Hornsea Project Four: Preliminary Environmental Information Report (PEIR)

Volume 5, Annex 8.1: Navigational Risk Assessment

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Hornsea Project Four Offshore Wind Farm – Navigational Risk Assessment

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Table of Contents

Table of Figures

Table of Tables

Glossary of Terms

Term	Definition
Allision	The act of striking or collision of a moving vessel against a stationary object.
Automatic Identification System (AIS)	A system by which vessels automatically broadcast their identity, key statistics including location, destination, length, speed and current status, e.g., under power. Most commercial vessels and European Union (EU) fishing vessels over 15 m length are required to carry AIS.
Cable Burial Risk Assessment (CBRA)	Risk assessment to determine suitable burial depths for cables, based upon hazards such as anchor strike, fishing gear interaction and seabed mobility.
Collision	The act or process of colliding (crashing) between two moving objects.
Commitment	A term used interchangeably with mitigation. Commitments are embedded mitigation measures. Commitments are either primary (design) or tertiary (Inherent) and embedded within the assessment at the relevant point in the Environmental Impact Assessment (EIA) (e.g. at Scoping or Preliminary Environmental Information Report (PEIR)). The purpose of Commitments are to reduce and/or eliminate Likely Significant Effects (LSEs), in EIA terms.
Design Envelope	A description of the range of possible elements that make up the Hornsea Four design options under consideration, as set out in detail in **Volume 1, Chapter 4: Project Description**. This envelope is used to define Hornsea Four for Environmental Impact Assessment purposes when the exact engineering parameters are not yet known. This is also often referred to as the "Rochdale Envelope" approach.
Environmental Statement (ES)	A document reporting the findings of the Environmental Impact Assessment (EIA) and produced in accordance with the EIA Directive as transposed into United Kingdom (UK) law by the EIA Regulations.
Flotel	A portmanteau of the terms floating and hotel. Refers to the installation of living quarters on top of rafts or semi-submersible platforms.
Formal Safety Assessment (FSA)	A structured and systematic process for assessing the risks and costs (if applicable) associated with shipping activity.
Former Hornsea Zone	The former Hornsea Zone was one of nine offshore wind generation zones around the UK coast identified by The Crown Estate (TCE) during its third round of offshore wind licensing. In March 2016, the Hornsea Zone Development Agreement was terminated and project specific agreements, Agreement for Leases (AfLs), were agreed with The Crown Estate for Hornsea Project One Offshore Wind Farm, Hornsea Project Two Offshore Wind Farm, Hornsea Project Three Offshore Wind Farm and Hornsea Four. The Hornsea Zone has therefore been dissolved and is referred to throughout the PEIR Technical Report as the former Hornsea Zone.
Future Case	The assessment of risk based on the predicted growth in future shipping densities and traffic types as well as foreseeable changes in the marine environment.
International Maritime Organization (IMO) Routeing	Predetermined shipping routes established by the IMO.

Term	Definition
Layout Principles	A set of rules relating to the final array layout designed to ensure that post consent the array layout chosen for Hornsea Four satisfactorily meets both navigational and Search and Rescue (SAR) requirements (see **Volume 4, Annex 4.7: Layout Principles**).
Main Route	Defined transit route (mean position) of commercial vessels identified within the specified shipping and navigation study area.
Marine Environmental High Risk Area (MEHRA)	Areas in UK coastal waters where vessel masters are advised of the need to exercise more caution than usual, i.e. crossing areas of high environmental sensitivity where there is a risk of pollution from commercial shipping.
Marine Guidance Note (MGN)	A system of guidance notes issued by the Maritime and Coastguard Agency (MCA) which provide significant advice relating to the improvement of the safety of shipping at sea, and to prevent or minimise pollution from shipping.
Maximum Design Scenario (MDS)	The combination of realistic parameters for Hornsea Four anticipated to produce the worst-case consequences.
Mitigation	A term used interchangeably with Commitment(s) by Hornsea Four. Mitigation measures (Commitments) are embedded within the assessment at the relevant point in the EIA (e.g. at Scoping or PEIR).
Navigational Risk Assessment (NRA)	A document which assesses the overall impact to shipping and navigation of a proposed Offshore Renewable Energy Installation (OREI) based upon Formal Risk Assessment (FSA).
Offshore Renewable Energy Installation (OREI)	As defined by *Marine Guidance Note 543 (Merchant and Fishing) Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response* (MCA, 2016). For the purposes of this report and in keeping with the consistency of the EIA, OREI can mean offshore Wind Turbine Generators (WTG) and the associated electrical infrastructure such as offshore transformer substations, offshore High Voltage Direct Current (HVDC) converter substations, accommodation platforms and High Voltage Alternating Current (HVAC) booster stations.
Radio Detection and Ranging (Radar)	An object-detection system which uses radio waves to determine the range, altitude, direction or speed of objects.
Regular Operator	Commercial operator whose vessel(s) are observed to transit through a particular region on a regular basis.
Traffic Separation Scheme (TSS)	A traffic management route system ruled by the International Maritime Organization (IMO). The traffic lanes (or clearways) indicate the general direction of the vessels in that zone; vessels navigating within a TSS all sail in the same direction or they cross the lane at an angle as close to 90 degrees (°) as possible.
Unique Vessel	An individual vessel identified on any particular calendar day, irrespective of how many tracks were recorded for that vessel on that day. This prevents vessels being over counted. Individual vessels are identified using their Maritime Mobile Service Identity (MMSI).
Vessel Traffic Service (VTS)	A service implemented by a Competent Authority designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area.

Abbreviations Table

Abbreviation	Definition
AC	Alternating Current
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
ALB	All-Weather Lifeboat
ARPA	Automatic Radar Plotting Aid
BEIS	Department for Business, Energy and Industrial Strategy
BMAPA	British Marine Aggregate Producers Association
BWEA	British Wind Energy Association
CA	Cruising Association
CAA	Civil Aviation Authority
CBA	Cost Benefit Analysis
CBRA	Cable Burial Risk Assessment
CEA	Cumulative Effect Assessment
CGOC	Coastguard Operations Centre
CHIRP	Confidential Human Factors Incident Reporting Programme
COLREGs	Convention on International Regulations for Preventing Collisions at Sea
CRO	Coastguard Rescue Officer
CRT	Coastguard Rescue Team
CTV	Crew Transfer Vessel
dB	Decibel
DC	Direct Current
DECC	Department of Energy and Climate Change
DF	Direction Finding
DfT	Department for Transport
DSC	Digital Selective Calling
ECA	Easington Catchment Area
ECC	Export Cable Corridor
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
ERCoP	Emergency Response Cooperation Plan
ERRV	Emergency Response and Rescue Vessel
ES	Environmental Statement
EU	European Union

Abbreviation	Definition
FSA	Formal Safety Assessment
GCAF	Gross Cost of Averting a Fatality
GIS	Geographic Information System
GPS	Global Positioning System
GRP	Glass Reinforced Plastic
GRT	Gross Register Tonnage
HAT	Highest Astronomical Tide
HMCG	Her Majesty's Coastguard
HMSO	Her Majesty's Stationary Office
HSE	Health, Safety and Environment
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ILB	Inshore Lifeboat
IMO	International Maritime Organization
IPS	Intermediate Peripheral Structure
ITAP	Institut für technische und angewandte Physik
kHz	Kilohertz
km	Kilometre
kt	Knot
LAT	Lowest Astronomical Tide
LMP	Lighting and Marking Plan
LOA	Length Overall
m	Metre
MAIB	Maritime Accident Investigation Branch
MCA	Maritime and Coastguard Agency
MEHRA	Marine Environmental High Risk Area
MEPC	Marine Environment Protection Committee
MGN	Marine Guidance Note
MHCC	Marine Helicopter Coordination Centre
MLWS	Mean Low Water Springs
mm	Millimetre
MMO	Marine Management Organisation
MMSI	Maritime Mobile Service Identity

Abbreviation	Definition
MOD	Ministry of Defence
MSC	Maritime Safety Council
MSI	Maritime Safety Information
MW	Megawatt
NAVTEX	Navigational Telex
nm	Nautical Mile
NMOC	National Maritime Operations Centre
NPS	National Policy Statement
NRA	Navigational Risk Assessment
OOW	Officer of the Watch
OREI	Offshore Renewable Energy Installation
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PEXA	Practice and Exercise Area
PLL	Potential Loss of Life
QHSE	Quality, Health, Safety and Environment
Racon	Radar Beacon
Radar	Radio Detecting and Ranging
REZ	Renewable Energy Zone
Ro Ro	Roll On Roll Off
RNLI	Royal National Lifeboat Institution
RYA	Royal Yachting Association
SAR	Search and Rescue
SCADA	Supervisory Control and Data Acquisition
SOLAS	International Convention for the Safety of Life at Sea
SONAR	Sound Navigation Ranging
SPS	Significant Peripheral Structure
TCE	The Crown Estate
TH	Trinity House
TSS	Traffic Separation Scheme
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
VHF	Very High Frequency
VTS	Vessel Traffic Service
WGS	World Geodetic System

Abbreviation	Definition
WTG	Wind Turbine Generator
µPa	Micropascal

1 Introduction

1.1 Background

Anatec was commissioned by Ørsted Hornsea Project Four Limited (the Applicant) to undertake a Navigational Risk Assessment (NRA) for the proposed Hornsea Project Four offshore Wind Farm (hereafter Hornsea Four) consisting of the array area (located within the former Hornsea Zone), offshore export cable corridor (ECC) and High Voltage Alternating Current (HVAC) booster station search area. This NRA presents information on the proposed development relative to the existing and estimated future navigational activity and forms an annex to **Volume 2, Chapter 8: Shipping and Navigation**. It is noted that the NRA will be expanded for the final Environmental Statement (ES) that will accompany the final DCO application, including outputs from a vessel-based traffic survey to be undertaken in July/August 2019, further consultation and collision and allision risk modelling.

1.2 Navigational Risk Assessment

An Environmental Impact Assessment (EIA) is a process which identifies the environmental effects of a project, both negative and positive, in accordance with European Union (EU) directives (Directive 2011/92/EU, as amended by Directive 2014/52/EU). An important requirement of the EIA for offshore projects is the NRA. Following the Maritime and Coastguard Agency (MCA) methodology (MCA, 2013) and Marine Guidance Note (MGN) 543 (MCA, 2016), this NRA includes:

- Overview of existing environment;
- Vessel traffic survey;
- Implications of offshore wind farms including position of wind turbine generators (WTG);
- Assessment of navigational risk pre- and post-development of Hornsea Four;
- Implications for marine navigation and communication equipment;
- Identification of mitigation measures;
- Emergency response; and
- Any required monitoring.

It is noted that a Formal Safety Assessment (FSA) has not been undertaken within the NRA; instead impacts have been assessed within **Volume 2, Chapter 8: Shipping and Navigation** to ensure a proportionate approach towards the assessment with consideration for the FSA approach required by the MCA. Assessment has been undertaken for each phase of development as follows:

- Construction;
- Operation and maintenance; and
- Decommissioning.

The assessment of Hornsea Four is based on a design envelope, an approach which is recognised in the Overarching National Policy Statement (NPS) for Energy (EN-1)

(Department of Energy and Climate Change (DECC), 2011a) and the NPS for Renewable Energy Infrastructure (EN-3) (DECC, 2011b). The design envelope includes conservative assumptions to form a Maximum Design Scenario (MDS) which is considered and assessed for all impacts. Further details on the design envelope are provided in **Volume 1, Chapter 4: Project Description**.

2 Guidance and Legislation

2.1 Primary Guidance

The primary guidance documents used during the assessment are the following:

- *MGN 543 (Merchant and Fishing) Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response* (MCA, 2016);
- *Methodology for Assessing the Marine Navigational Safety & Emergency Response Risks of Offshore Renewable Energy Installations (OREI)* (MCA, 2013); and
- *Revised Guidelines for FSA for Use in the Rule-Making Process* (International Maritime Organization (IMO), 2018).

MGN 543 highlights issues that shall be considered when assessing the effect on navigational safety from offshore renewable energy developments, proposed in United Kingdom (UK) internal waters, territorial sea or Renewable Energy Zones (REZ).

The MCA require that their methodology is used as a template for preparing NRAs. It is centred on risk management and requires a submission that shows that sufficient controls are, or will be, in place for the assessed risk to be judged as broadly acceptable or tolerable with mitigation. Across **Volume 2, Chapter 8: Shipping and Navigation** and the NRA both base and future case levels of risk have been identified and what measures are required to ensure the future case remains broadly acceptable or tolerable.

2.2 Other Guidance

Other guidance documents used during the assessment are as follows:

- *MGN 372 (Merchant and Fishing) Offshore Renewable Energy Installations (OREIs): Guidance to Mariners Operating in the Vicinity of UK OREIs* (MCA, 2008);
- *International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Recommendation O-139 on The Marking of Man-Made Offshore Structures* (IALA, 2013);
- *The Royal Yachting Association's (RYA) Position on Offshore Renewable Energy Developments: Paper 1 (of 4) – Wind Energy* (RYA, 2015); and
- *Standard Marking Schedule for Offshore Installations* (DECC, 2011).

3 Navigational Risk Assessment Methodology

3.1 Formal Safety Assessment Methodology

A shipping and navigation receptor can only be affected by an impact if there is a pathway through which an impact can be transmitted between the source activity and the receptor. In cases where a receptor is exposed to an impact, the overall severity of consequence to the receptor is determined. This process incorporates a degree of subjectivity. Assessments for shipping and navigation receptors used the following criteria:

- Baseline data and assessment;
- Expert opinion;
- Outputs of the Hazard Workshop;
- Level of stakeholder concern;
- Time and/or distance of any deviation;
- Number of transits of specific vessel and/or vessel type; and
- Lessons learnt from existing offshore developments.

3.2 Formal Safety Assessment Process

The IMO FSA process (IMO, 2018) approved by the IMO in 2018 under Maritime Safety Council (MSC)-Marine Environment Protection Committee (MEPC).2/Circ. 12/Rev.2 was applied within the Hazard Workshop by using the five steps outlined below and subsequently within the matrices used to assess the sensitivity and magnitude of impacts identified within **Volume 2, Chapter 8: Shipping and Navigation**. The FSA is a structured and systematic methodology based upon risk analysis and Cost Benefit Analysis (CBA) (if applicable) to reduce impacts to As Low as Reasonably Practicable (ALARP). There are five basic steps within this process as illustrated in Figure 3.1 and detailed in the following list:

- Step 1 – identification of hazards (a list is produced of hazards prioritised by risk level specific to the problem under review);
- Step 2 – risk analysis (investigation of the causes and initiating events and consequences of the more important hazards identified in step 1);
- Step 3 – risk control options (identification of measures to control and reduce the identified hazards);
- Step 4 – CBA (identification and comparison of the benefits and costs associated with the risk control options identified in step 3); and
- Step 5 – recommendations for decision-making (defining of recommendations based upon the outputs of steps 1 to 4).

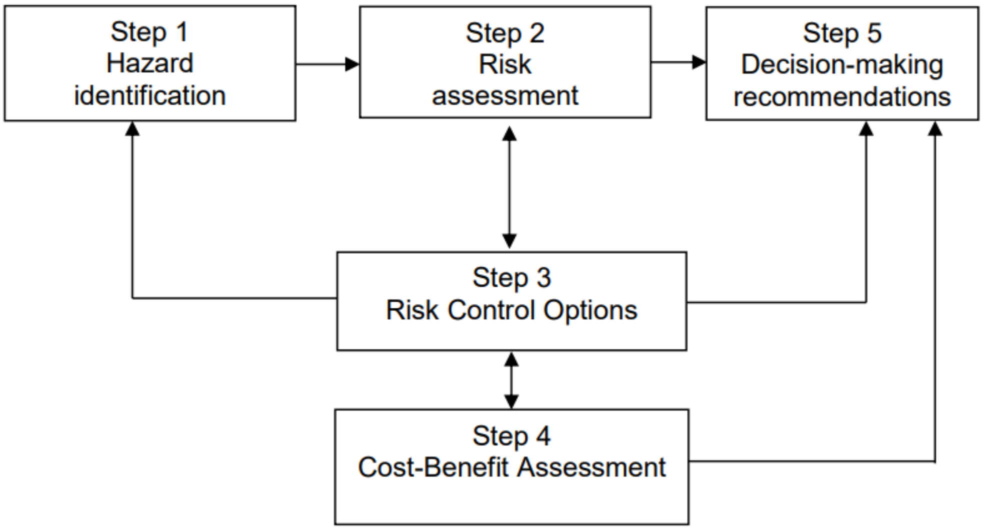


Figure 3.1 Flow chart of the FSA methodology (IMO, 2018)

3.2.1 Hazard Workshop Methodology

A key tool used in the NRA process is the Hazard Workshop which ensures that all risks are identified and qualified in agreement with Interested Parties prior to assessment within the EIA matrices contained within **Volume 2, Chapter 8: Shipping and Navigation**. Table 3.1 and Table 3.2 identify how the severity of consequence and the frequency of occurrence will be defined within the hazard log, respectively. It is noted that these rankings are the same as those used for the previous Hornsea projects to ensure comparison is possible.

Table 3.1 Severity of consequence ranking definitions

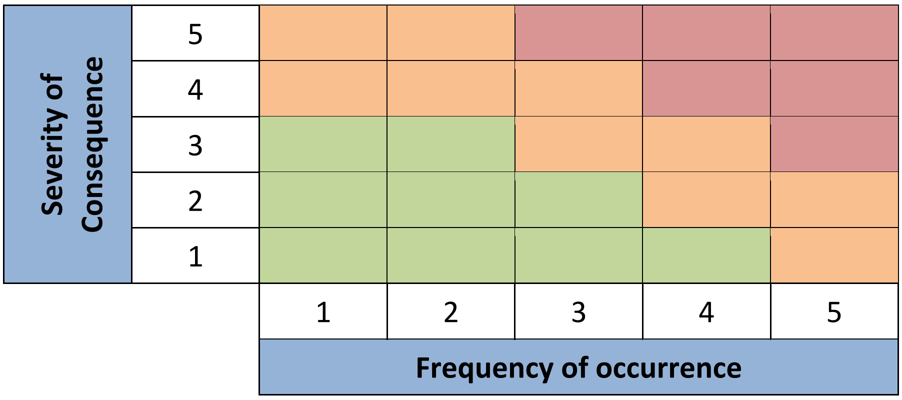
Rank	Description	Definition			
		People	Property	Environment	Business
1	Negligible	No perceptible impact	No perceptible impact	No perceptible impact	No perceptible impact
2	Minor	Slight injury(s)	£10,000–£100,000	Tier 1 local assistance required	£10,000–£100,000
3	Moderate	Multiple minor or single serious injury	£100,000–£1 million	Tier 2 limited external assistance required	£100,000–£1 million and local publicity
4	Serious	Multiple serious injury or single fatality	£1 million–£10 million	Tier 2 regional assistance required	£1 million–£10 million and national publicity
5	Major	More than one fatality	>£10 million	Tier 3 national assistance required	>£10 million and international publicity

Table 3.2 Frequency of occurrence ranking definitions

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

The severity of consequence and frequency of occurrence are then considered collectively using the ranking system to provide the level of tolerability of an impact; the tolerability matrix is presented in Table 3.3. The tolerability of an impact is defined as Broadly Acceptable (low risk), Tolerable (intermediate risk) or Unacceptable (high risk).

Table 3.3 Tolerability matrix and risk rankings



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

Once identified, the tolerability of an impact will be assessed to ensure it is ALARP. Further risk control measures may be required to further mitigate an impact in accordance with ALARP principles. Unacceptable risks are not considered to be ALARP.

Outputs of the hazard log will be used as evidence to support and refine the impact assessment contained within **Volume 2, Chapter 8: Shipping and Navigation.**

3.3 Methodology for Cumulative Effect Assessment

The impacts identified in the FSA are also assessed for cumulative effects with the inclusion of other projects and proposed developments – the Cumulative Effect Assessment (CEA) (see **Volume 4, Annex 5.3: Cumulative Effects**). Given the varying status and location of developments, a tiered approach to cumulative assessment has been undertaken, which splits developments into tiers depending upon project status, proximity to Hornsea Four and the level to which they are anticipated to cumulatively impact relevant users. It also considered data confidence i.e. whether a project may be decommissioned prior to or after the development of Hornsea Four. This is a more systematic approach than was undertaken for the previous Hornsea developments which relied upon the outcome of assessment undertaken as part of the Southern North Sea Offshore Wind Forum (SNSOWF).

The tiers are summarised in Table 3.4, with the level of assessment undertaken for each tier included.

Table 3.4 Cumulative development screening summary

Tier	Project Status	Description	Data Confidence Level	Level of CEA
1	Operational, under construction, consented or under determination	▪ May impact a main route passing within 1 nautical mile (nm) of the Hornsea Four array area or HVAC booster station search area and/or interacts with traffic which may be directly displaced by the Hornsea Four array area or HVAC booster station search area. *Offshore wind farms:* ▪ Up to 50 kilometres (km) from the Hornsea Four array area, offshore ECC or HVAC booster station search area. *Oil and gas infrastructure:* ▪ Up to 10 km from the Hornsea Four array area or HVAC booster station search area; or ▪ Up to 5 km from the Hornsea Four offshore ECC.	High or medium	Quantitative cumulative re-routeing of main routes

Tier	Project Status	Description	Data Confidence Level	Level of CEA
2	Operational, under construction, consented or under determination	▪ May impact a main route passing within 1 nm of the Hornsea Four array area or HVAC booster station search area and/or interacts with traffic which may be directly displaced by the Hornsea Four array area or HVAC booster station search area. *Offshore wind farms:* ▪ Between 50 km and 100 km from the Hornsea Four array area, offshore ECC or HVAC booster station search area. *Oil and gas infrastructure:* ▪ Between 10 km and 20 km from the Hornsea Four array area or HVAC booster station search area; or ▪ Between 5 km and 10 km from the Hornsea Four offshore ECC.	High or medium	Qualitative cumulative re-routeing of main routes
3	Scoped or under examination	▪ Does not impact a main route passing within 1 nm of the Hornsea Four array area or HVAC booster station search area and does not interact with traffic which may be directly displaced by the Hornsea Four array area or HVAC booster station search area. *Offshore wind farms:* ▪ Up to 100 km from the Hornsea Four array area, offshore ECC or HVAC booster station search area. *Oil and gas infrastructure:* ▪ Up to 20 km from the Hornsea Four array area or HVAC booster station search area; or ▪ Up to 10 km from the Hornsea Four offshore ECC.	Low	Qualitative assumptions of routeing only

Offshore wind farm developments are screened out if they are over 100 km from Hornsea Four or within 100 km of Hornsea Four but not yet scoped.

Similarly, oil and gas infrastructure is screened out if over 20 km from the Hornsea Four array area or HVAC booster station search area or over 10 km from the Hornsea Four offshore ECC or within these parameters but not yet scoped.

These distances represent a conservative approach, noting that beyond these distances it is not considered feasible that a cumulative effect would be present. This is a typical approach undertaken for the CEA in NRAs.

3.4 Assumptions

The shipping and navigation baseline and impact identification has been undertaken based upon the information available and responses received at the time of preparation. It was assessed based upon a conservative scenario, in particular noting that the locations of structures will not be finalised until post consent but will follow the Layout Principles provided in **Volume 4, Annex 4.7: Layout Principles** which are a commitment included as part of Hornsea Four (see Section 22).

4 Consultation

4.1 Types of Stakeholder

There are various stakeholder types; these are outlined in Table 4.1 and are as per the descriptions defined in the *Methodology for Assessing the Marine Navigational Safety & Emergency Response Risks of Offshore Renewable Energy Installations (OREI)* (MCA, 2013).

Table 4.1 Description of stakeholder types

Type of Stakeholder	Description
Risk imposer	Includes those whose actions or policies result in a risk and need action.
Risk taker	Includes those who action or inaction results in a risk.
Risk beneficiary	Includes those who benefit from imposing or taking a risk.
Risk payer	Includes those who pay for the management of a risk.
Risk sufferer	Includes those who suffer the consequence of a risk.
Risk observer	Includes those aware of a risk but affect directly by the risk.

In order to ensure that all stakeholders and their interested users were included within the NRA process, a review of stakeholder types was undertaken in line with the baseline study. Stakeholders have been represented by organisations who have different roles including:

- Proposers who are proposing the development;
- Approvers who are responsible for giving the development consent;
- Advisors who are formally consulted by the approvers;
- Users who are not formally consulted by the approvers but who may wish to provide input to them; and
- Observers.

4.2 Stakeholders Consulted in the Navigational Risk Assessment Process

Key marine and navigation stakeholders have been consulted in the NRA process. The following stakeholders have been or will be consulted via dedicated meetings:

- MCA;
- Trinity House (TH);
- Chamber of Shipping;
- RYA;
- Cruising Association (CA); and
- VISNED.

The Marine Management Organisation (MMO) has been consulted as part of the wider EIA process and consultation with Regular Operators has also been undertaken including through the Hazard Workshop. Consultation has also been undertaken with commercial fishery organisations as part of **Volume 2, Chapter 7: Commercial Fisheries**. A summary of the key consultation for Hornsea Four is provided in Section 14.

5 Data Sources

This section summarises the main data sources used in assessing the shipping and navigation baseline relative to Hornsea Four.

5.1 Summary of Data Sources

The main data sources used in assessing the shipping and navigation baseline relative to Hornsea Four are outlined in Table 5.1.

Table 5.1 Data sources used to inform shipping and navigation baseline

Data	Source(s)
Vessel traffic	▪ Automatic Identification System (AIS) summer survey data for the Hornsea Four array area shipping and navigation study area (14 days June 2018); ▪ AIS summer survey data for the Hornsea Four offshore ECC and HVAC booster station search area shipping and navigation study areas (14 days June 2018). ▪ AIS, visual and Radio Detecting and Ranging (Radar) winter survey data for the Hornsea Four array area shipping and navigation study area (14 days January/February 2019); and ▪ AIS, visual and Radar winter survey data for the Hornsea Four offshore ECC and HVAC booster station search area shipping and navigation study areas (14 days January/February 2019).
Maritime incidents	▪ Maritime Accident Investigation Branch (MAIB) marine accidents database (2005 to 2014); ▪ Royal National Lifeboat Institution (RNLI) incident data (2008 to 2017); and ▪ Department for Transport (DfT) UK civilian Search and Rescue (SAR) helicopter taskings (2016 to 2018).
Marine aggregate dredging	▪ Marine aggregate dredging areas (licenced and active) (The Crown Estate (TCE), 2019); and ▪ Transit routes (British Marine Aggregate Producers Association (BMAPA), published 2009, downloaded 2019).
Recreational traffic density and features	▪ *UK Coastal Atlas of Recreational Boating 2.0* (RYA, 2016).
Other navigational features	▪ Admiralty Charts 266, 1187, 1190, 1191 and 2182A (United Kingdom Hydrographic Office (UKHO), 2019).

The vessel traffic survey data recorded from a dedicated vessel on site and used in the NRA is summarised in Table 5.2.

It is noted that further dedicated vessel surveys for the Hornsea array area and HVAC booster station search area are planned for July/August 2019 and will be incorporated into the baseline assessment for the final NRA submitted alongside the ES. These surveys do not yet have specific dates but will each span 14 days as per the winter surveys and use the same vessel and AIS and Radar systems. The methodology for the vessel traffic survey data is outlined in Section 7.

Table 5.2 Summary of dedicated vessel traffic survey data

Survey Feature	Survey Period	
	11th January to 2nd February 2019	13th January to 15th February 2019
Location	Hornsea Four array area	Hornsea Four HVAC booster station search area
Data Type	AIS, visual and Radar	AIS, visual and Radar
Data Capture (Full Days)	14 days	14 days
Vessel	*Karima*	*Karima*
AIS System Type	JRC LHS-183	JRC LHS-183
Radar System Type	JRC JMA 5300Mk2	JRC JMA 5300Mk2
Personnel	Bridge crew (dedicated)	Bridge crew (dedicated)

5.2 Study Areas

5.2.1 Hornsea Four Array Area Shipping and Navigation Study Area

A 10 nautical mile (nm) buffer has been applied around the Hornsea Four array area, as shown in Figure 5.1. This study area has been defined in order to provide local context to the analysis of risks by capturing the relevant routes and vessel traffic movements within and in proximity to the proposed Hornsea Four array area. This 10 nm study area has been used within the majority of UK offshore wind farm NRAs including those for the previous Hornsea developments.

5.2.2 Hornsea Four Offshore Cable Corridor Shipping and Navigation Study Area

A 2 nm buffer has been applied around the Hornsea Four offshore ECC, as shown in Figure 5.1. As with the Hornsea Four array area shipping and navigation study area, this study area has been defined in order to capture relevant receptors and their movements within and near the Hornsea Four offshore ECC. The study area runs between the Mean Low Water Springs (MLWS) and the boundary of the Hornsea Four array area.

5.2.3 Hornsea Four HVAC Booster Station Search Area Shipping and Navigation Study Area

A 10 nm buffer has been applied around the Hornsea Four HVAC booster station search area within the Hornsea Four offshore ECC, as shown in Figure 5.1. Again, this study area has been defined in order to capture relevant receptors and their movements within and near the Hornsea Four HVAC booster station search area.

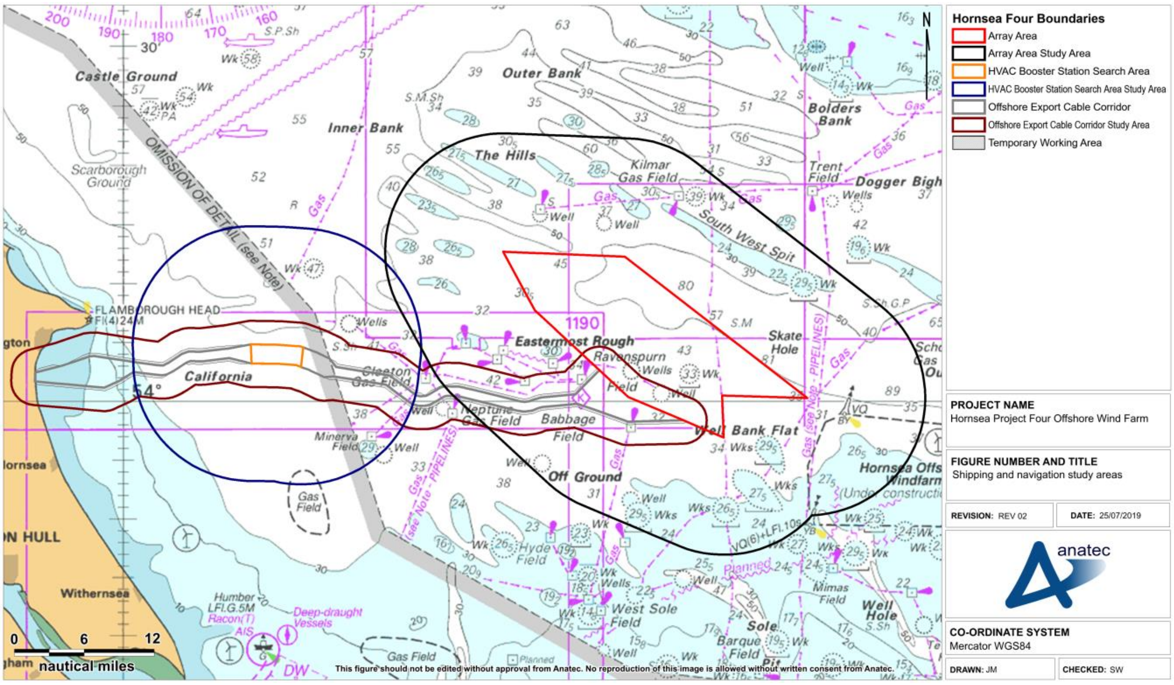


Figure 5.1 Shipping and navigation study areas

5.2.4 Hornsea Four Cumulative Shipping and Navigation Study Area

Changes to routeing at a cumulative level have been assessed in detail within a 10 nm buffer of the Hornsea Four array area, i.e. within the Hornsea Four array area shipping and navigation study area (see Section 5.2.1). Details of the methodology used to identify cumulative receptors are given in Section 3.3, noting that the receptors considered extend well beyond the Hornsea Four cumulative shipping and navigation study area.

5.3 Data Limitations

The desk based AIS data used to inform the existing baseline was the most up to date publicly available information at the time of retrieval. The data is therefore limited by what was available and by what has been made available, at the time of writing the NRA. However, as noted in Section 5.1, further dedicated vessel surveys are planned and will be incorporated into the baseline assessment for the final NRA submitted alongside the ES.

It is noted that specific agreement was given by the MCA and TH for the use of an AIS only dataset for characterising vessel movements within the Hornsea Four offshore ECC shipping and navigation study area (excluding where this intersects the Hornsea Four HVAC booster station shipping and navigation study area). Consequently, there will be limitations with the data associated with non-AIS targets.

6 Lessons Learnt

There is considerable benefit for the Applicant in the sharing of lessons learnt within the offshore industry. The NRA, and in particular the impact assessment, includes general consideration for lessons learnt and expert opinion from previous offshore wind farm developments and other sea users, capitalising upon the UK's position as a leading generator of offshore wind power.

Data sources for lessons learnt include the following:

- *Sharing the Wind – Recreational Boating in the Offshore Wind Strategic Areas* (RYA & CA, 2004);
- *Results of the Electromagnetic Investigations* (MCA & QinetiQ, 2004);
- *Offshore Wind and Marine Energy Health and Safety Guidelines* (RenewableUK, 2014);
- *Offshore Wind Farm Helicopter Search and Rescue Trials Undertaken at the North Hoyle Wind Farm* (MCA, 2005);
- *Interference to Radar Imagery from Offshore Wind Farms* (Port of London Authority (PLA), 2005);
- *Hornsea Three Offshore Wind Farm Environmental Statement Volume 2, Chapter 7: Shipping and Navigation* (Ørsted Energy, 2018);
- *Strategic Assessment of Impacts on Navigation of Shipping and Related Effects on Other Marine Activities Arising from the Development of Offshore Wind Farms in the UK REZ* (Anatec & TCE, 2012); and
- *G+ Global Offshore Wind Health & Safety Organisation 2018 Incident Data Report* (G+, 2019).

7 Marine Traffic Survey Methodology

This section describes the survey methodology used when recording vessel traffic data for the Hornsea Four array area, offshore ECC and HVAC booster station search area shipping and navigation study areas.

7.1 Baseline Survey Methodology

Baseline shipping activity for the Hornsea Four array area and HVAC booster station search area was assessed using AIS, visual and Radar track data. The period of data collection encompassed both seasonal fluctuations in shipping activity (i.e. summer/winter) and changing tidal conditions. As agreed with the MCA (see Table 8.3 in **Volume 2, Chapter 8: Shipping and Navigation**), and in line with standard practice, a vessel-based traffic survey of the sections of the Hornsea Four offshore ECC outside of the Hornsea Four HVAC booster station search area shipping and navigation study area was not required.

The survey vessel used at the Hornsea Four array area and HVAC booster station search area for the winter surveys was the *Karima*. A vessel-based traffic survey for the summer period will be undertaken in July/August 2019 and the outputs will be fed into the final NRA submitted alongside the ES, thus ensuring the baseline shipping activity assessment is compliant with MGN 543.

7.2 AIS Carriage Requirements and Coverage

The carriage of AIS is required on board all vessels of greater than 300 Gross Register Tonnage (GRT) engaged on international voyages, cargo vessels of more than 500 GRT not engaged on international voyages, passenger vessels irrespective of size built on or after 1st July 2002, and fishing vessels over 15 metres (m) length overall (LOA).

Therefore, larger vessels were recorded on AIS, while smaller vessels without AIS installed (i.e. fishing vessels under 15 m LOA and recreational craft) were recorded, where possible, on the Automatic Radar Plotting Aid (ARPA) radar on board the *Karima*. A proportion of smaller vessels also carry AIS voluntarily.

7.3 Commercial Vessels Dataset

The desktop vessel traffic data for the baseline navigation review of the Hornsea Four array area includes a combined dataset of 28 full days of AIS across two survey periods:

- 17th to 30th June 2018 (14 days summer); and
- 11th January to 2nd February 2019 (14 days winter).

The site specific winter survey was undertaken from the *Karima* survey vessel located at the Hornsea Four array area and incorporates visual and Radar data in addition to AIS data. As noted in Section 7.3, a further vessel-based survey will be carried out for the summer period in July/August 2019 and included in the final NRA as part of the ES.

For the Hornsea Four offshore ECC and HVAC booster station search area a combined dataset of 28 full days of AIS across two survey periods has therefore been used:

- 17th to 30th June 2018 (14 days summer); and
- 13th January to 15th February (14 days winter).

The site specific winter survey was undertaken from the *Karima* survey vessel located at the Hornsea Four HVAC booster station search area within the Hornsea Four offshore ECC, and incorporates visual and Radar data in addition to AIS data. For the Hornsea Four offshore ECC the vessel-based survey data has been supplemented with AIS data from on-shore sources. As with the Hornsea Four array area, a further vessel-based survey will be carried out for the Hornsea Four HVAC booster station search area for the summer period in July/August 2019 and included in the final NRA as part of the ES.

7.4 Recreational Activity

The RYA and CA represent the interests of recreational users including yachting and motor cruising. In 2005 the RYA, supported by TH and the CA, compiled and presented a comprehensive set of charts which defined the cruising routes, general sailing and race areas used by recreational craft around the UK coast. This information has been subsequently updated and is published as the *UK Coastal Atlas of Recreational Boating 2.0* (RYA, 2016). Geographical Information System (GIS) shapefiles from this publication, including a recreational AIS density grid in proximity to the east Yorkshire coast, have been used in this assessment.

The RYA has also developed a detailed position statement (RYA, 2015) based upon analysed data for common recreational craft which has been used to inform the NRA.

In addition, recreational vessel data was extracted from the vessel tracks recorded during the vessel traffic surveys.

7.5 Fishing Activity

Fishing vessel data was extracted from the vessel tracks recorded during the vessel traffic surveys.

In addition, data compiled in **Volume 2, Chapter 7: Commercial Fisheries** has been validated against the outputs of the vessel traffic surveys.

8 Other Offshore Users

8.1 Oil and Gas Installations

Offshore oil and gas installation data was assessed using charted information and research. For the purposes of the NRA, fixed platforms and wellheads which may impact a surface vessel's transit are considered. A desktop study was undertaken using these data to identify any possible cumulative effects with offshore oil and gas developments.

8.2 Marine Aggregate Dredging

Licenced and active marine aggregate dredging areas data was supplied by TCE and transit routes of marine aggregate dredgers was supplied by BMAPA. A desktop study was undertaken using these data to identify commercial aggregate dredging activity in proximity to Hornsea Four.

8.3 Other Navigational Features

Other navigational features including IMO routeing measures, Ministry of Defence (MOD) Practice and Exercise Areas (PEXA) and aids to navigation have been considered based upon charted information.

9 Maximum Design Scenario

The NRA reflects the design envelope which is outlined in full in **Volume 1, Chapter 4: Project Description**. The following subsections outline the maximum extent of Hornsea Four for which any shipping and navigation impacts are assessed.

9.1 Hornsea Four Development Boundaries

The proposed Hornsea Four array area is located approximately 35 nm (65 kilometres (km)) east of the UK coast, at Flamborough Head, East Riding of Yorkshire. The total area of the Hornsea Four array area is approximately 175 nm^2 (600 km^2) with water depths within the Hornsea Four array area ranging from between 31 m and 63 m below Lowest Astronomical Tide (LAT).

The coordinates defining the boundary of the Hornsea Four array area are illustrated in Figure 9.1 and provided in Table 9.1. It is noted that the Hornsea Four array area has been refined following the Scoping Report based on impact investigations, with the total area reduced by approximately 30%.

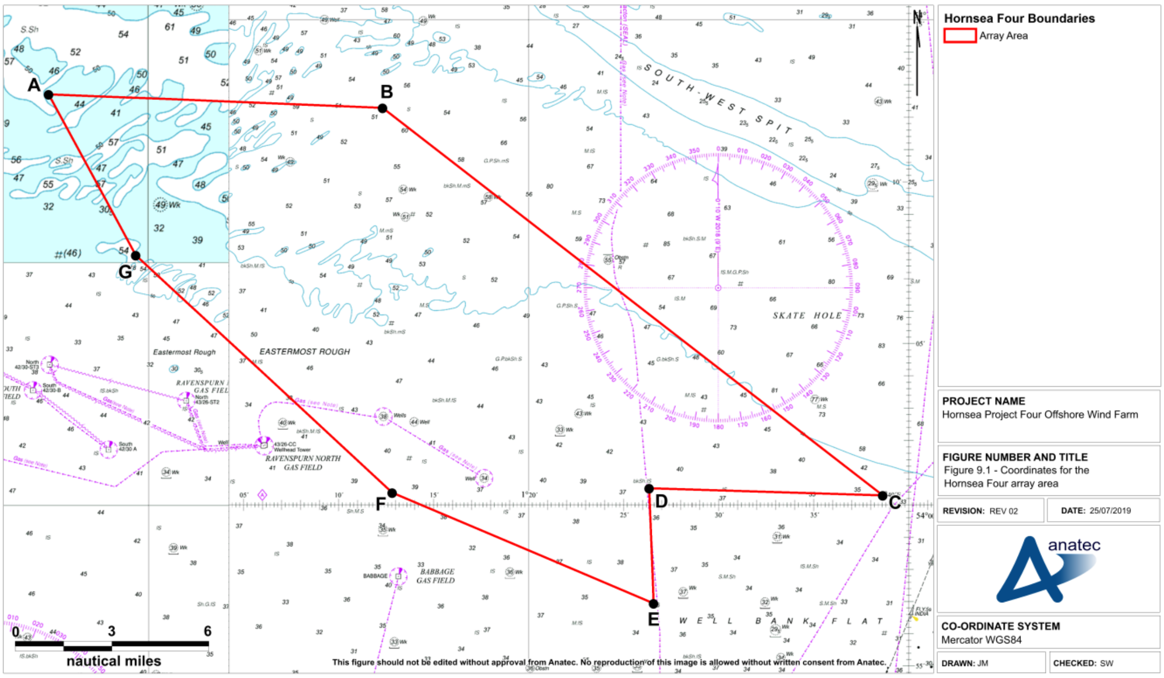


Figure 9.1 Coordinates for the Hornsea Four array area

Table 9.1 Coordinates for the Hornsea Four array area

Point	Latitude (World Geodetic System 1984 (WGS84))	Longitude (WGS84)
A	54° 12' 42.27''	000° 54' 44.36''
B	54° 12' 17.41''	001° 12' 18.26''
C	54° 00' 18.48''	001° 38' 37.32''
D	54° 00' 31.63''	001° 26' 19.99''
E	53° 56' 57.08''	001° 26' 33.77''
F	54° 00' 23.32''	001° 12' 48.81''
G	54° 07' 44.32''	000° 59' 19.03''

The layout of array infrastructure used to inform the assessment is shown in Figure 9.2 and includes a minimum spacing of 810 m tip t tip between all structures (including on the array area boundary) and a single line of orientation. The layout comprises the maximum number of structures within the array area (190 total) and thus represents the MDS for shipping and navigation.

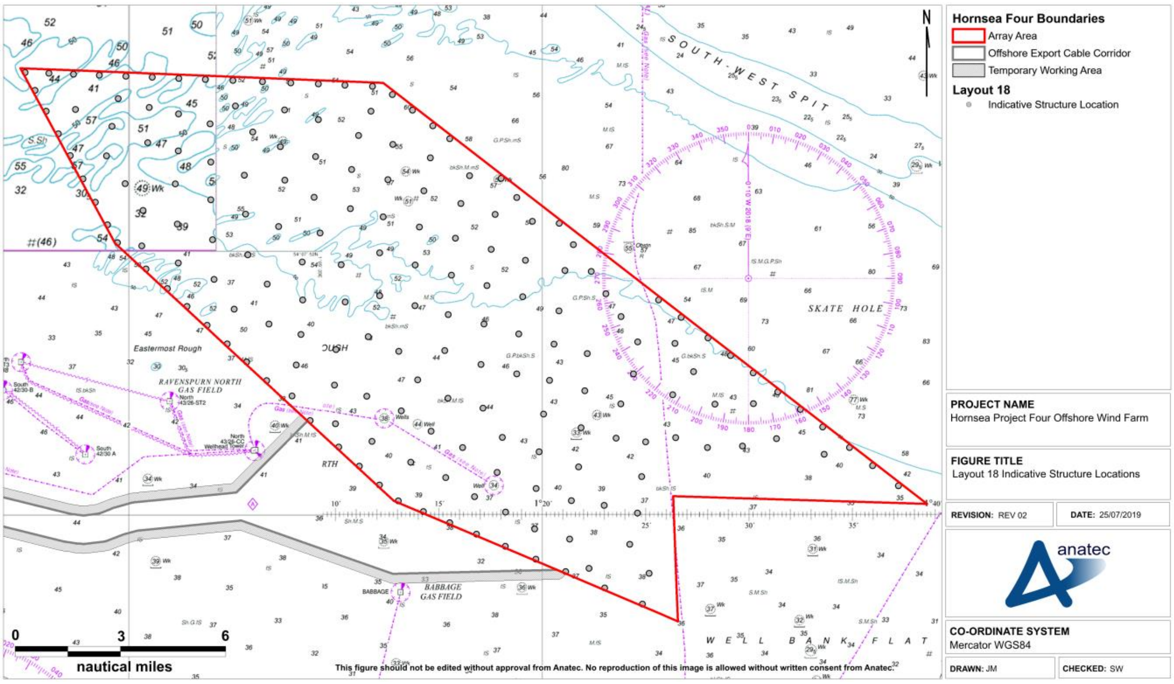


Figure 9.2 Overview of Layout (190 infrastructure locations)

9.2 Array Area Infrastructure

Layout incorporates 190 structures as follows:

- 180 WTGs;
- Six offshore transformer substations;
- Three offshore HVDC converter substations; and
- One accommodation platform.

It is noted that locations for substations and the accommodation platform have not yet been defined – for the collision and allision modelling in the final NRA submitted alongside the ES a MDS of these structures for shipping and navigation will be determined.

9.2.1 Wind Turbine Generators

The WTGs within the layout each have a maximum rotor blade diameter of 305 m and maximum blade tip height (above LAT) of 370 m.

Suction bucket jacket foundations have been considered as the MDS for shipping and navigation as this foundation type provides the maximum structure dimension at the sea surface. The MDS WTG measurements assuming use of suction bucket jacket foundation design for the layout are provided in Table 9.2.

Table 9.2 MDS for WTGs

Parameter	Specification for Layout
Foundation type	Suction bucket jacket
Dimensions at sea surface (dependent upon water depth, geology and WTG type)	25 m
Hub height	217.5 m
Maximum blade tip height (above LAT)	370 m
Minimum blade tip height (above LAT)	36.8 m
Maximum rotor blade diameter	305 m

Other foundation types under consideration include monopiles, mono suction buckets and piled jackets. Descriptions of each of these foundation types are provided in **Volume 1, Chapter 4: Project Description**.

9.2.2 Other Array Area Infrastructure

The number of other (non-WTG) array area structures and their maximum dimensions in relation to the layout are provided in Table 9.3.

Table 9.3 MDS for other array area infrastructure

Structure	Number	Maximum Sea Surface Dimensions (m)
Offshore transformer substation	6	170

Structure	Number	Maximum Sea Surface Dimensions (m)
Offshore HDVC converter substation	3	
Accommodation platform	1	75

9.3 Offshore Export Cable Corridor Infrastructure

9.3.1 HVAC Booster Stations

If the HVAC transmission option is selected, HVAC booster stations will be required. These will be located within the Hornsea Four HVAC booster station search area which itself is located within the Hornsea Four offshore ECC. If the HVDC transmission option is selected, then no HVAC booster stations will be required. Therefore the HVAC transmission option represents a conservative MDS in terms of the number of structures within the offshore ECC which may impact upon shipping and navigation.

Since the final location of the Hornsea Four HVAC booster stations is not known, deviations of main routes have been undertaken based on the concept of a full site build out, i.e. deviations around the complete Hornsea Four HVAC booster station search area. In reality, up to three HVAC booster stations may be constructed each with maximum sea surface dimensions of 170 m. It is intended that for the final NRA submitted alongside the ES main route deviations and collision and allision risk modelling will be undertaken around specific locations deemed to be the MDS.

9.3.2 Cables

Hornsea Four will require various types of submarine cables which can be separated into three main categories:

- Inter array cables;
- Interconnector cables; and
- Export cables.

9.3.2.1 Inter Array Cables

The inter array cables will connect individual WTGs to offshore transformer substations. Up to 324 nm (600 km) of inter array cables will be required with the total length determined by considerations such as the final array layout and voltage capacity.

9.3.2.2 Interconnector Cables

The interconnector cables will provide interlink connections between the offshore platforms within the array area. Up to six interconnector cables will be required, with a total length of up to 49 nm (90 km), depending upon the final array layout and number of substations.

9.3.2.3 Export Cables

The Hornsea Four offshore ECC runs for 53 nm (99 km) from the western boundary of the Hornsea Four array area to the landfall area on the east Yorkshire coast south of Bridlington. Up to six export cables of 320 millimetre (mm) diameter will be installed, depending upon the transmission option selected, with a total length of up to 353 nm (654 km) (including export cable within the array area).

The process of selection and routeing of the Hornsea Four offshore ECC has avoided, where possible, significant and environmental constraints, such as deep water and marine aggregate dredging areas (see **Volume 4, Annex 3.2: Selection and Refinement of Offshore Infrastructure**).

9.3.2.4 Cable Burial

Where available, the primary means of cable protection will be by seabed burial. The extent and method by which the subsea cables will be buried will depend on the results of a detailed seabed survey of the final cables routes and associated Cable Burial Risk Assessment (CBRA). Cable protection methods may be used where burial is not possible; this again will be assessed within the CBRA. In addition, cable protection will be used where cables cross existing seabed assets, such as existing cables and pipelines.

9.4 Construction Phase

The offshore construction phase will last up to three years and be undertaken in a single phase. Figure 9.3 provides an indicative construction programme for Hornsea Four which indicates the maximum duration of construction for each element of Hornsea Four.

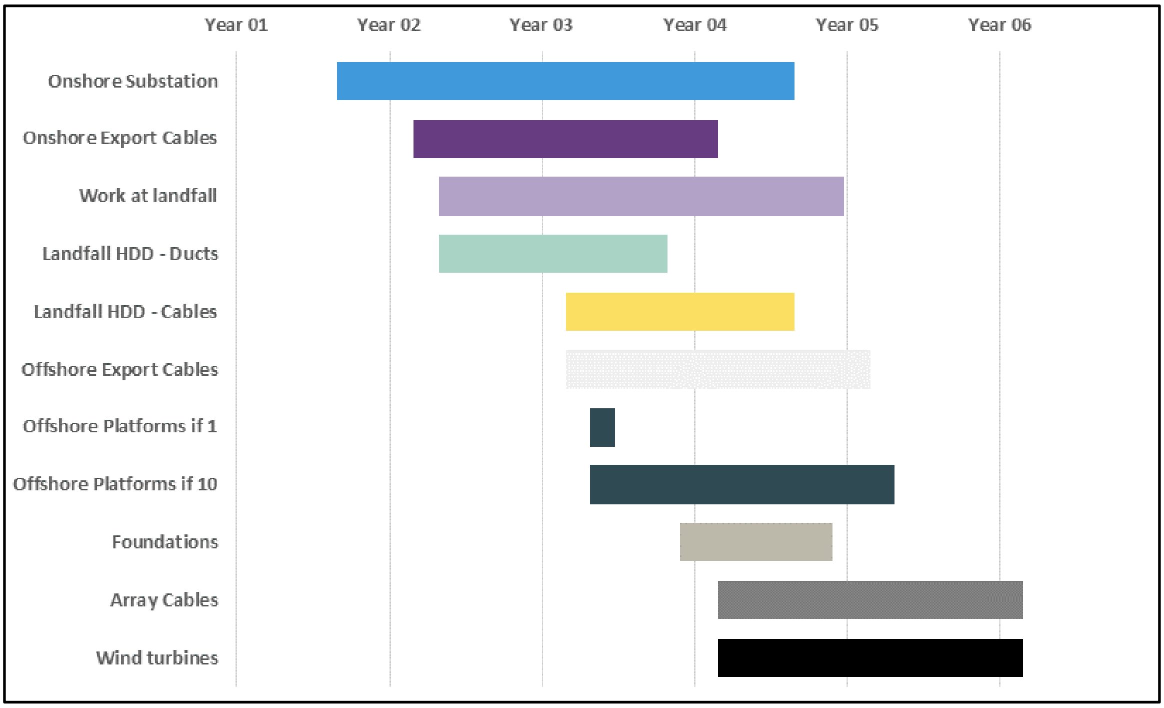


Figure 9.3 Indicative construction programme

9.5 Indicative Vessel Numbers

9.5.1 Construction Vessels

Up to 3,906 return trips per year by construction vessels may be made throughout the construction phase, breaking down as follows (noting that numbers are indicative and assumed to be a worst case for shipping and navigation):

- Up to 60 construction vessels for the WTG foundations engaged at any given time with up to 810 return trips;
- Up to 38 construction vessels for the WTGs engaged at any given time with up to 900 return trips;
- Up to 18 construction vessels for the substation foundations engaged at any given time with up to 180 return trips;
- Up to 18 construction vessels for the accommodation platform engaged at any given time with up to 30 return trips;
- Up to 18 construction vessels for the inter array and interconnector cables engaged at any given time with up to 1,488 return trips;
- Up to 24 construction vessels for the export cables engaged at any given time with up to 408 return trips; and
- Up to 18 construction vessels for the HVAC booster stations engaged at any given time with up to 90 return trips.

9.5.2 Operation and Maintenance Vessels

An indicative 3,525 return trips per year by operation and maintenance vessels is assumed to be a worst case for shipping and navigation over an anticipated 35-year operational life for Hornsea Four.

During both the construction and operation and maintenance phases logistics will be managed by a marine coordination team and an integrated Health, Safety and Environment (HSE) management system will be in place to ensure control of all vessels and their respective works. The project will be operational 24/7.

9.6 Summary of Maximum Design Scenario

The MDS for each shipping and navigation impact is outlined in **Volume 2, Chapter 8: Shipping and Navigation** and is based upon the parameters described in the preceding subsections.

10 Existing Environment

A plot of navigational features in proximity to the Hornsea Four array area and offshore cable corridor is presented in Figure 10.1. Each of the features shown is discussed in the following subsections and has been identified using the most detailed UHKO Admiralty Chart available. Features within the Humber Port Limits have been excluded from all figures in this section due to the lack of proximity to Hornsea Four.

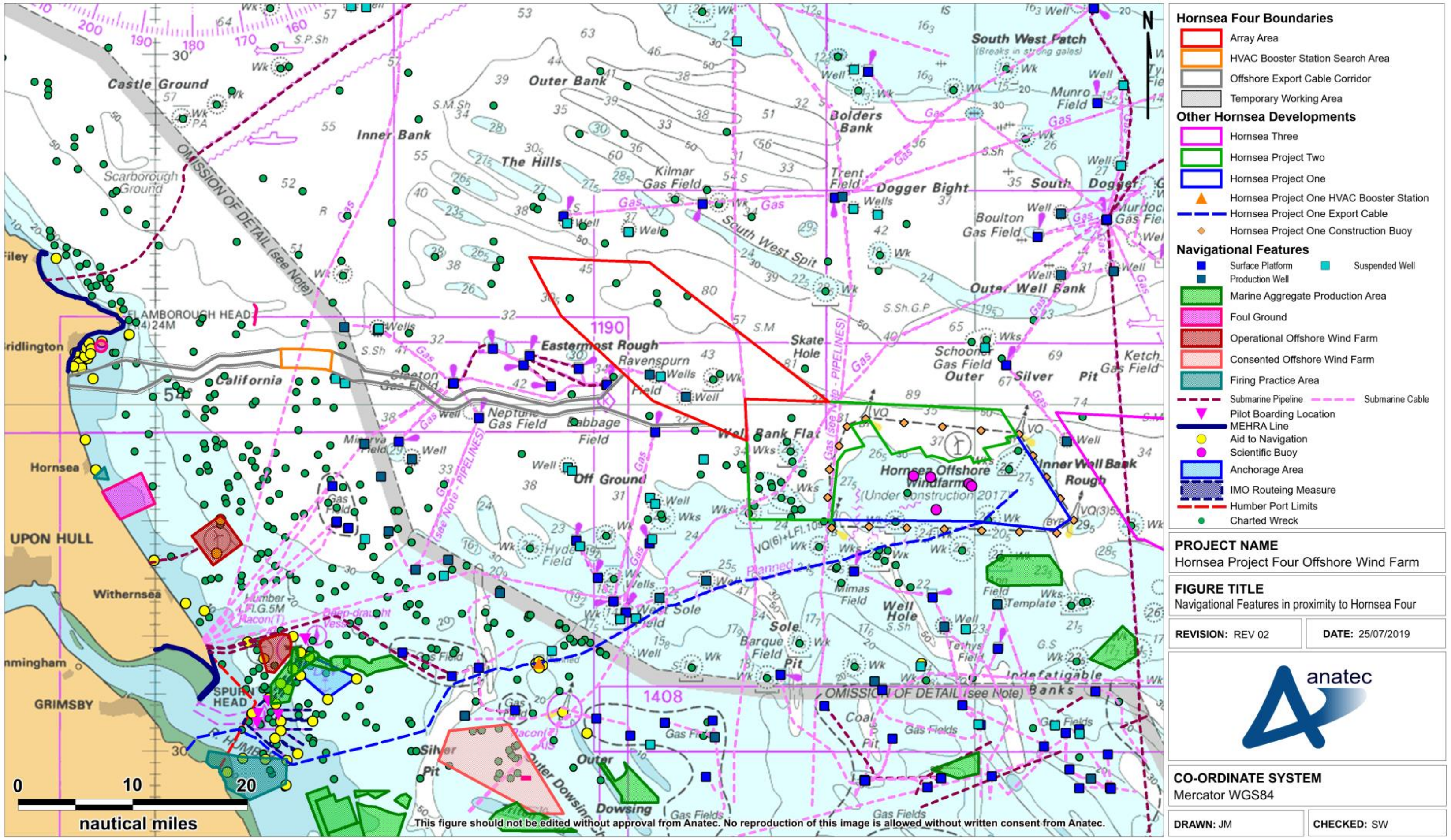


Figure 10.1 Navigational features in proximity to Hornsea Four

10.1 Other Offshore Wind Farm Developments

A plot of nearby UK offshore wind farm developments (operational or otherwise) in addition to Hornsea Four is presented in Figure 10.2.

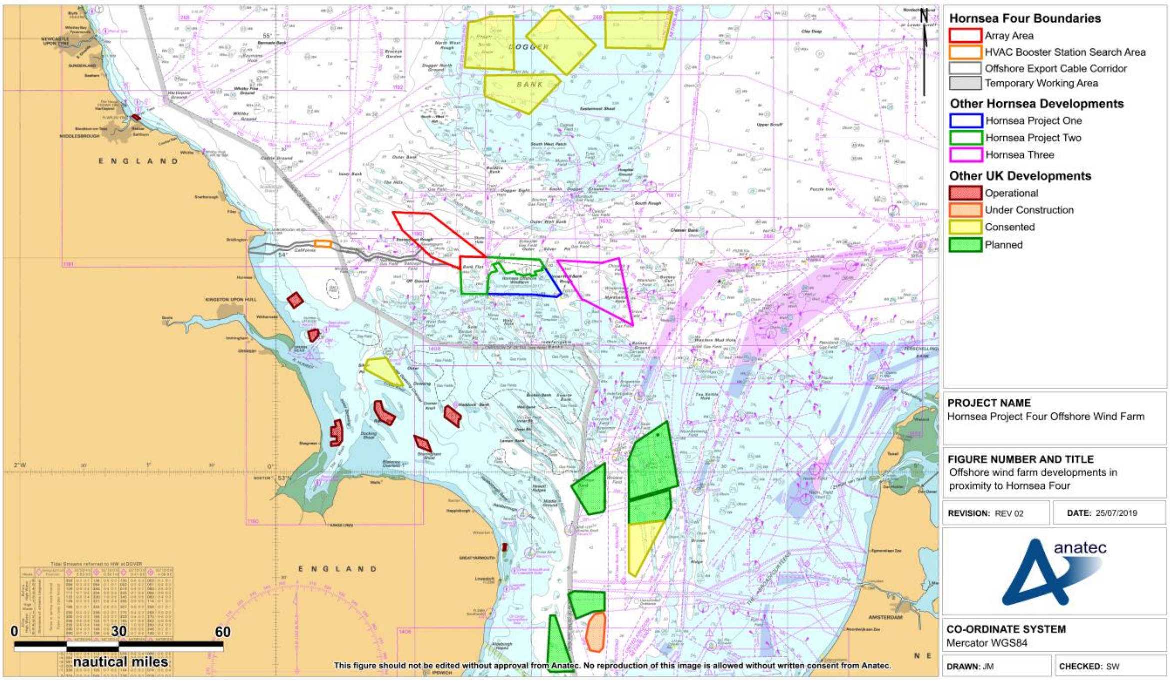


Figure 10.2 Offshore wind farm developments in proximity to Hornsea Four

The Hornsea Four array area shares a section of its boundary with the site boundary for Hornsea Project Two. Hornsea Project One and Hornsea Three are located approximately 2.7 nm and 19.4 nm from the Hornsea Four array area, respectively. Hornsea Project One is under construction (and borders Hornsea Two) and is scheduled to be fully commissioned in 2020. Hornsea Project Two was awarded consent in August 2016 and Hornsea Three is currently in the determination phase.

Beyond the former Hornsea Zone, there are other Round 3 sites located within the southern North Sea. Namely, the former Dogger Bank Zone and the former East Anglia Zone are located approximately 36 nm north east and 62 nm south east of the Hornsea Four array area, respectively. None of the sites within these zones are operational although the Dogger Bank sites and East Anglia THREE have been awarded consent and East Anglia ONE commenced offshore construction in June 2018 and is scheduled to be fully commissioned in 2020.

Since Hornsea Project One is under construction and will be operational by the time of Hornsea Four construction, it is considered as part of the baseline assessment. All other offshore wind farm developments (including non-UK developments not shown in Figure 10.2) within the wider southern North Sea which are not yet operational are considered only in the cumulative assessment – further information is given in Section 20.1.

10.2 Oil and Gas Features

A plot of surface platforms, production wells and suspended wells relating to the oil and gas sector is presented in Figure 10.3. Submarine pipelines relating to oil and gas features are outlined in Section 10.4.

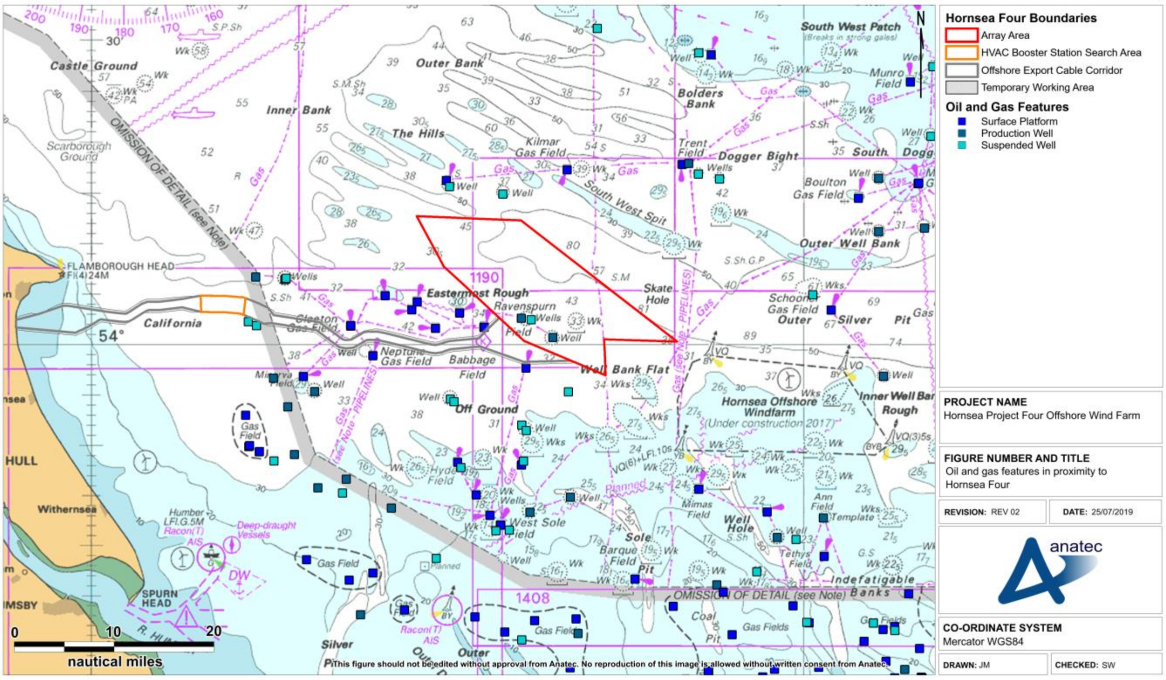


Figure 10.3 Oil and gas features in proximity to Hornsea Four

There are two production wells connected to the Ravenspurn North CCW platform (part of the Ravenspurn North Central Complex) which are located within the Hornsea Four array area alongside a suspended well. Details of the surface platforms located within 5 nm of the Hornsea Four array area are provided in Table 10.1. All fields in proximity to Hornsea Four are currently producing with the exception of the Cleeton field whose infrastructure is now used as a gathering hub for the Easington Catchment Area (ECA).

Table 10.1 Oil and gas surface platforms within 5 nm of Hornsea Four array area

Surface Platform	Field (Oil/Gas)	Operator	Closest Distance to Hornsea Four Array Area (nm)
Ravenspurn North Central Complex & CCW	Ravenspurn North (gas)	Perenco	1.6
Ravenspurn North ST2	Ravenspurn North (gas)	Perenco	2.2
Babbage	Babbage (gas)	Spirit Energy	2.4

Surface Platform	Field (Oil/Gas)	Operator	Closest Distance to Hornsea Four Array Area (nm)
Garrow	Garrow (gas)	Alpha Petroleum	3.8
Ravenspurn North ST3	Ravenspurn North (gas)	Perenco	4.3
Ravenspurn South Alpha	Ravenspurn South (gas)	Perenco	4.9

Ravenspurn North CCW, Ravenspurn North CC and Babbage are the closest surface platforms to the Hornsea Four offshore cable corridor, with closest distances approximately 390 m, 420 m and 480 m, respectively. There are no surface platforms currently in proximity to the Hornsea Four HVAC booster station search area, although there is a production well approximately 2.4 nm to the north east. It is noted that the Tolmount field is expected to be developed in the near future and will include a surface platform located approximately 0.73 nm south east of the Hornsea Four HVAC booster station search area.

10.3 Aids to Navigation

A plot of nearby aids to navigation is presented in Figure 10.4.

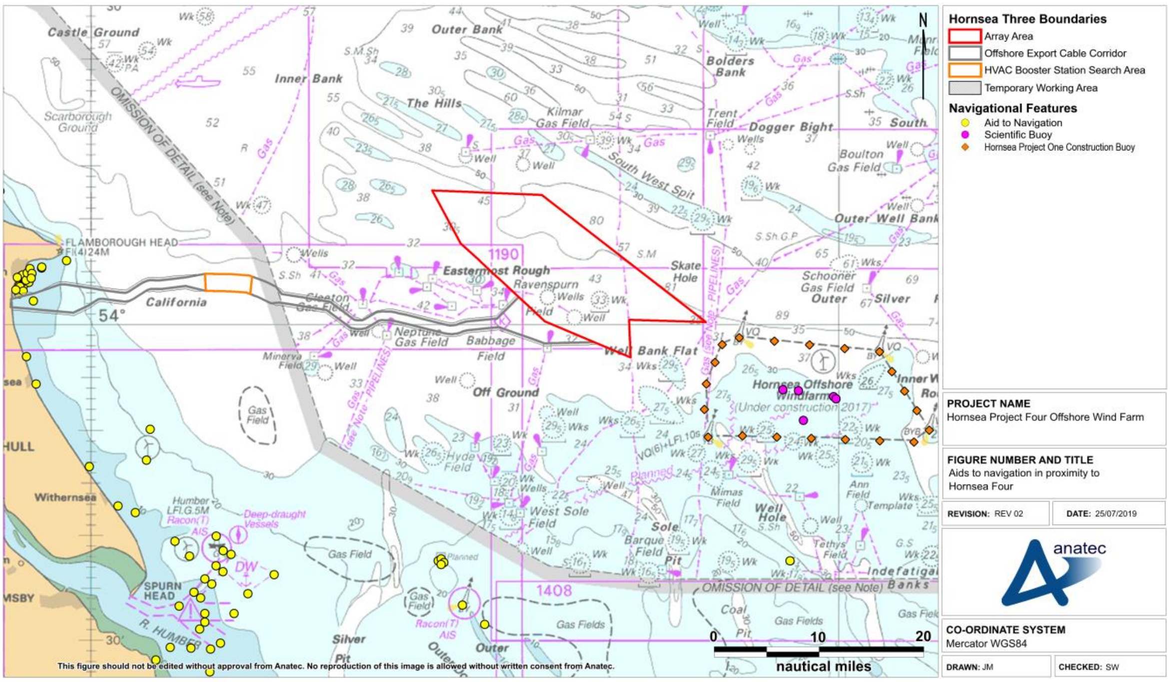


Figure 10.4 Aids to navigation in proximity to Hornsea Four

There are no aids to navigation located within the Hornsea Four array area. The closest aid to navigation is a west cardinal mark located approximately 2.6 nm south east of the

Hornsea Four array area. This mark forms part of the construction buoyage for Hornsea Project One and will be removed following the commissioning of the development.

There is one aid to navigation located within the Hornsea Four offshore ECC. This is the south west Smithic light buoy, a west cardinal mark designed to assist with entering Bridlington harbour.

10.4 Submarine Cables and Pipelines

A plot of submarine cables and pipelines is presented in Figure 10.5.

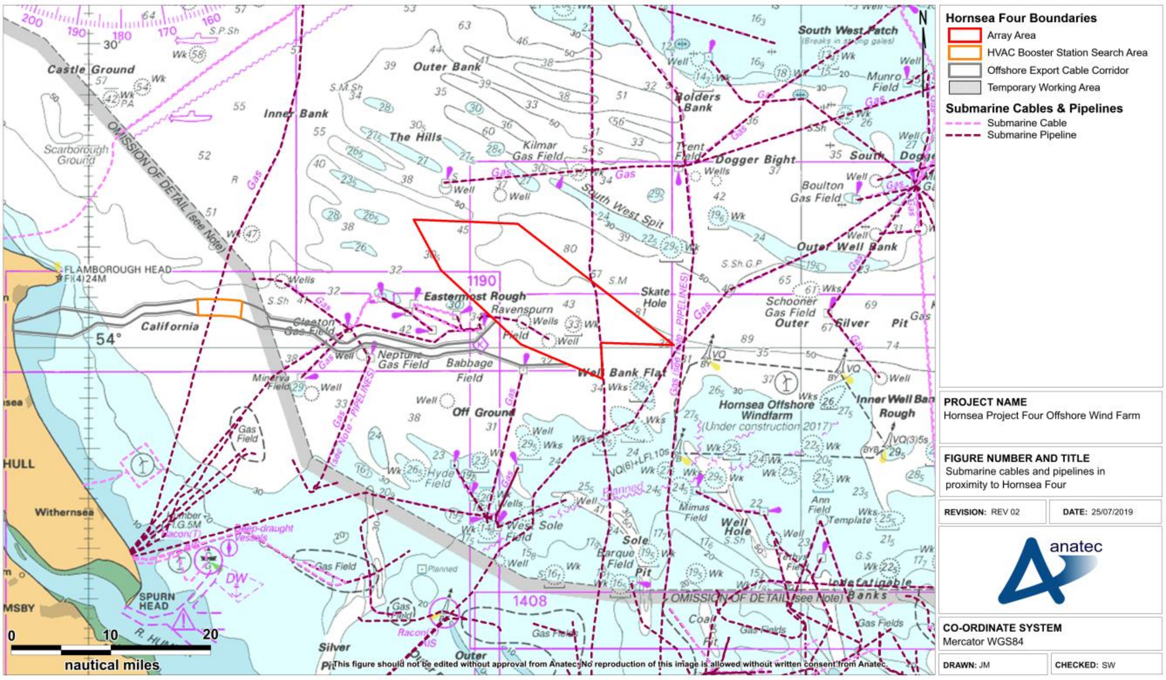


Figure 10.5 Submarine cables and pipelines in proximity to Hornsea Four

The submarine pipelines are associated with gas fields in the southern North Sea. There are two such pipelines located within the Hornsea Four array area; one passing north-south between the Bacton Gas Terminal on the Kent coast and the Elgin gas field within the central North Sea, and the other connecting production wells for the Ravenspurn North gas field (see Section 10.2).

10.5 Wrecks

A plot of charted wrecks is presented in Figure 10.5. Charted wrecks are those detailed on UKHO Admiralty charts and posing a risk to surface navigation or subsea operations. Further details relating to wrecks are provided in **Volume 2, Chapter 10: Marine Archaeology**.

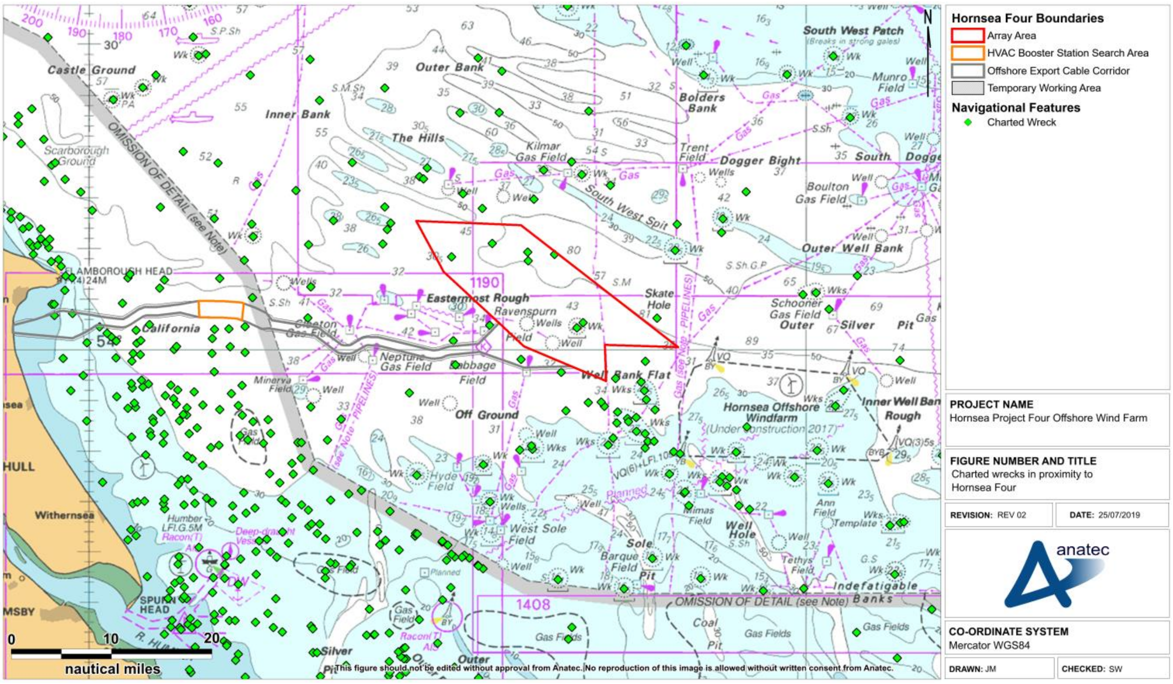


Figure 10.6 Charted wrecks in proximity to Hornsea Four

There are seven charted wrecks located within the Hornsea Four array area, with the shallowest at 33 m below chart datum. There are three charted wrecks located within the Hornsea Four offshore ECC, comprising two wrecks within 10 nm of the landfall site and one approximately 1.2 nm south of the Hornsea Four array area. There are no charted wrecks within the Hornsea Four HVAC booster station search area.

10.6 International Maritime Organization Routeing Measures

There are no IMO routeing measures in proximity to the Hornsea Four array area and offshore ECC. However the Inner Approaches Traffic Separation Scheme (TSS) lane to the Humber, located approximately 32 nm south west of the Hornsea Four site is used by a large number of vessels which transit in proximity to Hornsea Four. Similarly, some vessels passing in proximity to Hornsea Four may use the Off Botney Ground TSS located approximately 51 nm east of the Hornsea Four array area.

10.7 Ports

A plot of nearby ports is presented in Figure 10.7. It is noted that there are other ports within the Humber not labelled in Figure 10.8. Ports within the Humber are considered collectively throughout the NRA.

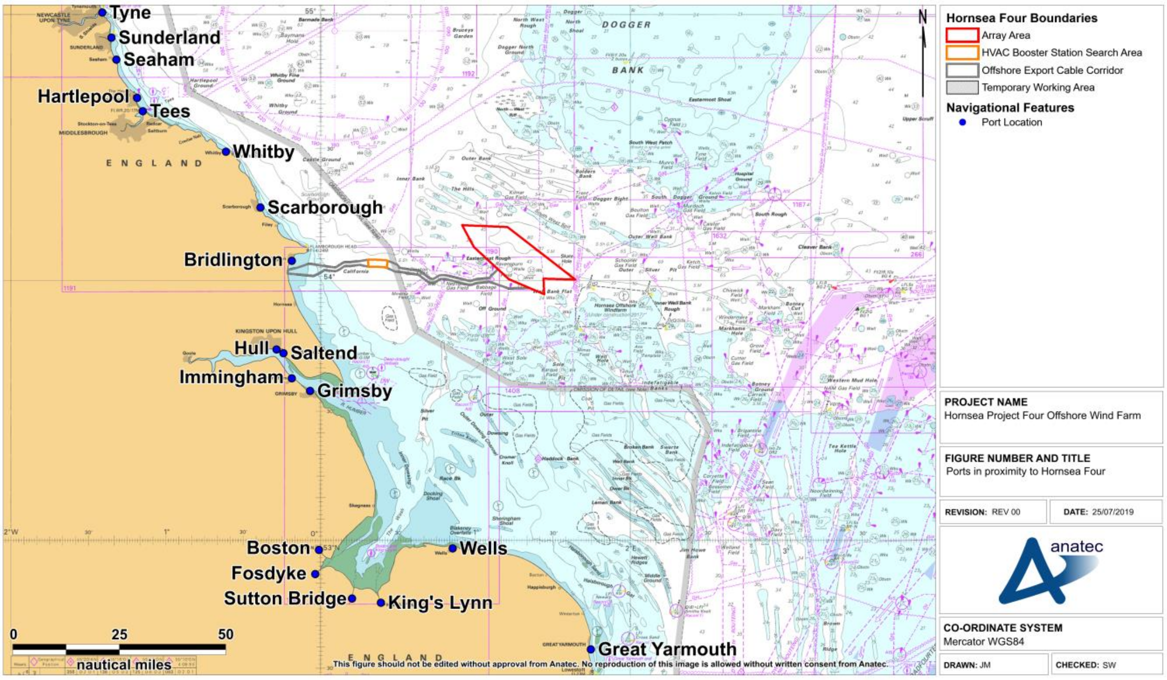


Figure 10.7 Ports in proximity to Hornsea Four

The closest port to the Hornsea Four array area is Bridlington, located approximately 39 nm to the west on the east Yorkshire coast.

The number of vessel arrivals at the most visited ports in the area (DfT, 2018) is presented in Figure 10.8. These statistics exclude some vessel movements which occur within port or harbour limits, but nevertheless give a clear indication of the relative traffic levels and trends. Ports within the Humber Estuary (including Hull, Grimsby and Immingham) have been grouped together since vessels using these ports will have comparable routeing when in proximity to the Hornsea Four array area and HVAC booster station search area.

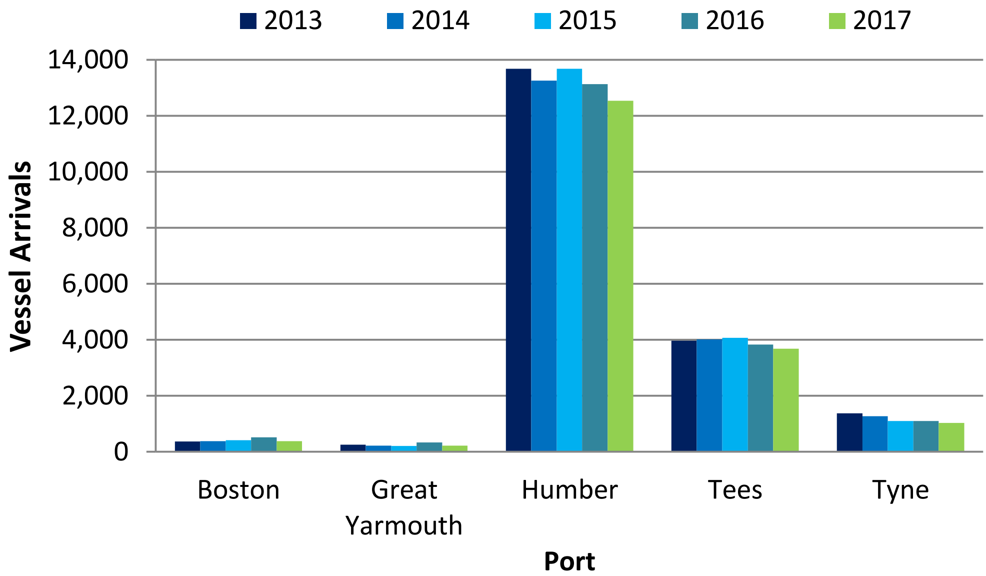


Figure 10.8 Vessel arrivals to ports in proximity to Hornsea Four (DfT, 2018)

10.8 Marine Environment High Risk Areas

Marine Environmental High Risk Areas (MEHRA) are areas along the UK coast designed to "*inform [ships'] Masters of areas where there is a real prospect of a problem arising. This prime purpose stands alone and regardless of any consequential defensive measures*" (Lord Donaldson, 1994). A plot of Marine Environmental High Risk Areas (MEHRA) is presented in Figure 10.9.

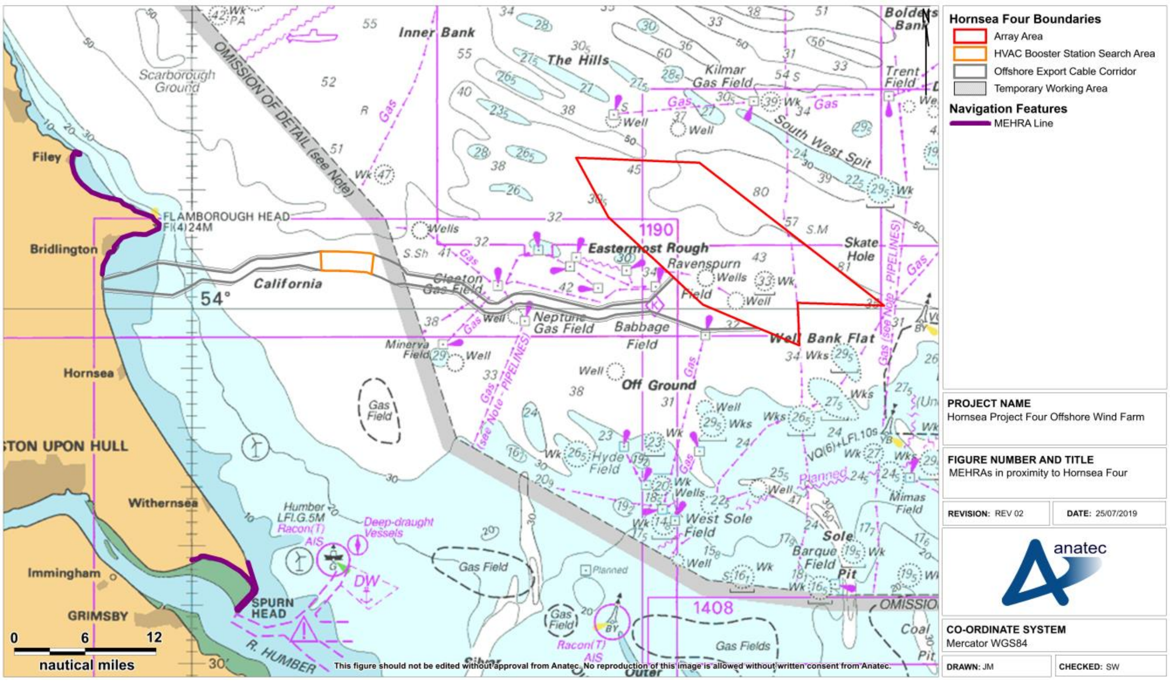


Figure 10.9 MEHRAs in proximity to Hornsea Four

There are two MEHRAs located in proximity to the Hornsea Four offshore ECC. The Flamborough Head MEHRA is in close proximity (less than 1 nm) to the landfall location while the Spurn Bight MEHRA is located at the Humber.

10.9 Other Navigational Features

10.9.1 Anchorage Areas

The only designated anchorage area located in the region is the Humber Deep Water Anchorage located approximately 24 nm south of the Hornsea Four offshore ECC, as shown in Figure 10.1.

10.9.2 Marine Aggregate Dredging Areas

There are no marine aggregate dredging areas in proximity to Hornsea Four. The closest areas are located near the Humber and are production areas owned by CEMEX UK Marine Ltd.

The BMAPA transit routes within the southern North Sea have been considered. There are only a small number of transit routes in proximity to the Hornsea Four array area and HVAC booster station search area. There is a high density of transit routes crossing the Hornsea Four offshore ECC nearshore, with these routes typically between the Tees or Tyne (UK) and the production areas located near the Humber.

10.9.3 Military Practice and Exercise Areas

There is a small arms firing practice area located off the coast of Rolston, approximately 6.8 nm south of the Hornsea Four offshore ECC, as shown in Figure 10.1.

There are some submarine exercise areas located to the north of the Hornsea Four array area and offshore ECC. No restrictions are placed on the right to transit a military PEXA at any time although mariners are advised to exercise caution. Exercises and firing only occur when the area is considered to be clear of all shipping.

There are not anticipated to be any impacts on shipping and navigation receptors associated with PEXAs, although military vessel traffic is considered as part of the baseline assessment in Section 15.

10.9.4 Foul and Spoil Grounds

There are two areas of foul ground in the region, located approximately 2.2 nm north and 7.1 nm south of the Hornsea Four offshore ECC, respectively, as shown in Figure 10.1.

There is one area of spoil ground in the region, located approximately 1.1 nm north of the Hornsea Four offshore ECC, as shown in Figure 10.1. It is noted that there is also a disused spoil ground which intersects the Hornsea Four offshore ECC close to the landfall location (not shown in Figure 10.1).

11 Meteorological Ocean Data

This section presents meteorological and oceanographic statistics local to Hornsea Four. The data presented in this section has been used as input to the risk assessment undertaken in **Volume 2, Chapter 8: Shipping and Navigation**, and in particular will be used in the collision and allision risk modelling within the final NRA submitted alongside the ES.

11.1 Wind

Wind data taken from the meteorological mast located at the nearby Hornsea Project One, in terms of the average annual wind direction, is presented in Figure 11.1 in the form of a wind rose.

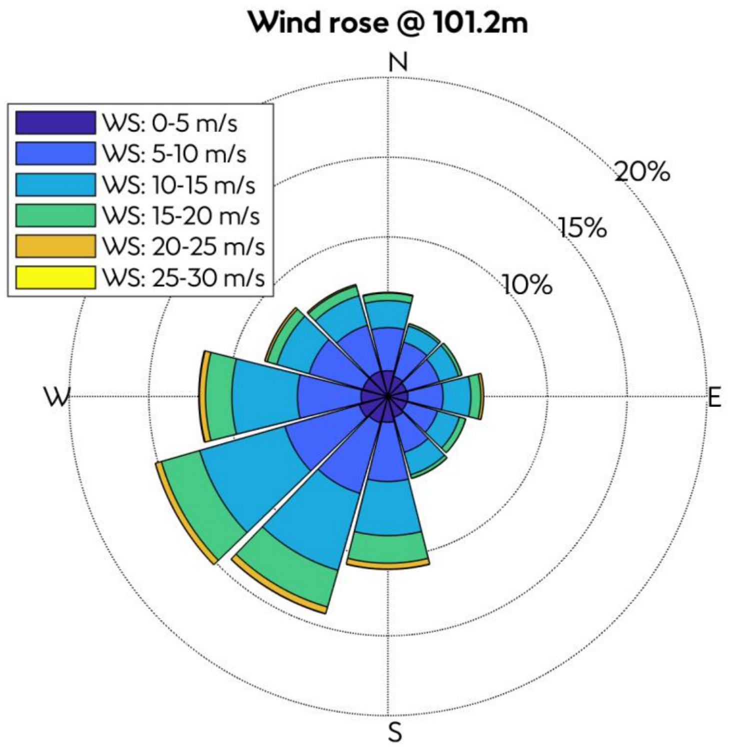


Figure 11.1 Annual wind direction distribution for Hornsea Four

It can be seen that winds are predominantly from the south west. This data was recorded at Hornsea Project One during construction and is considered for both the Hornsea Four array area and HVAC booster station search area.

11.2 Wave

11.2.1 Hornsea Four Array Area

Sea state data for the Hornsea Four array area, based upon the average annual percentage exceedance of the significant wave height, is presented in Table 11.1.

Table 11.1 Annual sea state distribution for Hornsea Four array area

Sea State	Proportion (%)
Calm (<1 m)	31
Moderate (1 m to 5 m)	68
Severe (>5 m)	1

11.2.2 Hornsea Four HVAC Booster Station Search Area

Sea state data for the Hornsea Four HVAC booster station search area, based upon the average annual percentage exceedance of the significant wave height, is presented in Table 11.2.

Table 11.2 Annual sea state distribution for Hornsea Four HVAC booster station search area

Sea State	Proportion (%)
Calm (<1 m)	34
Moderate (1 m to 5 m)	65.5
Severe (>5 m)	0.5

11.3 Visibility

The annual average incidence of poor visibility (defined as less than 1 km) for the North Sea is approximately 0.03 (i.e. an average of 3% of the year) (UKHO, 2016). This value has been applied at both the Hornsea Four array area and HVAC booster station search area.

11.4 Tide

11.4.1 Hornsea Four Array Area

From UKHO Admiralty Chart 1187 (tidal diamond "A" located approximately 2.8 nm from the Hornsea Four array area), currents in proximity to the Hornsea Four array area set in a generally north west to south east direction on the flood tide and south east to north west direction on the ebb tide, with a peak flood tidal rate of 1.4 knots (kt) and peak ebb tidal rate of 1.4 kt. Table 11.3 presents details for tidal diamond "A" from UKHO Admiralty Chart 1187.

Table 11.3 Details for tidal diamond "A" on UKHO Admiralty Chart 1187

Hours		Directions of Streams (°)	Rates at Spring Tide (kt)	Rate at Neap Tide (kt)
Before high water	6	134	1.4	0.8
	5	131	1.2	0.7
	4	125	0.9	0.5
	3	093	0.4	0.2
	2	345	0.4	0.2
	1	324	1.0	0.5
High water		317	1.4	0.8
After high water	1	311	1.4	0.8
	2	303	1.0	0.6
	3	271	0.4	0.2
	4	169	0.5	0.3
	5	145	1.0	0.6
	6	137	1.4	0.8

A number of other tidal diamonds will also be used in the collision and allision modelling, with the tidal diamond most local to any particular location being considered. Tidal diamonds on UKHO Admiralty Charts 266 and 1190 have been used in addition to further tidal diamonds on UKHO Admiralty Chart 1187.

11.4.2 Hornsea Four HVAC Booster Station Search Area

From UKHO Admiralty Chart 121 (tidal diamond "A" located approximately 3.3 nm from the Hornsea Four HVAC booster station search area), currents in proximity to the Hornsea Four HVAC booster station search area set in a generally north east to south west direction on the flood tide and south east to north west direction on the ebb tide, with a peak flood tidal rate of 1.8 kt and peak ebb tidal rate of 1.7 kt. Table 11.4 presents details for tidal diamond "A" from UKHO Admiralty Chart 121.

Table 11.4 Details for tidal diamond "A" on UKHO Admiralty Chart 121

Hours		Directions of Streams (°)	Rates at Spring Tide (kt)	Rate at Neap Tide (kt)
Before high water	6	326	1.0	0.6
	5	302	0.3	0.2
	4	170	0.7	0.4
	3	154	1.5	0.8
	2	153	1.7	1.0
	1	151	1.8	1.0
High water		150	1.2	0.7
After high water	1	139	0.4	0.2
	2	005	0.5	0.3
	3	348	1.1	0.6
	4	333	1.6	0.9
	5	333	1.7	1.0
	6	329	1.3	0.7

A number of other tidal diamonds will also be used in the collision and allision modelling, with the tidal diamond most local to any particular location being considered. Tidal diamonds on UKHO Admiralty Charts 129 and 1191 have also been used.

12 Emergency Response Overview

This section summarises the existing SAR resources in the southern North Sea and the issues being considered in relation to the design of Hornsea Four.

12.1 Search and Rescue Helicopters

Since April 2015, the Bristow Group have provided helicopter SAR operations in the UK and is contracted to do so until March 2026. The SAR helicopter service is operated out of 10 base locations around the UK, with the nearest located at Humberside Airport, approximately 58 nm south west of the closest point of the Hornsea Four array area (see Figure 12.1). This base was purpose-built when the Bristow Group took over SAR operations in the UK and "*provides vital life-saving support to the fishing and other marine industries and the offshore energy sector, as well as to land-based incidents including missing persons and other medical emergencies*" (Bristow Group, 2019). This base is most likely to respond to any incident requiring SAR helicopter services based upon the SAR helicopter data for the region (see Section 13.3).

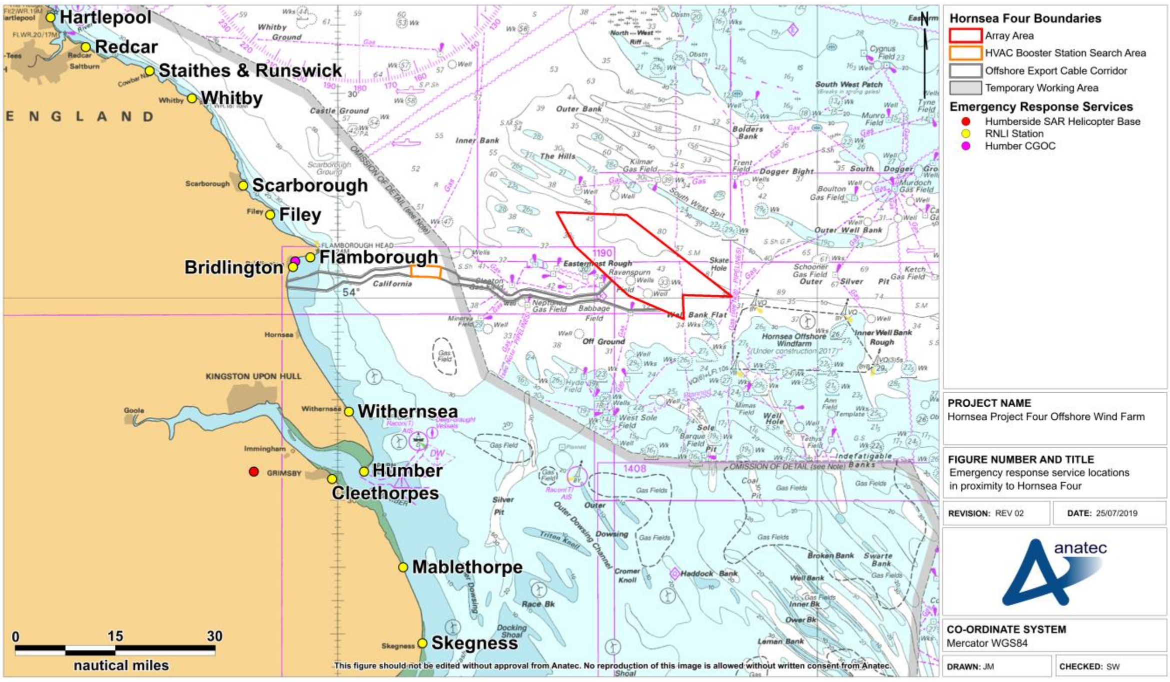


Figure 12.1 Emergency response service locations in proximity to Hornsea Four

Companies operating offshore typically have resources of vessels, helicopters and other equipment available for normal operations that can assist with emergencies offshore. Moreover, all vessels under IMO obligations set out in the International Convention for the Safety of Life at Sea (SOLAS) (IMO, 1974) as amended, are required to render assistance to any person or vessel in distress if safely able to do so.

12.2 Royal National Lifeboat Institution

The RNLI is organised into six divisions, with the relevant region for Hornsea Four being "North and East". Based out of more than 230 stations around the UK, there are around 350 lifeboats across the RNLI fleet, including both all-weather lifeboats (ALB) and inshore lifeboats (ILB). Figure 12.1 presents the locations of RNLI stations in proximity to the Hornsea Four and Table 12.1 summarises the types of lifeboat operated by the RNLI out of these stations.

Table 12.1 Types of lifeboat held at RNLI stations in proximity to Hornsea Four

Station	Lifeboat(s)	ALB Class	ILB Class	Minimum Distance to Hornsea Four Array Area (nm)
Flamborough	ILB	–	B Class	37
Bridlington	ALB and ILB	Shannon	D Class	39
Withernsea	ILB	–	D Class	41
Filey	ALB and ILB	Mersey	D Class	42
Scarborough	ALB and ILB	Shannon	D Class	46
Humber (full time crew)	ALB	Severn	–	46
Cleethorpes	ILB	–	D Class	50
Mablethorpe	ILB (×2)	–	B and D Class	52
Whitby	ALB and ILB	Trent	D Class	56
Skegness	ALB and ILB	Shannon	D Class	60
Staithes & Runswick	ILB	–	B Class	63
Redcar	ILB (×2)	–	B and D Class	73
Hartlepool	ALB and ILB	Trent	B Class	79

RNLI lifeboats are available on a 24-hour basis throughout the year. It is noted that the RNLI have a 100 nm operational limit and given the distance offshore of the Hornsea Four array area it is considered unlikely that an RNLI lifeboat would respond to an incident within the array area. This is reflected in the RNLI incident data for the region (see Section 13.2).

12.3 Her Majesty's Coastguard Stations

Her Majesty's Coastguard (HMCG), a division of the MCA, is responsible for requesting and tasking SAR resources made available to other authorities and for coordinating the subsequent SAR operations (unless they fall within military jurisdiction).

The HMCG coordinates SAR operations through a network of 11 Coastguard Operations Centres (CGOC), including a National Maritime Operations Centre (NMOC) based in Hampshire. A corps of over 3,500 volunteer Coastguard Rescue Officers (CRO) around the UK form 352 local Coastguard Rescue Teams (CRT) involved in coastal rescue, searches and surveillance.

All of the MCA's operations, including SAR, are divided into three geographical regions. The East of England region covers the east and south coasts of England from the Scottish border down to the Dorset-Devon border, and therefore covers the area encompassing Hornsea Four.

Each region is divided into six districts with its own CGOC, which coordinates the SAR response for maritime and coastal emergencies within its district boundaries (East of England includes an additional station, London Coastguard, for coordinating SAR on the River Thames). The nearest CGOC to Hornsea Four is the Humber CGOC based in Bridlington, in east Yorkshire, located approximately 39 nm west of the closest point of the Hornsea Four array area (see Figure 12.1).

13 Maritime Incidents

This section reviews maritime incidents which have occurred in proximity to Hornsea Four or are related to existing offshore wind farm developments.

The analysis is intended to provide a general indication of whether the area of the proposed development is currently low or high risk in terms of maritime accidents and whether offshore wind farms pose a high risk to vessels. If the area was found to be a particularly high risk area for incidents then this may indicate that the development could exacerbate the existing maritime safety risks in the area.

Data from the following sources has been analysed:

- MAIB;
- RNLI; and
- DfT.

It is noted that the same incident may be recorded by multiple sources.

13.1 Marine Accident Investigation Branch Incident Data

All UK flagged vessels and non-UK flagged vessels in UK territorial waters (12 nm), a UK port or carrying passengers to a UK port are required to report accidents to the MAIB. Between 1,500 and 1,800 accidents are reported to the MAIB annually.

The locations of accidents, injuries and hazardous incidents reported to the MAIB within the Hornsea Four array area, offshore ECC and HVAC booster station search area shipping and navigation study areas between 2005 and 2014 is presented in Figure 13.1, colour-coded by incident type. The same data is presented in Figure 13.2, colour-coded by casualty type.

13.1.1 Hornsea Four Array Area

A total of 12 unique incidents, with one incident involving two vessels, were reported to the MAIB within the Hornsea Four array area shipping and navigation study area, corresponding to an average of one to two unique incidents per year.

One of the incidents occurred within the Hornsea Four array area and 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.

Of the remaining 11 incidents within the Hornsea Four array area shipping and navigation study area, seven occurred between the array area and shore, with six of these involving an oil and gas support vessel. One of the oil and gas support vessel incidents involved an allision between the vessel and a surface platform at the Ravenspurn North gas field, with no injuries reported and minor damage to the vessel.

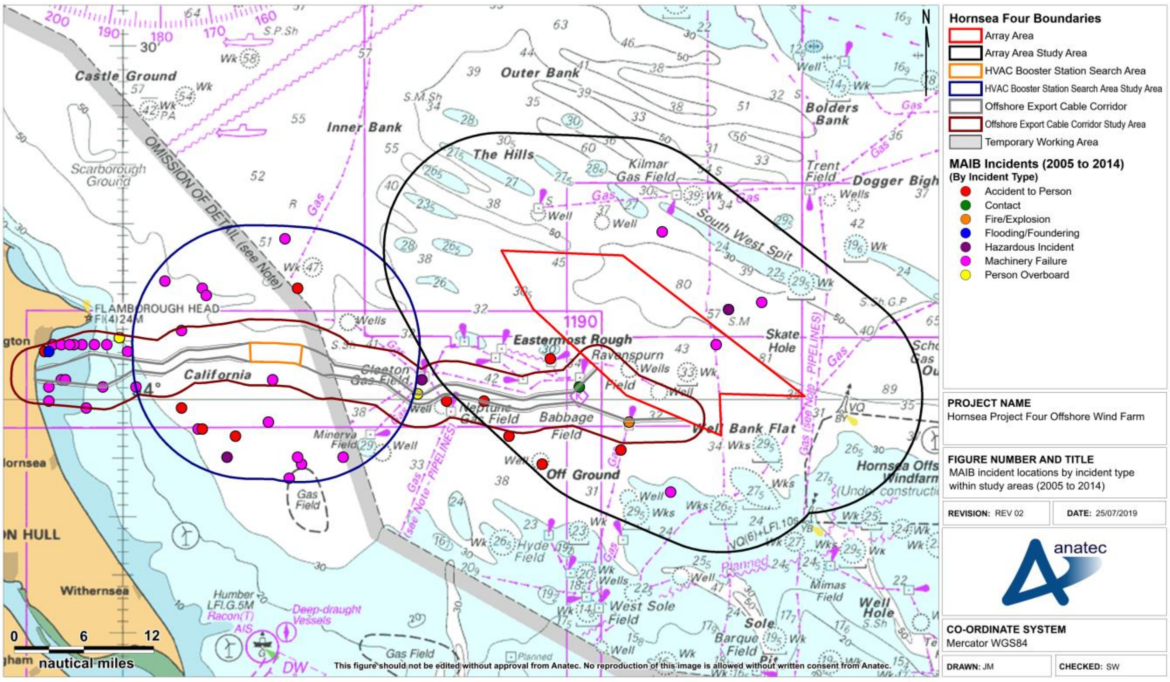


Figure 13.1 **MAIB incident locations by incident type within shipping and navigation study areas (2005 to 2014)**

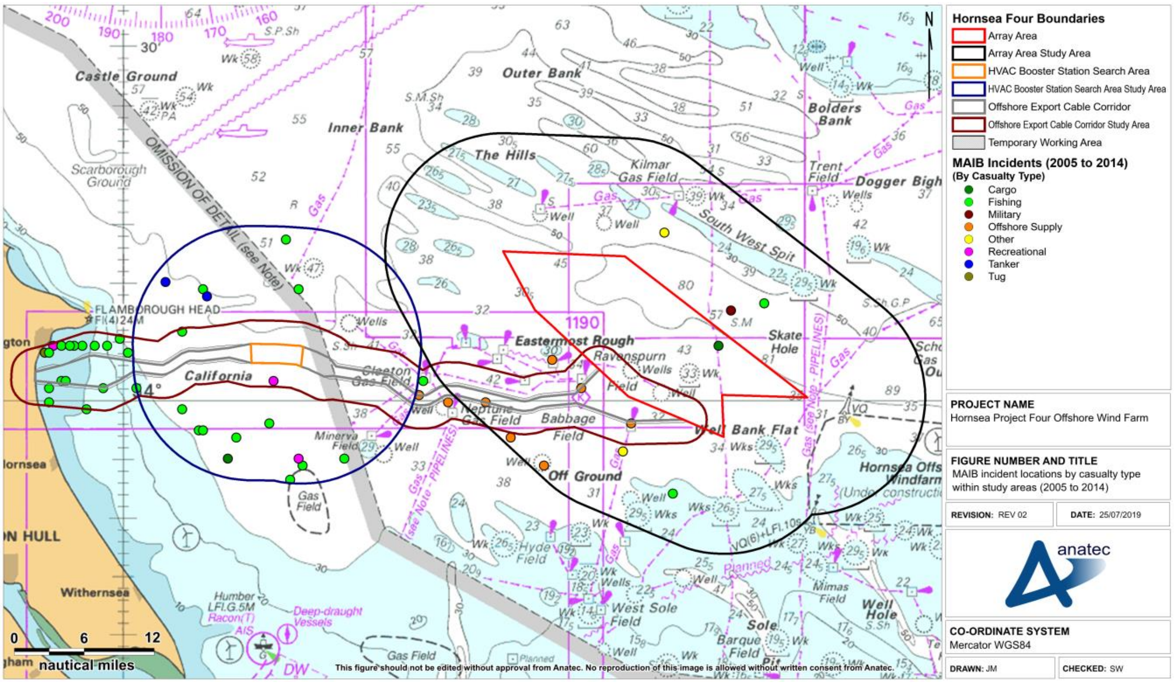


Figure 13.2 **MAIB incident locations by casualty type within shipping and navigation study areas (2005 to 2014)**

13.1.2 Hornsea Four Offshore ECC

A total of 26 unique incidents were reported to the MAIB within the Hornsea Four offshore ECC shipping and navigation study area, corresponding to an average of two to three unique incidents per year. Incidents were concentrated towards the coast, with the majority (approximately 50%) occurring within 5 nm of the east Yorkshire coast.

13.1.3 Hornsea Four HVAC Booster Station Search Area

A total of 18 unique incidents were reported to the MAIB within the Hornsea Four HVAC booster station search area shipping and navigation study area, corresponding to an average of one to two unique incidents per year (it is noted that three of these incidents also occurred within the Hornsea Four offshore ECC shipping and navigation study area). No incidents were reported within the Hornsea Four HVAC booster station search area itself with the closest occurring approximately 1.4 nm south. This incident involved a small recreational vessel which experienced a gearbox failure and required towing back to port in 2009.

13.2 Royal National Lifeboat Institution Data

Data on RNLI lifeboat responses within the Hornsea Four array area, offshore ECC and HVAC booster station search area shipping and navigation study areas for the 10-year period between 2008 and 2017 were analysed (excluding hoaxes or false alarms). As noted in Section 12.2, the RNLI have a strategic performance standard of reaching casualties up to a maximum of 100 nm offshore and therefore given the distance and journey time to respond, an RNLI lifeboat may respond to a drifting vessel but are unlikely to respond to a life-saving incident in proximity to the Hornsea Four array area.

The locations of incidents responded to by the RNLI within the Hornsea Four array area, offshore ECC and HVAC booster station search area shipping and navigation study areas are presented in Figure 13.3, colour-coded by incident type. The same data is presented in Figure 13.4, colour-coded by casualty type.

13.2.1 Hornsea Four Array Area

No RNLI lifeboat launches were reported within the Hornsea Four array area shipping and navigation study area.

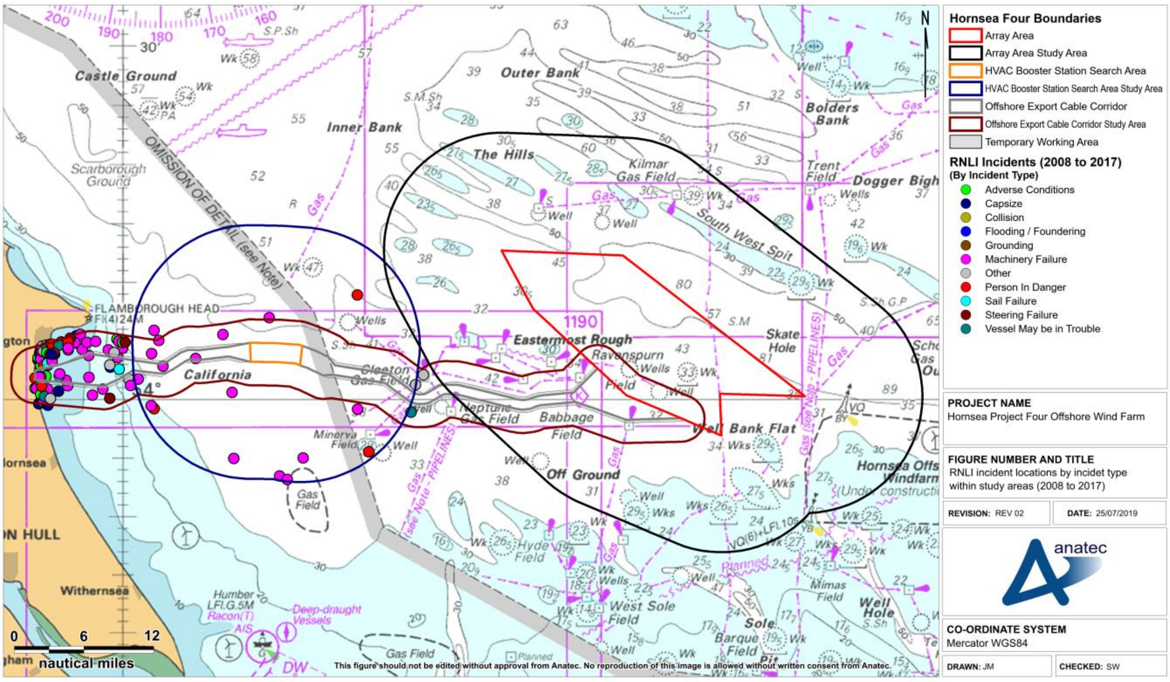


Figure 13.3 RNLI incident locations by incident type within shipping and navigation study areas (2008 to 2017)

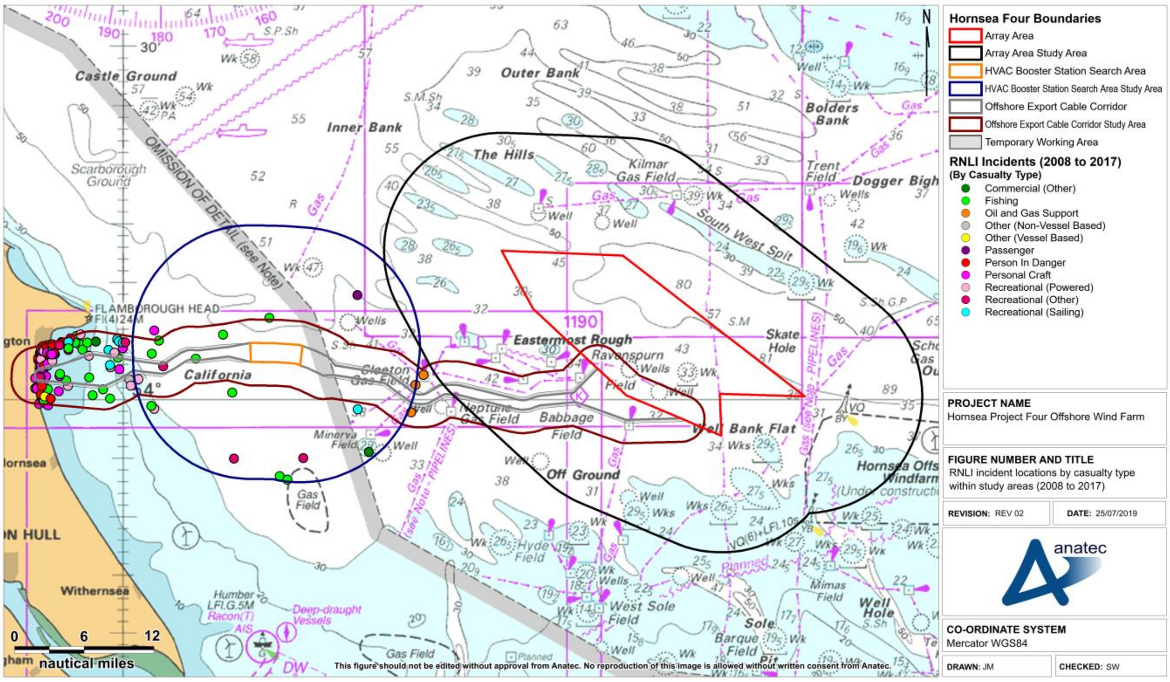


Figure 13.4 RNLI incident locations by casualty type within shipping and navigation study areas (2008 to 2017)

13.2.2 Hornsea Four Offshore Export Cable Corridor

A total of 190 RNLI lifeboat launches to 183 unique incidents were reported within the Hornsea Four offshore ECC shipping and navigation study area, corresponding to an average of 18 unique incidents per year. Incidents were concentrated towards the coast, with the majority (approximately 87%) occurring within 5 nm of the east Yorkshire coast. The incidents furthest offshore responded to by the RNLI were three incidents involving oil and gas support vessels at the Cleeton gas field in 2010, two of which were responded to by the ON1216 Severn class lifeboat from the Humber station (furthest distance approximately 35 nm from the station). In all three cases the incident was resolved without the aid of the RNLI lifeboat.

The majority of reported RNLI lifeboat launches were from the Bridlington station (84%) with Flamborough station (13%) also used frequently. The most frequent incident type was “Machinery Failure” (38%) followed by “Person in Danger” (16%) and “Adverse Conditions” (11%). Excluding “Person in Danger” and non-vessel incidents, the most frequent casualty vessel type was personal craft (28%) followed by fishing vessels and powered recreational vessels (both 23%).

13.2.3 Hornsea Four HVAC Booster Station Search Area

A total of 18 RNLI lifeboat launches, excluding hoaxes and false alarms, to 17 unique incidents were reported within the Hornsea Four HVAC booster station search area shipping and navigation study area, corresponding to an average of one to two incidents per year (it is noted that two of these incidents also occurred within the Hornsea Four offshore ECC shipping and navigation study area). None of these incidents occurred within the Hornsea Four HVAC booster station search area itself.

Fishing vessels were the most frequent casualty vessel type (approximately 47% of incident vessels) with the ON1169 Mersey class lifeboat from the Bridlington station the most frequent lifeboat responder (approximately 59% of incidents). This lifeboat was replaced in December 2017 by a new Shannon class lifeboat.

13.3 Department for Transport Search and Rescue Helicopter Data

The DfT has produced data on civilian search and rescue helicopter activity in the UK by the Bristow Group on behalf of the MCA between 2016 and 2018. The locations of SAR helicopter taskings within the Hornsea Four array area, offshore ECC and HVAC booster station search area shipping and navigation study areas are presented in Figure 13.5, colour-coded by tasking outcome. Taskings where the location was given as “land” have been excluded (leaving taskings with location “maritime” or “coast”).

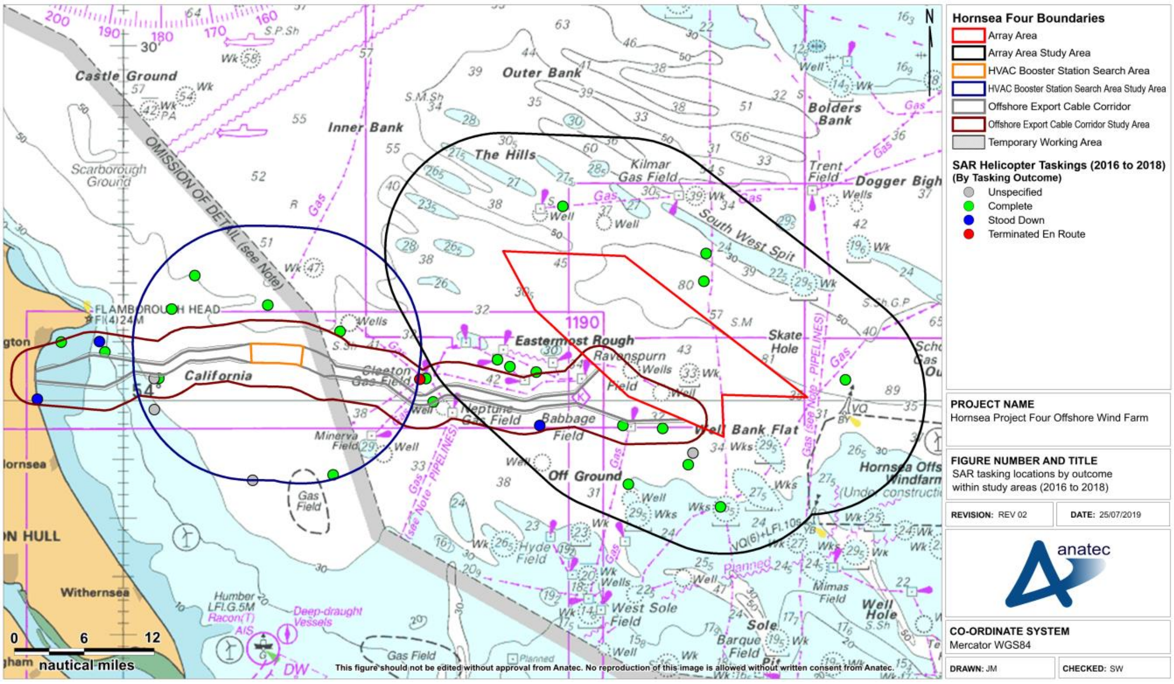


Figure 13.5 SAR helicopter tasking locations by outcome within shipping and navigation study areas (2016 to 2018)

13.3.1 Hornsea Four Array Area

A total of 14 SAR helicopter taskings were undertaken for incidents within the Hornsea Four array area shipping and navigation study area, corresponding to an average of four to five taskings per year. All of the taskings involved a “Rescue/Recovery”, with the majority (88%) completed, with one stood down and another with unspecified outcome. None of the incidents occurred within the Hornsea Four array area.

13.3.2 Hornsea Four Offshore ECC

A total of 11 SAR helicopter taskings were undertaken for incidents within the Hornsea Four offshore ECC shipping and navigation study area, corresponding to an average of three to four taskings per year. The majority of taskings involved a “Rescue/Recovery” (82%), with the majority (64%) completed.

13.3.3 Hornsea Four HVAC Booster Station Search Area

A total of nine SAR helicopter taskings were undertaken for incidents within the Hornsea Four HVAC booster station search area shipping and navigation study area, corresponding to an average of one tasking per year (it is noted that two of these incidents also occurred within the Hornsea Four offshore ECC shipping and navigation study area). All of the taskings involved a “Rescue/Recovery” with the majority (67%) completed. None of the incidents tasked to occurred within the Hornsea Four HVAC booster station search area.

13.4 Historical Offshore Wind Farm Incidents

At the time of writing there are 37 fully commissioned and operational offshore wind farms in the UK, ranging from the North Hoyle Offshore Wind Farm (fully commissioned in 2003) to the Beatrice Offshore Wind Farm (fully commissioned in May 2019). These developments consist of 10,944 fully operational WTG years.

MAIB incident data has been used to collate a list of historical collision and allision incidents involving UK offshore wind farm developments, which is summarised in Table 13.1. Other sources have also been used to produce this list including the UK Confidential Human Factors Incident Reporting Programme (CHIRP) for Aviation and Maritime, International Marine Contractors Association (IMCA) and basic web searches.

The worst consequences reported for vessels involved in a collision or allision incident involving a UK offshore wind farm development has been minor flooding, with no life-threatening injuries to persons reported.

To date there have been no collisions as a result of the presence of an offshore wind farm in the UK. The only reported collision incident in relation to a UK offshore wind farm involved a project vessel hitting a third-party vessel whilst in harbour.

To date there have been 10 cases of an allision between a vessel and a WTG (under construction, operational or disused), with all but one involving a support vessel for the development and the errant vessel in each case under power rather than drifting. Therefore, there has been an average of 995 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).

Table 13.1 Summary of historical collision and allision incidents involving UK offshore wind farm 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	23th 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 in to port.	Moderate	None	UK 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

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage*	Harm to Persons	Source
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 with various injuries sustained which required treatment from a doctor transferred on-board. 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	UK CHIRP
Project	Allision – project vessel with WTG	16th March 2013	An offshore service and supply vessel allided with a WTG foundation, causing serious damage to the bow fender of the twin hulled vessel.	Minor	None	UK CHIRP
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	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

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage*	Harm to Persons	Source
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)

(*) As per incident reports.

14 Key Consultation Overview

This section outlines key consultation undertaken as part of the NRA process.

14.1 Stakeholder Consultation

Consultation with stakeholders has taken place throughout the NRA process, including those stakeholders noted in Section 4.2. Section 8.4 of **Volume 2, Chapter 8: Shipping and Navigation** summarises the issues raised relevant to shipping and navigation during consultation and indicates either how these issues have been addressed within the PEIR and NRA or how Hornsea Four has had regard to them.

It is noted that further consultation is planned as part of the Section 42 Consultation and up to the submission of the final ES.

14.2 Regular Operator Consultation

There were 17 Regular Operators identified from the vessel traffic surveys which may be required to deviate their routes due to the Hornsea Four array area or HVAC booster stations. These Regular Operators were provided with an overview of the Project and offered the opportunity to provide comment and attend the Hazard Workshop (see Appendix A). The full list of Regular Operators identified is provided below. Only DFDS Seaways provided feedback; details of consultation held with DFDS Seaways is included in Section 8.4 of **Volume 2, Chapter 8: Shipping and Navigation**.

- A2B-online
- Amasus Shipping
- Bore Lines
- DFDS Seaways
- Euro Marine Carrier
- Hoegh Autoliners
- Island Offshore
- James Fisher Everard
- JT Essberger
- Nordic Tankers
- P&O Ferries
- Peederei H.P. Wegener
- Sea-Cargo
- SEACOR Marine
- Sloman Neptun
- Unifeeder
- Wilson Eurocarriers

15 Vessel Traffic Surveys

This section presents shipping data in relation to three areas – the Hornsea Four array area, offshore ECC and HVAC booster station search area shipping and navigation study areas. Details on the survey methodology used when recording the vessel traffic data is provided in Section 7 and details of the study areas applied is provided in Section 5.2.

15.1 Hornsea Four Array Area

A number of tracks recorded during the Hornsea Four array area survey periods were classified as temporary (non-routine), such as the tracks of the survey vessel (winter only) and tracks of vessels associated with the construction of Hornsea Project One. These have therefore been excluded from the analysis. Oil and gas support vessels operating at permanent installations were retained in the analysis.

A plot of the vessel tracks recorded during a 14-day survey period in June 2018 (summer, AIS only), colour-coded by vessel type and excluding temporary traffic, is presented in Figure 15.1. A plot of the vessel tracks recorded during a further 14-day survey period in January and February 2019 (winter, dedicated survey), colour-coded by vessel type and excluding temporary traffic, is presented in Figure 15.2.

Plots of the vessel tracks for the summer and winter survey periods converted to a density heat map are presented in Figure 15.3 and Figure 15.4, respectively.

15.1.1 Vessel Counts

For the 14 days analysed in the summer survey period, there were an average of 33 unique vessels per day recorded within the Hornsea Four array area shipping and navigation study area, recorded on AIS. In terms of vessels intersecting the Hornsea Four array area itself, there was an average of 15 unique vessels per day.

Figure 15.5 illustrates the daily number of unique vessels recorded within the Hornsea Four array area shipping and navigation study area and the Hornsea Four array area itself during the summer survey period. Throughout the summer survey period approximately 29% of vessel tracks recorded within the Hornsea Four array area shipping and navigation study area intersected the Hornsea Four array area itself.

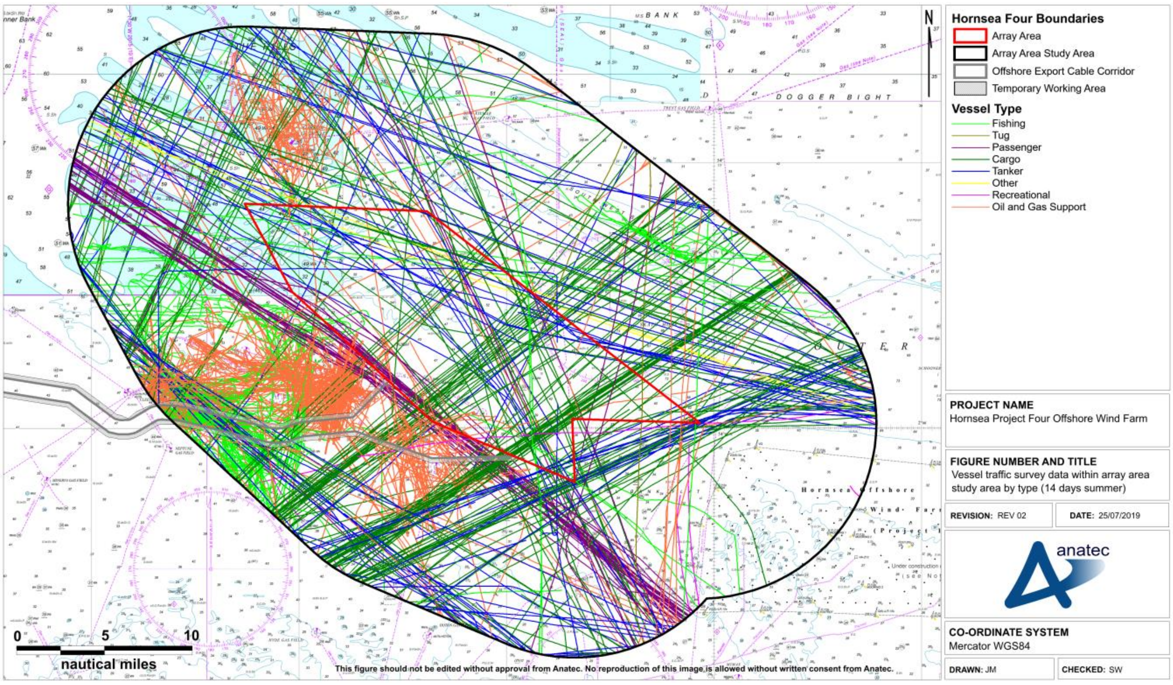


Figure 15.1 Vessel traffic survey data within Hornsea Four array area shipping and navigation study area colour-coded by vessel type (14 days summer 2018)

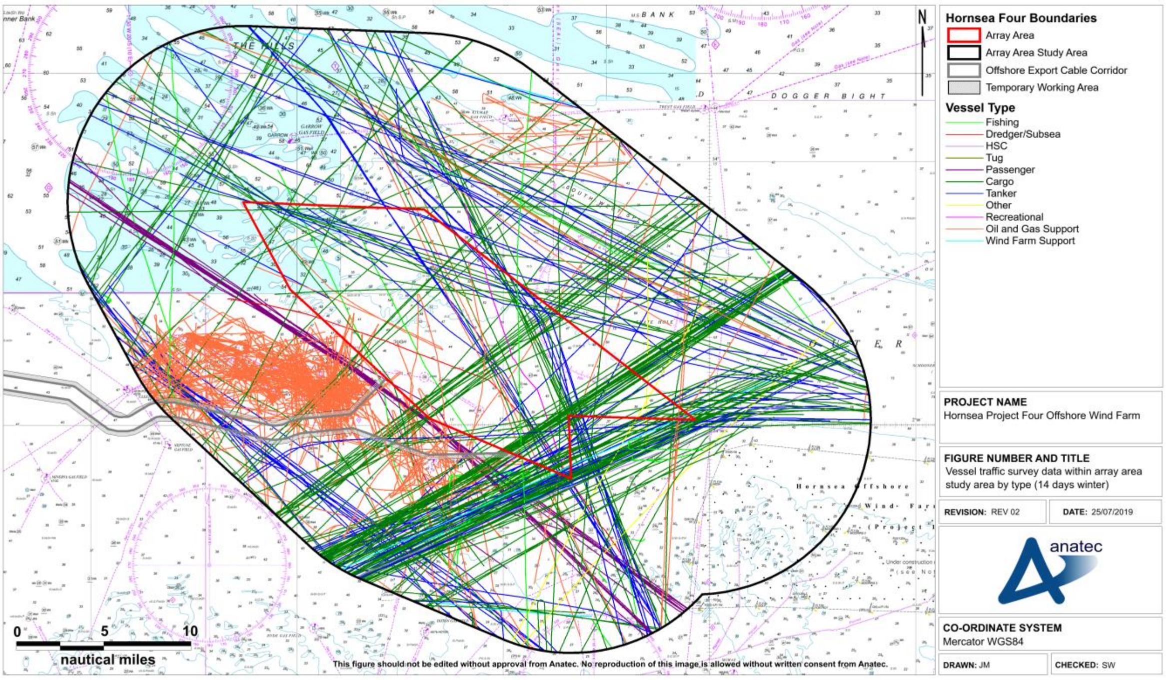


Figure 15.2 Vessel traffic survey data within Hornsea Four array area shipping and navigation study area colour-coded by vessel type (14 days winter 2019)

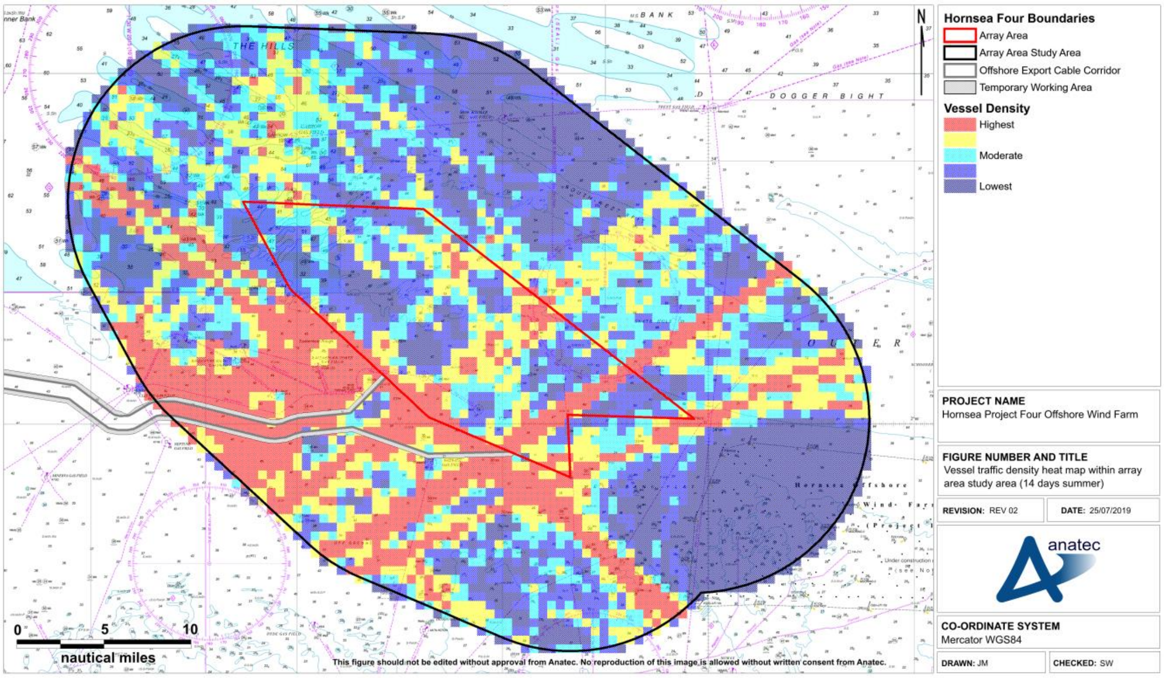


Figure 15.3 **Vessel traffic density heat map within Hornsea Four array area shipping and navigation study area excluding temporary traffic (14 days summer 2018)**

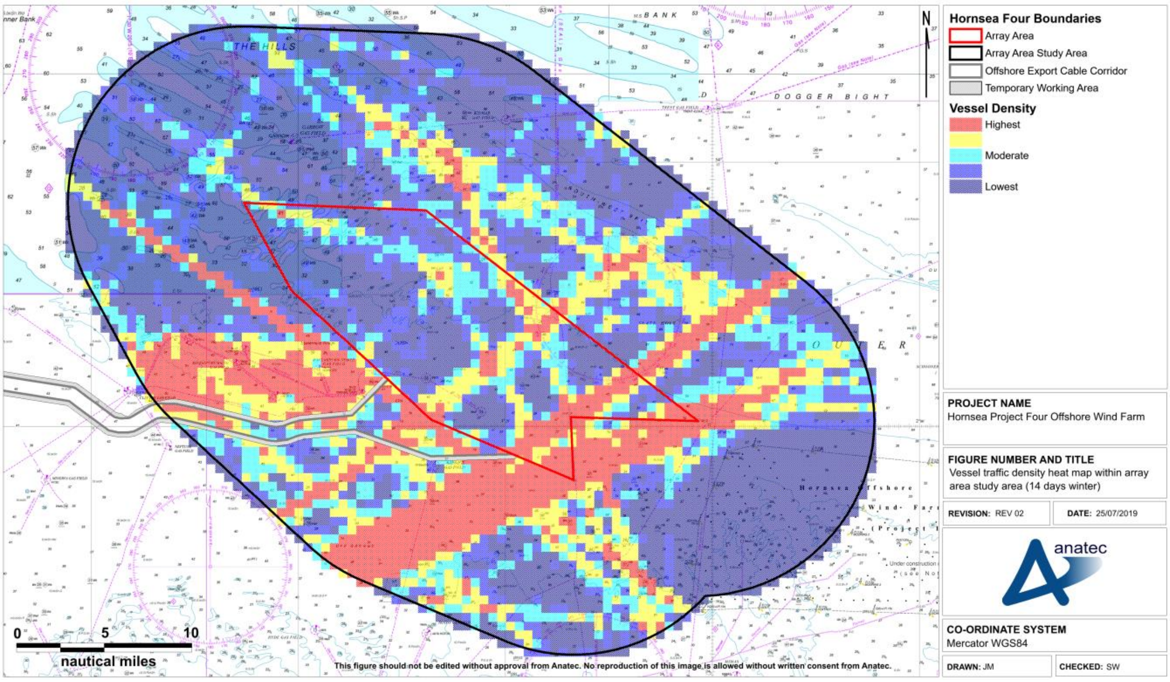


Figure 15.4 **Vessel traffic density heat map within Hornsea Four array area shipping and navigation study area excluding temporary traffic (14 days winter 2019)**

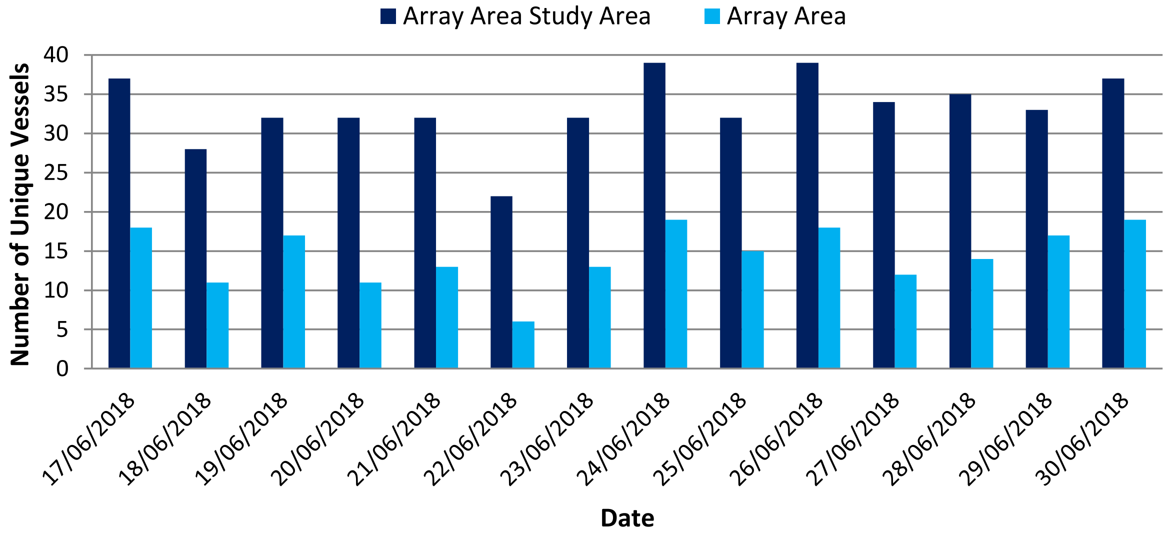


Figure 15.5 Unique vessels per day within Hornsea Four array area and shipping and navigation study area (14 days summer 2018)

The busiest days recorded within the Hornsea Four array area shipping and navigation study area throughout the summer survey period were the 24th and 26th June 2018 when 39 unique vessels were recorded. The busiest days recorded within the Hornsea Four array area itself throughout the summer survey period were the 24th and 30th June 2018 when 19 unique vessels were recorded.

The quietest day recorded throughout the summer survey period was 22nd June 2018 when 22 unique vessels were recorded within the Hornsea Four array area shipping and navigation study area. This was also the quietest day recorded within the Hornsea Four array area itself throughout the summer survey period with six unique vessels recorded.

For the 14 days analysed in the winter survey period, there were an average of 23 unique vessels per day recorded within the Hornsea Four array area shipping and navigation study area, recorded on AIS, visual and Radar. In terms of vessels intersecting the Hornsea Four array area itself, there was an average of 11 unique vessels per day.

Figure 15.6 illustrates the daily number of unique vessels recorded within the Hornsea Four array area shipping and navigation study area and the Hornsea Four array area itself during the winter survey period. Throughout the winter survey period approximately 33% of vessel tracks recorded within the Hornsea Four array area shipping and navigation study area intersected the Hornsea Four array area.

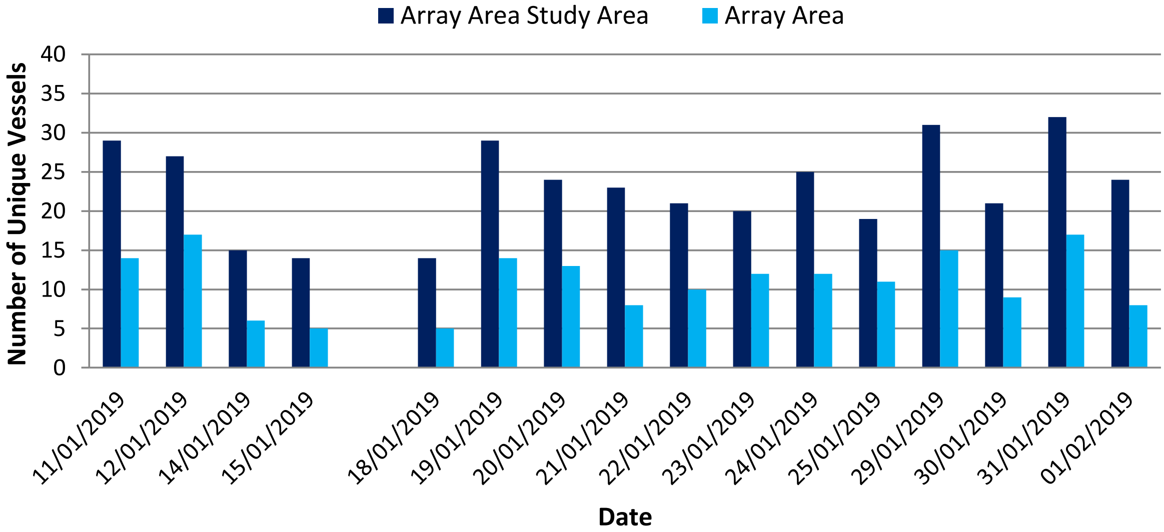


Figure 15.6 Unique vessels per day within Hornsea Four array area and shipping and navigation study area (14 days winter 2019)

The busiest day recorded within the Hornsea Four array area shipping and navigation study area throughout the winter survey period was the 31st January 2019 when 32 unique vessels were recorded. The busiest days recorded within the Hornsea Four array area itself throughout the winter survey period were the 12th and 31st January 2019 when 17 unique vessels were recorded.

The quietest days recorded throughout the winter survey period were the 15th and 18th January 2019 when 14 unique vessels were recorded within the Hornsea Four array area shipping and navigation study area, noting that these were not full survey days. These were also the quietest days recorded within the Hornsea Four array area itself throughout the winter survey period with five unique vessels recorded.

15.1.2 Vessel Types

The percentage distribution of the main vessel types recorded passing within the Hornsea Four array area shipping and navigation study area is presented in Figure 15.7.

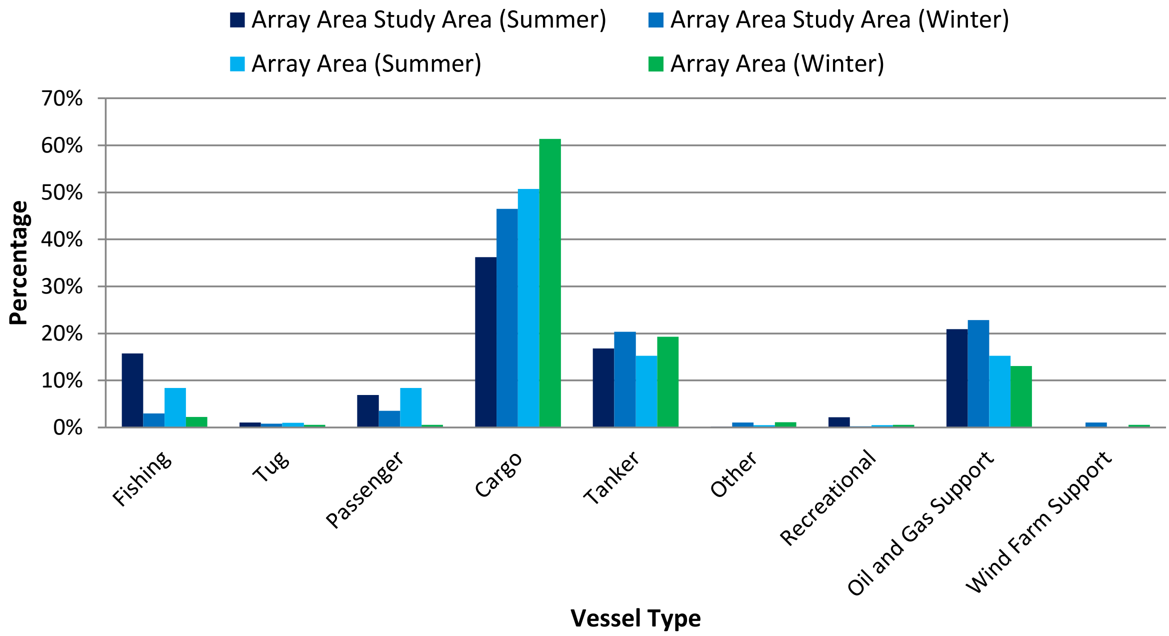


Figure 15.7 Vessel type distribution within Hornsea Four array area and shipping and navigation study area (28 days summer 2018 and winter 2019)

Throughout the summer period, the main vessel types were cargo vessels (51% within the Hornsea Four array area), tankers (15%) and oil and gas support vessels (15%). Throughout the winter period, the main vessel types were also cargo vessels (61% within the Hornsea Four array area), tankers (19%) and oil and gas support vessels (13%). It should be noted that the cargo vessel category includes commercial ferries which generally broadcast their vessel types on AIS as cargo. Details specific to commercial ferries are presented in Section 15.1.6.

15.1.2.1 Cargo Vessels

Figure 15.8 presents a plot of cargo vessels, including commercial ferries, recorded within the Hornsea Four array area shipping and navigation study area throughout both survey periods.

Throughout the survey periods, an average of 12 unique cargo vessels per day passed within the Hornsea Four array area shipping and navigation study area. Regular cargo vessels operating in proximity to the Hornsea Four array area include Roll On Roll Off (Ro Ro) vessels primarily operated by DFDS Seaways running routes between Immingham (UK) and Esbjerg (Denmark), Immingham and Gothenburg (Sweden) and Newcastle (UK) and Amsterdam (Netherlands).

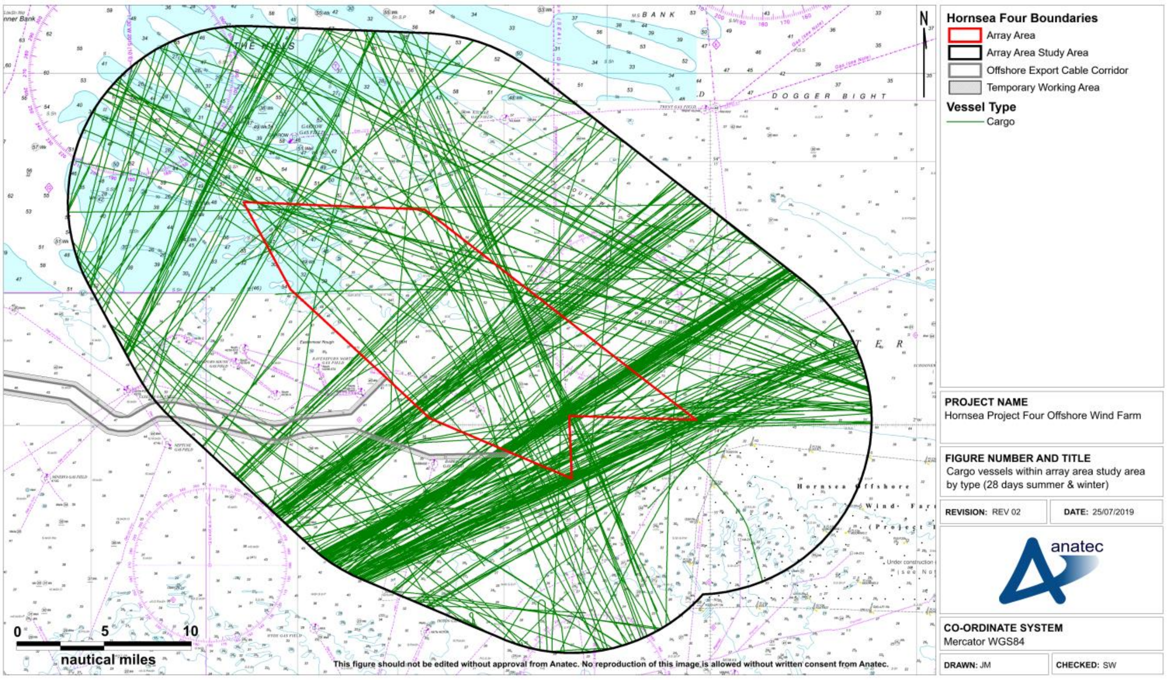


Figure 15.8 Cargo vessels within Hornsea Four array area shipping and navigation study area (28 days summer 2018 and winter 2019)

15.1.2.2 Oil and Gas Support Vessels

Figure 15.9 presents a plot of oil and gas support vessels recorded within the Hornsea Four array area shipping and navigation study area throughout both survey periods.

Throughout the survey periods, an average of six unique oil & gas support vessels per day passed within the Hornsea Four array area shipping and navigation study area. The majority of these vessels were on passage to/from oil and gas installations in the region. Oil and gas support vessels which were not transient included the *Island Condor* acting as a walk to work vessel for the nearby Ravenspurn gas field and the *Putford Defender* and *Putford Saviour*, both acting as Emergency Response and Rescue Vessels (ERRV) for Ravenspurn.

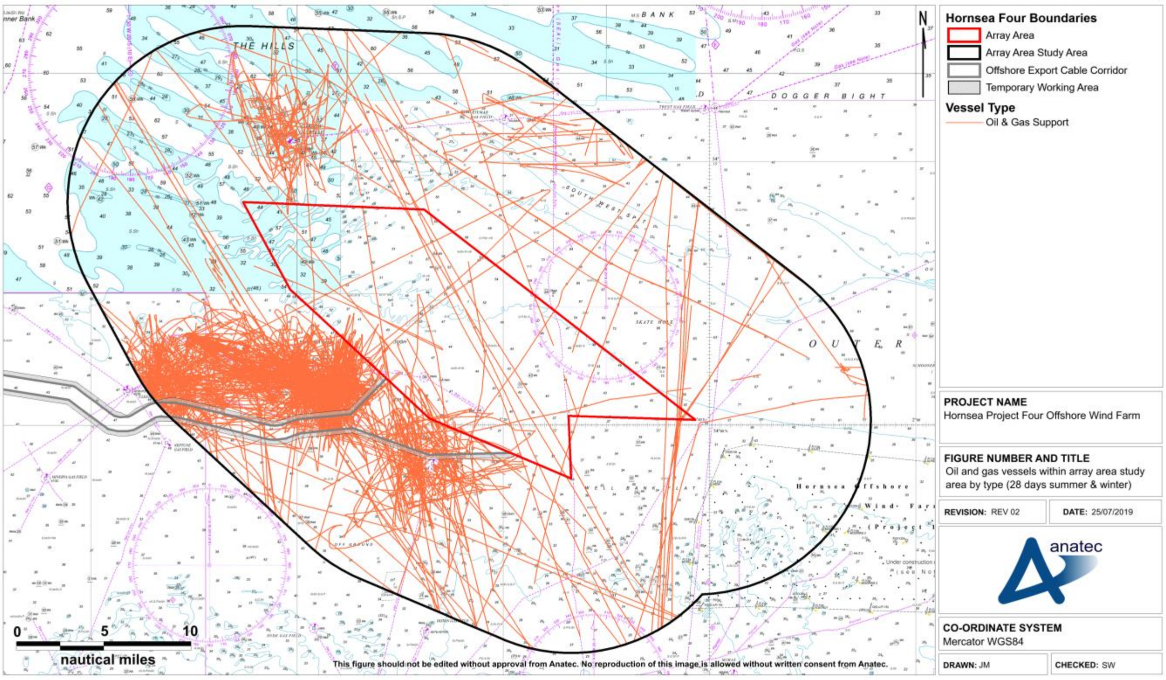


Figure 15.9 Oil and gas support vessels within Hornsea Four array area shipping and navigation study area (28 days summer 2018 and winter 2019)

15.1.2.3 Tankers

Figure 15.10 presents a plot of tankers recorded within the Hornsea Four array area shipping and navigation study area throughout both survey periods.

Throughout the survey periods, an average of five unique tankers per day passed within the Hornsea Four array area shipping and navigation study area. All of the tankers recorded throughout the survey period were on passage to oil and gas terminals throughout the UK and mainland Europe including Rotterdam and Antwerp (Belgium).

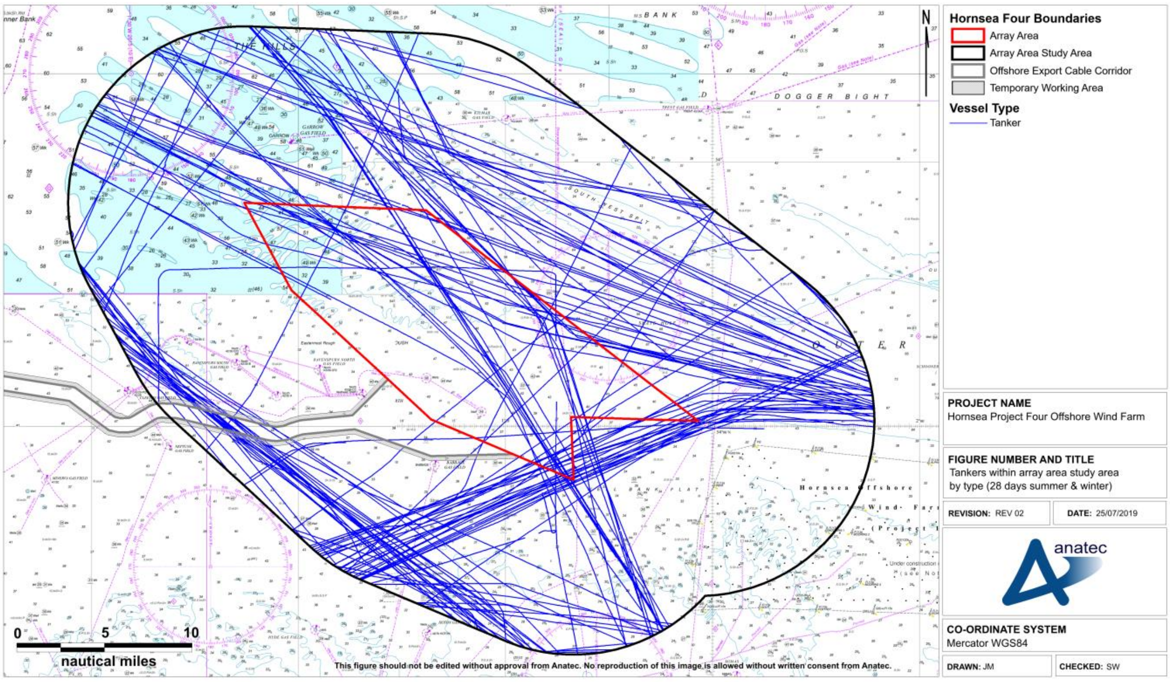


Figure 15.10 Tankers within Hornsea Four array area shipping and navigation study area (28 days summer 2018 and winter 2019)

15.1.3 Vessel Sizes

15.1.3.1 Vessel Length

Vessel LOA was available for more than 99% of vessels recorded throughout the survey periods and ranged from 7 m for a small yacht to 333 m for a large crude oil tanker. Figure 15.11 illustrates the distribution of vessel lengths recorded throughout each survey period.

Excluding the small proportion of vessels for which a length was not available the average length of vessels within the Hornsea Four array area shipping and navigation study area throughout the summer and winter survey periods were 108 m and 132 m, respectively. The proportion of smaller vessels (<50 m) was greater in the summer survey period, reflecting the lower proportion of fishing vessels recorded during the winter survey period.

Figure 15.12 presents a plot of all vessel tracks (excluding temporary traffic) recorded within the Hornsea Four array area shipping and navigation study area throughout the survey periods, colour-coded by vessel length.

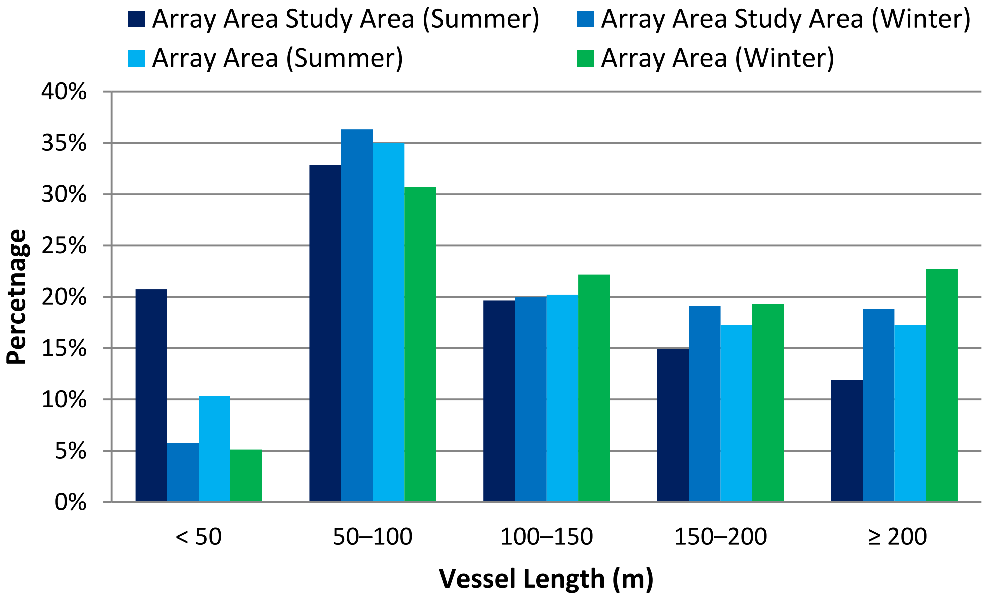


Figure 15.11 Vessel length distribution within Hornsea Four array area and shipping and navigation study area (28 days summer 2018 and winter 2019)

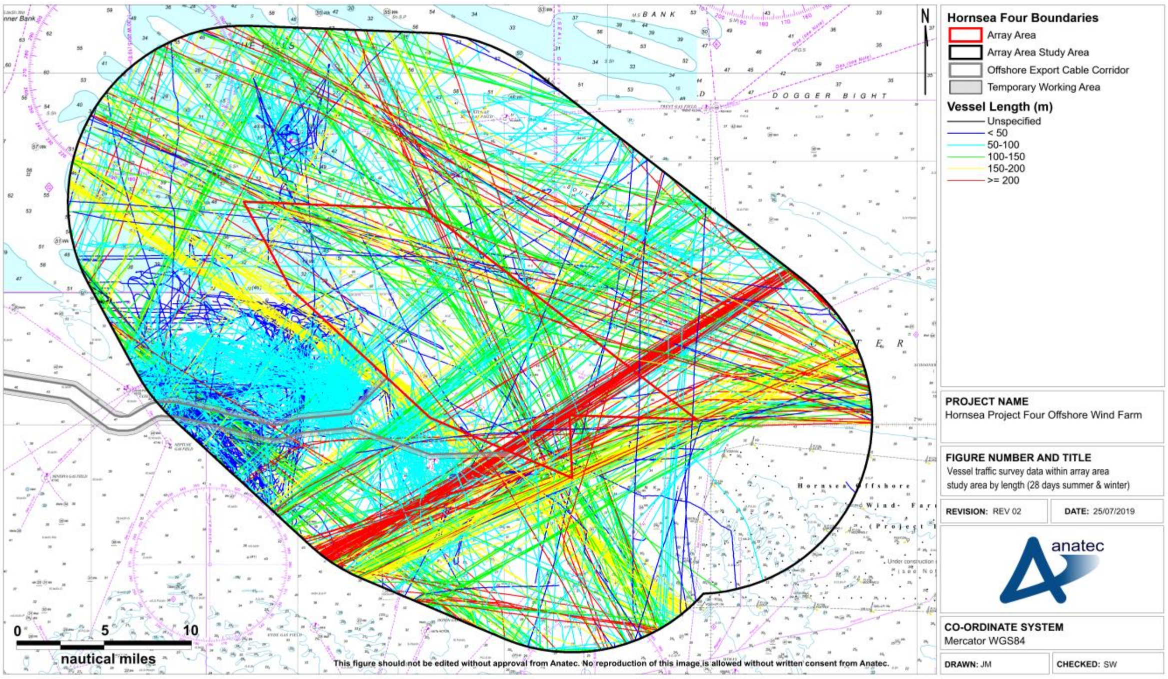


Figure 15.12 Vessel traffic survey data within Hornsea Four array area shipping and navigation study area colour-coded by vessel length (28 days summer 2018 and winter 2019)

15.1.3.2 Vessel Draught

Vessel draught was available for approximately 91% of vessel tracks recorded on AIS throughout the survey periods and ranged from 1.9 m for a small general cargo vessel to 14.0 m for a large bulk carrier. Figure 15.13 illustrates the distribution of vessel draughts recorded throughout each survey period.

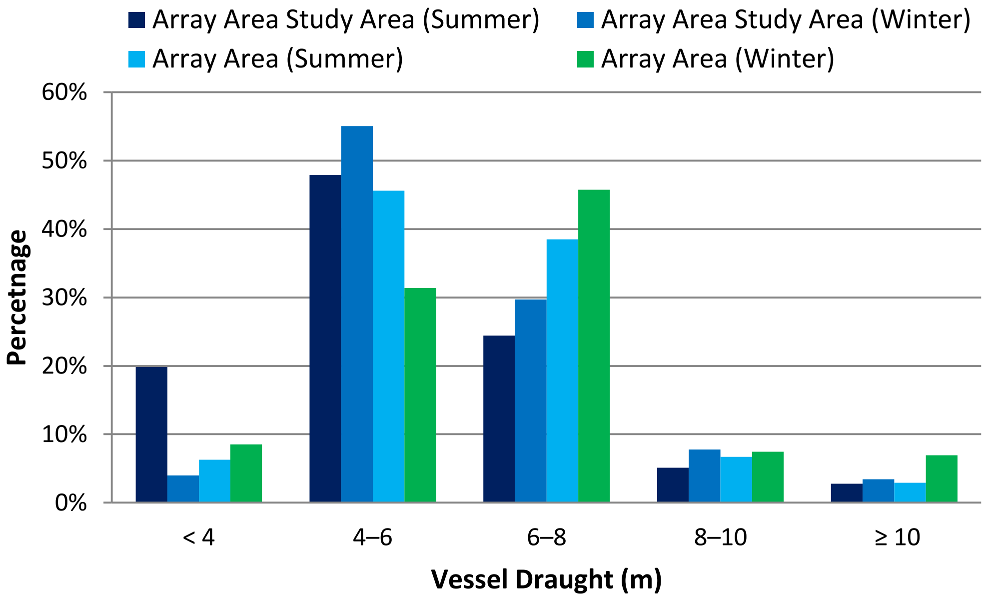


Figure 15.13 Vessel draught distribution within Hornsea Four array area shipping and navigation study area (28 days summer 2018 and winter 2019)

Excluding those vessels for which a draught was not available (mainly non-AIS vessels) the average draught of vessels within the Hornsea Four array area shipping and navigation study area throughout the summer and winter survey periods were 5.3 m and 6.0 m, respectively. As with vessel lengths, the proportion of lower draught vessels (<4 m) was greater during the summer survey period, reflecting the lower proportion of fishing vessels recorded during the winter survey period.

Figure 15.14 presents a plot of AIS, visual and Radar vessel tracks (excluding temporary traffic) recorded within the Hornsea Four array area shipping and navigation study area throughout the survey periods, colour-coded by vessel draught.

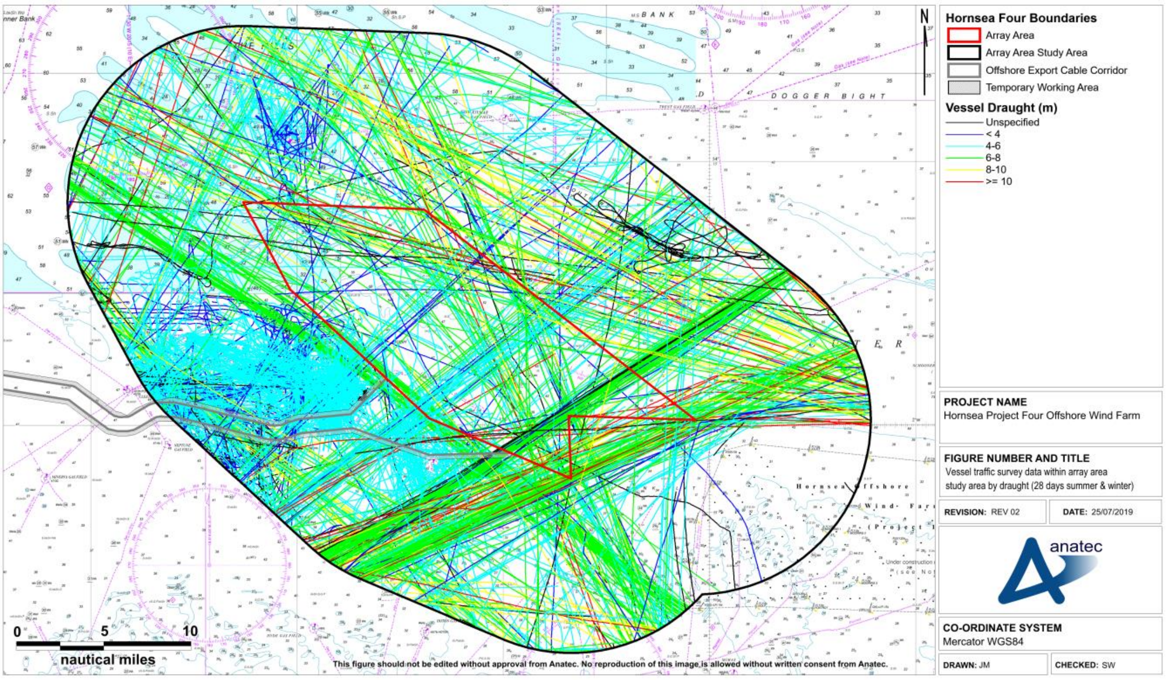


Figure 15.14 Vessel traffic survey data within Hornsea Four array area shipping and navigation study area colour-coded by vessel draught (28 days summer 2018 and winter 2019)

15.1.4 Anchored Vessels

Anchored vessels can be identified based upon the AIS navigational status which is programmed on the AIS transmitter on board a vessel. However, information is manually entered into the AIS, and therefore it is common for vessels not to update their navigational status if only at anchor for a short period of time.

For this reason, those vessels which travelled at a speed of less than 1 kt for more than 30 minutes were deemed to be at anchor. After applying these criteria, only one vessel was deemed to be at anchor. This was an offshore supply vessel operating at the Ravenspurn Charlie platform approximately 6.2 nm south west of the Hornsea Four array area.

15.1.5 Vessel Routeing

15.1.5.1 Definition of a Main Route

Main routes have been identified using the principles set out in MGN 543 (MCA, 2016). Vessel traffic data are assessed and vessels transiting at similar headings and locations are identified as a main route. To help identify main routes, vessel traffic data can also be interrogated to show vessels (by name and/or operator) that frequently transit those routes identifying “regular runner/operator routes”. The Shipping Route Template width is then calculated using the 90th percentile rule from the median line of the potential shipping route as shown in Figure 15.15.

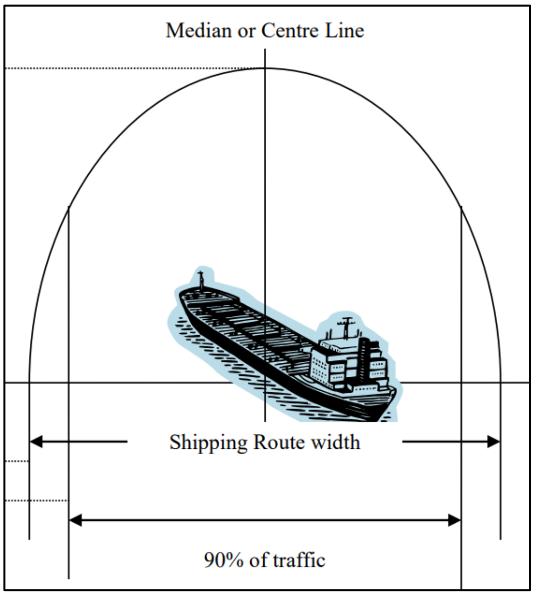


Figure 15.15 Illustration of main route calculation (MCA, 2016)

15.1.5.2 Pre-Wind Farm Main Routes

Main route identification was undertaken for the Hornsea Four array area shipping and navigation study area. Twelve main commercial routes were identified as transiting through the Hornsea Four array area shipping and navigation study area. Figure 15.16 presents a plot of the main routes and corresponding 90th percentiles within the Hornsea Four array area shipping and navigation study area.

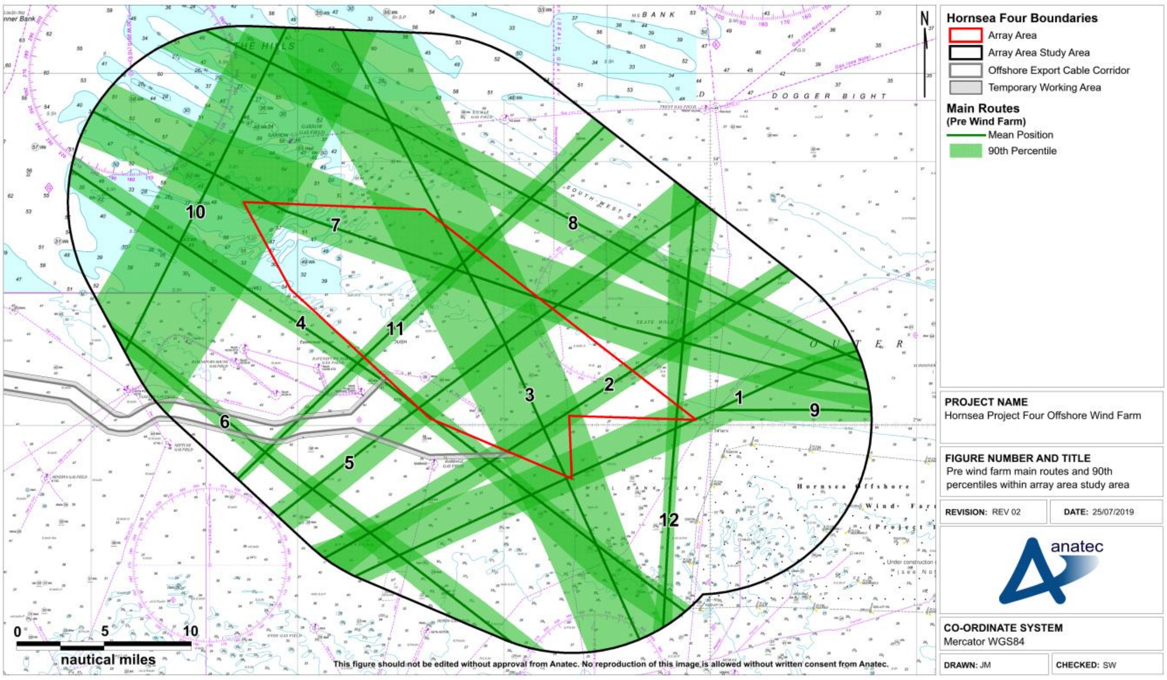


Figure 15.16 Pre-wind farm main routes and 90th percentiles within Hornsea Four array area shipping and navigation study area

A brief description of the traffic on each of the main routes identified is provided in Table 15.1.

Table 15.1 Description of main routes identified within Hornsea Four array area shipping and navigation study area

Route Number	Average Transits per Day	Description (main ports, also may include subsidiary ports)
1	2 to 3	**Immingham to Esbjerg**. Route 1 is generally used by cargo vessels (80%) and tankers (20%) and is a DFDS Seaways commercial ferry route. The main vessels operating on this route are the *Ark Dania* and *Ark Germania*.
2	2 to 3	**Immingham to Gothenburg**. Route 2 is generally used by cargo vessels and is a DFDS Seaways commercial ferry route. The main vessels operating on this route are the *Magnolia Seaways* and *Ficaria Seaways*.
3	2	**Grangemouth (UK) to Rotterdam (Netherlands)**. Route 3 is generally used by cargo vessels (45%), tankers (30%) and oil and gas support vessels (25%).
4	2	**Newcastle to Amsterdam**. Route 4 is generally used by passenger vessels and is a DFDS passenger ferry route between North Shields (UK) and Ijmuiden (Netherlands).
5	1 to 2	**Immingham to Baltic ports**. Route 5 is generally used by cargo vessels and is a Finn Lines commercial ferry route between Hull (UK) and Helsinki (Finland).
6	1 to 2	**Tees (UK) to Rotterdam**. Route 6 is generally used by tankers (55%) and cargo vessels (45%).
7	1 to 2	**Tees to Rotterdam**. Route 7 is generally used by cargo vessels (50%) and tankers (50%).
8	1 to 2	**Tees to Amsterdam**. Route 8 is generally used by cargo vessels (50%) and tankers (50%).
9	1	**Immingham to Hamburg (Germany)**. Route 9 is generally used by cargo vessels (50%) and tankers (50%).
10	1	**Immingham to southern Norway ports**. Route 10 is generally used by cargo vessels (80%) and tankers (20%) and is a Sea-Cargo commercial ferry route between Immingham and Tananger (Norway).
11	1	**Immingham to Baltic ports**. Route 11 is generally used by cargo vessels.
12	0 to 1	**Great Yarmouth (UK) to Trent gas field**. Route 12 is generally used by oil and gas support vessels

15.1.6 Commercial Ferry Activity

Throughout the survey periods 18 unique commercial ferries were identified, with 11 undertaking regular routes; each of these is among the main routes identified in Section 15.1.5. Figure 15.17 presents a plot of commercial ferries recorded within the Hornsea Four array area shipping and navigation study area on AIS, visual and Radar throughout the survey periods, colour-coded by route.

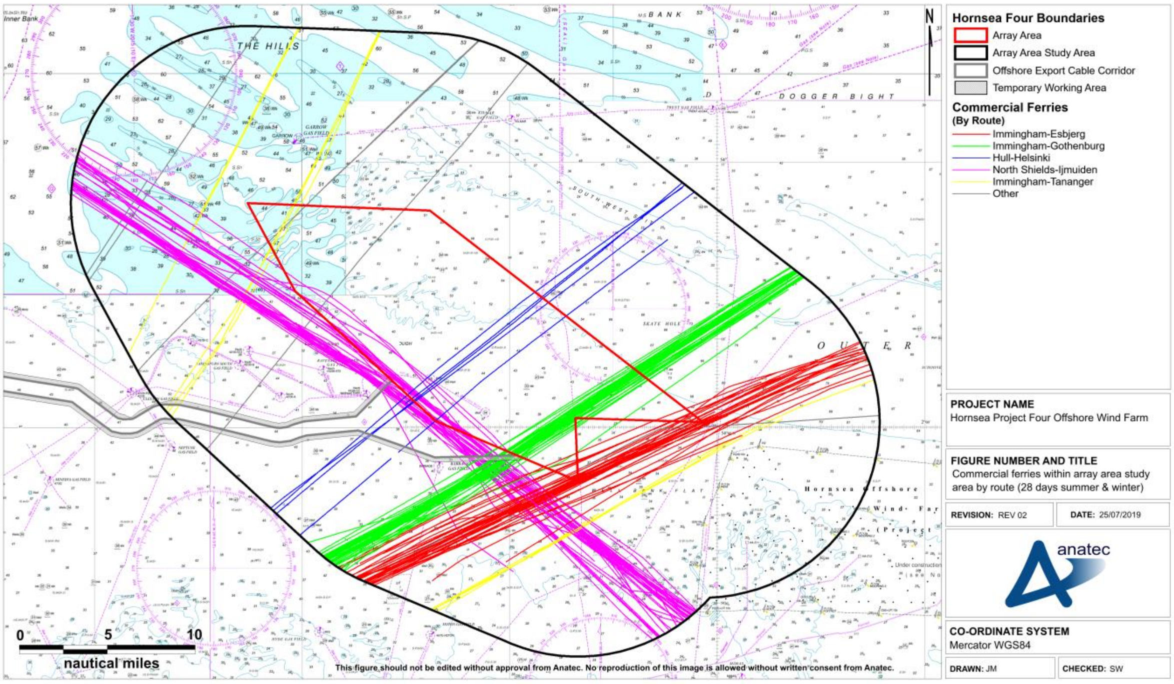


Figure 15.17 Commercial ferries within Hornsea Four array area shipping and navigation study area (28 days summer 2018 and winter 2019)

The most frequently transited commercial ferry route was a DFDS Seaways operated route between Immingham and Esbjerg, with the *Ark Dania* and *Ark Germania* making between one and two transits per day between them within the Hornsea Four array area shipping and navigation study area throughout the survey periods. Two other DFDS Seaways commercial ferry routes were also relatively prominent, with these operating between Immingham and Gothenburg and North Shields and Ijmuiden.

15.1.7 Recreational Vessel Activity

For the purposes of the NRA, recreational activity includes sailing and motor craft (including those undertaking dive and fishing charter trips) of between 2.4 and 24 m LOA.

Figure 15.18 presents a plot of recreational vessels recorded within the Hornsea Four array area shipping and navigation study area throughout both survey periods.

An average of one unique recreational vessel every two days passed within the Hornsea Four array area shipping and navigation study area. It is noted that all recreational craft recorded throughout the 28 days (including winter survey period) were recorded on AIS, with no recreational craft recorded on Radar.

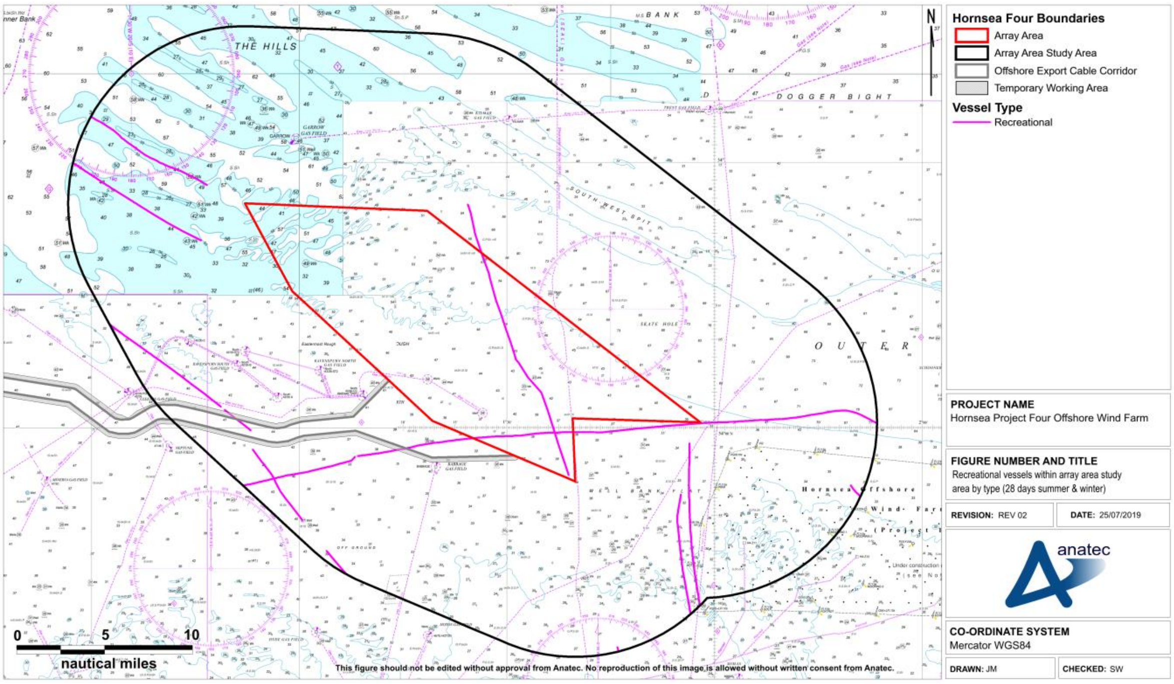


Figure 15.18 Recreational vessels within Hornsea Four array area shipping and navigation study area (28 days summer 2018 and winter 2019)

15.1.8 Commercial Fishing Vessels

15.1.8.1 Vessel Traffic Survey Data

Figure 15.19 presents a plot of fishing vessels recorded within the Hornsea Four array area shipping and navigation study area throughout both survey periods.

An average of three unique fishing vessels per day passed within the Hornsea Four array area shipping and navigation study area. It is noted that only one fishing vessel was recorded on Radar throughout the winter survey period, with the rest recorded on AIS. It is noted that AIS is only mandatory for fishing vessels plus 15 m LOA and fishing vessels smaller than this are less likely to be far offshore i.e. in vicinity of the Hornsea Four array.

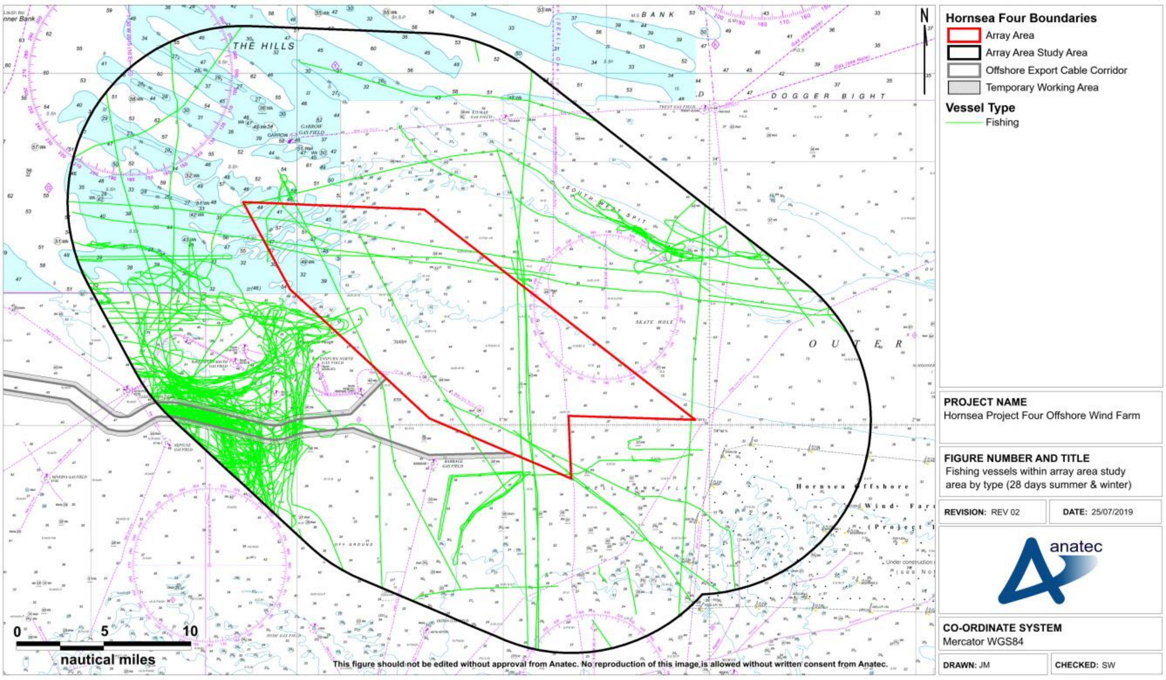


Figure 15.19 Fishing vessels within Hornsea Four array area shipping and navigation study area (28 days summer 2018 and winter 2019)

Fishing vessel movements were characteristic of both fishing vessels in transit and engaged in fishing activity. Fishing vessels were most prominent west of the Hornsea Four array area where a higher density of active fishing was observed. Fishing vessel movements were limited within the Hornsea Four array area itself with those tracks recorded characteristic of transiting fishing vessels.

Flag State (nationality) information was available for all fishing vessels recorded on AIS within the Hornsea Four array area shipping and navigation study area. Of the nationalities identified, the most common were France (61%) and the UK (25%).

Primary fishing method information was researched for all fishing vessels recorded on AIS within the Hornsea Four array area shipping and navigation study area. Of the fishing vessel methods identified, the most common were pots and traps (30%), seines (24%) and boat dredges (22%).

15.1.8.2 Comparison with Volume 2, Chapter 7: Commercial Fishing

Commercial fishing is assessed in detail in **Volume 2, Chapter 7: Commercial Fisheries**. The assessment of fishing vessel activity undertaken for this chapter found that a variety of nationalities were present in proximity to the Hornsea Four array area, including the UK, Netherlands, France and Belgium. UK flagged activity included potting, beam trawling and demersal otter trawling, a proportion of which featured vessels under 15 m length, and therefore may not have been broadcasting on AIS.

Herring, sandeel and brown crab were the leading species landed by vessels in proximity to the Hornsea Four array area, with the latter almost entirely from English flagged vessels.

This largely correlates with the AIS data; UK flagged fishing vessels are likely underrepresented in the AIS data given that they were predominantly potters which are typically smaller fishing vessels which may not have to carry AIS mandatorily.

15.2 Hornsea Four Offshore Export Cable Corridor

A number of tracks recorded during the Hornsea Four offshore ECC survey periods were classified as temporary (non-routine), such as the tracks of the survey vessel (winter only). These have therefore been excluded from the analysis. Oil and gas support vessels operating at permanent installations were retained in the analysis.

A plot of the vessel tracks recorded during a 28-day survey period in June 2018 (summer) and February 2019 (winter), colour-coded by vessel type and excluding temporary traffic, is presented in Figure 15.20.

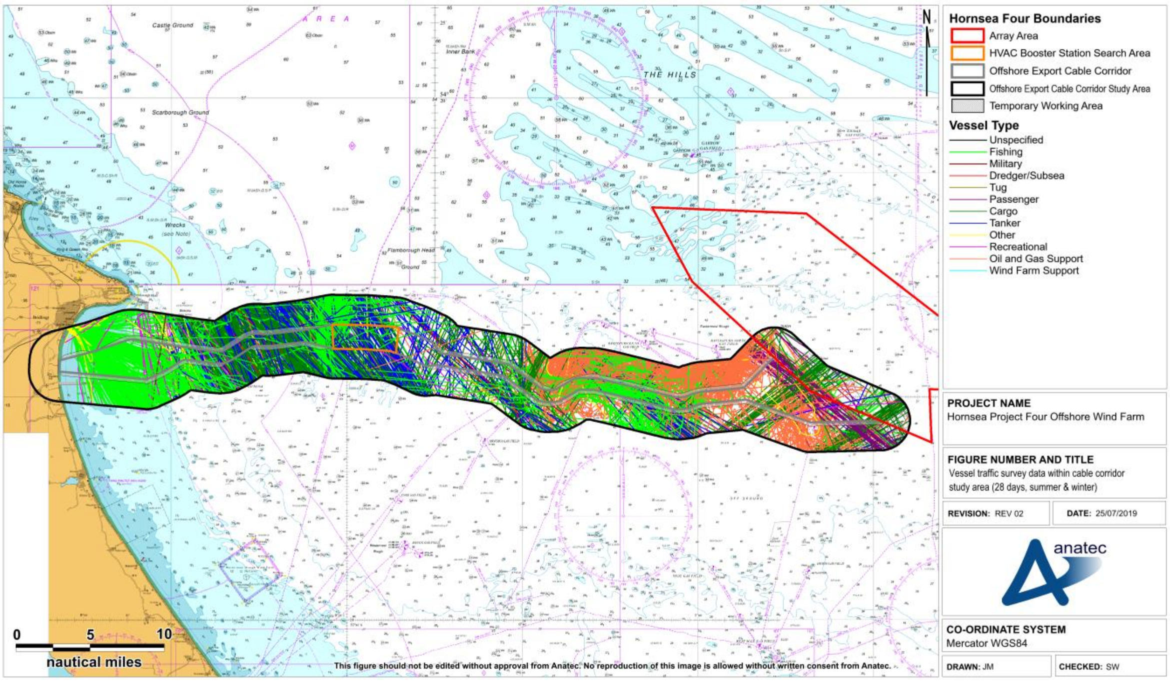


Figure 15.20 Vessel traffic survey data within Hornsea Four offshore ECC shipping and navigation study area colour-coded by vessel type (28 days summer 2018 and winter 2019)

15.2.1 Vessel Count

For the 14 days analysed in the summer survey period, there were an average of 63 unique vessels per day recorded within the Hornsea Four offshore ECC shipping and navigation study area, recorded on AIS. In terms of vessels intersecting the Hornsea Four offshore ECC itself, there was an average of 56 unique vessels per day.

Figure 15.21 illustrates the daily number of unique vessels recorded within the Hornsea Four offshore ECC shipping and navigation study area and the Hornsea Four offshore ECC itself during the summer survey period. Throughout the summer survey period approximately 76% of vessel tracks recorded within the Hornsea Four offshore ECC shipping and navigation study area intersected the Hornsea Four offshore ECC itself.

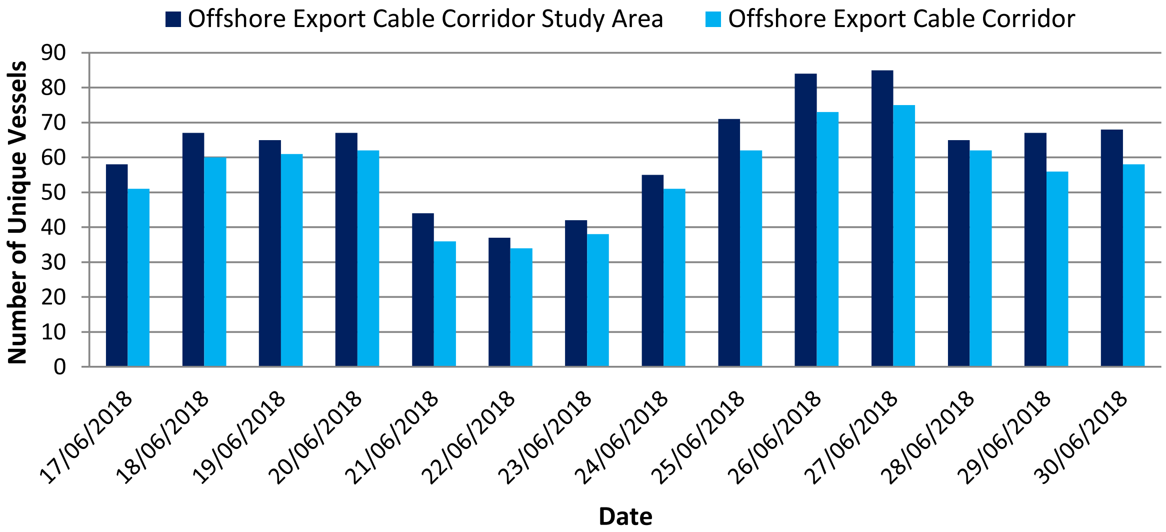


Figure 15.21 Unique vessels per day within Hornsea Four offshore ECC and shipping and navigation study area (14 days summer 2018)

The busiest day recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the summer survey period was the 27th June 2018 when 85 unique vessels were recorded. This was also the busiest day recorded within the Hornsea Four offshore ECC itself throughout the summer survey period with 75 unique vessels recorded.

The quietest day recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the summer survey period was the 22nd June 2018 when 37 unique vessels were recorded. This was also the quietest day recorded within the Hornsea Four offshore ECC itself throughout the summer survey period with 34 unique vessels recorded.

For the 14 days analysed in the winter survey period, there were an average of 51 unique vessels per day recorded within the Hornsea Four offshore ECC shipping and navigation study area, recorded on AIS, visual and Radar. In terms of vessels intersecting the Hornsea Four offshore ECC itself, there was an average of 45 unique vessels per day.

Figure 15.22 illustrates the daily number of unique vessels recorded within the Hornsea Four offshore ECC shipping and navigation study area and the Hornsea Four offshore ECC itself during the winter survey period. Throughout the winter survey period approximately 79% of vessel tracks recorded within the Hornsea Four offshore ECC shipping and navigation study area intersected the Hornsea Four offshore ECC.

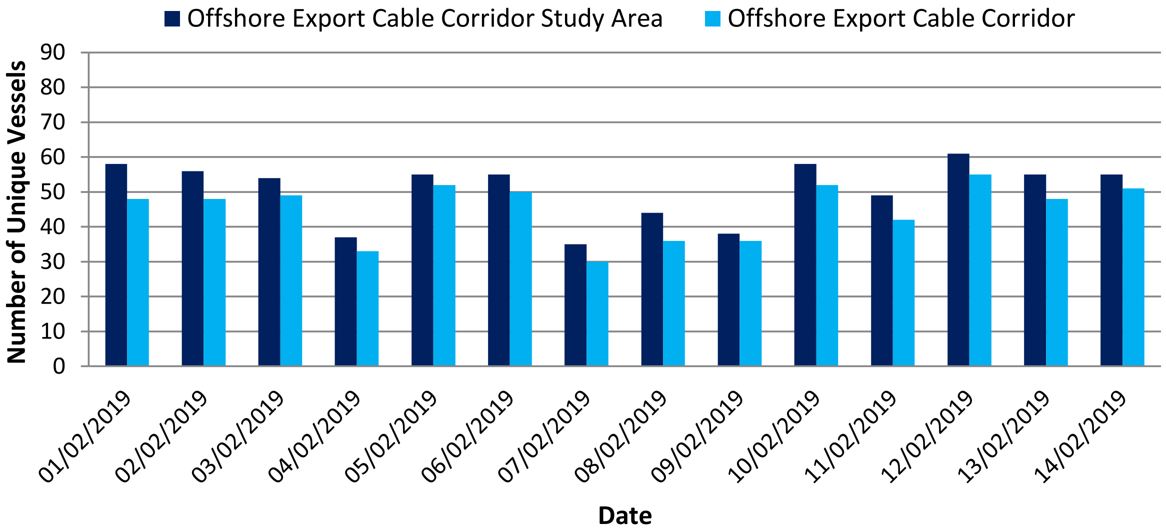


Figure 15.22 Unique vessels per day within Hornsea Four offshore ECC and shipping and navigation study area (14 days winter 2019)

The busiest day recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the winter survey period was the 12th February 2019 when 61 unique vessels were recorded. This was also the busiest day recorded within the Hornsea Four offshore ECC itself throughout the summer survey period with 55 unique vessels recorded.

The quietest day recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the winter survey period was the 7th February 2019 when 35 unique vessels were recorded. This was also the quietest day recorded within the Hornsea Four offshore ECC itself throughout the winter survey period with 30 unique vessels recorded.

15.2.2 Vessel Types

The distribution of the main vessel types recorded passing within the Hornsea Four offshore ECC shipping and navigation study area is presented in Figure 15.23.

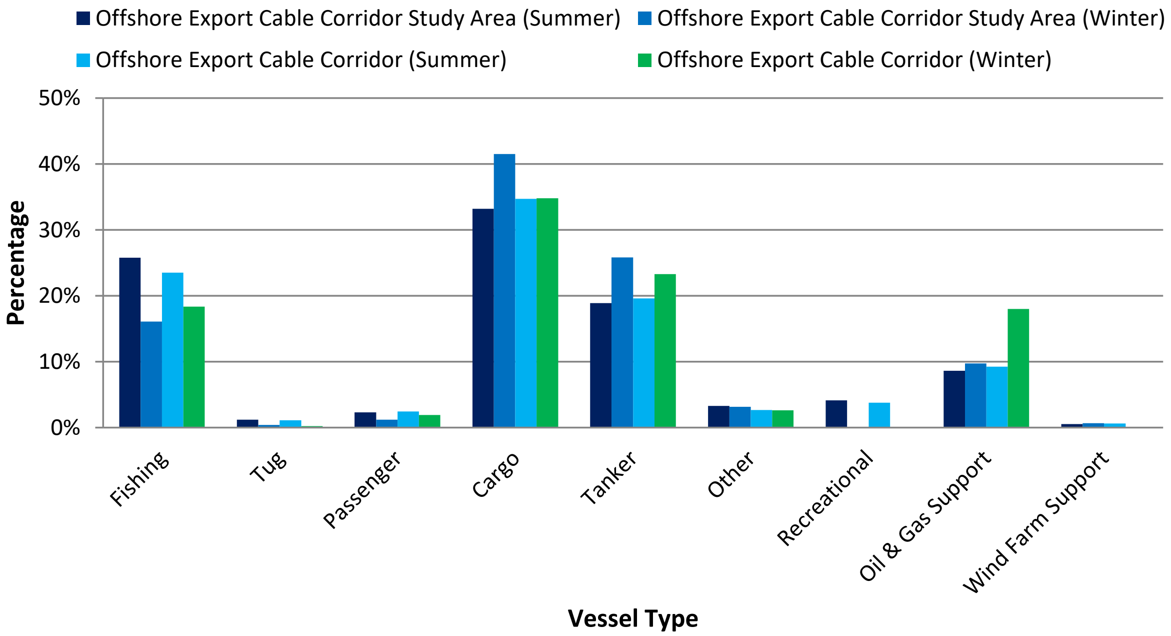


Figure 15.23 Vessel type distribution within Hornsea Four offshore ECC shipping and navigation study area (28 days summer 2018 and winter 2019)

Throughout the summer survey period, the main vessel types were cargo vessels (35% within the Hornsea Four offshore ECC), fishing vessels (24%) and tankers (20%). Throughout the winter survey period, the main vessel types were cargo vessels (35%), tankers (23%) and fishing vessels (18%). It should be noted that the cargo vessel category includes commercial ferries which generally broadcast their vessel types on AIS as cargo.

15.2.2.1 Cargo Vessels

Figure 15.24 presents a plot of cargo vessels, including commercial ferries, recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout both survey periods.

Throughout the survey periods, an average of 22 unique cargo vessels per day passed within the Hornsea Four offshore export cable shipping and navigation study area. The majority of these vessels were transiting coastal routes between northern UK ports and southern North Sea ports. Regular cargo vessels operating within the Hornsea Four offshore ECC shipping and navigation study area include Ro Ro vessels primarily operated by Bore Lines, P&O Ferries and DFDS Seaways running routes between Tees and Zeebrugge (Belgium), Immingham and Esbjerg and Immingham and Gothenburg.

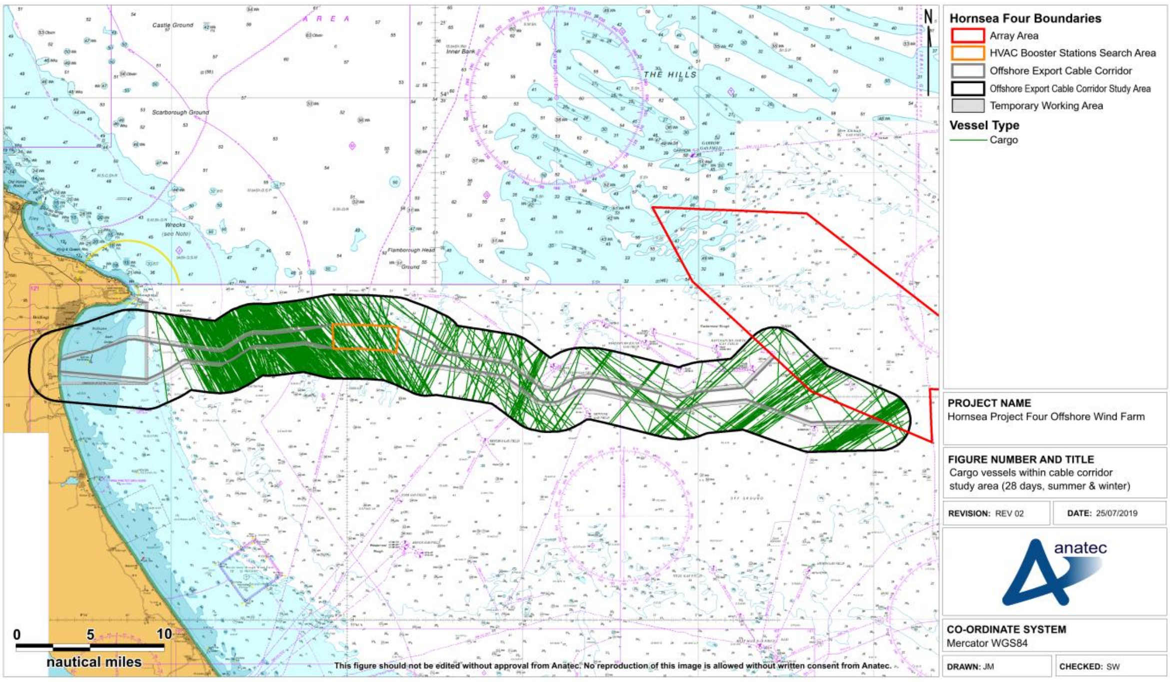


Figure 15.24 Cargo vessels within Hornsea Four offshore ECC shipping and navigation study area (28 days summer 2018 and winter 2019)

15.2.2.2 Tankers

Figure 15.25 presents a plot of tankers recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout both survey periods.

Throughout the survey periods, an average of 13 unique tankers per day passed within the Hornsea Four offshore ECC shipping and navigation study area. The majority of these vessels were transiting coastal routes between northern UK ports (including Grangemouth, Tees and Aberdeen (UK)) and southern North Sea ports (including Immingham, Antwerp and Rotterdam).

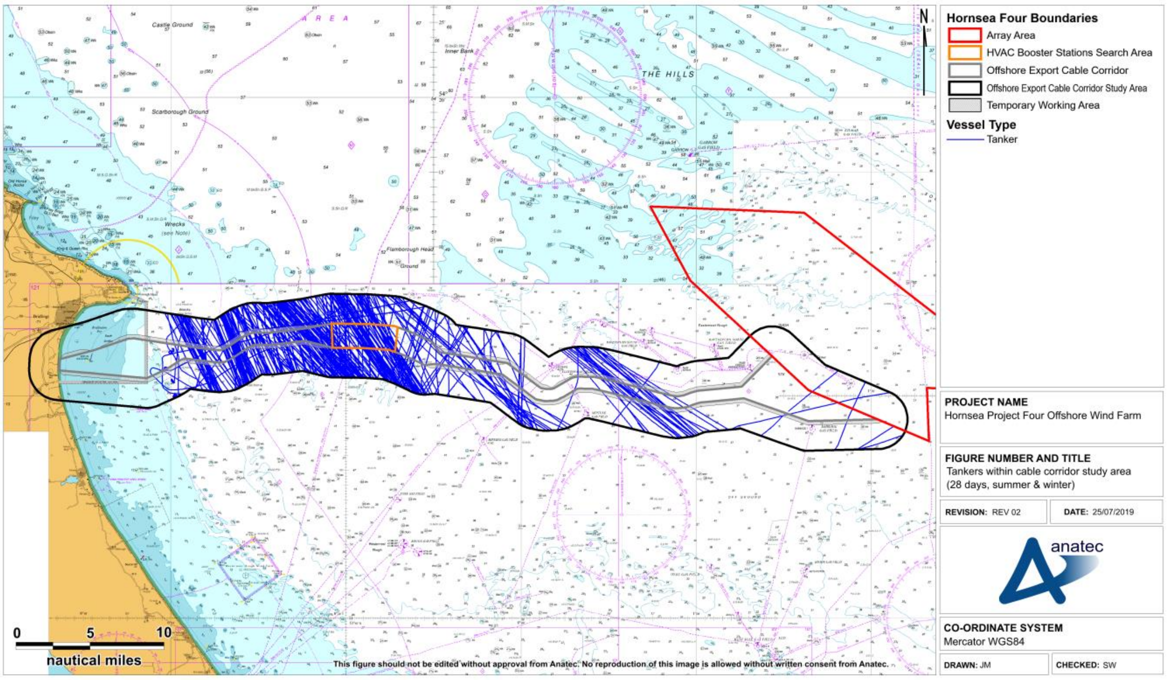


Figure 15.25 Tankers within Hornsea Four offshore ECC shipping and navigation study area (28 days summer 2018 and winter 2019)

15.2.2.3 Oil and Gas Support Vessels

Figure 15.26 presents a plot of oil and gas support vessels recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout both survey periods.

Throughout the survey periods, an average of five to six unique oil and gas support vessels per day passed within the Hornsea Four offshore ECC shipping and navigation study area. The majority of these vessels were undertaking operations for the platforms located at the Ravenspurn North, Ravenspurn South and Babbage gas fields, with minimal activity landward of this region since onshore bases are mainly at Great Yarmouth, Lowestoft and Grimsby.

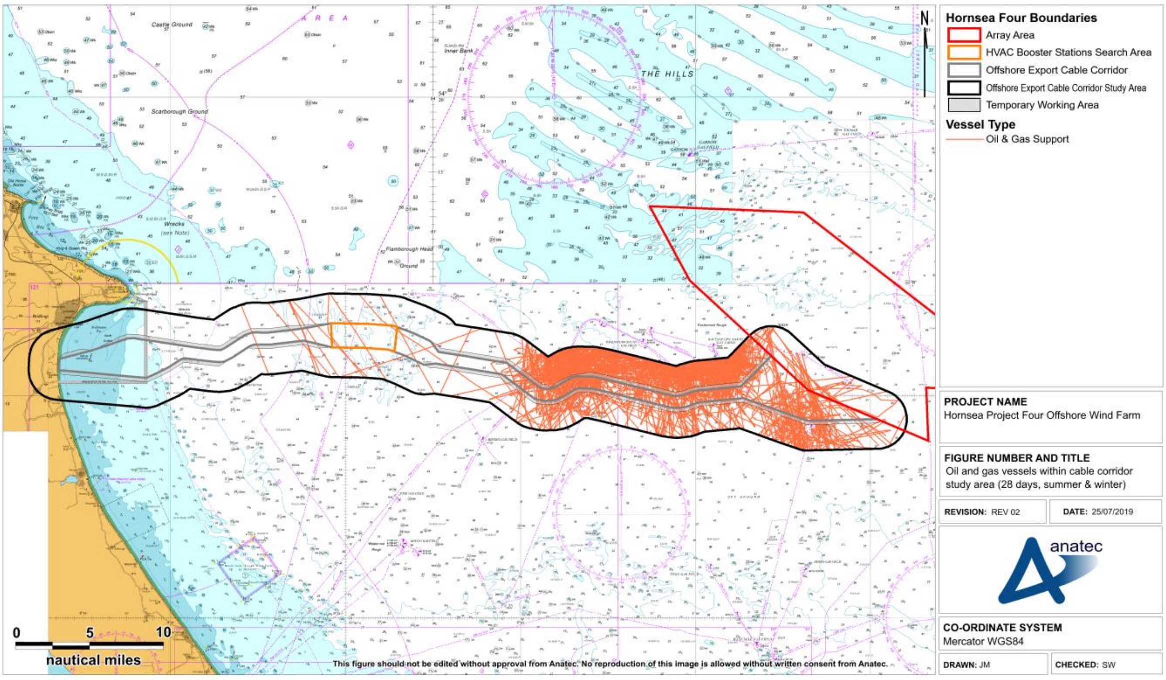


Figure 15.26 Oil and gas support vessels within Hornsea Four offshore ECC shipping and navigation study area (28 days summer 2018 and winter 2019)

15.2.3 Vessel Sizes

15.2.3.1 Vessel Length

Vessel LOA was available for approximately 97% of vessels recorded throughout the survey periods and ranged from 5 m for three small craft including an RNLI lifeboat to 330 m for a large passenger vessel. Figure 15.27 illustrates the distribution of vessel lengths recorded throughout each survey period.

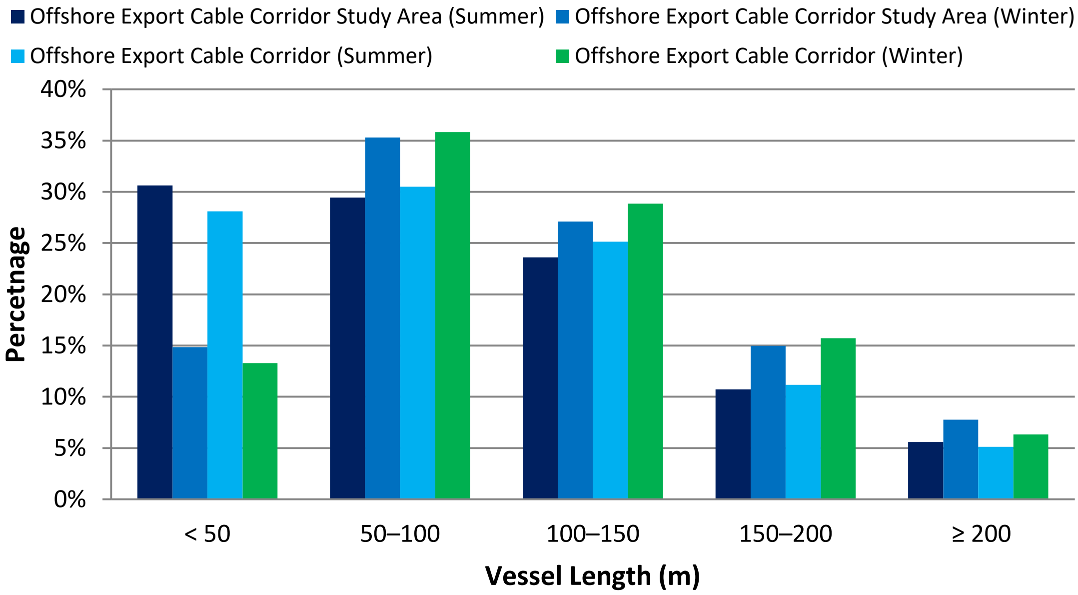


Figure 15.27 Vessel length distribution within Hornsea Four offshore ECC and shipping and navigation study area (28 days summer 2018 and winter 2019)

Excluding unspecified, the average length of vessels within the Hornsea Four offshore ECC shipping and navigation study area throughout the summer and winter survey periods were 85 m and 105 m, respectively. The proportion of smaller vessels (<50 m) was greater in the summer survey period, reflecting the lower proportion of fishing vessels recorded during the winter survey period.

Figure 15.28 presents a plot of vessel tracks (excluding temporary traffic) recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the survey periods, colour-coded by length. It can be seen that near the landfall it was mostly smaller vessels.

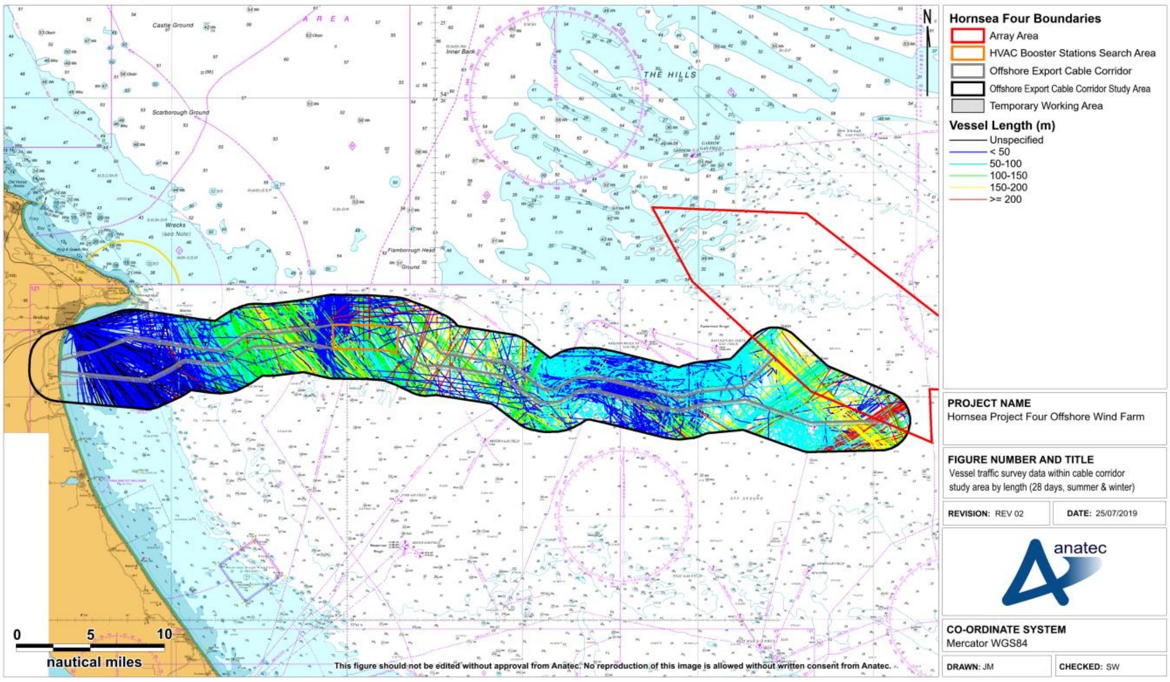


Figure 15.28 Vessel traffic survey data within Hornsea Four offshore ECC shipping and navigation study area colour-coded by vessel length (28 days summer 2018 and winter 2019)

15.2.3.2 Vessel Draught

Vessel draught was available for approximately 73% of vessel tracks recorded throughout the survey periods and ranged from 1.3 m for a catamaran to 14.2 m for a large bulk carrier. Figure 15.29 illustrates the distribution of vessel draughts recorded throughout each survey period.

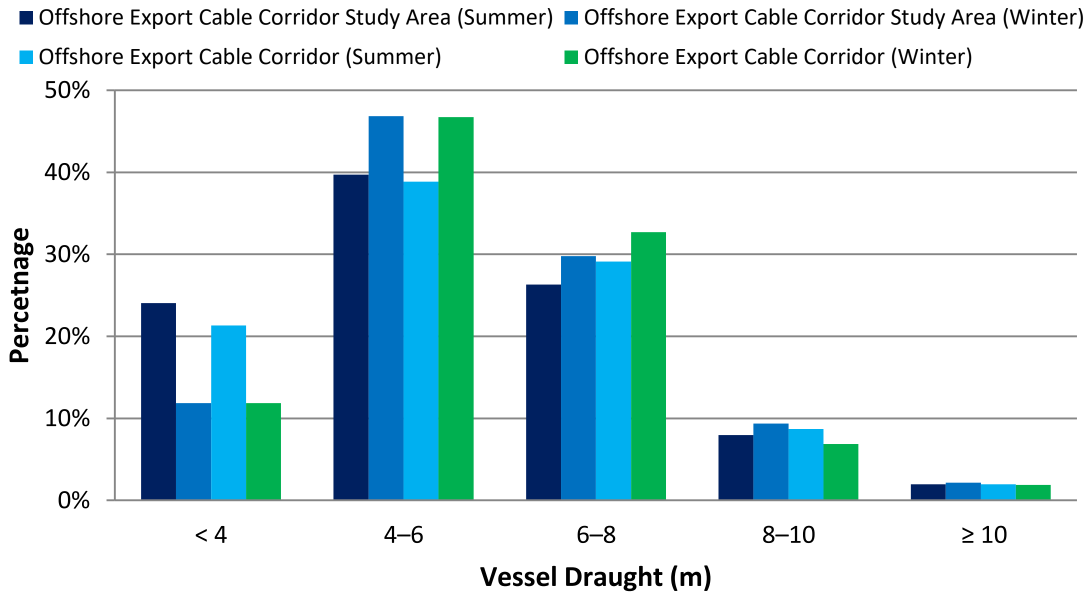


Figure 15.29 Vessel draught distribution within Hornsea Four offshore ECC shipping and navigation study area (28 days summer 2018 and winter 2019)

Excluding unspecified, the average draught of vessels within the Hornsea Four offshore ECC shipping and navigation study area throughout the summer and winter survey periods were 3.6 m and 4.6 m, respectively. As with vessel lengths, the proportion of lower draught vessels (<4 m) was greater during the summer survey period, reflecting the lower proportion of fishing vessels recorded during the winter survey period.

Figure 15.30 presents a plot of vessel tracks (excluding temporary traffic) recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the survey periods, colour-coded by vessel draught.

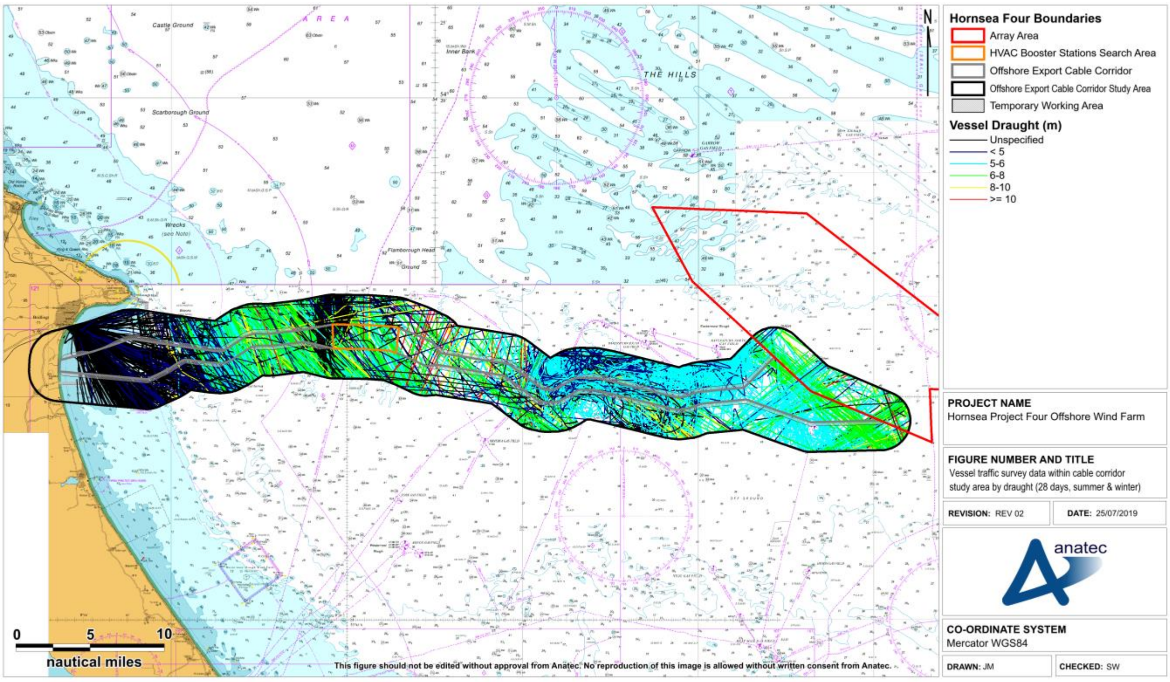


Figure 15.30 Vessel traffic survey data within Hornsea Four offshore ECC shipping and navigation study area colour-coded by vessel draught (28 days summer 2018 and winter 2019)

15.2.4 Anchored Vessels

Anchored vessels can be identified based upon the AIS navigational status which is programmed on the AIS transmitter on board a vessel. However, information is manually entered into the AIS, and therefore it is common for vessels not to update their navigational status if only at anchor for a short period of time.

For this reason, those vessels which travelled at a speed of less than 1 kt for more than 30 minutes were deemed to be at anchor. After applying these criteria, five cases of anchored vessels were identified, with the vessel broadcasting an AIS navigational status of "at anchor" in each case. Figure 15.31 presents a plot of anchored vessels recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the survey periods, colour-coded by vessel type.

All five were crude oil tankers broadcasting a destination of Flamborough Head.

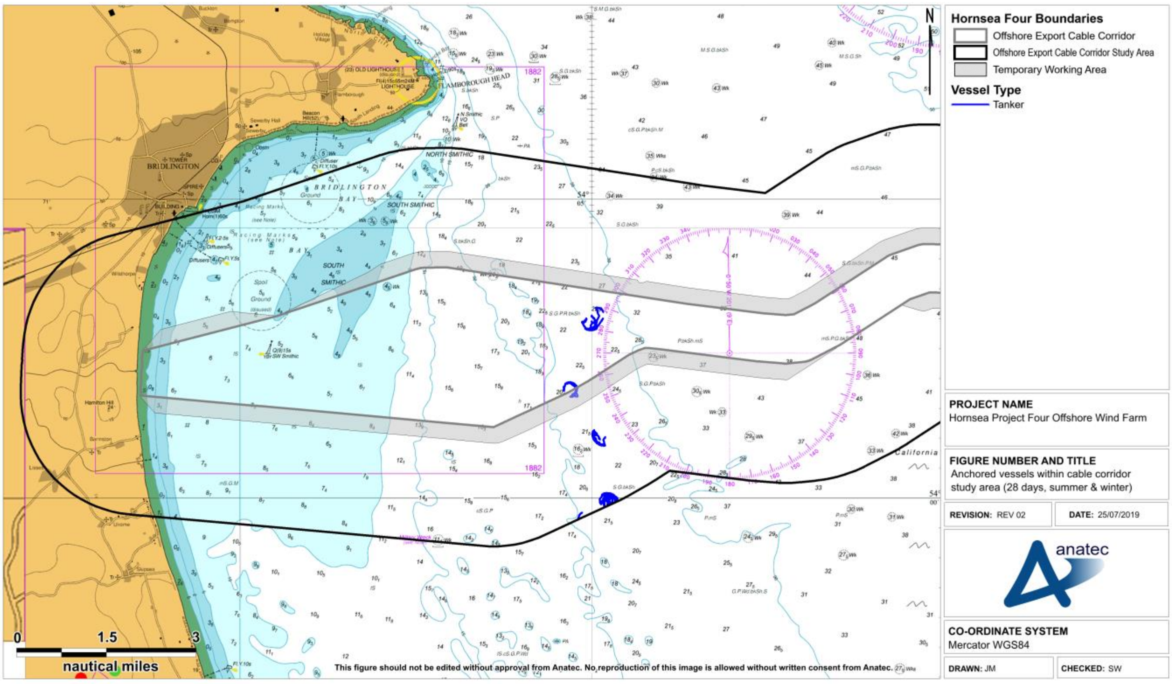


Figure 15.31 Anchored vessels within Hornsea Four offshore ECC shipping and navigation study area (28 days summer 2018 and winter 2019)

15.2.5 Recreational Vessel Activity

15.2.5.1 Vessel Traffic Survey Data

For the purposes of the NRA, recreational activity includes sailing and motor craft (including those undertaking dive and fishing charter trips) of between 2.4 and 24 m LOA.

Figure 15.32 presents a plot of recreational vessels recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout both survey periods.

Throughout the survey periods, an average of one to two unique recreational vessels every day passed within the Hornsea Four offshore ECC shipping and navigation study area. The majority of these vessels were transiting nearshore around Flamborough Head.

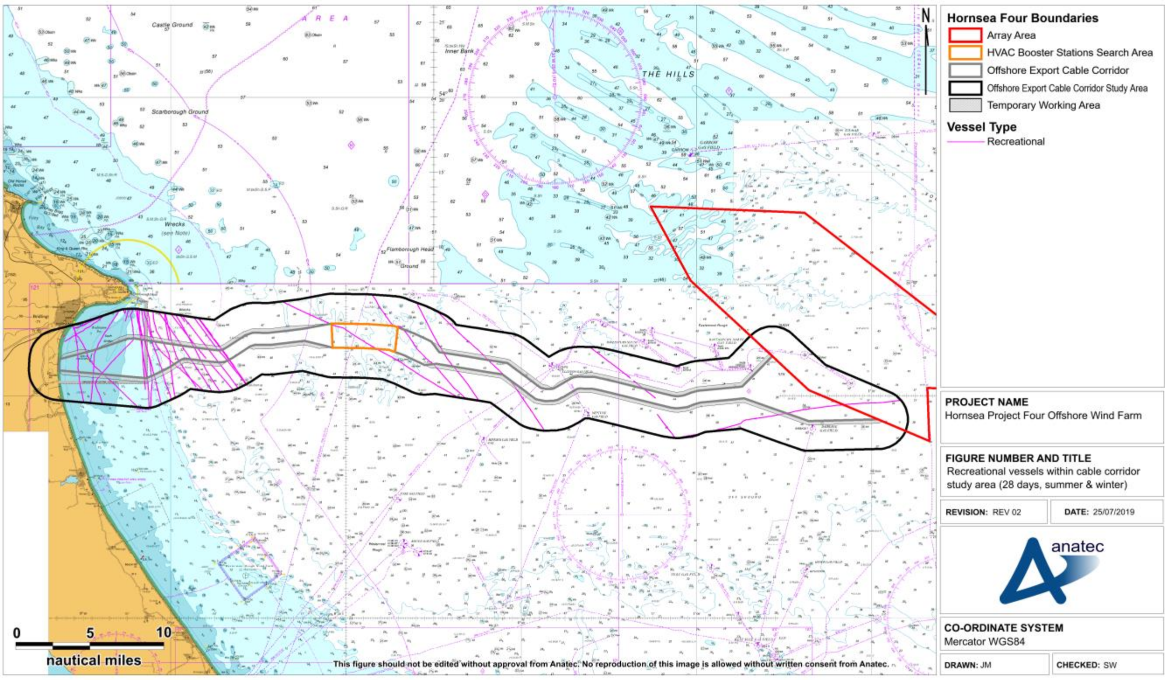


Figure 15.32 Recreational vessels within Hornsea Four offshore ECC shipping and navigation study area (28 days summer 2018 and winter 2019)

15.2.5.2 Royal Yachting Association Coastal Atlas

From the AIS intensity grid provided in the *UK Coastal Atlas of Recreational Boating 2.0* (RYA, 2016), there is a relatively high density of recreational traffic passes north-south within the nearshore area, as reflected in the vessel traffic survey data. It is noted that the AIS intensity grid only extends up to 12 nm offshore given that this is regarded as a reliable limit due to Very High Frequency (VHF) range, particularly for AIS Class B transponders.

The Coastal Atlas also includes generic recreational craft offshore routeing information which suggests that there may be eastbound routeing out of Bridlington Bay. Bridlington Bay includes a designated marina (Bridlington Harbour) and two RYA clubs (Royal Yorkshire Yacht Club and Yorkshire & Humberside Youth Sailing Association). The area containing Bridlington Bay is considered a general boating area.

15.2.6 Commercial Fishing Vessel Activity

Figure 15.33 presents a plot of fishing vessels recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout both survey periods.

Throughout the survey periods, an average of 13 unique fishing vessels per day passed within the Hornsea Four offshore ECC shipping and navigation study area. Fishing vessel movements were characteristic of both fishing vessels in transit and engaged in fishing activity. Fishing vessels were most prominent nearshore transiting in and out of Bridlington and at two locations along the Hornsea Four offshore ECC where tracks were characteristic of active fishing.

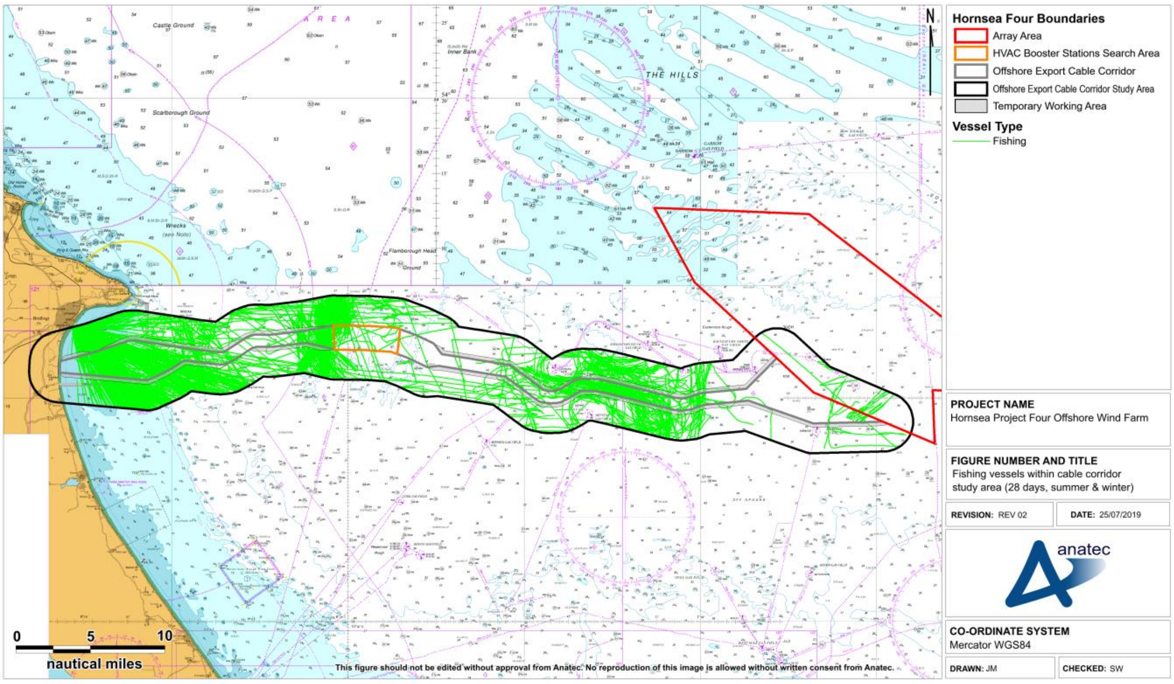


Figure 15.33 Fishing vessels within Hornsea Four offshore ECC shipping and navigation study area (28 days summer 2018 and winter 2019)

15.3 Hornsea Four HVAC Booster Station Search Area

A number of tracks recorded during the Hornsea Four HVAC booster station search area survey periods were classified as temporary (non-routine), such as the tracks of the survey vessel (winter only) These have therefore been excluded from the analysis. Oil and gas support vessels operating at permanent installations were retained in the analysis.

A plot of the vessel tracks recorded during a 14 day survey period in June 2018 (summer, AIS only), colour-coded by vessel type and excluding temporary traffic, is presented in Figure 15.34. A plot of the vessel tracks recorded during a further 14 day survey period in January and February 2019 (winter, dedicated survey), colour-coded by vessel type and excluding temporary traffic, is presented in Figure 15.34.

Plots of the vessel tracks for the summer and winter survey periods converted to a density heat map are presented in Figure 15.36 and Figure 15.37, respectively.

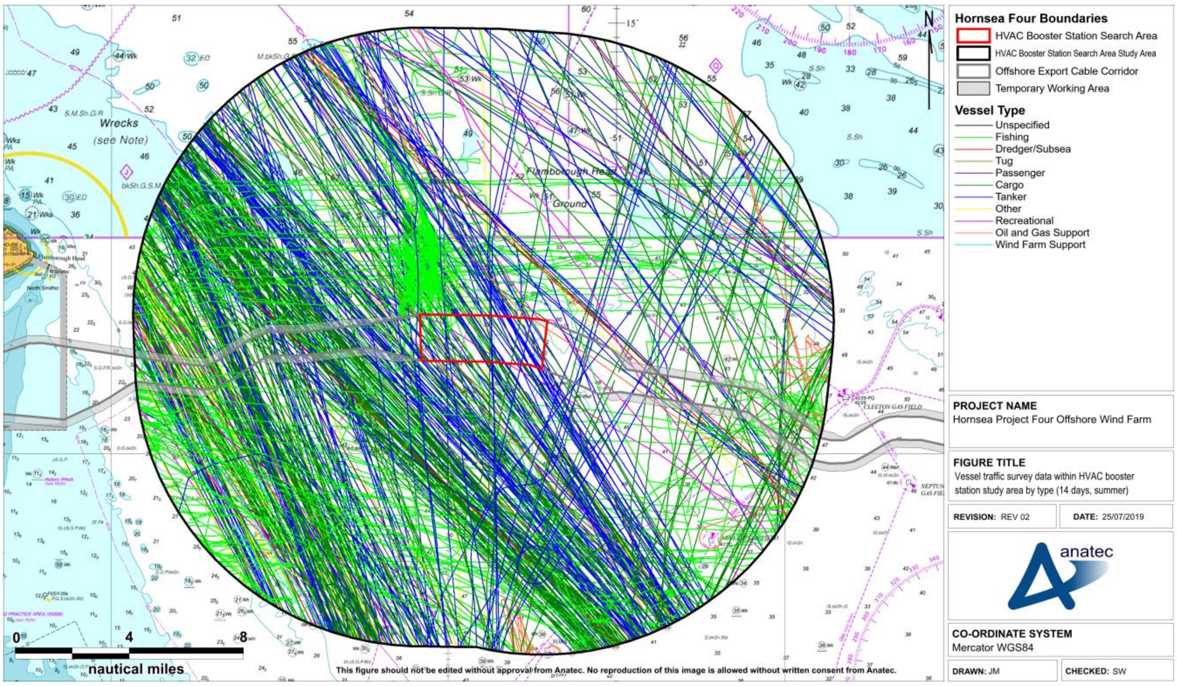


Figure 15.34 Vessel traffic survey data within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by vessel type (14 days summer 2018)

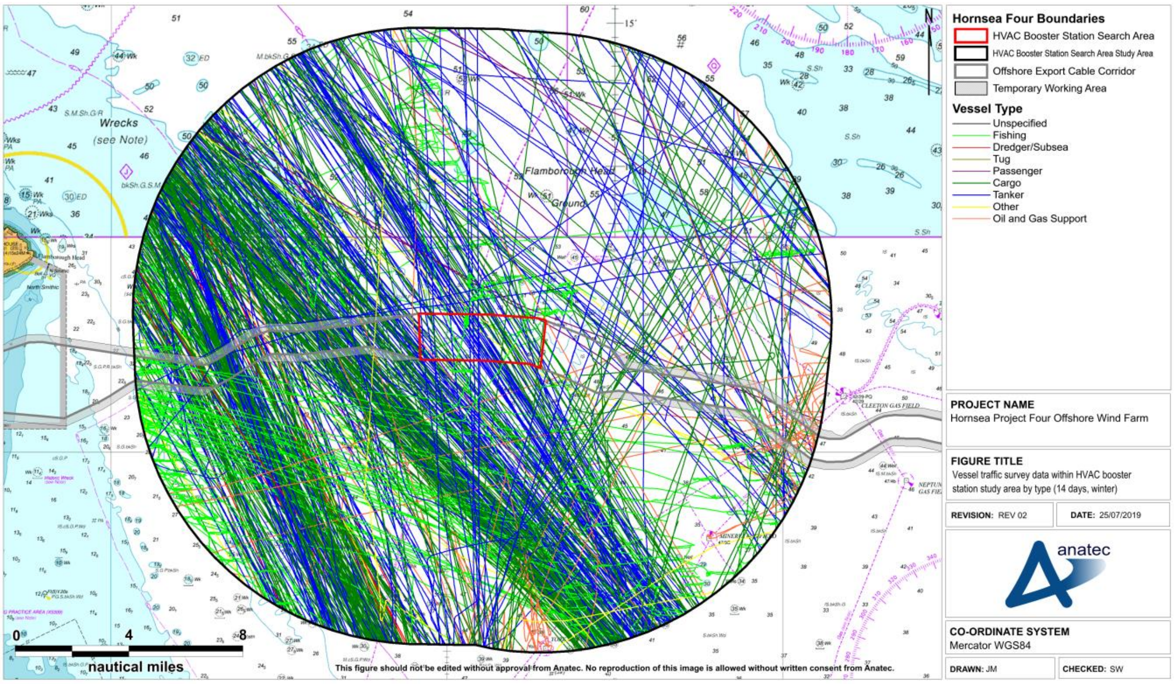


Figure 15.35 Vessel traffic survey data within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by vessel type (14 days winter 2019)

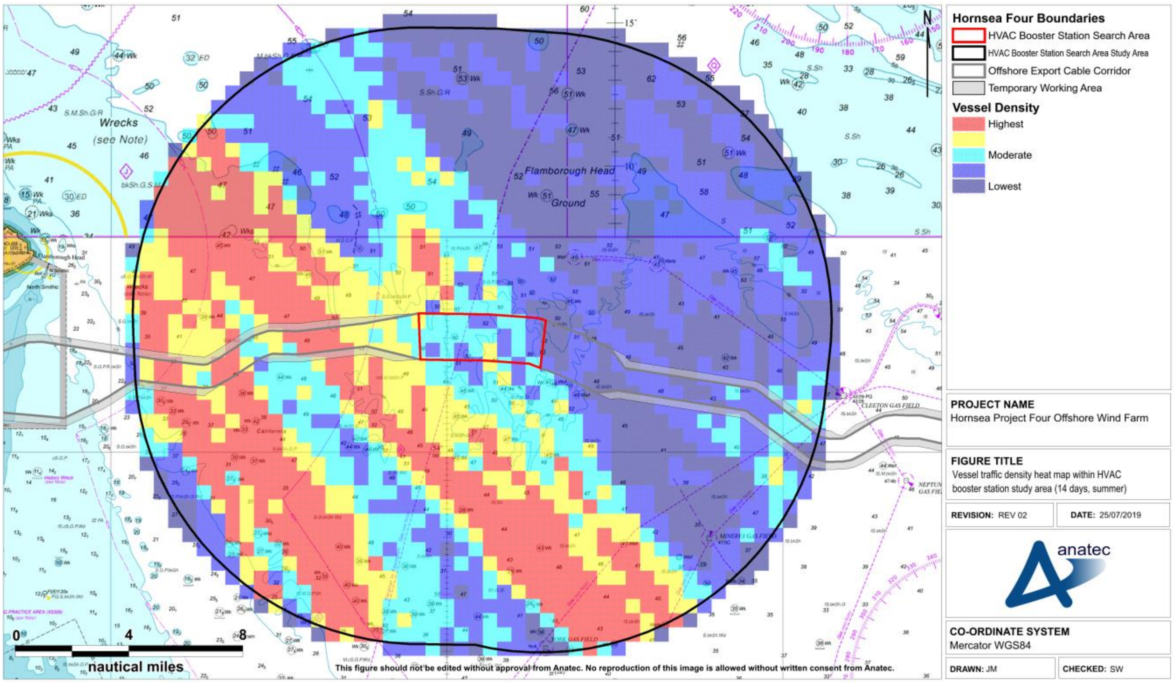


Figure 15.36 Vessel traffic density heat map within Hornsea Four HVAC booster station search area shipping and navigation study area excluding temporary traffic (14 days summer 2018)

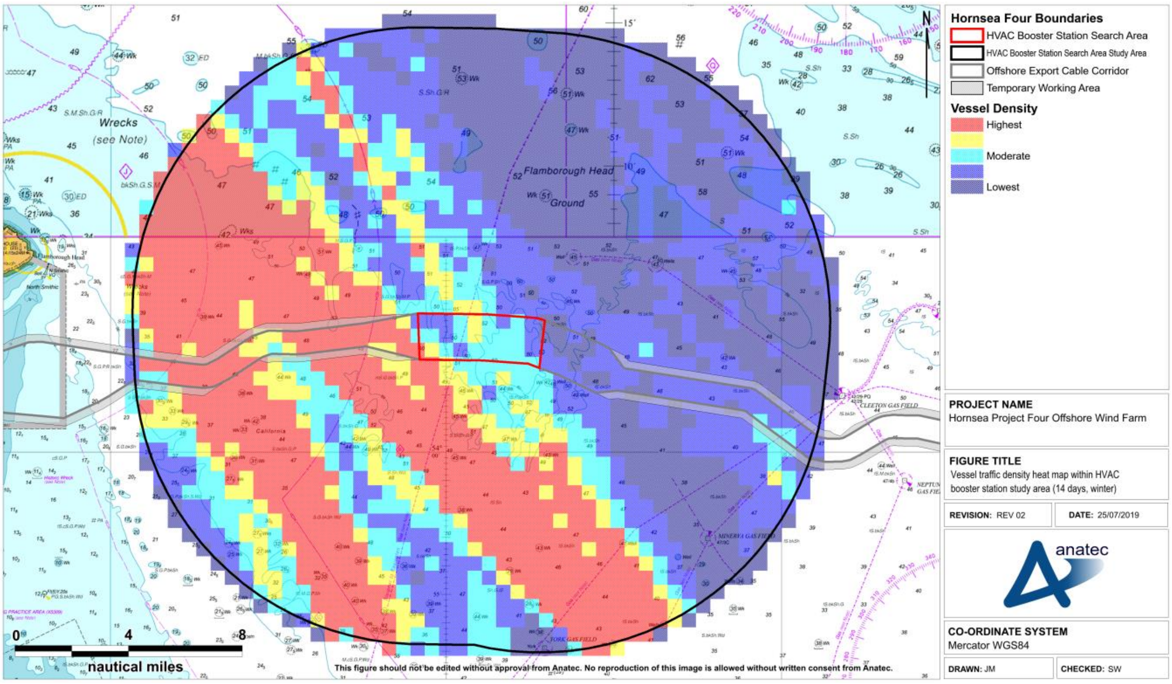


Figure 15.37 Vessel traffic density heat map within Hornsea Four HVAC booster station search area shipping and navigation study area excluding temporary traffic (14 days winter 2019)

15.3.1 Vessel Counts

For the 14 days analysed in the summer survey period, there were an average of 44 unique vessels per day recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area, recorded on AIS. In terms of vessels intersecting the Hornsea Four HVAC booster station search area itself, there was an average of seven unique vessels per day.

Figure 15.38 illustrates the daily number of unique vessels recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area and the Hornsea Four HVAC booster station search area itself during the summer survey period. Throughout the summer survey period approximately 10% of vessel tracks recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area intersected the Hornsea Four HVAC booster station search area.

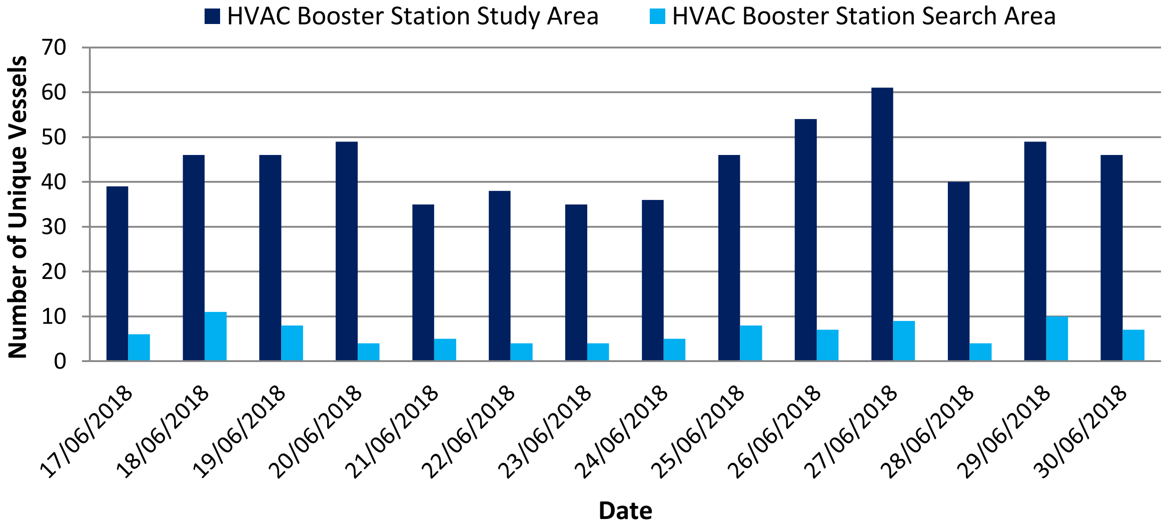


Figure 15.38 Unique vessels per day within Hornsea Four HVAC booster station search area and shipping and navigation study area (14 days summer 2018)

The busiest day recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the summer survey period was the 27th June 2018 when 61 unique vessels were recorded. The busiest day recorded within the Hornsea Four HVAC booster station search area itself throughout the summer survey period was the 18th June 2018 when 11 unique vessels were recorded.

The quietest day recorded throughout the summer survey period was 21st June 2018 when 35 unique vessels were recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area. The quietest days recorded within the Hornsea Four HVAC booster station search area itself throughout the summer survey period were the 20th, 22nd, 23rd and 28th June 2018 when four unique vessels were recorded.

For the 14 days analysed in the winter survey period, there were an average of 37 unique vessels per day recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area, recorded on AIS, visual and Radar. In terms of vessels intersecting the Hornsea Four HVAC booster station search area itself, there was an average of five unique vessels per day.

Figure 15.39 illustrates the daily number of unique vessels recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area and the Hornsea Four HVAC booster station search area itself during the winter survey period. Throughout the winter survey period 11% of vessel tracks recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area intersected the Hornsea Four HVAC booster station search area.

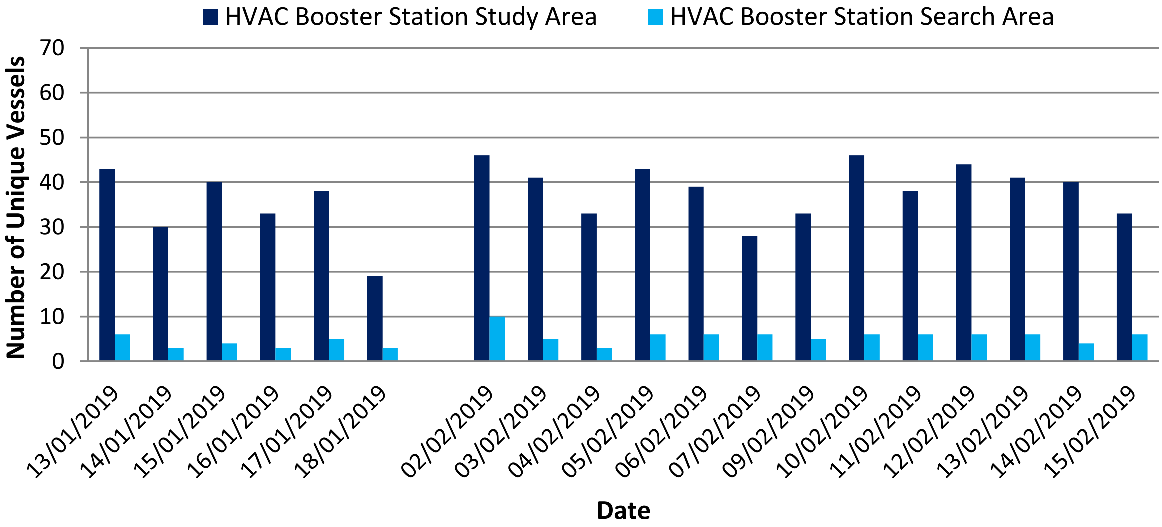


Figure 15.39 Unique vessels per day within Hornsea Four HVAC booster station search area and shipping and navigation study area (14 days winter 2019)

The busiest days recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the winter survey period were the 2nd and 10th February 2019 when 46 unique vessels were recorded. The busiest day recorded within the Hornsea Four HVAC booster station search area itself throughout the winter survey period was the 2nd February 2019 when 10 unique vessels were recorded.

The quietest day recorded throughout the winter survey period was the 18th January 2019 when 19 unique vessels were recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area, noting that this was not a full survey day. The quietest days recorded within the Hornsea Four HVAC booster station search area itself throughout the winter survey period were the 14th, 16th and 18th January 2019 and the 4th February 2019 with five unique vessels recorded.

15.3.2 Vessel Types

The distribution of the main vessel types recorded passing within the Hornsea Four HVAC booster station search area shipping and navigation study area is presented in Figure 15.40.

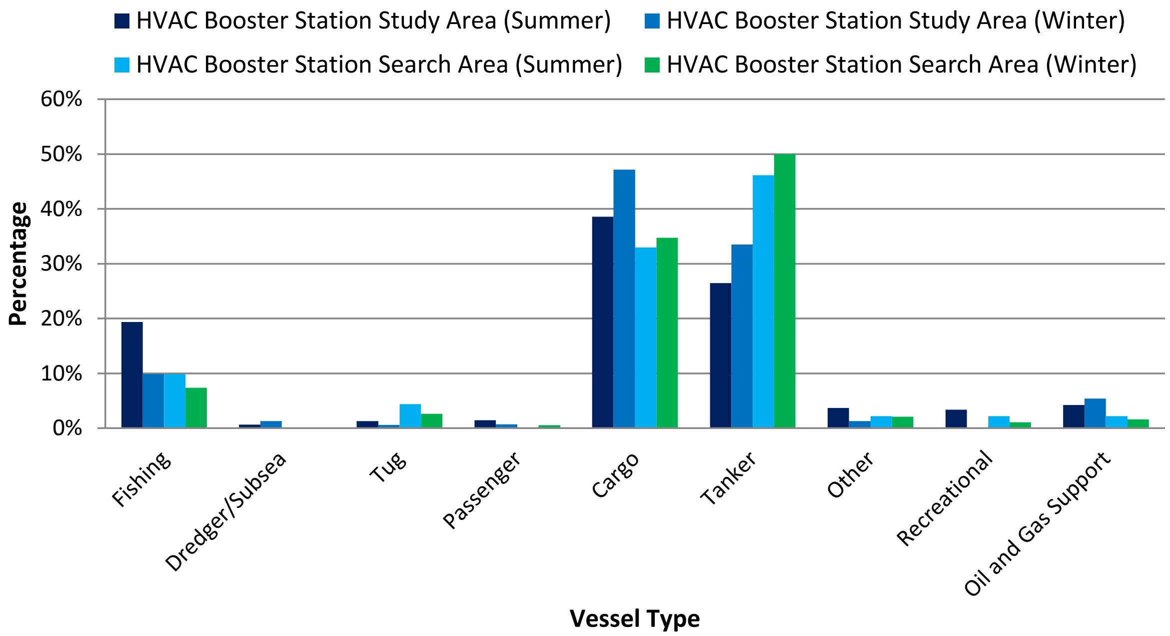


Figure 15.40 Vessel type distribution within Hornsea Four HVAC booster station search area and shipping and navigation study area (28 days summer 2018 and winter 2019)

Throughout the summer period, the main vessel types were tankers (46% within the Hornsea Four HVAC booster station search area) and cargo vessels (33%). Throughout the winter period, the main vessel types were also tankers (50% within the Hornsea Four HVAC booster station search area) and cargo vessels (35%). It should be noted that the cargo vessel category includes commercial ferries which generally broadcast their vessel types on AIS as cargo. Details specific to commercial ferries are presented in Section 15.3.6.

15.3.2.1 Cargo Vessels

Figure 15.41 presents a plot of cargo vessels, including commercial ferries, recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout both survey periods.

Throughout the survey periods, an average of 20 unique cargo vessels per day passed within the Hornsea Four HVAC booster station search area shipping and navigation study area. Regular cargo vessels operating in proximity to the Hornsea Four HVAC booster station search area include Ro Ro vessels primarily operated by Bore Lines and P&O Ferries running routes between Tees and Zeebrugge.

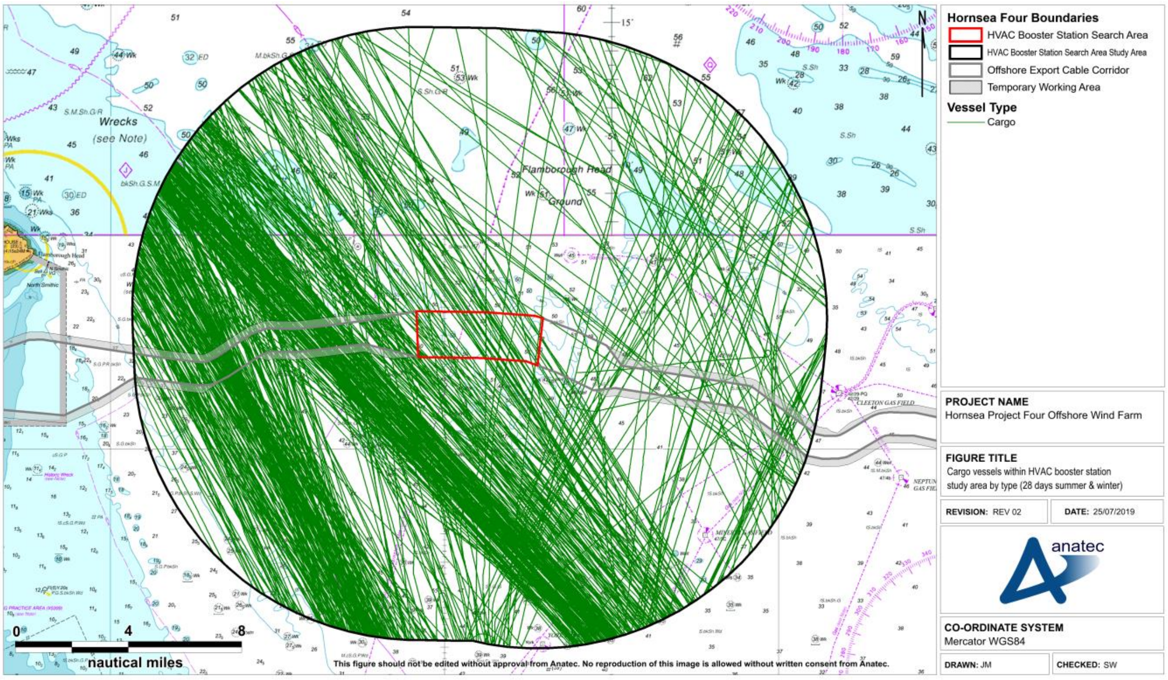


Figure 15.41 Cargo vessels within Hornsea Four HVAC booster station search area shipping and navigation study area (28 days summer 2018 and winter 2019)

15.3.2.2 Tankers

Figure 15.42 presents a plot of tankers recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area on AIS, visual and Radar throughout both survey periods.

Throughout the survey periods, an average of 14 unique tankers per day passed within the Hornsea Four HVAC booster station search area shipping and navigation study area. The majority of tankers recorded throughout the survey period were on passage to oil and gas terminals throughout the UK and mainland Europe.

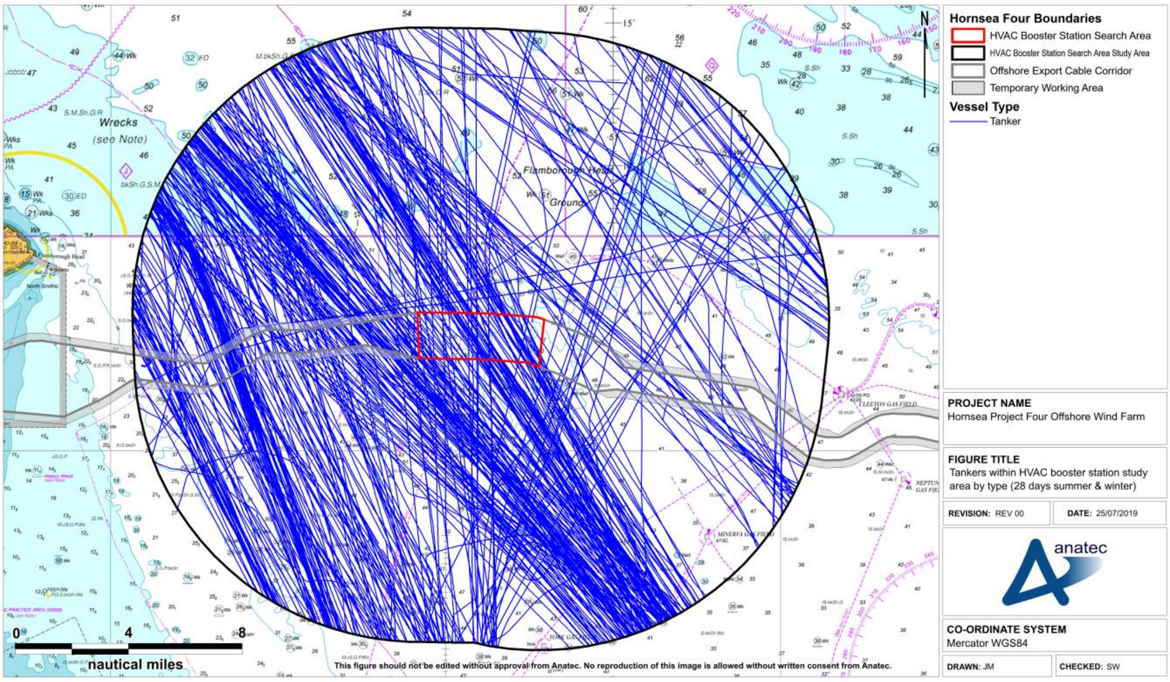


Figure 15.42 Tankers within Hornsea Four HVAC booster station search area shipping and navigation study area (28 days summer 2018 and winter 2019)

15.3.3 Vessel Sizes

15.3.3.1 Vessel Length

Vessel LOA was available for more than 99% of vessels recorded throughout the survey periods and ranged from 5 m for a small yacht to 300 m for a large bulk carrier. Figure 15.43 illustrates the distribution of vessel lengths recorded throughout each survey period.

Excluding unspecified, the average length of vessels within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the summer and winter survey periods were 92 m and 109 m, respectively. The proportion of smaller vessels (<50 m) was greater in the summer survey period, reflecting the lower proportion of fishing vessels recorded during the winter survey period.

Figure 15.44 presents a plot of all vessel tracks (excluding temporary traffic) recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the survey periods, colour-coded by vessel length.

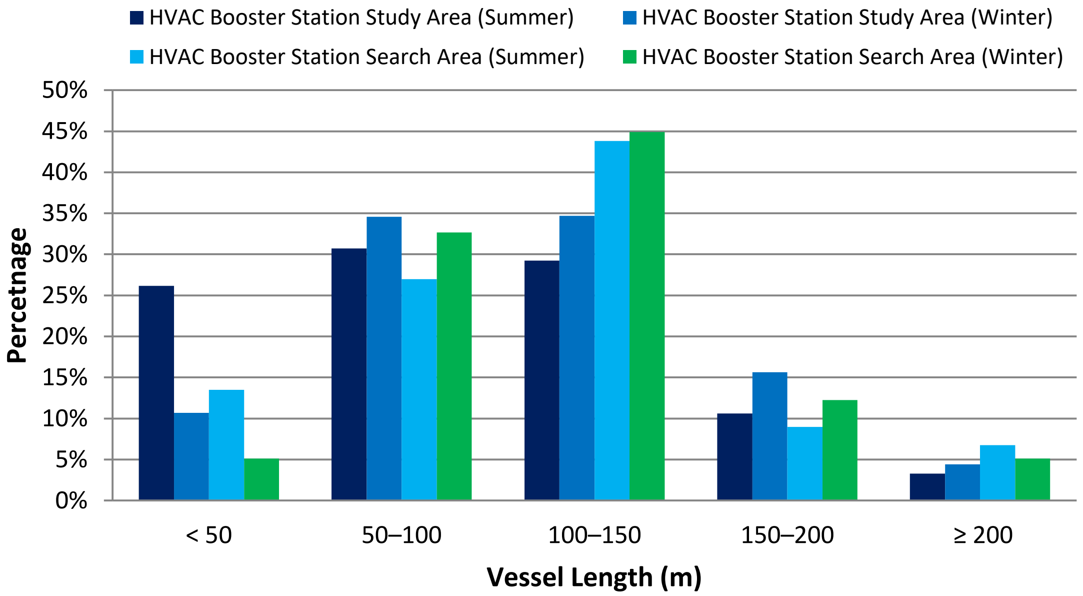


Figure 15.43 Vessel length distribution within Hornsea Four HVAC booster station search area and shipping and navigation study area (28 days summer 2018 and winter 2019)

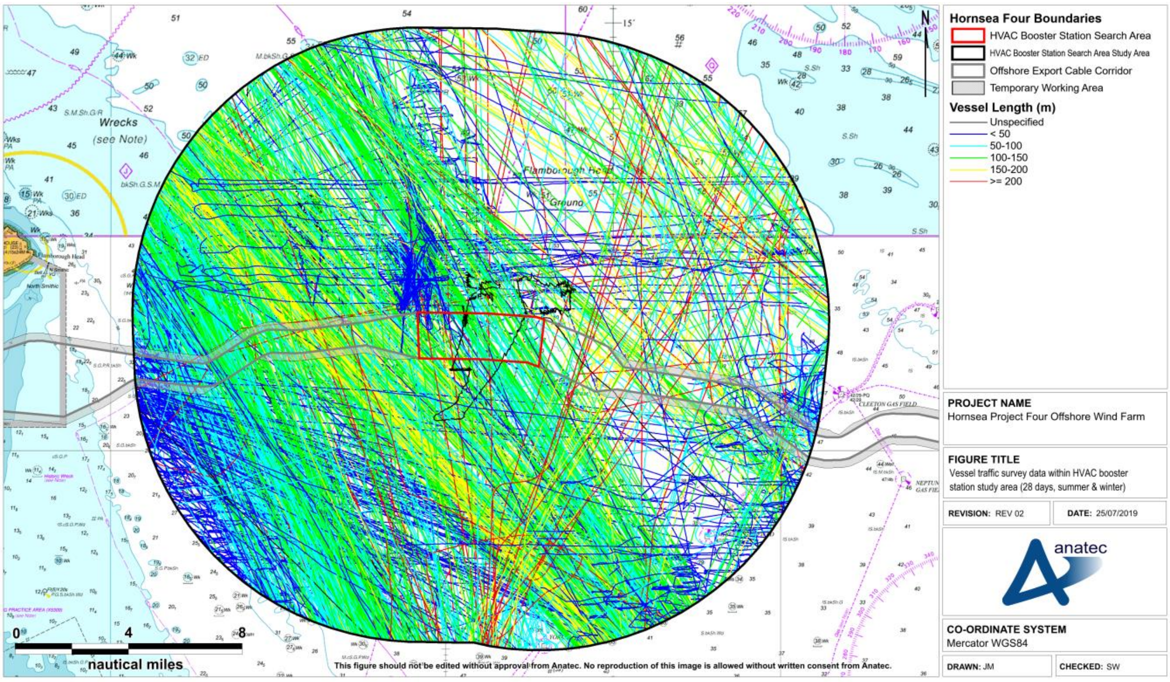


Figure 15.44 Vessel traffic survey data within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by vessel length (28 days summer 2018 and winter 2019)

15.3.3.2 Vessel Draught

Vessel draught was available for approximately 82% of vessel tracks recorded throughout the survey periods and ranged from 1.3 m for a catamaran to 14.2 m for a large bulk carrier. Figure 15.45 illustrates the distribution of vessel draughts recorded throughout each survey period.

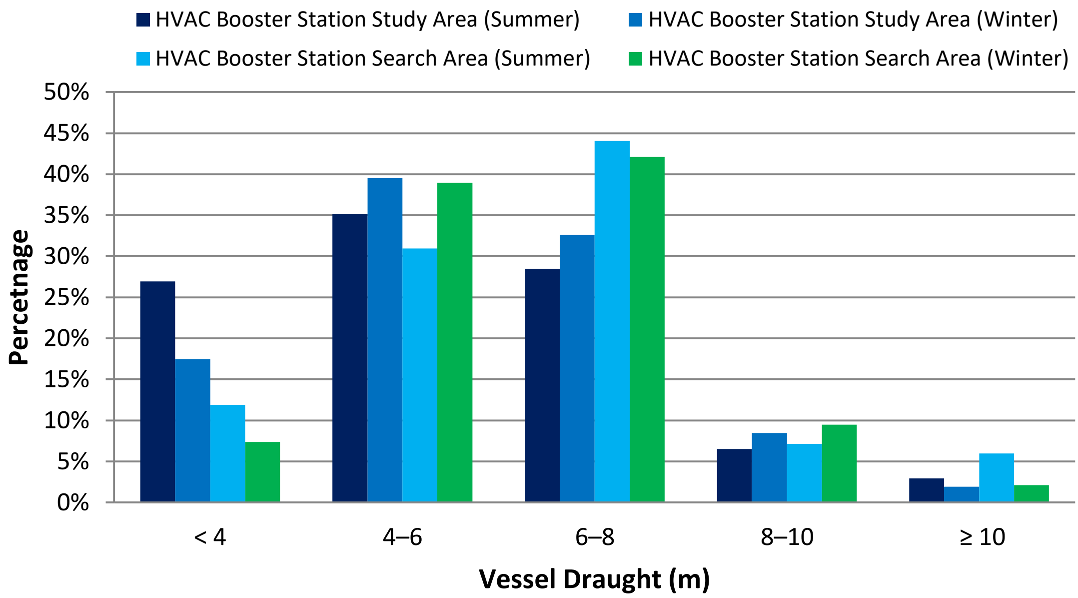


Figure 15.45 Vessel draught distribution within Hornsea Four HVAC booster station search area shipping and navigation study area (28 days summer 2018 and winter 2019)

Excluding unspecified, the average draught of vessels within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the summer and winter survey periods were 5.3 m and 4.9 m, respectively. As with vessel lengths, the proportion of lower draught vessels (<4 m) was greater during the summer survey period, reflecting the lower proportion of fishing vessels recorded during the winter survey period.

Figure 15.46 presents a plot of all vessel tracks (excluding temporary traffic) recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the survey periods, colour-coded by vessel draught.

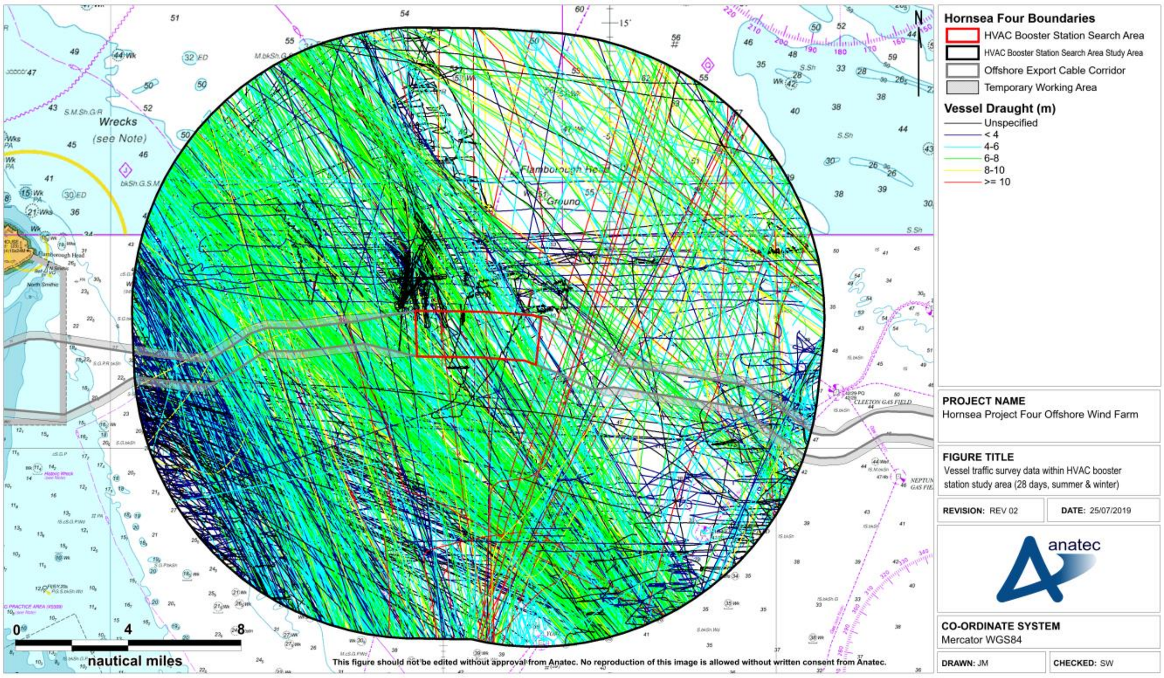


Figure 15.46 Vessel traffic survey data within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by vessel draught (28 days summer 2018 and winter 2019)

15.3.4 Anchored Vessels

Anchored vessels can be identified based upon the AIS navigational status which is programmed on the AIS transmitter on board a vessel. However, information is manually entered into the AIS, and therefore it is common for vessels not to update their navigational status if only at anchor for a short period of time.

For this reason, those vessels which travelled at a speed of less than 1 kt for more than 30 minutes were deemed to be at anchor. After applying these criteria, only one vessel was deemed to be at anchor. This was a crude oil tanker at the western extent of the Hornsea Four HVAC booster station search area shipping and navigation study area (this anchored tanker was also identified for the Hornsea Four offshore ECC vessel traffic analysis in Section 15.2.4).

15.3.5 Vessel Routeing

15.3.5.1 Pre-Wind Farm Main Routes

Main route identification was undertaken for the Hornsea Four HVAC booster station search area shipping and navigation study area. Ten main commercial routes were identified as transiting through the Hornsea Four HVAC booster station search area shipping and navigation study area. Figure 15.47 presents a plot of the main routes and corresponding 90th percentiles within the Hornsea Four HVAC booster station search area shipping and navigation study area.

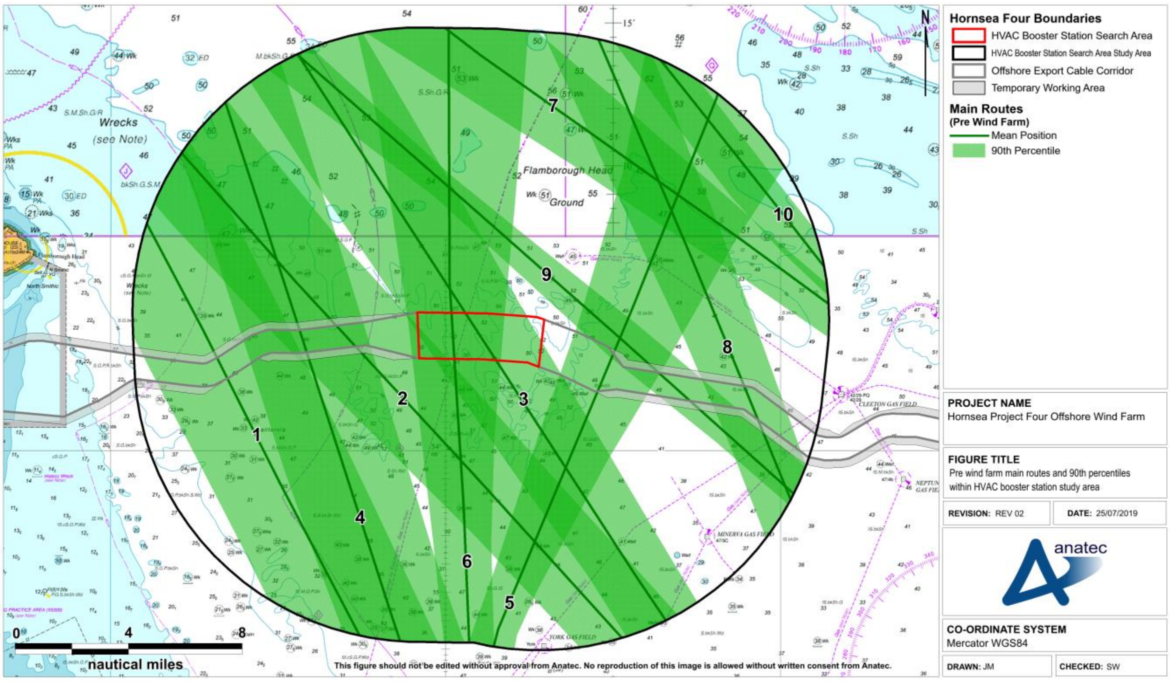


Figure 15.47 Pre-wind farm main routes and 90th percentiles within Hornsea Four HVAC booster station search area shipping and navigation study area

A brief description of the traffic on each of the main routes identified is provided in Table 15.2, including the main ports, noting that routes may include subsidiary ports.

Table 15.2 Description of main routes identified within Hornsea Four HVAC booster station search area shipping and navigation study area

Route Number	Average Transits per Day	Description
1	15	**Tees to Rotterdam**. Route 1 is generally used by cargo vessels (65%) and tankers (35%).
2	11	**Tees to Rotterdam/Zeebrugge**. Route 2 is generally used by cargo vessels (65%) and tankers (35%) and is a Bore Lines and P&O Ferries commercial ferry route between the Tees and Rotterdam and Zeebrugge. The main vessels operating on this route are the *A2B Energy*, *A2B Spirit*, *Bore Song*, *Estraden*, *H&S Bravery*, *Mistral* and *Stena Carrier*.
3	4 to 5	**Grangemouth to Rotterdam**. Route 3 is generally operated by cargo vessels (65%) and tankers (35%).
4	1 to 2	**Immingham to Moray Firth ports**. Route 4 is generally operated by cargo vessels (75%) and tankers (25%).
5	1	**Immingham to northern Norway ports**. Route 5 is generally operated by cargo vessels (60%) and tankers (40%).
6	1	**Immingham to northern Norway ports**. Route 6 is generally operated by tankers (65%) and cargo vessels (35%).

Route Number	Average Transits per Day	Description
7	1	**Tees to Rotterdam**. Route 7 is generally operated by tankers (60%) and cargo vessels (40%).
8	1	**Grangemouth to Rotterdam**. Route 8 is generally operated by cargo vessels (50%), tankers (25%) and oil and gas support vessels (25%).
9	0 to 1	**Tees to Amsterdam**. Route 9 is generally operated by cargo vessels (50%) and tankers (50%).
10	0 to 1	**Grangemouth to Ghent (Belgium)**. Route 10 is generally operated by tankers (65%) and cargo vessels (35%).

15.3.6 Commercial Ferry Activity

Throughout the survey periods 11 unique commercial ferries were identified, with six undertaking regular routes; each of these is among the main routes identified in Section 15.3.5. Figure 15.48 presents a plot of commercial ferries recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area on AIS, visual and Radar throughout the survey periods, colour-coded by route.

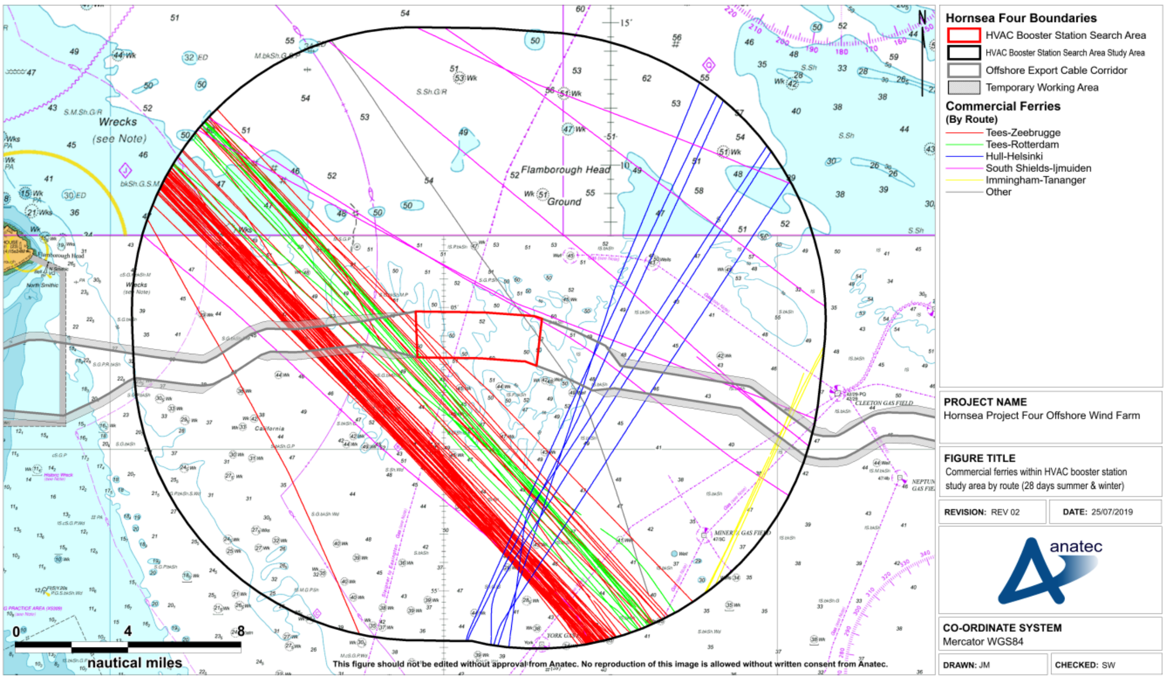


Figure 15.48 Commercial ferries within Hornsea Four HVAC booster station search area shipping and navigation study area (28 days summer 2018 and winter 2019)

The most frequently transited commercial ferry route was a Bore Lines operated route between the Tees and Zeebrugge, with the *Bore Song* and *Estraden* making on average two transits per day between them within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the survey periods. A P&O Ferries commercial ferry route between Tees and Zeebrugge was also identified, featuring the *Mistral*. A small number of tracks from the vessels on the DFDS Seaways commercial ferry route between North Shields and Ijmuiden identified in Section 15.1.6 for the Hornsea Four array area vessel traffic analysis were observed. These were primarily during the winter survey period, and are considered to be adverse weather transits. These are considered further in Section 16.

15.3.7 Recreational Vessel Activity

15.3.7.1 Vessel Traffic Survey Data

For the purposes of the NRA, recreational activity includes sailing and motor craft (including those undertaking dive and fishing charter trips) of between 2.4 and 24 m LOA.

Figure 15.49 presents a plot of recreational vessels recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout both survey periods.

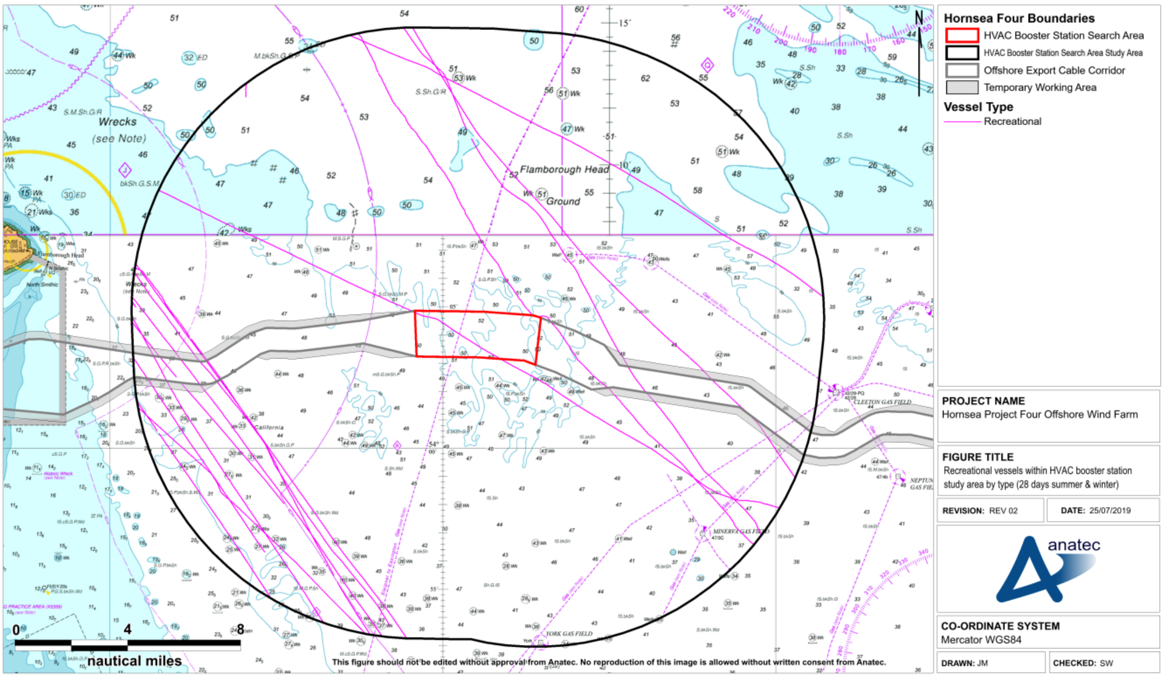


Figure 15.49 Recreational vessels within Hornsea Four HVAC booster station search area shipping and navigation study area (28 days summer 2018 and winter 2019)

Throughout the survey periods, an average of less than one unique recreational vessel per day passed within the Hornsea Four HVAC booster station search area shipping and navigation study area. It is noted that all recreational craft recorded throughout the winter survey period were recorded on AIS, with no recreational craft recorded on Radar.

15.3.7.2 Royal Yachting Association Coastal Atlas

The limit of the AIS intensity grid provided in the *UK Coastal Atlas of Recreational Boating 2.0* (RYA, 2016) is approximately 1.5 nm west of the Hornsea Four HVAC booster station search area. However, given the proximity of the AIS intensity grid, it can be deduced that there is a relatively low density of recreational traffic passes in proximity to the Hornsea Four HVAC booster station search area, as reflected in the vessel traffic survey data.

The Coastal Atlas also suggests that there may be eastbound routeing out of Bridlington Bay passing in proximity to the Hornsea Four HVAC booster station search area.

15.3.8 Commercial Fishing Vessels

Figure 15.50 presents a plot of fishing vessels recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout both survey periods.

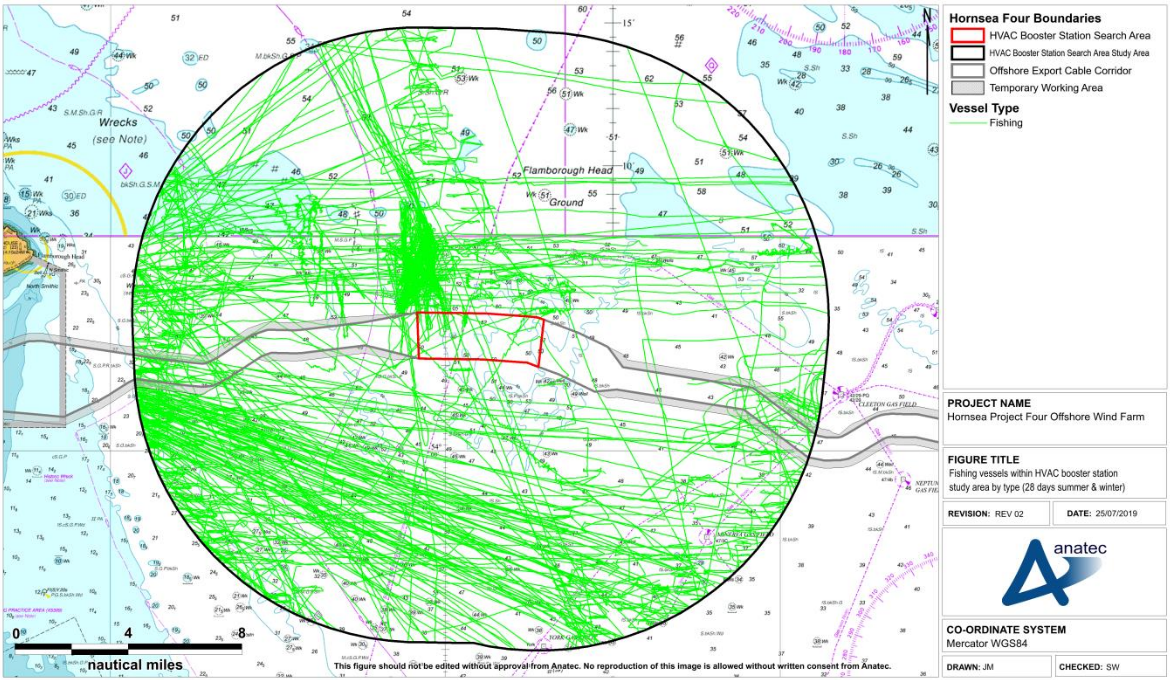


Figure 15.50 Fishing vessels within Hornsea Four HVAC booster station search area shipping and navigation study area (28 days summer 2018 and winter 2019)

Throughout the survey periods, an average of seven unique fishing vessels per day passed within the Hornsea Four HVAC booster station search area shipping and navigation study area. It is noted that only five fishing vessels were recorded on Radar during the winter survey period, with the rest recorded on AIS, including a large proportion of fishing vessels under the mandatory 15 m length for AIS broadcast.

Fishing vessel movements were characteristic of both fishing vessels in transit and engaged in fishing activity. Fishing vessels were most prominent nearshore transiting in and out of

Bridlington west of the Hornsea Four HVAC booster station search area and north of the Hornsea Four HVAC booster station search where a high density of active fishing was observed.

Flag State (nationality) information was available for approximately 96% of fishing vessels recorded on AIS within the Hornsea Four HVAC booster station search area shipping and navigation study area. The nationalities identified were the UK (87%), France (8%) and Denmark (1%).

Fishing method information was also researched and available for 96% fishing vessels recorded on AIS within the Hornsea Four HVAC booster station search area shipping and navigation study area. Of the fishing vessel methods identified, the most common were pots and traps (67%), bottom otter trawls (14%) and boat dredges (10%).

16 Adverse Weather Impacts on Routeing

Given the prominence of commercial ferries operated by DFDS Seaways within the vessel traffic survey data assessed for the Hornsea Four array area, additional consultation and assessment has been undertaken with DFDS Seaways[1] to ensure that their regular routeing was considered fully, including the identification of commercial ferries within the Hornsea Four array area shipping and navigation study area (see Section 15.1.6). This section focuses on adverse weather routeing given the implications if a vessel is unable to make passage in adverse weather due to the presence of the development.

Adverse weather includes wind, wave and tidal conditions as well as reduced visibility due to fog that can hinder a vessel's standard route and/or speed of navigation. Adverse weather routes are assessed to be significant course adjustments to mitigate vessel motion in adverse weather conditions. When transiting in adverse weather conditions, a vessel is likely to encounter various types of weather and tidal phenomena, which may lead to severe roll motions, potentially causing damage to cargo, equipment and/or discomfort and danger to persons on board. The sensitivity of a vessel to these phenomena will depend upon the actual stability parameters, hull geometry, vessel type, vessel size and speed.

Figure 16.1 presents a plot of three standard routes used by vessels operated by DFDS Seaways alongside the alternative routeing options used in adverse weather. The adverse weather routes are based upon vessel traffic survey data and information provided by DFDS Seaways during consultation and should be considered indicative only.

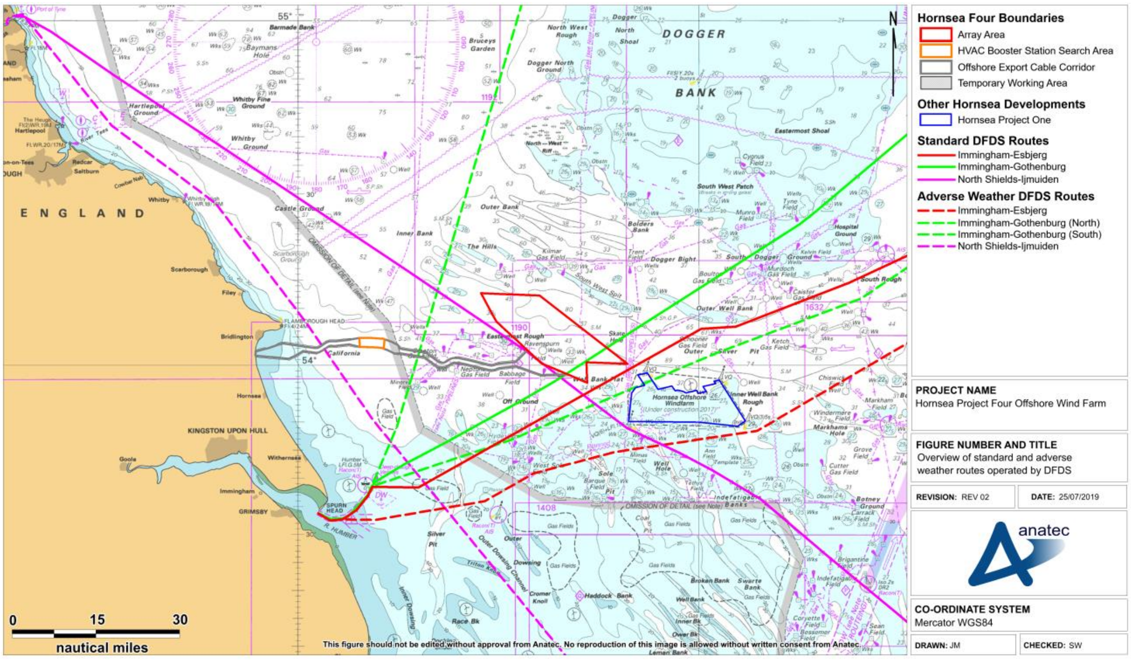


Figure 16.1 Overview of standard and adverse weather routes operated by DFDS Seaways

[1] Other commercial operators were contacted but either did not respond or declined attendance.

The following subsections assess each of the DFDS Seaways routes.

16.1 Immingham to Esbjerg

The Immingham to Esbjerg route is transited by two Ro Ro commercial ferries – the *Ark Dania* and *Ark Germania*. During adverse weather this route passes south of Hornsea Project One rather than north thus increasing the passing distance from the Hornsea Four array area. Therefore, this adverse weather route is not anticipated to be impacted by the presence of Hornsea Four.

16.2 Immingham to Gothenburg

The Immingham to Gothenburg route is primarily transited by two Ro Ro commercial ferries – the *Magnolia Seaways* and *Ficaria Seaways*. During adverse weather this route avoids the Dogger Bank which is regarded as particularly susceptible to adverse weather conditions. The route takes one of two alternatives:

- North of the Dogger Bank: Passes west of Hornsea Four in a north-south direction. Given that the route no longer passes through the Hornsea Four array area, this adverse weather route is not anticipated to be impacted by the presence of Hornsea Four.
- South of the Dogger Bank: Passes south of Hornsea Four in a south west-north east direction. It is noted that the presence of Hornsea Project One is not taken into consideration by this alternative route and the route would likely pass further north, possibly intersecting the Hornsea Four array area. With the Hornsea developments in place, this route would be able to shift south of the Hornsea developments, noting that this would place it on a similar passage to the already in use adverse weather route between Immingham and Esbjerg, i.e. a route known to be considered safe for DFDS Seaways vessels operating in adverse weather. Therefore this adverse weather route is not anticipated to be impacted by the presence of Hornsea Four.

16.3 North Shields to Ijmuiden

The North Shields to Ijmuiden route is transited by two Ro Ro passenger ferries – the *King Seaways* and *Princess Seaways*. During adverse weather this route shifts significantly towards the UK east coast thus passing a large distance clear of the Hornsea Four array area. Although the adverse weather route does pass in proximity to the Hornsea Four HVAC booster station search area (as illustrated within the vessel traffic survey data for the Hornsea Four HVAC booster station search area in Section 15.3.6), it follows a similar passage to a number of existing commercial ferry routes and is not anticipated to be impacted by the presence of the HVAC booster stations.

17 Future Case Vessel Traffic

This section presents the future case level of activity within and in proximity to the Hornsea Four array area and HVAC booster station search area. This activity will be input into the collision and allision risk modelling and is considered throughout the impact assessment undertaken in **Volume 2, Chapter 8: Shipping and Navigation**. Future case is the assessment of risk based upon the predicted growth in future shipping densities and traffic types as well as foreseeable changes in the marine environment. This is considered both with and without the presence of the array and HVAC booster stations.

17.1 Increases in Traffic Associated with Ports

Due to the distance offshore of the Hornsea Four array area, it is not considered likely that any increase in port traffic (i.e. vessels entering and existing ports) would directly impact on the general traffic levels around the Hornsea Four array area and offshore ECC; therefore the impact assessment considers an indicative 10% increase in traffic associated with ports.

17.2 Increases in Commercial Fishing Vessel Activity

An indicative 10% increase in commercial fishing vessel transits is considered in the impact assessment to demonstrate potential impacts (in line with other renewables assessments). This value is used due to there being limited reliable information on future activity levels upon which any firm assumption could be made. Increases in fishing activities are considered in a separate study of commercial fishing (see **Volume 2, Chapter 7: Commercial Fisheries**).

17.3 Increases in Recreational Vessel Activity

There are no known major developments which will increase the activity of recreational vessels within the southern North Sea. As with commercial fishing activity, given the lack of reliable information relating to future trends, a 10% increase is considered conservative.

17.4 Increase in Traffic Associated with Hornsea Four Operations

During the construction phase there will be up to 3,906 return trips made by vessels involved in the installation of Hornsea Four (see Section 9.5.1). During the operation and maintenance phase there will be up to 3,525 return trips per year made by vessels involved in the operation and maintenance of Hornsea Four. Although this traffic will not be considered in the collision and allision risk modelling since mean route positions will not be defined, this traffic will be considered within the hazard log.

17.5 Commercial Traffic Routeing

17.5.1 Methodology

It is not possible to consider all potential alternative routeing options for commercial traffic and therefore worst-case alternatives have been considered where possible in consultation with operators. Assumptions for re-routeing include:

- All alternative routes maintain a minimum distance of 1 nm from offshore installations and potential WTG boundaries in line with the MGN 543 Shipping Route Template (MCA, 2016). This distance is considered for shipping and navigation from a safety perspective as explained below; and
- All mean routes take into account sandbanks and known routeing preferences.

MGN 543 provides guidance to offshore renewable energy developers on both the assessment process and design elements associated with the development of an offshore wind farm. Annex 3 of MGN 543 defines a methodology for assessing passing distances between offshore wind farm boundaries but states that it is "*not a prescriptive tool but needs intelligent application*".

To date, internal and external studies undertaken by Anatec on behalf of the UK Government and individual clients show that vessels do pass consistently and safely within 1 nm of established offshore wind farms (including between different wind farms) and these distances vary depending upon the sea room available as well as the prevailing conditions. This evidence also demonstrates that the Mariner defines their own safe passing distance based upon the conditions and nature of the traffic at the time, but they are shown to frequently pass 1 nm off established developments. Evidence also demonstrates that commercial vessels do not transit through wind farm arrays.

The NRA also aims to establish the MDS case based on navigational safety parameters, and when considering this the conservative (realistic) scenario for vessel routeing is considered to be when main routes pass 1 nm off developments. Evidence collected during numerous assessments at an industry level confirms that it is a safe and reasonable distance for vessels to pass; however, it is likely that a large number of vessels would instead choose to pass at a greater distance depending upon their own passage plan and the current conditions.

17.5.2 Main Route Deviations

17.5.2.1 Hornsea Four Array Area

An illustration of the anticipated shift in the mean positions of the main commercial routes within the Hornsea Four array area shipping and navigation study area following the development of the Hornsea Four array area is presented in Figure 17.1. These deviations are based on Anatec's assessment of the worst-case scenario and consultation undertaken with DFDS who operate vessels on the main routes. It is noted that cumulative main route deviations as part of the CEA will be undertaken post PEIR and submitted alongside the final ES.

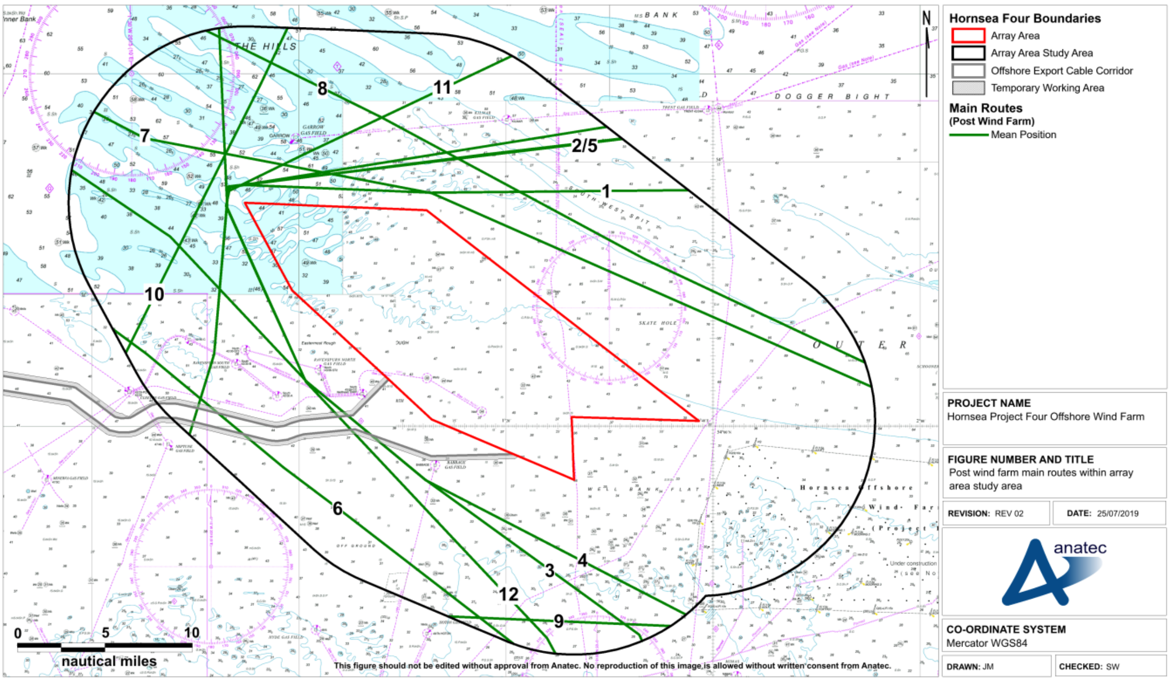


Figure 17.1 Post wind farm main routes within Hornsea Four array area shipping and navigation study area

Deviations would be required for nine out of the 12 main routes identified, with the level of deviation varying between no increase for Route 9 and 30.9 nm for Route 12. For the displaced routes, the increase in distance and percentage change from the pre-wind farm scenario are presented in Table 17.1. It is noted that increases in route length are based upon indicative final destinations and percentage changes are based upon the full route length.

Table 17.1 Summary of post wind farm main route deviations within Hornsea Four array area shipping and navigation study area

Route Number	Increase in Route Length (nm)	Increase in Total Route Length (%)
1	15.3	4.7
2	11.1	2.9
3	4.4	1.2
4	0.4	0.2
5	9.9	2.6
7	0.1	<0.1
9	No increase	N/A

Route Number	Increase in Route Length (nm)	Increase in Total Route Length (%)
11	5.4	1.5
12	30.9	22.6

17.5.2.2 Hornsea Four HVAC Booster Station Search Area

An illustration of the anticipated shift in the mean positions of the main commercial routes within the Hornsea Four HVAC booster station search area shipping and navigation study area following the development of the Hornsea Four array area is presented in Figure 17.2. Given that HVAC booster stations may be constructed in a "cluster" or apart, the conservative approach of deviating routes around the full Hornsea Four HVAC booster station search area has been applied.

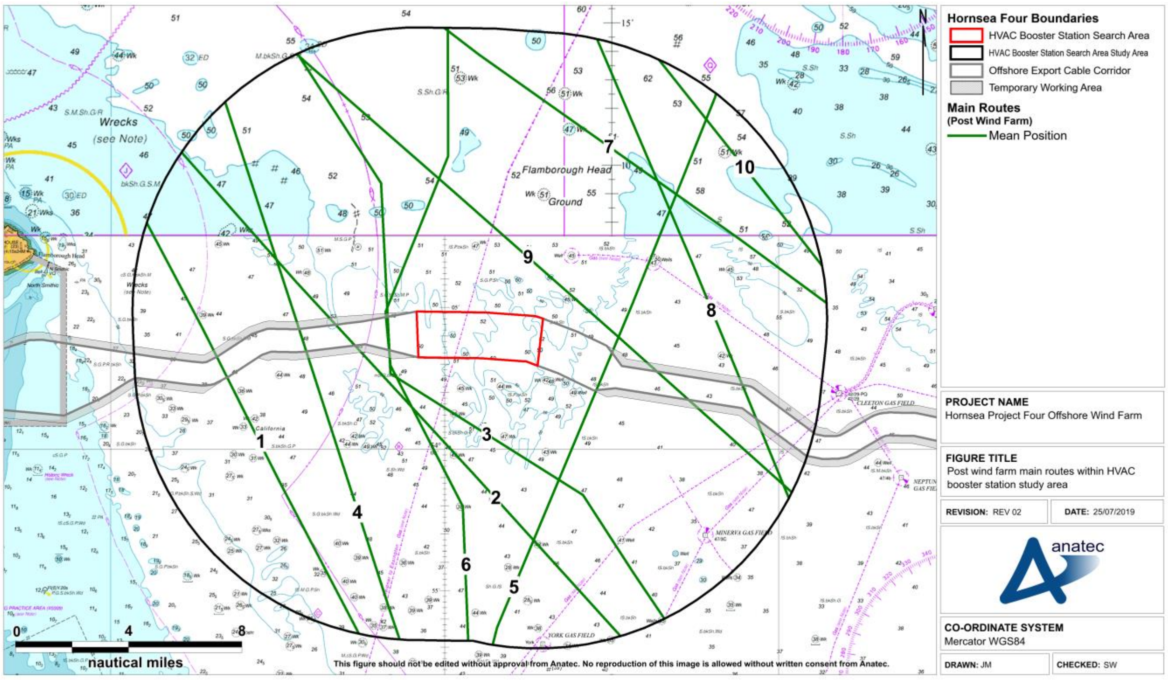


Figure 17.2 Post wind farm main routes within Hornsea Four HVAC booster station search area shipping and navigation study area

Deviations would be required for two out of the 10 main routes identified, with the deviation 1.0 nm for Route 6 and 1.7 nm for Route 3. For these displaced routes, the increase in distance and percentage change from the pre-wind farm scenario are presented in Table 17.2. As previously, it is noted that increases in route length are based upon indicative final destinations and percentage changes are based upon the full route length.

Table 17.2 Summary of post wind farm main route deviations within Hornsea Four HVAC booster station search area shipping and navigation study area

Route Number	Increase in Route Length (nm)	Increase in Total Route Length (%)
3	1.7	0.5
6	1.0	0.2

18 Navigation, Communication and Position Fixing Equipment

This section discusses the potential impacts upon the communication and position fixing equipment of vessels that may arise due to the infrastructure associated with Hornsea Four. The screening of the hazards into the impact assessment is summarised in Table 7.13 of **Volume 2, Chapter 8: Shipping and Navigation**.

18.1 Very High Frequency Communications (Including Digital Selective Calling)

In 2004, trials were undertaken at the North Hoyle Offshore Wind Farm, located off the coast of North Wales. As part of these trials, tests were undertaken to evaluate the operational use of typical small vessel VHF transceivers (including Digital Selective Calling (DSC)) when operated close to WTGs.

The WTGs had no noticeable effect on voice communications within the wind farm or ashore. It was noted that if small craft vessel to vessel and vessel to shore communications were not affected significantly by the presence of WTGs, then it is reasonable to assume that larger vessels with higher powered and more efficient systems would also be unaffected.

During this trial, a number of telephone calls were made from ashore, within the wind farm, and on its seawards side. No effects were recorded using any system provider (MCA and QinetiQ, 2004).

Furthermore, as part of SAR trials carried out at the North Hoyle Offshore Wind Farm in 2005, radio checks were undertaken between the Sea King helicopter and both Holyhead and Liverpool coastguards. The aircraft was positioned to the seaward side of the wind farm and communications were reported as very clear, with no apparent degradation of performance. Communications with the service vessel located within the wind farm were also fully satisfactory throughout the trial (MCA, 2005).

In addition to the North Hoyle trials, a desk-based study was undertaken for the Horns Rev 3 offshore wind farm in Denmark in 2014 and it was concluded that there was not expected to be any conflicts between point-to-point radio communications networks and no interference upon VHF communications (Energinet.dk, 2014).

Following consideration of these reports, and noting that since the trials detailed above there have been no significant issues with regards to VHF observed or reported, Hornsea Four is anticipated to have no significant impact upon VHF communications.

18.2 Very High Frequency Direction Finding

During the North Hoyle Offshore Wind Farm trials in 2004, the VHF Direction Finding (DF) equipment carried in the trial boats did not function correctly when very close to WTGs (within approximately 50 m). This is deemed to be a relatively small-scale impact due to the limited use of VHF direction finding equipment and will not impact operational or SAR activities (MCA and QinetiQ, 2004).

Throughout the 2005 SAR trials carried out at North Hoyle, the Sea King radio homer system was tested. The Sea King radio homer system utilises the lateral displacement of a vertical bar on an instrument to indicate the sense of a target relative to the aircraft heading. With the aircraft and the target vessel within the wind farm, at a range of approximately 1 nm, the homer system operated as expected with no apparent degradation.

Since the trials detailed above, no significant issues with regards to VHF DF have been observed or reported, and therefore Hornsea Four is anticipated to have no significant impact upon VHF DF equipment.

18.3 Automatic Identification System

No significant issues with interference to AIS transmission from operational offshore wind farms has been observed or reported to date. Such interference was also not evident in the trials carried out at the North Hoyle Offshore Wind Farm (MCA and QinetiQ, 2004).

In theory there could be interference when there is a structure located between the transmitting and receiving antennas (i.e. blocking line of sight) of the AIS. However, given no issues have been reported to date at operational developments or during trials, no significant impact is anticipated due to Hornsea Four.

18.4 Navigational Telex Systems

The Navigational Telex (NAVTEX) system is used for the automatic broadcast of localised Maritime Safety Information (MSI) and either prints it out in hard copy or displays it on a screen, depending upon the model.

There are two NAVTEX frequencies. All transmissions on NAVTEX 518 Kilohertz (kHz), the international channel, are in English. NAVTEX 518 kHz provides the mariner (both recreational and commercial) with weather forecasts, severe weather warnings and navigation warnings such as obstructions or buoys off station. Depending on the user's location, other information options may be available such as ice warnings for high latitude sailing.

The 490 kHz national NAVTEX service may be transmitted in the local language. In the UK full use is made of this secondary frequency including useful information for smaller craft, such as the inshore waters forecast and actual weather observations from weather stations around the coast.

Although no specific trials have been undertaken, no significant effect on NAVTEX has been reported to date at operational developments, and therefore no significant impact is anticipated due to Hornsea Four.

18.5 Global Positioning System

Global Positioning System (GPS) is a satellite based navigational system. GPS trials were also undertaken throughout the 2004 trials at North Hoyle Offshore Wind Farm and it was stated that "*no problems with basic GPS reception or positional accuracy were reported during the trials*".

The additional tests showed that "*even with a very close proximity of a wind turbine to the GPS antenna, there were always enough satellites elsewhere in the sky to cover for any that might be shadowed by the wind turbine tower*" (MCA and QinetiQ, 2004).

Therefore, there are not expected to be any significant impacts associated with the use of GPS systems within or in proximity to the Hornsea Four array area.

18.6 Electromagnetic Interference

A compass, magnetic compass or mariner's compass is a navigational instrument for determining direction relative to the earth's magnetic poles. It consists of a magnetised pointer (usually marked on the north end) free to align itself with the Earth's magnetic field. A compass can be used to calculate heading, used with a sextant to calculate latitude, and with a marine chronometer to calculate longitude.

Like any magnetic device, compasses are affected by nearby ferrous materials as well as by strong local electromagnetic forces, such as magnetic fields emitted from power cables. As the compass still serves as an essential means of navigation in the event of power loss or as a secondary source, it should not be allowed to be affected to the extent that safe navigation is prohibited. The important factors with respect to cables that affect the resultant deviation are:

- Water depth;
- Burial depth;
- Current (alternating or direct) running through the cables;
- Spacing or separation of the two cables in a pair (balanced monopole and bipolar designs); and/or
- Cable route alignment relative to the Earth's magnetic field.

Hornsea Four export and array cables could be either alternating current (AC) or direct current (DC), with studies indicating that AC does not emit an electromagnetic field (EMF) significant enough to impact marine magnetic compasses (Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), 2008).

No problems with respect to magnetic compasses have been reported to date in any of the trials carried out (inclusive of SAR helicopters). However, small vessels with simple magnetic steering and hand bearing compasses should be wary of using these close to WTGs as with any structure in which there is a large amount of ferrous material (MCA and QinetiQ, 2004). This will be considered as part of the Cable Specification, Installation and Monitoring plan (see Section 8.8 of **Volume 2, Chapter 8: Shipping and Navigation**).

18.7 Marine Radar

This section summarises trials and studies undertaken in relation to Radar effects from offshore wind farms in the UK. It is important to note that since the time of the trials and studies discussed, offshore wind turbine technology has advanced significantly, most notably in terms of the size of WTGs available to be installed and utilised. The use of these larger WTGs allows for a greater minimum spacing than was achievable at the time of the studies being undertaken, which is beneficial in terms of Radar interference effects (and surface navigation in general) as detailed below.

18.7.1 Trials

During the early years in offshore renewables within the UK, maritime regulators undertook a number of trials (both shore-based and vessel-based) into the effects of WTGs on the use and effectiveness of marine Radar.

In 2004 trials undertaken at the North Hoyle Offshore Wind Farm (MCA, 2004) identified areas of concern regarding the potential impact on marine and shore-based Radar systems due to the large vertical extents of the WTGs (based on the technology at that time). This resulted in Radar responses strong enough to produce interfering side lobes and reflected echoes (often referred to as false targets or ghosts).

Side lobe patterns are produced by small amounts of energy from the transmitted pulses that are radiated outside of the narrow main beam. The effects of side lobes are most noticeable within targets at short range (below 1.5 nm) and with large objects. Side lobe echoes form either an arc on the Radar screen similar to range rings, or a series of echoes forming a broken arc, as illustrated in Figure 18.1.

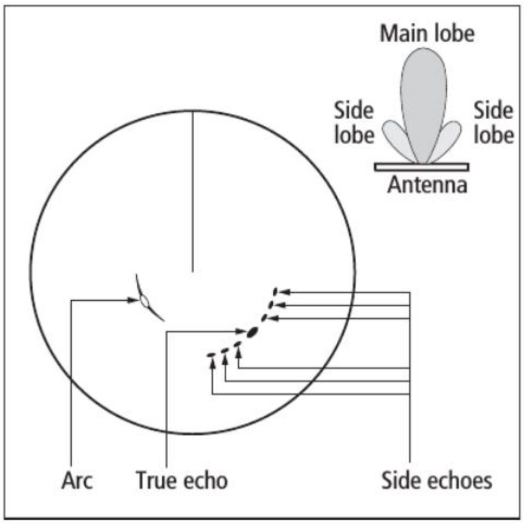


Figure 18.1 Illustration of side lobes on Radar screen

Multiple reflected echoes are returned from a real target by reflection from some object in the Radar beam. Indirect echoes or ‘ghost’ images have the appearance of true echoes but are usually intermittent or poorly defined; such echoes appear at a false bearing and false range, as illustrated in Figure 18.2.

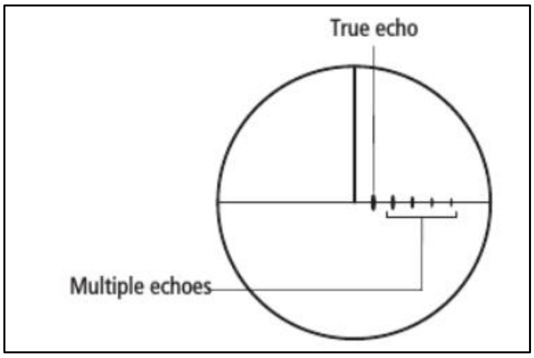


Figure 18.2 Illustration of multiple reflected echoes on Radar screen

Based upon the results of the North Hoyle trials, the MCA produced a Shipping Route Template designed to give guidance to mariners on the distances which should be established between shipping routes and offshore wind farms. However as experience of effects associated with use of marine Radar in proximity to offshore wind farms grew, the MCA refined their guidance, offering more flexibility within the most recent Shipping Route Template contained within MGN 543 (MCA, 2016).

A second set of trials conducted at Kentish Flats Offshore Wind Farm in 2006 on behalf of the British Wind Energy Association (BWEA) – now called RenewablesUK (BWEA, 2007) – also found that Radar antennas which are sited unfavourably with respect to components of the vessel's structure can exacerbate effects such as side lobes and reflected echoes. Careful adjustment of Radar controls suppressed these spurious Radar returns but mariners were warned that there is a consequent risk of losing targets with a small Radar cross section, which may include buoys or small craft, particularly yachts or glass reinforced plastic (GRP) constructed craft; therefore due care should be taken in making such adjustments.

Theoretical modelling of the effects of the development of the proposed Atlantic Array Offshore Wind Farm, which was to be located off the south coast of Wales in the UK, on marine Radar systems was undertaken by the Atlantic Array project (Atlantic Array, 2012) and considered a wider spacing of turbines than that considered within the early trials. The main outcomes of the modelling were the following:

- Multiple and indirect echoes were detected under all modelled parameters.
- The main effects noticed were stretching of targets in azimuth (horizontal) and appearance of ghost targets.
- There was a significant amount of clear space amongst the returns to ensure recognition of vessels moving amongst the WTGs and safe navigation.
- Even in the worst case with Radar operator settings artificially set to be poor, there is significant clear space around each WTG that does not contain any multipath or side lobe ambiguities to ensure safe navigation and allow differentiation between false and real (both static and moving) targets.

- Overall it was concluded that the amount of shadowing observed was very little (noting that the model considered lattice-type foundations which are sufficiently sparse to allow Radar energy to pass through).
- The lower the density of WTGs the easier it is to interpret the Radar returns and fewer multipath ambiguities are present.
- In dense, target rich environments S-Band Radar scanners suffer more severely from multipath effects in comparison to X-Band Radar scanners.
- It is important for passing vessels to keep a reasonable separation distance between the WTGs in order to minimise the effect of multipath and other ambiguities.
- The potential Radar interference is mainly a problem during periods of reduced visibility when mariners may not be able to visually confirm the presence of other vessels in the vicinity (i.e. those without AIS installed which are usually fishing and recreational craft).
- The performance of a vessel's ARPA could also be affected when tracking targets in or near the array. However, although greater vigilance is required, during the Kentish Flats trials false targets were quickly identified as such by the mariners and then by the equipment itself.

In summary, experience in UK waters has shown that mariners have become increasingly aware of any Radar effects as more offshore wind farms become operational. Based on this experience, the mariner can interpret the effects correctly, noting that effects are the same as those experienced by mariners in other environments such as in close proximity to other vessels or structures. Effects can be mitigated by "careful adjustment of Radar controls".

The MCA has also produced guidance to mariners operating in the vicinity of OREIs in the UK which highlights Radar issues amongst others to be taken into account when planning and undertaking voyages in proximity to OREIs (MCA, 2008). The interference buffers presented in Table 18.1 are based on MGN 371 (MCA, 2008), MGN 543 (MCA, 2018) and MGN 372 (MCA, 2008).

Table 18.1 Distances at which impacts on marine Radar occur

Distance at Which Effect Occurs (nm)	Identified Effects
0.5	▪ Intolerable impacts can be experienced. ▪ X-Band Radar interference is intolerable under 0.25 nm. ▪ Vessels may generate multiple echoes on shore-based Radars under 0.45 nm.

Distance at Which Effect Occurs (nm)	Identified Effects
1.5	▪ Under MGN 543, impacts on Radar are considered to be tolerable with mitigation between 0.5 nm and 3.5 nm. ▪ S-band Radar interference starts at 1.5 nm. ▪ Echoes develop at approximately 1.5 nm, with progressive deterioration in the Radar display as the range closes. Where a main vessel routes passes within this range considerable interference may be expected along a line of WTGs. ▪ The WTGs produced strong Radar echoes giving early warning of their presence. ▪ Target size of the WTG echo increases close to the WTG with a consequent degradation on both X and S-Band Radars.

As noted in Table 18.1, the onset range from the WTGs of false returns is approximately 1.5 nm, with progressive deterioration in the Radar display as the range closes. If interfering echoes develop, the requirements of the Convention on International Regulations for Preventing Collisions at Sea (COLREGs) *Rule 6 Safe Speed* are particularly applicable and must be observed with due regard to the prevailing circumstances. In restricted visibility, *Rule 19 Conduct of Vessels in Restricted Visibility* applies and compliance with *Rule 6* becomes especially relevant. In such conditions mariners are required, under *Rule 5 Look-out* to take into account information from other sources which may include sound signals and VHF information, for example from a Vessel Traffic Service (VTS) or AIS (MCA, 2016).

18.7.2 Experience from Operational Developments

The evidence from mariners operating in the vicinity of existing offshore wind farms is that they quickly learn to adapt to any effects. Figure 18.3 presents the example of the Galloper and Greater Gabbard Offshore Wind Farms, which are located in proximity to IMO routeing measures. Despite this proximity to heavily trafficked TSS lanes, there have been no reported incidents or issues raised by mariners who operate within the vicinity. The interference buffers presented in Figure 18.3 are as per Table 9.1.

As indicated by Figure 18.3, vessels utilising these TSS lanes will experience some Radar interference based on the available guidance. Both developments are operational, and each of the lanes is used by a minimum of five vessels per day on average. However, to date, there have been no incidents recorded (including any related to Radar use) or concerns raised by the users.

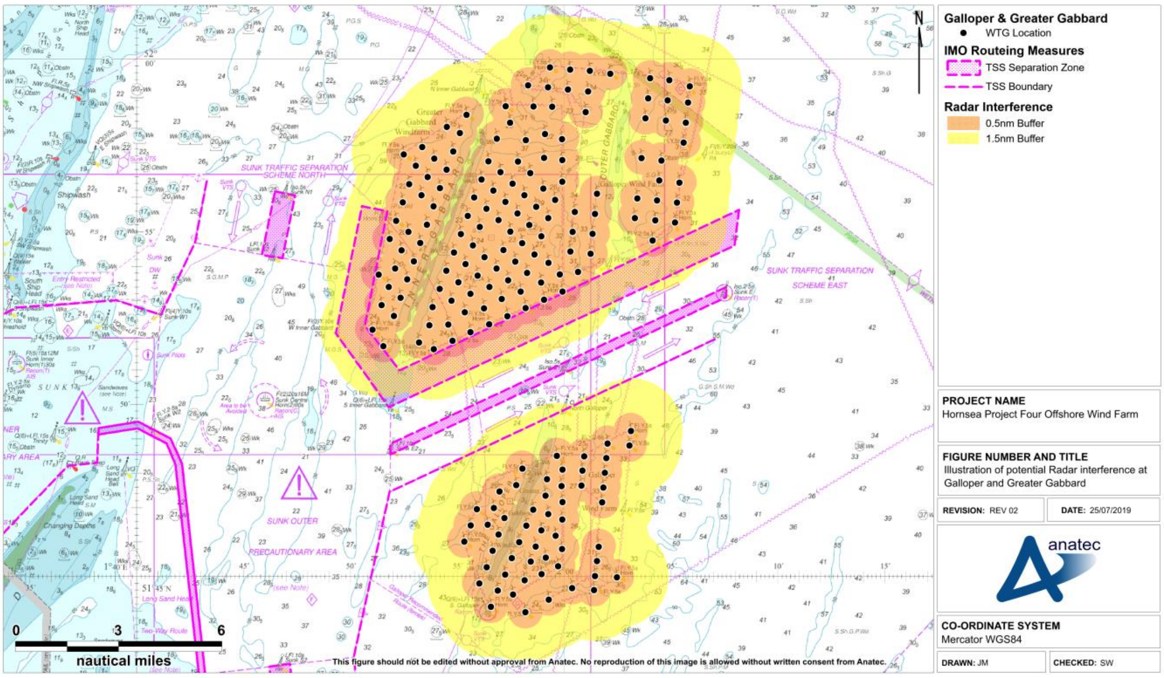


Figure 18.3 Illustration of potential Radar interference at Greater Gabbard and Galloper Offshore Wind Farms

AIS information can also be used to verify the targets of larger vessels (generally vessels over 15 m LOA – the minimum threshold for fishing vessel AIS carriage requirements). It is noted only approximately 1% of the vessel traffic recorded within the Hornsea Four array area shipping and navigation study area was under 15 m LOA, reflecting the distance offshore. For any smaller vessels, particularly fishing vessels and recreational vessels, AIS Class B devices are becoming increasingly popular and allow the position of these small craft to be verified when in proximity to an offshore wind farm.

18.7.3 Increased Target Returns

Beam width is the angular width, horizontal or vertical, of the path taken by the Radar pulse. Horizontal beam width ranges from 0.75° to 5°, and vertical beam width from 20° to 25°. How well an object reflects energy back towards the Radar depends upon its size, shape and aspect angle.

Larger WTGs (either in height or width) will return greater target sizes and/or stronger false targets. However, there is a limit to which the vertical beam width would be affected (20° to 25°) dependent upon the distance from the target. Therefore, increased WTG height in the array will not create any effects in addition to those already identified from existing operational wind farms (i.e., interfering side lobes, multiple and reflected echoes).

Again, when taking into consideration the potential options available to marine users (e.g. reducing gain to remove false returns) and feedback from operational experience, this shows that the effects of increased returns can be managed effectively.

18.7.4 Fixed Radar Antenna Use in Proximity to an Operational Wind Farm

It is noted that there are multiple operational wind farms including Galloper that successfully operate fixed Radar antenna from locations on the periphery of the array. These antennas are able to provide accurate and useful information to onshore coordination centres.

18.7.5 Application to Hornsea Four

Upon development of Hornsea Four, some commercial vessels may pass within 1.5 nm of the wind farm infrastructure and therefore may be subject to a minor level of Radar interference. Trials, modelling and experience from existing developments note that any impact can be mitigated by adjustment of Radar controls.

Figure 18.4 presents an illustration of potential Radar interference due to the Hornsea Four array relative to the post wind farm routeing illustrated in Section 17.5.2. The Radar effects have been applied to the indicative layout introduced in Section 9.2.1.

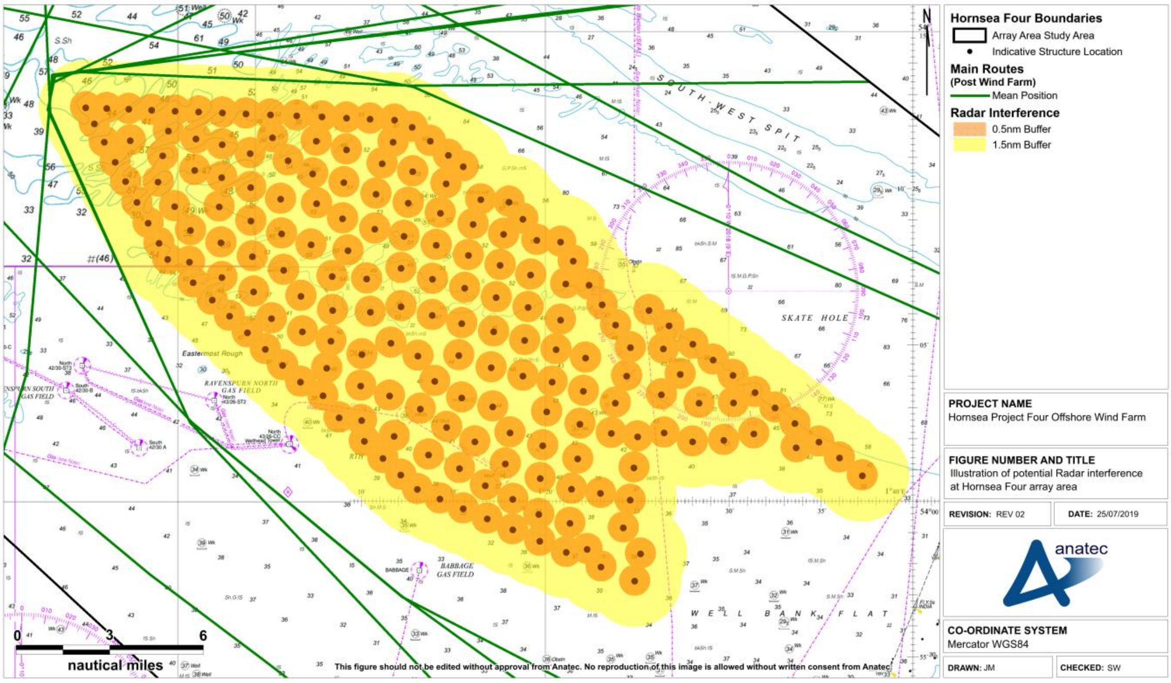


Figure 18.4 Illustration of potential Radar interference at Hornsea Four array area

Vessels passing within the array will be subject to a greater level of interference with impacts becoming significant in close proximity to the WTG. This will require additional mitigation by any vessels including consideration of the navigational conditions (i.e. visibility) when passage planning and compliance with the COLREGs will be essential. Again, looking at existing experience within UK offshore wind farms, vessels do navigate safely within arrays including those with spacing significantly less than at Hornsea Four.

Overall, impact on marine Radar is expected to be very low and no further impact upon navigational safety is anticipated within the parameters which can be mitigated by operational controls.

18.8 Sound Navigation Ranging Systems

No evidence has been found to date with regard to existing offshore wind farms to suggest that Sound Navigation Ranging (SONAR) systems produce any kind of SONAR interference which is detrimental to the fishing industry, or to military systems. No impact is therefore anticipated in relation to the Hornsea Four.

18.9 Noise

18.9.1 Surface Noise

The sound level from an offshore wind farm at a distance of 350 m has been predicted to be between 51 decibels (dB) and 54 dB (A). Furthermore, modelling undertaken during the consenting process for the Atlantic Array Offshore Wind Farm showed that the highest predicted level due to operational WTG noise (for a 125 m tall 8 Megawatt (MW) WTG) is around 60 dB (Atlantic Array, 2012).

A vessel's whistle for a vessel of 7 m should generate in the order of 138 dB and be audible at a range of 1.5 nm (IMO, 1972/77); hence this should be heard above the background noise of the WTGs. Similarly, foghorns will also be audible over the background noise of the WTGs.

There are therefore no indications that the sound level of Hornsea Four will have a significant influence on marine safety.

18.9.2 Underwater Noise

In 2005, the underwater noise produced by WTGs of 110 m height and with 2 MW capacity was measured at the Horns Rev Offshore Wind Farm in Denmark. The maximum noise levels recorded underwater at a distance of 100 m from the WTGs was 122 dB or 1 micropascal (µPa) (Institut für technische und angewandte Physik (ITAP), 2006).

During the operation and maintenance phase of Hornsea Four, the subsea noise levels generated by WTGs will likely be greater than that produced at Horns Rev given the larger WTG size, but nevertheless is not anticipated to have any significant impact as they are designed to work in pre-existing noisy environments. Operational subsea noise is considered in more detail in **Volume 4, Annex 4.5: Subsea Noise Technical Report**.

18.10 Existing Aids to Navigation

The only buoys within the Hornsea Four array area shipping and navigation study area are a selection of construction buoys for Hornsea Project One located south east of the Hornsea Four array area. As noted in Section 10.3, these marks will be removed following the commissioning of the development. Therefore, there is anticipated to be no associated impact on existing aids to navigation, with the array itself forming an aid to navigation given its lighting and marking.

19 Hazard Workshop Overview

A key element of the Hornsea Four consultation phase was the Hazard Workshop, which gathered local and national marine stakeholders to the development in order that shipping and navigation hazards could be identified, and subsequently included in a hazard log (post PEIR). This ensured that expert opinion and local knowledge was incorporated into the hazard identification process, and that the hazard log is site-specific.

The hazard log will detail the risks associated with each hazard and the industry standard plus additional commitments required to reduce the risks to ALARP, as identified in the Hazard Workshop. The hazard log will be created post PEIR and included in the final NRA alongside the ES and will incorporate Section 42 Consultation.

19.1 Hazard Workshop Attendance

The Hazard Workshop was held in London on Thursday 27th June 2019. The organisations which attended the Hazard Workshop were as follows:

- MCA;
- TH;
- Chamber of Shipping;
- DFDS Seaways;
- Perenco;
- Premier Oil; and
- Alpha Petroleum.

The CA, RYA and National Federation of Fishermen's Organisation (NFFO) were invited to the Hazard Workshop but were unable to attend. However both organisations will be included in consultation relating to the hazard log (see Section 19.3) during Section 42 Consultation.

19.2 Hazard Workshop Process

During the Hazard Workshop, key maritime hazards associated with the construction and operation and maintenance of Hornsea Four were identified and discussed. Where appropriate, hazards were considered by vessel type, to ensure risk control options could be identified on a type-specific basis (for example, risk controls for commercial ferries may differ from those considered appropriate for other commercial vessels).

Following the Hazard Workshop, the risks associated with the identified hazards were ranked based upon the discussions held during the workshop, with appropriate commitments identified. The rankings were then provided to the Hazard Workshop invitees for comment and any feedback will be incorporated into the NRA following Section 42 Consultation.

19.3 Hazard Log

The hazard log will be created post PEIR and included in the final NRA for DCO Application post Section 42 consultation.

20 Cumulative Overview

Cumulative effects have been considered for activities in combination and cumulatively with Hornsea Four. For the Cumulative Effect Assessment (CEA), projects and proposed developments were screened into the CEA based upon the criteria outlined in Section 3.3.

20.1 Other Offshore Wind Farms

In addition to Hornsea Four, there are a number of offshore wind farm developments within the North Sea, both within UK and non-UK waters. Table 20.1 includes details of the offshore wind farm developments (including the CEA tier applied) where a cumulative or in combination activity has been identified based upon the location and distance from Hornsea Four. Figure 20.1 presents the locations of these developments.

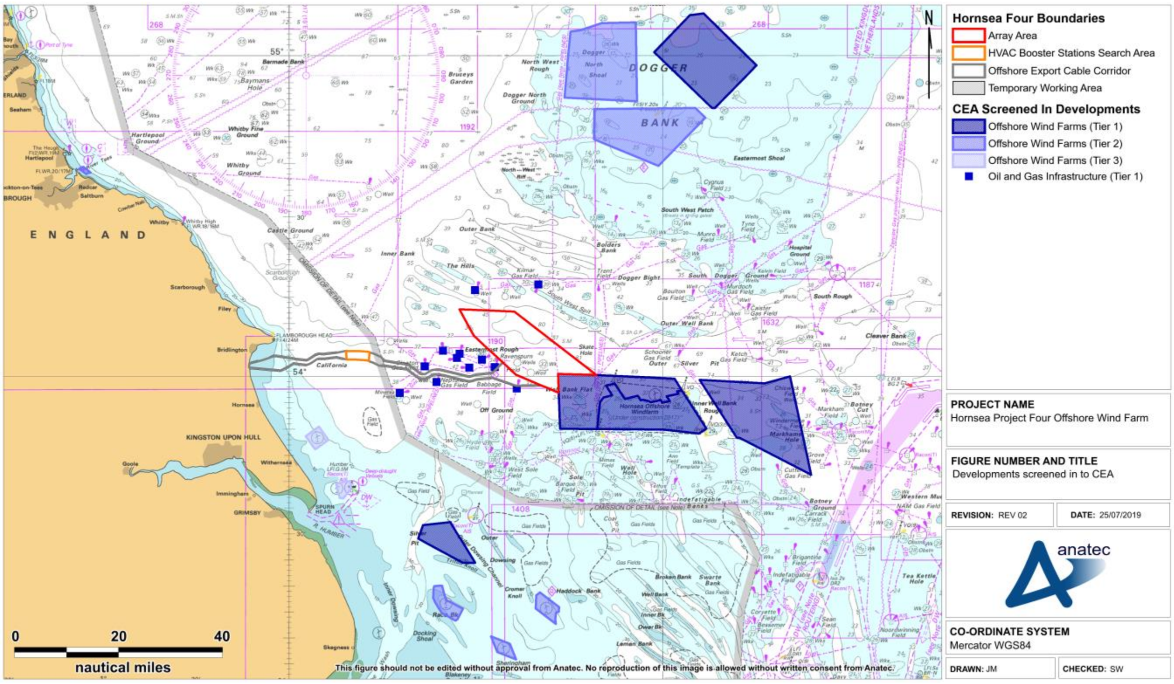


Figure 20.1 Developments screened in to CEA

20.2 Oil and Gas Infrastructure

There are a large number of oil and gas surface platforms within the North Sea, both within UK and non-UK waters. Table 20.1 includes details of the oil and gas infrastructure (including the CEA tier applied) where a cumulative or in combination activity has been identified based upon the location and distance from Hornsea Four. Figure 20.1 presents the locations of these developments.

Table 20.1 Summary of developments screened in to CEA

Tier	Project	Project Type	Project Status	Closest Distance			Data Confidence Level i.e. location or status
				Hornsea Four Array Area (km)	Hornsea Four Offshore ECC (km)	Hornsea Four HVAC Booster Station Search Area (km)	
1	Babbage	Oil and gas infrastructure	Operational	4	1	53	Medium
	Cleeton CC/PQ/WLTR	Oil and gas infrastructure	Operational	20	2	20	Medium
	Garrow	Oil and gas infrastructure	Operational	7	27	43	Medium
	Hornsea Project One	Offshore wind farm	Under construction	5	21	83	High
	Hornsea Project Two	Offshore wind farm	Consented	0	6	66	High
	Hornsea Three	Offshore wind farm	Under determination	36	56	116	High
	Kilmar	Oil and gas infrastructure	Operational	13	30	64	Medium
	Minerva	Oil and gas infrastructure	Operational	33	8	16	Medium
	Neptune	Oil and gas infrastructure	Operational	21	2	25	Medium
	Ravenspurn North CC/CCW	Oil and gas infrastructure	Operational	3	0.4	44	Medium

Tier	Project	Project Type	Project Status	Closest Distance			Data Confidence Level i.e. location or status
				Hornsea Four Array Area (km)	Hornsea Four Offshore ECC (km)	Hornsea Four HVAC Booster Station Search Area (km)	
1	Ravenspurn North ST2	Oil and gas infrastructure	Operational	4	5	39	Medium
	Ravenspurn North ST3	Oil and gas infrastructure	Operational	8	7	32	Medium
	Ravenspurn South Alpha	Oil and gas infrastructure	Operational	9	3	35	Medium
	Ravenspurn South Bravo	Oil and gas infrastructure	Operational	10	5	31	Medium
	Ravenspurn South Charlie	Oil and gas infrastructure	Operational	12	6	26	Medium
	Sofia	Offshore wind farm	Consented	98	113	143	High
	Triton Knoll	Offshore wind farm	Consented	57	50	61	High
2	Dogger Bank Creyke Beck A	Offshore wind farm	Consented	66	84	108	High
	Dogger Bank Creyke Beck B	Offshore wind farm	Consented	76	94	111	High
	Dudgeon	Offshore wind farm	Operational	71	73	102	High
	Race Bank	Offshore wind farm	Operational	79	72	83	High
	Sheringham Shoal	Offshore wind farm	Operational	90	89	106	High
	Teesside	Offshore wind farm	Operational	137	86	109	High
3	Humber Gateway	Offshore wind farm	Operational	66	41	42	High

Tier	Project	Project Type	Project Status	Closest Distance			Data Confidence Level i.e. location or status
				Hornsea Four Array Area (km)	Hornsea Four Offshore ECC (km)	Hornsea Four HVAC Booster Station Search Area (km)	
	Westermost Rough	Offshore wind farm	Operational	63	22	25	High

21 Impact Identification

This section outlines the shipping and navigation impacts which have been identified based upon the baseline data and consultation undertaken. These impacts have been fed into the FSA undertaken within **Volume 2, Chapter 8: Shipping and Navigation** where the magnitude of impact and sensitivity of the receptor are assessed to provide a significance of effect.

It is noted that the scope and assessment of impacts will be reassessed following section 42 consultation, further discussions with stakeholders, outputs of the hazard log, completion of the MGN 543 and updates to the baseline following the July/August 2019 vessel surveys.

Impacts associated with vessels engaged in fishing are contained in **Volume 2, Chapter 7: Commercial Fisheries**. Impacts associated with oil and gas infrastructure are contained in **Volume 2, Chapter 12: Infrastructure and Other Users**.

21.1 Construction Phase

Construction activities associated with the Hornsea Four array area, offshore ECC and HVAC booster station search area may cause vessels to be deviated leading to increased encounters and therefore also leading to increased vessel to vessel collision risk for all vessels in all weather conditions.

Pre-commissioned structures within the Hornsea Four array area and HVAC booster station search area will create powered and drifting allision risk for all vessels.

Pre-commissioned cables associated with the Hornsea Four array area and offshore ECC may increase anchor snagging risk for all vessels.

Construction activities associated with the Hornsea Four array area and offshore ECC may restrict the emergency response capability of existing resources.

21.2 Operation and Maintenance Phase

Presence of structures within the Hornsea Four array area, offshore ECC and HVAC booster station search area and activities associated with the Hornsea Four array area, offshore ECC and HVAC booster station search area may cause vessels to be deviated leading to increased encounters and therefore increased vessel to vessel collision risk for all vessels in all weather conditions.

Operational structures within the Hornsea Four array area and HVAC booster station search area may create powered and drifting allision risk for all vessels.

Operational cables within the Hornsea Four array area and offshore ECC may increase anchor snagging risk for all vessels and cable protection may reduce navigable water depths for all vessels.

Operation and maintenance activities associated with the Hornsea Four array area and offshore ECC may restrict the emergency response capability of existing resources.

Operational structures within the Hornsea Four array area and offshore ECC may impact a vessel's use of its Radar, communications and navigation equipment during navigational transits.

21.3 Decommissioning Phase

Decommissioning activities associated with the Hornsea Four array area and HVAC booster station search area may cause vessels to be deviated leading to increased encounters and therefore may also lead to increased vessel to vessel collision risk for all vessels in all weather conditions.

Decommissioning structures within the Hornsea Four array area and HVAC booster station search area will create powered and drifting allision risk for all vessels.

Decommissioning cables left in situ within the Hornsea Four array area and offshore ECC may increase anchor snagging risk for all vessels.

Decommissioning activities associated with the Hornsea Four array area and offshore ECC route may restrict the emergency response capability of existing resources.

22 Commitments Included as Part of Hornsea Four

As part of the Hornsea Four design process, a number of commitments included by Hornsea Four have been proposed to reduce the potential for impacts on shipping and navigation. These commitments are considered standard industry practice for this type of development and are summarised in Section 8.8 of **Volume 2, Chapter 8: Shipping and Navigation**, with all Hornsea Four commitments detailed in **Volume 4, Annex 5.2: Commitments Register**.

The following subsections provide additional details on some commitments, including in relation to marine aids to navigation and other lighting and marking considerations. These are covered by Co93 in **Volume 4, Annex 5.2: Commitments Register**.

22.1 Marine Aids to Navigation

Throughout the construction and operation and maintenance of Hornsea Four, aids to navigation will be provided in accordance with TH and MCA requirements, with consideration being given to *IALA Recommendation O-139 on the Marking of Man-Made Offshore Structures* (IALA, 2013), the *Standard Marking Schedule for Offshore Installations* (Department for Business, Energy and Industrial Strategy (BEIS), 2011) and MGN 543 (MCA, 2016).

22.1.1 Construction and Decommissioning Markings

During the construction and decommissioning of Hornsea Four, buoyed construction areas will be established and marked, where required, in accordance with TH requirements based upon the IALA Maritime Buoyage System. In addition to this, where advised by TH additional buoyage marking on structures may also be applied.

Notices to Mariners (including local), radio navigational warnings, NAVTEX and/or broadcast warnings as well as Notices to Airmen will be promulgated in advance of any proposed works, where required.

22.1.2 International Association of Marine Aids to Navigation and Lighthouse Authorities Guidance on the Marking of Groups of Structures

It is noted that the IALA O-139 guidance does not have to be followed and that TH may request additional or alternative mitigations; however it is assumed that the peripheral lighting will consist of significant peripheral structures (SPS), noting that TH are currently phasing out the use of intermediate peripheral structures (IPS) which have typically been used in the past. Given the distance offshore and the minimum spacing, further variations to the standard guidance may be required in consultation with the statutory stakeholders.

No lighting or marking will be required during the operation and maintenance phase for the export cables.

The HVAC booster stations will be marked as isolated structures, regardless of how far apart they are located.

Relevant guidance from the MCA and Civil Aviation Authority (CAA) will also be considered during the operation and maintenance phase. This is likely to include:

- Red aviation lighting synchronised Morse “W”;
- SAR helicopter lights;
- Heli-hoist lights for day-to-day operation; and
- Audible warnings.

22.2 Other Lighting and Marking Considerations

The following subsections identify additional measures which are requirements or are currently under consideration by Hornsea Four but will require consultation post consent.

22.2.1 Low Level Lighting on Foundations

Use of low-level lighting and retro reflective areas on signage, access platforms and ladders will be required.

22.2.2 Day Marks

The tower of every WTG (or relevant components) should be painted yellow all-round from the level of Highest Astronomical Tide (HAT) to 15 m or the height of the aid to navigation, if fitted, whichever is greater. Alternative marking may include horizontal yellow bands of not less than 2 m height and separation.

22.2.3 Location of Lights

The aids to navigation on the structure of a WTG will be mounted below the lowest point of the arc of the rotor blades. They should be exhibited at a height of at least 6 m above HAT.

22.2.4 Use of AIS Transmitters, Virtual Buoys and Radar Beacons

AIS transmitters, virtual buoys and/or Radar Beacons (Racon) may be used following consultation with TH. If required, these would be placed on the periphery of the array to assist safe navigation particularly in reduced visibility. AIS transmitters or virtual buoys could also be considered internally to assist with navigation within the Hornsea Four array area.

22.2.5 Sound Signals

Sound signals will be provided where appropriate, taking into account the prevailing visibility and vessel traffic conditions. The typical range of such a sound signal should not be less than 2 nm.

22.2.6 Spurious White Lights

Additional white lights will be kept to a minimum and Hornsea Four will ensure that regular checks are undertaken to identify any lights which should not be visible are extinguished after use.

22.2.7 Aviation Lighting

Aviation lighting will be as per CAA requirements; however they will be synchronised to Morse "W" at the request of TH.

22.2.8 Remote Monitoring Sensors

Remote monitoring sensors using Supervisory Control and Data Acquisition (SCADA) will be included as part of the lighting and marking scope to ensure a high level availability for all aids to navigation.

22.2.9 Numbering of Structures

The MCA will advise post consent on the specific requirements for the numbering of Hornsea Four structures; however a logical pattern with potential for additional visual marks may be considered by statutory stakeholders.

22.3 Design Specifications Noted in Marine Guidance Note 543

The individual WTGs and other structures will have functions and procedures in place for generator shut down in emergency situations, as per MGN 543 (MCA, 2016).

23 Additional Commitments Required

As part of the Hornsea Four design process additional commitments have been considered to reduce the potential for impacts on shipping and navigation. These commitments are summarised in Table 7.15 of **Volume 2, Chapter 8: Shipping and Navigation**.

23.1 Cost Benefit Analysis

The FSA Guidelines require a process of CBA to rank the proposed commitment (risk control) options in terms of risk benefit related to lifecycle costs. This will be considered in terms of Gross Cost of Averting a Fatality (GCAF). This is a cost effectiveness measure in terms of ratio of marginal (additional) cost of the risk control option to the reduction in risk to personnel in terms of the fatalities averted.

Until the array layout and associated commitments are finalised, a review of CBA cannot be undertaken; however, Hornsea Four intend to implement commitments which show a positive effect on the impact and a reduction in worst case potential loss of life (PLL) value in conjunction with the frequency of occurrence.

Further work will be undertaken post consent once final commitments are known in line with standard industry practice.

24 Through Life Safety Management

24.1 Quality, Health, Safety and Environment

Quality, Health, Safety and Environment (QHSE) documentation including a Safety Management System will be in place for Hornsea Four and will be continually updated throughout the development process. The following subsections provide an overview of documentation and how it will be maintained and reviewed with reference, where required, to specific marine documentation.

Monitoring, reviewing and auditing will be carried out on all procedures and activities and feedback actively sought. The designated person (identified in QHSE documentation), managers and supervisors are to maintain continuous monitoring of all marine operations and determine if all required procedures and processes are being correctly implemented.

24.2 Incident Reporting

After any incidents, including near misses, an incident report form will be completed in line with the Hornsea Four QHSE documentation. This will then be assessed for relevant outcomes and reviewed for possible changes required to operations.

Hornsea Four shall maintain records of investigation and analyse incidents in order to:

- Determine underlying deficiencies and other factors that may be causing or contributing to the occurrence of incidents;
- Identify the need for corrective action;
- Identify opportunities for preventive action;
- Identify opportunities for continual improvement; and
- Communicate the results of such investigations.

All investigations shall be performed in a timely manner.

A database (lessons learnt) of all marine incidents will be developed. It will include the outcomes of investigations and any resulting actions. Hornsea Four will promote awareness of their potential occurrence and provide information to assist monitoring, inspection and auditing of documentation.

When appropriate, the designated person (noted within the Emergency Response Cooperation Plan (ERCoP)) should inform the MCA of any exercise or incidents including any implications on emergency response. If required, the MCA should be invited to take part in incident debriefs.

24.3 Review of Documentation

Hornsea Four will be responsible for reviewing and updating all documentation including the risk assessments, ERCoP, safety management system and, if required, Hornsea Four will convene a review panel of stakeholders to quantify risk.

Reviews of the risk register should be made after any of the following occurrences:

- Changes to the development, conditions of operation and prior to decommissioning;
- Planned reviews; and
- Following an incident or exercise.

A review of potential risks should be carried out annually. A review of the response charts should be carried out annually to ensure that response procedures are up to date and should include any amendments from audits/incident reports/deficiencies.

24.4 Inspection of Resources

All vessels, facilities, and equipment necessary for marine operations are to be subject to appropriate inspection and testing to determine fitness for purpose and availability in relation to their performance standards. This will include monitoring and inspection of all aids to navigation to determine compliance with the performance standards specified by TH.

24.5 Audit Performance

Auditing and performance review are the final steps in QHSE management systems. The feedback loop enables an organisation to reinforce, maintain and develop its ability to reduce risks to the fullest extent and to ensure the continued effectiveness of the system. Hornsea Four will carry out audits and periodically evaluate the efficiency of the marine safety documentation.

The audits and possible corrective actions should be carried out in accordance with standard procedures and results of the audits and reviews should be brought to the attention of all personnel having responsibility in the area involved.

24.6 Safety Management System

Hornsea Four will manage the risks associated with the activities undertaken at the Hornsea Four array area, offshore ECC and HVAC booster stations. It shall establish an integrated safety management system which ensures that the safety and environmental impacts of those activities are ALARP. This includes the use of remote monitoring and switching for aids to navigation to ensure that if a light is faulty a quick fix can be instigated from the Marine Helicopter Coordination Centre (MHCC) (to be included in the Lighting and Marking Plan (LMP) and Aids to Navigation Management Plan which are required under the deemed Marine Licences for Hornsea Four).

24.7 Future Monitoring of Vessel Traffic

Whilst no Radar monitoring of vessel movements has been proposed for the Hornsea Four array area, AIS monitoring will be available from a vessel (during construction) and site location (during operation and maintenance) to record the movements of vessels around the Hornsea Four array area.

24.8 Decommissioning Plan

A decommissioning plan will be developed. With regards to impacts on shipping and navigation this will include consideration of the scenario where upon decommissioning and completion of removal operations, an obstruction is left on site (attributable to Hornsea Four) which is considered to be a danger to safe navigation and which it has not proven possible to remove. Such an obstruction may require to be marked until such time as it is either removed or no longer considered a danger to navigation.

25 Summary and Next Steps

Using baseline data and consultation undertaken, impacts relating to shipping and navigation have been identified for Hornsea Four for all phases of the development (construction, operation and maintenance and decommissioning). This has been fed into the FSA undertaken in **Volume 2, Chapter 8: Shipping and Navigation**. A cumulative baseline has also been determined and will inform the CEA to be undertaken as part of the final NRA and ES.

25.1 Consultation

Throughout the NRA process, consultation has been undertaken with regulators and stakeholders, including:

- MCA;
- TH;
- Chamber of Shipping;
- RYA;
- CA;
- Hazard Workshop attendees; and
- Regular operators.

Responses to the consultation effort were low based on experience at other offshore wind farms, particularly with regard to Regular Operators who were contacted by email on more than one occasion for comment.

25.2 Existing Environment

The Hornsea Four array area shares a section of its boundary with the site boundary for Hornsea Project Two (consented). Hornsea Project One (under construction) and Hornsea Three (determination phase) are also in proximity and there are a number of other offshore wind farm developments within the southern North Sea including other Round 3 sites in the former Dogger Bank Zone and former East Anglia Zone.

Two production wells connected to the Ravenspurn North CCW platform are located within the Hornsea Four array area alongside a suspended well. There are a number of other surface platforms in proximity to the Hornsea Four array area including at the Ravenspurn, Babbage, Garrow and Kilmar gas fields. Two submarine pipelines associated with gas fields in the southern North Sea pass through the Hornsea Four array area.

25.3 Maritime Incidents

From MAIB incident data analysed over a 10-year period, an average of one to two unique incidents per year occurred within 10 nm of the Hornsea Four array area with one incident occurring within the Hornsea Four array area itself. This involved a general cargo vessel experiencing an engine failure.

An average of two to three unique incidents reported to the MAIB per year occurred within 2 nm of the Hornsea Four HVAC booster station search area with the majority of incidents occurring within 5 nm of the Yorkshire coast.

An average of one to two unique incidents reported to the MAIB per year occurred within 10 nm of the Hornsea Four HVAC booster station search area with the closest incident to the Hornsea Four HVAC booster station search area itself involving a small recreational vessel approximately 1.4 nm south experiencing a gearbox failure and subsequent tow back to port.

From RNLI incident data analysed over a 10-year period, no RNLI lifeboat launches were reported within 10 nm of the Hornsea Four array area.

An average of 18 unique incidents reported to the RNLI per year occurred within 2 nm of the Hornsea Four offshore ECC with the majority of incidents occurring within 5 nm of the Yorkshire coast.

An average of one to two unique incidents reported to the RNLI per year occurred within 10 nm of the Hornsea Four HVAC booster station search area with fishing vessels the most frequent casualty vessel type.

25.4 Vessel Traffic

From vessel traffic survey data recorded on AIS over 14 full days in June 2018 (summer), there was an average of 33 unique vessels per day recorded within 10 nm of the Hornsea Four array area and 15 unique vessels per day within the Hornsea Four array area itself. Cargo vessels, tankers and oil and gas support vessels were the main vessel types recorded within the Hornsea Four array area throughout the summer survey period. Recreational vessel activity was minimal while fishing activity was moderate and characteristic of both transits and engagement in fishing activities.

From vessel traffic survey data recorded on AIS, visual and Radar over 14 full days in January/February 2019 (winter), there was an average of 23 unique vessels per day recorded within 10 nm of the Hornsea Four array area and 11 unique vessels per day within the Hornsea Four array area itself. Again, cargo vessels, tankers and oil and gas support vessels were the main vessel types recorded within the Hornsea Four array area throughout the winter survey period. Recreational vessel and fishing activity was minimal.

A total of 12 main routes were identified within 10 nm of the Hornsea Four array area, with the highest traffic volume route between two and three transits per day between Immingham and Esbjerg. This was one of three main routes featuring commercial ferries operated by DFDS Seaways with the others operating between Immingham and Gothenburg and North Shields and Ijmuiden.

From vessel traffic survey data recorded on AIS over 14 full days in June 2018 (summer), there was an average of 63 unique vessels per day recorded within 2 nm of the Hornsea Four offshore ECC and 56 unique vessels per day within the Hornsea Four ECC itself. Cargo vessels, fishing vessels and tankers were the main vessel types recorded within the Hornsea Four offshore ECC throughout the summer survey period. Recreational vessel activity was minimal out with the nearshore area.

From vessel traffic survey data recorded on AIS, visual and Radar over 14 full days in February 2019 (winter), there was an average of 51 unique vessels per day recorded within 2 nm of the Hornsea Four offshore ECC and 45 unique vessels per day within the Hornsea Four offshore ECC itself. Cargo vessels, tankers and fishing vessels were the main vessel types recorded within the Hornsea Four offshore ECC throughout the winter survey period. Recreational vessel activity was minimal.

From vessel traffic survey data recorded on AIS over 14 full days in June 2018 (summer), there was an average of 40 unique vessels per day recorded within 10 nm of the Hornsea Four HVAC booster station search area and seven unique vessels per day within the Hornsea Four HVAC booster station search area itself. Tankers and cargo vessels were the main vessel types recorded within the Hornsea Four HVAC booster station search area throughout the summer survey period. Recreational vessel activity was minimal out with the nearshore area while fishing activity was notable and characteristic of both transits (primarily out of Bridlington) and engagement in fishing activities.

From vessel traffic survey data recorded on AIS, visual and Radar over 14 full days in January/February 2019 (winter), there was an average of 37 unique vessels per day recorded within 10 nm of the Hornsea Four HVAC booster station search area and five unique vessels per day within the Hornsea Four HVAC booster station search area itself. Again, tankers and cargo vessels were the main vessel types recorded within the Hornsea Four HVAC booster station search area throughout the winter survey period. Recreational vessel activity was minimal while fishing activity was notable and characteristic of both transits (primarily out of Bridlington) and engagement in fishing activities.

A total of 10 main routes were identified within 10 nm of the Hornsea Four HVAC booster station search area, with the highest traffic volume route on average 15 transits per day between the Tees and Rotterdam. Another route with on average 11 transits per day between the Tees and Rotterdam/Zeebrugge featured commercial ferries operated by Bore Lines and P&O Ferries.

25.5 Future Case Vessel Traffic

An indicative 10% increase in traffic associated with ports, commercial fishing vessel transits and recreational vessel transits has been considered for the future case scenario. Additionally, transits made by vessels involved in the installation and operation and maintenance of Hornsea Four have been considered.

Deviations would be required for nine out of the 12 main routes identified within 10 nm of the Hornsea Four array area following construction of Hornsea Four, with the level of deviation varying between no increase and 30.9 nm. For the largest deviation, this corresponds to a 22.6% increase in the total route length.

Deviations would be required for two out of the 10 main routes identified within 10 nm of the Hornsea Four HVAC booster station search area following construction of Hornsea Four, with the level of deviation 1.0 nm and 1.7 nm for each of the deviated routes. In both cases the increase in the total route length is less than 1%.

Further modelling of the future case scenario for both the Hornsea Four array area and HVAC booster station search area will be undertaken as part of the final NRA submitted as part of the ES and will include collision and allision risk modelling using the vessel traffic baseline, array layout and meteorological/oceanographic data. This will assist in quantifying risk as part of the impact assessment undertaken in **Volume 2, Chapter 8: Shipping and Navigation**.

25.6 Next Steps

Post PEIR, a number of additional steps will be undertaken to ensure a comprehensive NRA. This includes the following:

- New analysis of shipping data collected from a vessel-based traffic survey in July/August 2019, thus ensuring that the baseline shipping activity assessment is compliant with MGN 543;
- Creation of a hazard log using the findings of the Hazard Workshop;
- Section 42 Consultation and meetings with stakeholders including the MCA, TH, Chamber of Shipping, RYA and CA as well as Regular Operators including DFDS Seaways;
- Updated post wind farm main route deviations;
- Collision and allision risk modelling;
- Creation of cumulative routeing; and
- Updated impacts following creation of the hazard log and consultation in parallel with updated FSA in **Volume 2, Chapter 8: Shipping and Navigation**.

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Appendix A Regular Operator Consultation

As part of the consultation process for Hornsea Four, Regular Operators identified (from the vessel traffic survey data) that would be required to deviate their routes due to the Hornsea Four array area or HVAC booster station search area were consulted via electronic mail. An example of the correspondence sent to the Regular Operators is presented below:

Hornsea 4 Ørsted

Stakeholder Consultation on Impacts Relating to Shipping and Navigation for the Proposed Hornsea Project Four Offshore Wind Farm

07/05/2019

Dear Stakeholder,

As you may be aware, Ørsted Hornsea Project Four UK Ltd. is the developer of the Hornsea offshore wind farms located off the Yorkshire coast. There are three existing Hornsea developments: Hornsea Project One is currently under construction, Hornsea Project Two was awarded consent in August 2016 and Hornsea Three submitted an application for Development Consent in May 2018.

Following a Scoping Report submitted to the Planning Inspectorate in October 2018, Hornsea Four is the fourth and final site from the original Hornsea Zone being developed and consists of offshore wind turbines and associated infrastructure located in a defined area to the west of the other Hornsea sites, as well as export cables to shore, associated infrastructure and an onshore grid connection.

The Hornsea Four array area is located approximately 35 nm (65 km) from the Yorkshire coast and covers an area of 247 nm^2 (846 km^2). Figure 1 presents the location of the Hornsea Four array area alongside the wind farm areas for the other Hornsea developments.

Further information relating to Hornsea Four is available at: https://hornseaprojects.co.uk/en/Hornsea-Project-Four.

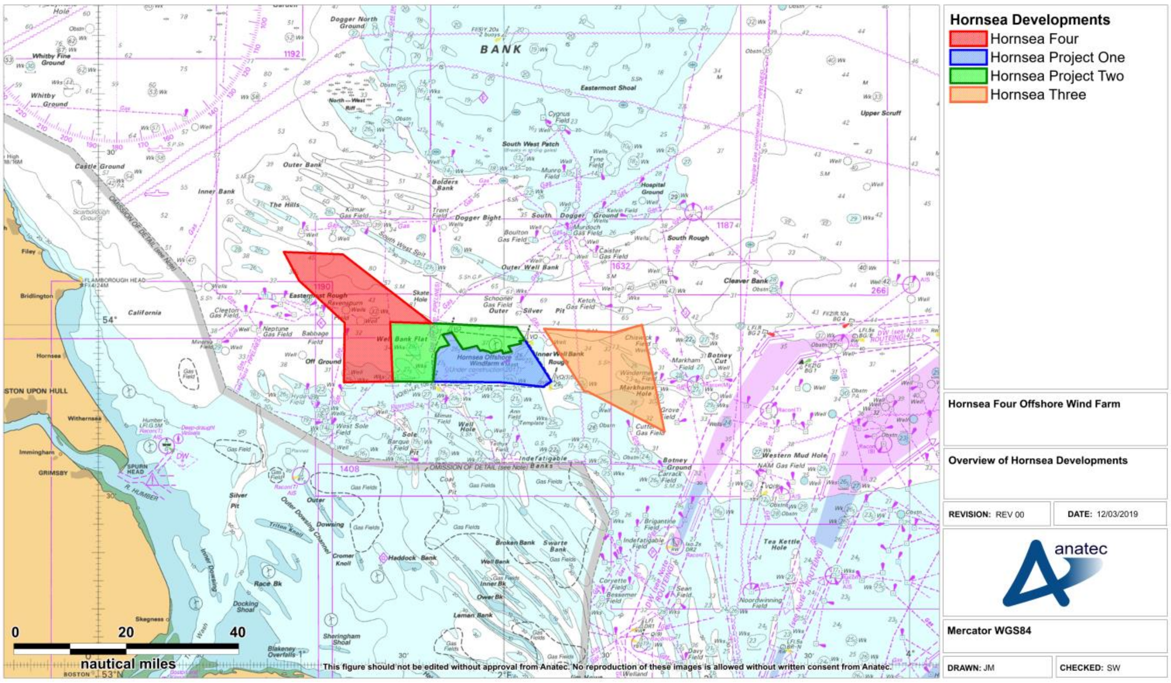

Figure 2. Overview of Hornsea developments

Anatec has been contracted by Ørsted Hornsea Project Four UK Ltd. to provide technical support on shipping and navigation during the consent process, and to coordinate consultation with stakeholders. Therefore, we are writing to you on behalf of Ørsted A/S to inform you of our relationship with Hornsea Four and to kindly request your comments, which will help inform the proposed development.

The Environmental Impact Assessment process requires Ørsted Hornsea Project Four UK Ltd. to identify impacts that Hornsea Four may potentially have upon shipping and navigation, and to ensure consultation is carried out comprehensively and consistently. In order to analyse shipping movements within and in the vicinity of the Hornsea Four array area, Automatic Identification System (AIS), visual observations, and Radar data obtained from vessel-based surveys has been collected and assessed, and will feed into the Navigational Risk Assessment (NRA) required by the Maritime and Coastguard Agency (MCA).

According to the assessment of AIS, visual and Radar data, your company's vessel(s) has regularly navigated within, and/or in the vicinity of, the Hornsea Four array area and consequently your company has been identified as a potential Marine Stakeholder for Hornsea Four. We therefore invite your feedback on the potential development including any impact it may have upon the navigation of vessels.

We would be grateful if you could provide us with any comments or feedback that you may have by the 31st May 2019. This will allow us to assess your feedback as part of the NRA which is currently being undertaken. We would also be grateful if you could forward a copy of this information to any vessel operators/owners you feel may be interested in commenting.

In particular, we are keen to receive comments on the following:

1. Whether the proposal to construct Hornsea Four is likely to impact the routeing of any specific vessels, including the nature of any change in regular passage;

2. Whether any aspect of Hornsea Four poses any safety concerns to your vessels, including any adverse weather routeing;
3. Whether you would choose to make passage internally through the array;
4. Whether you wish to be retained on our list of Marine Stakeholders and consulted throughout the NRA process; and
5. Whether you wish to attend a Hazard Workshop being held in central London in June where impacts relating to shipping and navigation will be discussed.

Responses should be sent via email to [redacted]. Should you have any queries about the published information or require any further information to support your review, please do not hesitate to contact us.

Yours sincerely,

[redacted]

Anatec Ltd

cc. [redacted] - Ørsted Hornsea Project Four UK Ltd