneficial impacts on emergency response provision for all users.

127. From recent SAR helicopter taskings data, the frequency of SAR operations in proximity to the Hornsea Four array area is moderate, although the majority of incidents occurred land side of the Hornsea Four array area and none occurred within the Hornsea Four array area itself. The frequency of SAR helicopter taskings is not expected to change markedly given the self-help capabilities and emergency response which will be provided by Hornsea Four.

128. Further details pertaining to SAR helicopter taskings in proximity to Hornsea Four and details pertaining to the location of emergency response resources are provided in Section 13 of **Volume A5, Annex 7.1: Navigational Risk Assessment**. Given the large area covered by emergency responders the extent of the impact is considered to be on a national level.

129. Given the increased presence of vessels and personnel on site during the operational phase there will be a small increase in the likelihood (frequency) of an incident occurring, which could diminish the overall ability of the current level of emergency response provision, including pollution response. In such a scenario the consequences could be high or very high.

130. However, under national and international law, the operators of Hornsea Four would be required to comply with the existing emergency response requirements of SOLAS (IMO, 1974) as well as give consideration to other response groups within the area (MCA). Owing to the increased level of activity relating to Hornsea Four there would be expected to be some increased demands on SAR facilities within the area; however this would likely be mitigated by the presence of new on site resources (associated with the operation and maintenance activities) that will be able to respond in an emergency (either related to Hornsea Four or a third party) under SOLAS obligations. Therefore, the likelihood of emergency response capability being compromised is considered to be low, even with the increased likelihood of an incident occurring.

131. Commitments included as part of Hornsea Four, which will help mitigate the impact on emergency response capability, include the agreement of Layout Principles which are designed to assist with ensuring acceptable SAR access within the array.

132. Overall this impact is predicted to be of national spatial extent, medium-term duration, intermittent and not reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **minor**.

133. The receptor is deemed to be generally not vulnerable, have good recoverability and high value. The sensitivity of the receptor is therefore, considered to be **medium**.

134. Overall, it is predicted that the sensitivity of the receptor is considered to be **medium** and the magnitude is deemed to be **minor**. The effect could be either **slight** or **moderate**, however given the positive effect the presence of new on site resources will have the effect is considered to be of **slight** significance, which is not significant in EIA terms (and broadly acceptable under FSA).

9.3.4 Emergency Response Capability (Decommissioning Phase)

135. Given that the decommissioning phase will occur after three years of construction and 35 years of operational life of Hornsea Four, even with the increase in activity, there are not expected to be any perceptible effects on the emergency response capability of existing resources. On this basis, the extent of the impact is considered to be local.

136. Overall this impact is predicted to be of local spatial extent, short-term duration, intermittent and reversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **negligible**.

137. Irrespective of the sensitivity of the receptor, the significance of the impact on all vessels is **not significant** and is therefore not considered further in this assessment.

10 Summary and Conclusions

138. This report represents the safety justification for Hornsea Four to demonstrate that a layout containing a SLoO is safe from a surface navigation and SAR perspective.

139. It is noted that a number of constraints on layout have already been taken into account, including wake loss, ground conditions, water depths and numerous environmental constraints. With these taken into account, the Hornsea Four array area has been reduced by approximately 45% from the scoping stage, thus reducing the overall layout options. The ability to incorporate a layout containing a SLoO would serve as an effective means to mitigate the reductions in the Hornsea Four array area already accommodated to benefit other users, including for example shipping and navigation commercial interests.

10.1 Surface Navigation

140. From a study of long-term vessel traffic data at existing arrays it can be seen that commercial vessels typically avoid transiting internally within an array. This is aligned with the feedback received from commercial vessel operators during consultation for Hornsea Four, which suggested that commercial vessels will avoid transiting internally within the array. Smaller craft (fishing vessels and recreational vessels) are seen to operate internally within arrays but do not necessarily follow the lines of orientation defined by the layout. Instead, such vessels often transit at a diagonal to lines of orientation or deploy a waypoint whilst within the array, altering their course.

141. The vessel traffic data analysed for the Hornsea Four array area indicates that fishing vessel activity is relatively low and recreational vessel activity is very low. It should be considered that the summer survey period (25th July to 7th August 2020) is AIS only, and as such fishing vessel activity may be underrepresented (however, it is considered unlikely that smaller non-AIS fishing vessels would transit this far offshore on a regular basis). Furthermore, when comparing the vessel traffic data collected for Hornsea Four to that collected during the NRA process for the other Hornsea developments it can be seen that the relative density of traffic within the array area is lower. Therefore, it is anticipated that level of vessel activity (from third-party vessels) within the array will be lower.

142. It is also noted that the minimum spacing between structures within the Hornsea Four array area (810 m) is significantly greater than at most existing arrays and will provide additional flexibility for any vessel choosing to navigate internally within the array.

143. The impact assessment undertaken in **Volume A2, Chapter 7: Shipping and Navigation** included an assessment of internal allision risk during the operation and maintenance phase and concluded a 'slight' significance which is 'not significant' in EIA terms and 'broadly acceptable' under FSA.

10.2 SAR Activities

144. Based on historical incident data – including MAIB incidents, RNLI incidents and DfT SAR helicopter taskings – the frequency of incidents which may require a SAR operation at the Hornsea Four array area is low. If an incident were to occur, under SOLAS regulations any nearby vessels would be obliged to render assistance where it is safe to do so. This may include not only passing vessels but also project vessels associated with the operation of Hornsea Four, vessels associated with the operation of the other three Hornsea developments and vessels associated with other developments in the area including the various gas fields. Therefore, it is highly unlikely that a SAR asset would be the first responder at the scene of an incident.

145. Where a SAR asset is required to attend an incident, the expected time on scene for a SAR helicopter out of Humberside Airport (the closest SAR helicopter base to the Hornsea Four array area) is 39 minutes during the day and 69 minutes at night. Based on this, it is anticipated that any search for a missing person would already be at a developed stage once the SAR helicopter arrives, particularly at night.

146. A technical assessment has determined that, based on classic aerodynamic theory, the radius of turn for a SAR asset at 80 kt with angle of bank 20° would be approximately 0.25 nm (diameter 0.50 nm), with this value reduced in poor visibility due to reduced airspeeds. Given the minimum spacing of 810m between structures at Hornsea Four, it is therefore considered that a SAR asset could safely turn within the array, irrespective of the number of lines of orientation. This is furthered but the presence of an HRA specifically for the purpose of SAR helicopter movements. It is also noted that conditions at the Hornsea Four array area (in terms of cloud base) are generally suitable to allow a SAR asset to safely undertake a search from above the array.

147. The impact assessment undertaken in **Volume A2, Chapter 7: Shipping and Navigation** included an assessment of restrictions on emergency response capability during all phases and concluded a ‘slight’ significance which is ‘not significant’ in EIA terms and ‘broadly acceptable’ under FSA.

10.3 Conclusion

148. Taking all of the above into account, Hornsea Four is not expected to be present a significant risk due to the application of a SLoO in the layout, either to surface navigation or SAR activities.

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