Hornsea Project Three
Offshore Wind Farm

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Environmental Statement:
Volume 5, Annex 7.1 – Navigational Risk Assessment

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Hornsea 3
Offshore Wind Farm

Ørsted

Environmental Impact Assessment

Environmental Statement

Volume 5 – Offshore

Annex 7.1 – Navigational Risk Assessment

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Glossary

Term	Definition
Allision	Contact between a moving and stationary object.
Area To Be Avoided (ATBA)	An area within defined limits in which either navigation is particularly hazardous or it is exceptionally important to avoid casualties and which should be avoided by all ships, or by certain classes of ships.
Automatic Identification System (AIS)	Automatic Identification System. A system by which vessels automatically broadcast their identity, key statistics e.g. length, brief navigation details e.g. location, destination, speed and current status e.g. survey. Most commercial vessels and European Union (EU) fishing vessels over 15 metres (m) are required to have AIS.
Base Case	The assessment of risk based on current shipping densities and traffic types as well as the marine environment.
Collision	The act or process of colliding (crashing) between two moving objects.
COLLRISK	Anatec Collision Risk Modelling Software.
Cloud Base	The lowest altitude of the visible portion of the cloud.
Deep Water Route (DWR)	A route in a designated area within defined limits which has been accurately surveyed for clearance of sea bottom and submerged articles. They are of particular use to vessels restricted in their ability to manoeuvre due to their draught size.
Emergency Position Indicating Radio Beacon (EPIRB)	An EPIRB is used to alert search and rescue services in the event of an emergency. It does this by transmitting a coded message on the 406 Megahertz (MHz) distress frequency via satellite and earth stations to the nearest rescue co-ordination centre. EPIRBs are registered to a vessel or aircraft and some also transmit on 121.5MHz which allows a Search and Rescue (SAR) aircraft to home in on them.
Entonox	A ready-to-use medical gas mixture of 50% nitrous oxide and 50% oxygen used for short-term pain relief.
Environmental Statement	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.
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.
Global Maritime Distress and Safety System (GMDSS) Sea Area A2	GMDSS sea areas serve two purposes: to describe areas where GMDSS services are available, and to define what radio equipment GMDSS vessels must carry (carriage requirements). Hornsea Three array area is within Sea Area A2 which is within the radiotelephone coverage of at least one medium frequency (MF) coast station in which continuous Digital Selective Calling (DSC) (2187.5 kilohertz (kHz)) alerting and radiotelephony services are available. For planning purposes, this area typically extends to up to 180 nautical miles (nm) (330 kilometres (km)) offshore during daylight hours, but would exclude any A1 designated areas. In practice, satisfactory coverage may often be achieved out to around 150 nm (280 km) offshore during night time.

Term	Definition
International Maritime Organization (IMO) Routeing	Predetermined shipping routes established by the IMO. Referred to as international sea lanes in EN-3 para 2.6.155.
Marine Environmental High Risk Area (MEHRA)	Areas in UK coastal waters where ships' 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 and of life at sea, and to prevent or minimise pollution from shipping.
Medrescue	Transfer of sick or injured persons(s) from a hostile environment to a recognised medical facility (e.g. hospital or chamber).
Meteorological Mast	A met mast or tower structure, on which meteorological observation and recording equipment is mounted.
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.
Not Under Command (NUC)	Under Part A of the International Regulations for Preventing Collisions at Sea (COLREGs), the term "vessel not under command" means a vessel which through some exceptional circumstance is unable to manoeuvre as required by these Rules and is therefore unable to keep out of the way of another vessel.
Offshore Renewable Energy Installation (OREI)	OREIs as defined by Guidance on UK Navigational Practice, Safety and Emergency Response Issues, MGN 543. For the purpose of this report and in keeping with the consistency of the EIA, OREI can mean offshore turbines and the associated electrical infrastructures such as offshore High Voltage Alternating Current (HVAC) transformer substations, offshore High Voltage Direct Current (HVDC) converter stations, accommodation platforms and offshore HVAC booster stations.
Personal Locator Beacon (PLB)	A PLB works in exactly the same way as an EPIRB by sending a coded message on the 406 MHz distress frequency which is relayed via the Cospas-Sarsat global satellite system. PLBs are typically carried on the person and are registered to the owner and may also transmit on 121.5 MHz.
Radar	Radio Detection And Ranging – an object-detection system which uses radio waves to determine the range, altitude, direction, or speed of objects.
Regular Operator	A commercial vessel operator whose vessel(s) are observed to transit through a particular region on a regular basis.
Safety Zone	A statutory marine zone demarcated for the purposes of safety around a possibly hazardous installation or works/ construction area.
Traffic Separation Scheme	A Traffic Separation Scheme (TSS) is a traffic-management route-system ruled by the 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 in an angle as close to 90 degrees as possible.
Vessel Traffic Services (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.

Acronyms

Acronym	Description
AC	Alternating Current
AfL	Agreement for Lease
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
ALB	All-Weather Lifeboat
ARPA	Automatic Radar Plotting Aid
ATBA	Area To Be Avoided
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
CEA	Cumulative Effect Assessment
CGOC	Coastguard Operations Centre
CHIRP	Confidential Reporting Programme for Aviation and Maritime
COLREGs	Convention on the International Regulations for Preventing Collisions at Sea 1972 as amended
CoS	Chamber of Shipping
CRO	Coastguard Rescue Officer
CRT	Coastguard Rescue Team
CTV	Crew Transfer Vessel
DC	Direct Current
DCO	Development Consent Order
DfT	Department for Transport
DSC	Digital Selective Calling
DWR	Deep Water Route
E	East

Acronym	Description
EASA	European Aviation Safety Agency
EIA	Environmental Impact Assessment
ELT	Emergency Locator Transmitter
EMF	Electromagnetic Field
EPIRB	Emergency Position Indicating Radio Beacon
ERCoP	Emergency Response Cooperation Plan
ERRV	Emergency Response and Rescue Vessel
EU	European Union
FLIR	Forward Looking Infra-Red
FMS	Flight Management System
FOV	Field of View
FSA	Formal Safety Assessment
GCAF	Gross Cost of Averting a Fatality
GIS	Geographical Information System
GMDSS	Global Maritime Distress and Safety System
GPS	Global Positioning System
GRP	Glass Reinforced Plastic
HAT	Highest Astronomical Tide
HF	High Frequency
HMCG	Her Majesty's Coastguard
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
IAMSAR	International Aeronautical and Maritime Search and Rescue
IFSD	In Flight Shut Down
IHO	International Hydrographic Organisation
ILB	Inshore Lifeboat
IMC	Instrument Meteorological Conditions

Acronym	Description
IMCA	International Marine Contractors Association
IMO	International Maritime Organization
IPS	Intermediate Peripheral Structure
IRC	International Rating Certificate
ITOPF	International Tanker Owners Pollution Federation
LAT	Lowest Astronomical Tide
LCD	Liquid Crystal Display
LOA	Length Overall
MAIB	Maritime Accident Investigation Branch
MCA	Maritime and Coastguard Agency
MEHRA	Marine Environmental High Risk Area
Metocean	Meteorological Ocean
MF	Medium Frequency
MGN	Marine Guidance Note
MHCC	Marine Helicopter Coordination Centre
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MMSI	Maritime Mobile Service Identity
MOD	Ministry of Defence
MSC	Maritime Safety Council
MSI	Maritime Safety Information
N	North
NAVTEX	Navigational Telex
NOREL	Nautical Offshore Renewable Energy Liaison
NRA	Navigational Risk Assessment
NUC	Not Under Command
NVG	Night Vision Googles
OGA	Oil and Gas Authority

Acronym	Description
OOW	Officer of the Watch
OREI	Offshore Renewable Energy Installation
OSV	Offshore Support Vessel
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
PEXA	Practice and Exercise Areas
PINS	Planning Inspectorate
PLA	Port of London Authority
PLB	Personal Locator Beacon
PLL	Potential Loss of Life
POB	Persons On Board
POD	Probability of Detection
PPE	Personal Protective Equipment
QHSE	Quality, Health, Safety and Environment
Racon	Radar Beacon
Radar	Radio Detecting and Ranging
RAF	Royal Air Force
REZ	Renewable Energy Zone
RNLI	Royal National Lifeboat Institution
Ro Ro	Roll on roll off
RV	Research Vessel
RYA	Royal Yachting Association
SAR	Search and Rescue
SCADA	Supervisory Control and Data Acquisition
SMS	Safety Management System
SNSOWF	Southern North Sea Offshore Wind Forum
SOLAS	Safety of Life at Sea
SPS	Significant Peripheral Structure
TCE	The Crown Estate

Acronym	Description
TH	Trinity House
TI	Thermal imaging
TSS	Traffic Separation Scheme
UHF	Ultra High Frequency
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UKHO	United Kingdom Hydrographic Office
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VTS	Vessel Traffic Services
WGS	World Geodetic System
ZAP	Zone Appraisal and Planning
ZEA	Zone Environmental Appraisal

Units

Unit	Description
£	Great British pound (currency)
°C	Degrees Celsius (temperature)
dB	Decibel (sound)
ft	Foot (distance)
GRT	Gross Registered Tonne (volume)
GW	Gigawatt (power)
km	Kilometre (distance)
kn	Knot (speed)
m	Metre (distance)
MHz	Megahertz (frequency)
mi.	Mile (distance)
MW	Megawatt (power)
nm	Nautical Mile (distance)
Pa	Pascal (pressure)
yd	Yard (distance)

1. Introduction

1.1 Background

1.1.1.1 Anatec were commissioned by Ørsted to undertake a Navigational Risk Assessment (NRA) for the proposed Hornsea Three array area (located within the former Hornsea Zone), the Hornsea Three offshore cable corridor and the Hornsea Three offshore High Voltage Alternating Current (HVAC) booster station search area. This NRA report presents information on the proposed development relative to the existing and future case navigational activity and forms an annex to the Environmental Statement.

1.2 Navigational Risk Assessment

1.2.1.1 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. An important requirement of the EIA for offshore projects is the NRA. Following the Maritime and Coastguard Agency (MCA) methodology (MCA, 2015) and Marine Guidance Note (MGN) 543 (MCA, 2016), an NRA for Hornsea Three has been undertaken and includes:

- Overview of base case environment;
- Marine traffic survey;
- Implications of offshore wind farms including position of turbines;
- Assessment of navigational risk pre and post development of Hornsea Three;
- Formal Safety Assessment (FSA);
- Implications for marine navigation and communication equipment;
- Identification of mitigation measures;
- Emergency response; and
- Any required monitoring.

1.2.1.2 Assessments will be undertaken for each development phase as follows:

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

1.2.1.3 The assessment of Hornsea Three is based on a Design Envelope which includes conservative assumptions that have been considered and assessed for all impacts. Further details of the Hornsea Three Design Envelope are outlined in volume 1, chapter 3: Project Description.

2. Guidance and Legislation

2.1 Primary guidance

2.1.1.1 The primary guidance documents used during the assessment are listed below:

- MCA MGN 543 (Merchant and Fishing) Safety of Navigation Offshore Renewable Energy Installations (OREIs) – Guidance on United Kingdom (UK) Navigational Practice, Safety and Emergency Response (MCA, 2016);
- MCA Methodology for Assessing Marine Navigational Safety Risks of Offshore Wind Farms (MCA, 2015); and
- Guidelines for FSA – Maritime Safety Council (MSC)/Circular 1023/MEPC/Circular 392 (International Maritime Organization, 2002).

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

2.1.1.3 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. The NRA identifies both base case and future case levels of risk and what measures are required to ensure the future case remains broadly acceptable or tolerable.

2.2 Other guidance

2.2.1.1 Other guidance documents used during the assessment are listed below:

- MCA MGN 372 (Merchant and Fishing) OREIs Guidance to Mariners Operating in the Vicinity of UK OREIs (MCA, 2008b);
- International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Recommendation O-139 on The Marking of Man-Made Offshore Structures, Edition 2 (IALA, 2013);
- Royal Yachting Association (RYA) – The RYA's Position on Offshore Renewable Energy Developments Paper 1 – Wind Energy (RYA, 2015); and
- Department for Business, Energy and Industrial Strategy (BEIS) Standard Marking Schedule for Offshore Installations (2011).

3. Navigational Risk Assessment Methodology

3.1 Formal Safety Assessment methodology

3.1.1.1 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, to assess:

- Baseline data and assessment;
- Expert opinion;
- Outputs of the Hazard Workshop (see Appendix B);
- 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

3.2.1.1 The International Maritime Organization (IMO) FSA process (IMO, 2002) approved by the IMO in 2002 under MSC/Circ.1023/MEPC/Circ.392 has been applied within this study. This is a structured and systematic methodology based on risk analysis and cost benefit analysis (if applicable). There are five basic steps within this process:

- Step 1 – Identification of hazards (a list of all relevant accident scenarios with potential causes and outcomes);
- Step 2 – Assessment of risks (evaluation of risk factors);
- Step 3 – Risk control options (devising measures to control and reduce the identified risks);
- Step 4 – Cost Benefit Analysis (CBA) (determining cost effectiveness of risk control measures); and
- Step 5 – Recommendations for decision-making (information about the hazards, their associated risks and the cost effectiveness of alternative risk control measures).

3.2.1.2 A tool used to assess risk is the Hazard Workshop; by ensure that all risks are identified and qualified prior to the NRA and EIA process. The following tables (Table 3.1 and Table 3.2) identify how the severity of consequence and the frequency of occurrence are defined within the hazard log; these rankings are the same rankings used for Hornsea Project One and Hornsea Project Two so that cross comparison is possible. The rankings for severity of consequence are shown in Table 3.1.

Table 3.1: Severity of consequences.

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-£1million	Tier 2 Limited external assistance required	£100,000-£1million Local publicity
4	Serious	Multiple serious injury or single fatality	£1million-£10million	Tier 2 Regional assistance required	£1million-£10million National publicity
5	Major	More than one fatality	>£10million	Tier 3 National assistance required	>£10million International publicity

3.2.1.3 The rankings for frequency of occurrence are shown in Table 3.2.

Table 3.2: Frequency of occurrence.

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

3.2.1.4 The severity of consequences is then assessed against the frequency of occurrence to provide the level of tolerability of the impact. This tolerability matrix is shown in Table 3.3. The tolerability of the impact is defined as Broadly Acceptable (low risk), Tolerable (intermediate risk) or Unacceptable (high risk).

3.2.1.5 Once identified, the impact will then be assessed to ensure it is As Low As Reasonably Practicable (ALARP). Further risk control measures may be required to further mitigate the impact in accordance with ALARP principles. Unacceptable risks are considered not to be ALARP.

Table 3.3: Tolerability matrix and risk rankings.

Severity of consequences						
	5 (Major**)**	Amber	Amber	Red	Red	Red
	4 (Serious)	Amber	Amber	Amber	Red	Red
	3 (Moderate)	Green	Green	Amber	Amber	Red
	2 (Minor)	Green	Green	Green	Amber	Amber
	1 (Negligible)	Green	Green	Green	Green	Amber
		1	2	3	4	5
		Frequency of occurrences				

Green	Broadly Acceptable (low risk)
Amber	Tolerable (intermediate risk)
Red	Unacceptable (high risk)

3.3 Methodology for assessing cumulative effects

3.3.1.1 The assessment of cumulative effects includes considering the impacts arising from other offshore wind farms and development activities within the southern North Sea.

3.3.1.2 Cumulative issues on a zonal development plan basis were assessed as part of the Southern North Sea Offshore Wind Forum (SNSOWF) remit in 2013. It was recognised that, due to the scale and location of Round 3 zones in the southern North Sea (Dogger Bank, the former Hornsea Zone and the former East Anglia Zone), coordination was required between zones in order for the developers of these zones to successfully undertake their respective Zone Appraisal and Planning (ZAP) process. Therefore, the developers of the three zones established the SNSOWF to extend the principles of ZAP beyond the boundaries of their respective zones and to help manage wider cumulative issues between these zones. An overview of this work is detailed in section 21.3. Although the work has not been refreshed since 2013, the routes identified have been validated against the surveys undertaken for Hornsea Three.

3.3.1.3 The following methods have been used to assess these effects identified as part of the baseline study:

- Stakeholder consultation and expert opinion;
- Lessons learned;
- Desktop study;
- Collision and allision risk modelling; and
- Regular Operator feedback.

3.4 Assumptions

3.4.1.1 The shipping and navigation baseline and impact assessment has been carried out based on the information available and responses received at the time of preparation. It has assessed a conservative scenario noting the final locations of structures will not be finalised until post consent.

4. Consultation

4.1 Stakeholder types

4.1.1.1 There are a variety of stakeholder types:

- "Risk imposer" includes those whose actions or policies result in a risk and need action;
- "Risk taker" includes those whose action or inaction results in a risk;
- "Risk beneficiary" benefits from imposing or taking a risk;
- "Risk payer" pays for the management of a risk;
- "Risk sufferer" suffers the consequence of a risk; and
- "Risk observer" is aware of a risk but it does not affect them directly.

4.1.1.2 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 a 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 as part of Navigational Risk Assessment process

4.2.1.1 Key marine and navigation stakeholders have been consulted as part of the NRA process. The following stakeholders have been consulted via dedicated meetings:

- MCA;
- TH;
- Chamber of Shipping (CoS);
- RYA; and
- Cruising Association (CA).

4.2.1.2 The MMO have been consulted as part of the wider Environmental Statement process.

4.2.1.3 Consultation with Regular Operators was also undertaken including through the Hazard Workshop.

4.2.1.4 A summary of the key consultation for Hornsea Three is included in section 14.

5. Data Sources

5.1 Summary of data sources

5.1.1.1 This section summarises the main data sources used in assessing the baseline shipping activities relative to Hornsea Three. The main data sources used in this assessment are listed below:

- Marine traffic survey: Automatic Identification System (AIS), visual and Radio Detecting and Ranging (Radar) survey data (26 days throughout June and July 2016 and 14 days throughout November and December 2016) for the Hornsea Three array area collected from two survey vessels. Further detail is given in section 15;
- Marine traffic survey: AIS, visual and Radar survey data (14 days throughout September 2016 and 14 days throughout November and December 2016) for the Hornsea Three offshore HVAC booster station search area collected from two survey vessels. Further detail is given in section 15.4;
- Shore based AIS survey data Hornsea Three offshore cable corridor search area combined with Hornsea Three array area data (period coinciding with the marine traffic survey being undertaken in the Hornsea Three array area). This data is collected using shore based receivers and not a survey vessel;
- AIS fishing and recreational survey data (365 days throughout March 2016 to February 2017) for the London Array offshore wind farm (OWF) site. Further detail is given in section 22.13;
- Fishing surveillance satellite data (2009) and observation data (2005 to 2009) which was validated against data in volume 2, chapter 6: Commercial Fisheries;
- Maritime incident data from the Maritime Accident Investigation Branch (MAIB) (2005 to 2014) and Royal National Lifeboat Institution (RNLI) (2005 to 2014);
- Marine aggregate dredging data (licence areas and active areas) and transit routes from The Crown Estate (TCE) and British Marine Aggregate Producers Association (BMAPA) (2017);
- Admiralty Sailing Direction – North Sea (West) Pilot NP 54 United Kingdom Hydrographic Office (UKHO) (UKHO, 2016);
- UKHO Admiralty Charts 105-0, 1187-0 and 2182A-0; and
- RYA UK Coastal Atlas of Recreational Boating 2.0 (2016).

5.1.1.2 The marine traffic survey data used in the NRA is summarised in section 7 and Table 5.1 below.

5.2 Study areas

5.2.1 Hornsea Three array area shipping and navigation study area

5.2.1.1 A 10 nautical mile (nm) buffer has been applied around the Hornsea Three array area. This study area has been defined in order to provide local context to the analysis of risks by capturing the relevant routes and traffic movements within and near the proposed Hornsea Three array area. This 10 nm study area has been used within the majority of UK wind farm NRAs including Hornsea Project One and Hornsea Project Two.

5.2.2 Hornsea Three offshore cable corridor shipping and navigation study area

5.2.2.1 A 2 nm buffer has been applied around the Hornsea Three offshore cable corridor. As with the Hornsea Three 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 Three offshore cable corridor. The study area runs between the Mean Low Water Springs (MLWS) and the boundary of the Hornsea Three array area.

5.2.3 Hornsea Three offshore HVAC booster station search area shipping and navigation study area

5.2.3.1 A 5 nm buffer has been applied around the Hornsea Three offshore HVAC booster station search area within the Hornsea Three offshore cable corridor. This extent is based on routeing of vessels and the likely size of deviations required. This search area overlaps with the Hornsea Three offshore cable corridor because of a regulator requirement for a marine traffic survey (AIS data and Radar) to be undertaken where surface structures are proposed and to identify relevant receptors that may be affected.

5.2.4 Hornsea Three cumulative shipping and navigation study area

5.2.4.1 It should be noted that, due to the national and international nature of shipping and navigation, risks have been considered within a wider southern North Sea perspective (where relevant) for vessels routeing as per section 21 and Table 22.1. Changes to routeing have been shown in detail within a combined 10 nm buffer around the Hornsea Three, Hornsea Project One and Hornsea Project Two array areas.

Table 5.1: Summary of marine traffic survey data.

Survey period	Survey location	Data type	Data capture (full days)	Vessel	AIS System Type	Radar System Type	Personnel
6–18 June & 22 June–4 July 2016	Hornsea Three array area	AIS, visual and Radar	26 days	*Neptune* Research / survey vessel Flagged Iceland	JRC 182 JHS	JRC JMA 531	FLO/bridge crew & dedicated surveyor
16–29 September 2016	Hornsea Three offshore HVAC booster station search area	AIS, visual and Radar	14 days	*Willing Lad* Survey vessel Flagged UK	Koden AIS, Type KAT-100	JRC JMA 3210-6	Bridge crew (dedicated)
10–16 November & 26 November–3 December 2016	Hornsea Three array area	AIS, visual and Radar	14 days	*Research Vessel (RV) Aora* Research / survey vessel Flagged UK	Furuno FA100	Decca Bridgemaster E	Bridge crew (dedicated)
17–19 November & 4–15 December 2016	Hornsea Three offshore HVAC booster station search area	AIS, visual and Radar	14 days	*RV Aora* Research / survey vessel Flagged UK	Furuno FA100	Decca Bridgemaster E	Bridge crew (dedicated)

6. Lessons Learnt

6.1.1.1 There is considerable benefit for the Applicant in the sharing of lessons learnt within the offshore industry. The NRA and in particular the hazard assessment, includes general consideration for lessons learnt and expert opinion from previous offshore wind farm developments and other sea users.

6.1.1.2 Lessons learnt data sources include:

- RYA and CA (2004) Sharing the Wind – Identification of recreational boating interests in the Thames Estuary, Greater Wash and North West (Liverpool Bay), Southampton, RYA;
- Department for Transport (DfT) (2004) Results of the electromagnetic investigations 2nd edition, Southampton, MCA and QinetiQ;
- Renewables UK (RUK) (2014 issue 2) Guidelines for Health and Safety in the Wind Energy Industry;
- MCA (2005) Offshore Wind Farm Helicopter Search and Rescue (SAR) – Trials Undertaken at the North Hoyle Wind Farm Report of helicopter SAR trials undertaken with Royal Air Force (RAF) Valley "C" Flight 22 Squadron on March 22 2005, Southampton, MCA;
- Nautical Offshore Renewable Energy Liaison (NOREL Group) (unknown) A Report compiled by the Port of London Authority (PLA) based on experience of the Kentish Flats Wind Farm Development, NOREL Work Paper, WP4 (2nd NOREL);
- SMart Wind (2014) Hornsea Project Two Environment Statement Volume 2, Chapter 7: Shipping and Navigation; and
- TCE and Anatec (2012) 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.

7. Marine Traffic Survey Methodology

7.1 Introduction

7.1.1.1 This section describes the survey methodology used when recording marine traffic survey data for the Hornsea Three array area and offshore HVAC booster station search area shipping and navigation study areas.

7.2 Baseline survey methodology

7.2.1.1 Baseline shipping activity was assessed using AIS, visual and Radar track data. The period of data collection encompassed seasonal fluctuations in shipping activity (i.e. summer/winter), and also accounted for a range of tidal conditions. For the Hornsea Three offshore cable corridor shipping and navigation study area this data was supplemented with data from shore based AIS stations. For the Hornsea Three array area shipping and navigation study area, the quality of coverage of such shore based survey data was insufficient to further enhance the vessel-based survey data. As agreed with the MCA, and in line with standard best practice, a vessel-based marine traffic survey of the sections of the offshore cable corridor that lie beyond the Hornsea Three offshore HVAC booster station search area shipping and navigation study area is not required.

7.2.1.2 The survey vessels used at the Hornsea Three array area shipping and navigation study area were the *Neptune* (summer) and *RV Aora* (winter). The survey vessels used at the Hornsea Three offshore HVAC booster station search area shipping and navigation study area were the *Willing Lad* (summer) and *RV Aora* (winter).

7.3 AIS and Radar coverage

7.3.1.1 AIS is required on board all vessels of more than 300 Gross Register Tonnes (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 1 July 2002, and fishing vessels over 15 metres (m) in length.

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

7.4 Commercial vessels dataset

7.4.1.1 The marine traffic survey for the baseline navigation review of the Hornsea Three array area included a combined dataset of 40 days of AIS, visual and Radar data recorded from survey vessels working at the Hornsea Three array area during 6 June to 4 July 2016 and 10 November to 3 December 2016.

7.4.1.2 The marine traffic survey for the baseline navigation review of the Hornsea Three offshore HVAC booster station search area included a combined dataset of 28 days of AIS, visual and Radar data recorded from survey vessels working at the Hornsea Three offshore HVAC booster station search area during 16 to 29 September 2016 and 4 to 15 December 2016.

7.5 Recreational activity

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

7.5.1.2 The RYA has also developed a detailed position statement (RYA, 2015) based on analysed data for common recreational crafts; this, along with consultation at the Hazard Workshop, were used to inform the NRA.

7.5.1.3 In addition, recreational vessel data was extracted from the AIS, visual and Radar survey tracks recorded during the marine traffic surveys (June to July 2016 and November to December 2016).

7.6 Fishing activity

7.6.1.1 Fishing activity data was extracted from the AIS, visual and Radar tracks recorded during the marine traffic surveys (June to July 2016 and November to December 2016).

7.6.1.2 In addition, fishing vessel sightings and satellite monitoring data were obtained (fishing surveillance satellite data (2009) and observation data (2005 to 2009) which was validated against data in volume 2, chapter 6: Commercial Fisheries) from the Marine Management Organisation (MMO) and presented in density grids to validate the fishing survey data presented in the baseline assessment.

7.6.1.3 Sightings data were analysed for the 2005 to 2009 period These data have been collected through the deployment of patrol vessels, surveillance aircraft and the sea fisheries inspectorate. Each patrol logs the position and details of fishing vessels within the area being patrolled. All vessels are logged, irrespective of size, provided they can be identified from their Port Letter Number (PLN).

7.6.1.4 Satellites record the positions of fishing vessels of 15 m length and over every two hours. Data have been analysed on a full annual basis from 2009 (all nationalities).

7.6.1.5 It is noted that satellite and sightings data is no longer available in the point format, and therefore these datasets cannot be updated.

7.6.1.6 Validation of fishing data was also undertaken against volume 2, chapter 6: Commercial Fisheries.

8. Other Offshore Users

8.1 Oil and gas installations

8.1.1.1 Offshore oil and gas installation data were assessed using charted information. Including fixed platforms and wellheads that may have an impact on navigational transit by a surface vessel. A desktop study was undertaken using these data to identify any possible cumulative effects with offshore oil and gas developments.

8.2 Marine aggregate areas

8.2.1.1 Marine aggregates dredging data (licenced areas and active areas) were supplied by TCE and passage plans of dredgers were supplied by BMAPA. A desktop study was carried out using this information to identify commercial aggregate dredging activity in the vicinity of the development area.

8.3 Navigational features

8.3.1.1 Other navigational features such as IMO routeing measures and Ministry of Defence (MOD) Practice and Exercise Areas (PEXAs) have been considered based on information from Admiralty charts.

9. Design Envelope

9.1 Introduction

9.1.1.1 The NRA reflects the Design Envelope defined in volume 1, chapter 3: Project Description. The following section details the maximum extent of Hornsea Three for which any identified impacts will be assessed.

9.2 Hornsea Three development boundaries

9.2.1.1 The proposed Hornsea Three array area is located approximately 65.3 nm (121 kilometres (km)) to the northeast of the UK coast, at Trimingham, Norfolk. The total area of the Hornsea Three array area is approximately 203 nm^2 (696 km^2) with water depths within the Hornsea Three array area ranging from approximately 27 m to 73 m above Lowest Astronomical Tide (LAT).

9.2.1.2 The main co-ordinates defining the boundary of the Hornsea Three array area are presented in Table 9.1.

Table 9.1: Main co-ordinates of the Hornsea Three array area.

Latitude (World Geodetic System (WGS) 84)	Longitude (WGS 84)
53° 59’ 22.42’’ north (N)	002° 11’ 50.69’’ east (E)
53° 58’ 42.51’’ N	002° 32’ 43.90’’ E
54° 00’ 04.03’’ N	002° 40’ 52.65’’ E
53° 41’ 22.17’’ N	002° 47’ 35.93’’ E
53° 48’ 23.27’’ N	002° 24’ 43.63’’ E
53° 48’ 27.12’’ N	002° 23’ 43.61’’ E

9.2.1.3 The turbine layout being used to inform the assessment (Layout A) is shown in Figure 9.1. Layout A includes a minimum 1,000 m spacing between all infrastructure (including periphery locations) and a single line of orientation. It is noted that the symbology used in Figure 9.1 for turbine locations has been designed to give a clearer idea of the size of the turbines in relation to the Hornsea Three array area as a whole.

9.3 Infrastructure

9.3.1.1 Layout A incorporates the following 319 structures:

- 300 turbines;
- 12 offshore HVAC transformer substations;
- Four offshore High Voltage Direct Current (HVDC) converter substations; and
- Three accommodation platforms.

9.3.1.2 The turbines within Layout A each have a maximum rotor diameter of 195 m and maximum blade tip height (above LAT) of 250 m.

9.3.1.3 A minimum structure spacing of 1,000 m has been included.

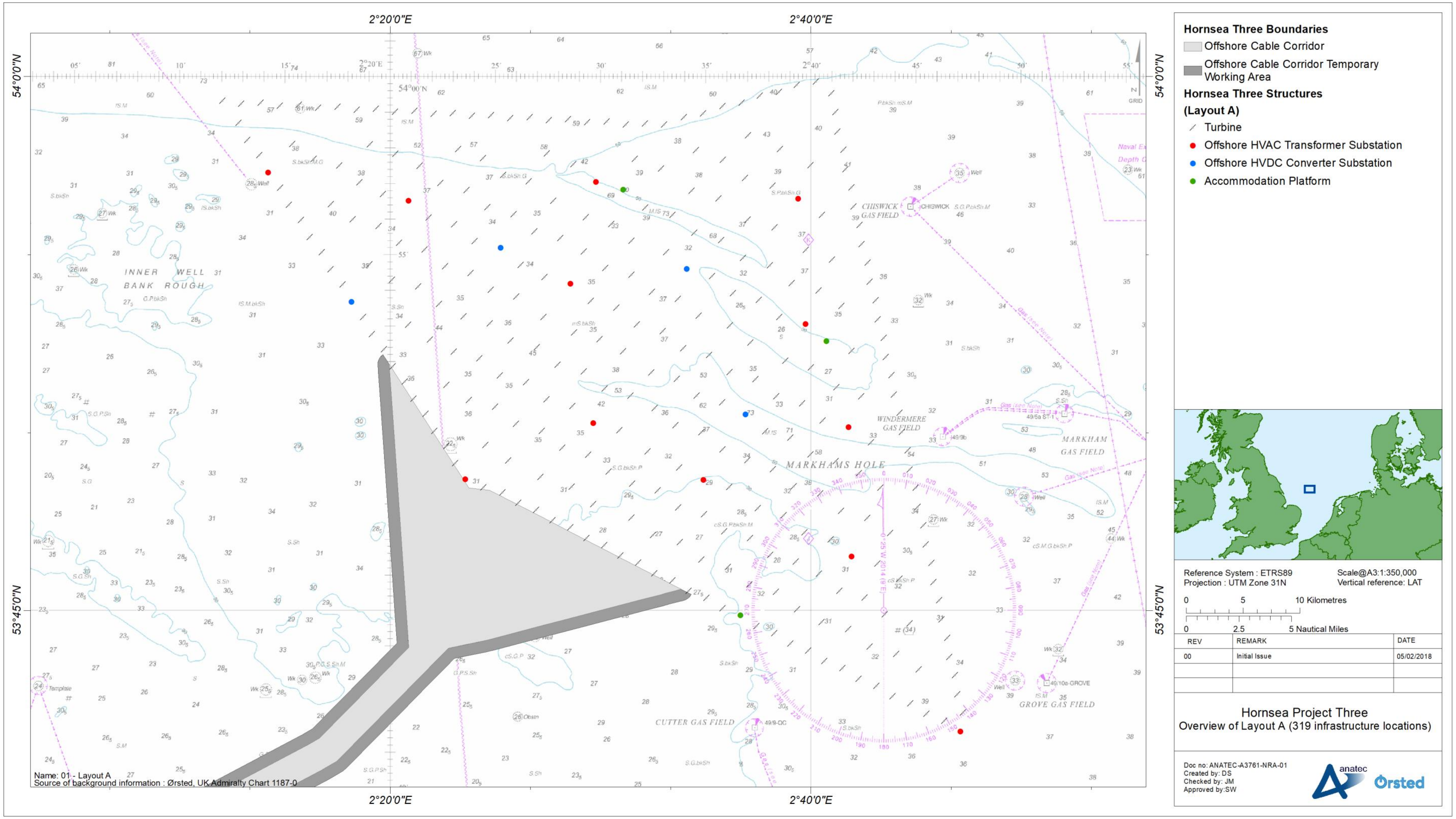

Figure 9.1: Overview of Layout A (319 infrastructure locations).

9.4 Turbine design

9.4.1.1 Jacket foundations have been considered as the maximum design scenario for shipping and navigation as this foundation type provides the maximum surface area of infrastructure at the water line. The maximum design scenario turbine measurements assuming jacket foundation design for Layout A are presented in Table 9.2.

9.4.1.2 Other types of foundation being considered include a monopile, suction bucket (mono or multi leg) and gravity base. Descriptions of these foundation types can be found within volume 1, chapter 3: Project Description.

9.4.1.3 Table 9.2 identifies the maximum design scenario parameters.

Table 9.2: Maximum design scenario (and modelled) parameters for turbines design.

Parameter	Specification for 300 turbines (Layout A)
Foundation type	Jacket
Maximum design scenario dimensions at the water line (dependent on water depth, geology and turbine type)	25×25 m
Hub height (above LAT)	153 m
Maximum blade tip height (above LAT)	250 m
Minimum blade tip height (above LAT)	34.97 m
Rotor diameter	195 m

9.5 Development Principles

9.5.1.1 Development Principles are contained within volume 4 annex 3.7: Layout Development Principles and the Statement of Common Ground and are agreed with the MCA and TH. The Development Principles have been written in consultation with key regulators to ensure that post consent the turbine layout within the Hornsea Three array area satisfactorily meets both navigational and SAR safety requirements.

9.6 Further detail on other structures within the Hornsea Three array area and offshore cable corridor

9.6.1.1 The following section details the associated structures within the Hornsea Three array area and offshore cable corridor as described in volume 1, chapter 3: Project Description.

9.6.1.2 Table 9.3 identifies the number of structures and their maximum dimensions, as applicable for Layout A.

Table 9.3: Structures within the Hornsea Three array area and offshore cable corridor.

Structure	Location	Specification (maximum)	At water line dimensions
Offshore HVAC transformer substation	Hornsea Three array area	12	80×80 m *Could be 90×90 if accommodation included, however maximum design scenario is the presence of additional platforms.*
Offshore HVDC converter substation	Hornsea Three array area	4	180×90 m
Accommodation platform	Hornsea Three array area	3	60×60 m
Hornsea Three offshore HVAC booster station	Hornsea Three offshore cable corridor	4	80×80 m

9.6.1.3 If the HVDC transmission option is selected, offshore HVAC transformer substations and offshore HVDC converter substations may be required within the Hornsea Three array area. The HVDC transmission option therefore represents a conservative case in terms of the number of structures within the Hornsea Three array area and has therefore been modelled for the Hornsea Three array area.

9.6.1.4 If the HVAC transmission option is selected, Hornsea Three offshore HVAC booster stations will be required within the Hornsea Three offshore HVAC booster station search area located along the Hornsea Three offshore cable corridor. If the HVDC transmission option is selected, no Hornsea Three offshore HVAC booster stations will be required. The HVAC transmission option therefore represents a conservative case in terms of the number of structures within the Hornsea Three offshore HVAC booster station search area and has therefore been modelled for the offshore HVAC booster station search area shipping and navigation study area. As the final location of the Hornsea Three offshore HVAC booster station(s) is not known, modelling has been undertaken on a location central to the Hornsea Three offshore HVAC booster station search area and conservative surface area (largest number of platforms within a cluster). Any other design is then considered to be lower risk.

9.7 Cables

9.7.1.1 Hornsea Three will require various types of submarine cables which can be split into three main categories:

- Array cables;
- Interconnector cables; and
- Export cables.

9.7.2 Array cables

9.7.2.1 The array cables will connect individual turbines to offshore HVAC transformer substations. Hornsea Three may require a total of up to 448 nm (830 km) of array cables. The total length will be determined by considerations such as the layout and voltage capacity. Including installation and protection, each cable may directly affect a 30 m width of the seabed (when considering sandwaves).

9.7.3 Interconnector cables

9.7.3.1 The purpose of offshore platform interconnector cables is to provide interlink connections between the offshore platforms within the array area. Hornsea Three will require up to 15 interconnector cables, with a total length of up to 121 nm (225 km), depending on the chosen layout, number of substations and substation locations.

9.7.4 Export cables

9.7.4.1 The proposed Hornsea Three offshore cable corridor runs southwest for 88 nm (163 km) from the southern and western boundary of the Hornsea Three array area to the landfall area at Weybourne, Norfolk. Up to six offshore export cables of diameter 320 millimetres (mm) will be installed, depending on the transmission option selected.

9.7.4.2 The process of selection and routeing of the Hornsea Three offshore cable corridor has avoided, where possible, significant engineering and environmental constraints, such as deep water and aggregate dredging areas.

9.7.5 Cable burial

9.7.5.1 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 cable routes and associated cable burial assessment. Cable protection methods may be used where burial is not possible; this will again be assessed within the cable burial assessment.

9.8 Construction phase(s)

9.8.1.1 The combined maximum design scenario for the offshore construction phase is considered to be up to eight years, split over two phases.

9.8.1.2 For turbines, foundations and array cables the maximum design scenario is:

- Up to eight years over two phases; this would also assume construction buoyage is deployed throughout that phase.

9.8.1.3 For the Hornsea Three offshore cable corridor and offshore HVAC booster stations the maximum design scenario is:

- Maximum installation duration for the surface or subsea HVAC booster stations of two phases of up to four years duration (including periods of construction and inactivity) for which construction buoyage would be deployed throughout; and
- Maximum installation duration for the export cables of three years with gaps of up to three years.

9.9 Indicative vessel numbers

9.9.1 Construction vessels

9.9.1.1 The following numbers are the indicative numbers assumed to be a conservative case for shipping and navigation over the eight year construction phase.

- Up to 10,774 return trips:
  - Up to four installation vessels and up to 24 transport vessels;
  - Up to three installation vessels, up to 13 support vessels, up to 12 dredging vessels and on average four transport vessels (tugs) for turbine gravity base foundation installation;
  - Up to two installation vessels, up to 12 support vessels and up to four transport vessels for offshore substation foundation installation;
  - Up to three main cable laying vessels, up to three main cable burial vessels, up to four crew boats or Offshore Support Vessels (OSV), up to two service vessels, up to two service vessels, up to two diver vessels, up to two pre lay grapnel run vessels, and up to two dredging vessels for array cable installation; and
  - Up to four main cable laying vessels comprising up to one barge and three associated tugs, up to four main jointing vessels comprising one barge and three associated tugs, up to four main burial support vessels comprising up to one barge and three associated tugs and up to two crew boats or OSVs, up to one service vessel, up to one diver vessel, up to one pre lay grapnel run vessel and up to one dredging vessel for export cable installation.

9.9.2 Operation and maintenance vessels

9.9.2.1 The following numbers are the indicative numbers assumed to be a conservative case for shipping and navigation over a 35 year operational phase.

- Up to 20 Crew Transfer Vessels (CTV) (2,433 return trips per year);
- Up to four OSVs;
- Supply vessel return trips 312 per year;
- 140 jack up return trips per year;
- Number of personnel 680 (onshore and offshore);
- Accommodation platforms housing up to 150 people; and
- Up to 3,785 total helicopter return trips.

9.9.2.2 During both the construction and the 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.

9.9.2.3 The project will be operational 24/7.

9.10 Maximum design scenarios

9.10.1.1 It is noted that the anticipated design life of Hornsea Three is 35 years (as stated in Table 9.4). However it may be desirable to "repower" Hornsea Three at or near the end of the design life of Hornsea Three to the end of the 50 year Crown Lease period. If the specifications and designs of the new turbines and/or foundations fell outside of the maximum design scenario or the impacts of constructing, operation and maintenance, and decommissioning them were to fall outside those considered by this NRA, repowering would require further consent (and NRA) and is therefore outside the scope of this document.

9.10.1.2 Table 9.4 details the maximum design scenarios considered within the NRA.

Table 9.4: Maximum design scenarios considered.

Phase	Element	Maximum design scenario
Construction	Hornsea Three array area	• Construction of the Hornsea Three array area could take up to eight years and up to two phases; and • Buoyed construction area around the Hornsea Three array area for the duration of construction.
Construction	Hornsea Three offshore cable corridor	• Buoyed construction area around the Hornsea Three offshore HVAC booster station development area for the duration of construction; • Maximum installation duration for the surface or subsea offshore HVAC booster stations is two phases of six years; • Maximum export cable installation duration of three years with gaps of up to three years; and • Minimum safe passing distance of 1,000 m for cable laying vessels.
Construction	Construction vessel return trips	Up to 10,774 return trips: • Turbine installation vessels: up to 40 vessels (3,000 return trips); • Turbine foundation installation vessels: up to 60 vessels (2,250 return trips) OR up to 32 vessels (gravity base) (4,200 return trips); • Substation foundation installation vessels: up to 18 vessels (304 return trips); • Array cable installation vessels: up to 18 vessels (2,520 return trips); and • Export cable installation vessels: up to 18 vessels (750 return trips).
Operation and Maintenance	Hornsea Three array area	• Anticipated design life of 35 years; • Up to 300 turbines with jacket foundations; • Total development area of up to 696 km^2; • Up to 12 offshore HVAC transformer substations; • Up to three accommodation platforms; • Up to four offshore HVDC converter substations. • Bridge links (up to 100 m); • Up to 830 km array and 225 km interconnector cables; and • Safety zones of 500 m may be applied for, for example around all infrastructure during major maintenance activities and around all platforms during operations.
Operation and Maintenance	Hornsea Three offshore cable corridor	• Anticipated design life of 35 years; • 163 km offshore cable corridor; • Up to six export cables of up to 163 km in length (from Hornsea Three array boundary to the landfall area) – buried or protected within 1,000 m consented corridor width (550 to 850 m final corridor width); • Cable protection measures; • Rock protection berm, sloped profile above seabed level: 7 m overall width and 2 m maximum height; • Up to four surface or six subsea offshore HVAC booster stations; • Up to 44 cable/pipeline crossings; and • Minimum safe passing distance of 1,000 m for cable laying vessels (maintenance).

Phase	Element	Maximum design scenario
Operation and Maintenance	Maintenance vessel and helicopter return trips and personnel	• Anticipated design life of 35 years; • Up to 20 CTVs (2,433 return trips per year); • Up to four OSVs; • Supply vessel return trips 312 per year; • 140 jack up return trips per year; • Operational hours 24/7; • Number of personnel 680 (onshore and offshore); • Accommodation platforms housing up to 150 people; and • Up to 3,785 total helicopter return trips.
Decommissioning	Hornsea Three array area	• Decommissioning of the Hornsea Three array area could take up to eight years and up to two phases; and • Buoyed area around the Hornsea Three array area for the duration of decommissioning.
Decommissioning	Hornsea Three offshore cable corridor	• Buoyed area around the Hornsea Three offshore HVAC booster station development area for the duration of decommissioning; • Maximum decommissioning duration for the surface or subsea offshore HVAC booster stations is two phases of six years; and • Minimum safe passing distance of 1,000 m for cable laying vessels.
Decommissioning	Vessels	• Maximum number of decommissioning vessels.

10. Existing Environment

10.1 Navigational features

10.1.1.1 Figure 10.1 presents an overview of the navigational features in proximity to the Hornsea Three array area and offshore cable corridor. These features are discussed in the following subsections.

10.2 Ports

10.2.1.1 The ports in the vicinity of the Hornsea Three array area and offshore cable corridor are presented in Figure 10.1 based on Admiralty charts. The number of vessel arrivals to the principal ports in the northeast and Humber (DfT, 2016) is presented in Figure 10.2.

10.2.1.2 It is noted that while these statistics exclude some movements, which occur within the port or harbour limits, they provide a good indication of the relative traffic levels and trends. Ports within the Humber Estuary have been grouped together and therefore show an above average number of arrivals in comparison to other single ports; however this does not impact the assessment given that routeing of these vessels through Hornsea Three are the same.

10.2.1.3 Great Yarmouth is the closest port to the Hornsea Three array area, located approximately 76 nm (121 km) southwest of the Hornsea Three array area and southeast of the landfall area. There are a number of ports within the Humber Estuary including Kingston upon Hull, Grimsby, Immingham and Goole. For the purposes of this assessment, the Humber Estuary ports have been considered cumulatively.

10.3 Anchoring

10.3.1.1 There are no anchorage areas in the vicinity of the Hornsea Three array area and offshore cable corridor. The only anchorage areas within the region are located in or nearby to the Humber Harbour Authority. The Humber Deep Water Anchorage, where large vessels awaiting a pilot should anchor, lies 10 nm to the east of Spurn Head, within Vessel Traffic Services (VTS) Humber.

10.3.1.2 The Bull Anchorage and Hawke Anchorage, located within the Humber Harbour Authority, are general anchorage areas each containing 25 designated anchorage berths. These are used by smaller vessels.

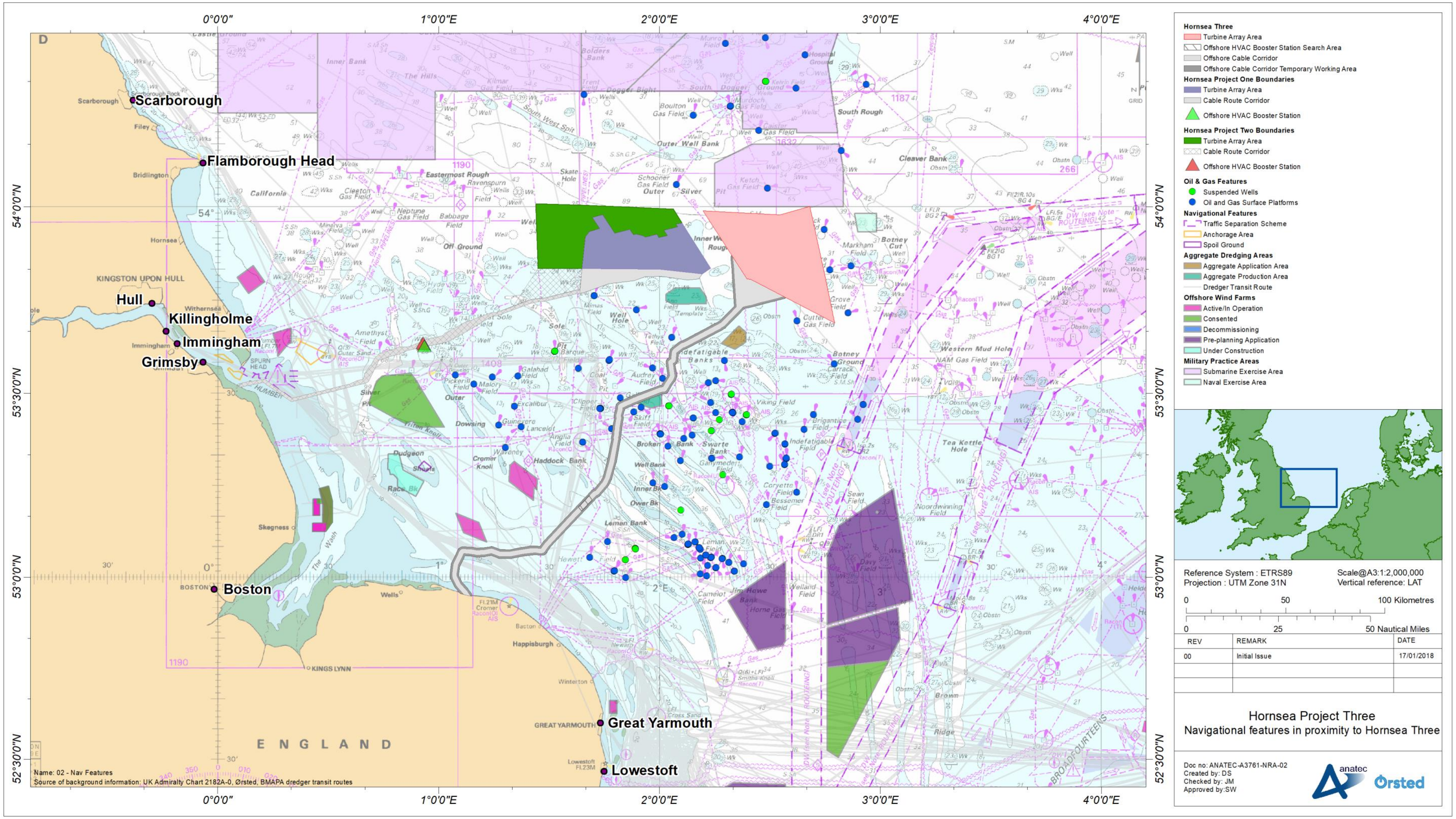

Figure 10.1: Navigational features in proximity to Hornsea Three.

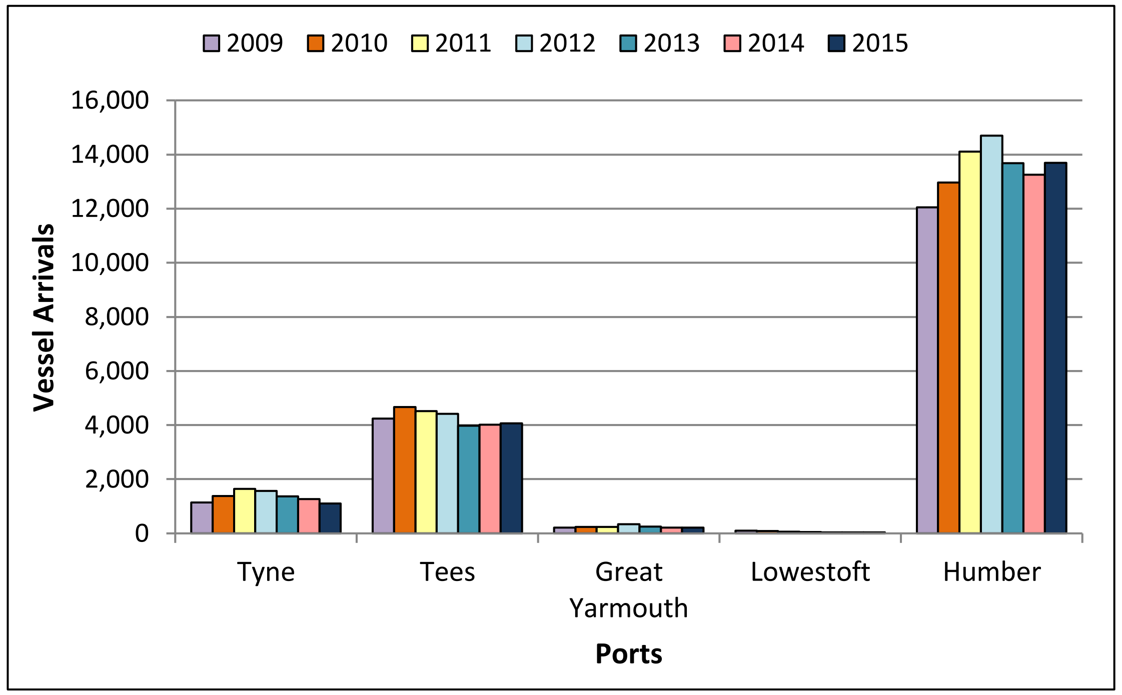

Figure 10.2: Vessel arrivals to principal ports (2009 to 2015) (DfT, 2016).

10.4 International Maritime Organization routeing measures and existing aids to navigation

10.4.1.1 There are several IMO routeing measures located within the region of the southern North Sea containing the Hornsea Three array area and offshore cable corridor, as presented in Figure 10.1. The Off Botney Ground Traffic Separation Scheme (TSS) is the closest IMO routeing measure, located approximately 6.54 nm (12.1 km) southeast of the southeastern corner of the Hornsea Three array area. This TSS connects to the DR1 light-buoy Deep Water Route (DWR). The West Friesland TSS and Off Brown Ridge TSS are also located in the region, with the former connecting to the West Friesland TSS.

10.4.1.2 There are no IMO routeing measures in place in the vicinity of the Hornsea Three offshore cable corridor and landfall area.

10.4.1.3 There are a number of existing Aids to Navigation located in proximity to the Hornsea Three array area and offshore cable corridor.

10.4.1.4 The closest Aid to Navigation to the Hornsea Three array area is a buoy located approximately 2.90 nm (5.37 km) to the southwest. Among the other Aids to Navigation in the vicinity of the Hornsea Three array area is the Hornsea Meteorological Mast located within Hornsea Project One.

10.4.1.5 The closest Aid to Navigation to the Hornsea Three offshore cable corridor is a buoy located approximately 3.18 nm (5.89 km) to the southeast.

10.5 Oil and gas infrastructure

10.5.1.1 Oil and gas surface platforms and charted suspended wells (wells that could pose a risk to navigational safety) in proximity to the Hornsea Three array area and offshore cable corridor are presented in Figure 10.1.

10.5.1.2 There are no oil or gas surface platforms located within the Hornsea Three array area. The nearest existing offshore surface installations to Hornsea Three are detailed Table 10.1.

10.5.1.3 There are a number of offshore oil and gas installations in proximity to the Hornsea Three offshore cable corridor, with the closest being the Clipper South platform located 0.49 nm (910 m) to the west and the Audrey A platform located 0.74 nm (1.37 km) to the northwest.

10.5.1.4 Existing platforms are generally protected by safety zones (i.e. typically 500 m radius) which prohibit vessels from transiting within 500 m of the platforms.

10.5.1.5 There are no suspended wells located within the Hornsea Three array area or offshore cable corridor. The closest suspended well to the Hornsea Three array area is located 950 m from the western boundary.

Table 10.1: Offshore surface installations within 6 nm of Hornsea Three array area.

Offshore surface installation	Approximate distance from Hornsea Three array area	Nearest array area boundary to the offshore surface installation
Windermere platform	0.98 nm	East
Chiswick platform	1.45 nm	East
Grove platform	2.43 nm	East
Cutter platform	2.52 nm	South
Ketch platform	4.15 nm	North
ST-1 platform (Markham)	4.46 nm	East
Schooner A platform	5.98 nm	North / west

10.5.1.6 There are not anticipated to be any impacts on shipping and navigation receptors associated with oil and gas platforms, however routeing to these installations is considered as part of the baseline within section 15 and as part of cumulative routeing in section 22.7.

10.6 Aggregate dredging areas and transit routes

10.6.1.1 The aggregate dredging areas in the vicinity of the Hornsea Three array area and offshore cable corridor are presented in Figure 10.1. There are no aggregate dredging areas intersecting the Hornsea Three array area or offshore cable corridor.

10.6.1.2 The nearest aggregate dredging area is a production area (Area 484) which is located approximately 330 m from the Hornsea Three offshore cable corridor. This dredging area is owned by DEME Building Materials UK Ltd. Another production area (Area 506) and an application area (Area 483) are also located in proximity to the Hornsea Three offshore cable corridor and are also owned by DEME Building Materials UK Ltd.

10.6.1.3 Passage plans of dredgers from BMAPA show that the Hornsea Three array area is not used heavily by transiting dredgers, with only one passage plan intersecting the Hornsea Three array area.

10.6.1.4 There are not anticipated to be any impacts on shipping and navigation receptors associated with marine aggregate dredging; however routeing of marine aggregate dredgers is considered within section 15 as part of the baseline assessment.

10.7 Other wind farm developments

10.7.1.1 Other offshore wind farm developments in the vicinity of Hornsea Three are presented in Figure 10.1. There are a number of Round 1 and Round 2 offshore wind farms to the southwest of the Hornsea Three array area, closer to shore. The nearest of these sites are Dudgeon Offshore Wind Farm, and Triton Knoll Offshore Wind Farm, located approximately 46.9 nm (86.9 km) and 54.4 nm (101 km) to the southwest respectively.

10.7.1.2 In addition to the former Hornsea Zone, there are two further Round 3 zones within the southern North Sea. The former East Anglia Zone, consisting of seven developments, is located approximately 28.5 nm (52.7 km) to the south of the Hornsea Three array area and the Dogger Bank Zone, consisting of four developments, is located approximately 41.0 nm (75.9 km) to the north of the Hornsea Three array area.

10.7.1.3 Other wind farm developments are given further consideration in section 21 as part of the cumulative overview.

10.8 Ministry of Defence practice and exercise areas

10.8.1.1 It can be seen from Figure 10.1 that there are several MOD PEXAs to the north of the Hornsea Three array area. These include a submarine exercise area immediately north of the Hornsea Three array area and a naval exercise area located approximately 6.75 nm (12.5 km) to the east of the Hornsea Three array area.

10.8.1.2 No restrictions are placed on the right to transit these areas at any time although mariners are advised to exercise caution. Exercises and firing only take place when the areas are considered to be clear of all shipping.

10.8.1.3 There are not anticipated to be any impacts on shipping and navigation receptors associated with MOD PEXAs, however military vessel traffic is considered as part of the baseline in section 15

10.9 Marine Environment High Risk Areas

10.9.1.1 It can be seen from Figure 10.1 that there are no Marine Environmental High Risk Areas (MEHRAs) located in the vicinity of the Hornsea Three array area and offshore cable corridor. The nearest MEHRA is the Spurn Bight MEHRA located approximately 46.4 nm (85.9 km) to the northwest of the Hornsea Three offshore cable corridor.

10.10 Wrecks

10.10.1.1 Based on Admiralty Charts of the region there are two charted wrecks within the Hornsea Three array area, located near the northern and western boundaries. There are two charted wrecks within the Hornsea Three offshore cable corridor, each located near the Hornsea Three landfall area.

11. Meteorological Ocean Data

11.1 Introduction

11.1.1.1 This section presents nearby meteorological and oceanographic statistics for Hornsea Three which have been used as input to the risk assessment.

11.2 Wind

11.2.1.1 The wind data for the Hornsea Three array area (HSE, 2001), in terms of the average annual wind direction, are presented in Figure 11.1 in the form of a wind rose. It can be seen that winds are predominantly from the south and west, with 22% of the annual winds recorded from the southwest. This wind data has been used as an input throughout the collision and allision risk modelling carried out as part of the NRA (see section 18).

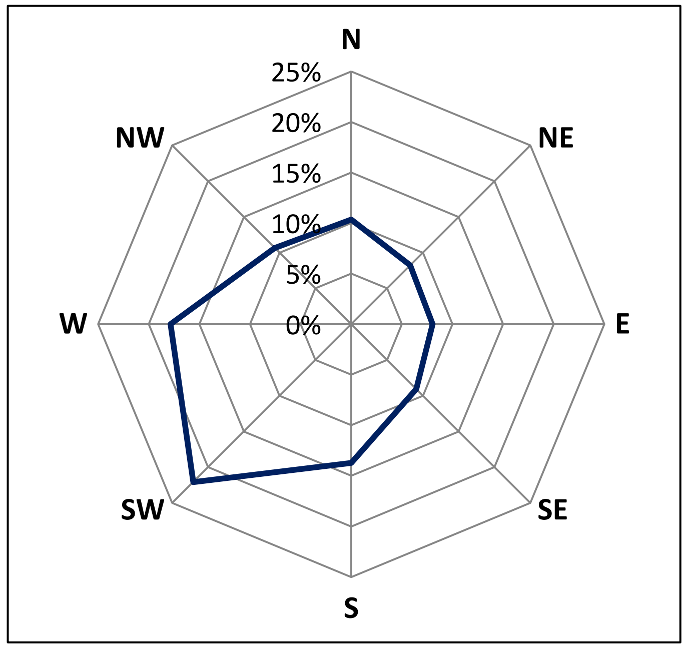

Figure 11.1: Annual wind direction distribution in proximity to Hornsea Three.

11.3 Wave

11.3.1.1 The wave data for the area (HSE, 2001), in terms of the average percentage exceedence of the significant wave height, are presented in Figure 11.2. The sea state is defined as follows:

- Calm (significant wave height <1 m);
- Moderate (1–5 m); and
- Severe (>5 m).

11.3.1.2 Overall, 39.5% of significant wave height recordings are deemed to be characteristic of a calm sea state and 59.7% deemed to be characteristic of a moderate sea state, leaving 0.8% deemed to be characteristic of a severe sea state.

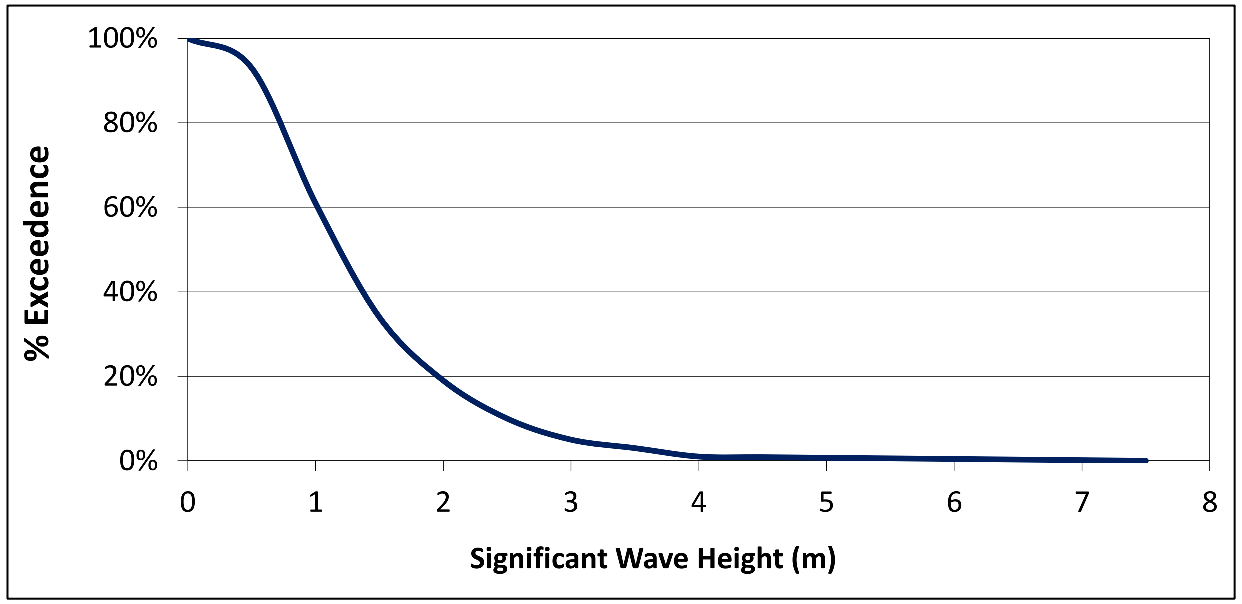

Figure 11.2: Annual significant wave height distribution in proximity to Hornsea Three.

11.4 Visibility

11.4.1.1 Appendix C notes that visibility is generally good or very good at the Hornsea Three array area and that the total percentage of time that the visibility is below 2 km over the course of a year is 1.3% for the Hornsea Three array area.

11.4.1.2 From a marine perspective, historically, visibility has been shown to have a major influence on the risk of vessel collision. The annual average incidence of poor visibility (defined as less than 1 km) for the UK North Sea is approximately 0.03 (i.e. an average of 3% of the year) (UKHO, 2016).

11.5 Tide

11.5.1.1 Admiralty Chart 1187-0 (Tidal Diamond "K" located within the Hornsea Three array area), indicates that currents in the area set in a generally northwest to southeast direction on the flood tide and southeast to northwest direction on the ebb tide, with a peak spring tidal rate of 1.1 knots (kn) and peak neap tidal rate of 0.6 kn. The Tidal Diamond "K" information from Admiralty Chart 1187-0 can be seen in Table 11.1.

Table 11.1: Details for Tidal Diamond "K" on Admiralty Chart 1187-0.

Hours		Directions of streams (degrees)	Rates at spring tide (kn)	Rates at neap tide (kn)
Before high water	6	119	0.7	0.4
	5	123	1.0	0.5
	4	126	1.1	0.6
	3	133	0.9	0.5
	2	142	0.7	0.4
	1	190	0.1	0.1
High water		291	0.6	0.3
After high water	1	302	1.0	0.5
	2	307	1.1	0.6
	3	315	1.0	0.6
	4	326	0.5	0.3
	5	030	0.2	0.1
	6	110	0.5	0.3

12. Emergency Response Overview

12.1 Introduction

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

12.2 Emergency response resources

12.2.1.1 In March 2013, the Bristow Group were awarded the contract by the MCA (through their DfT remit) to provide helicopter SAR operations in the UK over a ten year period, and took over the service from the previous provider in April 2015. There are ten base locations for the SAR helicopter service. The nearest SAR helicopter base is a new purpose-built base located at Humberside, approximately 105 nm to the west of the centre of the Hornsea Three array area (see Figure 13.3) and has been in operation since April 2015. This base operates two Sikorsky S-92 aircraft.

12.2.1.2 Further information on SAR helicopters is provided in Appendix C.

12.2.1.3 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.

12.2.1.4 The RNLI is organised into six divisions, with the relevant regions for Hornsea Three being North and East. Based out of more than 230 stations, there are more than 350 lifeboats across the RNLI fleet, including both all-weather lifeboats (ALBs) and inshore lifeboats (ILBs). Based on the offshore position of Hornsea Three it is likely that ALBs from Humber would not respond to an incident in proximity to Hornsea Three given that they generally operate closer to shore due to endurance and transit time. It is also noted that the RNLI have a 100 nm operational limit. Locations of RNLI lifeboat stations along the east coast of England are presented Figure 13.3 and details of the types of lifeboats operating out of these stations are given in Table 12.1. At each station ALBs or ILBs are available on a 24-hour basis throughout the year.

12.3 Her Majesty's Coastguard stations

12.3.1.1 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 co-ordinating the subsequent SAR operations (unless they fall within military jurisdiction).

Table 12.1: Lifeboats held at nearby RNLI stations.

Station	Lifeboats	ALB class	ILB class	Approximate distance to centre of Hornsea Three array area (nm)
Scarborough	ALB & ILB	Shannon	D Class	106
Filey	ALB & ILB	Mersey	D Class	101
Flamborough	ILB		B Class	94
Bridlington	ALB & ILB	Mersey	D Class	97
Withernsea	ILB		D Class	88
Humber	ALB	Severn		88
Cleethorpes	ILB		D Class	93
Mablethorpe	ILB (×2)		B & D Class	87
Skegness	ALB & ILB	Mersey	D Class	89
Hunstanton	ILB & Hovercraft		B Class	91
Wells	ALB & IRB	Mersey	D Class	81
Sheringham	ILB		B Class	73
Cromer	ALB & ILB	Tamar	D Class	72
Happisburgh	ILB (×2)		B & D Class	73

12.3.1.2 The HMCG co-ordinates 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.

12.3.1.3 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 around Hornsea Three.

12.3.1.4 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 co-ordinating SAR on the River Thames). The nearest rescue co-ordination centre to Hornsea Three is the Humber CGOC based in Bridlington, East Yorkshire, located approximately 83.7 nm (155 km) from Hornsea Three.

13. Maritime Incidents

13.1 Introduction

13.1.1.1 This section reviews maritime incidents that have occurred in the vicinity of Hornsea Three between 2005 and 2014.

13.1.1.2 The analysis relies on expert opinion and is intended to provide a general indication as to whether the area of the proposed development is currently low or high risk in terms of maritime incidents. If it was found to be a particularly high risk area for incidents, this may indicate that the development could exacerbate the existing maritime safety risks in the area.

13.1.1.3 Data from the following sources have been analysed:

- MAIB; and
- RNLI.

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

13.2 Marine Accident Investigation Branch incident data

13.2.1.1 All UK commercial vessels are required to report accidents to the MAIB. Non-UK vessels do not have to report unless they are in a UK port or are in 12 nm territorial waters and carrying passengers to a UK port. There are no requirements for non-commercial recreational craft to report accidents to the MAIB.

13.2.1.2 The locations of accidents, injuries and hazardous incidents reported to the MAIB within the Hornsea Three array area, offshore cable corridor and offshore HVAC booster station search area shipping and navigation study areas are presented in Figure 13.1 and are colour-coded by incident type. Following this, Figure 13.2 presents the same dataset colour-coded by casualty type. It should be noted that the MAIB aim for 97% accuracy in reporting locations of incidents.

13.2.1.3 A total of five unique incidents, with one incident involving two vessels, were reported within the Hornsea Three array area shipping and navigation study area, corresponding to an average of approximately one incident every two years. None of these incidents occurred within the Hornsea Three array area.

13.2.1.4 The most frequently recorded incident type within the Hornsea Three array area shipping and navigation study area (throughout the ten year dataset) was "Accident to Person", representing 60% of the total incidents.

13.2.1.5 Fishing and oil and gas affiliated vessels were the most frequently recorded casualty types (33% each of all incident vessels) within the Hornsea Three array area shipping and navigation study area throughout the ten year period analysed.

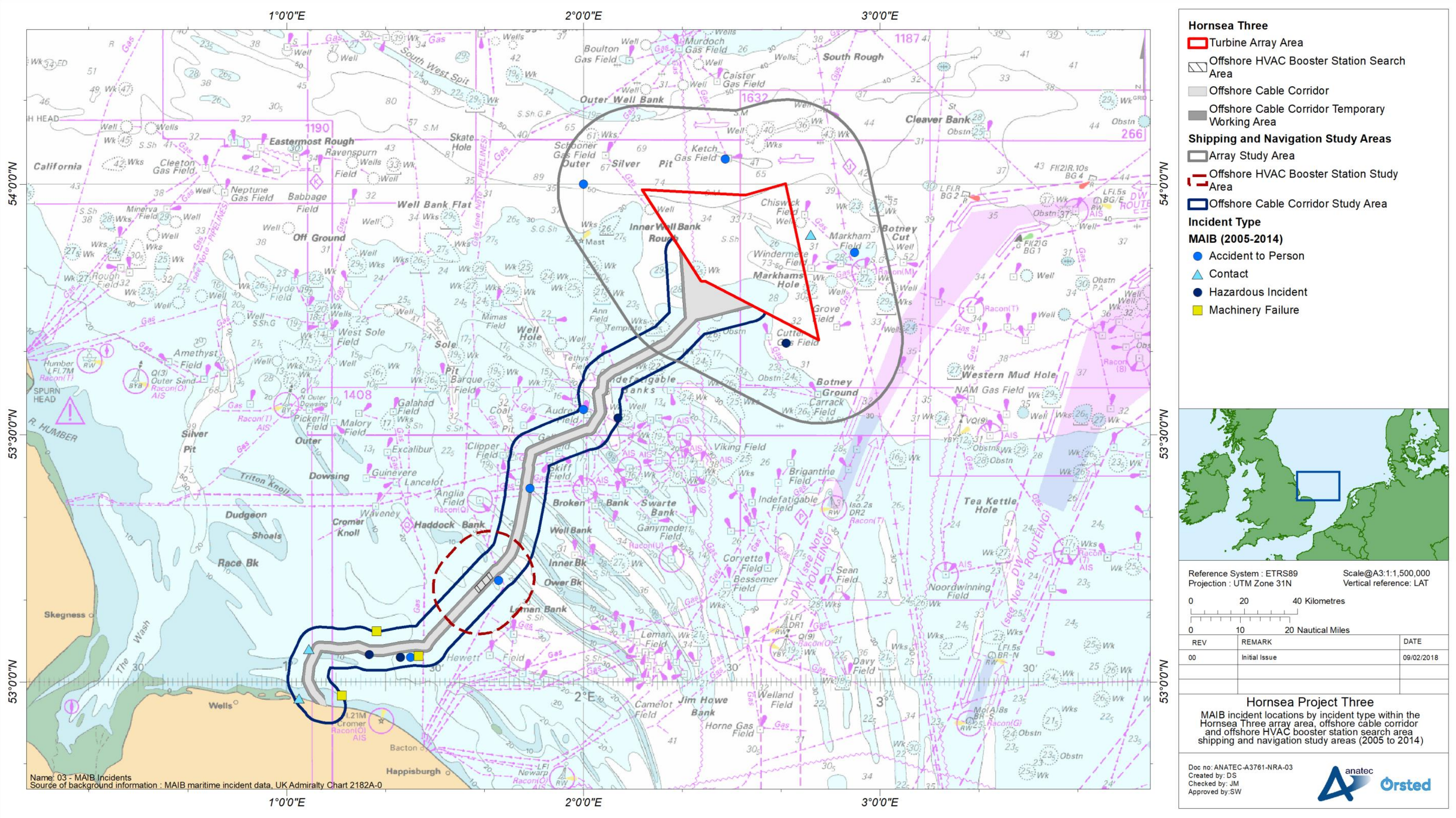

Figure 13.1: MAIB incident locations by incident type within the Hornsea Three array area, offshore cable corridor and offshore HVAC booster station search area shipping and navigation study areas (2005 to 2014).

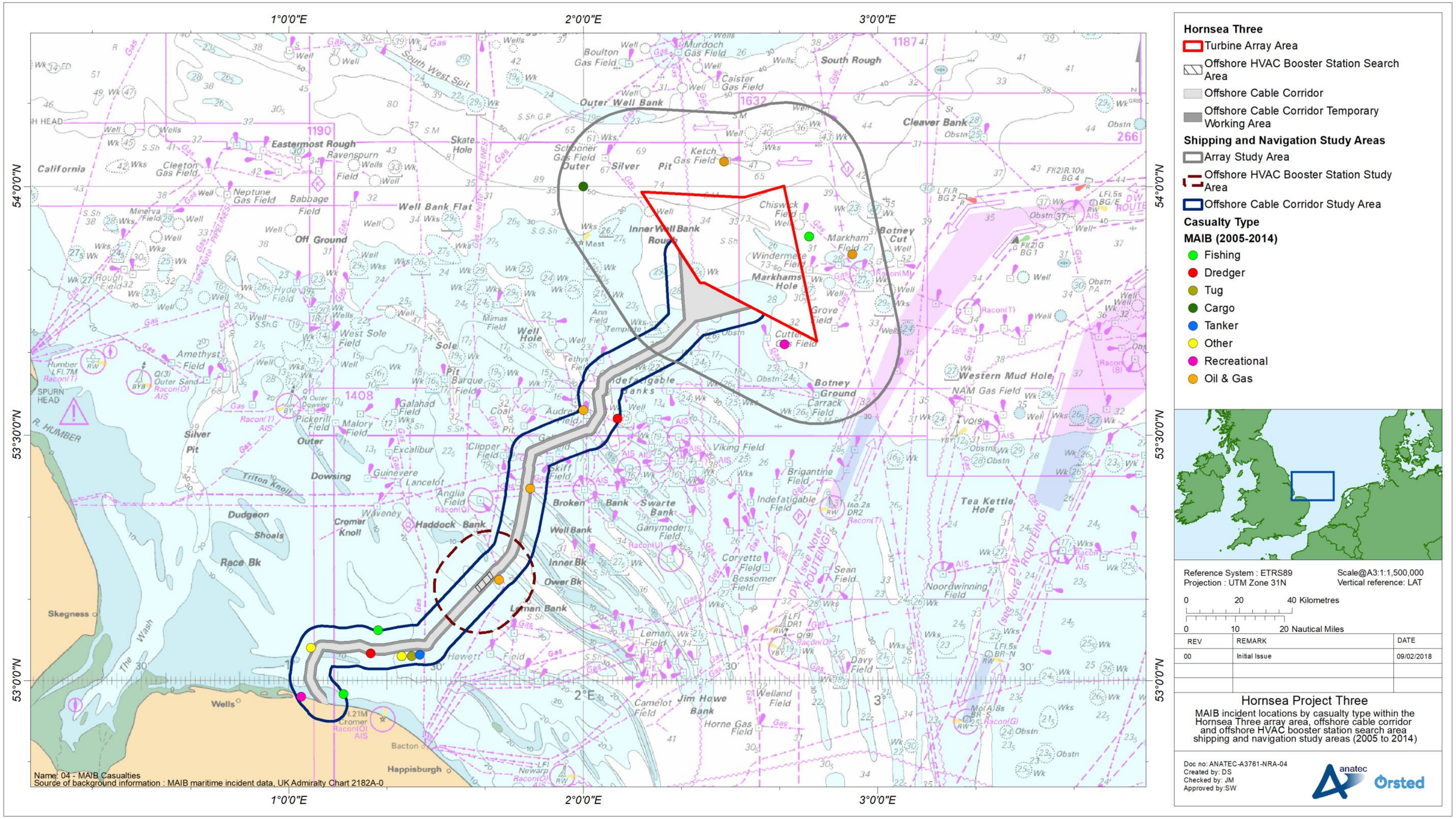

Figure 13.2: MAIB incident locations by casualty type within the Hornsea Three array area, offshore cable corridor and offshore HVAC booster station search area shipping and navigation study areas (2005 to 2014).

13.2.1.6 A total of 11 unique incidents, with one incident involving two vessels, were reported within the Hornsea Three offshore cable corridor shipping and navigation study area, corresponding to an average of approximately one incident per year. None of these incidents occurred within the Hornsea Three offshore cable corridor.

13.2.1.7 The most frequently recorded incident type within the Hornsea Three offshore cable corridor shipping and navigation study area (throughout the ten year dataset) was "Accident to Person", representing 33% of the total incidents.

13.2.1.8 One of the 11 unique incidents reported within the Hornsea Three offshore cable corridor shipping and navigation study area was also located within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area. This was an "Accident to Person" involving a standby safety vessel located approximately 0.78 nm east of the Hornsea Three offshore HVAC booster station search area.

13.2.1.9 Oil and gas affiliated vessels were the most frequently recorded casualty type (25% of all incident vessels) within the Hornsea Three offshore cable corridor shipping and navigation study areas throughout the ten year period analysed.

13.3 Royal National Lifeboat Institution incident data

13.3.1.1 Data on RNLI lifeboat responses within the Hornsea Three array area, offshore cable corridor and offshore HVAC booster station search area shipping and navigation study areas for the ten year period between 2005 and 2014 were analysed, with cases of a hoax or false alarms excluded. It is noted that the RNLI have a strategic performance standard of reaching casualties up to a maximum of 100 nm from shore and therefore due to the distance offshore and journey time to respond, the RNLI may respond to a drifting vessel but are unlikely to respond to a life-saving incident in proximity to the Hornsea Three array area.

13.3.1.2 The locations of incidents responded to by the RNLI within the Hornsea Three array area, offshore cable corridor and offshore HVAC booster station search area shipping and navigation study areas are presented in Figure 13.3 and are colour-coded by incident type. Following this Figure 13.4 presents the same dataset colour-coded by casualty type.

13.3.1.3 It was found that no launches to incidents were reported by the RNLI within the Hornsea Three array area shipping and navigation study area throughout the ten year period analysed. The closest incident reported by the RNLI occurred approximately 215 m outside of the Hornsea Three array area shipping and navigation study area and featured a fishing vessel involved in a collision.

13.3.1.4 A total of 26 RNLI lifeboat launches, excluding hoaxes and false alarms, to 23 unique incidents were reported within the Hornsea Three offshore cable corridor shipping and navigation study area, corresponding to an average of two to three incidents per year. Five of these incidents occurred within the Hornsea Three offshore cable corridor, with the majority of incidents attended by the RNLI located in proximity to the coast and in shallow waters.

13.3.1.5 The majority of the reported RNLI incidents within the Hornsea Three offshore cable corridor shipping and navigation study area were responded to by lifeboats from the Sheringham or Cromer RNLI lifeboat station.

13.3.1.6 The most frequently reported incident type within the Hornsea Three offshore cable corridor shipping and navigation study area (throughout the ten year dataset) was "Machinery failure", representing 43% of the total incidents.

13.3.1.7 Recreational vessels were the most frequently reported casualty types (43% of all incident vessels) within the Hornsea Three offshore cable corridor shipping and navigation study area throughout the ten year period analysed.

13.3.1.8 A total of three RNLI lifeboat launches, excluding hoaxes and false alarms, to three unique incidents were reported within the Hornsea Three offshore 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 appeared in the Hornsea Three offshore cable corridor shipping and navigation study area dataset.

13.3.1.9 All three incidents reported within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area were responded to by lifeboats from the Cromer RNLI lifeboat station.

13.3.1.10 Two of the incident types reported involved "Machinery Failure" with the other a "Person in Danger". Both of the "Machinery Failure" incidents featured a recreational vessel, whilst the "Person in Danger" was in relation to an oil and gas affiliated vessel.

13.3.1.11 It is noted that based upon the available data, one of the RNLI incidents reported within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area coincided with the single MAIB incident recorded within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area.

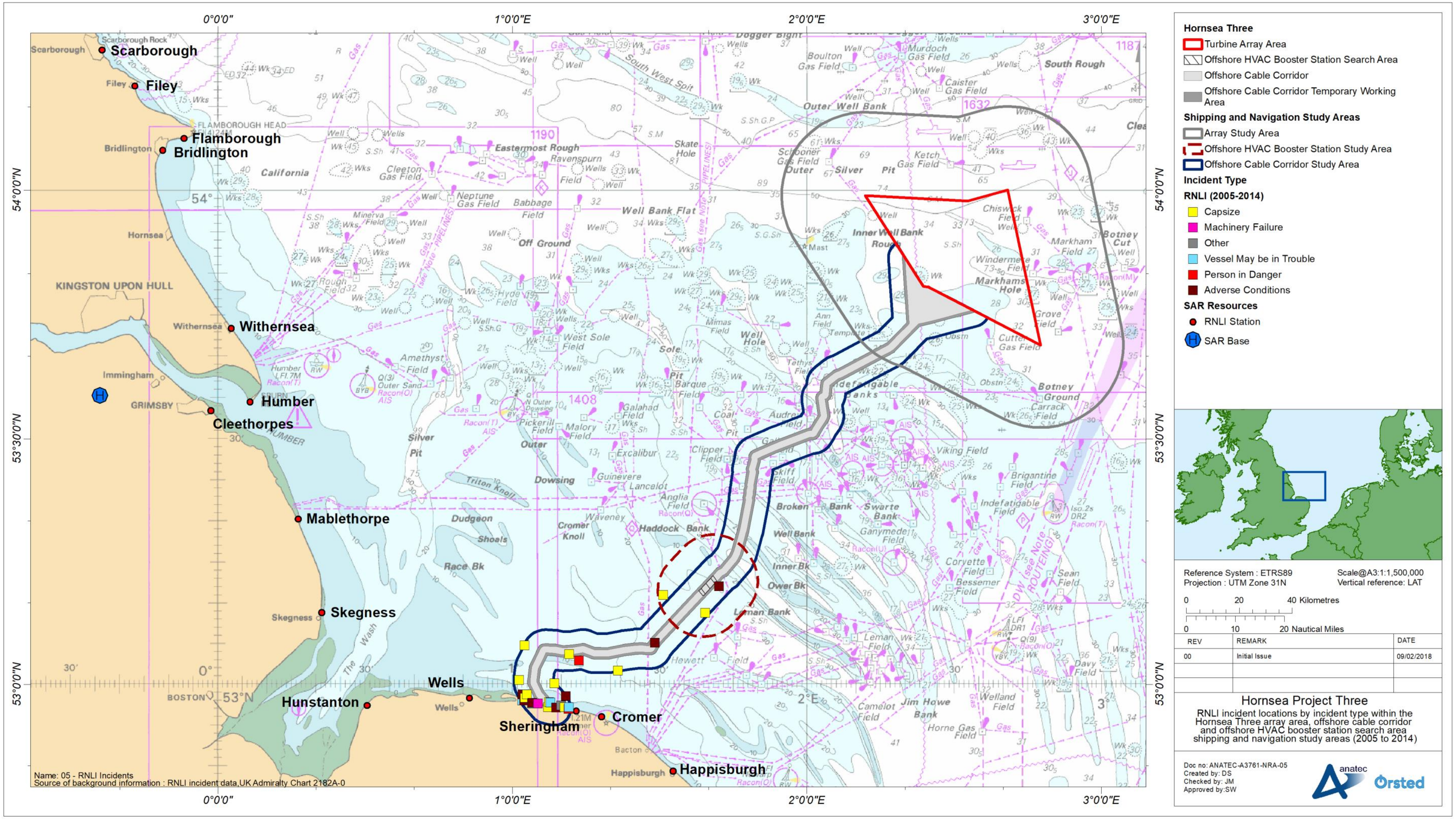

Figure 13.3: RNLI incident locations by incident type within the Hornsea Three array area, offshore cable corridor and offshore HVAC booster station search area shipping and navigation study areas (2005 to 2014).

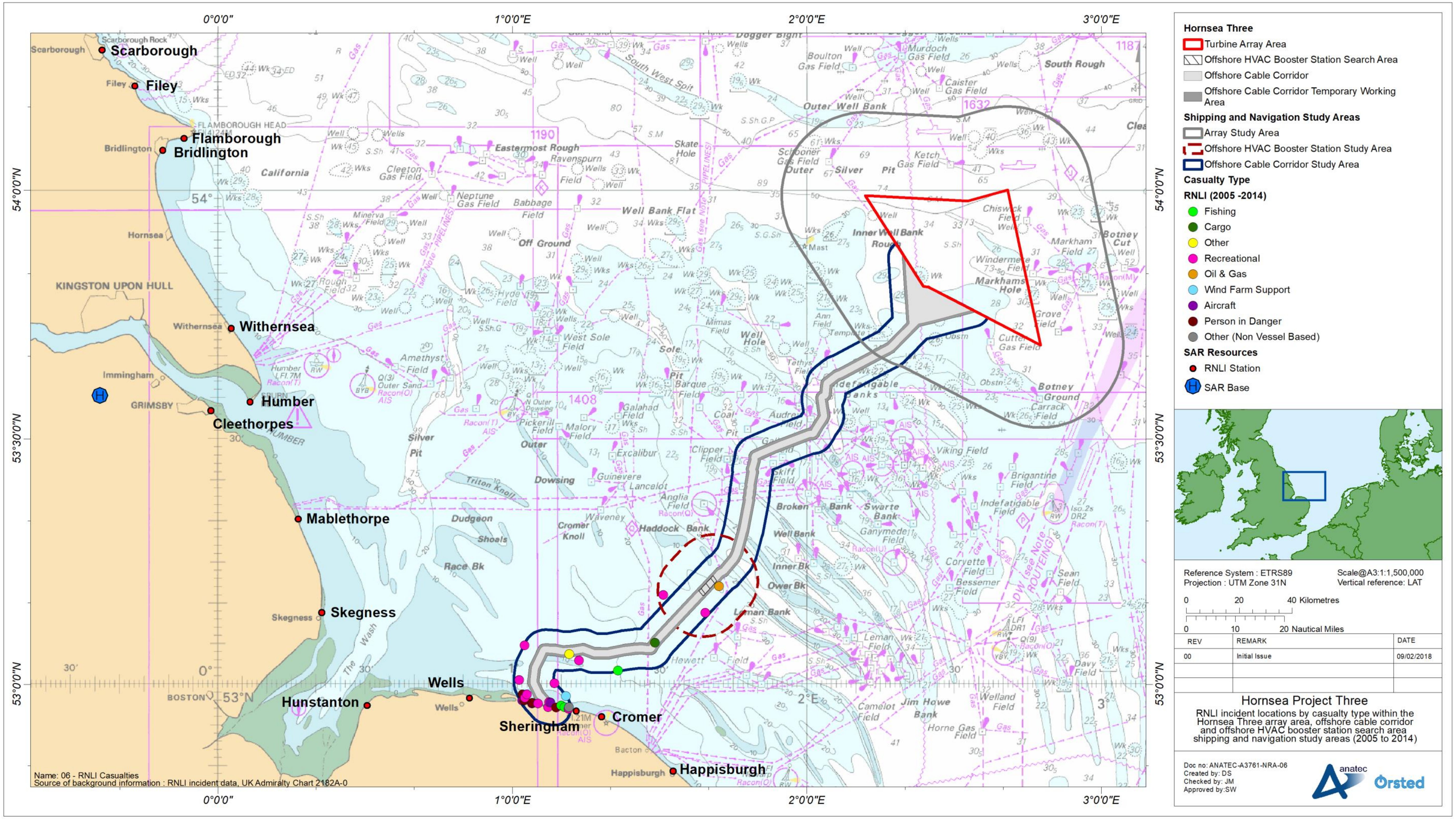

Figure 13.4: RNLI incident locations by casualty type within the Hornsea Three array area, offshore cable corridor and offshore HVAC booster station search area shipping and navigation study areas (2005 to 2014).

13.4 Historical offshore wind farm incidents

13.4.1.1 Table 13.1 presents historical collision and allision incidents involving wind farm sites and the resulting damage to the vessel involved and/or injury to the people involved.

13.4.1.2 Between 2005 and 2016 there were 13 incidents involving a renewable energy installation and/or a wind farm vessel. Of the 13, two were collision incidents and 11 allision incidents.

13.4.1.3 Of the two collision incidents, one was a third party vessel to wind farm vessel whilst manoeuvring within harbour and the second was between two wind farm vessels. To date there have not been any third party to wind farm vessel incidents or third party to third party incidents at or near a wind farm site.

13.4.1.4 As shown in Figure 13.5, minor damage to vessels involved in the incidents was the most frequent (approximately 46%) followed by moderate damage (30%). No incidents resulted in vessel loss and in some cases no damage was sustained to the vessel involved (8%). Major damage was reported in approximately 15% of incidents. The majority of incidents involved wind farm vessels.

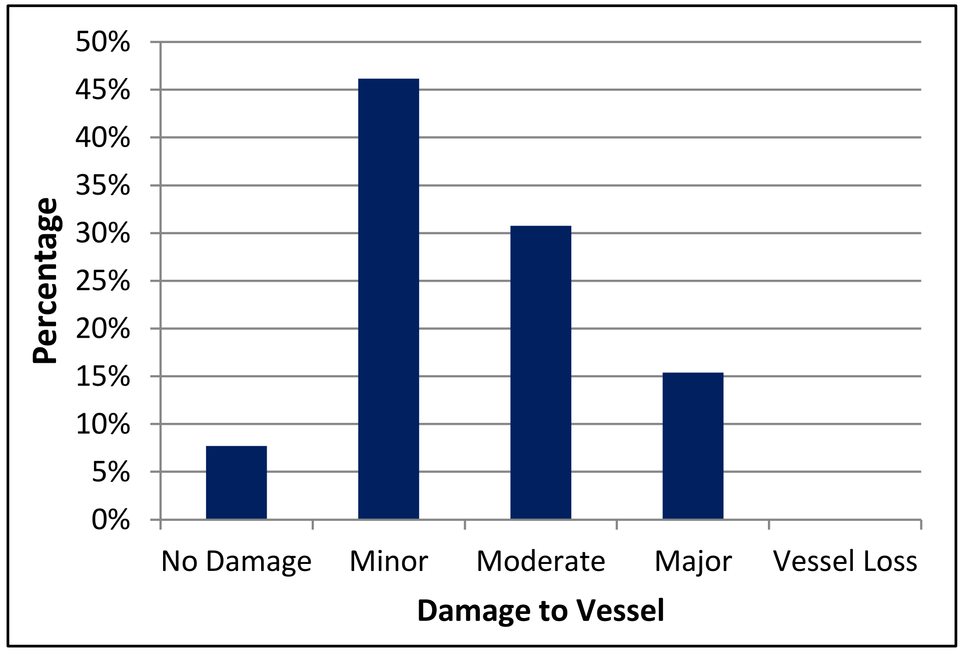

Figure 13.5: Damage to vessels involved in incidents.

13.4.1.5 As shown in Figure 13.6, the majority of incidents resulted in no injury (approximately 77%). Injury occurred in approximately 23% of incidents and no fatalities were recorded. Again the majority of incidents involved wind farm vessels.

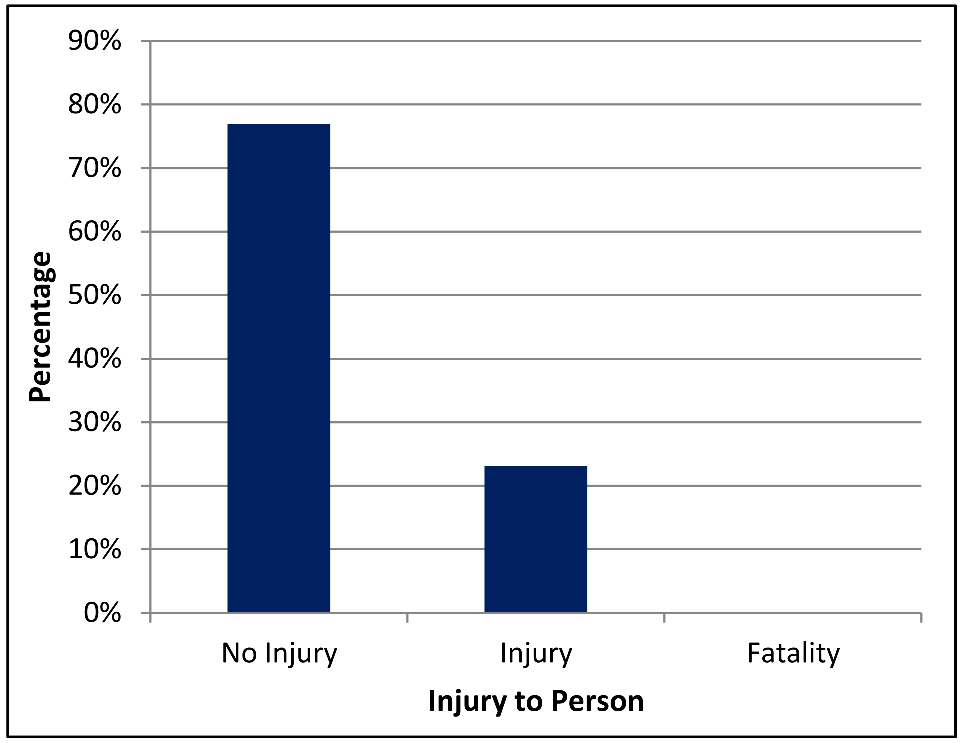

Figure 13.6: Injury as result of incident.

Table 13.1: Summary of historical collision and allision incidents involving wind farm sites.

Project or third party	Incident type	Date	Description of incident	Damage to vessel (as per the incident reports)	Injury to person	Source
Project	ALLISION - Service vessel with turbine	7 August 2005	A vessel involved with the installation of turbines underestimated the effect of the current and made contact with the base of a turbine while manoeuvring alongside it. Minor damage was sustained to a gangway on the vessel, the tower and a turbine blade.	Minor damage to gangway on the vessel	No injury	MAIB
Project	ALLISION - service vessel with turbine	29 September 2006	When approaching a turbine, to conduct servicing operations, an OSV was struck by the tip of a turbine blade. The accident occurred because the blade was not secured in a fixed position, and was rotating as the vessel approached.	No damage to vessel	No Injury	MAIB
Project	ALLISION - service vessel with disused pile	8 February 2010	An 18 m work boat was servicing a wind farm. Directly astern of the vessel was a test pile (now disused and no longer required), the position of which was well marked and known to the skipper. While the vessel was manoeuvring within about 3 m of this pile, the skipper's hand slipped on the throttle controls, pulling the port throttle to full astern. The skipper realised there was a problem, and quickly tried to stop the vessel from moving astern, but as the pile was so close, there was not time nor room to do so. The vessel struck the pile, causing minor damage to the stern fenders and deck plating. The impact caused a passenger, who was moving around the interior to be thrown off his feet, to fall against furniture and injure himself. The passenger's injuries did not seem to be very serious at the time and he mounted the turbine to work as usual, but later reported sick and was taken to hospital where back injuries were diagnosed. Once the vessel was safely clear of the pile and the situation stabilised, the skipper checked around for further damage but no serious damage was found. No water ingressed.	Minor damage to vessel	Injury	MAIB
Third party and project in harbour	COLLISION - service vessel collision with vessel	23 April 2011	Third party catamaran was hit by a project guard boat. The collision took place in Ramsgate harbour.	Moderate damage to vessel	No injury	MAIB
Project	ALLISON - service vessel with turbine	18 November 2011	A cable laying vessel suffered two hull breaches in way of a fresh tank and damage to the steel rubbing strake after it struck the foundations of a partially completed turbine. The subsequent company investigation found that the Officer of the Watch (OOW) had fallen asleep while on watch and woke to find the vessel inside the wind farm. He attempted to take the vessel out of the farm on autopilot but the settings were such that the vessel did not turn quickly enough and the vessel made contact with the partially built structure. Nobody on the vessel felt the impact and the second officer deleted the passage on the electronic chart system to avoid detection. However, when the crew woke the next morning, the mate found that the vessel had lost 90 tonnes of fresh water and there was further cause for concern when the vessel's potable water supply tasted salty. The electronic chart system track was recovered and the second officer challenged. He eventually admitted what had happened and following the investigation, was dismissed from the vessel.	Major damage to vessel	No injury	MAIB
Project	COLLISION - Service vessel collision with service vessel	2 June 2012	Nine wind farm workers were safely evacuated from their personnel transfer vessel into a life raft after their vessel became lodged under the boat landing equipment of a Flotel. The workers were returning to their accommodation on the Flotel after their shift installing and commissioning turbines when the incident occurred. A section of the Flotel's boat landing equipment detached and the bow of the personnel transfer vessel was lodged underneath just as workers were preparing to transfer on-board. The life raft was deployed and all passengers were safely evacuated and transferred to a nearby vessel before being brought in to port.	Moderate damage to vessel	No Injury	UK Confidential Reporting Programme for Aviation and Maritime (CHIRP)
Project	ALLISION - service vessel collision with OWF structure	20 October 2012	A wind farm service vessel caused minor damage when the OOW misjudged the distance from the monopile and made contact with the vessel's stern at a wind farm site.	Minor damage to vessel	No Injury	MAIB

Project or third party	Incident type	Date	Description of incident	Damage to vessel (as per the incident reports)	Injury to person	Source
Project	ALLISION - service vessel with turbine	21 November 2012	A wind farm passenger transfer catamaran struck a floating target at a speed of 23.5 kn, whilst supporting operations at a wind farm. During the incident, the 15 member crew were forced to abandon the work boat and the vessel was towed into harbour. The port hull was holed, causing extensive flooding, but there were no injuries. The investigation found that the master did not hold the correct qualifications and that navigation practices, including passage planning and monitoring, use of lookouts and knowledge of the navigation equipment were weak. In addition, the company's crew assessment procedures were not followed and the master had not been formally assessed to determine his suitability for his role. It was also noted that best practice guidance for managers and crew of offshore renewable energy passenger transfer vessels was limited and disparate, and there was no integrated method of promulgating lessons learned to the industry.	Major damage to vessel	No Injury	MAIB
Project	ALLISION - service vessel with turbine	21 November 2012	A work boat allided head on with the unlit transition piece of a turbine in an offshore wind farm, at a speed of 12 kn. The impact caused the five persons on board to be forced out of their seats and sustain various injuries. A doctor was transferred to the vessel by lifeboat to treat the injured personnel. The structure immediately aft of the vessels bow fender crumpled as a result of the impact but no water ingress occurred. The investigation determined that the accident occurred because the master had relied too heavily on visual cues and had made insufficient use of the lookout and navigation equipment available. There was insufficient training, particularly in regard to navigation equipment, and no formal assessment of new masters, allowing the possibility of ingrained poor working practices being passed on. Although the turbine transition piece had been reported as unlit, the system for reporting defects had failed to result in a navigation warning being promulgated. Although not formal Aids to Navigation, it was inevitable that the lights would be utilised as such.	Moderate damage to vessel	Injury	MAIB
Project	ALLISION - service vessel with turbine	16 February 2013	An offshore service and supply vessel collided with a turbine foundation, causing serious damage to the bow fender of the twin hulled vessel.	Minor damage to vessel	No Injury	UK CHIRP
Project	ALLISION - service vessel with turbine	July 2013	A wind farm service vessel collided with a turbine foundation after the failure of the vessel jet drive. The incident occurred after the vessel had disembarked passengers at an offshore substation and had reversed away to drift, whilst standing by for the next assignment. The jets were disengaged and engines left running, as was common practice. Under the influence of currents, the vessel drifted towards another turbine foundation and when approximately 30 m away, the vessel's coxswain/skipper attempted to engage the jets. At this moment it was found that neither jet would engage. Several minutes were spent fault finding to no avail, after which the vessel coxswain/skipper assisted the deckhand with fenders. The vessel collided with the foundation, causing a buckled frame and bent plate in the port quarter bulwark, but no damage to the foundation. It was found that there was no guidance from the wind farm operator on a minimum distance of approach to offshore structures while drifting. At the speed the wind farm vessel was drifting, 30 m was not sufficient distance to allow enough time to restart the jets or to anchor.	Minor damage to vessel	No injury	International Marine Contractors Association (IMCA) Safety Flash
Project	ALLISION - service vessel with turbine	14 August 2014	A standby safety vessel collided with a turbine's pile. The accident caused the vessel to leak marine gas oil and a surface sheen, 5-10 m wide and around 0.7 nm in length, trailed from the vessel. The standby vessel moved under its own power to a location outside the Port Authority limits, away from environmentally sensitive areas until the leak was stopped.	Minor damage to vessel and pollution	No Injury	UK CHIRP
Third party	ALLISION – fishing vessel with turbine	26 May 2016	A fishing vessel collided with a turbine. The incident occurred after a crew member left the vessel on auto-pilot. A lifeboat attended the incident. The vessel had been travelling to Ravenglass at the time of the incident. The vessel master was prosecuted.	Moderate damage to vessel	Injury	Web Search (BBC, 2016)

14. Overview of Key Consultation

14.1.1.1 There were 47 Regular Operators identified (from the marine traffic surveys) that would be required to deviate their routes due to the Hornsea Three array area or offshore HVAC booster station(s) were consulted via electronic or hardcopy mail. The email/letter gave an overview of Hornsea Three. Table 14.1 details the Regular Operators and responses received. Appendix E details the consultation email/letter sent to the Regular Operators.

14.1.1.2 Issues raised relevant to shipping and navigation during consultation for Hornsea Project One and Hornsea Project Two; and applicable to Hornsea Three, are set out in volume 4, annex 1.1: Hornsea Project One and Hornsea Project Two Consultation of Relevance to Hornsea Three.

14.1.1.3 Table 14.2 summarises the issues raised relevant to shipping and navigation, which have been identified during consultation activities undertaken to date for Hornsea Three. Table 14.2 also indicates either how these issues have been addressed within this NRA or how Hornsea Three has had regard to them. Further information on the consultation activities undertaken for Hornsea Three can be found in the Consultation Report (document reference number A5.1) that accompanies the application for Development Consent.

Table 14.1: Regular Operators and responses.

Vessel operator	Comments received
Acciona Trasmediterranea	No comments received.
Aggregate Industries UK Ltd.	No comments received but attended Hazard Workshop.
Arklow Shipping	No comments received.
Associated Maritime CO HK Ltd.	No comments received.
BG Freight Line BV	No comments received.
Boston Putford Offshore Safety	No comments received.
Brostrom AB	No comments received.
Carnival Plc	No comments received.
Chemgas Shipping BV	No comments received.
Cobelfret Ferries NV	No comments received.
DFDS Seaways	Note that following the Hazard Workshop, an additional assessment was undertaken in liaison with DFDS Seaways regarding adverse weather routes (see section 16). *Received 17 February 2017:* The Cuxhaven-Immingham route used by the *Selandia Seaways* will be impacted by the Hornsea Three array area, with extra fuel for a longer passage necessary in order to maintain the average speed required to keep the current schedule. Navigating in adverse weather would be a concern from a safety perspective. DFDS Seaways suggest that the Hornsea Three offshore HVAC booster station(s) are located on or close to the banks where navigation is not possible anyway. The Newcastle-Amsterdam route used by the *King Seaways* and *Princess Seaways* will not be directly affected by the Hornsea Three array area as this route normally operates south of the Hornsea Three array area through Hornsea Project One and Hornsea Project Two. DFDS Seaways see no benefit to the proposed navigational corridor. The Esbjerg-Immingham route used by the *Ark Germania* and *Ark Dania* will require a change to the normal passage due to the Hornsea Three array area but this change will not increase the crossing time. However the Hornsea Three array area may make complying with Convention on the International Regulations for Preventing of Collision at Sea (COLREGs) (IMO, 1972 as amended) difficult due to the presence of the wind farm and nearby oil and gas infrastructure resulting in the turn to starboard being an issue. The current adverse weather route will require a change as it passes directly through the Hornsea Three array area. This will result in a significant increase in the distance of the route and will impact upon safety due to limited manoeuvrability. DFDS Seaways will not use the proposed navigational corridor. The northerly Cuxhaven-Immingham route used in the past by the *Suecia Seaways* will require a deviation due to the Hornsea Three array area. However the southerly route used is not affected. The Hornsea Three offshore HVAC booster station search area will not pose a problem for the *Suecia Seaways* on its current Vlaardingen-Immingham route.
Eckero Shipping AB Ltd.	No comments received.
Eimskip Ehf	No comments received.
Essberger JT GmbH	No comments received.
Euro Marine Carrier BV	No comments received.
Euronav NV	No comments received.
Exmar NV	No comments received.
GloMar Shipmanagement BV	No comments received.
GulfMark UK Ltd.	No comments received.
HJH Shipmanagement GmbH	No comments received.
Hyundai Glovis Co Ltd.	No comments received.
James Fisher Everard Ltd.	No comments received.
Kawasaki Kisen Kaisha Ltd. ("K"-Line)	No comments received.

Vessel operator	Comments received
KESS	*Received 16 February 2017:* The Hornsea Three array area may have a slight impact on routeing, although vessels can avoid the area, and therefore there are no notable safety concerns. KESS vessels will not use the proposed navigational corridor as the transits to and from the UK are west-east bound only.
Longship BV	No comments received.
Lundqvist Rederierna AB	No comments received.
MarConsult Schiffahrt GmbH	No comments received.
Mitsui OSK Lines Ltd	No comments received.
Neda Maritime Agency Co Ltd.	No comments received.
NGM Energy SA	No comments received.
Nordic Tankers Trading A/S	No comments received.
North Sea Tankers BV	No comments received.
P&O North Sea Ferries Ltd.	*Received 26 January 2017:* (From the *Pride of Rotterdam*) The ideal position for the Hornsea Three offshore HVAC booster station(s) is between the Leman and Haddock Banks, but to keep clear of the P&O routes they should be located north of 53° 11' 00''. Vessels sailing from Europort to Teesport are using routes south of the Hornsea Three offshore HVAC booster station search area, including the *Estraden*, although this vessel only does so once or twice per year.
Samskip Multimodal Container	No comments received.
Sea-Cargo AS	No comments received.
Sentinel Marine Pte Ltd.	No comments received.
Stena Line BV	No comments received.
Stenersen Chartering AS	No comments received.
Subsea 7 Int'l Contracting Ltd (Subsea).	*Received 3 February 2017:* Subsea 7 vessels operate on an ad-hoc basis and the routeing is generally governed by the projects and where they are operating. Subsea 7 only had one vessel in this location [the Hornsea Three array area] in 2016 (*Seven Pacific*) and have no vessels which would transit the area on a standard shipping / cargo route. Therefore the impact for any routeing is not possible to confirm. As with any other navigational hazard, as long as the development is charted, details available via Notices to Mariners, charts etc. then there are no specific concerns.
Thenamaris Ships Management	No comments received.
UECC	No comments received.
Unifeeder A/S	No comments received.

Vessel operator	Comments received
Unigas International Ltd.	No comments received.
Vroon Offshore Services Ltd.	No comments received but attended Hazard Workshop.
Wagenborg Shipping BV	No comments received.
Wijnne & Barends Cargadoors	No comments received.
Wilson EuroCarriers AS	No comments received.

Table 14.2: Summary of key consultation issues raised during consultation activities undertaken for Hornsea Three relevant to shipping and navigation.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
July 2016, September 2016, November 2016	MCA and Trinity House (TH) – consultation meeting	Three consultation meetings relating to the proposed approach for Hornsea Three. Marine traffic survey method was discussed and agreed. MCA confirmed they were content with the proposed NRA method and should follow the usual process. MCA noted the project's own vessels should also be considered within the NRA. Hornsea Three confirmed that minimum spacing of infrastructure would be 1,000 m centre point to centre point, and that there was no maximum spacing. MCA SAR indicated this was acceptable. It was agreed that the design of a corridor should not prevent compliance, or give reason for a vessel not complying with COLREGs (narrow channels and overtaking).	The NRA methodology is contained within section 3. The marine traffic survey methodology is within section 7. The outcomes of the proposed navigational corridor assessment are in section 22.9. An assessment of the proposed navigational corridor has been undertaken with the cumulative collision risk associated with the proposed navigational corridor assessed in section 22.9.
November 2016	MCA – Scoping Opinion	The NRA and Environmental Statement should comply with MGN 543. The NRA should consider routeing particularly in heavy weather so that vessels can make safe passage without significant larger scale deviations. The MCA require that a Cable Burial Protection Index study should be undertaken in respect to export cabling. Reductions in water depth, particularly nearshore should be assessed. Any application for safety zones would need to be carefully assessed and supported by experience at the development and construction stages. Assessment of impacts on SAR capability within the region must be undertaken. An Emergency Response Cooperation Plan (ERCoP) will be required within the draft Development Consent Order (DCO). Hydrographic data (International Hydrographic Organisation Order 1a) should be supplied to the MCA as per MGN 543.	The NRA methodology is contained within section 3 and has had regard to MGN 543. Adverse weather is considered within section 16 and assessed within section 22.5. Measures adopted as part of Hornsea Three are outlined in section 23. They include Aids to Navigation and commitment to a cable burial assessment and ERCoP. Hornsea Three SAR impacts are considered in section in Appendix C and assessed within section 22.16. The project shall comply with MGN 543 hydrographic requirements as per section 23.
November 2016	Marine Management Organisation (MMO) – Scoping Opinion	The MMO agrees with the approach and data sources outlined by the applicant regarding navigation and other sea users. We would expect due consideration of all navigation and sea user issues to be included within the EIA process. We understand that the applicant will be holding a number of public consultation events to involve, engage and communicate with consultees prior to submission of the proposal to the Planning Inspectorate (PINS). Iterative discussions with consultees upon the requirement and feasibility of any mitigation measures are expected to provide a robust assessment of the proposed development.	Noted, consultation feedback is within section 14.
November 2016	TH – Scoping Opinion	Require comprehensive vessel traffic analysis as per MGN 543. Any proposed layout should confirm to MGN 543 and any structure out with the actual wind farm should have additional risk assessments undertaken. The separation between the Hornsea Three array area and Hornsea Project One and Hornsea Project Two array areas should be individually risk assessed and the final proposed separation should be submitted to both the MCA and TH for review. TH will require the Hornsea Three array area and obstructions within the Hornsea Three offshore cable corridor to be marked as per IALA-O-139. Any possible national trans-boundary issues should be assessed and consultation should be undertaken with the Dutch authorities. A decommissioning plan which includes a scenario where obstructions are left on site should be considered.	Measured adopted as part of Hornsea Three are outlined in section 23 and include Aids to Navigation. The marine traffic survey methodology is within section 7. Rijkwaterstraat were issued the Preliminary Environmental Information Report (PEIR) and NRA (DONG Energy (now Ørsted), 2017) as part of the section 42 consultation and their responses are detailed in Table 14.2 under an entry dated September 2017. The outcomes of the consultation on the proposed navigational corridor and assessment are in section 22.9. A decommissioning plan is considered in section 25.8.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
December 2016	PINS – Scoping Opinion	The Environmental Statement should assess the impacts on ports and harbours. The layout of the Hornsea Three array area will not be fixed at the point of the application and therefore the maximum design scenario should be considered within the NRA. The proposed navigational corridor should be considered in consultation with the MCA and TH. The MCA require that a Cable Burial Protection Index study should be undertaken in respect to export cabling. The marine traffic survey must "include non-AIS traffic". The NRA must be in line with MGN 543. Consultation will be undertaken with the MCA on SAR capability within the region. An ERCoP will be required within the draft DCO. The Environmental Statement must consider phasing of the development.	Ports assessment is considered in section 10.2; however no impacts were identified. The NRA methodology is contained within section 3. The marine traffic survey methodology is within section 7. SAR impacts are considered in Appendix C and assessed in section 22.16. Section 22 considers the impact of phasing.
January 2017	Regular Operator consultation – consultation letters issued to the identified Regular Operators. Responses received are summarised here.	P&O Ferries: Ideal location for the Hornsea Three offshore HVAC booster station(s) would be between the Lehman and Haddock Bank, but to avoid vessel routeing should stay North of 53°11.0'N. Marine Aggregate Industries: Requested attendance at the Hazard Workshop. KESS: Noted that there were small but manageable deviations for their vessels that operated east – west. Subsea 7: As their vessel routeing was governed by specific projects they were working on they could not confirm specifics but did not raise any notable impacts. Subsea 7 noted that as with any other navigational hazard, as long as the development is chartered, details available via Notices to Mariners, charts etc. then they did not have any specific concerns. DFDS Seaways: Noted that increases in distance and time would be required for their Cuxhaven to Immingham track. This route also raised concerns about adverse weather routeing and agreed to provide more information. No notable impacts for Hornsea Three were noted for the Newcastle to Amsterdam route. The Esbjerg to Immingham route noted no changes to the crossing time but noted adverse weather concerns including compliance with COLREGs.	Final location of the Hornsea Three offshore HVAC booster station(s) has not yet been agreed but the maximum design scenario locations for shipping and navigation have been assessed in section 18.4 and section 22. Marine Aggregate Industries attended the Hazard Workshop – see section 20. Vessel deviations are reported in section 18.2.2 and section 22.3. Commercial ferry impacts are assessed in section 22.
February 2017	CA – consultation meeting	CA stated that it is difficult to consult on sites this far offshore due to the variation in routes taken by recreational craft as well as the international component; however it was stated that CA have no major issues with the development. CA stated that the proposed navigational corridor was at a good angle and the width more than adequate for any recreational vessels sailing in the area. With respect to layouts the CA preferred larger straight lines where possible. The CA would also like to see advice added to the Nautical Almanac for recreational vessels sailing through the area, advice on courses etc. for navigating through the proposed navigational corridor or Hornsea Three array area. They stated that lots of yachtsmen will not go through a wind farm.	Internal navigation impacts are considered in section 22.
February 2017	CoS – consultation meeting	Introductory meeting to the Hornsea Three development. Overview of the winter and summer marine traffic was shown; no specific comments were raised by the CoS. It was noted that there are DFDS Seaways Roll on roll off (Ro Ro) routes passing through the Hornsea Three array area, CoS noted that it would be for the operator of those routes to comment in the first instance. Anatec explained the process for identification of Regular Operators within the marine traffic survey datasets and showed examples of the consultation letters issued. A number of Regular Operator letters (40+) had been issued either by email or surface mail, requesting feedback on the Hornsea Three array area and offshore cable corridor. Approach to the NRA, in line with MCA guidance was discussed. No comments were made. CoS queried if any additional routeing measures had been considered for the proposed navigational corridor; it was noted that this would be a decision for the MCA.	Future case routeing is considered in section 17. Cumulative scenarios for Hornsea Three are considered in section 21. Identified impacts are assessed in section 22.
February 2017	Hazard Workshop	See the hazard log in Appendix B.	N/A

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
February 2017	MCA and TH – consultation meeting	MCA and TH confirmed that they were content with the marine traffic survey and that it met with the requirements of MGN 543. TH confirmed that any navigational corridor would be assessed on a case by case basis and that given the location of the Hornsea Three array area and the volume of traffic, they were content with the red line boundary and thus corridor width. TH and MCA were clear that MGN 543 states that developers should plan for two lines of orientation unless they can clearly demonstrate that fewer is acceptable and safe for SAR helicopter operations. TH indicated that, using the experience of the oil and gas industry, and the approach taken for wrecks, any subsea structures would need a 30 m vertical clearance distance or require additional marking on the surface. As the water depths in the offshore HVAC booster station search area are less than 30 m surface marking will therefore be required.	Outcomes of the proposed navigational corridor assessment are in section 22.9. Subsea impacts are considered in section 22. Internal navigation impacts are considered in section 22.
February 2017	RYA – consultation meeting	RYA mentioned that, from a recreational perspective, the Hornsea Three array area did not present any significant problems. This is largely based on the fact that there is very little recreational activity that far offshore and anyone who is transiting that far offshore would be very experienced and well equipped. The RYA's main concern would be relating to the cable landfall where the cable comes within the 10 m contour and any resulting reduction in water depth. With respect to layouts the RYA stated that they did not have any concerns regarding the indicative layouts presented. The RYA also considered the corridor between the projects to be more than adequate with respect to use by recreational craft.	Measures adopted as part of Hornsea Three are outlined in section 23 and include a cable burial assessment. Internal navigation impacts are considered in section 22.
September 2017	BP Shipping Ltd – section 42 consultation response	The analysis identifies various impacted vessel types and routes via AIS survey, explicitly naming a few individual vessels. Please can you share a list of the vessel names from your AIS surveys, and advise whether you have done any direct consultation with vessel operators of those vessels and what that looked like?	Minor amendments have been made to this chapter of the Environmental Statement to highlight Regular Operator consultation. A letter has been sent to BP Shipping confirming consultation undertaken to date and a consultation meeting has been offered if required.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
September 2017	CA – section 42 consultation response	The layout of turbines should be in straight lines following a rectangular or similar pattern aligned with the prevailing wind thus enabling a "see-through" passage by small craft. Point is eased by adoption of a minimum turbine spacing of 1,000 m or greater and disorientation of helmsmen can be mitigated to an extent by additional internal marking and lighting. Support fewer, larger, turbines than greater numbers of smaller turbines. Of the two layouts presented in the PEIR we would opt for the layout with the maximum number of turbines but would defer to the view of the MCA/TH on the matter. Summer survey data (Hornsea Three offshore HVAC booster stations) rather misses the peak summer season when perhaps double the number of recreational craft surveyed may be typically expected. We reserve on marking and lighting of the structure(s) until more details are available but suspect that additional standard navigation marks may be needed. We have no concerns about cable burial, protection, etc. in depths greater than 10 m. In lesser depths we ask that cables are buried 1 m with a minimum of 1.5 m where yachts may commonly anchor. A smooth bottom with no berms or "humps" over the cable should be maintained at all times. When more details are available we may also ask for provision of a marker beacon or daymark to indicate the landing point from seaward. We fully support safety zones of 50 m around completed turbines and 500 m around maintenance procedures (as indicated by presence of workboats) and accommodation platforms plus 500 m moving zones around cable layers and similar specialised vessels. Hornsea Three should if possible be co-ordinated in layout with the other Hornsea wind farms. The proposed navigational corridor will prove valuable in resolving this concern but may be treated as a narrow channel under Rule 9 of COLREGs and require additional buoyage and lighting. We agree that recreational craft are likely to use the Hornsea Three array area as a passage waypoint and that they can do so safely. CA policy is therefore always to seek consistency in overall design and regulation of all wind farms in northwest Europe. We doubt the very low figures recorded for yachts crossing the Hornsea Three offshore cable corridor. Yacht traffic is not heavy but all on passages between the Channel/east coast rivers and the Humber northwards including Scotland plus those originating from the continent must cross the corridor somewhere. We reserve comment on your landside operating port since the location of this is not yet known. Publishing fixed routeing of construction traffic and the construction site may be advisable.	Internal navigation impacts are considered in section 22. The survey period for the summer season was agreed with the MCA and satisfies the requirements of MGN 543. Regarding burial depths, a cable burial assessment is included as a measure adopted as part of Hornsea Three with detail provided in section 23. This section also provides detail on the application and use of safety zones. Marine traffic surveys for the Hornsea Three offshore cable corridor also considers desktop resources such as the RYA UK Coastal Atlas of Recreational Boating (2016). The cumulative impact assessment (CEA) in section 21 takes into account the impact associated with Hornsea Three together with other projects and plans. This includes the proposed navigational corridor. Construction traffic will be monitored and managed by a marine coordinator so that vessels do not impact on other users. Decisions on the classification of the proposed navigational corridor and requirement for additional marking remain with the MCA and TH.
September 2017	CoS – section 42 consultation response	The CoS has no particular comments to make.	N/A

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
September and December 2017	MCA – section 42 consultation response	MGN 543 Annex 2 Paragraph 6 requires that hydrographic surveys should fulfil the requirements of the International Hydrographic Organisation (IHO) Order 1a standard, with the final data supplied as a digital full density data set, and survey report to the MCA Hydrography Manager. This information will need to be submitted, ideally at the Environmental Statement stage. Export cable routes, Cable Burial Protection Index and cable protections are issues that are yet to be fully developed. However due cognisance needs to address cable burial and protection, particularly close to shore where impacts on navigable water depth may become significant. Any consented cable protection works must ensure existing and future safe navigation is not compromised. The MCA would accept a maximum of 5% reduction in surrounding depth referenced to Chart Datum. Existing charted anchorage areas should be avoided. The array layout will require MCA approval prior to construction to minimise the risks to surface vessels, including rescue boats, and SAR aircraft operating within the site. As such, MCA will seek to ensure all structures are aligned in straight rows and columns. Any additional navigation safety and/or SAR requirements, as per MGN 543 Annex 5, will be agreed at the approval stage. Safety zones during the construction, operation and maintenance and decommissioning phases are supported; however it should be noted that operational safety zones may have a maximum 50 m radius from the individual turbines. A detailed justification would be required for a 50 m operational safety zone, with significant evidence from the construction phase in addition to the baseline NRA required supporting the case. An ERCoP is required to meet the requirements of MCA guidance. The template is available on the MCA website at www.gov.uk. An approved ERCoP will need to be in place prior to construction. A study should be undertaken/updated which establishes the electromagnetic deviation affecting vessels' compasses and other navigating systems due to the cable route to the satisfaction of the MCA.	Hydrographic data will be supplied to the MCA. This will consist of the Hornsea Three array area and the surrounding 500 m provided pre-consent, the Hornsea Three export cable route provide post-construction, and both the Hornsea Three array area and the surrounding 500 m and the Hornsea Three export cable route provided post decommissioning. Measures adopted as part of Hornsea Three are outlined in section 23 and include a cable burial assessment, details on the application and use of safety zones and commitment to an ERCoP. The MMO will sign off the final layout post-consent, in consultation with the MCA. Lessons learnt from previous offshore wind farm developments are provided in section 6 and include electromagnetic interference trials undertaken at the North Hoyle offshore wind farm (MCA, 2005). These trials found that offshore wind farm infrastructure did not have any effect on compasses.
September 2017	Ministry of Infrastructure and the Environment, Dutch Government (Rijkwaterstraat) – section 42 consultation response	We would like to get the information about the handling of ferries (passenger and Ro Ro) through the wind farm. More specifically: • Are ferries allowed to pass through the wind-farm, and are there limitations based upon vessel length? • Are the adverse weather routes for ferries analysed before or after the construction phase? • Are alternative routes provided through the wind farm, such as by a channel? • Does the routeing of ferries through the Hornsea Three array area differ from in the vicinity of the Hornsea Three offshore HVAC booster station(s)? We would be grateful if you would take some time to get us familiar with the way the Applicant is handling the ferry traffic for this development.	Main routes including ferry routes have been considered at both a base and future case level in section 15 and section 18.2.2 respectively. Adverse weather routeing is considered in section 16 and assessed in section 22.5. Outcomes of the proposed navigational corridor assessment are in section 22.9. Given the small development area of the Hornsea Three offshore HVAC booster station(s) there are not expected to be any impacts on ferry or other vessel routeing – this is considered in section 18.4.
September 2017	Peel Ports Great Yarmouth – section 42 consultation response	Vessel access to the Port will in no way be fettered as a result of the construction or operation of the wind farm or the presence of the export cables.	Measures adopted as part of Hornsea Three are outlined in section 23 include compliance with UK and Flag State regulations and IMO conventions and marine coordination. These mitigations will assist in ensuring that vessel traffic associated with Hornsea Three is safely and effectively managed and does not impact upon third party users.
September 2017	TH – section 42 consultation response	TH is satisfied with the PEIR, the contents of which have been noted. However, our concerns remain over the structural design of the substations, as well as their locations and also the proposed layout of the array of turbines. We would of course welcome the earliest of consultation on these matters once further details become available.	TH confirmed (at the consultation meeting in December 2017) that their concerns were in relation to subsea substations (sited on the seabed) and the under keel clearance risk such structures may pose to deep draught vessels, particularly during the construction phase when the structures may not be fully lit and marked. Subsea substations are only under consideration for the offshore HVAC booster stations and not the array substations. An assessment of under keel clearance has been undertaken as part of this NRA (see section 18.4) and provides an overview of the key areas of risk identified throughout the export cable route, including the offshore HVAC booster station search area.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
December 2017	MCA – consultation meeting	In general MCA thought the new Layout A was a positive step forward; and the Development Principles would work well as part of the DCO process once agreed between parties. Comments from MCA included: • Micro-siting of ±150 m should be reduced to allow for greater Probability of Detection (POD). • Would like to see how curved perimeter developments lanes would look in reality; curved layouts can cause issues for SAR. It was noted that internal development lanes would be straight and the curve was to allow for the shape of the lease area. The western boundary would also be straight (subject to micro-siting). • MCA noted that 20 nm (approx.) was too long for a SAR access corridor and that a buffer zone may be required. MCA to look to feed back further info on what is an acceptable distance. • Trials on Helicopter Refuge Area are being undertaken and MCA will feed back guidance. • Minimum spacing of 1,000 m centre to centre was noted as was the 500 m minimum corridor width which would always be maintained. It was noted that in reality there may be more than one SAR corridor between development lanes. • The Development Principle relating to the inclusion of dense boundaries should also refer to the 1,000 m minimum spacing requirement. • All agreed that the Development Principles would work well as part of the DCO process once the principles had been agreed between parties. No other comments were made on changes to the envelope and MCA saw the removal of floating foundations and the reduction in size of the Hornsea Three offshore HVAC booster station search area as positive steps.	Noted that changes to the proposed project envelope are positive. Development Principles have been considered in volume 4, annex 3.7: Layout Development Principles and the Statement of Common Ground.
December 2017	TH – consultation meeting	TH noted the single line of orientation and commented that the indicative layout represented a positive step forward compared to the irregular layout with no lines of orientation considered in the PEIR. It was agreed that commercial vessels will not navigate within the array and that in the event of a SAR incident a Hornsea Three vessel would likely be the first responder. TH noted that in general they were content with the Development Principles but had concerns over 300 m micro siting and would like to see this reduced. TH were content with the marine traffic survey data. TH agreed with the reduction in the size of the Hornsea Three offshore HVAC booster station search area and noted that any deviations required for the offshore HVAC booster stations (up to six) would be minimal. *Post minute note: TH also raised a query on how external curved boundaries could be used/designed.*	Noted that changes to the proposed project envelope are positive. Development Principles have been considered in volume 4, annex 3.7: Layout Development Principles and the Statement of Common Ground.

15. Marine Traffic Surveys

15.1 Introduction

15.1.1.1 This section presents shipping data in relation to three areas; the Hornsea Three array area, offshore cable corridor and offshore HVAC booster station search area shipping and navigation study areas. Details on the survey methodology used when recording the marine traffic survey data is provided in section 7.

15.2 Hornsea Three array area survey analysis

15.2.1.1 A number of tracks recorded during the summer and winter survey were classified as temporary (non-routine), such as the tracks of the survey vessels and traffic associated with temporary drilling rigs. These have therefore been excluded from the analysis. Oil and gas affiliated vessels supporting permanent installations were retained in the analysis.

15.2.1.2 A plot of the vessel tracks recorded during a 26 day survey period in June and July 2016 (summer), colour-coded by vessel type, and excluding temporary traffic (as defined above) is presented in Figure 15.4, Panel A. A plot of the tracks recorded during a further 14 day survey period in November and December 2016 (winter), colour-coded by vessel type, and excluding temporary traffic, is presented in Figure 15.4, Panel B. The summer survey was longer in duration on account of the fact that it was a piggy-back survey and so the additional survey days were acquired at minimal additional cost.

15.2.1.3 In order to provide a comparison of marine traffic between the two survey periods (which are of differing duration), plots of the vessel tracks for each survey period converted to a tracks per day density grid are presented in Figure 15.4 (Panel C and Panel D respectively). Furthermore, the analysis presented in the remainder of this section is given in terms of the unique vessels per day.

15.2.1.4 A unique vessel is defined as an individual vessel identified on that calendar day even if there are multiple AIS tracks associated with that vessel. Individual vessels are identified, in the majority, by their Maritime Mobile Service Identity (MMSI) number.

15.2.2 Vessel counts

15.2.2.1 For the 26 days analysed in summer 2016, there were an average of 42 unique vessels per day passing within the Hornsea Three array area shipping and navigation study area, recorded on AIS, visual and Radar. In terms of vessels intersecting the Hornsea Three array area, there was an average of 15 unique vessels per day.

15.2.2.2 Figure 15.1 illustrates the daily number of unique vessels passing through the Hornsea Three array area shipping and navigation study area and the Hornsea Three array area during summer 2016.

15.2.2.3 The busiest day recorded throughout the survey period was 10 June 2016 when 55 unique vessels were recorded within the Hornsea Three array area shipping and navigation study area and 18 within the Hornsea Three array area.

15.2.2.4 The quietest day throughout the survey period was 23 June 2016 when 29 unique vessels were recorded within the Hornsea Three array area shipping and navigation study area and ten within the Hornsea Three array area.

15.2.2.5 Throughout the survey period 36% of traffic recorded within the Hornsea Three array area shipping and navigation study area intersected the Hornsea Three array area.

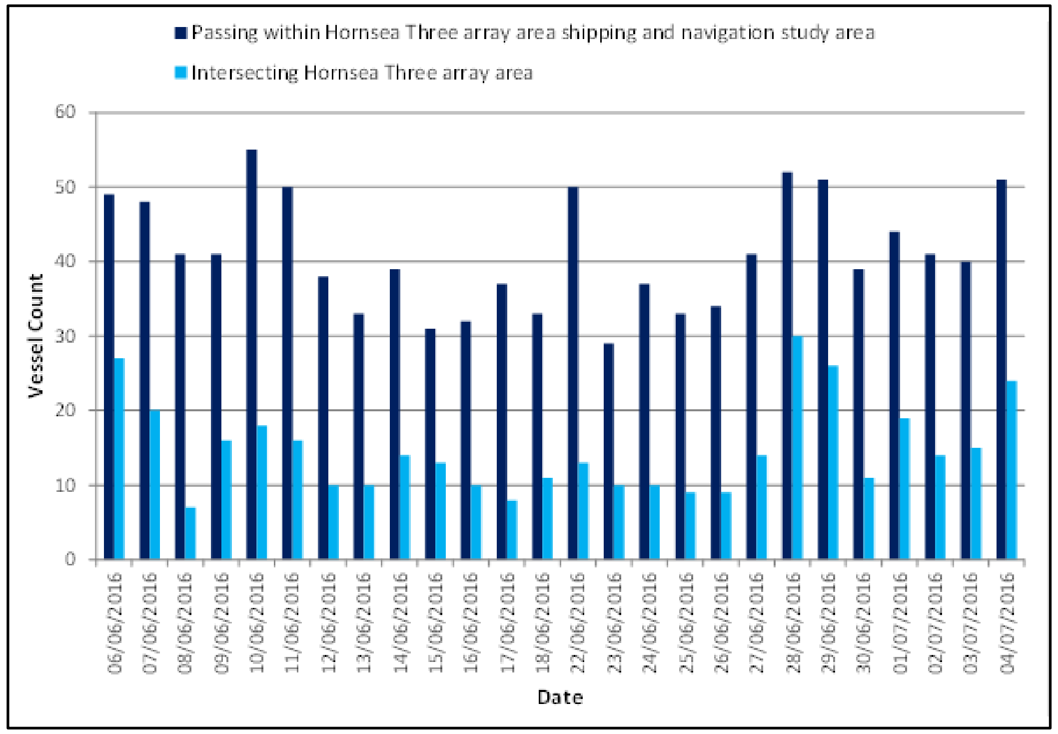

Figure 15.1: Unique vessels per day within Hornsea Three array area shipping and navigation study area during 26 days summer 2016 (AIS, Visual and Radar).

15.2.2.6 For the 14 days analysed in winter 2016, there were an average of 28 unique vessels per day passing within the Hornsea Three array area shipping and navigation study area, recorded on AIS, visual and Radar (excluding temporary traffic). In terms of vessels intersecting the Hornsea Three array area, there was an average of 13 unique vessels per day.

15.2.2.7 Figure 15.2 illustrates the daily number of unique vessels passing through the Hornsea Three array area shipping and navigation study area and the Hornsea Three array area during 14 days between November and December 2016.

15.2.2.8 The busiest day recorded throughout the survey period was the 14 November 2016 when 39 unique vessels were recorded within the Hornsea Three array area shipping and navigation study area and 22 within the Hornsea Three array area.

15.2.2.9 The quietest day throughout the survey period was the 26 November 2016 when 16 unique vessels were recorded within the Hornsea Three array area shipping and navigation study area and three within the Hornsea Three array area.

15.2.2.10 Throughout the survey period 45% of traffic recorded within the Hornsea Three array area shipping and navigation study area intersected the Hornsea Three array area.

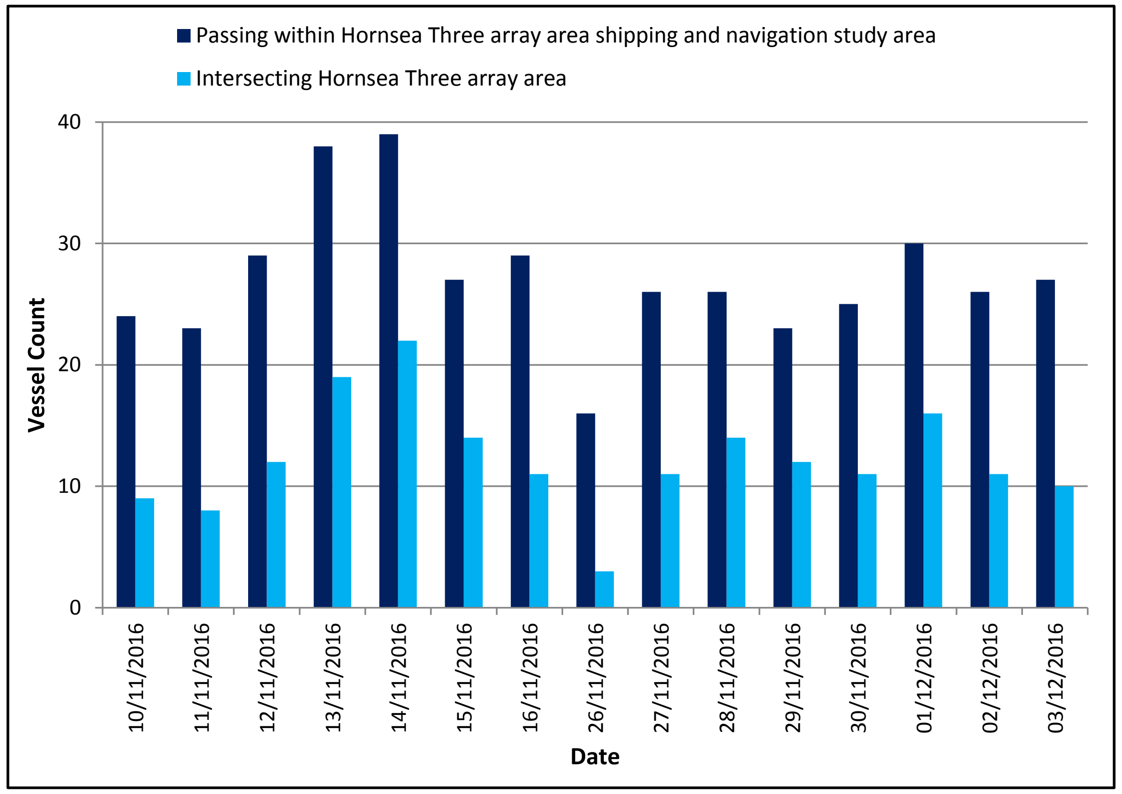

Figure 15.2: Unique vessels per day within the Hornsea Three array area shipping and navigation study area during 14 days winter 2016 (AIS, visual and Radar).

15.2.3 Vessel types

15.2.3.1 Analyses of the vessel types recorded passing within the Hornsea Three array area shipping and navigation study area and Hornsea Three array area throughout both survey periods are presented in Figure 15.3. The category of "other" vessels includes those that are not large enough in quantities (i.e. less than 5%) to merit a separate category. This includes the likes of anchor handling vessels, dive support vessels, pipe-lay vessels and research/survey vessels.

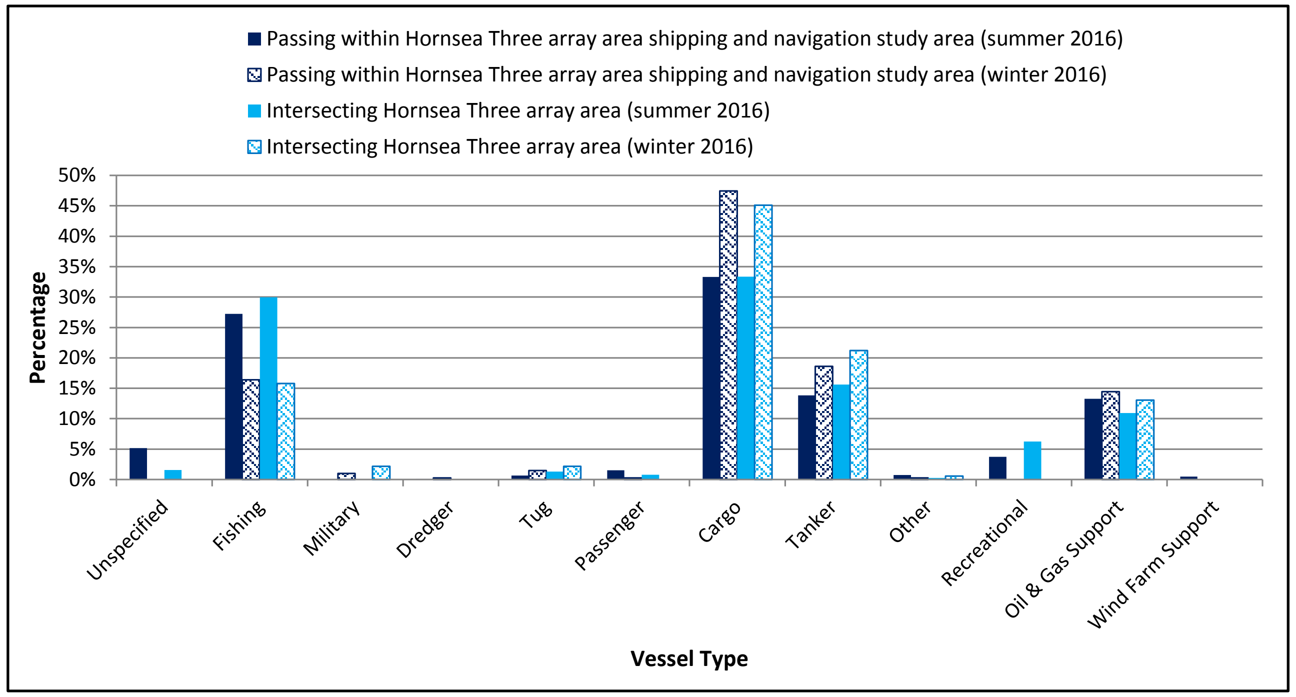

Figure 15.3: Distribution of vessel types within the Hornsea Three array area shipping and navigation study area during 40 days summer and winter 2016 (AIS, visual and Radar).

15.2.3.2 Throughout the summer period, the majority of tracks were cargo vessels (33% within the Hornsea Three array area) and fishing vessels (30%). Throughout the winter period the majority of tracks were cargo vessels (45% in the Hornsea Three array area) and tankers (21%). It should be noted that the cargo vessel category includes commercial ferries (e.g. DFDS Seaways) operating in the Hornsea Three array area shipping and navigation study area who generally broadcast their vessel types on AIS as cargo. Details specific to commercial ferries are presented in section 15.2.8.

15.2.3.3 Figure 15.5 presents a plot of cargo vessels, including commercial ferries, recorded within the Hornsea Three array area shipping and navigation study area on AIS, visual and Radar throughout both the summer and winter survey periods. Equivalent plots of tankers and oil and gas affiliated vessels are presented in Figure 15.6 and Figure 15.7 respectively.

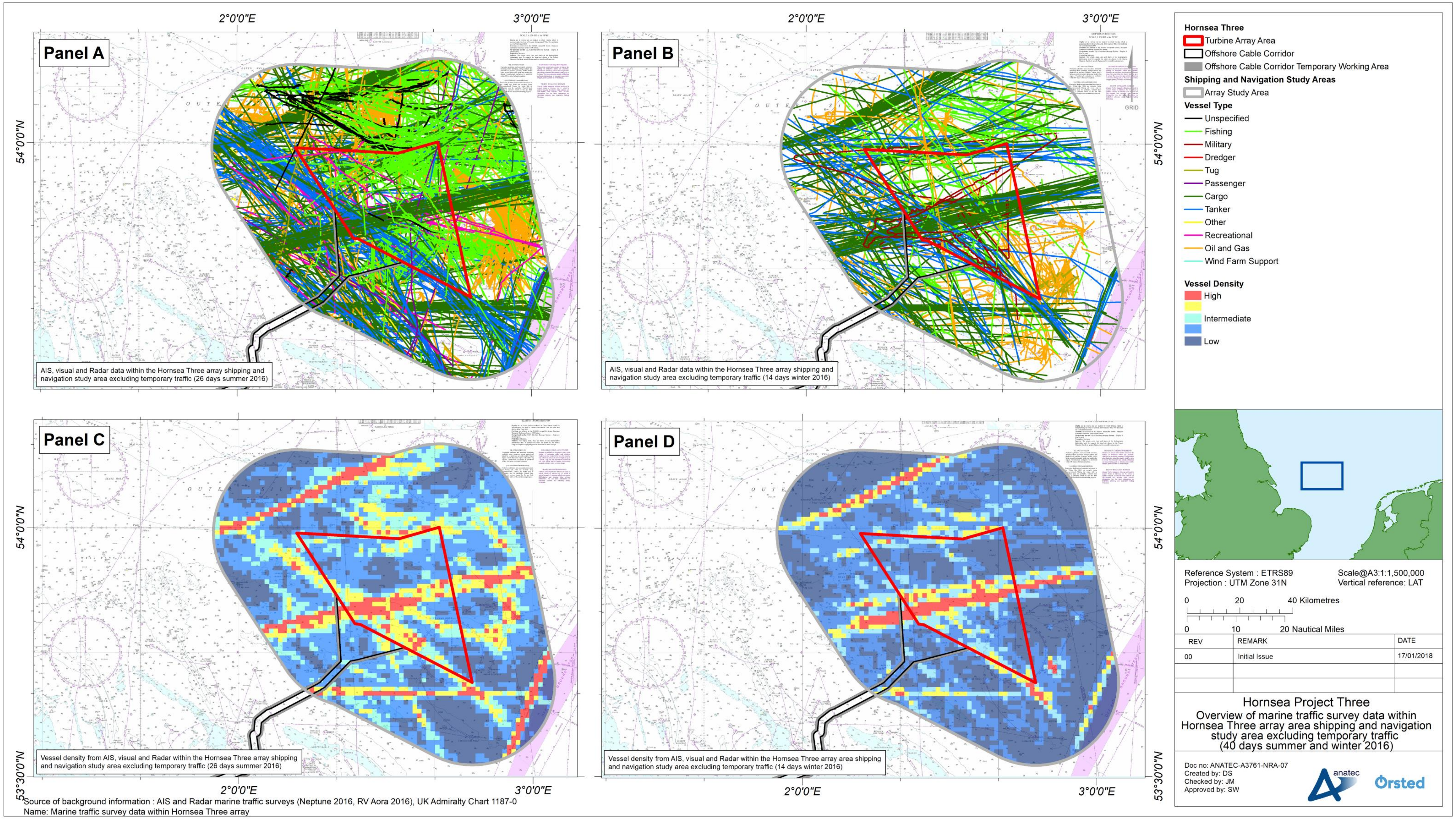

Figure 15.4: Overview of marine traffic survey data within the Hornsea Three array area shipping and navigation study area excluding temporary traffic (40 days summer and winter 2016).

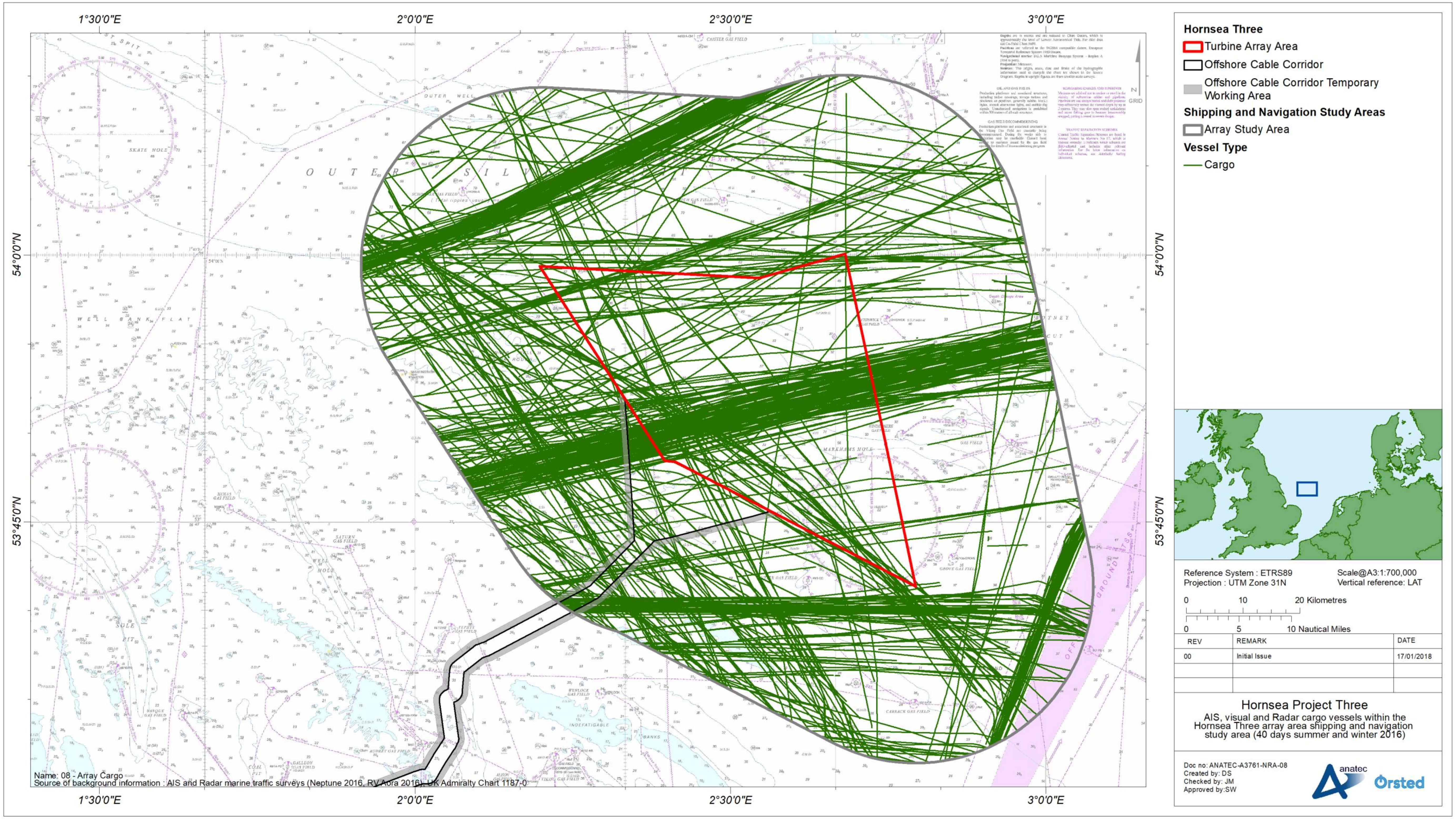

Figure 15.5: AIS, visual and Radar cargo vessels within the Hornsea Three array area shipping and navigation study area (40 days summer and winter 2016).

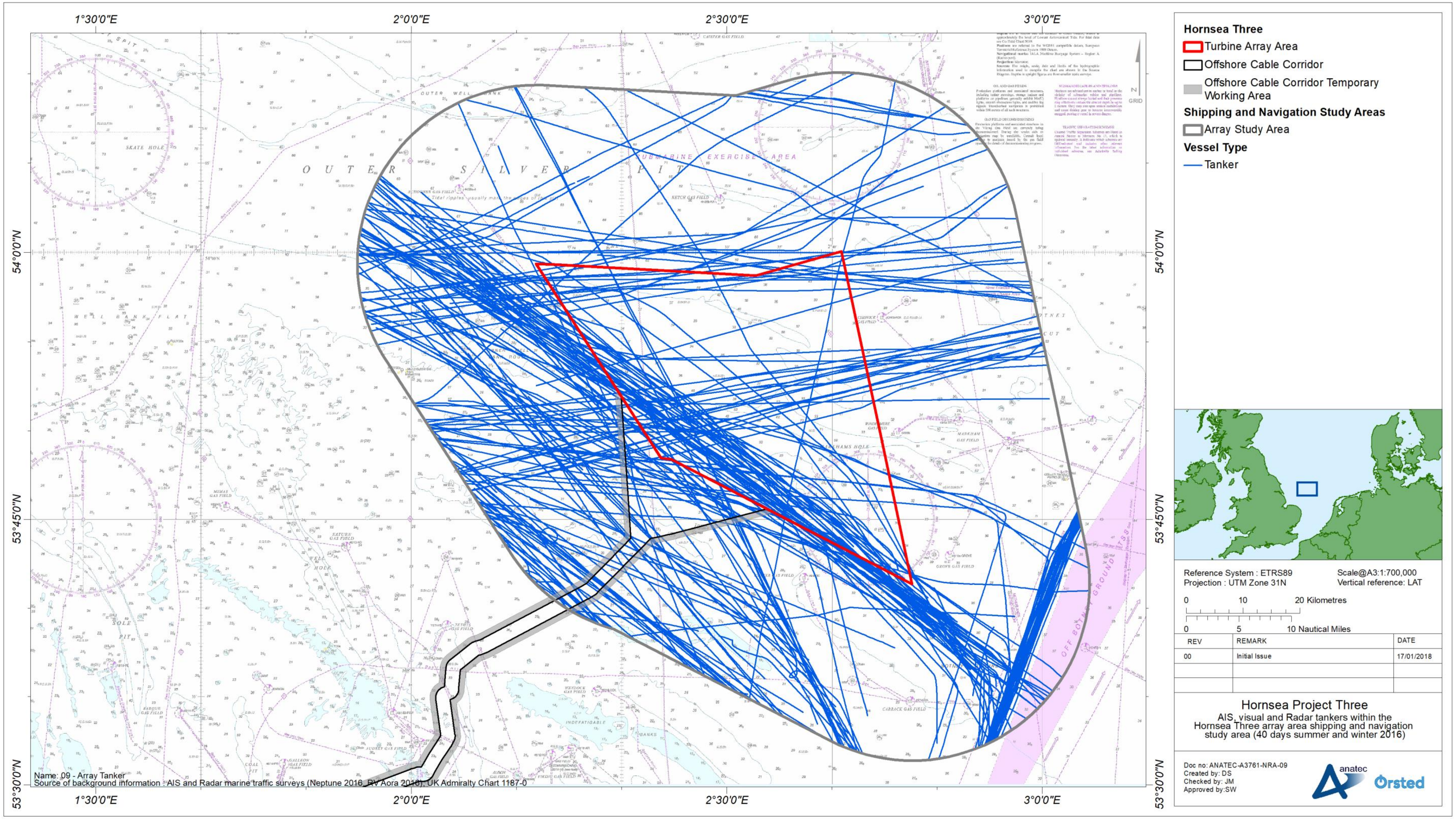

Figure 15.6: AIS, visual and Radar tankers within the Hornsea Three array area shipping and navigation study area (40 days summer and winter 2016).

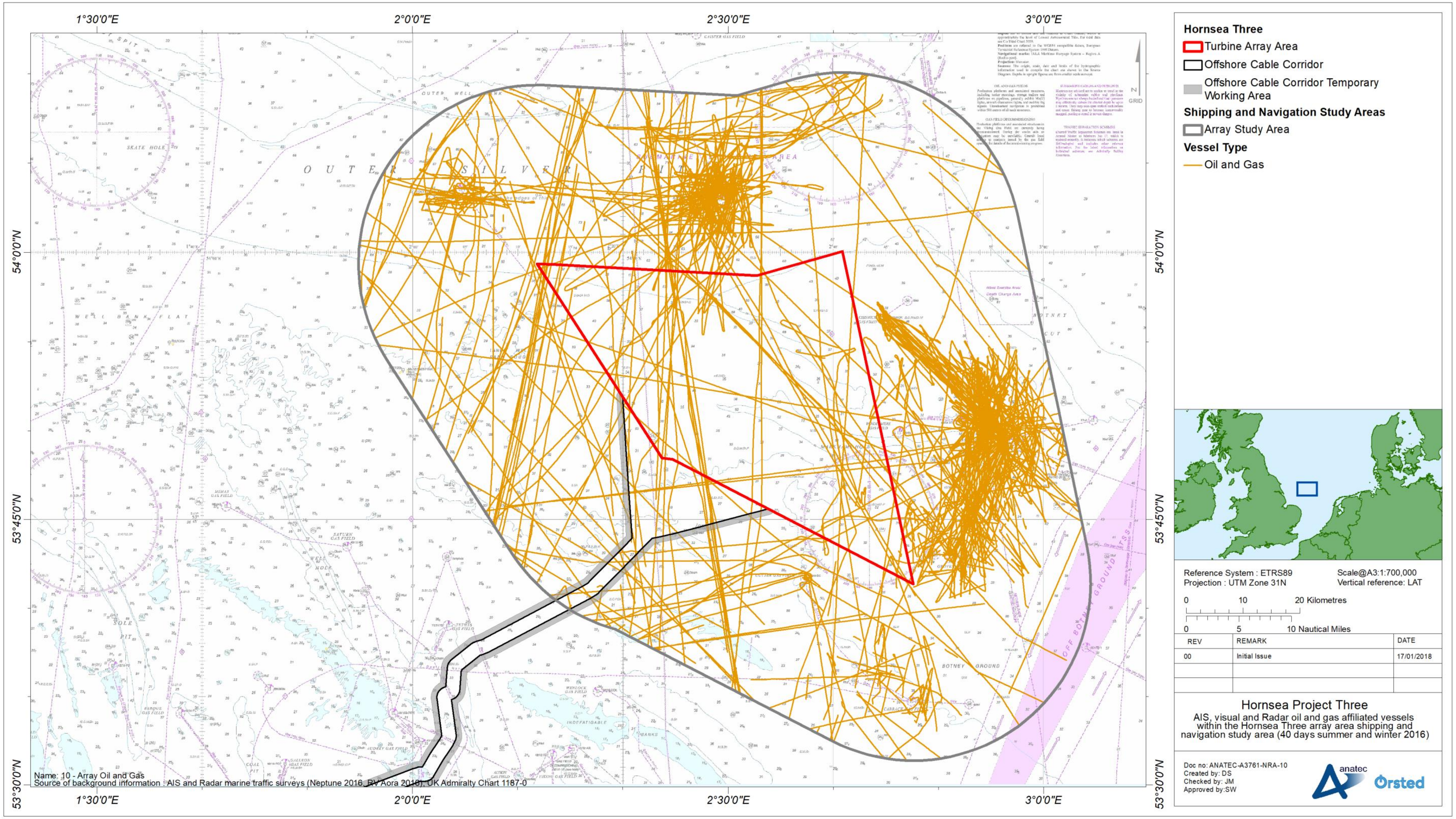

Figure 15.7: AIS, visual and Radar oil and gas affiliated vessels within the Hornsea Three array area shipping and navigation study area (40 days summer and winter 2016)

15.2.3.4 Throughout the combined summer and winter survey period, an average of 14 unique cargo vessels per day passed within the Hornsea Three array area shipping and navigation study area.

15.2.3.5 Regular cargo vessels operating in the vicinity of the Hornsea Three array area shipping and navigation study area include DFDS Seaways Ro Ro vessels operating routes between Immingham (UK) and Esbjerg (Denmark) and Immingham (UK) and Cuxhaven (Germany).

15.2.3.6 Throughout the combined summer and winter survey period, an average of six unique tankers per day passed within the Hornsea Three array area shipping and navigation study area.

15.2.3.7 All of the tankers recorded throughout the survey period were on passage to oil and gas terminals throughout the UK and mainland Europe including: Immingham (UK), Rotterdam (Netherlands), Teesport (UK) and Grangemouth (UK).

15.2.3.8 Throughout the combined summer and winter survey period, an average of five unique offshore affiliated (transiting to/from oil or gas platforms) vessels per day passed within the Hornsea Three array area shipping and navigation study area. The majority of these vessels were on passage to/from offshore oil and gas installations in the vicinity of the Hornsea Three array area shipping and navigation study area.

15.2.3.9 Offshore affiliated vessels that were not transient included the *Putford Viking* and *Putford Trader* which were acting as the Emergency Response and Rescue Vessels (ERRV) for the nearby Markham and Ketch gas fields respectively. The *Glomar Endurance* was also carrying out guard duties for the J6-A platform at the Markham gas field.

15.2.4 Vessel size distribution

Maximum Length Overall (LOA)

15.2.4.1 Vessel lengths overall (LOA) recorded throughout the survey periods ranged from 9 m (the pleasure craft *Bjxrkski-2*) to a maximum of 333 m (four crude oil tankers including the *Athina*, *Selene Trader*, *New Pearl* and *Argenta*). Figure 15.8 illustrates the distribution of vessel lengths recorded throughout each survey period.

15.2.4.2 The average lengths of vessels within the Hornsea Three array area shipping and navigation study area throughout the summer and winter survey periods were 104 m and 120 m, respectively. There was a greater proportion of small vessels (< 50 m) recorded throughout the summer survey within the Hornsea Three array area shipping and navigation study area.

15.2.4.3 Figure 15.9 provides an overview of AIS, visual and Radar vessel tracks (excluding temporary traffic) recorded within the Hornsea Three array area shipping and navigation study area throughout the combined 40 day summer and winter survey periods, colour-coded by vessel length.

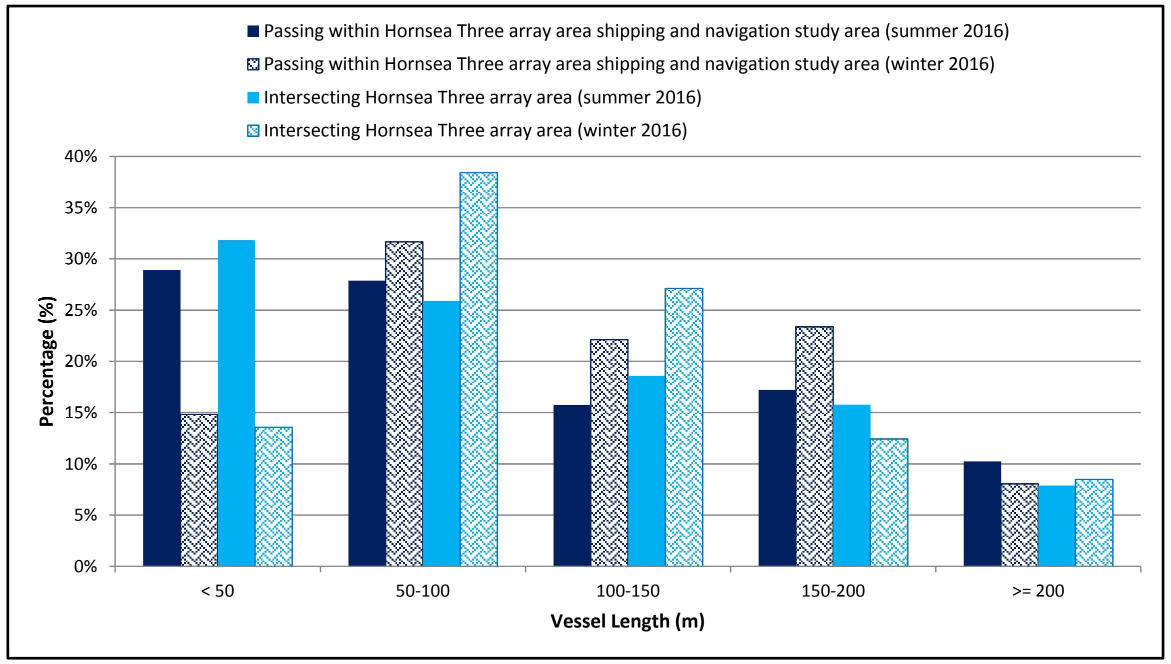

Figure 15.8: Vessel length distribution within the Hornsea Three array area shipping and navigation study area during 40 days summer and winter 2016 (AIS, visual and Radar).

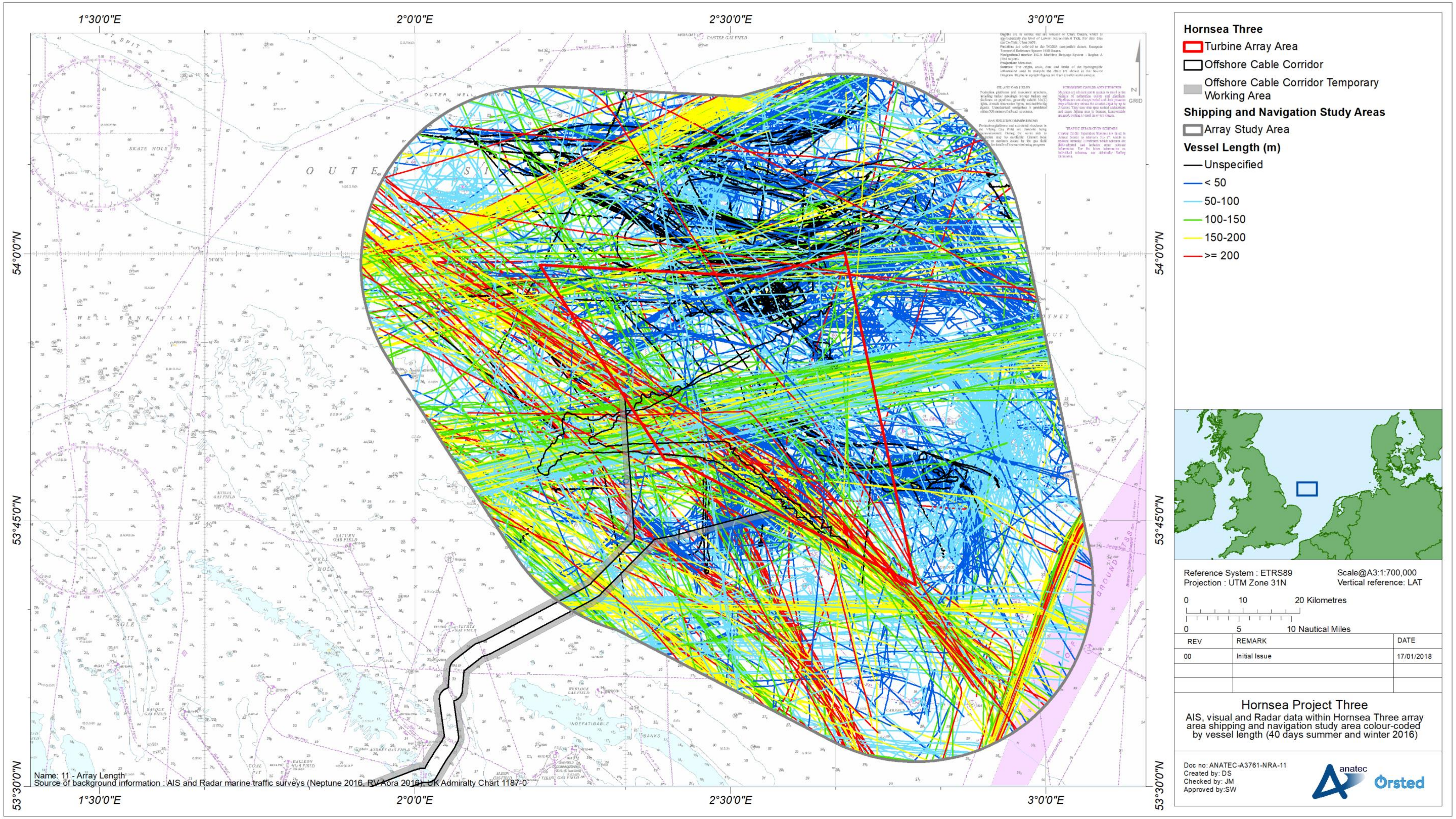

Figure 15.9: AIS, visual and Radar data within the Hornsea Three array area shipping and navigation study area colour-coded by vessel length (40 days summer and winter 2016).

Vessel draught

15.2.4.4 Vessel draughts recorded throughout the survey periods ranged from 1.8 m (the wind farm support vessel *MCS Blue Norther*) to a maximum of 20.6 m (the oil products tanker *Victory 1*). Figure 15.10 illustrates the distribution of vessel draughts recorded throughout each survey period.

15.2.4.5 It should be noted that 10% of the total number of unique vessels recorded within the Hornsea Three array area shipping and navigation study area did not broadcast a draught on AIS and hence have been excluded from further analysis. Based on experience working with vessel data within the area, it is assumed however that the data is an accurate reflection of the types of draughts likely to be recorded within the area.

15.2.4.6 The average draughts of vessels within the Hornsea Three array area shipping and navigation study area throughout the summer and winter survey periods were 5.1 m and 5.9 m respectively. This reflects the greater proportion of small-draught vessels (< 4 m) recorded throughout the summer survey within the Hornsea Three array area shipping and navigation study area.

15.2.4.7 Figure 15.11 provides an overview of AIS, visual and Radar vessel tracks (excluding temporary traffic) recorded throughout the combined 40 day summer and winter survey periods, colour-coded by vessel draught.

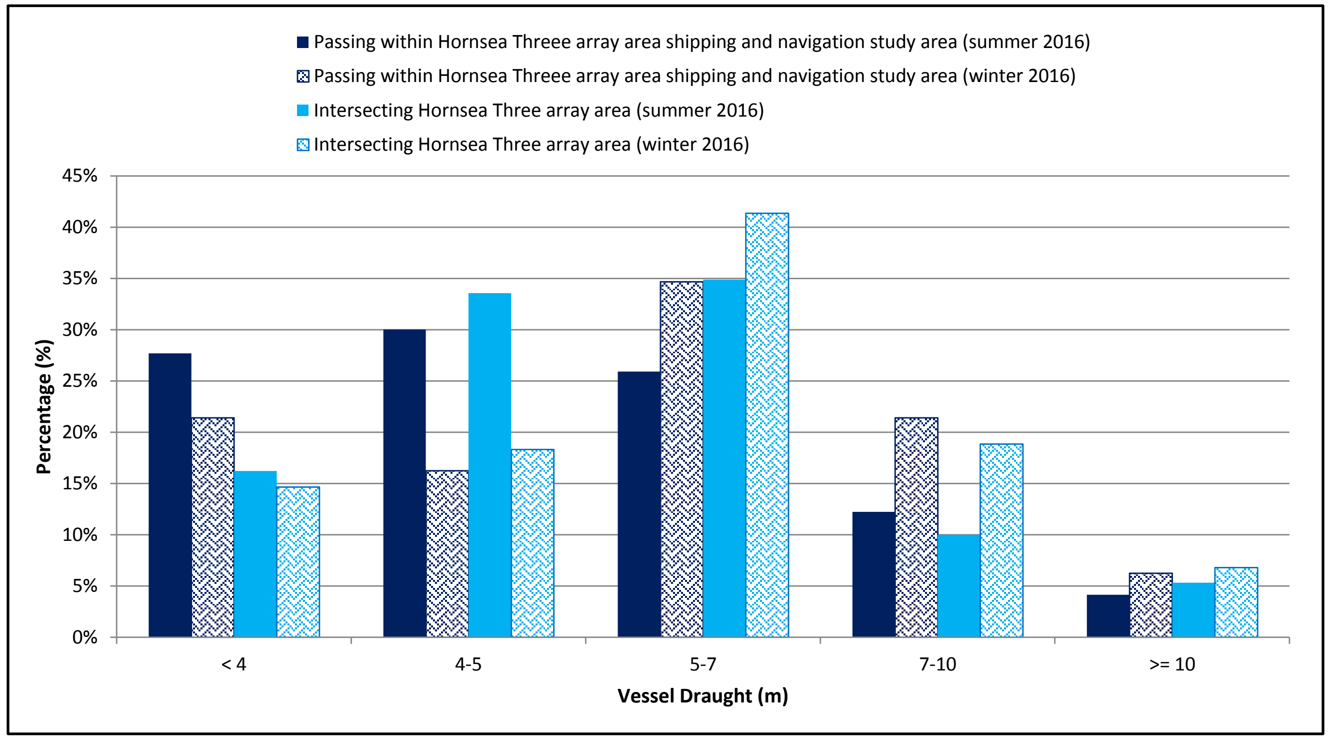

Figure 15.10:Vessel draught distribution within the Hornsea Three array area shipping and navigation study area during 40 days summer and winter 2016 (AIS, visual and Radar).

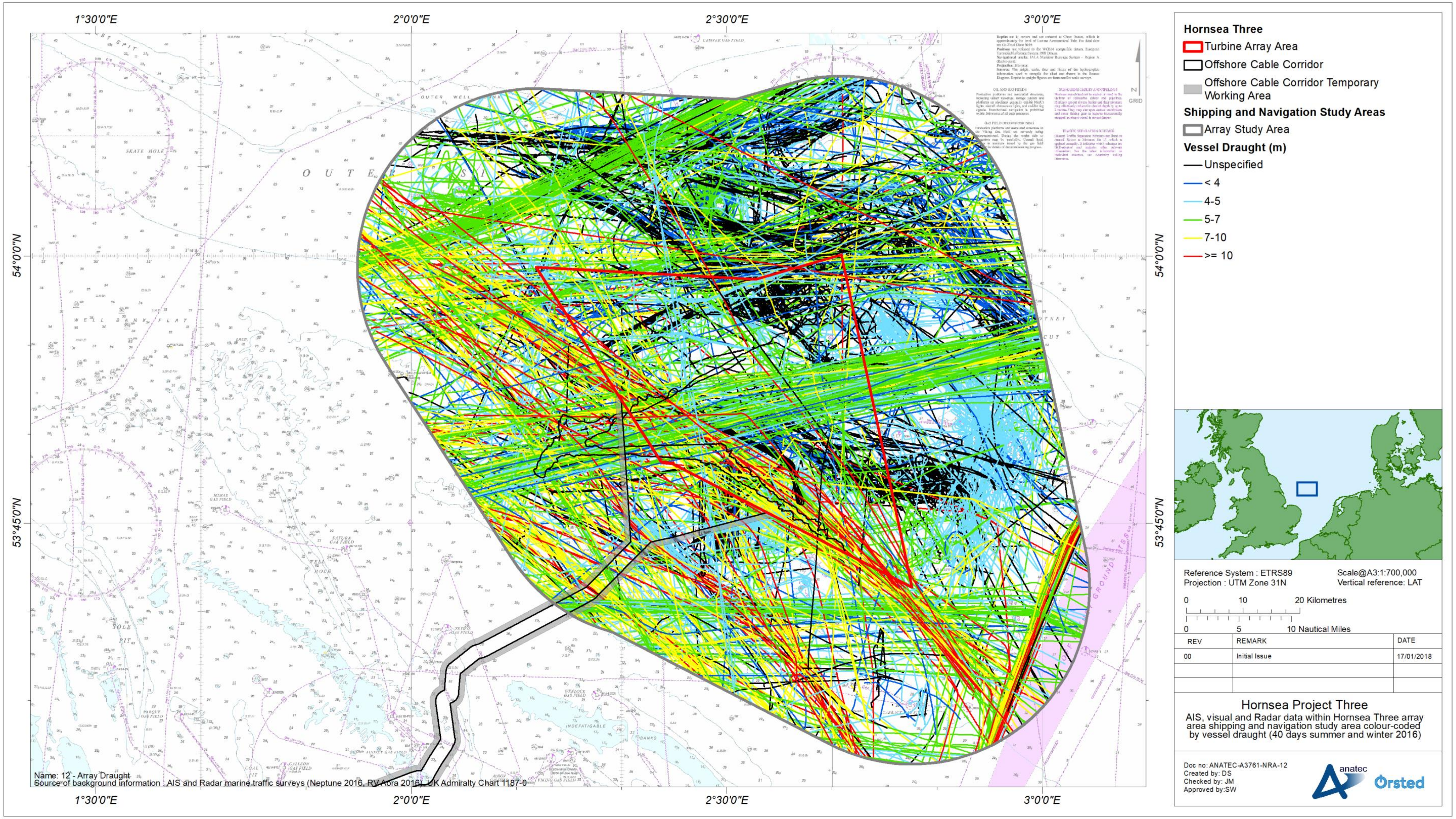

Figure 15.11: AIS, visual and Radar data within the Hornsea Three array area shipping and navigation study area colour-coded by vessel draught (40 days summer and winter 2016).

15.2.5 Anchored vessels

15.2.5.1 Anchored vessels can be identified based on the AIS navigational status which is programmed on the AIS transmitter on board a vessel. No vessels were broadcasting as “at anchor” within the Hornsea Three array area shipping and navigation study area during the 40 day survey period. However, information is manually entered into the AIS; and therefore it is common for vessels not to update the navigational status if they are anchored for only a short period of time.

15.2.5.2 For this reason, those vessels which travelled at a speed of less than 1 kn for more than 30 minutes were assumed to be at anchor. After applying these criteria, no vessels were deemed to be at anchor. This result can be attributed to the distance between the Hornsea Three array area shipping and navigation study area and the coast, and the generally moderate water depth within the Hornsea Three array area shipping and navigation study area.

15.2.6 Definition of a main route

15.2.6.1 Main routes have been identified by principles set out in MGN 543 (MCA, 2016). AIS data are assessed and vessels transiting at similar headings and locations are identified as a main route. To help identify main routes, AIS 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 width is then calculated using the 90th percentile rule from the median line of the potential shipping route as shown in Figure 15.12.

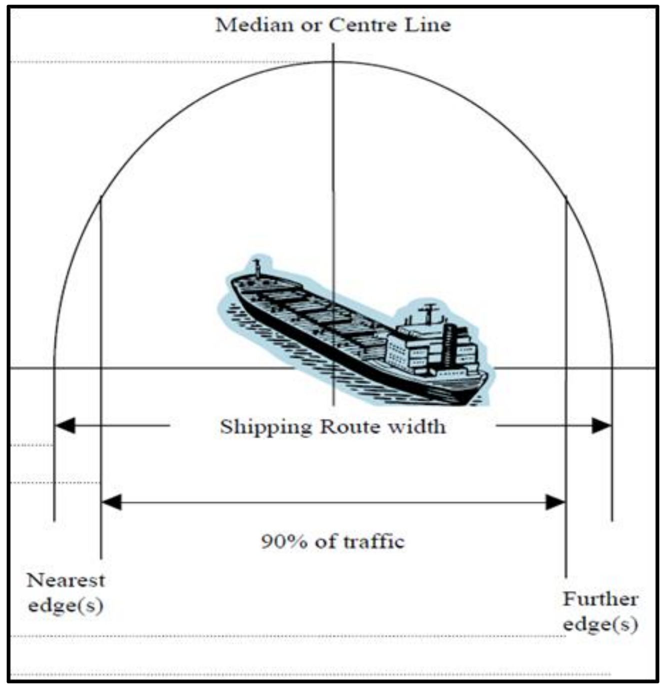

Figure 15.12: Illustration of main route calculation.

15.2.7 Base case main routes

15.2.7.1 Main route identification was undertaken for the Hornsea Three array area shipping and navigation study area. Sixteen main commercial routes have been identified as transiting through the Hornsea Three array area shipping and navigation study area. Plots of the main routes and corresponding 90th percentiles within the Hornsea Three array area shipping and navigation study area are presented in Figure 15.13.

15.2.7.2 A brief description of the traffic on each of the main routes is presented in Table 15.1.

15.2.7.3 It is noted that the main routes reflect key directions of traffic routeing within the Hornsea Three array area shipping and navigation study area; and that other vessels do operate outside of these routes. Typically a main route would consist of at least one vessel every two days or be associated with an offshore installation.

15.2.8 Commercial ferry activity

15.2.8.1 This section reviews the commercial ferry activity in the Hornsea Three array area shipping and navigation study area based on the marine traffic surveys.

15.2.8.2 Throughout the combined summer and winter survey period, five regular commercial ferry routes were identified, with each of these included among the base case main routes outlined in section 15.2.7. Figure 15.14 presents a plot of commercial ferries recorded within the Hornsea Three array area shipping and navigation study area on AIS, visual and Radar throughout both the summer and winter survey periods.

15.2.8.3 The most frequently transited commercial ferry route was a DFDS Seaways commercial ferry route between Immingham (UK) and Esbjerg (Denmark), with the *Ark Dania*, *Primula Seaways* and *Ark Germania* making 74 transits between them within the Hornsea Three array area shipping and navigation study area throughout the summer and winter survey periods. Two other DFDS Seaways commercial ferry were also relatively prominent, with these both being between Immingham (UK) and Cuxhaven (Germany) (the *Hafnia Seaways* and *Jutlandia Seaways* each made 18 transits within the Hornsea Three array area shipping and navigation study area throughout the summer and winter survey periods).

15.2.8.4 In addition to DFDS Seaways, other commercial ferry operators with vessels passing within the Hornsea Three array area shipping and navigation study area include KESS, Hyundai Glovis, Sea-Cargo and Eckero Shipping.

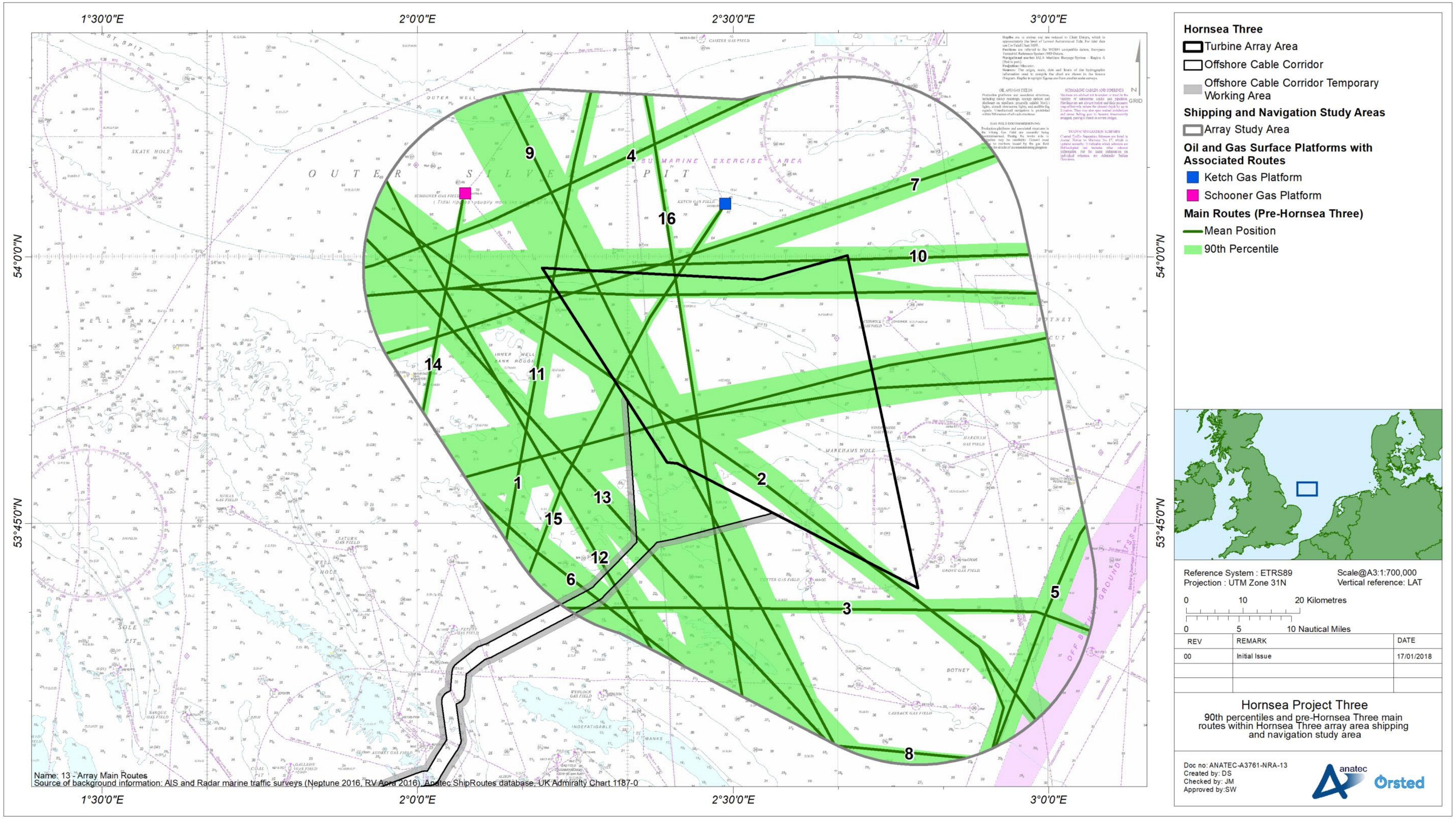

Figure 15.13: 90th percentiles and pre-Hornsea Three main routes within the Hornsea Three array area shipping and navigation study area.

Table 15.1: Main routes details within Hornsea Three array area shipping and navigation study area.

Route number	Number of vessels per day (average)	Destinations and main vessel types identified
Route 1	3 to 4 vessels per day	Immingham (UK) to Cuxhaven (Germany). Route 1 is used by cargo vessels (90%) and tankers (10%). Route 1 is a DFDS Seaways ferry route from Immingham to Cuxhaven and splits on approach to the Off Botney Ground TSS. The main vessel operating on this route is the *Hafnia Seaways*.
Route 2	1 to 2 vessels per day	Forth Ports (UK) to Rotterdam (Netherlands). Route 2 is generally used by tankers (64%) and cargo vessels (34%).
Route 3	1 to 2 vessels per day	Immingham (UK) to Cuxhaven (Germany). Route 3 is generally used by cargo vessels (97%). Route 3 is a DFDS Seaways ferry route (as with route 1) and also includes a KESS Ro Ro freight service from Grimsby (UK) to Emden (Germany). The main vessels operating on this route are the *Jutlandia Seaways* (DFDS Seaways) and the *Neckar Highway* (KESS).
Route 4	2 to 3 vessels per day	Immingham (UK) to Esbjerg (Denmark). Route 4 is generally used by cargo vessels (96%). Route 4 is a DFDS Seaways Ro Ro freight service operated by three vessels; the *Ark Dania*, *Ark Germania* and the *Primula Seaways*.
Route 5	2 vessels per day	Off Botney Ground TSS southbound. Route 5 is generally used by cargo vessels (42%), tankers (42%) and passenger vessels (14%). Route 5 includes vessels transiting to many locations, particularly ports within the English Channel.
Route 6	1 to 2 vessels per day	Forth Ports (UK) to Amsterdam (Netherlands). Route 6 is generally used by tankers (53%) and cargo vessels (39%).
Route 7	1 vessel per 2 days	Immingham (UK) to Esbjerg (Denmark). Route 7 is used by cargo vessels (67%) and tankers (33%). Route 7 is a DFDS Seaways Ro Ro freight service (as with route 4) operated by the *Ark Dania* (eastbound transits only).
Route 8	1 vessel per 2 days	Immingham (UK) to Emden (Germany). Route 8 is used by cargo vessels (100%). Route 8 is a KESS route from Grimsby to Emden (as with Route 3) generally operated by the *Weser Highway* (westbound transits only).
Route 9	1 vessel per 2 days	Icelandic Ports to Rotterdam (Netherlands). Route 9 is generally used by cargo vessels (63%) and tankers (26%).
Route 10	1 vessel per day	Immingham (UK) to German Ports. Route 10 is generally used by cargo vessels (56%) and tankers (42%) with German port destinations including Bremen, Hamburg and Cuxhaven.
Route 11	1 vessel per 2 days	Great Yarmouth (UK) to Murdoch gas platform. Route 11 is used by oil and gas affiliated vessels.
Route 12	1 vessel per 2 days	Icelandic Ports to Rotterdam (Netherlands). Route 12 is generally used by cargo vessels (87%).
Route 13	2 vessels per 3 days	Icelandic Ports to Amsterdam (Netherlands). Route 13 is generally used by cargo vessels (48%) and tankers (34%).
Route 14	1 vessel per 10 days	Great Yarmouth (UK) to Schooner A platform. Route 14 is used by oil & gas affiliated vessels (100%). The main vessel using this route is the *Putford Trader*.
Route 15	1 vessel per 5 days	Great Yarmouth (UK) to Ketch gas platform. Route 15 is used by oil & gas affiliated vessels (100%). The main vessel using this route is the *Putford Trader*.
Route 16	1 vessel per 5 days	Great Yarmouth (UK) to Murdoch gas platform. Route 16 is an alternative to route 11 and is used by oil & gas affiliated vessels (100%). The main vessels using this route are the *VOS Glory* and *VOS Gorgeous*.

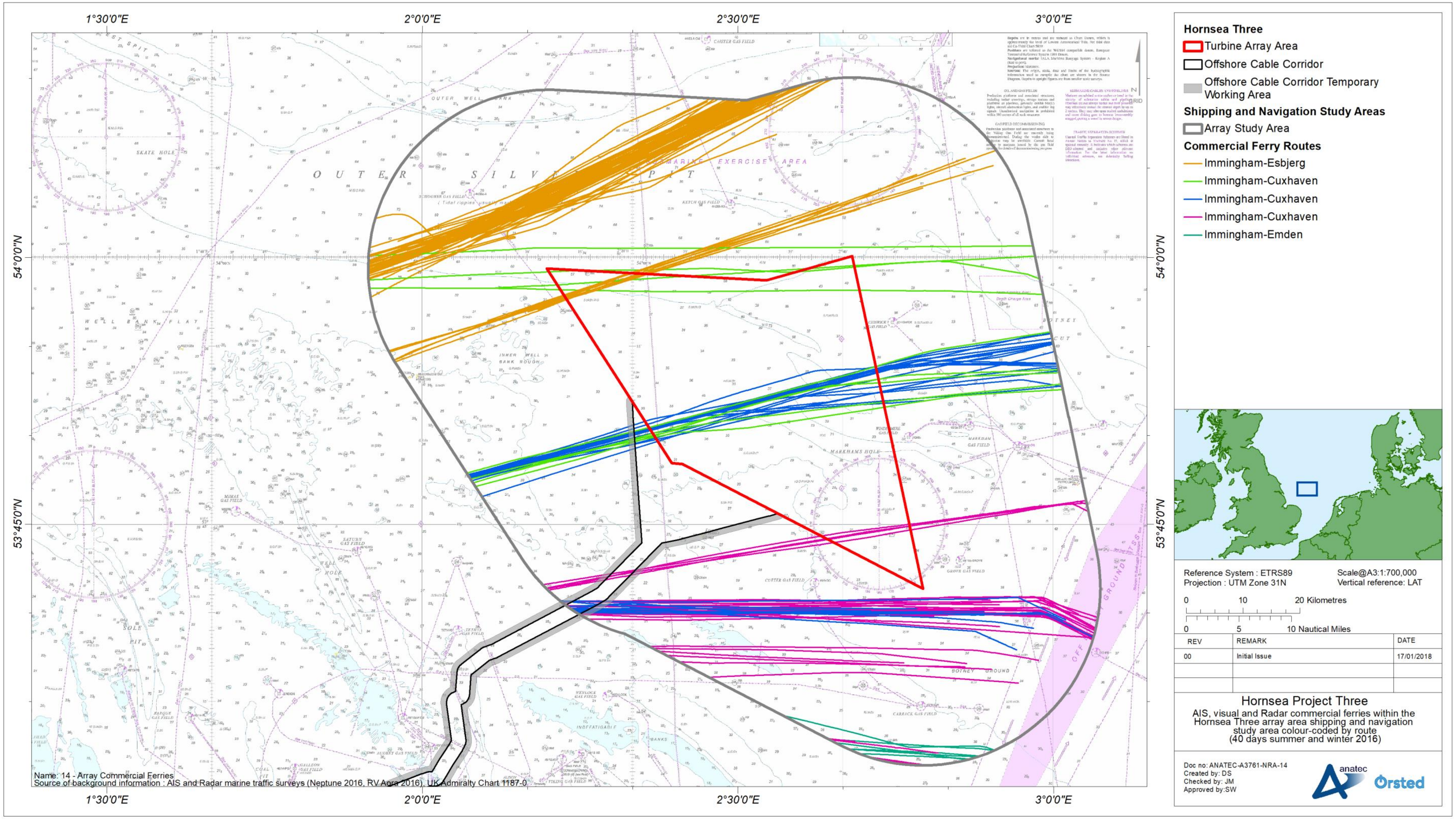

Figure 15.14:AIS, visual and Radar commercial ferries within the Hornsea Three array area shipping and navigation study area colour-coded by route (40 days summer and winter 2016).

15.2.9 Recreational vessel activity

15.2.9.1 This section reviews recreational vessel activity in proximity to the Hornsea Three array area based on the marine traffic surveys.

15.2.9.2 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, as per the Recreational Craft Regulations 2017 No. 737.

15.2.9.3 Figure 15.15 presents the recreational tracks recorded during the marine traffic survey.

15.2.9.4 Throughout the combined summer and winter survey period, an average of one unique recreational craft per day passed within the Hornsea Three array area shipping and navigation study area. However, 45% of all recreational activity was recorded on two days, 28 and 29 June 2016, when the annual *500 Mile North Sea Race* for sailing vessels passed through the Hornsea Three array area.

15.2.9.5 It is noted that 87% of recreational craft recorded throughout the combined summer and winter survey period were recorded on AIS; with only 13% recorded on Radar.

15.2.10 Fishing vessel activity

15.2.10.1 This section reviews the fishing vessel activity in proximity to the Hornsea Three array area based on the marine traffic surveys and commercial fisheries study (volume 2, chapter 6: Commercial Fisheries).

Survey data

15.2.10.2 Fishing vessel activity was recorded during the AIS, visual and Radar marine traffic surveys and is presented in Figure 15.16.

15.2.10.3 It can be seen that fishing vessel activity was recorded within the Hornsea Three array area shipping and navigation study area, with vessels tracked transiting through the Hornsea Three array area as well as actively engaged in fishing.

15.2.10.4 Flag State (nationality) information was available for approximately 85% of fishing vessels recorded on AIS, visual and Radar within the Hornsea Three array area shipping and navigation study area. Of the nationalities identified, the most common were the Netherlands (37%), UK (24%), France (15%) and Belgium (12%).

15.2.10.5 Fishing method information was available for approximately 78% of fishing vessels recorded on AIS, visual and Radar within the Hornsea Three array area shipping and navigation study area. Of the fishing methods identified, the most common were demersal stern trawlers (34%), beam trawlers (33%) and seine netters (20%). No recreational fishing vessels were identified within the marine traffic survey data.

Sightings data

15.2.10.6 Fishing vessel sightings (over flight and/or vessel-based) recorded between 2005 and 2009 was analysed for the Hornsea Three array area shipping and navigation study area.

15.2.10.7 The most common nationalities identified were the Netherlands (41%), UK (25%) and Belgium (14%), while the most common fishing methods identified were unspecified trawlers (43%), beam trawlers (43%) and demersal stern trawlers (10%). Both the nationality and fishing method distributions show good agreement with the corresponding distributions for the marine traffic survey data.

15.2.10.8 In terms of fishing vessel activity, 91% of fishing vessels whose activity type was available were actively engaged in fishing activity (with 7% in transit and 2% laid stationary). This shows good agreement with the fishing vessel tracks shown in Figure 15.16.

Satellite data

15.2.10.9 Satellite data (from the MMO and collected for fishing vessels of 15 m length and over) recorded throughout 2009 was analysed for the Hornsea Three array area shipping and navigation study area.

15.2.10.10 The most common nationalities identified were the Netherlands (33%), UK (30%) and Germany (12%), while the most common fishing methods identified were demersal stern trawlers (47%), beam trawlers (18%) and seine netters (16%). As with the sightings data, both the nationality and fishing method distributions show good agreement with the corresponding distributions for the marine traffic survey data.

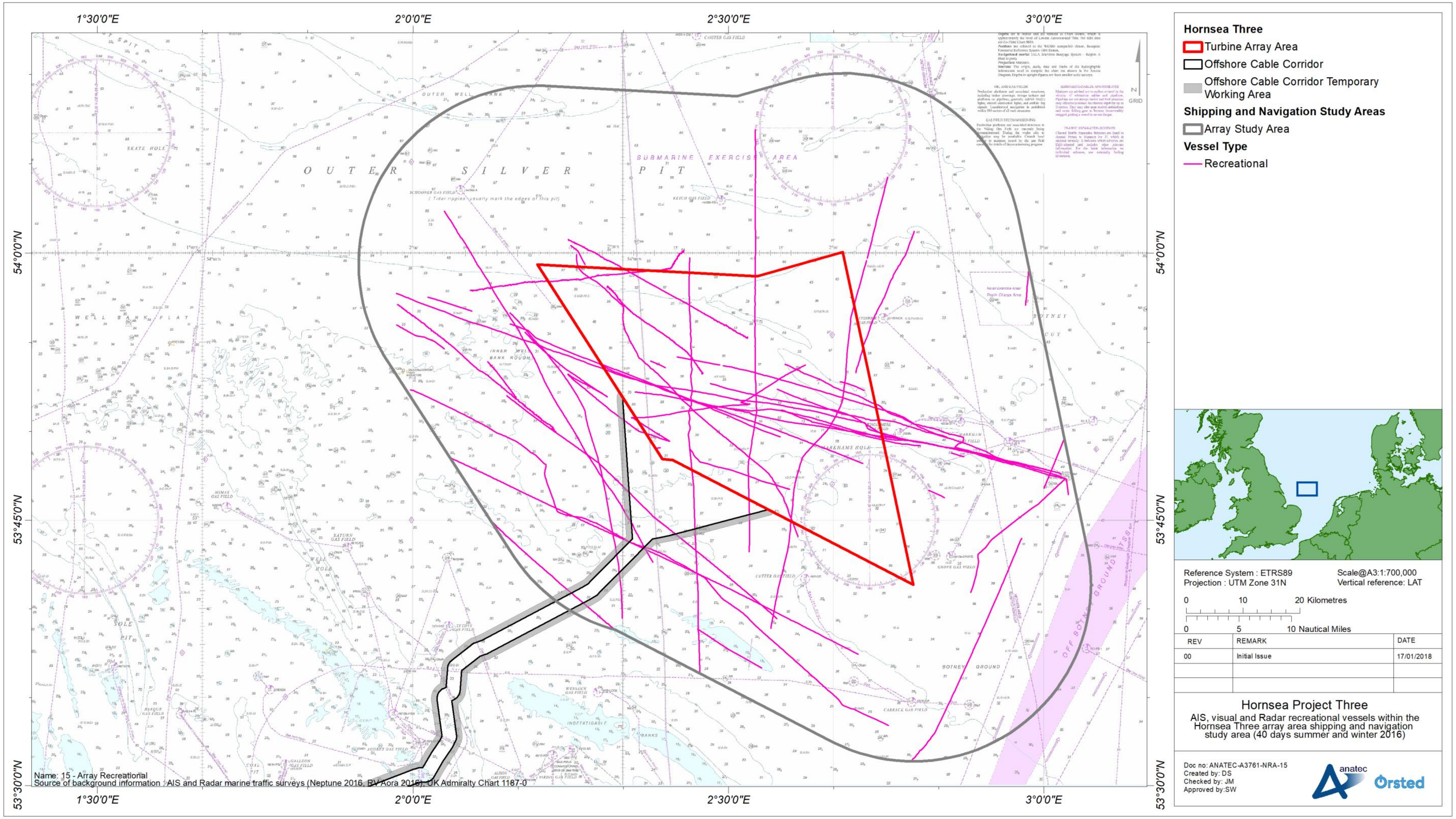

Figure 15.15: AIS, visual and Radar recreational vessels within the Hornsea Three array area shipping and navigation study area (40 days summer and winter 2016).

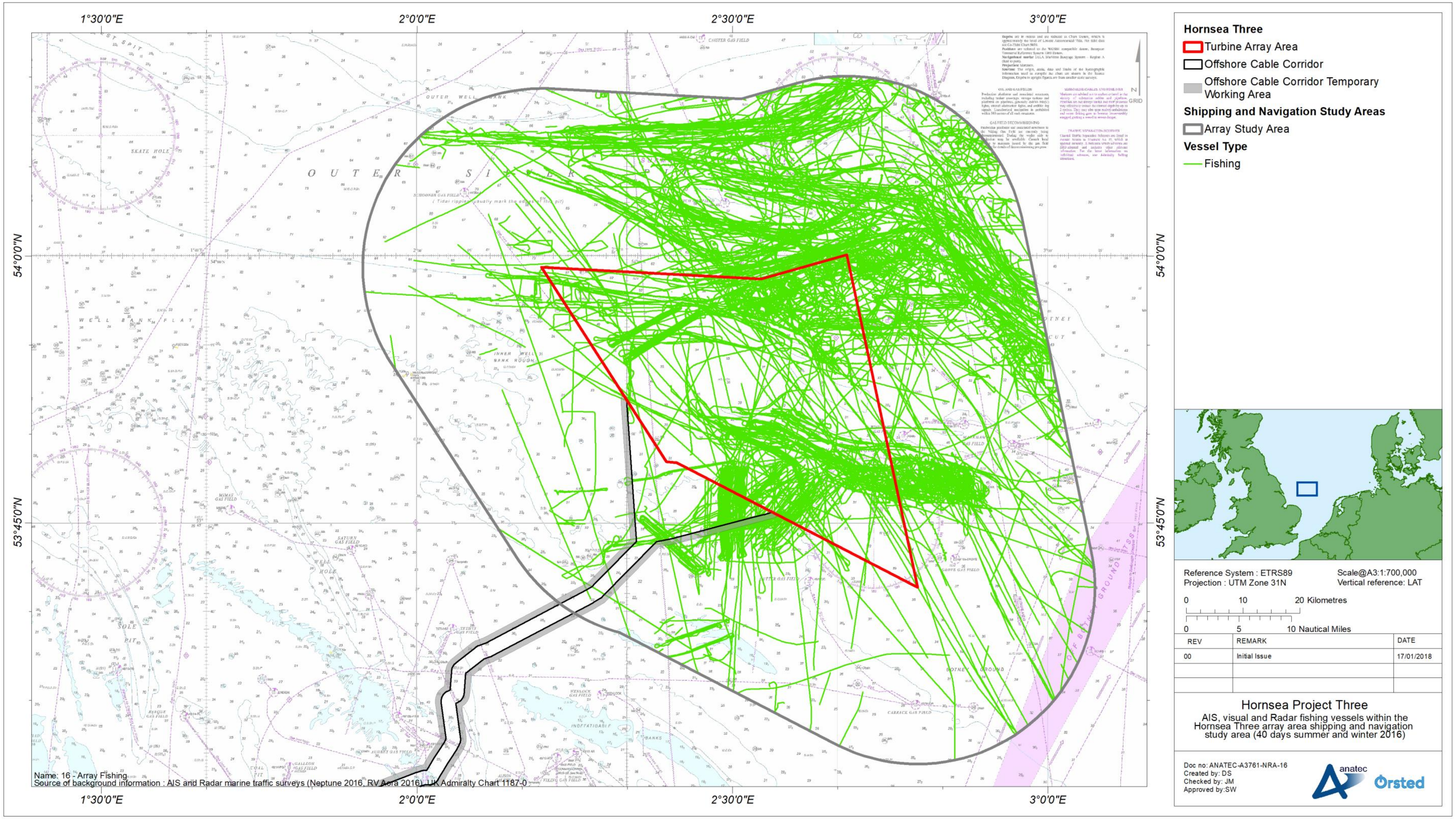

Figure 15.16: AIS, visual and Radar fishing vessels within the Hornsea Three array area shipping and navigation study area (40 days summer and winter 2016).

15.3 Hornsea Three offshore cable corridor

15.3.1.1 AIS data collected for the Hornsea Three offshore cable corridor shipping and navigation study area between 6 June to 4 July 2016 and between 10 November and 15 December 2016 has been analysed. The Hornsea Three offshore cable corridor is crossed by a number of dense traffic routes, with the majority of these between the UK east coast and mainland Europe, including the Netherlands, Belgium, Germany and France. There are also a notable number of dense traffic routes between UK east coast ports in areas close to shore and routes associated with oil and gas affiliated vessels, with Great Yarmouth the primary base port.

15.3.1.2 A number of tracks recorded during the survey were classified as temporary (non-routine) such as the tracks of the survey vessels and traffic associated with temporary drilling rigs and have therefore been excluded from the analysis. Oil and gas vessels supporting permanent installations were retained in the analysis.

15.3.1.3 A plot of vessel tracks recorded during the combined 40 day summer and winter survey period, colour-coded by vessel type and excluding temporary traffic (as defined above) are presented in Figure 15.18.

15.3.1.4 For the 26 days analysed in June and July 2016, there were an average of 94 unique vessels per day passing within the Hornsea Three offshore cable corridor shipping and navigation study area and 86 through the Hornsea Three offshore cable corridor itself, recorded on AIS (excluding temporary traffic).

15.3.1.5 Figure 15.19 illustrates the daily number of unique vessels passing within the Hornsea Three offshore cable corridor shipping and navigation study area and intersecting the Hornsea Three offshore cable corridor, during 26 days from June and July 2016.

15.3.1.6 The busiest day recorded throughout the summer period was the 9 June 2016 when 116 unique vessels were recorded within the Hornsea Three offshore cable corridor shipping and navigation study area and 103 within the Hornsea Three offshore cable corridor.

15.3.1.7 The quietest day recorded throughout the summer period was the 15 June 2016 when 68 unique vessels were recorded within the Hornsea Three offshore cable corridor shipping and navigation study area and 60 within the Hornsea Three offshore cable corridor.

15.3.1.8 For the 14 days analysed in November to December 2016, there were an average of 92 unique vessels per day passing within the Hornsea Three offshore cable corridor shipping and navigation study area and 86 through the Hornsea Three offshore cable corridor itself, recorded on AIS (excluding temporary traffic).

15.3.1.9 Figure 15.19 illustrates the daily number of unique vessels passing within the Hornsea Three offshore cable corridor shipping and navigation study area and intersecting the Hornsea Three offshore cable corridor during 14 days between November and December 2016.

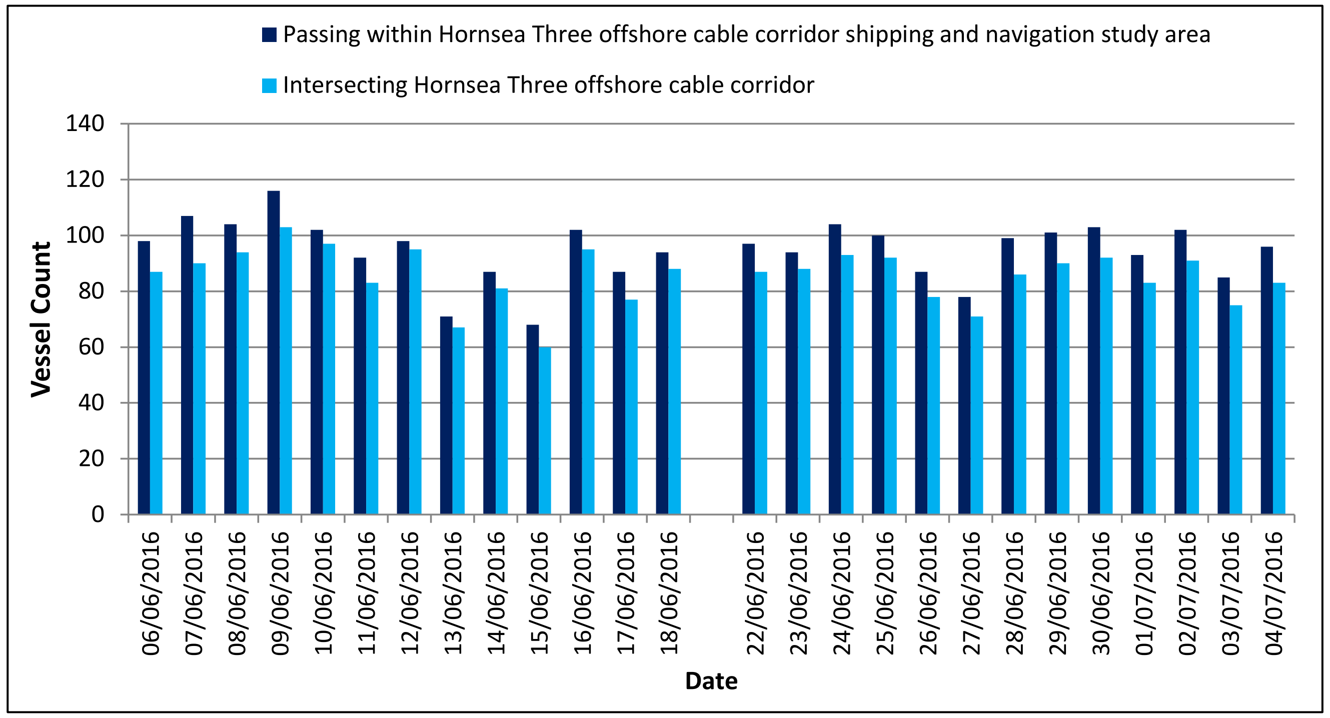

Figure 15.17: Unique vessels per day within the Hornsea Three offshore cable corridor shipping and navigation study area during 26 days summer 2016 (AIS).

15.3.1.10 The busiest day recorded throughout the winter period was the 26 November 2016 when 106 unique vessels were recorded within the Hornsea Three offshore cable corridor shipping and navigation study area and 102 within the Hornsea Three offshore cable corridor.

15.3.1.11 The quietest day throughout the winter period was the 28 November 2016 when 74 unique vessels were recorded within the Hornsea Three offshore cable corridor shipping and navigation study area and 67 within the Hornsea Three offshore cable corridor.

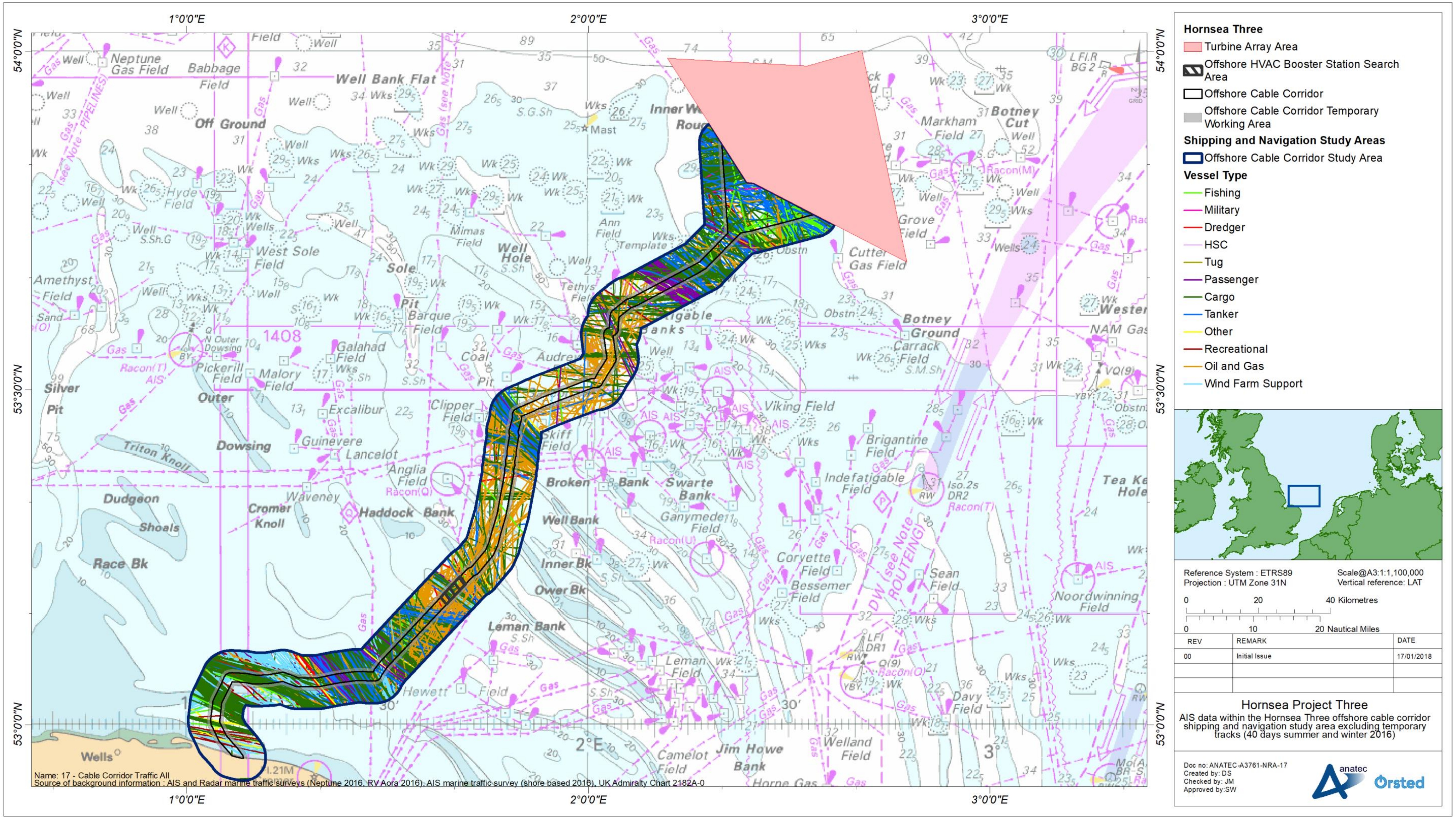

Figure 15.18:Overview of AIS data within the Hornsea Three offshore cable corridor shipping and navigation study area excluding temporary tracks (40 days summer and winter 2016).

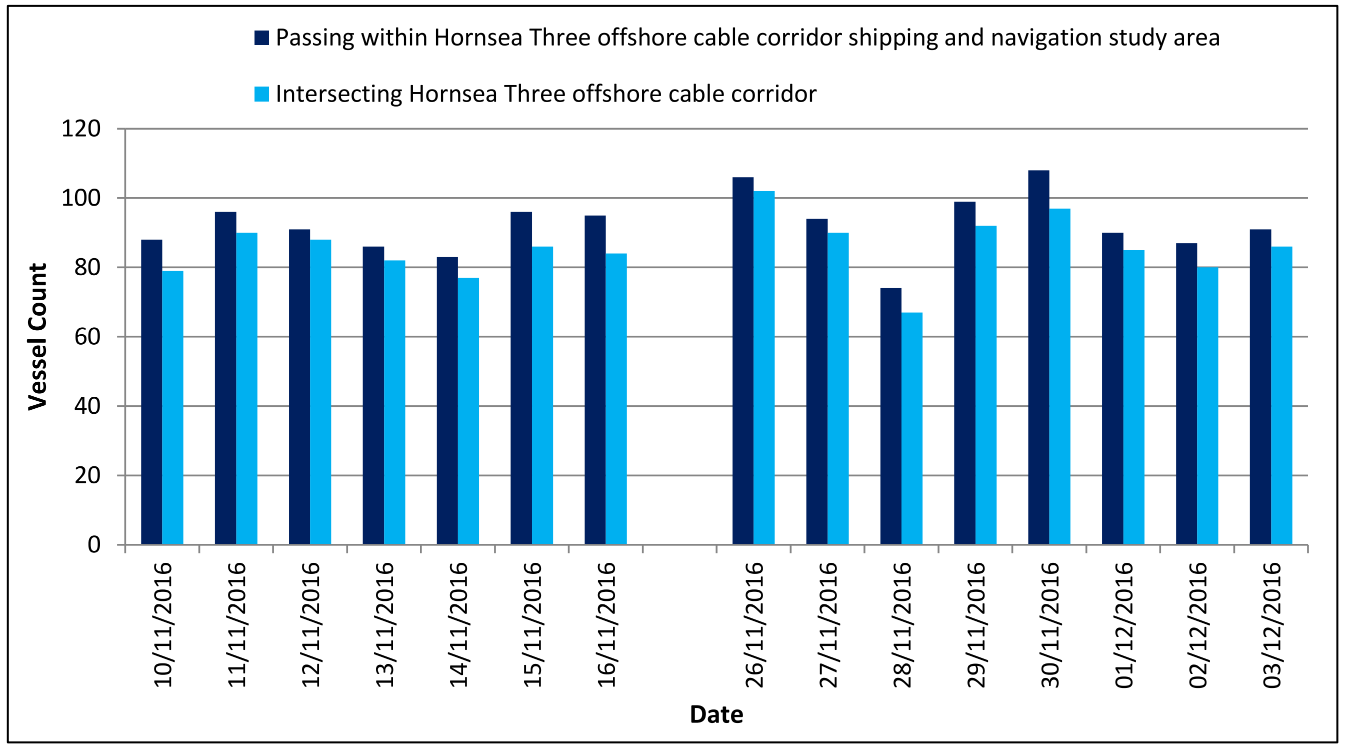

Figure 15.19: Unique vessels per day within the Hornsea Three offshore cable corridor shipping and navigation study area during 14 days winter 2016 (AIS).

15.3.2 Vessel types

15.3.2.1 Analyses of the main vessel types recorded passing within the Hornsea Three offshore cable corridor shipping and navigation study area and intersecting the Hornsea Three offshore cable corridor throughout both survey periods are presented in Figure 15.20.

15.3.2.2 Throughout June and July 2016 (summer) the majority of tracks were cargo vessels (approximately 52% within the Hornsea Three offshore cable corridor) and tankers (20%). Throughout November and December 2016 (winter) the majority of tracks were also cargo vessels (57% within the Hornsea Three offshore cable corridor) and tankers (21%). It should be noted that the cargo vessel category includes commercial ferries (e.g. DFDS Seaways commercial ferries) who generally broadcast their vessel types on AIS as cargo.

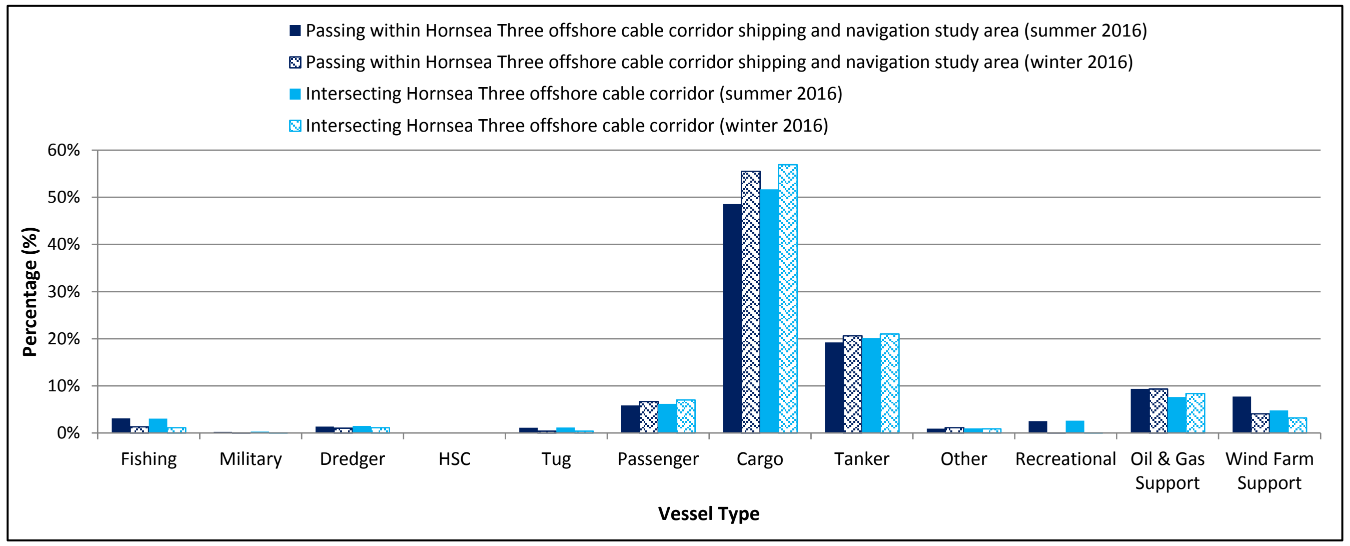

Figure 15.20: Distribution of vessel types within the Hornsea Three offshore cable corridor shipping and navigation study area during 40 days summer and winter 2016 (AIS).

15.3.2.3 Figure 15.21 presents plots of the main vessel types recorded on AIS within the Hornsea Three offshore cable corridor shipping and navigation study area, including cargo vessels (including commercial ferries) (Panel A), tankers (Panel B), Oil and Gas affiliated vessels (Panel C) and wind farm support vessels (Panel D) throughout both the summer and winter survey periods.

15.3.2.4 Throughout the combined summer and winter survey period, an average of 49 unique cargo vessels per day passed within the Hornsea Three offshore cable corridor shipping and navigation study area and 47 within the Hornsea Three offshore cable corridor itself.

15.3.2.5 Regular cargo vessels operating in the Hornsea Three offshore cable corridor shipping and navigation study area includes DFDS Seaways commercial Ro Ro ferries vessels operating routes between Rosyth (UK) and Zeebrugge (Belgium), Immingham (UK) and Rotterdam (Netherlands), and Immingham (UK) and Cuxhaven (Germany).

15.3.2.6 Throughout the combined summer and winter survey period, an average of 19 tankers per day passed within the Hornsea Three offshore cable corridor shipping and navigation study area and 18 within the Hornsea Three offshore cable corridor itself.

15.3.2.7 All of the tankers recorded throughout the survey period were on passage to oil and gas terminals throughout the UK and mainland Europe including: Antwerp (Belgium), Rotterdam (Netherlands), Immingham (UK), Grangemouth (UK) and Teesport (UK).

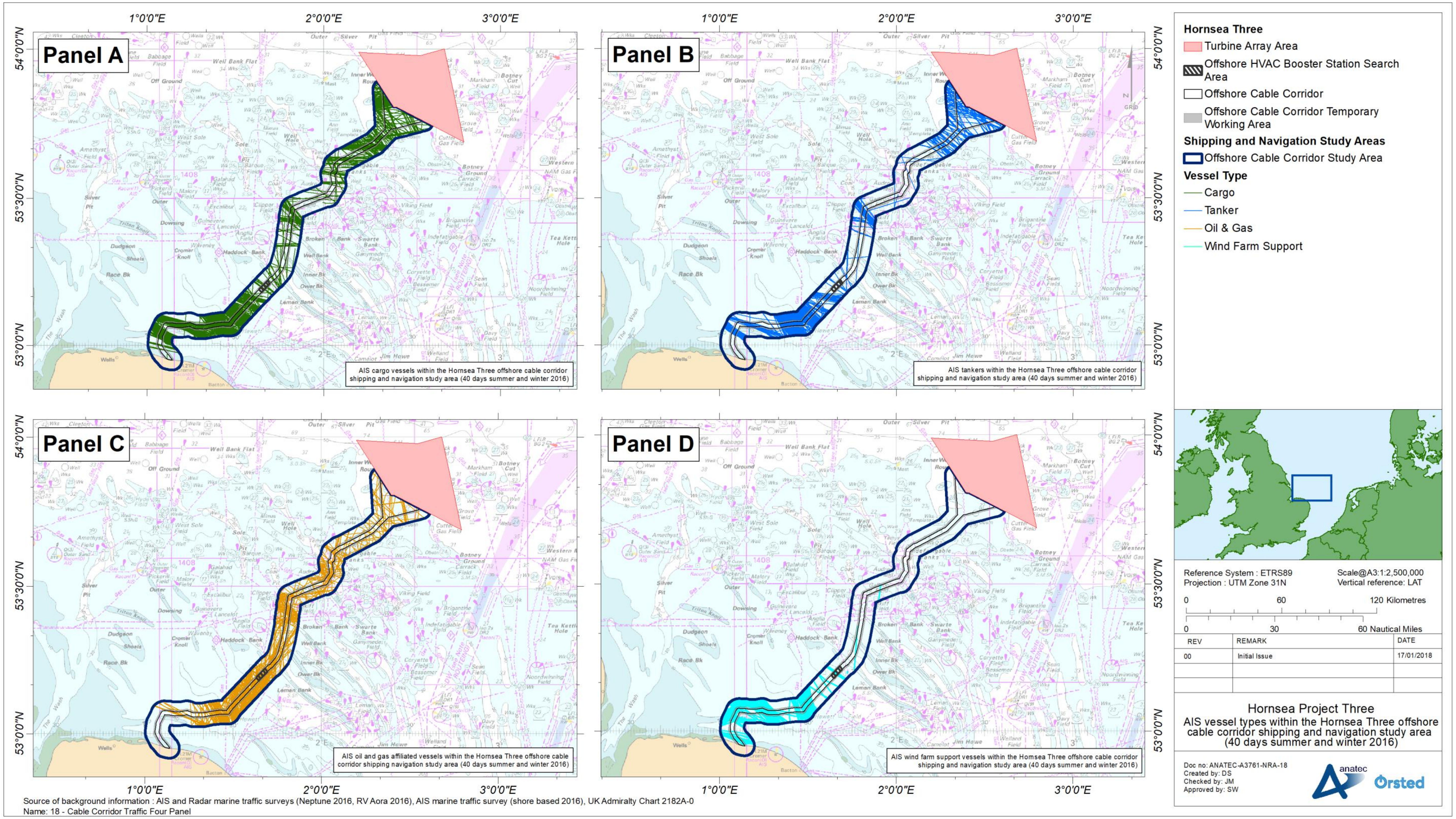

Figure 15.21: AIS vessel types within the Hornsea Three offshore cable corridor shipping and navigation study area (40 days summer and winter 2016).

15.3.2.8 Throughout the combined summer and winter survey period, an average of nine unique offshore oil and gas affiliated vessels per day passed within the Hornsea Three offshore cable corridor shipping and navigation study area and seven within the Hornsea Three offshore cable corridor itself. The majority of these vessels were on passage to/from oil and gas installations in the vicinity of the Hornsea Three offshore cable corridor.

15.3.2.9 Offshore oil and gas affiliated vessels that were not transient included vessels which were acting as the ERRV for nearby oil and gas surface platforms in the vicinity of the Hornsea Three offshore cable corridor shipping and navigation study area.

15.3.2.10 Throughout the combined summer and winter survey period, an average of six wind farm support vessels per day passed within the Hornsea Three offshore cable corridor shipping and navigation study area and three to four within the Hornsea Three offshore cable corridor itself.

15.3.2.11 Wind farm support vessels recorded throughout the survey period were generally on passage to the Sheringham Shoal Offshore Wind Farm and Dudgeon Offshore Wind Farm, within the southern section of the Hornsea Three offshore cable corridor shipping and navigation study area. Sheringham Shoal has been operational since 2013, with regular maintenance traffic recorded during the survey period. Dudgeon was under construction at the time of the marine traffic survey, with regular construction traffic recorded.

15.3.3 Recreational vessel activity

15.3.3.1 This section reviews recreational vessels activity in the Hornsea Three offshore cable corridor shipping and navigation study area based on the recreational AIS density grid published by the RYA, as well as AIS data recorded during the marine traffic surveys. The RYA recreational AIS density grid is based upon data recorded over three summer periods between 2011 and 2013 and generally covers the sea area up to 12 nm offshore.

15.3.3.2 Figure 15.22 presents a plot of recreational vessels recorded on AIS throughout both the summer and winter survey periods, along with the RYA recreational AIS density grid within the Hornsea Three offshore cable corridor shipping and navigation study area.

15.3.3.3 Throughout the combined summer and winter survey period, an average of one to two recreational vessels per day passed within the Hornsea Three offshore cable corridor shipping and navigation study area and one to two within the Hornsea Three offshore cable corridor itself. The majority of these vessels were undertaking a passage alongside the shore.

15.3.3.4 The RYA recreational density grid indicates a reasonably high level of recreational activity from AIS equipped craft in the nearshore area of the Hornsea Three offshore cable corridor, including a number of distinctive regular routes. It is noted that the RYA request the use of this data source to identify recreational traffic levels.

15.3.4 Fishing vessel activity

15.3.4.1 A plot of fishing vessels recorded on AIS throughout both the summer and winter survey periods is shown in Figure 15.23.

15.3.4.2 Throughout the combined summer and winter survey period, an average of two to three fishing vessels per day passed within the Hornsea Three offshore cable corridor shipping and navigation study area and two within the Hornsea Three offshore cable corridor itself. The majority of these vessels were either on passage in a north-south direction or actively engaged in fishing activities in the vicinity of the Hornsea Three array area or the shore.

15.3.5 Vessel size distribution

Maximum LOA

15.3.5.1 LOAs recorded throughout the survey periods ranged from 5 m (recreational sailing vessel *Wolfies Toy* and *RNLI Lifeboat D-734*) to a maximum of 333 m (crude oil tanker *Selene Trader*). Figure 15.24 illustrates the distribution of vessel lengths throughout each survey period.

15.3.5.2 The average length of vessels within the Hornsea Three offshore cable corridor shipping and navigation study area throughout the summer and winter survey periods were 105 m and 114 m respectively. This reflects the greater proportion of small vessels (<50 m) recorded throughout the summer survey within the Hornsea Three offshore cable corridor shipping and navigation study area.

15.3.5.3 Figure 15.25 provides an overview of AIS vessel tracks (excluding temporary traffic) recorded throughout the combined summer and winter survey period colour-coded by vessel length.

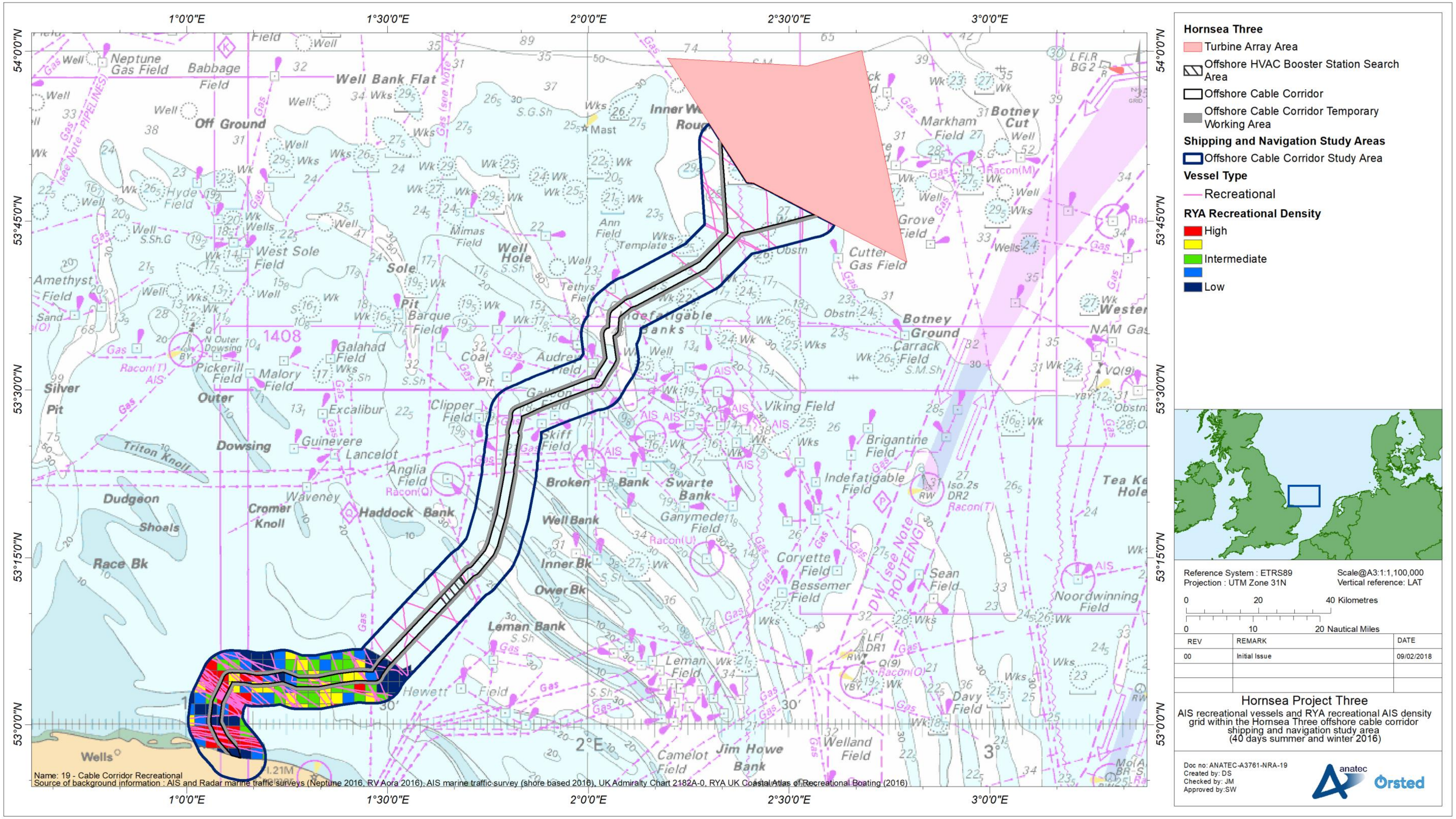

Figure 15.22:AIS recreational vessels and RYA recreational AIS density grid within Hornsea Three offshore cable corridor shipping and navigation study area (40 days summer and winter 2016).

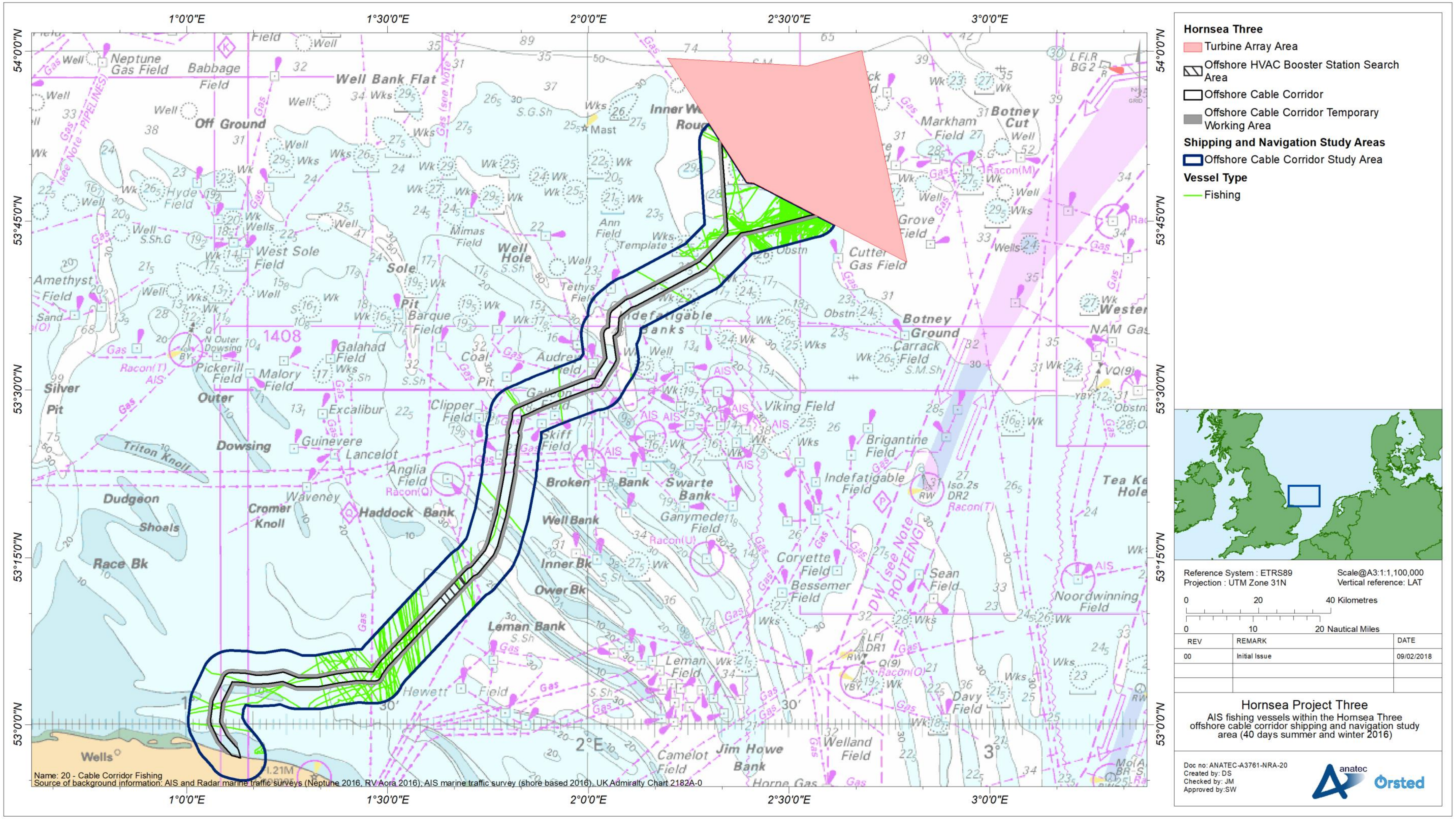

Figure 15.23: AIS fishing vessels within the Hornsea Three offshore cable corridor shipping and navigation study area (40 days summer and winter 2016).

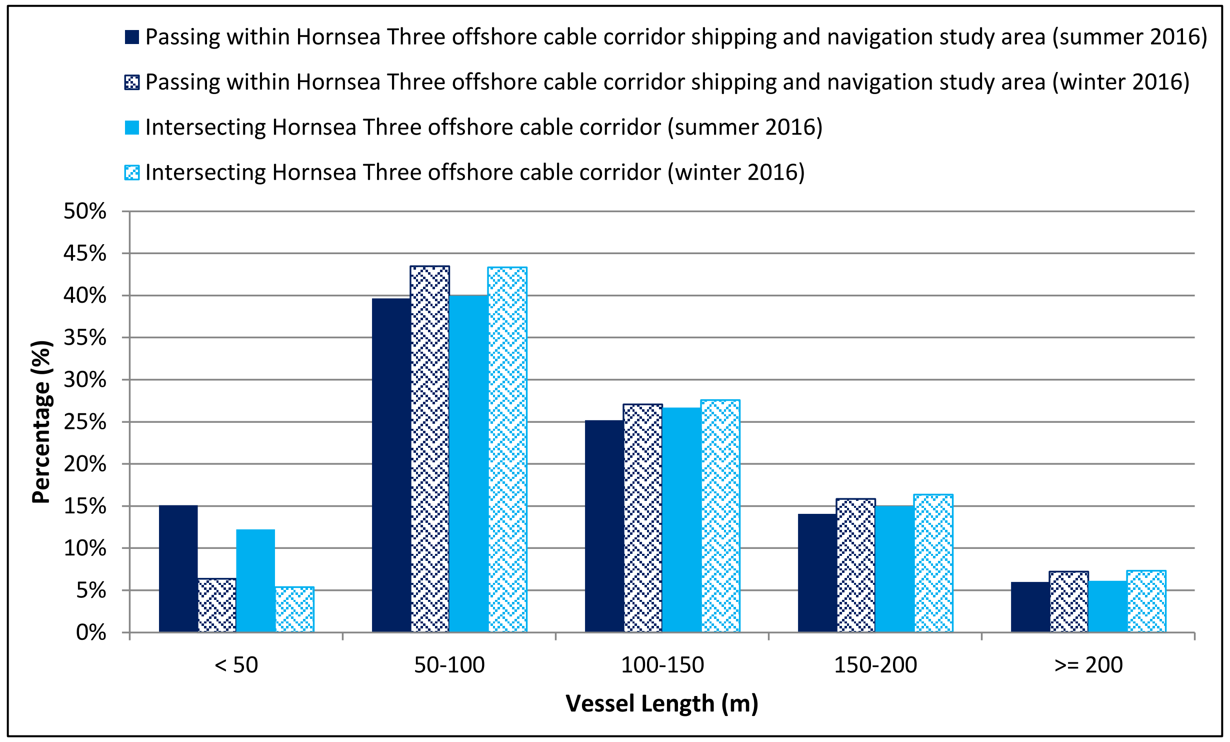

Figure 15.24: Vessel length distribution within the Hornsea Three offshore cable corridor shipping and navigation study area during 40 days summer and winter 2016 (AIS).

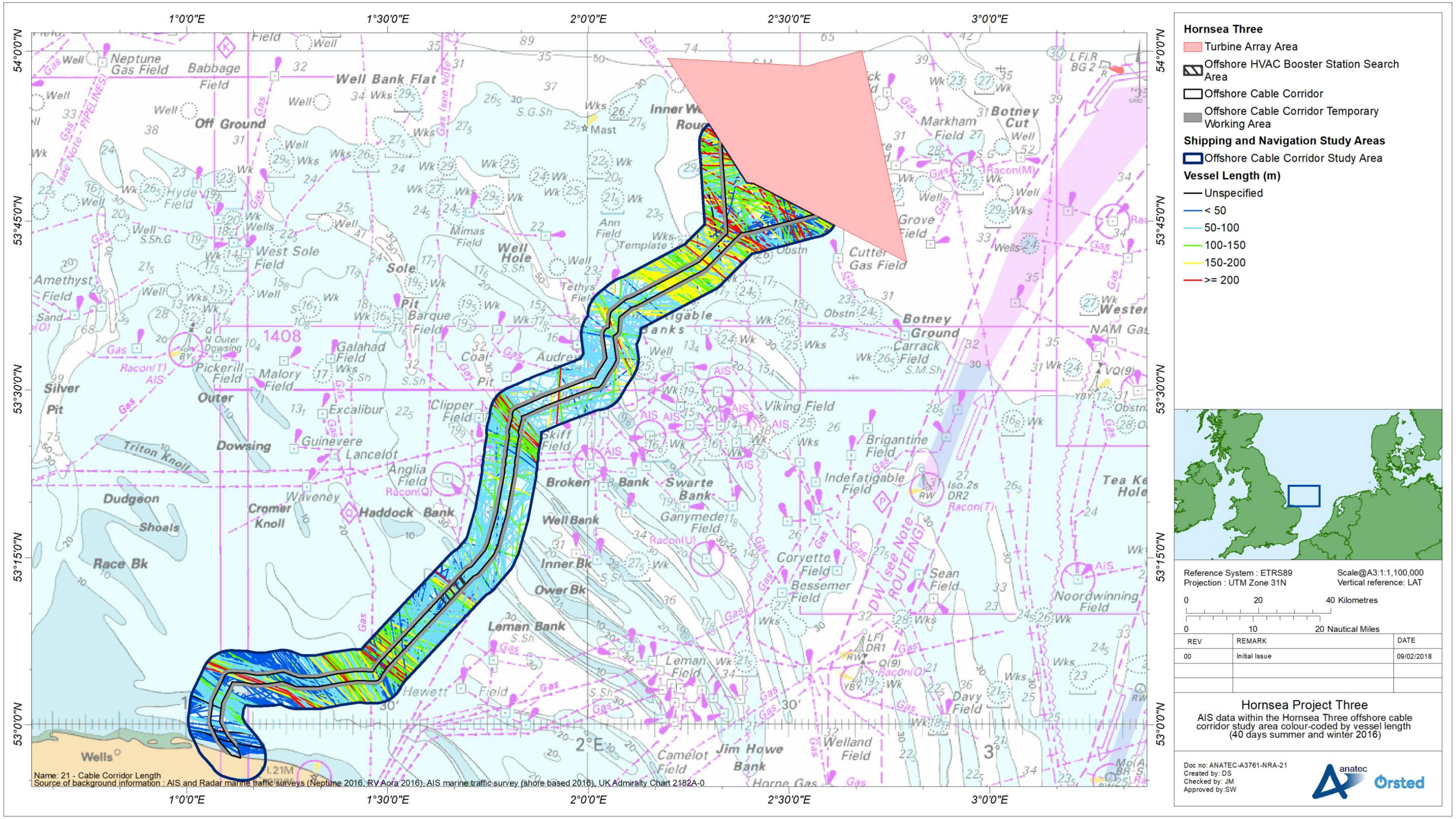

Figure 15.25: AIS data within the Hornsea Three offshore cable corridor shipping and navigation study area colour-coded by vessel length (40 days summer and winter 2016).

Vessel draught

15.3.5.4 Vessel draughts recorded throughout the survey periods ranged from 0.9 m (wind farm support vessel *Eastern Aura*) to 15.0 m (crude oil tanker *Victory 1*). Figure 15.26 illustrates the distribution of vessel draughts recorded throughout each survey period.

15.3.5.5 It should be noted that approximately 7% of the total number of unique vessels within the Hornsea Three offshore cable corridor shipping and navigation study area did not broadcast a draught on AIS and hence have been excluded from the analysis.

15.3.5.6 The average draughts of vessels within the Hornsea Three offshore cable corridor shipping and navigation study area throughout the summer and winter survey periods were 5.2 m and 5.3 m respectively.

15.3.5.7 Figure 15.27 provides an overview of AIS vessel tracks (excluding temporary traffic) recorded throughout the combined summer and winter survey period colour-coded by vessel draught.

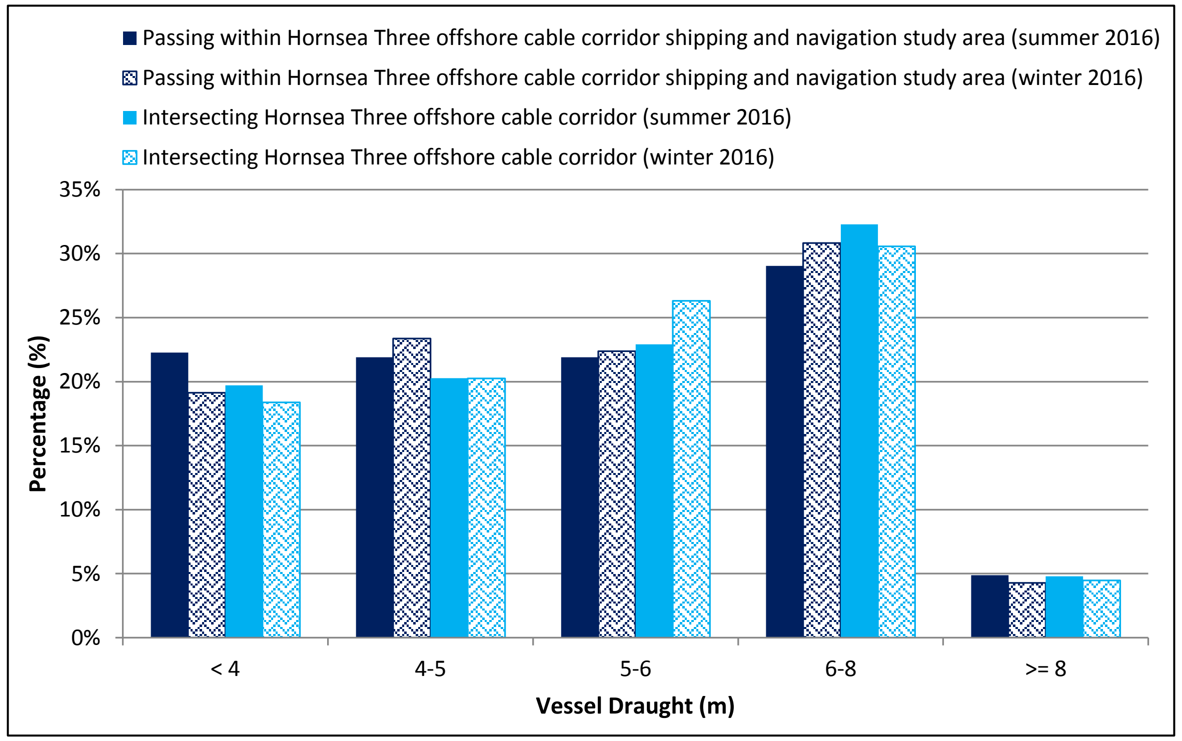

Figure 15.26: Vessel draught distribution within offshore cable corridor shipping and navigation study area during 40 days summer and winter 2016 (AIS).

15.3.6 Anchored vessels

15.3.6.1 Anchored vessels can be identified based on the AIS navigational status which is programmed on the AIS transmitter on-board a vessel.

15.3.6.2 Throughout the 40 day period analysed, only one vessel was recorded broadcasting “at anchor” which was the wind farm support vessel *Yvonne W*.

15.3.6.3 However, as information is manually entered into the AIS; it is common for vessels not to update the navigational status if they are anchored for only a short period of time. For this reason, those vessels which travelled at a speed of less than one knot for more than 30 minutes are assumed to be at anchor.

15.3.6.4 After applying these criteria, no further vessels were deemed to be at anchor.

15.4 Hornsea Three offshore HVAC booster station search area survey analysis

15.4.1.1 As with the Hornsea Three array area and offshore cable corridor marine traffic surveys, a number of tracks recorded during the summer and winter surveys for the Hornsea Three offshore HVAC booster station search area were classified as temporary (non-routine), such as the tracks of the survey vessels and traffic associated with temporary drilling rigs. This includes the survey vessel *Bibby Athena* which was carrying out survey operations along the Hornsea Three offshore cable corridor during the summer period. These tracks have therefore been excluded from the analysis. Oil and gas affiliated vessels supporting permanent installations were retained in the analysis given stakeholder feedback.

15.4.1.2 A plot of vessel tracks recorded during the combined 28 day summer and winter survey period, colour-coded by vessel type and excluding temporary traffic (as defined above) is presented in Figure 15.28.

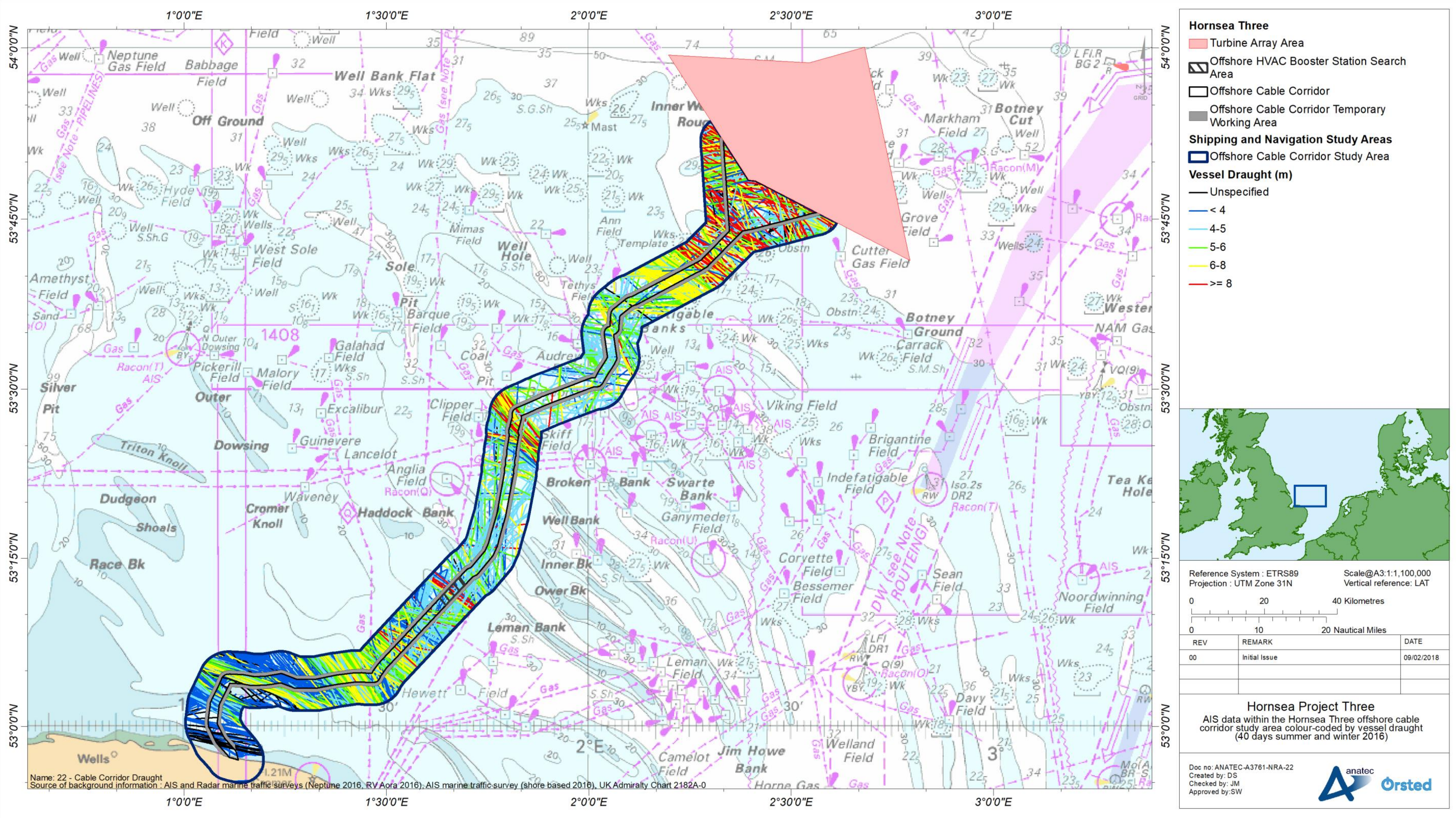

Figure 15.27:AIS data within the Hornsea Three offshore cable corridor shipping and navigation study area colour-coded by vessel draught (40 days summer and winter 2016).

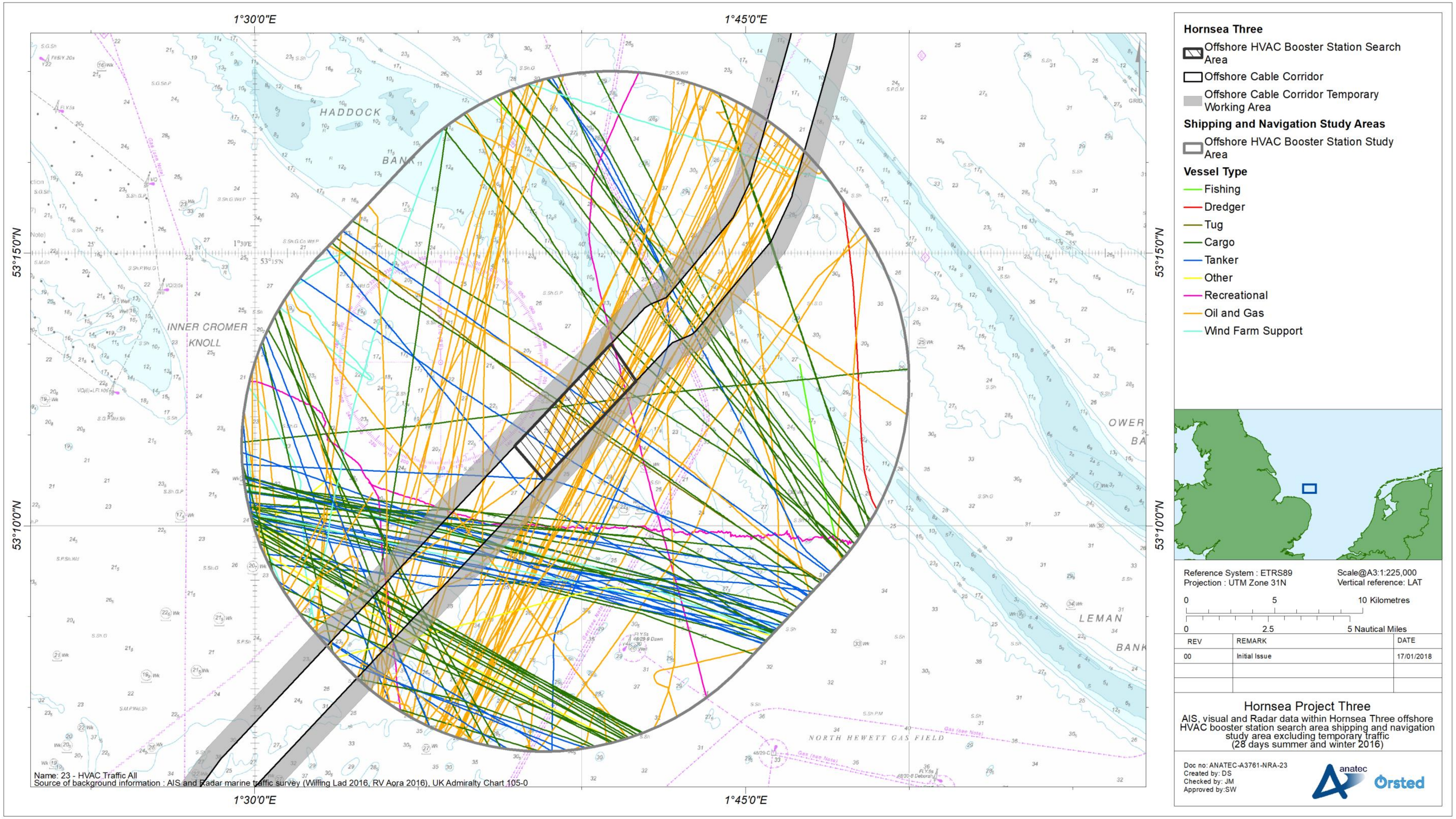

Figure 15.28:AIS, visual and Radar data within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area excluding temporary traffic (28 days summer and winter 2016).

15.4.2 Vessel counts

15.4.2.1 For the 14 days analysed in summer 2016, there were an average of six unique vessels per day passing within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area, recorded on AIS, visual and Radar. In terms of vessels intersecting the Hornsea Three offshore HVAC booster station search area, there was on average less than one unique vessel per day.

15.4.2.2 For the 14 days analysed in winter 2016, there were an average of five unique vessels per day passing within the Hornsea Three offshore HVAC booster station search shipping and navigation study area, recorded on AIS, visual and Radar. In terms of vessels intersecting the Hornsea Three offshore HVAC booster station search area, there was on average less than one unique vessel per day.

15.4.2.3 Figure 15.29 illustrates the daily number of unique vessels passing through the Hornsea Three offshore HVAC booster station search area shipping and navigation study area and intersecting the Hornsea Three offshore HVAC booster station search area throughout the survey period.

15.4.2.4 The busiest day recorded throughout the survey period, excluding partial days, was 22 November 2016 when ten unique vessels were recorded within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area; however only one unique vessel was recorded within the Hornsea Three offshore HVAC booster station search area on this day. The busiest day within the Hornsea Three offshore HVAC booster station search area itself was 13 December 2016 with four unique vessels.

15.4.2.5 The quietest days throughout the survey period, excluding partial days, were 4 and 11 December 2016 when two unique vessels were recorded within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area. There were 12 days (approximately 43% of the total survey period days) when no vessels were recorded intersecting the Hornsea Three offshore HVAC booster station search area.

15.4.2.6 Throughout the survey period only 13% of traffic recorded within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area intersected the Hornsea Three offshore HVAC booster station search area.

15.4.3 Vessel types

15.4.3.1 Analyses of the vessel types recorded passing within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area and intersecting the Hornsea Three offshore HVAC booster station search area throughout both survey periods are presented in Figure 15.30.

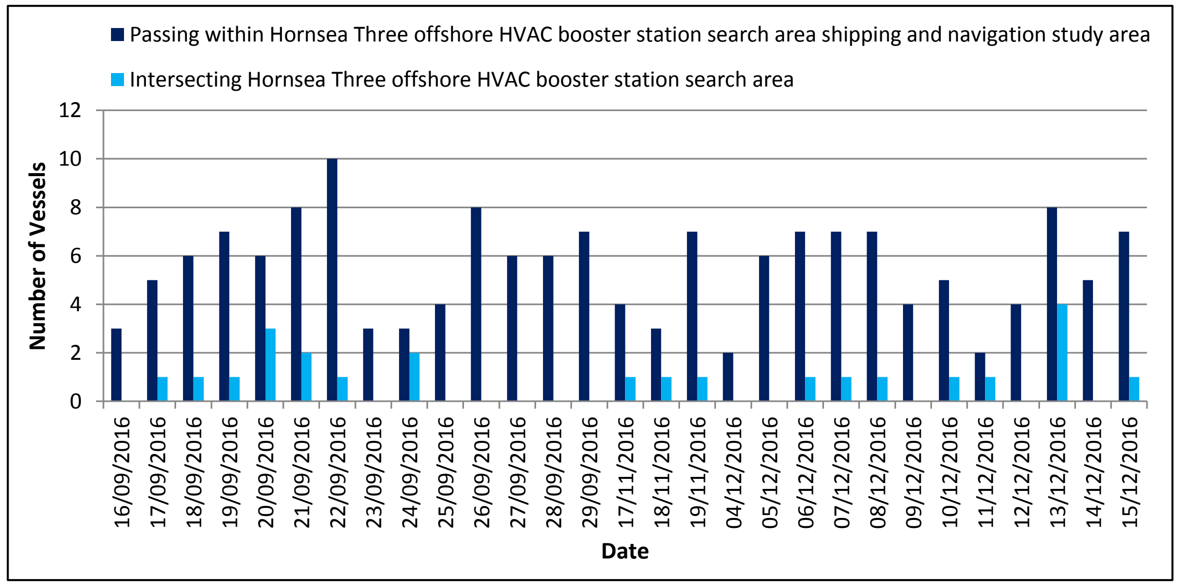

Figure 15.29: Unique vessels per day within offshore HVAC booster station search area shipping and navigation study area during 28 days summer and winter 2016 (AIS, visual and Radar).

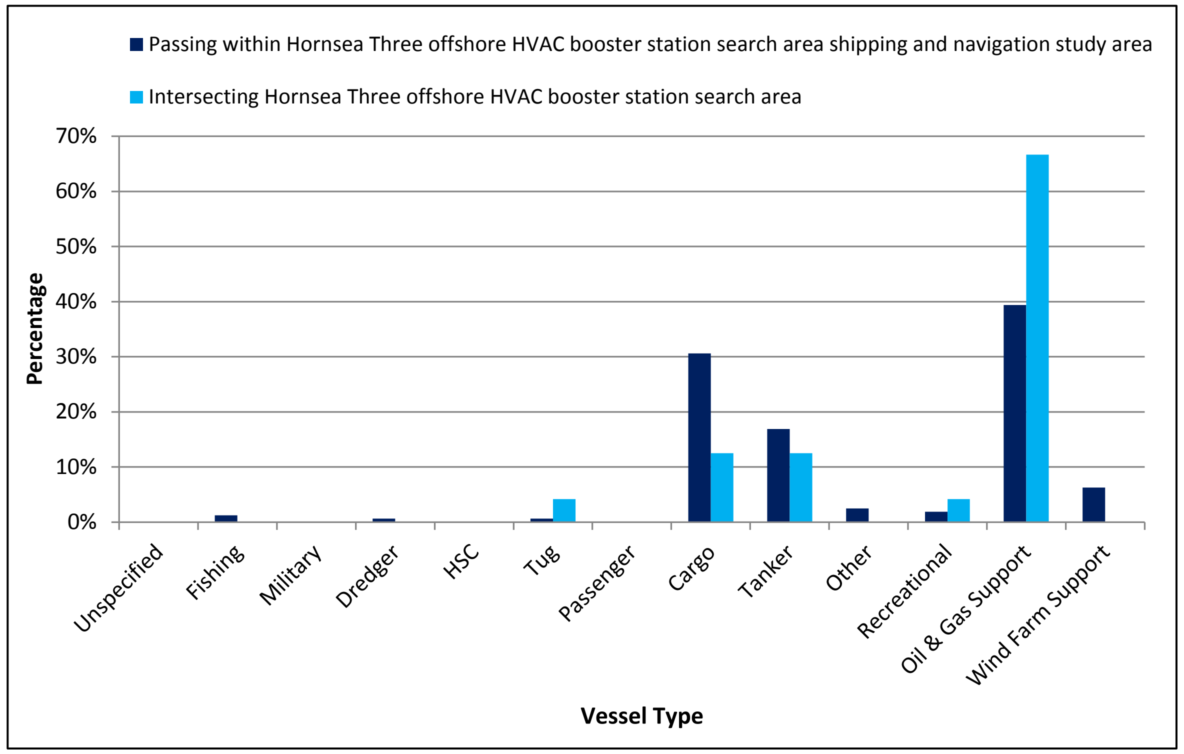

Figure 15.30: Distribution of vessel types within offshore HVAC booster station search area shipping and navigation study area during 28 days summer and winter 2016 (AIS, visual and Radar).

15.4.3.2 Throughout the survey periods the majority of tracks were oil and gas affiliated vessels (67% within the Hornsea Three offshore HVAC booster station search area) followed by cargo vessels and tankers (both 13%). It is noted that a small proportion of tracks intersecting the Hornsea Three offshore HVAC booster station search area were wind farm support vessels transiting to and from Dudgeon Offshore Wind Farm. This traffic is temporary and associated with the construction of the Dudgeon site; however it remains within the assessment given the potential for operational routeing. It should be noted that the cargo vessel category includes commercial ferries (e.g. DFDS Seaways ferries) operating in the area who generally broadcast their vessel types on AIS as cargo.

15.4.3.3 Figure 15.31 presents a plot of cargo vessels, including commercial ferries, recorded within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area on AIS, visual and Radar throughout both the summer and winter survey periods. Equivalent plots of tankers and oil and gas affiliated vessels are presented in Figure 15.32 and Figure 15.33 respectively.

15.4.3.4 Throughout the combined summer and winter survey period, an average of one to two unique cargo vessels per day (excluding partial days) passed within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area. However, only three cargo vessel tracks were recorded intersecting the Hornsea Three offshore HVAC booster station search area throughout the survey period.

15.4.3.5 Regular cargo vessels operating in the vicinity of the Hornsea Three offshore HVAC booster station search area shipping and navigation study area include two DFDS Seaways Ro Ro vessels operating routes between Immingham (UK) and Cuxhaven (Germany).

15.4.3.6 Throughout the combined summer and winter survey period, an average of one unique tanker per day passed within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area. However, only three tanker tracks were recorded intersecting the Hornsea Three offshore HVAC booster station search area throughout the survey period.

15.4.3.7 All of the tankers recorded throughout the survey period were on passage to oil and gas terminals throughout the UK and mainland Europe including Immingham, Teesport and Rotterdam.

15.4.3.8 Throughout the combined summer and winter period, an average of two to three unique oil and gas affiliated vessels per day passed within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area. The majority of these vessels were on passage to/from offshore oil and gas installations in the vicinity of Hornsea Three.

15.4.3.9 Offshore affiliated vessels that were not transient included the *Forties Sentinel* which was acting as the ERRV for the nearby Clipper South gas platform.

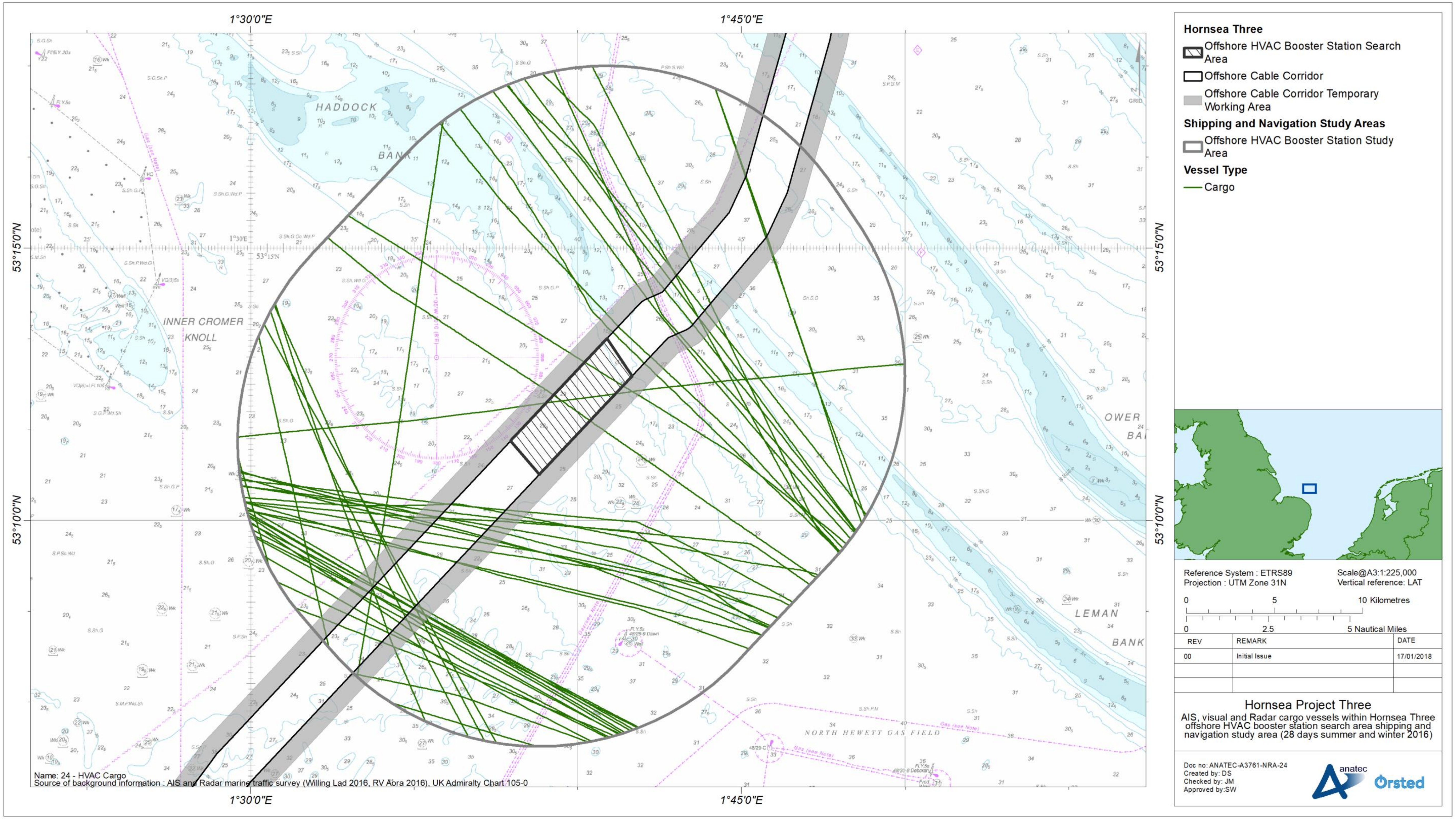

Figure 15.31:AIS, visual and Radar cargo vessels within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area (28 days summer and winter 2016).

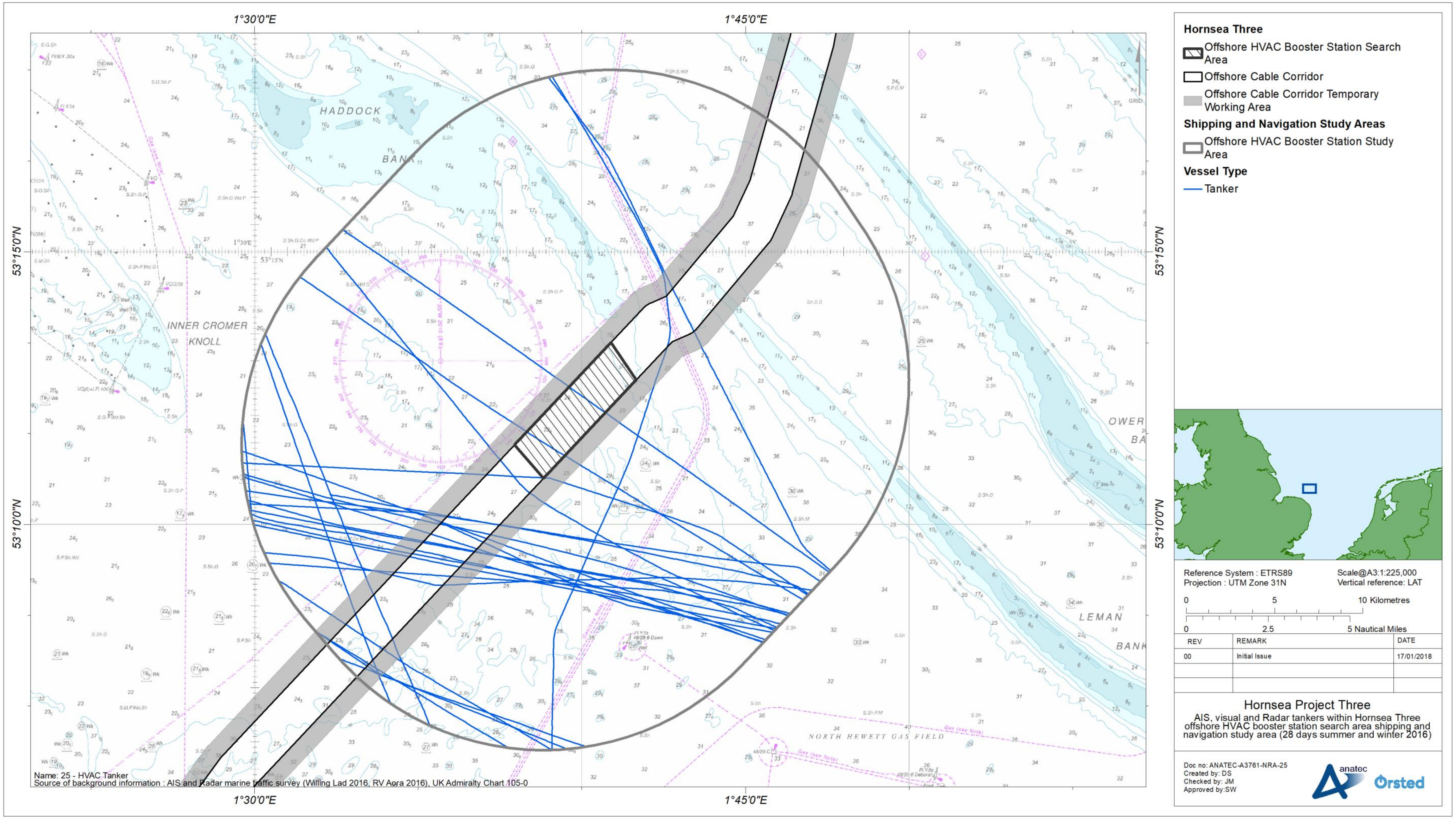

Figure 15.32: AIS, visual and Radar tankers within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area (28 days summer and winter 2016).

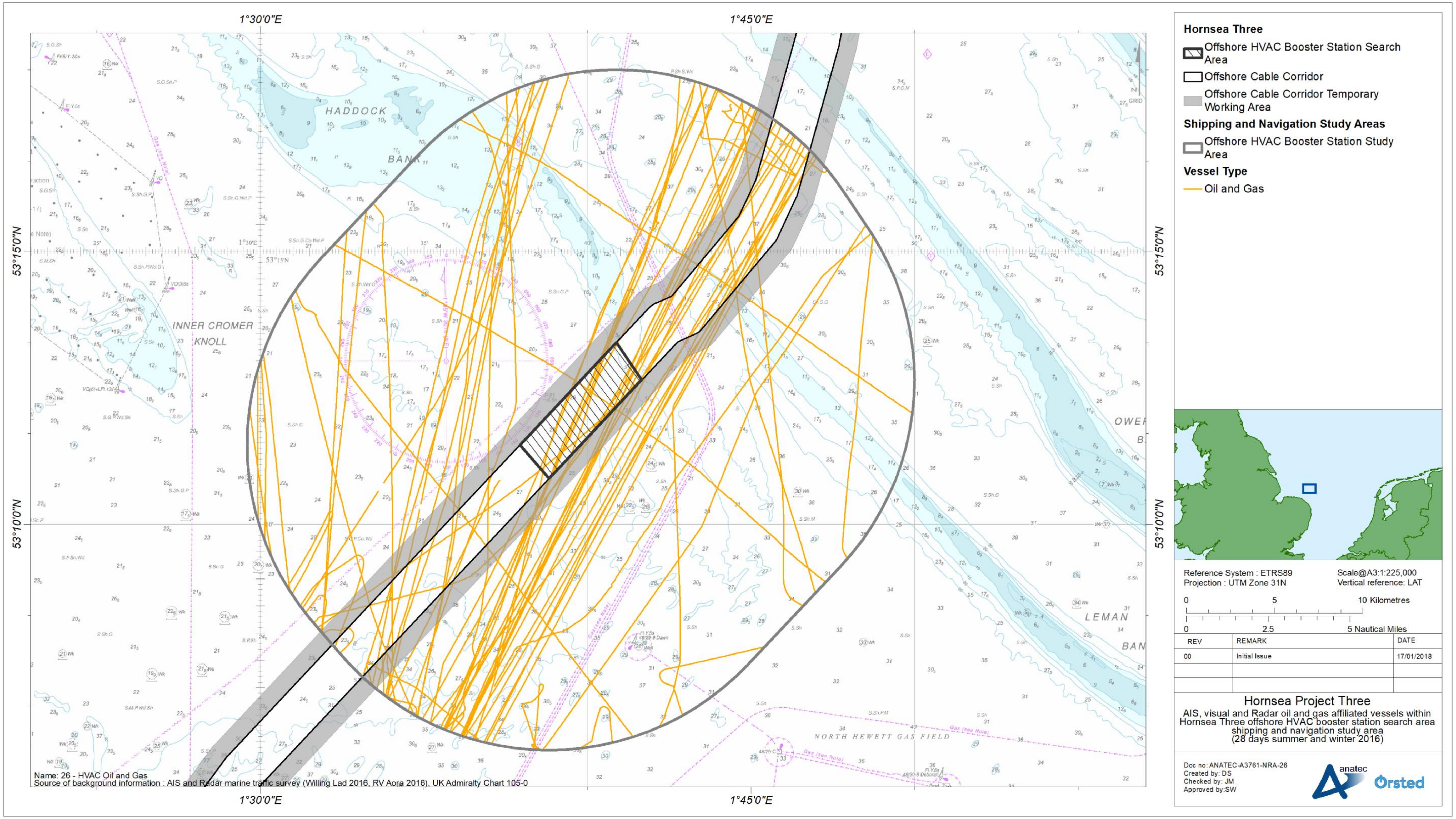

Figure 15.33:AIS, visual and Radar oil and gas affiliated vessels within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area (28 days summer and winter 2016).

15.4.4 Vessel size distribution

Maximum LOA

15.4.4.1 Vessel LOAs recorded throughout the survey periods ranged from 18 m (the wind farm support vessel *Windcat 9*) to a maximum of 200 m (the bulk carrier *Federal Bristol*). Figure 15.34 illustrates the distribution of vessel lengths recorded throughout each survey period.

15.4.4.2 The average lengths of vessels within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area throughout the summer and winter survey periods were 80 m and 75 m, respectively.

15.4.4.3 Figure 15.35 provides an overview of AIS, visual and Radar vessel tracks (excluding temporary traffic) recorded within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area throughout the combined 28 day summer and winter survey periods, colour-coded by vessel length.

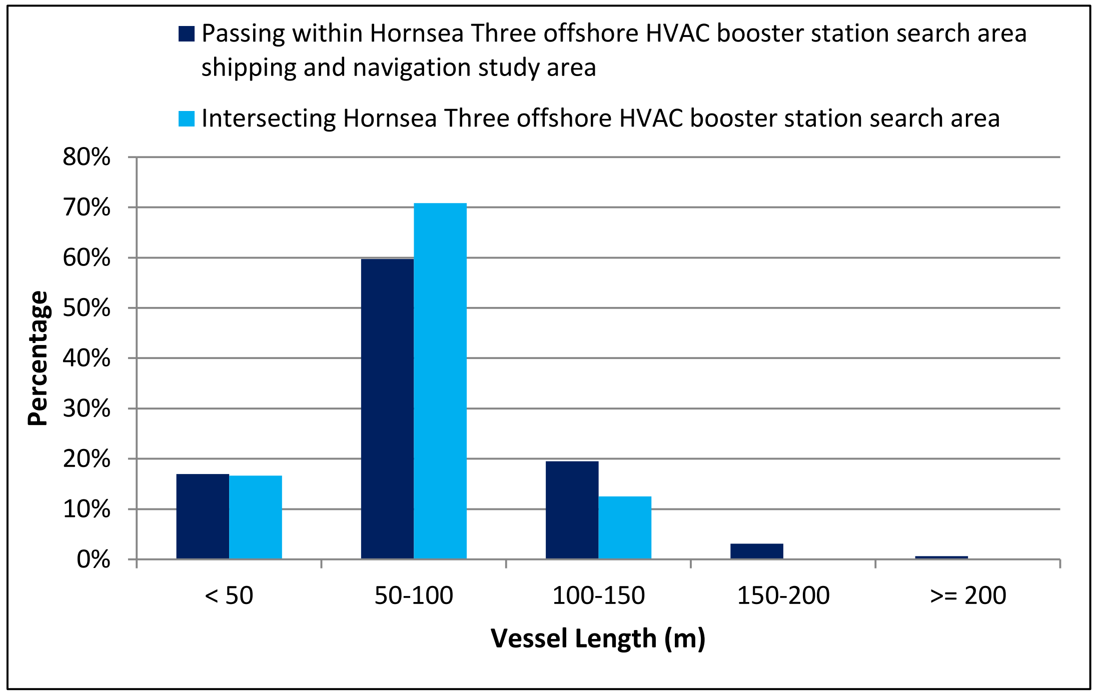

Figure 15.34: Vessel length distribution within offshore HVAC booster station search area shipping and navigation study area during 28 days summer and winter 2016 (AIS, visual and Radar).

Vessel draught

15.4.4.4 Vessel draughts recorded throughout the survey periods ranged from 1.2 m (the wind farm support vessel *Dalby Swale*) to a maximum of 8.9 m (the chemical tanker *Sten Frigg*). Figure 15.36 illustrates the distribution of vessel draughts recorded throughout the survey period.

15.4.4.5 It should be noted that 5% of the total number of unique vessels within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area did not broadcast a draught on AIS and hence have been excluded from further analysis.

15.4.4.6 The average draughts of vessels within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area throughout the summer and winter survey periods were 4.6 m and 4.8 m respectively.

15.4.4.7 Figure 15.37 provides an overview of AIS, visual and Radar vessel tracks (excluding temporary traffic) recorded throughout the combined 28 day summer and winter survey periods, colour-coded by vessel draught.

15.4.5 Base case main routes

15.4.5.1 Main route identification was undertaken for the Hornsea Three offshore HVAC booster station search area shipping and navigation study area. Four main commercial routes have been identified as transiting through or in close proximity to the Hornsea Three offshore HVAC booster station search area. Plots of the main routes and corresponding 90th percentiles within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area are presented in Figure 15.38.

15.4.5.2 A brief description of the traffic on each of the main routes is presented in Table 15.2.

15.4.5.3 It is noted that the main routes reflect key directions of traffic routeing within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area; and that other vessels do operate outside of these routes. Typically a main route would consist of at least one vessel every two days.

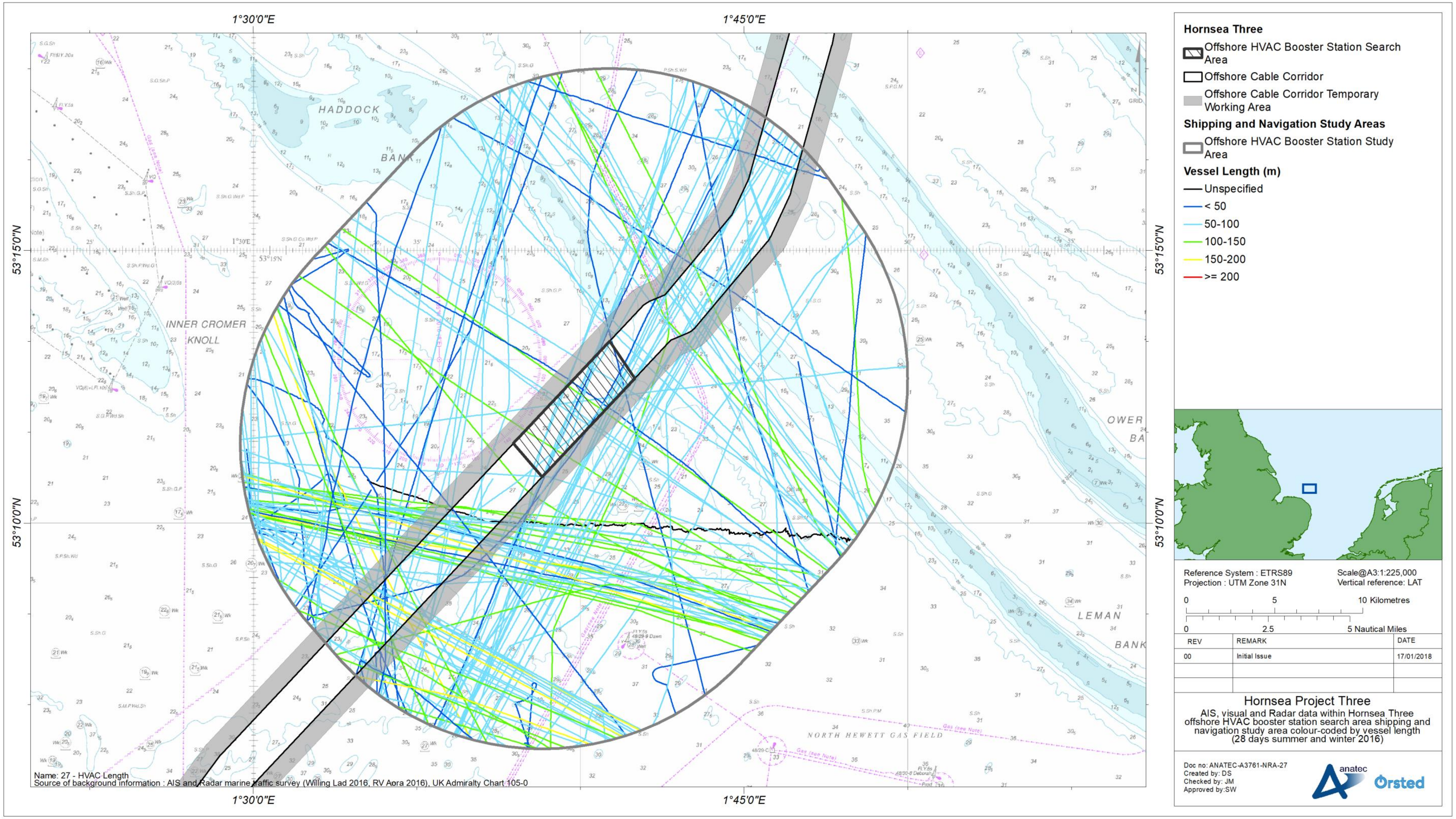

Figure 15.35:AIS, visual and Radar data within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area colour-coded by vessel length (28 days summer and winter 2016).

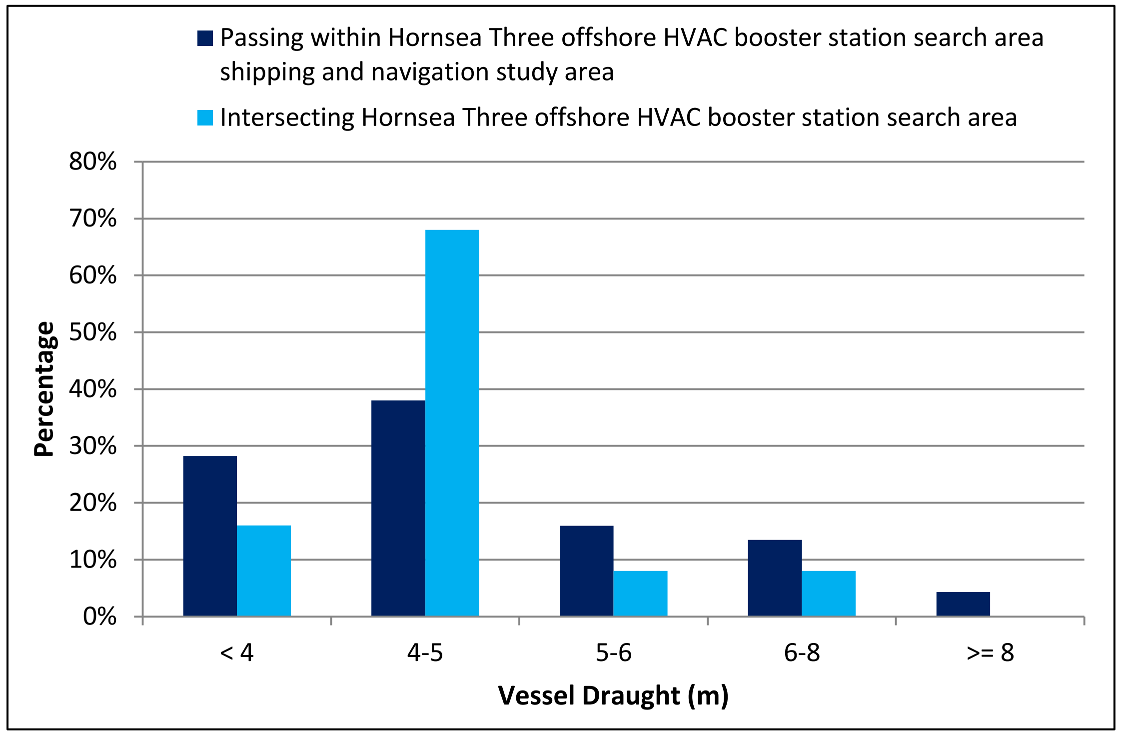

Figure 15.36: Vessel draught distribution within offshore HVAC booster station search area shipping and navigation study area during 28 days summer and winter 2016 (AIS, visual and Radar).

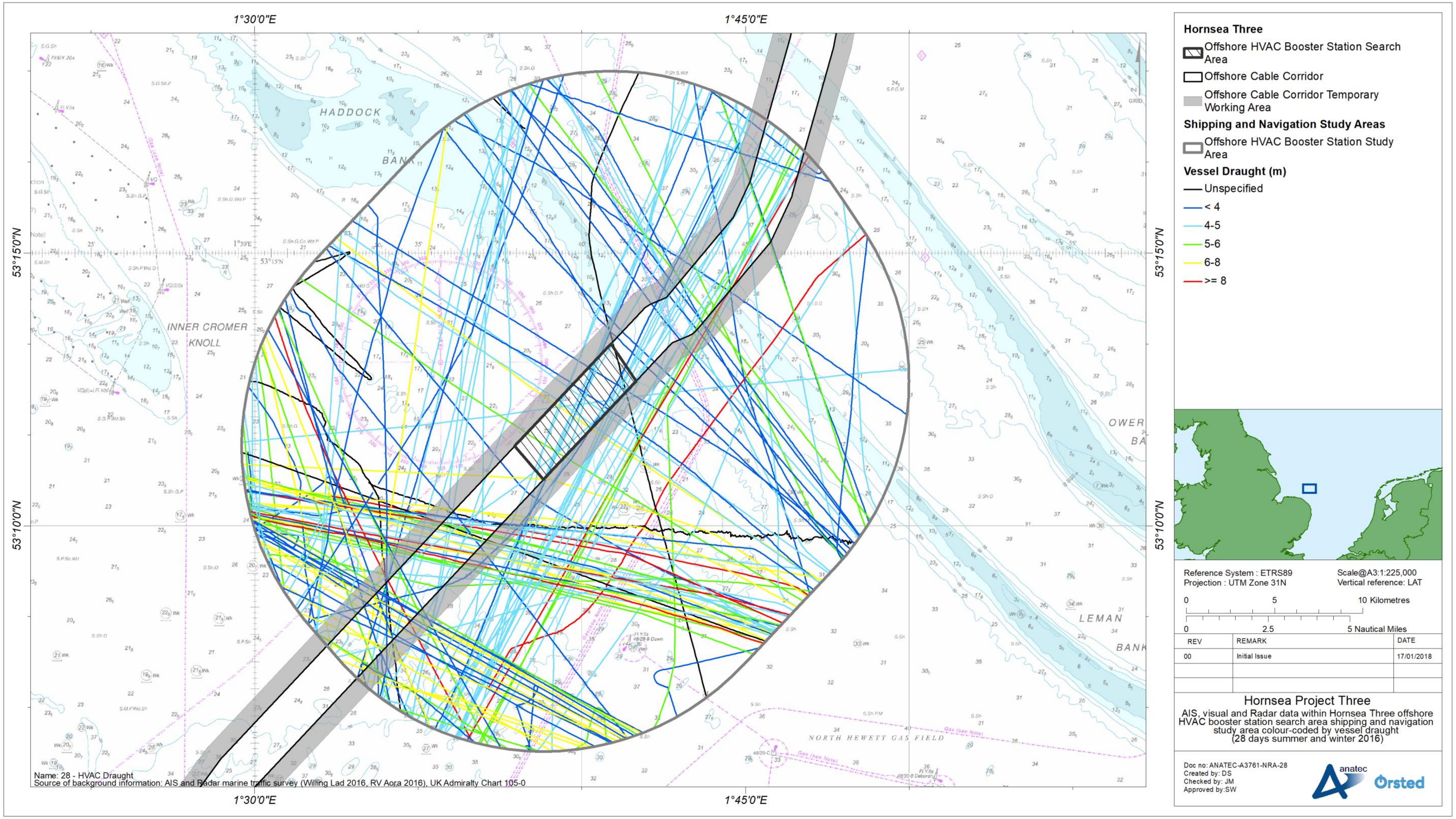

Figure 15.37: AIS, visual and Radar data within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area colour-coded by vessel draught (28 days summer and winter 2016).

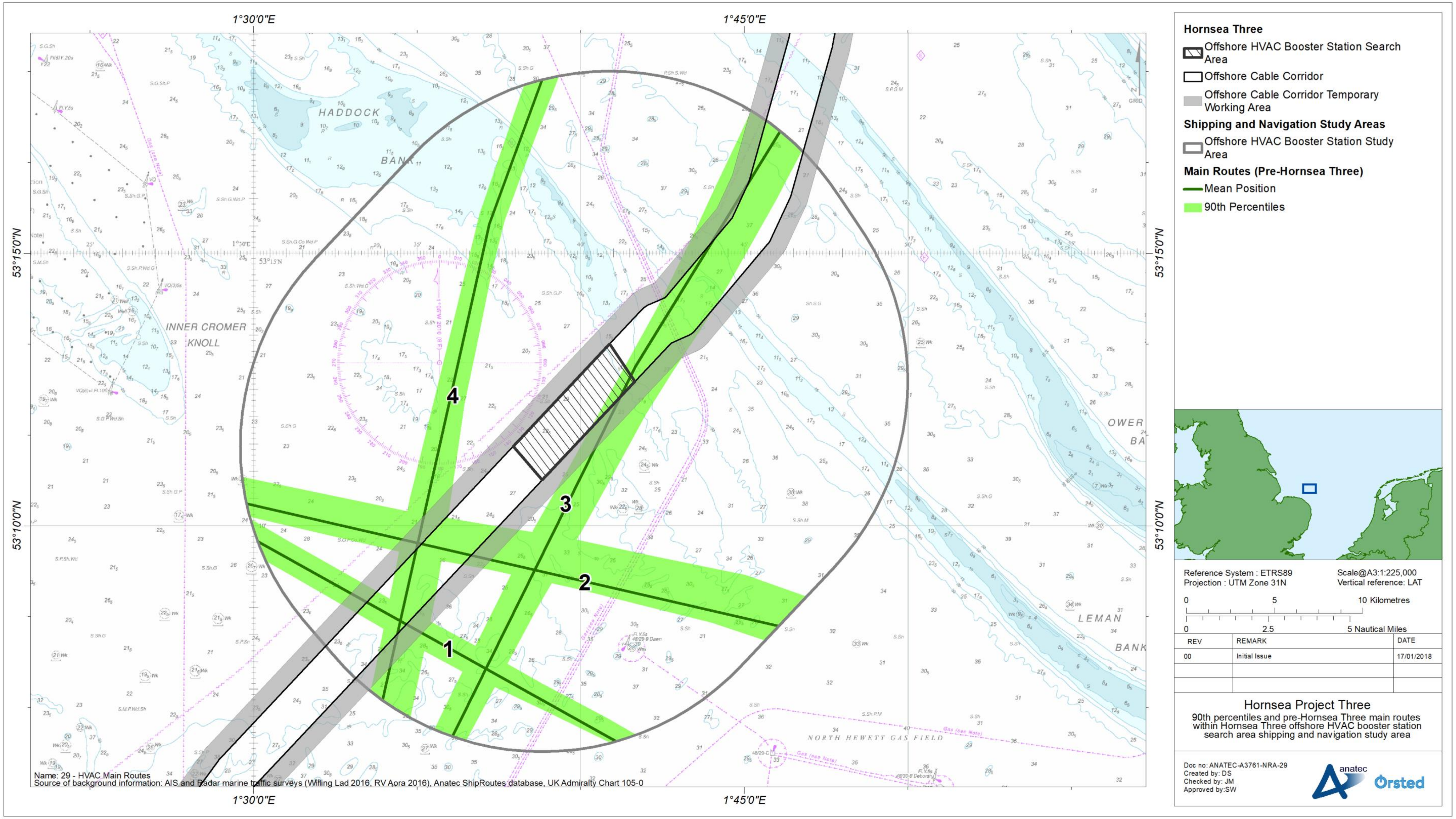

Figure 15.38:90th percentiles and pre-Hornsea Three main routes within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area.

Table 15.2: Main routes, average numbers and destination within Hornsea Three offshore HVAC booster station search area shipping and navigation study area.

Route number (as shown in Figure 15.38)	Number of vessels per day (average)	Destinations and main vessel types identified
Route 1	1 vessel per 2 days	Immingham (UK) to Rotterdam (Netherlands). Route 1 is generally used by cargo vessels (78%) and tankers (17%). Route 4 includes a small number of adverse weather transits by DFDS Seaways vessels between Immingham and Cuxhaven.
Route 2	1 vessel per day	Immingham (UK) to Rotterdam (Netherlands). Route 2 is generally used by tankers (52%) and cargo vessels (39%).
Route 3	1 vessel per 2 days	Great Yarmouth (UK) to Audrey gas platform. Route 3 is used by oil and gas affiliated vessels visiting a number of surface platforms to the north of the Hornsea Three offshore HVAC booster station search area.
Route 4	1 vessel per 2 days	Great Yarmouth (UK) to Clipper gas platform. Route 4 is used by oil and gas affiliated vessels visiting a number of surface platforms to the north of the Hornsea Three offshore HVAC booster station search area.

15.4.6 Recreational vessel activity

15.4.6.1 As previously, 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, as per the Recreational Craft Regulations 2017 No. 737.

15.4.6.2 Figure 15.39 presents a plot of recreational vessels recorded within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area on AIS, visual and Radar throughout both the summer and winter survey periods.

15.4.6.3 Throughout the combined summer and winter survey period, only three recreational vessel tracks were recorded, all on AIS.

15.4.7 Fishing vessel activity

15.4.7.1 Figure 15.40 presents a plot of fishing vessels recorded within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area on AIS, visual and Radar throughout both the summer and winter survey periods.

15.4.7.2 Throughout the combined summer and winter survey period, only two fishing vessel tracks were recorded, both on AIS.

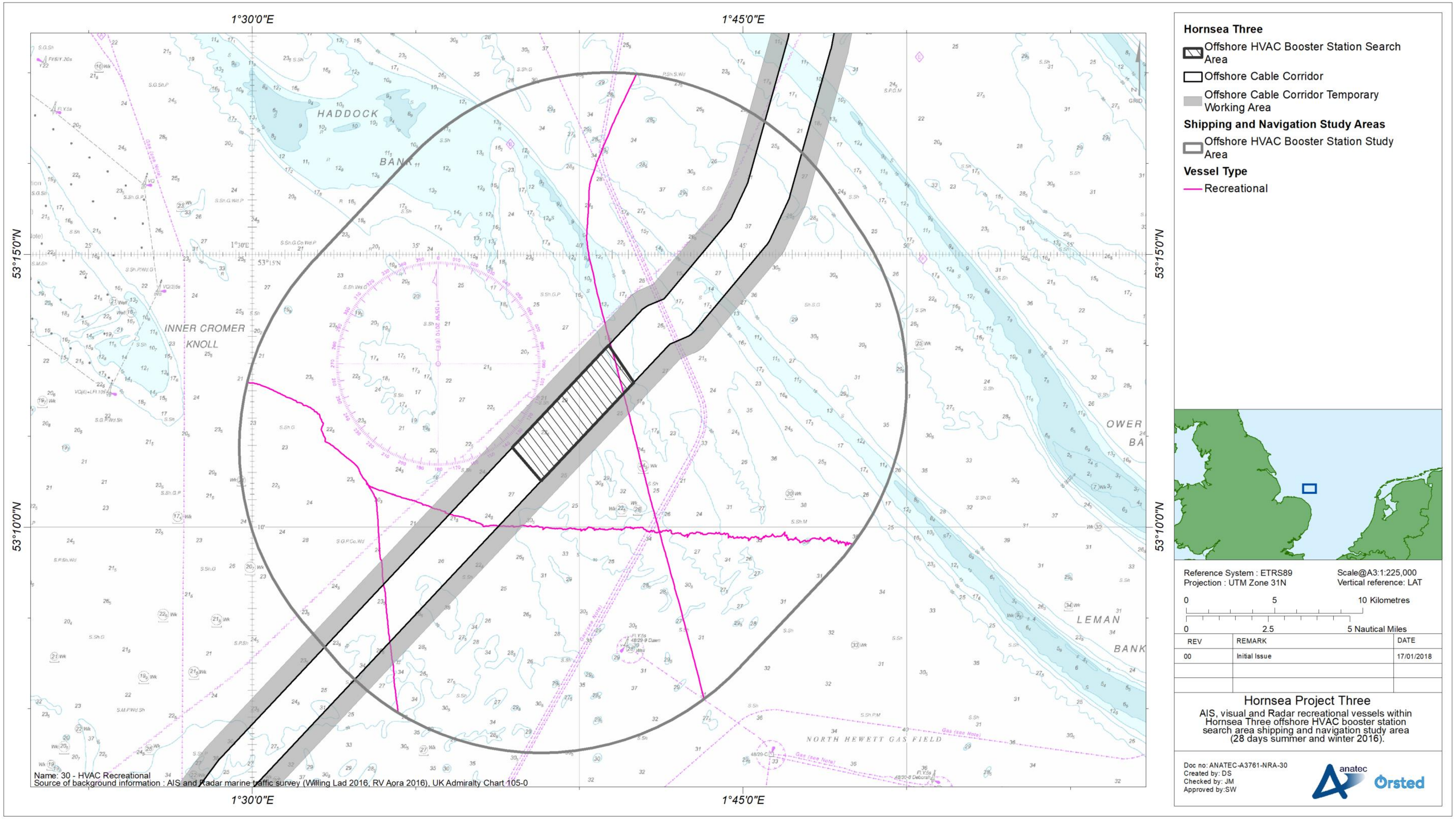

Figure 15.39: AIS, visual and Radar recreational vessels within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area (28 days summer and winter 2016).

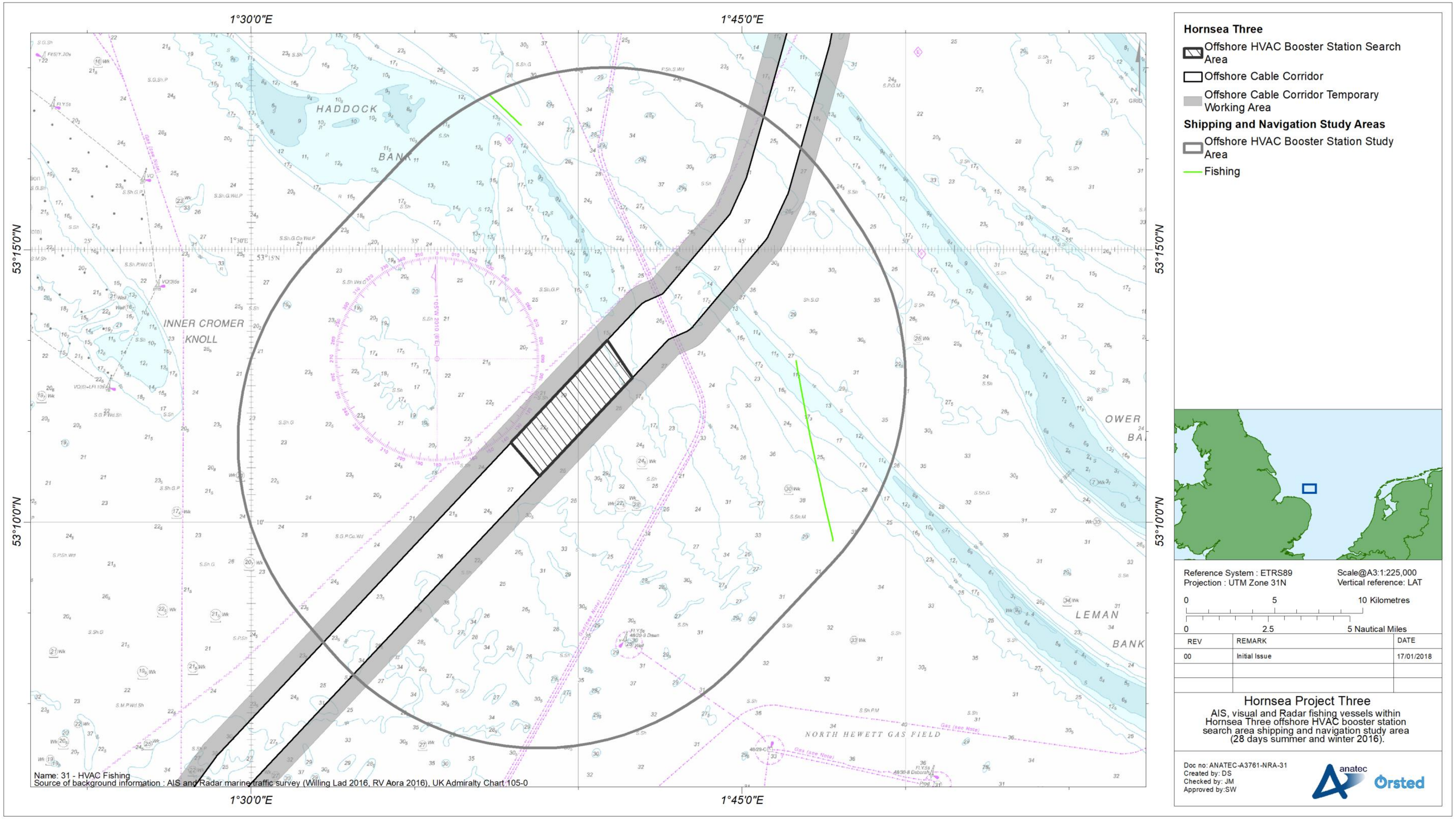

Figure 15.40: AIS, visual and Radar fishing vessels within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area (28 days summer and winter 2016).

16. Adverse Weather Impacts on Routeing

16.1.1.1 No adverse weather impacts on routeing were identified within the marine traffic survey data for commercial routes in general, nor recreational or fishing vessels with regards to route deviations. Collision and allision impacts are considered in section 18.

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

16.1.1.3 Following the Hazard Workshop where concerns were raised about commercial ferry adverse weather routes, an additional assessment was undertaken in liaison with DFDS Seaways to ensure that their adverse weather routes were considered. Four commercial routes which altered their course to account for adverse weather conditions are presented in Figure 16.1; all routes are operated by DFDS Seaways who provided way point information used in the assessment. Shore based AIS data for the *Hafnia Seaways* recorded to the northwest of the Hornsea Three array area which indicates additional adverse weather routes has also been included. These routes do not intersect the Hornsea Three array area.

16.1.1.4 The Ro Ro vessel *Hafnia Seaways* operates various passages between Cuxhaven (Germany) and Immingham (UK). It is noted that the Ro Ro is a commercial ferry and carries mostly containerised cargo and a maximum of 12 passengers plus crew. Figure 16.2 presents an image of the *Hafnia Seaways*.

16.1.1.5 The Rosyth (UK) to Zeebrugge (Belgium) and the Newcastle (UK) to Ijmuiden (Netherlands) adverse weather routes operate to the west of the Hornsea Three array area shipping and navigation study area and do not pass through the Hornsea Three array area. The Newcastle (UK) to Ijmuiden (Germany) route is transited by a cruise ferry and the coastal Rosyth (UK) to Zeebrugge (Belgium) route is operated by a Ro Ro. Again the Ro Ro is commercial and carries mostly containerised cargo and a maximum of 12 passengers plus crew.

16.1.1.6 No adverse weather routeing was identified in relation to the Hornsea Three offshore HVAC booster station search area.

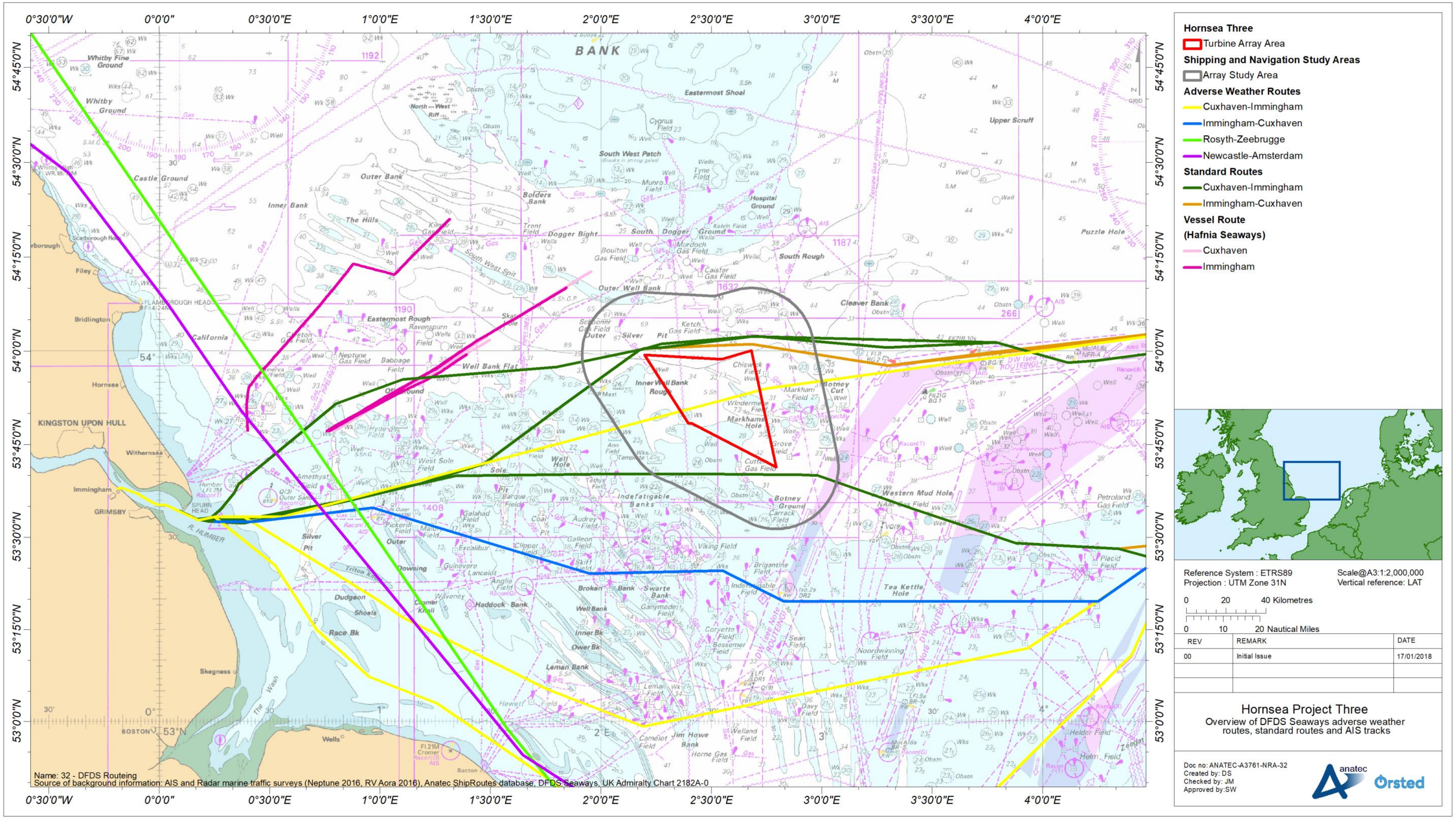

Figure 16.1: Overview of DFDS Seaways adverse weather routes, standard routes and AIS tracks.

Figure 16.2: *Hafnia Seaways* – Copyright DFDS Seaways.

17. Future Case Marine Traffic

17.1 Introduction

17.1.1.1 This section presents the future case level of activity in the Hornsea Three array area and offshore HVAC booster station search area shipping and navigation study areas, which has been input into the collision and allision risk modelling. Future case is 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. This is considered both with and without the wind farm and Hornsea Three offshore HVAC booster station(s) being present.

17.2 Increases in traffic associated with ports

17.2.1.1 Due to the distance offshore of the Hornsea Three array area, it is not considered likely that any increase in port traffic would impact on the general traffic levels around the Hornsea Three array area; therefore within the collision and allision modelling scenarios an indicative increase of 10% was used to show an example future case scenario in traffic.

17.3 Increases in fishing vessel activity

17.3.1.1 For commercial fishing vessel transits a 10% increase was used to demonstrate potential impacts (in line with other renewables assessments); this value is used as a standard value throughout future case modelling to demonstrate what changes would occur to the area if vessel activity increased. This value is used due to there being limited reliable information on future activity levels on which any firm assumption could be made. Increases in fishing activities have been covered in a separate study of commercial fishing (volume 2, chapter 6: Commercial Fisheries).

17.4 Increases in recreational vessel activity

17.4.1.1 In terms of recreational vessel activity, there are no known major developments that will increase the activity of these vessels within the southern North Sea.

17.4.1.2 As with fishing activity, given the lack of reliable information into future trends a set 10% is considered as a conservative increase.

17.5 Increases in traffic associated with Hornsea Three operations

17.5.1.1 During the construction period there may be as many as 10,774 return trips made by vessels involved in the installation of Hornsea Three. During the operation and maintenance period there may be up to 2,433 CTV return trips per year, along with many return trips from supply vessels and other support vessels.

17.5.1.2 Although not considered in the collision and allision risk modelling since routes will not be defined, this traffic has been considered within the hazard log (see Appendix B).

17.6 Collision and allision probabilities

17.6.1.1 The increased activity would also increase the probability of vessel to vessel encounters and hence collisions. Whilst this is not a direct result of Hornsea Three, the increased congestion caused by the potential displacement of traffic due to the array and offshore HVAC booster station(s) may have an influence. Again, a 10% overall increase was assumed on base case with wind farm collision risk given the lack of reliable information of likely shipping trends, especially given the distance from a port, of the Hornsea Three array area. Developments in ports and subsequent changes to vessel sizes are the most likely factors to influence traffic levels, and these are most notable and quantifiable near ports and harbours.

17.6.1.2 The potential increase in vessel activity levels would increase the probability of vessel to structure allisions (both powered and drifting). Whilst in reality the risk would vary by vessel type, size and route, it is estimated that this would lead to a linear 10% increase on the base case with wind farm allision risk. This is used in order to demonstrate how allision risk may change if the number of vessels increase within the area.

17.7 Commercial traffic routeing

17.7.1.1 The following section analyses the potential alternative routeing options for routes where displacement may occur. It is not possible to consider all options and so the shortest and therefore mostly likely alternatives have been considered. Assumptions for re-routes include:

- All alternative routes maintain a minimum distance of 1 nm from offshore installations and potential turbine boundaries in line with the MGN 543 shipping 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.

17.7.1.2 MGN 543 (MCA, 2016) 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 wind farm boundaries but states that it is "not a prescriptive tool but needs intelligent application".

17.7.1.3 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 on the sea room available as well as the prevailing conditions. This evidence also demonstrates that the Mariner defines their own safe passing distance based on the conditions and nature of the traffic at the time, but they are shown to frequently pass 1 nm off established developments. The NRA also aims to establish the maximum design scenario 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 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 on their own passage plan and the current conditions.

17.7.1.4 It should be noted that alternatives do not consider adverse weather routeing; however due to the open sea room and navigable water depths in the vicinity of the Hornsea Three array area the ability for vessels to alter their headings to reduce the impacts of adverse weather is not considered to be reduced (see section 16).

18. Collision and Allision Risk Modelling and Assessment

18.1 Introduction

18.1.1.1 This section assesses the major hazards associated with the development of the Hornsea Three offshore wind farm. This consists of a base case and future case assessment for the Hornsea Three array area, both in isolation and cumulatively, as well as a base case and future case assessment for the Hornsea Three offshore HVAC booster stations. These assessments include major hazards associated with:

- Increased vessel to vessel collision risk;
- Additional vessel to structure allision risk;
- Additional fishing vessel to structure allision risk;
- Additional recreational craft (sailing/cruisers) allision risk;
- Additional risk associated with vessels Not Under Command (NUC); and
- Anchor/cable interaction.

18.1.1.2 The base case assessment used the present day vessel activity level identified from the marine traffic surveys, consultation and other data sources. The future case assessment made assumptions on shipping traffic growth over the life of Hornsea Three.

18.1.1.3 The modelling for the Hornsea Three array area for the in isolation assessments was undertaken using Layout A (see section 9). Further detail on the models and results can also be found in Appendix A.

18.1.1.4 The modelling for the Hornsea Three array area cumulative assessment did not consider any layouts, only the Agreement for Lease (AfL) boundaries which are considered the maximum design scenario for route deviations, encounters and collision risk.

18.1.1.5 The modelling for the Hornsea Three offshore HVAC booster stations was undertaken using the maximum design scenario dimensions appearing in the Design Envelope equivalent to four offshore HVAC booster stations positioned in a square and connected by bridge links. Further detail on design parameters is contained within section 9.5.

18.2 Hornsea Three array area in isolation assessment

18.2.1 Base case without Hornsea Three

Vessel to vessel encounters

18.2.1.1 An assessment of current vessel to vessel encounters was carried out by replaying at high speed 40 days of AIS, visual and Radar data from the *Neptune* and *RV Aora* (June/July 2016 and November/December 2016). It is noted that encounters involving two recreational craft participating in the *500 Mile North Sea Race* on 28 June 2016 have been excluded from this assessment since these vessels were transiting in a race pattern in the same direction (and are likely to get in close proximity to each other) and are therefore not representative of the vessel traffic within the region.

18.2.1.2 Within the model, an encounter is defined as two vessels passing within 1 nm of one another within one minute. This helps to illustrate where existing vessel congestion is highest and therefore where offshore developments, such as a wind farm, could potentially increase congestion and therefore also increase the risk of encounters and collisions. No account has been given to whether the encounters are head on or stern to head; just close proximity.

18.2.1.3 A heat map based on the geographical distribution of vessel encounter tracks within a 0.5×0.5 nm grid of cells is presented in Figure 18.1.

18.2.1.4 It can be seen that the density of vessel encounters in the vicinity of the Hornsea Three array area is variable, with higher vessel encounter density occurring across the centre of the Hornsea Three array area as well as to the north and east. This is due to the moderate level of fishing activity in the region, with the longer duration fishing vessels present within the Hornsea Three array area shipping and navigation study area resulting in an increased number of vessel encounters. There are also high density spots at the locations of the Markham and Grove gas platforms. Again, given the slow speed that fishing vessels operate, it is likely that they will encounter each other but not be at risk of collision.

18.2.1.5 Figure 18.2 and Figure 18.3 present the number of vessel encounters per day throughout the summer and winter survey period respectively.

18.2.1.6 There were 365 encounters observed throughout the 40 day period, corresponding to an average of nine encounters per day. The day with the most vessel encounters was 7 June 2016 with 43 unique encounters observed. In contrast there were no encounters observed on 26 November 2016.

18.2.1.7 Figure 18.4 presents the distribution of vessel types involved in encounters within the Hornsea Three array area shipping and navigation study area.

18.2.1.8 The majority of encounters involved fishing vessels (61% during summer and 19% during winter), oil and gas affiliated vessels (15% during summer and 20% during winter) and cargo vessels (10% during summer and 14% during winter).

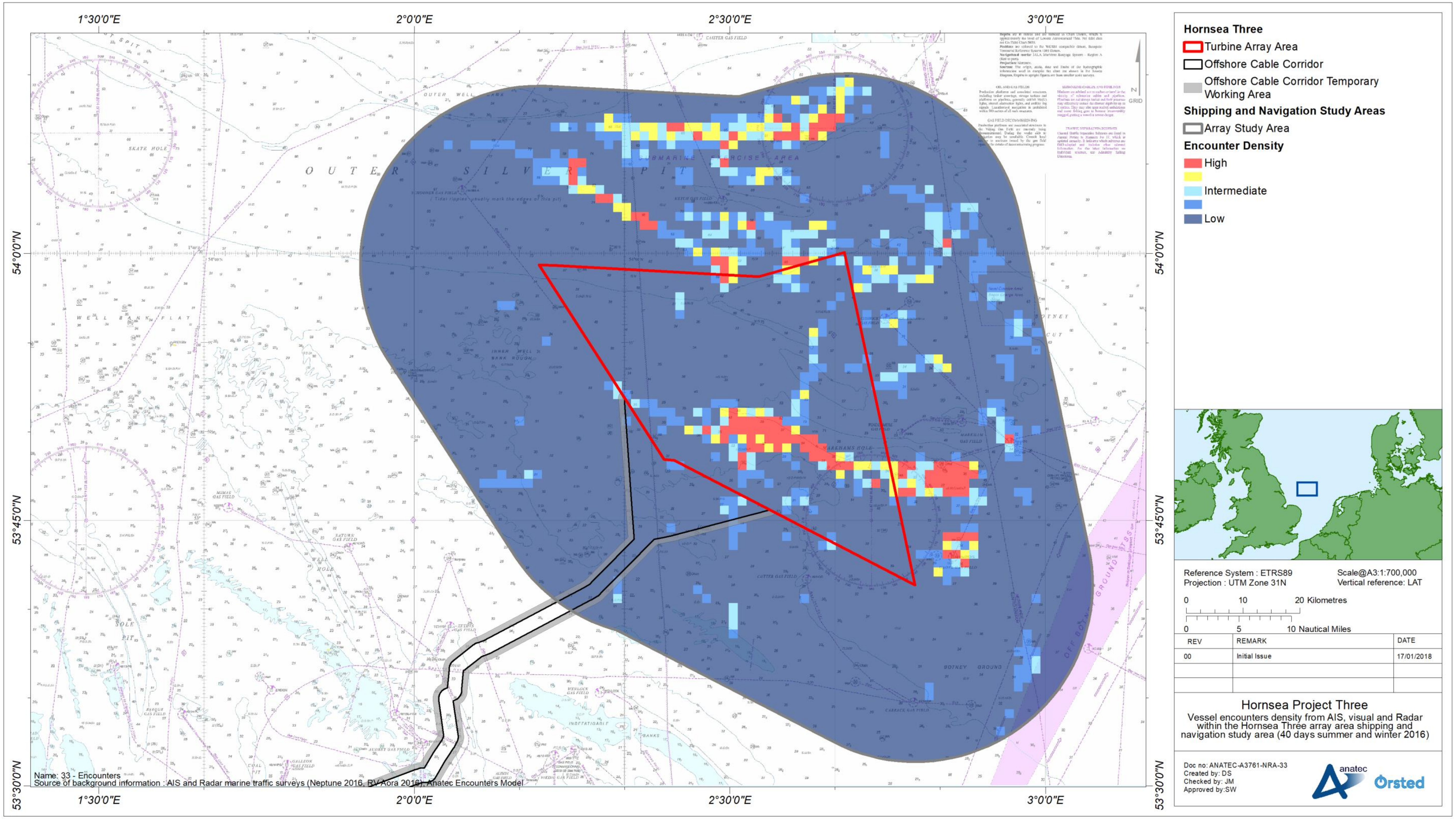

Figure 18.1: Vessel encounters density from AIS, visual and Radar within the Hornsea Three array area shipping and navigation study area (40 days summer and winter 2016).

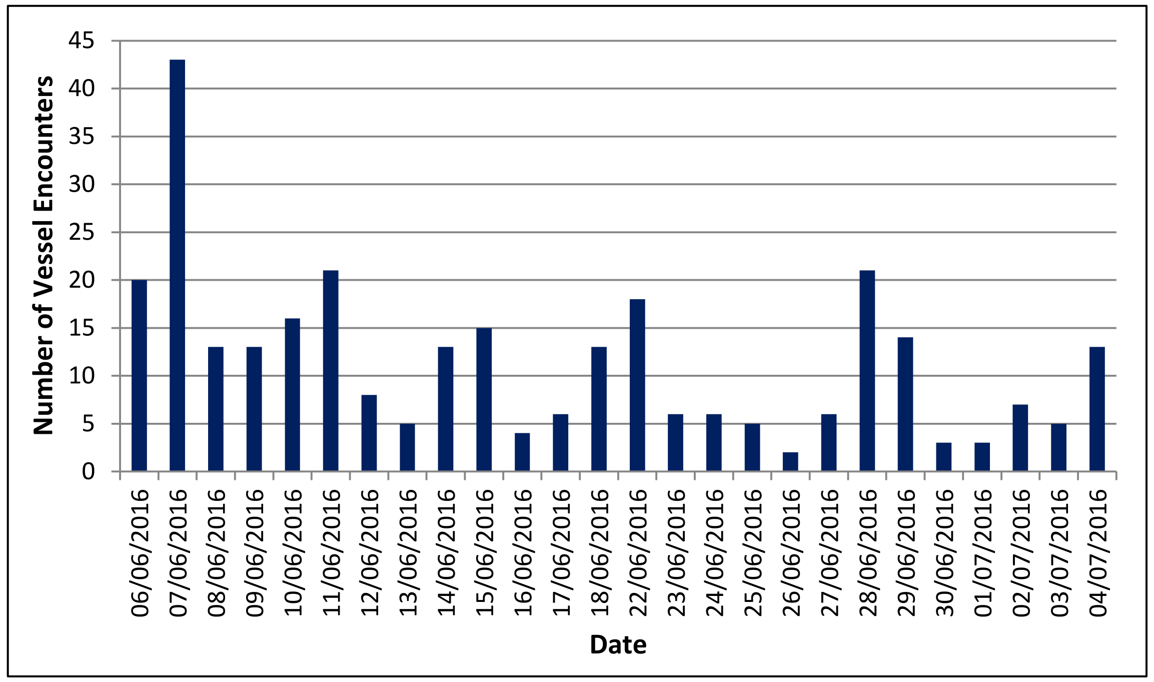

Figure 18.2: Vessel encounters per day within the Hornsea Three array area shipping and navigation study area during 26 days summer 2016 (AIS, visual and Radar).

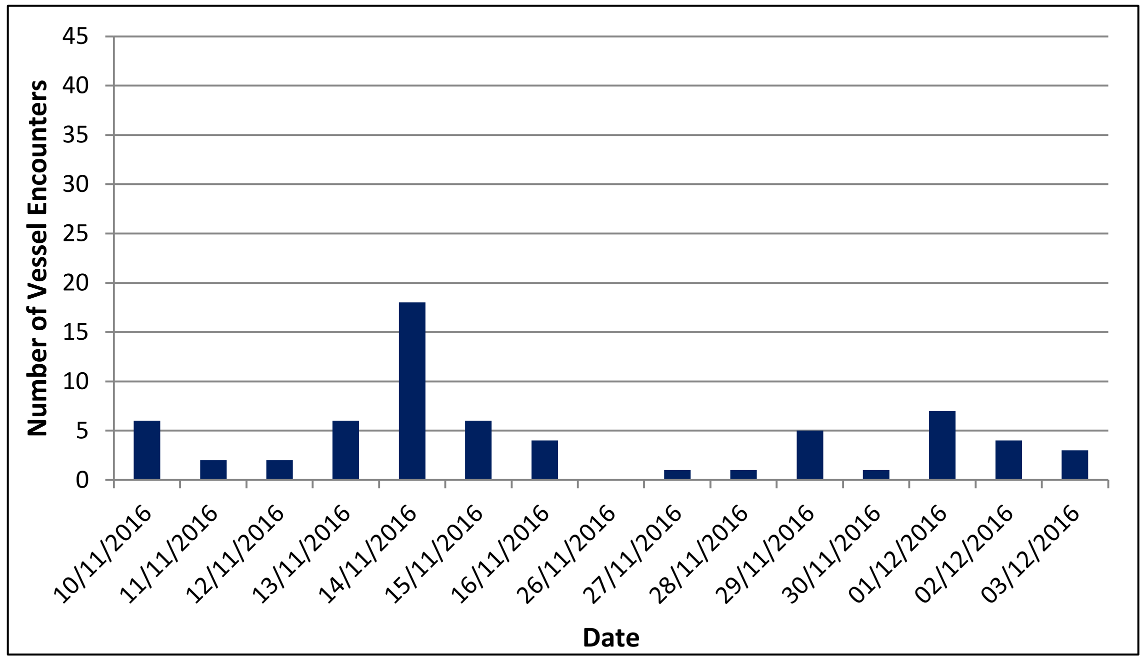

Figure 18.3: Vessel encounters per day within the Hornsea Three array area shipping and navigation study area during 14 days winter 2016 (AIS, visual and Radar).

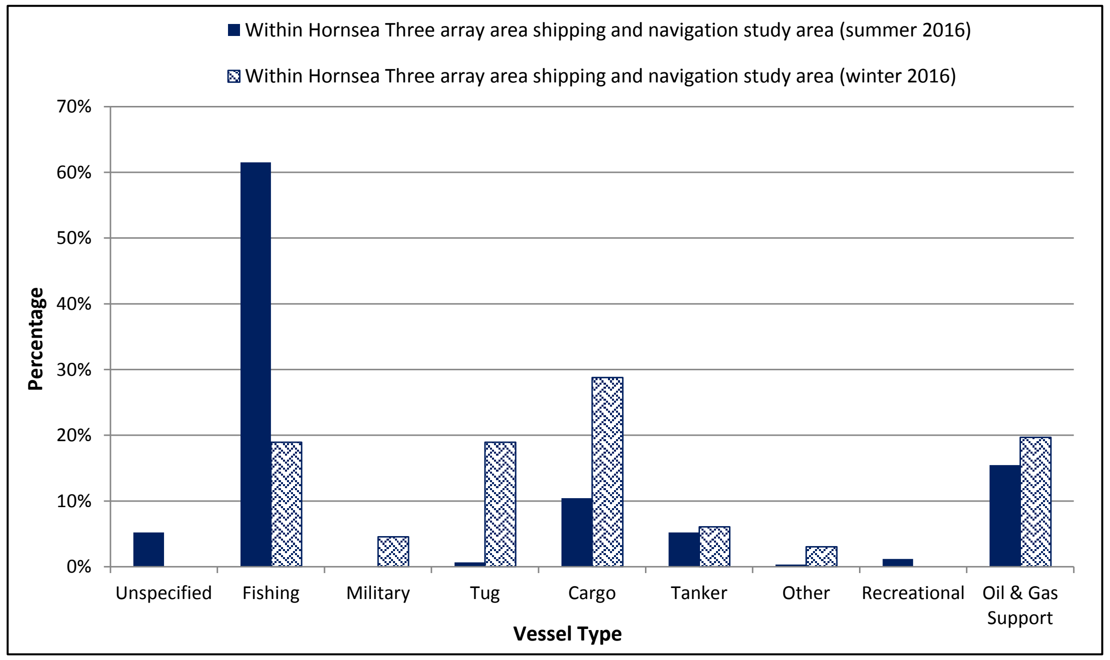

Figure 18.4: Distribution of encounter vessel types within the Hornsea Three array area shipping and navigation study area during 40 days summer and winter 2016 (AIS, visual and Radar).

18.2.1.9 Military vessel encounters were also noted within the Hornsea Three array area; it is likely that these vessels were undertaking operations where they were required to transit in parallel and were not at risk of collision.

Vessel to vessel collisions

18.2.1.10 Based on the existing routeing and encounter levels in the area, Anatec's COLLRISK model has been run to estimate the existing vessel to vessel collision risks within the vicinity of the Hornsea Three array area. The route positions and widths are based on the marine traffic survey dataset, with the annual densities based on port logs and Anatec's ShipRoutes database, which take seasonal variations into consideration.

18.2.1.11 The annual vessel to vessel collision frequency prior to the installation of Hornsea Three was 5.18×10^{-3}, corresponding to a major collision return period of one in 193 years. It is emphasised that the model is calibrated based on major incident data at sea which allows for benchmarking but does not cover all incidents, such as minor impacts. Other incident data from the MAIB and RNLI is presented in section 13, which includes other minor incidents.

18.2.2 Base case with Hornsea Three

Post-Hornsea Three main route deviations

18.2.2.1 An illustration of the anticipated shift in main route positions following the development of Hornsea Three is presented in Figure 18.5.

18.2.2.2 Deviations would be required for eight of the 16 main routes identified, with the level of deviation required varying between 5.59 nm for route 1 (eastbound) and 0.21 nm for route 2 (eastbound). For the displaced routes, the increase in distance, both in terms of distance and percentage change, are presented in Table 18.1. It is noted that increases in route length are based on indicative final destinations, and those routes for which a differing deviation is reported in each direction of transit followed a different passage in each direction of transit in the base case scenario.

Table 18.1: Summary of future case main route deviations within the Hornsea Three array area shipping and navigation study area.

Route number	Increase in distance (nm)	Increase in total route length
Route 1 (eastbound)	4.62	1.59%
Route 1 (westbound)	4.21	1.44%
Route 2 (eastbound)	0.21	0.05%
Route 2 (westbound)	0.51	0.13%
Route 7	0.51	0.16%
Route 9 (eastbound)	0.56	0.05%
Route 9 (westbound)	0.55	0.05%
Route 10 (eastbound)	0.38	0.13%
Route 10 (westbound)	0.51	0.17%
Route 11	0.29	0.27%
Route 15	5.59	5.48%
Route 16	3.17	2.69%

Simulated automatic identification system

18.2.2.3 Anatec's AIS Track Simulation program was used to gain an insight into the potential re-routed traffic following the installation of Hornsea Three. The AIS Simulator uses identified routes within the Hornsea Three array area shipping and navigation study area, standard deviations and the average number of vessels on each route to simulate the tracks. It is noted that fishing vessels and recreational vessels are not included in the identified main routes given the AIS carriage requirements but also due to the lack of trend within routeing. They have therefore been excluded from the simulation. Figure 18.6 presents the simulated AIS.

18.2.2.4 It can be seen that the areas of highest density produced are the three Hornsea Three array area corners along the southern and western boundaries. There is a relatively small number of routeing vessels to the east of the Hornsea Three array area, with no routes required to deviate along the eastern boundary of the Hornsea Three array area. It is noted that this simulated AIS represents a maximum design scenario based on a 1 nm passing distance from the Hornsea Three array area for deviated routes.

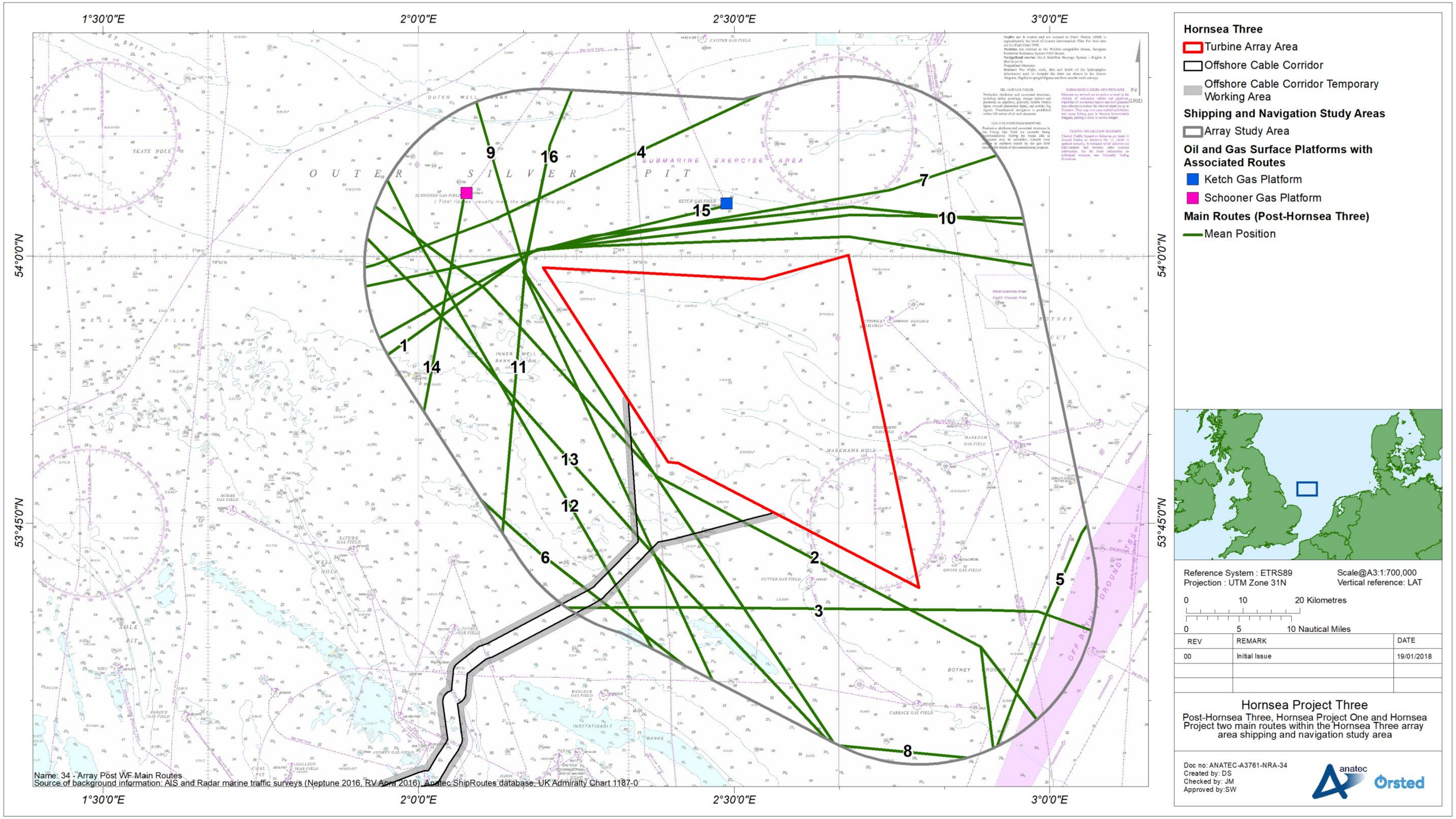

Figure 18.5: Post-Hornsea Three main routes within the Hornsea Three array area shipping and navigation study area.

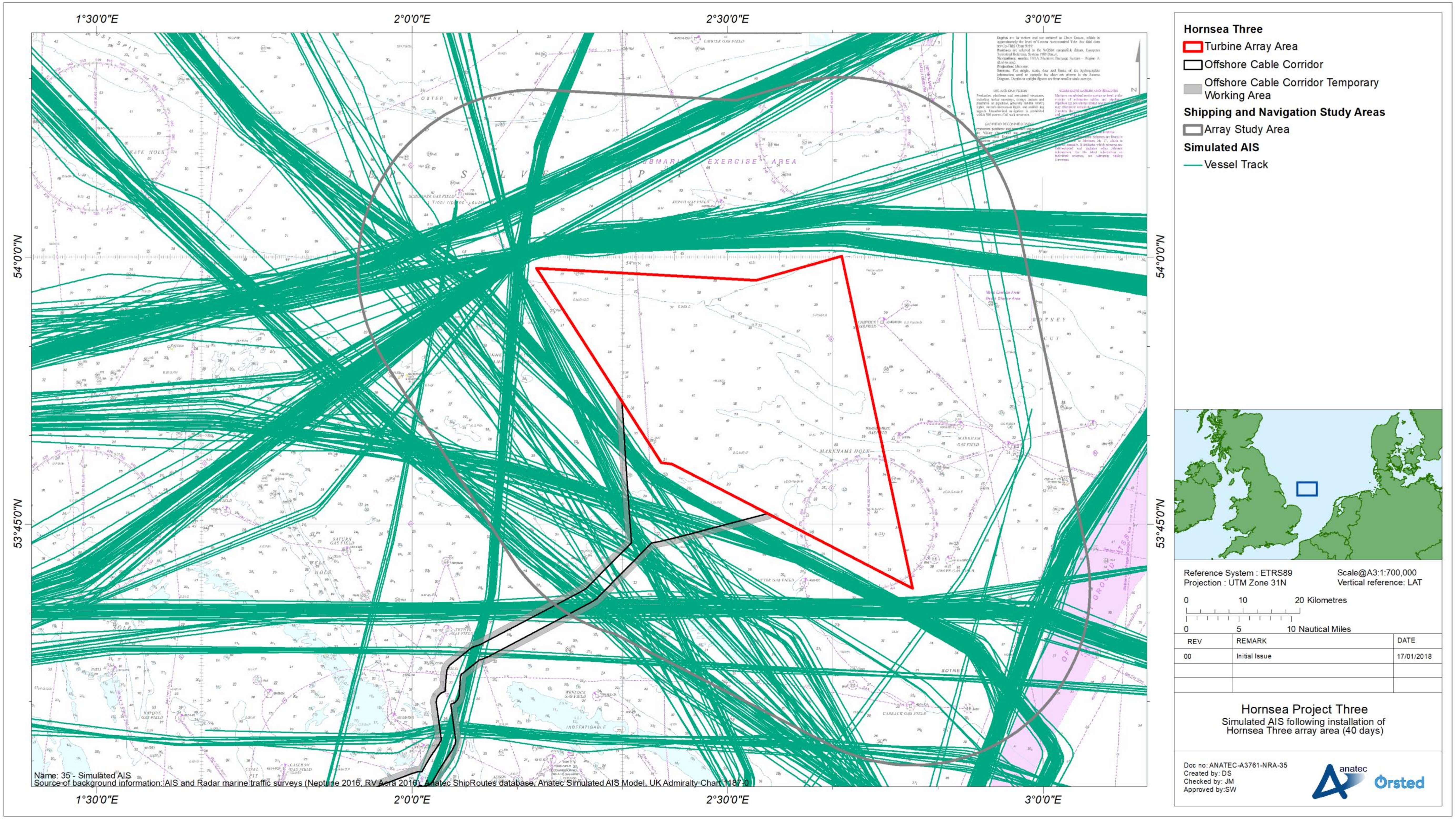

Figure 18.6: Simulated AIS following installation of the Hornsea Three array area (40 days).

Potential for increased vessel to vessel collisions

18.2.2.5 The revised routeing pattern following construction of the Hornsea Three array area has been estimated for Layout A based on the review of impact on navigation (see section 17).

18.2.2.6 The annual vessel to vessel collision frequency following the installation of Hornsea Three was 6.59×10^{-3}, corresponding to a major collision return period of one in 152 years. This represents a 21.4% increase in collision frequency compared to the pre-wind farm result.

18.2.2.7 The following potential effects have not been quantified but may indirectly influence the vessel to vessel collision risk and have been discussed in section 18 and section 22:

- Interference with communication equipment; and
- Collisions associated with the structures obstructing the visibility of vessels to other vessels.

Potential for additional vessel to structure allision risk

18.2.2.8 The two main scenarios for passing vessels colliding with structures such as turbines are:

- Powered allision where the vessel is under power but errant; and
- NUC (drifting) allision where a vessel on a passing route experiences propulsion failure and drifts under the influence of the prevailing conditions.

Powered vessel to structure allision

18.2.2.9 Based on the vessel routeing identified for the region, the anticipated change in routeing due to the Hornsea Three array area, and assumptions that mitigation measures adopted as part of Hornsea Three are in place (section 23), the frequency of an errant vessel under power deviating from its route to the extent that it comes into proximity with the Hornsea Three array area is not considered to be a probable occurrence.

18.2.2.10 From consultation with the shipping industry it is also assumed that commercial vessels would be highly unlikely to navigate between structures due to the restricted sea room and will be directed by the Aids to Navigation located in the region.

18.2.2.11 Based on modelling of the revised routeing (see Figure 18.5 and Table 18.1), Layout A and local Meteorological Ocean (Metocean) data, the annual powered vessel to structure allision frequency was 7.51×10^{-4}, corresponding to an allision return period of one in 1,331 years.

18.2.2.12 This is a higher allision frequency than the historical average of 5.3×10^{-4} per operational year for offshore installations (i.e. oil and gas infrastructure) on the United Kingdom Continental Shelf (UKCS) (one in 1,900 years). The risk to Hornsea Three is estimated to be approximately 1.4 times higher. This reflects the high number of structures included in Layout A and the conservative deviations assumed (1 nm passing distance from the edge of the array).

18.2.2.13 The individual wind farm structure allision frequencies ranged from 5.39×10^{-4} for the structure located on the southeastern corner of the Hornsea Three array area to negligible for a number of structures located within the centre and to the east of the Hornsea Three array area.

Not under command vessel to structure allision

18.2.2.14 The risk of a vessel losing power and drifting into a wind farm structure was assessed using Anatec's COLLRISK model. This model is based on the premise that propulsion on a vessel must fail before a vessel will drift. The model takes into account the type and size of the vessel, number of engines and average time to repair in different conditions but it does not consider navigational error caused by human actions.

18.2.2.15 The exposure times for a NUC scenario are based on the vessel-hours spent in proximity to the Hornsea Three array area (up to 10 nm from the perimeter). These have been estimated based on the traffic levels, speeds and revised routeing pattern. The exposure is divided by vessel type and size to ensure these factors, which based on analysis of historical accident data have been shown to influence accident rates, are taken into account within the modelling.

18.2.2.16 Using this information the overall rate of mechanical failure within the area surrounding the Hornsea Three array area was estimated. The probability of a vessel drifting towards a wind farm structure and the drift speed are dependent on the prevailing wind, wave and tidal conditions at the time of the accident.

18.2.2.17 The following drift scenarios were modelled, using the Metocean data detailed in section 11:

- Wind;
- Peak spring flood tide; and
- Peak spring ebb tide.

18.2.2.18 The probability of vessel recovery from drift is estimated based on the speed of drift and hence the time available before reaching the wind farm structure. Vessels that do not recover within this time are assumed to allide.

18.2.2.19 After modelling each of the drift scenarios it was established that wind-dominated drift produced the worst case results. The annual NUC vessel to structure allision frequency for the wind-dominated drift was 6.39×10^{-4}, corresponding to an allision return period of one in 1,564 years.

18.2.2.20 NUC allisions are assessed to be less frequent than powered allisions which reflect historical data. There have been no reported "passing" NUC vessel allisions with offshore installations on the UKCS in over 6,000 operational years. Whilst a large number of NUC vessels have occurred each year in UK waters, most vessels have been recovered in time, (such as by anchoring, restarting engines or being taken in tow). There have also been a small number of "near-misses".

18.2.2.21 The majority of the annual NUC vessel allision frequency is associated with those structures located on the western and southern boundary of the Hornsea Three array area since the prevalent wind direction in the region is from the southwest. It is also noted that future case traffic routes are also denser to the southwest of the proposed Hornsea Three array area.

Potential for fishing vessel to structure allision

18.2.2.22 Anatec's COLLRISK fishing vessel risk model has been calibrated using fishing vessel activity data along with offshore installation operating experience in the UK (oil and gas) and the experience of collisions between fishing vessels and UKCS offshore installations gathered from HSE statistics noted within Appendix A.

18.2.2.23 The two main inputs to the model are the fishing vessel density for the area and the wind farm structure details (for jacket foundations). The fishing vessel density in the Hornsea Three array area was based on the AIS, visual and Radar dataset from the marine traffic survey.

18.2.2.24 Using the site-specific data as an input to the model, the annual fishing vessel to structure allision frequency was estimated for Layout A. The annual fishing vessel to structure allision frequency was 1.74×10^{-1}, corresponding to an estimated allision return period of one in 5.74 years for an allision at surface level.

18.2.2.25 This is a moderate level of allision frequency when compared to other areas of the UK and reflects the relatively medium level of fishing vessel activity within the region. It is noted that the model assumes that the fishing vessel density remains the same as current levels following the installation of Hornsea Three, and is therefore a conservative estimate, whereas in reality vessel activity would decrease as well as be affected by seasonal and annual fluctuations. The model does not assume the severity of the allision and could account for a low energy and low impact allision.

Potential for recreational vessel to structure allision

18.2.2.26 The RYA considers that the largest risk to recreational craft from offshore wind developments is the risk of rotor blade allision and under keel allision. An allision between a turbine blade and the mast of a yacht or damage to the keel could result in the structural failure of a yacht.

18.2.2.27 To determine the extent to which yacht masts could interact with the rotor blades, details on the air draughts of the International Rating Certificate (IRC) fleet are presented in Figure 18.7 based on a fleet size of over 2,500 vessels. IRC is a rating (or "handicapping" system) used worldwide which allows vessels of different sizes and designs to race on equal terms. The UK IRC fleet, although numerically only a small proportion of the total number of sailing yachts in the UK, is considered representative of the range of modern sailing boats in general use in UK waters.

18.2.2.28 From these data, approximately 1% of boats have air draughts exceeding 30 m and noting that the minimum blade clearance is 34.97 m LAT a negligible amount of vessels would be at risk of dismasting if they were directly under a rotating blade in the worst-case conditions.

18.2.2.29 The turbines will be equipped with access ladders. MGN 543 states that these "could conceivably be used, in an emergency situation, to provide refuge on the turbine structure for distressed mariners". MGN 543 (annex 5) (MCA, 2016) states that this scenario should be considered when identifying the optimum position of such ladders and take into account the prevailing wind, wave and tidal conditions. This should provide a place of refuge until such time as rescue services arrive.

18.2.2.30 It should be noted that following the approach outlined in MGN 543 may not be appropriate for all recreational vessels or foundation types based on, for example, the potential for insufficient underwater clearance in the immediate vicinity of the structures. The marine traffic survey recorded a low level of recreational vessel activity in the Hornsea Three array area shipping and navigation study area, and suitable promulgation of information will be defined to alert recreational vessels of any underwater clearance issues.

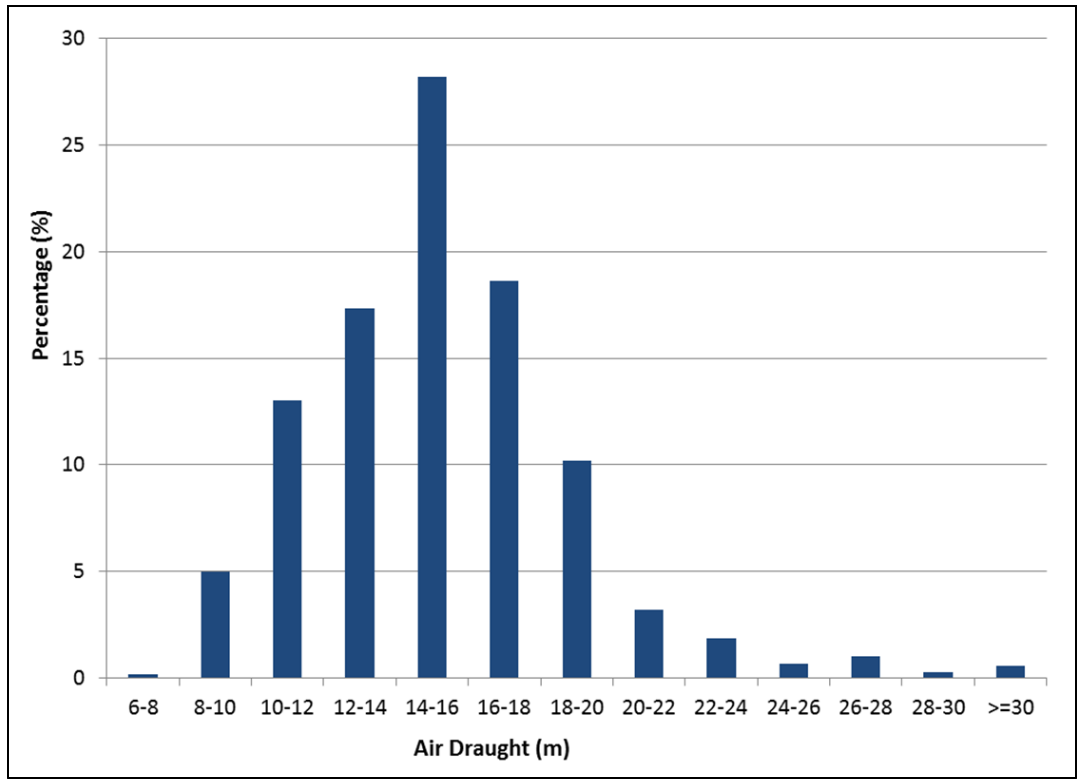

Figure 18.7: Air draught data for IRC fleet (collected 2009 to 2011) (RYA, 2015).

18.2.3 Risk results summary

18.2.3.1 The base case with Hornsea Three and future case with Hornsea Three (based on the assumptions detailed in section 17) is summarised in Table 18.2. The change in risk is also shown, (namely the estimated collision/allision risk with the Hornsea Three array area minus the baseline collision/allision risk without the Hornsea Three array area (which is zero except for vessel to vessel collisions)).

Table 18.2: Summary of annual collision and allision frequency levels for the Hornsea Three array area.

Allision and collision scenario	Base case			Future case		
	Without Hornsea Three array area	With Hornsea Three array area	Change	Without Hornsea Three array area	With Hornsea Three array area	Change
Vessel to vessel collision	5.18×10^{-3}	6.59×10^{-3}	1.41×10^{-3}	5.70×10^{-3}	7.25×10^{-3}	1.55×10^{-3}
Powered vessel to structure allision	0.00×10^{0}	7.51×10^{-4}	7.51×10^{-4}	0.00×10^{0}	8.27×10^{-4}	8.27×10^{-4}
NUC vessel to structure allision	0.00×10^{0}	6.39×10^{-4}	6.39×10^{-4}	0.00×10^{0}	7.03×10^{-4}	7.03×10^{-4}
Fishing vessel to structure allision	0.00×10^{0}	1.74×10^{-1}	1.74×10^{-1}	0.00×10^{0}	1.92×10^{-1}	1.92×10^{-1}
Total	**5.18×10^{-3}**	**1.82×10^{-1}**	**1.77×10^{-1}**	**5.70×10^{-3}**	**2.00×10^{-1}**	**1.95×10^{-1}**

18.3 Hornsea Three array area cumulative effect assessment

18.3.1 Base case without Hornsea Three, Hornsea Project One and Hornsea Project Two

Pre-Hornsea Three, Hornsea Project One and Hornsea Project Two route deviations

18.3.1.1 Twenty five main routes have been identified as transiting through or in close proximity to Hornsea Three, Hornsea Project One or Hornsea Project Two. A plot of the main routes is presented in Figure 18.8. It is noted that only the array areas have been considered given that neither the offshore cable corridors nor the offshore HVAC booster station will contribute to a cumulative routeing effect.

18.3.1.2 It is noted that this section considers the main routes within a larger study area encompassing Hornsea Three, Hornsea Project One and Hornsea Project Two. Further details regarding the Hornsea Three cumulative shipping and navigation study area can be found in section 5.2.4.

Vessel to vessel collisions

18.3.1.3 Based on the existing routeing in the area, Anatec's COLLRISK model has been run to estimate the existing vessel to vessel collision risks within the vicinity of the array areas for Hornsea Three, Hornsea Project One and Hornsea Project Two. The route positions and widths are based on the marine traffic survey dataset and Anatec's ShipRoutes, with the annual densities based on port logs and Anatec's ShipRoutes database, which take seasonal variations into consideration.

18.3.1.4 The annual vessel to vessel collision frequency prior to the installation of Hornsea Three, Hornsea Project One and Hornsea Project Two was 8.62×10^{-3}, corresponding to a major collision return period of one in 116 years. As stated in section 18.2, it is emphasised that the model is calibrated based on major incident data at sea which allows for benchmarking but does not cover all incidents, such as minor impacts.

18.3.1.5 Other cumulative routeing impacts are considered in section 22.

18.3.2 Base case with Hornsea Three, Hornsea Project One and Hornsea Project Two

18.3.2.1 An illustration of the anticipated shift in main route positions following the development of Hornsea Three, Hornsea Project One and Hornsea Project Two is presented in Figure 18.9.

Potential for increased vessel to vessel collisions

18.3.2.2 The revised routeing pattern following construction of Hornsea Three, Hornsea Project One and Hornsea Project Two has been estimated based on the review of impact on navigation carried out as part of the SNSOWF assessment in 2013 (which considered project development within the former Hornsea Zone including Hornsea Three), but validated against the results of the marine traffic surveys.

18.3.2.3 The annual vessel to vessel collision frequency following the installation of Hornsea Three, Hornsea Project One and Hornsea Project Two was 9.55×10^{-3}, corresponding to a major collision return period of one in 105 years. This represents a 9.72% increase in collision frequency compared to the pre-wind farm result.

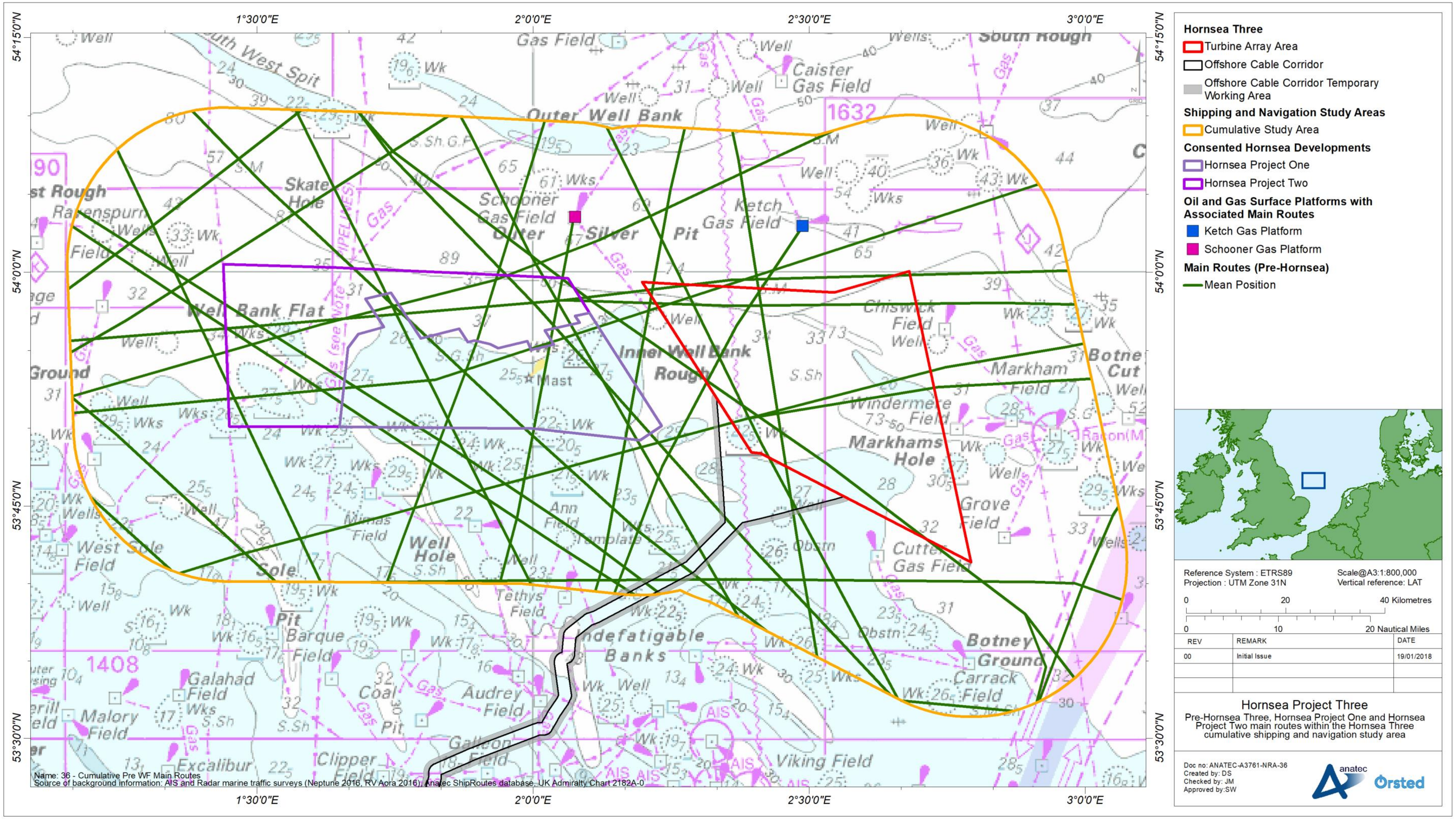

Figure 18.8: Pre-Hornsea Three, Hornsea Project One and Hornsea Project Two main routes within the Hornsea Three cumulative shipping and navigation study area.

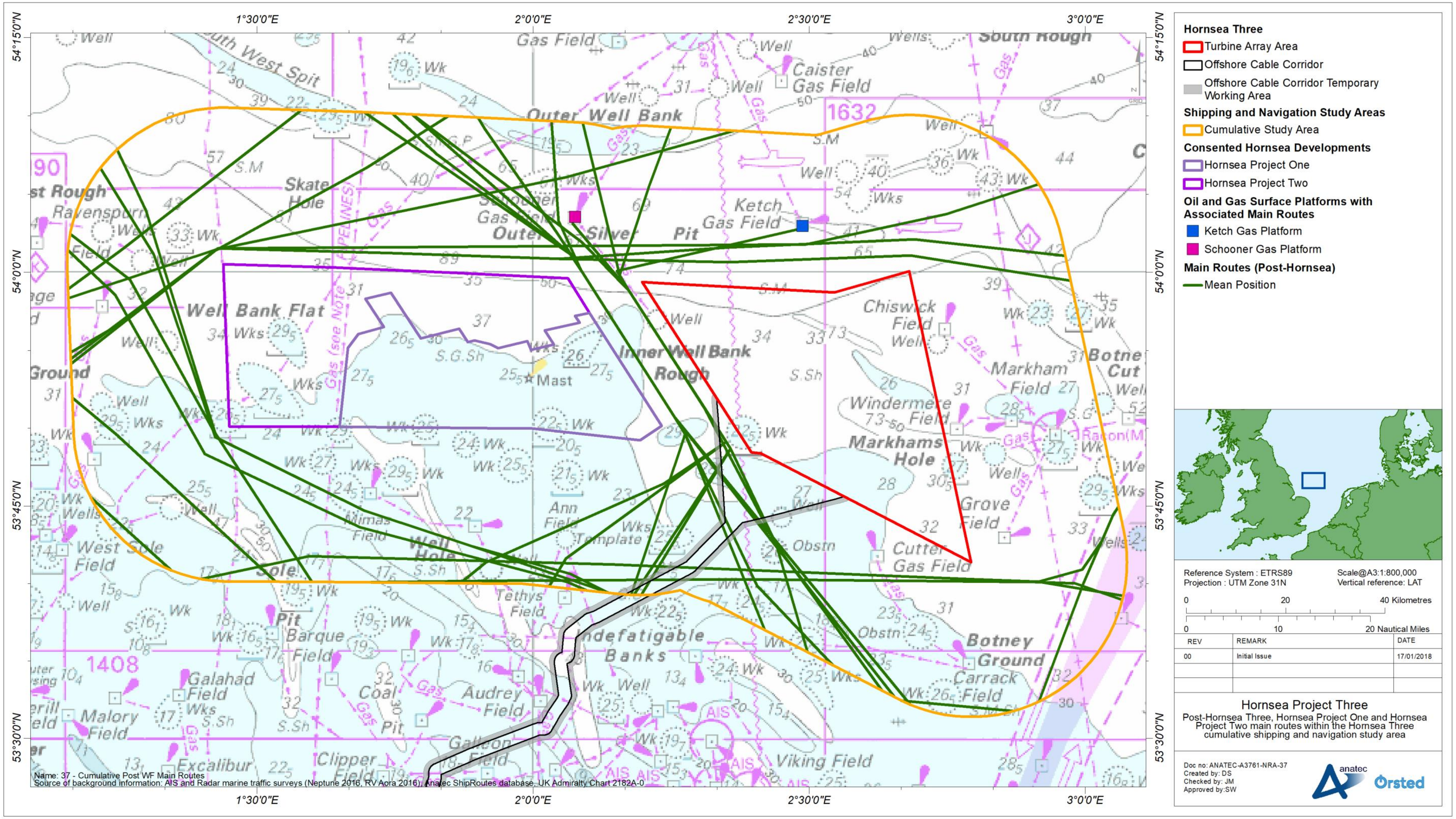

Figure 18.9: Post-Hornsea Three, Hornsea Project One and Hornsea Project Two main routes within the Hornsea Three cumulative shipping and navigation study area.

18.4 Hornsea Three offshore cable corridor assessment

18.4.1.1 An assessment of potential under keel clearance impacts has been undertaken for the Hornsea Three offshore cable corridor. The assessment used long term marine traffic survey data recorded during 2016 to identify any areas within the Hornsea Three offshore cable corridor where vessel draughts were such that reducing water depths may adversely impact navigational safety.

18.4.1.2 The key area of risk was identified as the section of the Hornsea Three offshore cable corridor located approximately 5 nm north of the landfall location, where a busy traffic route utilised by large commercial vessels crossed shallow waters west of the Sheringham Shoal bank. Shallows above banks further offshore (the Leman Bank and the Ower Bank) were also identified as areas of potential under keel clearance impact, however traffic was less dense within these areas and largely comprised oil and gas associated traffic.

18.4.1.3 An assessment of crossings of the Hornsea Three offshore cable corridor cable with established or planned cables and pipelines identified the crossings with the Dudgeon wind farm export cable area, the Stratos 1 cable, and the Clipper to Galleon and Clipper to Skiff pipelines as further areas of concern with regards to under keel clearance (noting that additional cable protection may be needed at crossing points).

18.4.1.4 The assessment of the offshore HVAC booster station(s) indicated that further mitigation would be required should subsea offshore HVAC booster stations be utilised to reduce the under keel impact to ALARP levels.

18.5 Hornsea Three offshore HVAC booster stations assessment

18.5.1 Base case without Hornsea Three offshore HVAC booster stations

18.5.1.1 Four main routes have been identified as transiting through or in close proximity to the Hornsea Three offshore HVAC booster station search area. The plots of the main routes are presented in Figure 15.38.

18.5.2 Base case with Hornsea Three offshore HVAC booster stations

Overview

18.5.2.1 Final locations for the proposed offshore HVAC booster stations (surface or subsea) have not yet been defined. However, given the relatively small size of the Hornsea Three offshore HVAC booster station search area, an indicative location central to the search area has been assessed based on a tightly packed layout.

Post-Hornsea Three main route deviations

18.5.2.2 An illustration of the anticipated shift in main route positions following the installation of the Hornsea Three offshore HVAC booster stations at the indicative location is presented in Figure 18.10.

18.5.2.3 Based on the indicative location, a deviation would be required for one of the four routes identified, with this being a small deviation for route 3 which would result in the length of the route decreasing by 0.02 nm, based on indicative final destinations. This decrease is a result of the route effectively being straightened out over a large distance.

Potential for additional vessel to structure allision risk

18.5.2.4 As previously stated (paragraph 18.2.2.8) the two main scenarios for passing vessels alliding with OREIs such as turbines and other wind farm structures are powered allision and NUC (drifting) allision.

<u>Powered vessel to structure allision</u>

18.5.2.5 Based on the vessel routeing identified for the region, the anticipated change in routeing due to the Hornsea Three offshore HVAC booster stations, and assumptions that the mitigation measures adopted as part of Hornsea Three (section 23) are in place, the frequency of an errant vessel under power deviating from its route to the extent that it comes into proximity with a Hornsea Three offshore HVAC booster station is not considered to be a probable occurrence.

18.5.2.6 Based on modelling of the revised routeing (see Figure 18.10), Layout A and local Metocean data, the annual powered vessel to structure allision frequency for the indicative offshore HVAC booster station location is 1.06×10^{-4}, which corresponds to an allision return period of one in 9,435 years.

18.5.2.7 This is a lower allision frequency than the historical average of 5.3×10^{-4} per operational year for offshore installations on the UKCS (one in 1,900 years). The risk to the Hornsea Three offshore HVAC booster stations is estimated to be approximately five times lower. This reflects the relatively low level of traffic passing nearby.

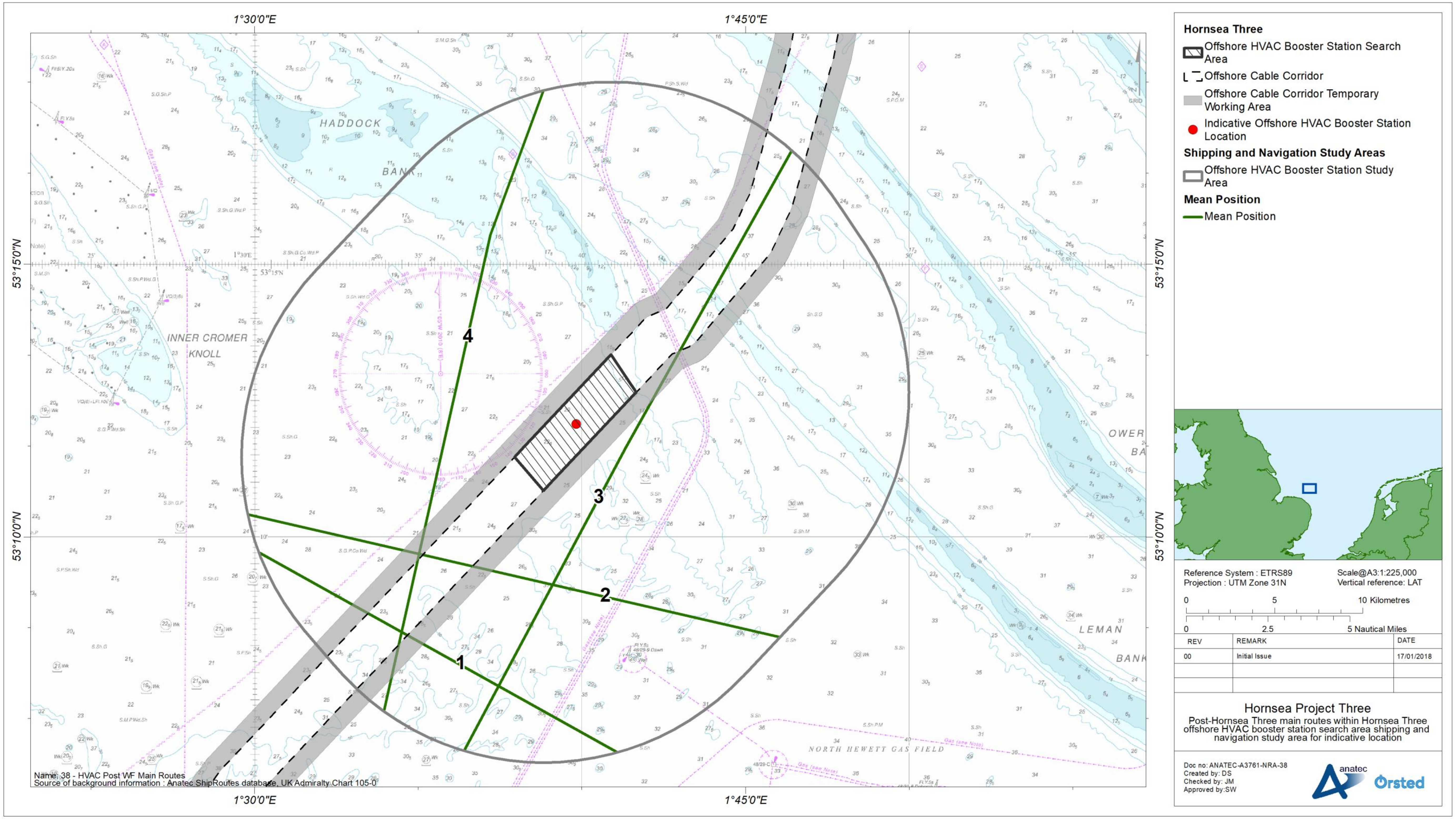

Figure 18.10:Post-Hornsea Three main routes within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area for indicative location.

NUC vessel to structure allision

18.5.2.8 The risk of a vessel losing power and drifting into a wind farm structure was assessed using Anatec's COLLRISK model. As outlined previously this model is based on the premise that propulsion on a vessel must fail before a vessel will drift, and takes into account the type and size of the vessel, number of engines and average time to repair in different conditions. However human error is not considered by the model.

18.5.2.9 Again, the following drift scenarios were modelled:

- Wind;
- Peak spring flood tide; and
- Peak spring ebb tide.

18.5.2.10 The probability of vessel recovery from drift is estimated based on the speed of drift and hence the time available before reaching the wind farm structure. Vessels that do not recover within this time are assumed to collide.

18.5.2.11 After modelling each of the drift scenarios it was established that ebb tide-dominated drift produced the worst case results. The annual NUC vessel to structure allision frequency for the indicative offshore HVAC booster station location is 2.48×10^{-6}, which corresponds to an allision return period of one in 403,170 years.

18.5.2.12 NUC allisions are assessed to be less frequent than powered allisions which reflect historical data. As stated previously, there have been no reported "passing" NUC vessel allisions with offshore installations on the UKCS in over 6,000 operational years.

Potential for fishing and recreational vessel to structure allision

18.5.2.13 As shown in section 15.4.7, the level of fishing and recreational vessel activity within the offshore HVAC booster station search area shipping and navigation study area was very low throughout the marine traffic survey. Only two unique fishing vessel tracks and three unique recreational vessel tracks were recorded throughout the 28 day survey period. The fishing vessels recorded were all in transit rather than actively engaged in fishing activities, and none intersected the Hornsea Three offshore HVAC booster station search area.

18.5.2.14 Given that the fishing vessel and recreational densities for the area are one of the main inputs to Anatec's COLLRISK fishing vessel risk model (which may also be applied to recreational data), it was not considered reasonable to analyse the fishing or recreational vessel to structure allision risk.

18.5.3 Risk results summary

18.5.3.1 The base case with the Hornsea Three offshore HVAC booster stations and future case with the Hornsea Three offshore HVAC booster stations (based on the assumptions detailed in section 17) annual levels of risk at each location are summarised in Table 18.3.

Table 18.3: Summary of risk results for indicative Hornsea Three offshore HVAC booster stations location.

Allision scenario	Base case	Future case
Powered vessel to structure allision	1.06×10^{-4}	1.17×10^{-4}
NUC vessel to structure allision	2.48×10^{-6}	2.73×10^{-5}

18.6 Other Round Three wind farms

18.6.1.1 Table 18.4 presents the collision and allision risk modelling results (taken from their NRAs published by the planning inspectorate) for consented wind farms or wind farms that are within the consent process with MCA approval. Given the areas of build only Round Three projects have been included. Values for the maximum design scenario layouts have been shown; some results are not directly comparable given the modelling undertaken and therefore have been excluded (such as projects including multiple site_. It should be noted that different foundation sizes were used for the modelling across the various projects.

Table 18.4: Collision and allision risk modelling results for other wind farm projects.

Round Three wind farm project	Average vessel encounters per day within 10 nm buffer		Future case external vessel to vessel collision return period	Future case external vessel to structure allision return period	Future case external NUC vessel to structure allision return period	Future case fishing vessel to structure allision return period
	Average	Maximum				
Hornsea Three *319 structures* (Non Grid) Planning	9	43	1 every 152 years	1 every 1,084 years	1 every 1,369 years	1 every 6 years
Hornsea Project Two *368 structures* (One line of orientation) Consented	5	14	1 every 36 years	1 every 2,089 years	1 every 878 years	1 every 7 years
Hornsea Project One *345 structures* (Grid) Consented	3	6	1 every 60 years	1 every 878 years	1 every 986 years	1 every 34 years
East Anglia One *325 structures* (Grid) Consented	55	85	Not directly comparable	1 every 197 years	1 every 434 years	1 every 6 years
East Anglia Three *182 structures* (Grid) Consented	35	59	Not directly comparable	1 every 34 years	1 every 483 years	1 every 15 years
Rampion *175 structures* (Grid) Consented and partially constructed	42	75	1 every 1.5 years	1 every 5,100 years	1 every 1,800 years	1 every 7 years

19. Communication and Position Fixing

19.1.1.1 The following section summarises the potential impacts of the different communications and position fixing devices used in and around offshore wind farms.

19.2 Very high frequency communications (including digital selective calling)

19.2.1.1 As part of the 2004 SAR provider (MCA and QinetiQ, 2004) trials at North Hoyle wind farm, tests were undertaken to evaluate the operational use of typical small vessel Very High Frequency (VHF) transceivers when operated close to wind farm structures.

19.2.1.2 The wind farm structures 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 turbines, then it is reasonable to assume that larger vessels with higher powered and more efficient systems would also be unaffected.

19.2.1.3 During this trial a number of mobile 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).

19.2.1.4 Furthermore, as part of the SAR trials carried out at North Hoyle 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).

19.2.1.5 Following consideration of these independent reports, the Hornsea Three array area is anticipated to have no significant impact upon VHF communications as demonstrated at other operational sites.

19.3 Very high frequency direction finding

19.3.1.1 During the 2004 trials at North Hoyle wind farm, the VHF direction finding equipment carried in the trial boats did not function correctly when very close to turbines (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 upon operational or SAR activities, especially as the effect is not recognised by the MCA (MCA and QinetiQ, 2004).

19.3.1.2 Throughout the 2005 SAR trials carried out at North Hoyle wind farm, 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.

19.4 Automatic Identification System

19.4.1.1 In theory there could be interference when there is a structure located between the transmitting and receiving antennae (i.e. blocking line of sight) of the AIS. This was not evident in the trials carried out at the North Hoyle offshore wind farm site and no significant impact is anticipated for AIS signals being transmitted and received at the Hornsea Three array area. (MCA and QinetiQ, 2004).

19.5 Navigational Telex systems

19.5.1.1 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 Liquid Crystal Display (LCD) screen, depending on the model.

19.5.1.2 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 users' location other information options may be available such as ice warnings for high latitude sailing.

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

19.5.1.4 Although no specific trials have been undertaken, no significant effect has been noted at operational sites and therefore no effects are expected for the Hornsea Three array area.

19.6 Global Positioning System

19.6.1.1 Global Positioning System (GPS) is a satellite based navigational system. GPS trials were also undertaken throughout the 2004 trials at North Hoyle wind farm and the trial report stated that "no problems with basic GPS reception or positional accuracy were reported during the trials".

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

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

19.7 Electromagnetic interference (from turbines or cables) on navigation equipment

19.7.1.1 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.

19.7.1.2 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 advent of power loss or a secondary source, it should not be allowed to be affected to the extent that safe navigation is prohibited. The important factors that affect the resultant deviation are:

- Water and burial depth;
- Current (whether 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.

19.7.1.3 Hornsea Three 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 significant enough to impact marine magnetic compasses (OSPAR, 2008).

19.7.1.4 It is noted that should any DC cables be used they may cause electromagnetic interference for vessels using magnetic compasses. However effects on larger vessels using inertial navigation systems and GPS as their main navigational system are expected to be limited. Smaller craft which may only carry a magnetic compass and operate within nearshore waters are likely to experience the highest effects but only for the period where they are directly above an unbundled DC cable.

19.7.1.5 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 turbines as with any structure in which there is a large amount of ferrous material (MCA and QinetiQ, 2004).

19.8 Impact on marine Radar systems

19.8.1.1 The 2004 MCA North Hoyle wind farm trials identified areas of concern with regard to the potential impact on marine and shore based Radar systems. This is due to the large vertical extent of the turbines returning Radar responses strong enough to produce interfering side lobes, multiple and reflected echoes (ghosts). This has also been raised as a major concern by the maritime industry with further evidence of the problems being identified by the PLA around the Kentish Flats offshore wind farm in the Thames Estuary. Based on the results of the North Hoyle trial, the MCA produced a wind farm/shipping route template to give guidance on the distances which should be established between shipping routes and offshore wind farms.

19.8.1.2 A second trial was conducted at Kentish Flats between 30 April 2006 and 27 June 2006 on behalf of the British Wind Energy Association (BWEA) (BWEA, 2007). The project steering group had members from the BEIS, MCA and PLA. This trial was conducted in pilotage waters and in an area covered by the PLA Vessel Traffic Services (VTS). It therefore had the benefit of pilot advice and experience but was also able to assess the impact of the generated effects on VTS Radars.

19.8.1.3 The trial concluded that:

- The phenomena referred to above detected on marine Radar displays in the vicinity of wind farms can be produced by other strong echoes close to the observing vessel although not necessarily to the same extent;
- Reflections and distortions by vessels' structures and fittings created many of the effects and the effects vary from vessel to vessel and Radar to Radar;
- VTS scanners static Radars can be subject to similar phenomena as above if passing vessels provide a suitable reflecting surface but the effect did not seem to present a significant problem for the PLA VTS; and
- Small vessels operating in or near the wind farm would be detectable by Radars located on vessels operating near the Hornsea Three array area but would be less detectable when the vessel was operating within the Hornsea Three array area.

19.8.1.4 Throughout the 2005 MCA SAR helicopter trials at the North Hoyle wind farm, side lobe returns were found to extend approximately 100 m to either side of each turbine, with side lobe depth estimated at less than 50 m. The Radar target, which was moving between the turbines within the wind farm, was tracked from an aircraft positioned in the 50 foot (ft) hover position between 0.25 to 0.5 nm clear of the wind farm boundary. The target could be tracked to a distance of approximately 100 m from each turbine. Beyond this point the target could be recognised at a slightly closer range to the turbine, but only if it had been previously identified at a greater separation and Radar processing continuously adjusted (MCA, 2005).

19.8.1.5 Theoretical modelling of the composite effects of the development of the Atlantic Array offshore wind farm on marine Radar systems was carried out by Ledwood Technology in October 2011 (Atlantic Array, 2012). The main outcomes of the modelling were as follows:

- *"Multipath effects (false targets) were detected under all modelled parameters. The main effects noticed were stretching of targets in azimuth and appearance of more ghost targets due to multipath energy arriving through the side lobes. However, it was concluded that there was a significant amount of clear space amongst the returns to ensure recognition of vessels moving amongst the wind farm structures and safe navigation;*
- *Even in the worst case with Radar operator settings set artificially bad there is significant clear space around each turbine 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 can be concluded that the amount of shadowing observed was very little. However, it should be noted that this was modelled on lattice-type base structures which are sufficiently sparse to allow Radar energy to pass through;*
- *The lower the density of structures 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 scanners;*
- *It is important for passing vessels to keep a reasonable separation distance between the wind farm structures in order to minimise the effect of multipath and other ambiguities; and*
- *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)".*

19.8.1.6 Based on the trials carried out to date, the onset range from the turbines 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 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 Lookout, to take into account information from other sources which may include sound signals and VHF information, for example from a VTS, or AIS (MCA, 2016).

19.8.1.7 It is noted that upon development of Hornsea Three, commercial vessels are likely to pass over 1 nm from the Hornsea Three array area, and are thereby potentially subject to minor levels of Radar interference. There is sufficient sea room around the proposed wind farm for vessels to increase their clearance further if necessary to greater than 2 nm and out with the range of Radar interference.

19.8.1.8 Experienced mariners should be able to suppress the observed problems to an extent and for short periods (a few sweeps) by careful adjustment of the receiver amplification (gain), sea clutter and range settings of the Radar. However, there is a consequential 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 is needed in making such adjustments. The Kentish Flats study observed that the use of an easily identifiable reference target (a small buoy) can help the operator select the optimum Radar settings.

19.8.1.9 The performance of a vessel's ARPA could also be affected when tracking targets in or near the Hornsea Three array area. However, although greater vigilance is required, it appears that during the Kentish Flats trials, false targets were quickly identified as such by the mariners and then by the equipment itself.

19.8.1.10 The evidence from mariners operating in the vicinity of existing wind farms is that they quickly learn to work with and around the effects. The MCA has produced guidance to mariners operating in the vicinity of UK OREIs which highlights Radar issues amongst others to be taken into account when planning and undertaking voyages in the vicinity of renewable energy installations off the UK coast (MCA, 2016).

19.8.1.11 AIS information can also be used to verify the targets of larger vessels (generally vessels above 300 tonnes) and fishing vessels of 18 m length and over which are required to carry AIS. Since May 2014 the carriage requirements of AIS for fishing vessels require all fishing vessels of 15 m length and over to carry AIS. It is noted that no fishing vessels recorded within the Hornsea Three array area were less than 15 m length, noting also that 19% of fishing vessels did not specify a length. Furthermore an increasing number of small fishing vessels (currently not required to carry AIS) and recreational craft are voluntarily utilising Class B AIS units thus enabling verification of these small craft when in proximity to a wind farm.

19.8.2 Increased turbine size

19.8.2.1 Following analysis of Radar interference studies and general Radar principles the following impacts associated with the use of the large turbines (maximum hub height of 193 m and rotor tip of 325 m above LAT) which could be used in Hornsea Three have been identified. This is specifically to identify potential impacts with the increasing size of turbines due to the operation of marine Radar beam widths and does not consider impacts associated with the total number of turbines or amount of exposure for transiting vessels passing within 2 nm.

19.8.2.2 Figure 19.1 shows an example of how Radar range is determined – the curve of the earth plus the sum of the scanner and target height. A higher target height (point B in Figure 19.1) will result in a greater range of detection (point C) of the target, especially for larger vessels with a higher antenna (point A). However the increased distance would result in a weaker Radar return and therefore the effects recorded whilst operating in close proximity to a wind farm (e.g. interfering side lobes, multiple and reflected echoes), are not likely to occur at this increased range. Therefore the increased range of detection of larger turbines will not impact on a vessels' ability to navigate safely.

19.8.2.3 Increased turbine size would mean that small craft transiting within the Hornsea Three array area would be able to identify turbine targets at a greater distance, especially if they are not in rows. Consequently, the Hornsea Three array area, ahead of the vessel, would be clear on the Radar screen.

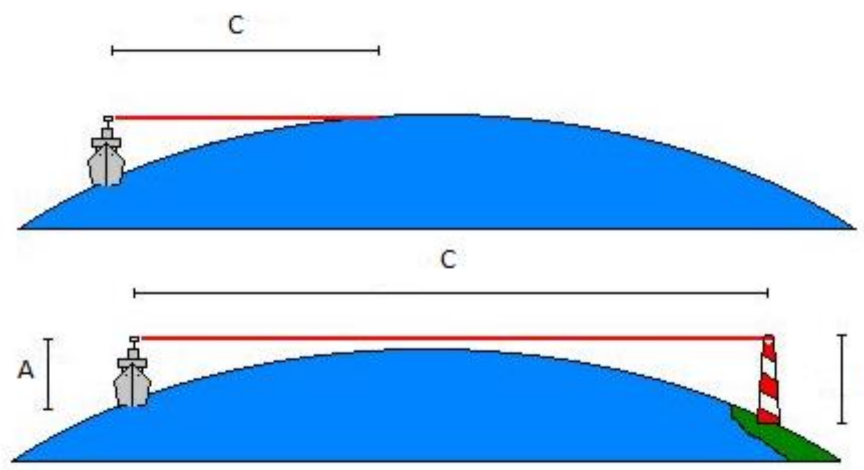

Figure 19.1: Determining Radar range.

19.8.3 Increased target returns

19.8.3.1 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 on its size, shape and aspect angle.

19.8.3.2 The larger turbines (either in height or width) will return a greater target size or stronger false targets. However there is a limit to which the vertical beam width would be affected (20 to 25°) dependant on the distance from the target. Therefore the increased turbine height at the Hornsea Three array area will not create any effects in addition to those already identified from existing operational wind farms (e.g. interfering side lobes, multiple and reflected echoes).

19.8.3.3 The most likely occurrence will be a greater target return due to increased width of turbine towers and foundations resulting in similar effects to those previously described (e.g. 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 trials carried out to date that the effects of increased returns can be managed effectively, this effect is expected to be negligible and not further impact on navigational safety.

19.9 Structures and turbines affecting sonar systems

19.9.1.1 No evidence has been found to date with regard to existing wind farms to suggest that they produce any kind of sonar interference which is detrimental to the fishing industry, or to military systems. No impact is therefore anticipated for the Hornsea Three array area and offshore cable corridor.

19.10 Noise impact

19.10.1.1 The concern which must be addressed under MGN 543 is whether acoustic noise from the wind farm could mask prescribed sound signals.

19.10.1.2 The sound level from a wind farm at a distance of 350 m has been predicted to be 51 (decibels) dB to 54 dB (A). Furthermore recent predictions of noise levels have been carried out throughout the consenting process of the Atlantic Array offshore wind farm. Modelling shows that the highest predicted level due to operational turbine noise (for a 125 m tall 8 megawatt (MW) turbines) is around 60 dB (Atlantic Array Offshore Wind Farm, 2012).

19.10.1.3 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 turbines. Foghorns will also be audible over the background noise of the project.

19.10.1.4 There are therefore no indications that the sound level of the wind farm will have a significant influence on marine safety.

19.10.1.5 The Scoping Opinion scoped out all airborne noise impacts and these have therefore not been considered further within the Environmental Statement.

19.11 Underwater noise

19.11.1.1 Underwater noise radiated from 110 m tall, 2 MW capacity turbines during the operation of the Horns Rev offshore wind farm (Denmark) was measured in November 2005. The maximum levels recorded at 100 m from the turbines were a sound pressure of 122 dB re 1µ pascals (Pa) (ITAP, 2006).

19.11.1.2 During the operation and maintenance phase of Hornsea Three, the subsea noise levels generated by turbines are not anticipated to have any significant impact on sonar systems as they are designed to work in pre-existing noisy environments.

19.12 Summary of communication and position fixing equipment effects

19.12.1.1 Table 19.1 summarises the impacts of Hornsea Three on communication and position fixing equipment.

Table 19.1: Summary of effects on communication and position fixing equipment.

Topic		Sensitivity	Screen in – Hornsea Three	Screen in - Cumulative
Type	Specific			
Communication	VHF	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
Communication	VHF direction finding	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
Communication	AIS	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
Communication	NAVTEX	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
Communication	GPS	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
Electromagnetic Field (EMF)	Cables	No anticipated impacts.	Screened out	Screened out
EMF	Turbines	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
Marine Radar	Use of marine Radar	Vessels have sufficient sea room to distance themselves from the Hornsea Three array area, in line with the shipping template, to mitigate any effects as per the shipping template within MGN 543 (MCA, 2016). Cumulatively, vessels within the proposed navigational corridor could be sensitive but have the ability to distance themselves further from the boundary or to make manual adjustments to mitigate any temporary impacts.	Screened out	Screened out
Noise	Turbine generated noise	No anticipated impacts. Not impact by layout design.	Screened out	Screened out
Noise	SONAR	No anticipated impacts. Not impact by layout design.	Screened out	Screened out

20. Hazard Workshop Overview

20.1.1.1 A key part of the Hornsea Three consultation phase was the Hazard Workshop, which gathered local and national marine stakeholders relevant to the project in order that shipping and navigation hazards could be identified, and subsequently included in a hazard log. This ensured that expert opinion and local knowledge was incorporated into the hazard identification process, and that the final hazard log was site-specific.

20.1.1.2 The hazard log details the risks associated with each hazard, and the industry standard and additional mitigation measures required to reduce the risks to ALARP, as identified in the Hazard Workshop.

20.1.1.3 The Hazard Workshop was held in London on Thursday 23 February 2017.

20.1.2 Hazard Workshop attendance

20.1.2.1 The organisations invited to attend the Hazard Workshop are listed in Table 20.1.

Table 20.1: Hazard Workshop invitees.

Company/organisation	Attendance
Anatec Ltd	Yes
Ørsted	Yes
RPS	Yes
Aggregate Industries UK Ltd.	Yes
Centrica	Yes
Chamber of Shipping	Yes
Cruising Association	Yes
DEME Building Materials Ltd.	Yes
DFDS Seaways	Yes
Maritime and Coastguard Agency	Yes
Poseidon	Yes
VISNED	Yes
Vroon Offshore Services Ltd.	Yes
ABP	No
British Marine Aggregate Producers Association	No

Company/organisation	Attendance
Boston Putford Offshore Safety	No
Cooperative Maritime Etaploise	No
Conoco Phillips	No
CRPMEM Nord	No
Danish Shipowners' Association	No
Danish Fishermen's Association	No
Department for Transport	No
Faroe Petroleum	No
From Nord	No
GloMar Shipmanagement BV	No
Lowestoft Port Authority	No
Nederlandse Visserbond	No
NFFO	No
P&O North Sea Ferries Ltd.	No
PD Ports	No
Peel Ports Great Yarmouth	No
Rederscentrale	No
Royal National Lifeboat Institute	No
Rotterdam Harbour Master	No
Royal Association of Netherlands Shipowners	No
Royal Yachting Association	No
Scarborough Yacht Club	No
Shell	No
Trinity House	No

20.2 Hazard Workshop process

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

20.2.1.2 Post workshop, the risks associated with the identified hazards were ranked based on the discussions held during the workshop, with appropriate mitigation measures identified. The rankings were then agreed with the invitees to the Hazard Workshop.

20.3 Hazard log

20.3.1.1 The hazard log can be found in Appendix B.

20.4 Tolerability of risks

20.4.1.1 When the most likely outcome was considered, 29 of the risks were ranked as broadly acceptable, with the remaining nine ranked as tolerable. No impacts were ranked as unacceptable. For the maximum design scenario, 36 risks were ranked as broadly acceptable, with the remaining two classed as tolerable. Again, no impacts were ranked as unacceptable.

21. Cumulative Overview

21.1 Introduction

21.1.1.1 Cumulative effects have been considered for activities in combination and cumulatively with Hornsea Three as part of the Zone Environmental Appraisal (ZEA) and ZAP to consider the cumulative effects of future offshore wind farm developments within the former Hornsea Zone and also as part of the 2013 SNSOWF report which considered routeing across the wider North Sea area.

21.1.1.2 For the Hornsea Three CEA projects and proposed developments were screened into the CEA only where a potential pathway has been identified between other activities and receptors. These were screened in or out on both a spatial and temporal basis.

21.2 Proposed navigational corridor between Hornsea Three, Hornsea Project One and Hornsea Project Two

21.2.1.1 The proposed navigational corridor located between Hornsea Three on the east and Hornsea Project One and Hornsea Project Two on the west is considered in section 22.9.

21.3 Other offshore wind farm developments

21.3.1 Overview

21.3.1.1 In addition to Hornsea Three, Hornsea Project One and Hornsea Project Two, there are a number of offshore wind farm developments within the North Sea, both within UK waters and non-UK waters. Table 21.1 presents details of the offshore wind farms where a cumulative or in combination activity has been identified based on type of installation and the distance from Hornsea Three. Figure 21.1 presents the locations of these developments.

21.3.2 Southern North Sea Offshore Wind Forum

21.3.2.1 The SNSOWF is a group comprising representatives from the UK Round Three wind farm zones located within the southern North Sea. These are Dogger Bank, Hornsea and East Anglia.

21.3.2.2 The SNSOWF group was established at the request of TCE in order to manage wider cumulative impacts, which are likely to arise between the zones due to the scale and location of these developments. With this purpose, applicants for the Dogger Bank, former Hornsea Zone and former East Anglia Zone work together to undertake the ZAP process and address the issues arising beyond the boundaries of their respective zones. This has further been identified as part of the consultation process for the applicants and identified as an action from key stakeholders including the MCA and TH including:

- Consideration for cumulative and in combination effects;
- Re-routeing with consideration for vessels existing preferences; and
- Impacts on Regular Operators and timetabled routes.

21.3.2.3 Figure 21.1 shows the defined 90th percentiles from the SNSOWF study against the current cumulative scenario defined in Table 21.1. Note the routeing scenario included a larger development to the east of the inshore routeing at the former Hornsea Zone.

21.4 Oil and gas infrastructure

21.4.1.1 There are no oil or gas surface platforms located within the Hornsea Three array area or offshore cable corridor. However the Schooner A platform located to the north of the Hornsea Three array area has been screened into the CEA given its proximity to the Hornsea Three array area and its location to the north of the proposed navigational corridor. Cumulative impacts are then considered in section 22.

21.4.1.2 The impact to the oil and gas industry is assessed in volume 2, chapter 11: Infrastructure and Other Users.

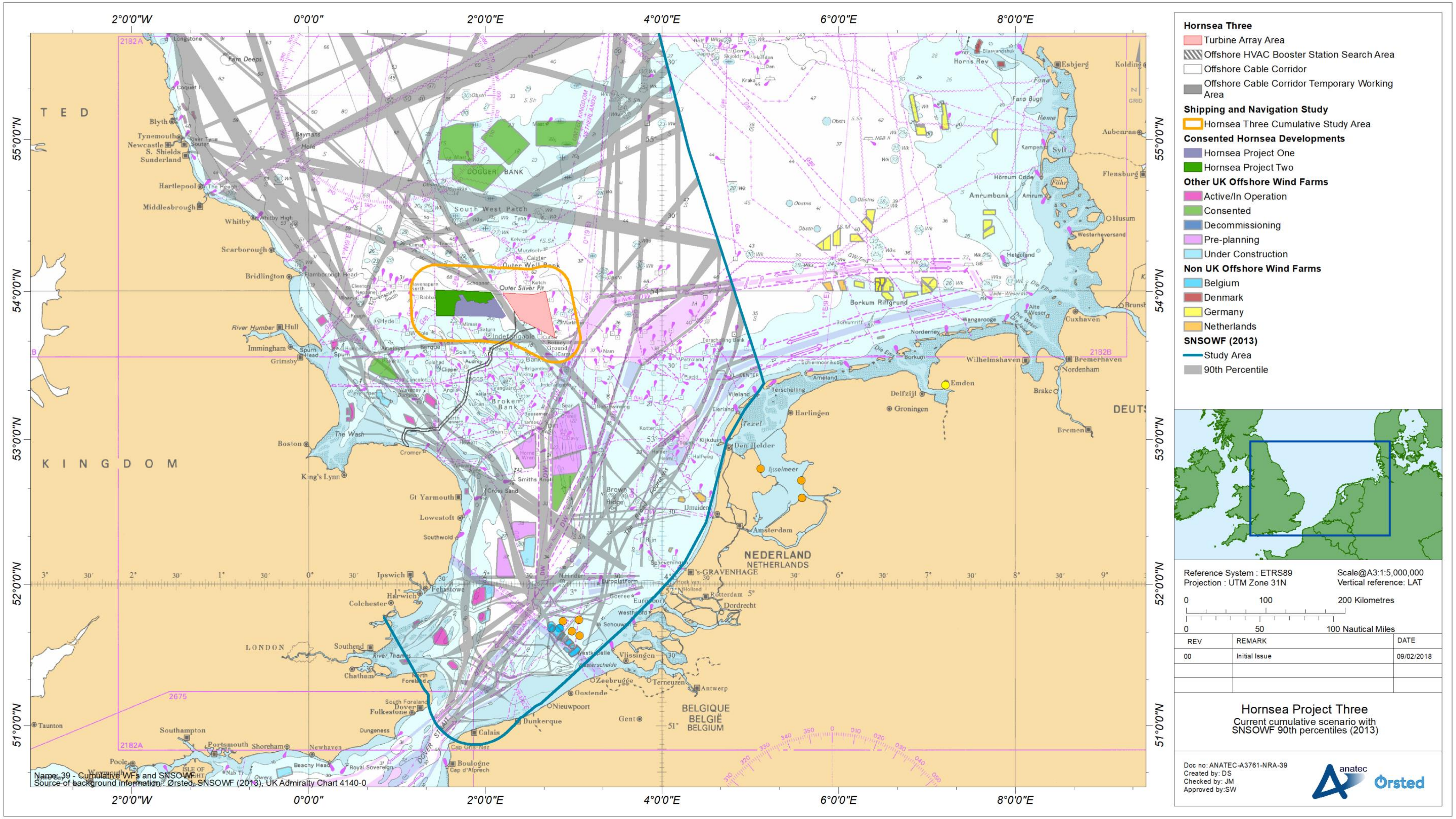

Figure 21.1: Current cumulative scenario with SNSOWF 90th percentiles (2013).

Table 21.1: Summary of offshore wind farms and oil and gas infrastructure screened-in to CEA.

Tier	Phase	Project/Plan	Distance from Hornsea Three array area (km)	Distance from Hornsea Three offshore cable corridor (km)	Details	Date of construction (if applicable)	Overlap of construction phase with Hornsea Three construction phase	Overlap of operation phase with Hornsea Three operation phase
1	***Offshore wind farms***							
	Operational	Alpha Ventus (Formerly Borkum West I) (Germany)	252	266		N/A	No	Yes
	Operational	Amrumbank West (Germany)	328	342	80 turbines.	N/A	No	Yes
	Operational	BARD Offshore 1 (Germany)	215	229	80 turbines.	N/A	No	Yes
	Operational	Belwind 1 (Belgium)	220	141	55 turbines.	N/A	No	No
	Operational	Belwind Alstom Haliade Demonstration (Belgium)	222	178	One turbine.	N/A	No	Yes
	Operational	Blyth (UK)	270	284	Two turbines.	N/A	No	No
	Operational	Borkum Riffgrund 1 (Germany)	245	259	77 turbines.	N/A	No	Yes
	Operational	Butendiek (Germany)	346	364	80 turbines.	N/A	No	Yes
	Operational	DanTysk (Germany)	314	333	80 turbines.	N/A	No	Yes
	Operational	Dudgeon (UK)	87	11	67 turbines.	N/A	No	Yes
	Operational	Emden (Germany)	295	311	One turbine.	N/A	No	No
	Operational	Eneco Luchterduinen (Netherlands)	170	185	43 turbines.	N/A	No	Yes
	Operational	Greater Gabbard (UK)	198	119	140 turbines.	N/A	No	Yes
	Operational	Gunfleet Sands Demo (UK)	245	137	Two turbines.	N/A	No	Yes
	Operational	Gunfleet Sands I (UK)	240	133	30 turbines.	N/A	No	Yes
	Operational	Gunfleet Sands II (UK)	239	134	18 turbines.	N/A	No	Yes
	Operational	Horns Rev (Denmark)	368	388	80 turbines.	N/A	No	Yes
	Operational	Horns Rev 2 (Denmark)	358	379	91 turbines.	N/A	No	Yes
	Operational	Humber Gateway (UK)	128	86	Up to 73 turbines.	N/A	No	Yes
	Operational	Hywind Scotland Pilot Park (UK)	438	455	5 turbines.	2017	No	Yes
	Operational	Irene Vorrink I (Netherlands)	223	240	19 turbines but part of a larger 28 turbine project.	N/A	No	No
	Operational	Irene Vorrink II (Netherlands)	223	240	9 turbines but part of a larger 28 turbine project.	N/A	No	No
	Operational	Kentish Flats (UK)	272	164	30 turbines.	N/A	No	Yes

Tier	Phase	Project/Plan	Distance from Hornsea Three array area (km)	Distance from Hornsea Three offshore cable corridor (km)	Details	Date of construction (if applicable)	Overlap of construction phase with Hornsea Three construction phase	Overlap of operation phase with Hornsea Three operation phase
1	Operational	Kentish Flats Extension (UK)	273	165	15 turbines.	N/A	No	Yes
	Operational	Lely (Netherlands)	184	201		N/A	Yes	Yes
	Operational	Lincs / LID6 1 /(UK)	139	41	75 turbines.	N/A	No	Yes
	Operational	London Array (UK)	230	92	175 turbines.	N/A	No	Yes
	Operational	Lynn and Inner Dowsing Wind Farms (UK)	147	43	54 turbines.	N/A	No	Yes
	Operational	Meerwind Süd/Ost (Germany)	326	339	80 turbines.	N/A	No	Yes
	Operational	Mermaid (Belgium)	217	135	48 turbines.	N/A	No	Yes
	Operational	Methil (Samsung) Demo (Levenmouth Turbine)	411	426	One turbine.	N/A	No	Yes
	Operational	Noerdlicher Grund Teil Sandbank (Germany)	297	316	72 turbines.	N/A	No	Yes
	Operational	Nordsee Ost (Germany)	326	340	48 turbines.	N/A	No	Yes
	Operational	Northwind (Belgium)	229	153	72 turbines.	N/A	No	Yes
	Operational	Offshore Windpark Egmond aan Zee (Netherlands)	157	173	36 turbines.	N/A	No	Yes
	Operational	Prinses Amaliapark (Netherlands)	153	168	60 turbines.	N/A	No	Yes
	Operational	Riffgat (Germany)	241	356	30 turbines.	N/A	No	Yes
	Operational	Robin Rigg East (UK)	391	369	30 turbines.	N/A	No	Yes
	Operational	Robin Rigg West (UK)	392	369	30 turbines.	N/A	No	Yes
	Operational	Scroby Sands (UK)	132	48	30 turbines.	N/A	No	No
	Operational	Sheringham Shoal (UK)	109	7	88 turbines.	N/A	No	Yes
	Operational	Teesside (UK)	224	229	27 turbines.	N/A	No	Yes
	Operational	Thanet (UK)	260	168	100 turbines.	N/A	No	Yes
	Operational	Thornton Bank Phase I (Zone 1 C-Power) (Belgium)	237	158	Six turbines.	N/A	No	Yes
	Operational	Thornton Bank Phase II (Belgium)	237	158	30 turbines.	N/A	No	Yes
	Operational	Thornton Bank Phase III (Zone 1 C-Power 2) (Belgium)	235	160	18 turbines.	N/A	No	Yes
	Operational	Trianel Windpark Bokrum (Borkum West II) Phase 1 (Germany)	241	255	40 turbines.	N/A	No	Yes
	Operational	Trianel Windpark Borkum Phase 1 (Germany)	242	255	40 turbines.	N/A	No	Yes

Tier	Phase	Project/Plan	Distance from Hornsea Three array area (km)	Distance from Hornsea Three offshore cable corridor (km)	Details	Date of construction (if applicable)	Overlap of construction phase with Hornsea Three construction phase	Overlap of operation phase with Hornsea Three operation phase
1	Operational	Westermeerdijk buitendijks (Netherlands)	215	232	48 turbines.	N/A	No	Yes
	Operational	Westermost Rough (UK)	132	106	35 turbines.	N/A	No	Yes
	Under construction	Buitengaats (Netherlands)	214	228	75 turbines.	N/A	No	Yes
	Under construction	Galloper (UK)	195	79	Up to 56 turbines.	N/A	No	Yes
	Under construction	Global Tech I (Germany)	245	258	80 turbines.	N/A	No	Yes
	Under construction	Gode Wind I (Germany)	275	289	55 turbines.	N/A	No	Yes
	Under construction	Gode Wind II (Germany)	276	290	42 turbines.	N/A	No	Yes
	Under construction	Hornsea Project One (UK)	7	7	Up to 240 turbines.	2017 to 2019	No	Yes
	Under construction	INNOGY Nordsee I (Germany)	262	276	54 turbines.	N/A	No	Yes
	Under construction	MEG Offshore I (now Merkur Offshore Wind Farm) (Germany)	247	260		N/A	No	Yes
	Under construction	Nordergruende (Germany)	353	368	18 turbines.	N/A	No	Yes
	Under construction	Race Bank (UK)	114	28	91 turbines.	2017	No	Yes
	Under construction	Rampion Wind Farm (UK)	388	266	116 turbines.	N/A	No	Yes
	Under construction	Sandbank 24 (Germany)	298	317	72 turbines.	N/A	No	Yes
	Under construction	Veja Mate (Germany)	208	221	40 turbines.	N/A	No	Yes
	Under construction	ZeeEnergie (Netherlands)	203	216	75 turbines.	N/A	No	Yes
	Consented	Borssele 1 and 2 (Netherlands)	216	181	Between 69 and 127 turbines.	2017 to 2020	No	Yes
	Consented	Borssele 3 and 4 (Netherlands)	217	175	123 turbines.	2018 to 2021	No	Yes
	Consented	Deutsche Bucht Offshore Wind Farm (Germany)	203	217	30 turbines.	2017 to 2019	No	Yes
	Consented	East Anglia One (UK)	152	106	102 turbines.	2018 to 2019	No	Yes
	Consented	He dreiht I (Germany)	228	311	Up to 80 turbines.	Unavailable	Unavailable	Unavailable
	Consented	Hohe See (Germany)	239	254	71 turbines.	2018 to 2020	No	Yes
	Consented	Hornsea Project Two (UK)	7	18	Up to 300 turbines.	2020 to 2022	No	Yes
	Consented	Kincardine Offshore Wind Farm (UK)	422	438	Eight turbines.	2018 to 2019	No	Yes
	Consented	Noerdlicher Grund (Germany)	295	314	64 turbines.	Unavailable	Unavailable	Unavailable
	Consented	Norther (Belgium)	236	163	44 turbines.	2017 to 2018	No	Yes
	Consented	Rental Area A (Belgium)	231	155	42 turbines.	2017 to 2018	No	Yes

Tier	Phase	Project/Plan	Distance from Hornsea Three array area (km)	Distance from Hornsea Three offshore cable corridor (km)	Details	Date of construction (if applicable)	Overlap of construction phase with Hornsea Three construction phase	Overlap of operation phase with Hornsea Three operation phase
1	Consented	Seastar (Belgium)	225	149	42 turbines.	2017 to 2018	No	Yes
	Consented	Trianel Windpark Bokrum (Bokrum West II) Phase 2 (Germany)	242	255	32 turbines.	2018	No	Yes
	Consented	Triton Knoll (UK)	100	44	Between 113 and 288 turbines.	2020 to 2021	No	Yes
	Oil and gas infrastructure							
	Active	Schooner A platform	11	27	Gas Field – Producing	N/A	N/A	Yes
2	***Offshore wind farms***							
	Consented	East Anglia Three (UK)	103	87	Up to 172 turbines.	2019 to 2022	Yes	Yes
	Consented	Dogger Bank Creyke Beck A (UK)	76	91	Up to 200 turbines.	2021 to 2024	Yes	Yes
	Consented	Dogger Bank Creyke Beck B (UK)	99	115	Up to 200 turbines.	2021 to 2024	Yes	Yes
	Consented	Dogger Bank Teesside A (UK)	107	123		2023 to 2026	Yes	Yes
	Consented	Dogger Bank Teesside B (now Sofia offshore wind farm) (UK)	95	108		2023 to 2026	Yes	Yes
3	***Offshore wind farms***							
	Pre-planning application	Bokrum-Riffgrund West II (Germany)	224	238	43 turbines.	2019 to 2020	No	Yes
	Pre-planning application	East Anglia One North (UK)	141	90		2021 to 2022	Yes	Yes
	Pre-planning application	East Anglia Two (UK)	158	94		2023 to 2025	Yes	Yes
	Pre-planning application	Methil Demonstration Project - 2B Energy (UK)	411	426		Unavailable	Unavailable	Unavailable
	Pre-planning application	Norfolk Boreas (UK)	53	64		2024 to 2029	Yes	Yes
	Pre-planning application	Norfolk Vanguard (UK)	73	51	Between 120 and 257 turbines.	2020 to 2022	Yes	Yes
	Pre-planning application	Northwester 2 (Belgium)	222	175	Between 22 and 70 turbines.	2018 to 2020	No	Yes
	Concept/early planning	Thanet Extension (UK)	260	168	34 turbines.	2020 to 2021	No	Yes

22. Formal Safety Assessment

22.1 Introduction

22.1.1.1 This section assesses the major hazards associated with the development of Hornsea Three, considering the baseline data, assessment and consultation contained within this NRA. This assessment is carried out as per the FSA methodology outlined in section 3.1.

22.2 Human element

22.2.1.1 MGN 372 has been developed to provide guidance on planning and undertaking voyages in the vicinity of offshore wind farms and states that although offshore renewable energy installations present new challenges to safe navigation around the UK coast, proper voyage planning, taking into account all relevant information, should ensure a safe passage and that the safety of life and the vessel is not compromised. To date there has only been one incident involving a third party vessel and a fixed offshore wind farm structure since offshore development began in 2000; with 76 offshore wind farms currently in operation, under construction/decommissioning or decommissioned within the UK REZ and the southern North Sea (see section 13).

22.3 Deviations

22.3.1 All phases

22.3.1.1 Marine traffic movements around the Hornsea Three array area, offshore cable corridor and offshore HVAC booster station search area have been captured through dedicated marine traffic surveys and AIS surveys as noted in section 15. When marine traffic survey data assessments are considered alongside historical analysis in the form of the Hornsea Project Two NRA and vessel route databases (Anatec ShipRoutes, 2016) a full and detailed picture of commercial vessel movement has been defined (section 15.4.5). The multiple sources used have allowed this NRA to clearly identify all key routes operating within the Hornsea Three array area, offshore cable corridor and offshore HVAC booster station search area shipping and navigation study areas using the principles defined within MGN 543 (MCA, 2016). This includes the identification of main routes, 90th percentiles and Regular Operators who have been consulted as part of the stakeholder process (section 14). This baseline information has then enabled the assessment to look at future case routeing (section 17).

Hornsea Three array area

22.3.1.2 Of the 16 main routes identified transiting through the Hornsea Three array area shipping and navigation study area, eight routes will be deviated from their current main route (section 15.4.5). Of these routes two were operated by commercial ferries which are also considered separately in section 22.4. The shortest and therefore most likely alternative routes have been considered for the eight identified routes. Assumptions for re-routes assume the following:

- All deviated routes maintain a minimum separation of 1 nm from offshore installations and potential turbine boundaries (see paragraph 17.7.1.2); and
- All alternative routes take into account sandbanks, existing infrastructure and known routeing preferences for the vessels identified on those routes.

22.3.1.3 Average speeds for vessels on each individual route have been noted but time increases have not been considered given the minor increases to journey length. See section 17.7 for details on future case routeing.

22.3.1.4 Maximum deviations during the construction and decommissioning phase would be associated with the buoyed construction or decommissioning area. As this area for displacement cannot be increased in size given the maximum extent of the AfL, this impact can only be lower post consent; and would be caused by a significant decrease in the total number of turbines and thus development area with the result that deviations would be reduced.

22.3.1.5 Section 42 consultation included feedback from one operator; BP shipping, who queried the level of consultation undertaken. An explanation of the Regular Operator process was issued and no further communication was received.

22.3.1.6 When the deviations noted in section 17 are considered against the consultation responses received there are predicted to be no significant impacts on commercial vessels and the impact is assessed to be **broadly acceptable** with measures adopted as part of Hornsea Three in place (including information promulgation in place to aid passage planning) for all phases. This is associated with the vessels not being on timetabled services, not carrying large numbers of passengers (no significant safety effects) and the small increases in length compared to the overall journey. Further examination of commercial ferry routes was also undertaken in section 22.4.

Hornsea Three offshore cable corridor and offshore HVAC booster station(s)

22.3.1.7 There are expected to be very small and temporary deviations associated with the export cable installation and therefore any impact is negligible. For the Hornsea Three offshore HVAC booster station(s) there will be deviations required during construction, operation and maintenance, and decommissioning. The impact of this during the construction and decommissioning phases will be greater than the operation and maintenance phase given the need for a buoyed construction area around the Hornsea Three offshore HVAC booster station(s). The Hornsea Three offshore HVAC booster station deviations would be dictated by the construction or decommissioning buoyage put in place by TH to manage passing traffic. This impact would be temporary during the construction and decommissioning of the Hornsea Three offshore HVAC booster station(s) itself.

22.3.1.8 For operation and maintenance there will be small deviations required for the surface Hornsea Three offshore HVAC booster station(s) and the subsea HVAC booster station(s) (including any associated marker buoys); however these impacts are expected to be very low given the small deviation required against the total journey length.

22.3.1.9 Therefore for all phases the impact is assessed to be **broadly acceptable** with mitigation measures adopted as part of Hornsea Three (including information promulgation in place to aid passage planning) in place as per section 23.

22.4 Commercial ferry deviations

22.4.1 All phases

Hornsea Three array area

22.4.1.1 Similar principles apply as per paragraph 22.3.1.1 whereby commercial ferry routes have been identified and assessed using principles defined in MGN 543. For commercial ferries, although the frequency is medium given the number of transits made, the consequences are considered low given that the ferries only carry small (less than 12) numbers of passengers thus minimising on board health and safety impacts for non-crew. The journey increases are small when considered against total journey length and there is available sea room for safe manoeuvring and deviations to be made.

22.4.1.2 Following consultation with DFDS Seaways, the only operator directly impacted, they noted that their main concern was with adverse weather routes (this hazard is assessed separately in section 22.6).

22.4.1.3 It is assessed that the impact for Hornsea Three is **broadly acceptable** with measures adopted as part of Hornsea Three in place.

Hornsea Three offshore cable corridor and offshore HVAC booster station(s)

22.4.1.4 There are no deviations identified in association with the Hornsea Three offshore cable corridor or Hornsea Three offshore HVAC booster station(s) for commercial ferries.

22.5 Adverse weather routeing

22.5.1 All phases

22.5.1.1 Adverse weather includes wind, wave and tidal conditions as well as reduced visibility due to fog that can hinder a vessel's normal route and/or speed of navigation. Adverse weather routes are assessed to be significant course adjustments to mitigate vessel movement in adverse weather conditions. When transiting in adverse weather conditions, a vessel is likely to encounter various kinds of weather and tidal phenomena, which may lead to severe roll motions, potentially causing damage to cargo, equipment and/or 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.

22.5.1.2 The probability of occurrence, in a particular sea state, may differ for each vessel. Adverse weather is considered most significant for passenger carrying vessels, due to the potential health and safety risks (as well as comfort) to people on board (health and safety risk such as sea sickness and difficulty moving around the vessel). This can also have implications for regular timetabled vessels, due to increases in journey time and potential cancellations. Mitigations for vessels include adjusting their heading to position themselves 45° to the wind, altering or delaying sailing times, reducing speed and/or potentially cancelling journeys. However due to the open sea area around Hornsea Three, there is not expected to be any significant limitations to routeing options.

22.5.1.3 With regards to reduced visibility, standard mitigations are required by both the Applicant and the vessel operator. The Applicant will ensure that Hornsea Three is marked and lit in accordance with requirements defined by TH and this scheme will include fog horns to alert vessels to the position of structures when visibility is poor. Vessels are also required to take appropriate measures with regards to safe speed under the COLREGs (IMO, 1972 as amended), which considers determining a safe speed in conjunction with the state of visibility, the state of the wind, sea and current as well as the proximity of navigational hazards. No section 42 consultation responses were received with regards to adverse weather routeing (excluding passenger carrying vessels).

Hornsea Three array area

22.5.1.4 When the mitigation measures accepted as part of Hornsea Three are assessed against the probability of adverse weather including restricted visibility, the low numbers of vessels within the Hornsea Three array area and the available sea room the impact is assessed to be **broadly acceptable.**

Hornsea Three offshore cable corridor and offshore HVAC booster station(s)

22.5.1.5 There are no adverse weather impacts identified in association with the Hornsea Three offshore cable corridor or offshore HVAC booster station(s).

22.6 Commercial ferry adverse weather routeing

22.6.1 All phases

22.6.1.1 Commercial ferry adverse weather routeing has been identified in section 16.

Hornsea Three array area

22.6.1.2 For the operation and maintenance phase and following consultation with DFDS Seaways it was identified that the Hornsea Three array area was intersected by one adverse weather route for the Immingham to Cuxhaven route. However a year of AIS from 2016 was analysed, during which eight potential adverse weather transits were identified on AIS. When considered against the number of potential normal crossings this equates to less than 2% of transits (during the 2016 sample) using adverse weather routeing to the north of the Hornsea Three array area. The vessels on this route are commercial Ro Ro vessels that carry limited number of passengers and are therefore more able to withstand adverse weather conditions than passenger ferries (due to health and safety risks to on-board passengers).

22.6.1.3 Of the known commercial ferry operators only DFDS Seaways raised concerns pre PEIR regarding their adverse weather routeing; however they had no further comments to make during the section 42 consultation phase. DFDS Seaways are the only identified commercial ferry operator to transit through the Hornsea Three array area. Commercial ferry routeing was raised by the Ministry of Infrastructure and the Environment, of the Dutch government (Rijkwaterstaat) but as noted in Table 14.2 main routes including ferry routes have been considered at both a base and future case level.

22.6.1.4 This considered against the frequency of occurrence means that the impact is considered **broadly acceptable.**

Hornsea Three offshore cable corridor and offshore HVAC booster station(s)

22.6.1.5 There are no deviations identified in association with the Hornsea Three offshore cable corridor or offshore HVAC booster station(s) for commercial ferries.

22.7 Cumulative deviations

22.7.1 All phases

Hornsea Three array area

22.7.1.1 Cumulative deviations have been considered in line with the Hornsea Three cumulative shipping and navigation study area described in section 5.2.4 and the cumulative project list in Table 21.1.

22.7.1.2 Following work undertaken for the ZAP, including the routeing reports undertaken as part of SNSOWF; a navigational corridor was designed to mitigate impacts on cumulative deviations associated with the former Hornsea Zone.

22.7.1.3 Within the Hornsea Project Two Environmental Statement (SMartWind, 2015) the cumulative impact of Hornsea Project One and Hornsea Project Two was considered to be a long term and continuous impact but of a low frequency. Although further deviations are now required due to the presence of the Hornsea Three array area; assessment and consultation responses do not consider this to be greater than Hornsea Project One or Hornsea Project Two and therefore Hornsea Three, Hornsea Project One and Hornsea Project Two in combination too. The cumulative impact is therefore considered **broadly acceptable** under the FSA given the following reasons:

- The majority of routes impacted by the cumulative developments run east to west and therefore are already deviated to the maximum extent by Hornsea Project One and Hornsea Project Two;
- Impacts were considered minor adverse within the Hornsea Project Two Environmental Statement;
- There are fewer dense and significant routes passing through Hornsea Three (than Hornsea Project One and Hornsea Project Two); and
- The proposed navigational corridor provides a useable alternative to deviating around the area.

22.7.1.4 It is noted that Hornsea Project One and Hornsea Project Two are consented. Therefore cumulative adverse weather scenario impacts would be the same given the routes do not intersect Hornsea Three, Hornsea Project One or Hornsea Project Two. Other offshore wind farm developments have no impact given the distance from the former Hornsea Zone and the direction of the adverse routes. The cumulative impact given the available sea room, distance from shore (giving numerous routeing options) and the preference identified for coastal passenger ferry routeing (section 16) is therefore assessed to be **broadly acceptable.** Mitigation includes marking, charting and promulgation of information to ensure that vessels are able to effectively passage plan.

22.7.1.5 No section 42 responses on the proposed navigational corridor were received from commercial vessels; the CA noted "*the proposed navigational corridor will prove valuable in resolving this concern but may be treated as a narrow channel under Rule 9 of COLREGs and require additional buoyage and lighting*." It is noted that additional buoyage would need to be at the request of TH.

22.7.1.6 Cumulative collision risk is considered further in section 22.9.

Hornsea Three offshore cable corridor and offshore HVAC booster station(s)

22.7.1.7 There were no cumulative deviations identified in association with the Hornsea Three offshore cable corridor or offshore HVAC booster station(s); based on the lack of consultation responses and also limited AIS data assessed it is assumed the impact is **negligible.**

22.8 Increased encounters and collision risk

22.8.1 Construction and decommissioning phases

Hornsea Three array area

22.8.1.1 The presence of construction (or decommissioning activities) within the Hornsea Three array area may cause low numbers of vessels to be deviated potentially increasing encounters and the risk of vessel to vessel collision. This impact can be separated into two impacts; encounters and collision between third party vessels and encounters and collision between a third party vessel and a vessel associated with Hornsea Three construction (or decommissioning). The following section details the two impacts.

Encounters and collision risk between third party vessels

22.8.1.2 The increased level of vessel activity required for Hornsea Three construction (or decommissioning) may lead to an increase in vessel to vessel collision risk due to displacement of third party vessels and increased encounters with construction (or decommissioning) vessels.

22.8.1.3 Mitigation measures accepted as part of Hornsea Three are in place to manage increased traffic levels and encounters between construction (or decommissioning) vessels and third party vessels.

22.8.1.4 Mitigation measures adopted as part of Hornsea Three (section 23) include:

- Compliance with Flag State regulations including IMO conventions including COLREGs (IMO, 1972 as amended) and the SOLAS (IMO, 1974 as amended);
- MGN 372 (MCA, 2008); and
- Promulgation of information.

22.8.1.5 When considering experience at other constructing wind farms it is identified that third party vessels do consider Notice to Mariners during passage planning and avoid currently constructing areas. To date there have not been any recorded incidents within a buoyed construction area whereby a third party vessel has collided within a construction vessel (see section 13).

22.8.1.6 As already noted under paragraph 22.3.1.2, it is likely that given the available sea room vessels will pass more than the 1 nm distance considered within this conservative deviation assessment to keep clear from the edge of the buoyed construction area meaning that, given the sea room, the number of hot spots where vessels would be likely to meet would be reduced lowering the risk of encounter.

22.8.1.7 Considering this and given the low numbers of third party vessels in the area (compared to the other UK sea areas), when assessed with existing regulations such as COLREGs (IMO, 1972 as amended) and guidance such as MGN 372 (MCA, 2008) there is considered to be a low frequency of encounters. The impact is therefore assessed to be ALARP.

Encounters and collision risk with construction (or decommissioning) vessels

22.8.1.8 It is anticipated that up to 10,774 return trips will be made between the Hornsea Three array area and base ports during the construction of Hornsea Three. Construction could last up to eight years in two phases (periods of activity and inactivity), however given that the mitigation measures adopted as part of Hornsea Three (section 23) will be in place until fully commissioned, the length of the construction phases or number of phases is not assessed to influence this impact.

22.8.1.9 Encounters with vessels associated with Hornsea Three are not considered likely given the mitigation measures adopted as part of Hornsea Three that will be in place to manage them and ensure that they do not encounter third party vessels, and fully comply with UK and Flag State regulation. Section 42 consultation did not include any concern over the impact of construction (and decommissioning vessels) for identified receptors. Peel Ports did raise concerns regarding impacts on port traffic; however construction (or decommissioning) ports have not yet been selected and therefore a specific assessment could not be made. However mitigation measures adopted as part of Hornsea Three as listed below would ensure this impact was ALARP.

22.8.1.10 Mitigation measures adopted as part of Hornsea Three (section 23) include:

- Compliance with Flag State regulations including IMO conventions including COLREGs (IMO, 1972 as amended);
- Buoyed construction (or decommissioning) area clearly identifying the location of construction (or decommissioning) works and vessels;
- 500 m construction safety zones around partially constructed offshore wind farm structures that are attended by large construction vessels;
- The Marine Coordination Centre will fully manage vessel movements associated with Hornsea Three (including between phase management); and
- Vessels will have a traffic management plan in place that may include options such as entry and exit points into the Hornsea Three array area. This will help to ensure that vessels do not exit into key vessel routes. From a cumulative impact perspective, this will also include the proposed navigational corridor.

22.8.1.11 It is noted that collision risk frequency is also likely to increase further in reduced visibility when identification of construction vessels exiting/entering the wind farm construction area may become more difficult. However COLREGs (IMO, 1972 as amended) does regulate vessel movements in adverse weather and requires all vessels operating in reduced visibility to reduce speed and allow more time to react to encounters, thus minimising the risk of collision.

22.8.1.12 As already noted under paragraph 22.3.1.2, it is likely that given the available sea room vessels will pass more than the 1 nm distance considered within this conservative deviation assessment to keep clear from the edge of the buoyed construction area. The frequency of vessels encountering construction (or decommissioning) vessels near the Hornsea Three array area would therefore be very low.

22.8.1.13 When considering the low numbers of third party vessels in the area (compared to the other UK areas), existing regulations such as COLREGs (IMO, 1972 as amended), guidance such as MGN 372 (MCA, 2008), other mitigation measures adopted as part of Hornsea Three (section 23) and mitigation in place to manage Hornsea Three's own vessels, the impact is assessed to be **broadly acceptable.**

Hornsea Three offshore HVAC booster station(s)

22.8.1.14 Any increase in collision risk associated with the Hornsea Three offshore HVAC booster station(s) is expected to be mitigated by the measures adopted as part of Hornsea Three (section 23) and the small buoyed construction area required by TH for the Hornsea Three offshore HVAC booster stations either in isolation or in a group.

22.8.1.15 No significant consultation response was noted from Regular Operators in the area following the section 42 consultation.

22.8.1.16 When considered with mitigation measures adopted as part of Hornsea Three included within section 23, the low density of third party vessels operating in the area (meaning low encounters and thus low collision risk) and a maximum construction duration (split over two phases) the impact is assessed to be **broadly acceptable.**

Hornsea Three offshore cable corridor

22.8.1.17 When considering construction (or decommissioning) within the Hornsea Three offshore cable corridor including a maximum installation of three years, there are not anticipated to be any significant impacts, given that mitigation measures adopted as part of Hornsea Three including minimum safe passing distances for installation or decommissioning vessels and Notice to Mariners will be in place to ensure vessels are pre warned of activity and are able to temporarily avoid areas of current activity. Therefore **negligible** effects have been identified for the Hornsea Three offshore cable corridor.

22.8.2 Operation and maintenance phase

Hornsea Three array area

22.8.2.1 It is noted that collision modelling is assessed at a maximum design scenario level as it assumed that all vessels pass 1 nm from the Hornsea Three array area. In reality vessels will use all available sea room, reducing hot spots and collision risk.

22.8.2.2 Further details of encounter and collision modelling can be found in section 18.

Encounters and collision risk between third party vessels

22.8.2.3 The presence of the infrastructure within Hornsea Three has the potential to increase vessel to vessel collisions through displacement of vessels, when compared with the existing vessel routeing.

22.8.2.4 The annual vessel to vessel collision frequency following the installation of Hornsea Three was 6.59×10^{-3}, corresponding to a major collision return period of one in 152 years based on conservative vessel routeing and Layout A.

22.8.2.5 Although not modelled beyond the Hornsea Three array area shipping and navigation study area, the extent of this impact will cover a large geographical area due to the start and finishing locations of the vessel routes and the early alterations to course they could be required to make; however the large extent is likely to also aid mitigation of the impact by preventing the creation of collision risk hotspots near the Hornsea Three array area by increasing the distance at which vessels will alter course to deviate around the Hornsea Three array area.

22.8.2.6 Mitigation measures adopted as part of Hornsea Three are in place to manage increased traffic levels and encounters between third party vessels; given the low levels (compared to other UK sea areas) and these mitigations; the increase in risk of encounters is expected to be ALARP.

22.8.2.7 Relevant measures adopted as part of Hornsea Three (section 23) include:

- Compliance with Flag State regulations including IMO conventions including COLREGs (IMO, 1972 as amended);
- Marine coordination;
- IALA (2013) guidance and Aids to Navigation; and
- MGN 372 (MCA, 2008).

Encounters with third party vessels exiting the wind farm

22.8.2.8 MGN 543 (MCA, 2016) identifies the potential for visual navigation to be impaired by the location of offshore wind farm structures, decreasing the ability of vessels to sight each other (when hidden behind structures). Based on the hazard log, collision risk frequency could increase further in reduced visibility when wind farm related vessels exiting the wind farm may not be easily sighted. However COLREGs (IMO, 1972 as amended) should mitigate this impact by regulating all vessels to operate at a safe speed and use sound signals to notify others of their presence.

22.8.2.9 A total of 38 recreational vessels were recorded within the Hornsea Three array area shipping and navigation study area throughout the 40 day marine traffic survey, 17 of which were identified operating over two days and as part of an annual long distance yacht race – the *500 Mile North Sea Race*. Therefore recreational vessel numbers per day within the Hornsea Three array are expected to be one or less; or excluding the yacht race one every two days. On average 11 unique fishing vessels per day were present within the Hornsea Three array area shipping and navigation study area but were concentrated in general to the northwest of the Hornsea Three array area away from commercial routes.

22.8.2.10 Due to the low level of small craft/vessels likely to be operating within the Hornsea Three array area or in proximity to the commercial vessel routes, the number of encounters and thus collision frequency will be low.

22.8.2.11 Hornsea Three represents an increased minimum spacing between structures when compared against existing developed and planned wind farms. One kilometre spacing is a significant distance in which targets would only be temporarily masked from other approaching vessels noting that the maximum design foundation diameter is 50 m. Considering the spacing and the size of structures it is unlikely that a small craft within or about to exit the Hornsea Three array area would be masked from passing vessels. It is also likely, as noted under paragraph 22.3.1.2, that vessels would pass more than the conservative 1 nm distance assessed. Therefore this impact is assessed to be ALARP.

<u>Visual interference (aids to navigation and/or landmarks)</u>

22.8.2.12 Due to the distance of Hornsea Three offshore it is predicted there will be no impacts on existing Aids to Navigation and/or landmarks. On the contrary it is likely to become a key navigational aid in an area previously devoid of lights and marks to assist passing vessels. This could be of particular benefit to the portion of recreational and small craft that may lack advanced navigational technology; given cost and bridge space.

<u>Encounters and collision risk with operation and maintenance vessels</u>

22.8.2.13 It is anticipated that up to 2,433 return trips by CTVs will be made between the Hornsea Three array area and base ports per year. Aside from personnel transfer there will also be up to four OSVs stationed on site, 312 supply vessels return trips per year and up to 140 jack up return trips per year. As with the construction and decommissioning phases, encounters between project and third party vessels are expected to be of a low frequency given the confirmed mitigation measures adopted as part of Hornsea Three (section 23).

22.8.2.14 Operation and maintenance vessel visits to the Hornsea Three offshore cable corridor are expected to be negligible and therefore no significant impacts are expected. However, measures adopted as part of Hornsea Three and maritime regulations and standard industry practices (including COLREGs (IMO, 1972 as amended) and minimum safe passing distances) are in place to minimise encounters, near misses and thus allision.

22.8.2.15 Pre and post section 42 consultation responses from Regular Operators did not identify any concern for vessels operating in or near Hornsea Three associated with collision with operation and maintenance vessels. Peel Ports did raise concerns regarding impacts on port traffic; however operation ports have not yet been selected and therefore a specific assessment could not be made. However mitigation measures adopted (marine coordination) would ensure this impact was ALARP,

22.8.2.16 When considered with mitigation measures adopted as part of Hornsea Three (section 23), and the low density of third party vessels operating in the area (meaning low encounters and thus low collision risk), lessons learnt and experience within the industry show a negligible impact on encounters and collision risk. The effect for the operation and maintenance phase is assessed to be **broadly acceptable.**

Hornsea Three offshore HVAC booster station(s)

22.8.2.17 As final locations for the proposed offshore HVAC booster station(s) (surface or subsea) have not been defined, it is not yet possible to risk assess the final locations. However, given the relatively small size of the Hornsea Three offshore HVAC search area, an indicative location central to the search area has been assessed based on a tightly packed layout. Modelling results detailed in section 18.

22.8.2.18 Scenarios where the offshore HVAC booster station(s) have been sited in isolation, pairs or other small groups have not been modelled. It is noted that in 2016 the offshore HVAC booster station search area was reduced in size to exclude a dense navigational route to the southwest and was further refined in 2017 following section 42 consultation. The indicative location does not require any notable deviations for the four main routes identified and would have similar effects to any isolated structure, with regards to vessel routeing, located within the central and southern North Sea. The proposed changes to the Hornsea Three offshore HVAC booster search area were discussed with the MCA and TH at consultation meetings in December 2017. Both parties agreed that the change to the search area was positive and that there were no significant effects with regards to vessel routeing.

22.8.2.19 Final agreement will be required with statutory stakeholders as to the location of the Hornsea Three offshore HVAC booster station(s); however the level of concern as to the location was limited to the avoidance of key navigational routes and mitigated by the reduction in the Hornsea Three offshore HVAC booster station search area. Fishing and recreational users had no concerns. The impact is considered to be **broadly acceptable.**

22.8.2.20 It is assumed that there is no maximum spacing required by the regulators given that each structure, as with oil and gas platforms, can be marked as an isolated structure.

Hornsea Three offshore cable corridor

22.8.2.21 As the export cables will be buried or protected there are not anticipated to be any effects associated with increased encounters or collision risk for vessels within the offshore cable corridor during the operation and maintenance phase.

22.9 Cumulative increased encounters and collision risk

22.9.1 Construction and decommissioning phases

22.9.1.1 Cumulatively during the construction and decommissioning of Hornsea Three (and assuming Hornsea Project One and Hornsea Project Two are constructed), the proposed navigational corridor (as shown in Figure 22.1) should be assessed to ensure risk or inconvenience to third parties caused by buoyed construction areas is mitigated (as per further mitigation). If there is significant overlap between the Hornsea Three construction area and the proposed navigational corridor there may need to be temporary measures put in place in consultation with the MCA and TH to ensure that any works on the western edge of the Hornsea Three array area do not adversely impact the safety of third party vessels within the proposed navigational corridor by increasing the risk of encounters.

22.9.1.2 However, it is anticipated that the proposed navigational corridor will be generally available for use by transiting vessels during construction and decommissioning and consideration (in consultation with the MCA and TH) will be given to the size and location of the buoyed construction (or decommissioning) area around the Hornsea Three array area to minimise impacts. It is also likely that marine coordination will be facilitated from a central location for all Ørsted projects, therefore ensuring effective lines of communication and information transfer during all construction, operation and decommissioning phases.

22.9.2 Operation and maintenance phase

22.9.2.1 For the operation and maintenance phase a separate technical study Assessment of Marine Traffic Corridor Design (Anatec, 2016) was undertaken in consultation with the MCA and TH. The aim of the report was to assess whether the proposed navigational corridor width was adequate for the purposes of navigation.

<u>Radar interference with the proposed navigational corridor</u>

22.9.2.2 MGN 543 states that, dependent on the proximity to turbines and the location of Radar scanners on the super structure, some vessels may experience degradation of the Radar display by false echoes. It may be possible that this will reduce the ability of the bridge team to identify other vessels, including crossing vessels at the extremities of the proposed navigational corridor, which may require avoiding action. It is common to find that the Radar instrumentation is often adjusted to reduce the unwanted interference which can have the effect of reducing actual target acquisition. This effect has been assessed by the MCA and formed the basis of the MGN 543 (MCA, 2016) shipping template. It is noted that since offshore wind farms have become operational (largely over the past 15 years) there has been no notable issues raised by mariners that have required the MCA to undertaken any further assessment. See section 19.8 for further information on Radar interference.

22.9.2.3 Further details regarding the proposed navigational corridor are contained within the separate technical note; however following consideration of the report TH have confirmed that, given the location and indicative traffic numbers, they were content with the proposed navigational corridor (see section 14). The MCA have confirmed that they have no major reservations in relation to the conclusions of the report.

22.9.2.4 Concerns were raised at the Hazard Workshop regarding smaller vessels exiting the wind farm into the proposed navigational corridor; with no regard to Rule 9 of COLREGs (IMO, 1972 as amended). COLREGs notes that within narrow channels the risk of further vessel to vessel conflict will be consequently increased and therefore requires the following to be adhered to (COLREGs Rule 9 b-d (IMO, 1972 as amended)):

- A vessel of less than 20 m in length or a sailing vessel shall not impede the passage of a vessel which can safely navigate only within a narrow channel or fairway; and
- A vessel engaged in fishing shall not impede the passage of any other vessel navigating within a narrow channel or fairway.

22.9.2.5 No section 42 consultation responses were received.

22.9.2.6 Given the concern raised, the MCA noted consideration of a routeing measure (likely a DWR given the low number of anticipated vessels) or fairway buoys to clearly identify navigational priorities within the proposed navigational corridor. However given the consultation undertaken with Hornsea Three to date and the additional technical assessment, it is considered that based on the current size and orientation of the proposed navigational corridor, the associated risk is ALARP and that additional mitigation would only be required to confirm routeing priorities within its boundaries for small crossing vessels/craft. Any routeing measures would be agreed by the MCA in consultation with the UK Safety of Navigation committee before requiring approval by the IMO member states.

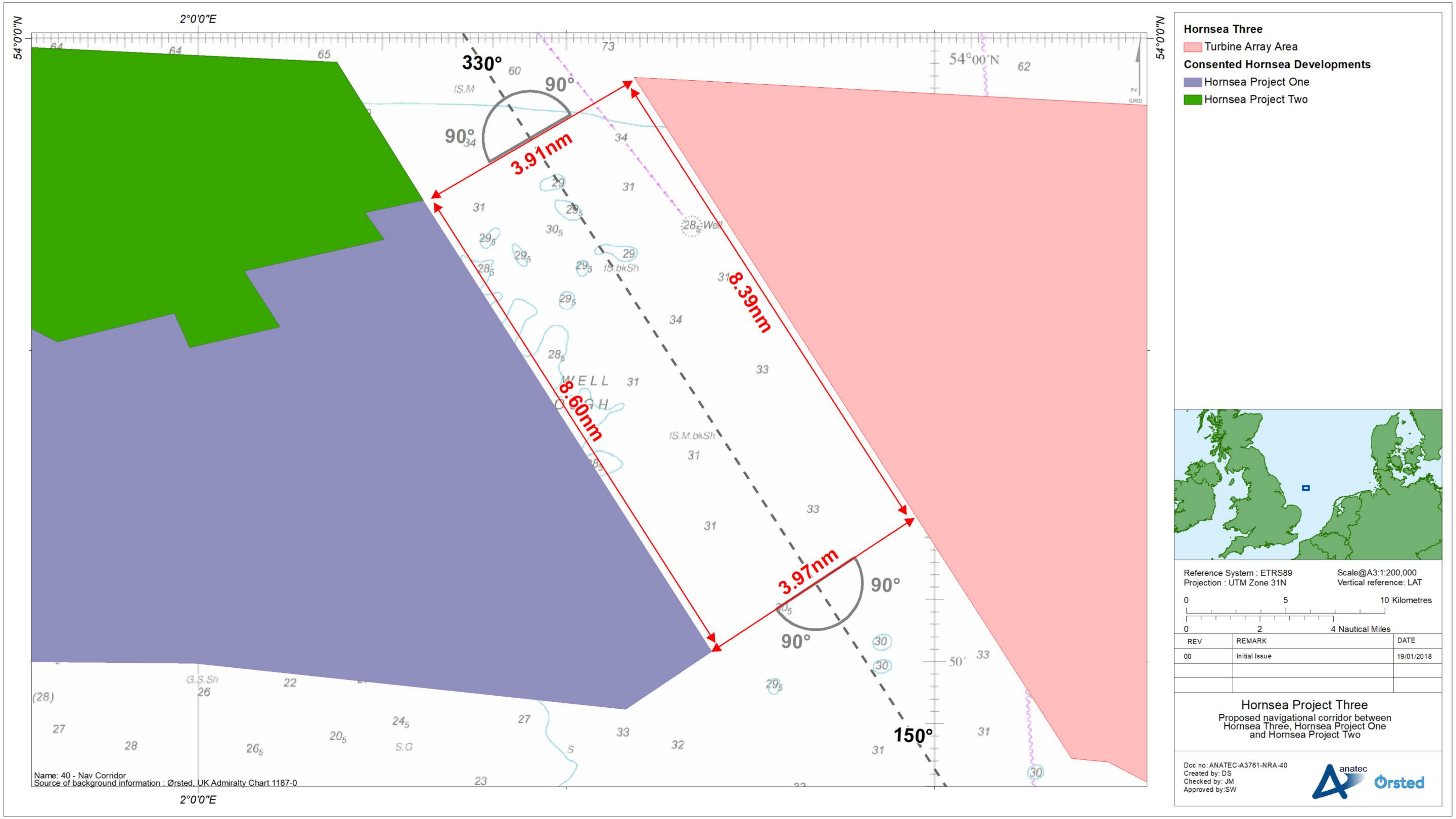

Figure 22.1: Proposed navigational corridor between Hornsea Three, Hornsea Project One and Hornsea Project Two.

Cumulative modelling

22.9.2.7 Based on the existing routeing in the area, Anatec's COLLRISK model has been run to estimate the existing vessel to vessel collision risks within the vicinity of the array areas for Hornsea Three, Hornsea Project One and Hornsea Project Two. The route positions and widths are based on the marine traffic survey dataset and Anatec's ShipRoutes, with the annual densities based on port logs and Anatec's ShipRoutes database, which take seasonal variations into consideration.

22.9.2.8 The annual vessel to vessel collision frequency prior to the installation of Hornsea Three, Hornsea Project One and Hornsea Project Two was 8.62×10^{-3}, corresponding to a major collision return period of one in 116 years.

22.9.2.9 Given the complexity of routeing within the cumulative area and in view of the fact that the Hornsea Project Two layout has been significantly developed, but not yet finalised, following the submission of the Hornsea Project Two Environmental Statement, allision modelling has not been undertaken. However, as part of the zone appraisal and planning process undertaken in 2010/2011, key stakeholders required that an independent assessment into cumulative routeing was undertaken by the three key developers at the time (SMart Wind, East Anglia and Forewind). A report into shipping and navigation was therefore undertaken by the SNSOWF in 2011 and subsequently updated in 2013 with validated traffic plans and updated zonal plans (Anatec, 2013).

22.9.2.10 During consultation on the SNSOWF report in 2013 no significant concerns were raised in relation to collision risk for the southern North Sea; these assessments include five projects within the former Hornsea Zone development (Anatec, 2013) as well as a proposed navigational corridor. Given the measures adopted as part of Hornsea Three, the three Hornsea projects considered within the cumulative assessment (Hornsea Three, Hornsea Project One and Hornsea Project Two), the low return period for cumulative collision risk related to those three projects and the results of the cumulative assessment undertaken within the Hornsea Project Two Environmental Statement (SMart Wind, 2015) which ranked the impacts as minor adverse (for a maximum design scenario) the impacts are assessed to be **tolerable with mitigation**.

22.10 Hornsea Three allision risk (external)

22.10.1 Construction and decommissioning phases

Hornsea Three array area

22.10.1.1 Presence of infrastructure within the Hornsea Three array area may cause increased allision risk for passing vessels; however during the construction and decommissioning phase mitigation measures adopted as part of Hornsea Three will be in place to ensure that the risk is maintained within ALARP parameters.

22.10.1.2 Mitigation measures adopted as part of Hornsea Three (section 23) include:

- Buoyed construction (or decommissioning) area which clearly identifying the location of construction (or decommissioning) works and vessels (both for the Hornsea Three array area and offshore HVAC booster station(s));
- 500 m construction and 50 m pre commissioning safety zones;
- A Marine Coordination Centre will manage vessel movements associated with Hornsea Three (although command of each vessel remains with each individual Master);
- Extensive promulgation of information.
- Minimum safe passing distance for installation vessels promulgated by Notice to Mariners, VHF broadcasts and other standard marine methods of communication; and
- Increase vessel presence on site including guard vessels.

22.10.1.3 Experience in wind farm construction for developers, their contractors and the vessel operators is now extensive, with a number of wind farms having been constructed within dense shipping and development areas meaning that standard mitigation measures within the industry are tried and tested. Considering this along with consultation feedback the risk of allision within the Hornsea Three array area during construction is assessed to be **broadly acceptable** with the mitigation measures adopted as part of Hornsea Three in place.

Hornsea Three offshore cable corridor and the Hornsea Three offshore HVAC booster station(s)

22.10.1.4 As with construction of the Hornsea Three array area, external allision impacts for the construction (or decommissioning) of the Hornsea Three offshore HVAC booster station(s) are assessed to be **broadly acceptable** with the mitigation measures adopted as part of Hornsea Three in place.

22.10.1.5 Mitigation measures adopted as part of Hornsea Three (section 23) include:

- Buoyed construction (or decommissioning) area clearly identifying the location of construction (decommissioning) works and vessels;
- 500 m construction (or decommissioning) safety zones;
- A Marine Coordination Centre will fully manage vessels movements associated with the installation of the Hornsea Three offshore HVAC booster station(s) (although command of each vessel remains with each individual Master);
- Extensive promulgation of information; and
- Minimum safe passing distance for installation and construction vessels promulgated by Notice to Mariners, VHF broadcasts and other standard marine methods of communication.

22.10.2 Operation and maintenance phase

Hornsea Three array area

22.10.2.1 Presence of infrastructure within the Hornsea Three array area may cause increased allision risk for passing vessels during the operation and maintenance phase. Based on modelling of the revised routeing (see Figure 18.5 and Table 18.1), Layout A and local Metocean data, the annual powered vessel to structure allision frequency was 7.51×10^{-4}, corresponding to an allision return period of one in 1,331 years.

22.10.2.2 The individual wind farm structure allision frequencies ranged from 3.88×10^{-4} for the turbine located on the southeastern corner of the Hornsea Three array area to negligible for a number of structures located within the centre and to the east of the Hornsea Three array area.

<u>External lighting and marking</u>

22.10.2.3 It is noted that there is no maximum spacing value included within the Design Envelope. This means that the preferred intervals for lighting indicated within IALA O-139 guidance (IALA, 2013) may not be achievable noting that IALA guidance states that "*in the case of a large or extended windfarm, the distance between Significant Peripheral Structures (SPS) should not exceed 3 nm*". It is noted that an SPS light should also have a 5 nm range. Therefore, following consent and once a final layout is decided, additional consultation with TH may be required to identify additional lighting requirements. This will be required to ensure that lighting is fully visible around the Hornsea Three array area and may include the need for additional floating Aids to Navigation, increased light intensity or potential (given the future date of construction) novel technologies with regards electronic Aids to Navigation.

22.10.2.4 Similar consultation will also be required with the Civil Aviation Authority (CAA) noting that the CAA guidance assumes maximum spacing of 900 m. No consultation feedback has been received by the CAA on this issue (at the time of writing the NRA) but it is anticipated this can be mitigated.

22.10.2.5 Following consideration of the guidance and experience at other developments it is considered that this impact is manageable through post consent consultation to identify additional mitigations; this would mean that spacing above 1,000 m does not impact upon operational (and peripheral) lighting and marking.

22.10.2.6 If a SPS turbine was unexpectedly extinguished, internal or unlit turbines could be exposed to an increased allision risk. However given measures adopted as part of Hornsea Three including back up power supplies, Supervisory Control and Data Acquisition (SCADA) systems and Aids to Navigation Management Plans this impact is again expected to be manageable when considered against the frequency of occurrence which would be low given that SPS lights are required to have an IALA category one availability of 99.8% (IALA. 2013).

<u>Offshore HVAC transformer substations, accommodation platforms and offshore HVDC converter substations</u>

22.10.2.7 Maximum design scenario locations for offshore HVAC transformer substations, accommodation platforms and offshore HVDC converter substations have been identified within Layout A. These platforms may be placed on the extreme peripheral of the Hornsea Three array area in proximity to dense traffic routes (west, north and south boundaries of the Hornsea Three array area only given the risk to traffic within the proposed navigational corridor) given the increased allision risk for vessels due to the size of the structure and potential consequences due to the resistant force of the structure compared to the energy of the impact.

22.10.2.8 When considering the maximum design scenario, Developments Rules, shipping routes, layout modelled and with the mitigation measures adopted as part of Hornsea Three in place, the impact is assessed to be **broadly acceptable.**

Hornsea Three offshore HVAC booster station(s)

<u>Surface structures</u>

22.10.2.9 As with collision risk, allision risk associated with the surface offshore HVAC booster station(s) is considered to be acceptable assuming they are located away from key navigational routes. The maximum design scenario could include up to four surface offshore HVAC booster stations and they shall:

- Be placed so as to be sympathetic to shipping and within ALARP parameters;
- Aids to Navigation installed (in consultation with TH) to identify the offshore HVAC booster station(s) potentially as isolated structure(s); and
- Potentially additional buoyage (in consultation with TH) may be required depending on the number, location and type of the offshore HVAC booster station(s).

22.10.2.10 Surface allision modelling has been undertaken and shows that all selected locations were within acceptable parameters. If the principles listed above are followed then the risk is assessed to be **broadly acceptable**; noting that no significant feedback was received during section 42 consultation aside from the CA whose concerns were mitigated by the reduction in the size of the search area.

Subsea structures

22.10.2.11 Presence of subsea offshore HVAC booster stations within the Hornsea Three offshore HVAC booster station search area may increase vessel to subsea structure allision risk for all vessels; however the assessment of this risk will depend upon the final location(s) of the subsea HVAC booster station(s).

22.10.2.12 Following identification of both a location and layout of the (up to) six subsea HVAC booster stations, it is recommended that under keel allision modelling is undertaken. Following section 42 consultation responses, section 18.4 summarises an initial assessment undertaken to consider risk based on indicative information on both the location of and the existing marine traffic (AIS only) passing through the Hornsea Three offshore HVAC booster station search area. This initial assessment shows that under keel clearance could be of a concern in some areas (reduction in water depth greater than the maximum 5% accepted by the MCA without further assessment) depending on the final design of the offshore HVAC booster station(s), but it does not consider traffic displacing itself from the development area or the additional mitigations that could be used to protect both vessels and the installations. For example, TH have indicated that a surface buoy (likely per structure) will be required where the under keel clearance is less than 30 m and further work to finalise the location should be undertaken post consent. If the principles for surface structures are followed then the risk is assessed to be **tolerable with mitigation** noting that post consent under keel assessment will need to be undertaken on the final location(s)**.**

Hornsea Three offshore cable corridor

22.10.2.13 The assessment in section 18.4 also includes an initial assessment of under keel clearance associated with cable burial and protection that was undertaken post section 42 consultation to address concerns raised by the MCA with regards to reductions in water depth greater than 5%. Although the assessment identifies that the areas where the 5% restriction is exceeded will be minimal, designed in measures for Hornsea Three should still include a cable burial assessment to ensure that any protection methods used for the export cables do not impact under keel clearance for small craft in the nearshore area or at cable crossings. This was specifically raised as a concern by the RYA and CA (section 42 consultation) and recreational impacts shall be considered during the Cable burial assessment.

22.10.2.14 To prevent impacts on navigational equipment post installation, Hornsea Three will ensure that electromagnetic interference is mitigated by cable burial, water depth or cable protection.

22.11 Hornsea Three allision risk (not under command)

22.11.1 All phases

Hornsea Three array area, offshore cable corridor and offshore HVAC booster station(s)

22.11.1.1 Presence of infrastructure within the Hornsea Three array area and offshore cable corridor including the offshore HVAC booster station(s) may increase allision risk to NUC vessels in an emergency situation (including machinery related problems or navigational system errors). However given incidents statistics (within section 13), lessons learnt from other offshore wind farms and modelling results which indicate one allision incident every 1,564 years in relation to the Hornsea Three array area for a worst case weather assisted NUC vessel, this impact is considered to be of low frequency.

22.11.1.2 Given this low frequency and the increased presence of vessels (including OSVs during the operation and maintenance phase) able to render assistance at Hornsea Three, this impact is considered ALARP. Although not specified within the Design Envelope it is assumed that there will be vessel support on site throughout the majority of the operation and maintenance phase to help ensure that all emergency response impacts can be effectively managed.

22.11.1.3 Considering this along with consultation feedback, the risk of allision within the Hornsea Three array area during operation and maintenance is assessed to be **broadly acceptable** with mitigation measures adopted as part of Hornsea Three in place.

22.12 Hornsea Three allision risk (cumulative)

22.12.1 All phases

Hornsea Three array area, offshore cable corridor and offshore HVAC booster station(s)

22.12.1.1 Following assessment of the change to baseline assessed as part of the cumulative assessment (as per section 21) it has been identified that the development of Hornsea Three, Hornsea Project One and Hornsea Project Two and the presence of the Schooner A platform has the potential to cumulatively impact on navigational transits and thus allision risk. The following effects and mitigations (where required) have been identified.

Alignment either side of the proposed navigational corridor.

22.12.1.2 In order to facilitate vessel transits within the proposed navigational corridor, turbines adjacent to the proposed navigational corridor must be approximately aligned as per the indicative Layout A. Where feasible, options for sequences of lighting and marking (of the proposed navigational corridor) with the Hornsea Three array area and Hornsea Project One and Hornsea Project Two array areas may be considered. It is noted that significant concave or convex sections can cause negative effects on marine Radar and visual navigation by obscuring or preventing position fixing. When defining layouts the Applicant will give full consideration to cumulative issues caused by structures along the edge of the proposed navigational corridor.

Cumulative lighting and marking within the proposed navigational corridor

22.12.1.3 As well as lighting and marking within the proposed navigational corridor, all cumulative lighting must be considered in order to minimise any potential effects and avoid confusion from the proliferation of Aids to Navigation in a high density development of turbines. The mariner will use SPS lights (similar to entering a port) to navigate with, including fixing their position. Following agreement on the final layout post consent a user group should be established, in consultation with TH, to identify those Aids to Navigation which best assist with navigation within the proposed navigational corridor.

22.12.1.4 Full consideration should be given to the use of different light characters and varied light ranges. Lighting and marking will be discussed with TH in conjunction with the relevant guidance (IALA, 2013). Therefore, when defining layouts, the Applicant will give full consideration to cumulative issues caused by lighting and marking.

NUC vessels within the proposed navigational corridor

22.12.1.5 Within the proposed navigational corridor emergency anchoring (dependent upon the vessel's speed) could be used to prevent allision with a structure. Apart from a pipeline (linked to the Topaz subsea well head) within the northeast sector of the corridor, the corridor is hazard free which will generally allow safe anchoring. A vessel will have emergency anchoring procedures for areas where there might be subsea hazards (such as port approaches), and these procedures would be likely to be used within the proposed navigational corridor. It is noted that Rule 9 of COLREGs (IMO, 1972 as amended) prevents anchoring within a narrow channel under normal conditions. It is also noted that the operator of the Topaz subsea well head has confirmed that the well head is no longer producing and that the pipeline will be decommissioned (possibly in-situ) prior to the construction of Hornsea Three.

22.12.1.6 For other types of emergency incidents it is noted that Hornsea Three, Hornsea Project One and Hornsea Project Two will all be significant marine operations, with each including a variety of support vessels during the construction and operation and maintenance phases that will be able to provide emergency support (noting potential downtime during periods of adverse weather).

Differing design envelopes

22.12.1.7 Hornsea Project One and Hornsea Project Two, given the time at which they were assessed, included different design envelopes to that proposed for Hornsea Three. Turbines on opposing sides of the proposed navigational corridor are therefore to be designed so as to be sympathetic to shipping using the proposed navigational corridor (not impacting on navigation including Radar, visual navigation and position fixing of navigating vessels).

22.12.1.8 Considering the mitigation measures adopted as part of Hornsea Three, the "in isolation" modelling results and the consultation responses over the various developments within the former Hornsea Zone, cumulative allision risk external (external meaning risk to passing vessels) to the wind farm arrays is assessed to be **tolerable with mitigation** (see section 23 for mitigation measures adopted as part of Hornsea Three).

22.13 Hornsea Three allision risk (internal)

22.13.1.1 For the purpose of assessment of shipping and navigation impacts for the Hornsea Three Environmental Statement, surface craft and SAR helicopters impacts are being considered in two separate technical reports:

- Surface craft are considered within the main section of this NRA; and
- SAR helicopters have been considered separately by a specialist within Appendix C.

22.13.2 Construction and decommissioning phases

Hornsea Three array area

22.13.2.1 The presence of infrastructure within the Hornsea Three array area may cause an increase in allision risk for vessels navigating internally within the Hornsea Three array area; however during the construction and decommissioning phases measures adopted as part of Hornsea Three will ensure that the risk is within tolerable limits.

22.13.2.2 Mitigation measures adopted as part of Hornsea Three (section 23) include:

- Buoyed construction (or decommissioning) area clearly identifying the location of construction (or decommissioning) works and vessels;
- For areas where active platform or turbine construction (or decommissioning) activities are occurring, 500 m safety zones will be in place to protect both construction and third party vessels. Additionally, 50 m pre-commission safety zones will be used to ensure users are aware of the risk associated with approaching pre-commissioned turbines;
- A Marine Coordination Centre will fully manage vessels movements associated with Hornsea Three (although command of each vessel remains with each individual Master); and
- Extensive promulgation of information.

22.13.2.3 Experience of wind farm construction for developers, contractors and vessel operators is now extensive, with a number of operational wind farms located within dense shipping areas. Hornsea Three shall be monitored throughout construction by the Marine Coordination Centre using VHF and AIS but also through the presence of construction (or decommissioning) vessels. Currently Hornsea Three is out with the Global Maritime Distress and Safety System (GMDSS) sea area A1, but is within sea area A2 meaning that only Medium Frequency (MF) calling or satellite communications are available (see Figure 22.2).

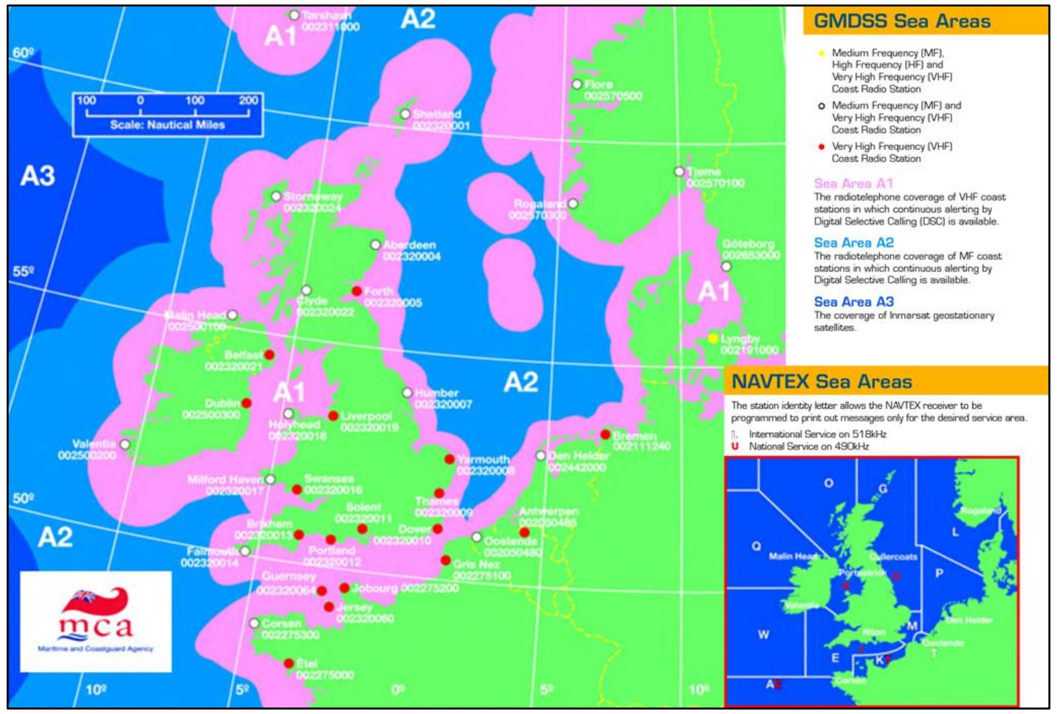

Figure 22.2: GMDSS sea areas.

22.13.2.4 However MF and satellite communications are not generally carried by recreational vessels or other smaller vessels due to the high cost of equipment. Therefore the presence of the Marine Coordination Centre, offshore VHF aerials, AIS receivers and the presence of on site construction vessels (or decommissioning vessels) will provide benefits for communication, monitoring and SAR. Should a vessel on site require assistance, then Hornsea Three vessels, including under SOLAS obligations, are beneficially placed to provide information and assets including navigational information (including weather forecasting) and safety support.

22.13.2.5 When considering the mitigation measures adopted as part of Hornsea Three, and the positive effects associated with the presence of the Hornsea Three array area, the risk of allision within the Hornsea Three array area during construction is assessed to be **broadly acceptable.**

22.13.3 Operation and maintenance phase

Hornsea Three array area

Project vessels

22.13.3.1 Any vessel and crew present within the Hornsea Three array area during the operation and maintenance phase shall have a level of competence pre-determined by the Hornsea Three Safety Management Systems (SMS) and their own Flag State regulations. It is noted that, given the size of vessels required for the distance offshore of the Hornsea Three array area (65.3 nm), all vessels including small CTVs will be under the command of experienced mariners, more so than previously seen at offshore wind farm developments closer to the coast given vessel certification and coding requirements. MGN 280 *Small Vessels in Commercial Use for Sport or Pleasure, Workboats and Pilot Boats – Alternative Construction Standards* (MCA, 2004) requires vessels operating over 60 nm from a safe haven to be category one or zero vessels (scale is six to zero, with six being the lowest level of capability). When considering this in combination with the level of knowledge the vessel crew will have about the array design, marine coordination, and the previous low frequency of allision for internal navigation involving project vessels, the impact are assessed to be ALARP.

Third party vessels

22.13.3.2 Regular Operators were consulted as part of the NRA process and were asked to indicate whether they would enter the Hornsea Three array area or would navigate around it. Of those that responded, including during the Hazard Workshop, the majority indicated that they would not enter the Hornsea Three array area in part due to the small deviations that would be required in order to avoid it (as part of the entire journey and considering speed reduction they would likely make to enter the Hornsea Three array area (as with a port entrance channel)). When considering this alongside lessons learnt from other wind farms where negligible levels of commercial vessels have been recorded passing through arrays it is considered extremely unlikely that a commercial vessel would enter the Hornsea Three array area. It is noted that in other countries (such as the Netherlands) commercial vessels are excluded from entering offshore wind farms by the regulatory authority. This option has however not been employed by the MCA, who prefer that vessels make their own risk assessment using guidance such as MGN 372 (MCA, 2008).

22.13.3.3 The SAR guidance annexed to MGN 543 (implemented December 2016) notes SOLAS (IMO, 1974) obligations for third party vessels and the potential need for vessels to enter wind farm array areas to render assistance. It notes "*International practice for SAR response to persons in distress at sea includes alerting and notifying the nearest vessel(s) (this includes small vessels e.g. fishing vessels and leisure craft) to an incident location, and asking them to render assistance in accordance with the SOLAS regulations"* (MCA, 2016).

22.13.3.4 The following list identifies the maximum number of accommodation platforms and vessels on site during operation:

- Up to three accommodation platforms or up to four OSVs which are likely to carry daughter craft;
- Up to 20 CTVs;
- Supply vessels which are likely to carry daughter craft; and
- Marine traffic coordination 24/7.

22.13.3.5 Although not specified within the Design Envelope it is assumed that there will be vessel support on site throughout the majority of the operation and maintenance phase that will help to ensure that all emergency response impacts can be effectively managed. Hornsea Three also plan to use helicopters on a regular basis and will have advanced medical provision on site.

22.13.3.6 When considering Hornsea Three resources on site against the low number of third party vessels in the area it is highly probable that Hornsea Three project vessels would be the first to render assistance in the event of an emergency. It is therefore considered extremely unlikely that a third party vessel would need to enter the Hornsea Three array area under any SOLAS (IMO, 1974) obligation. The risks associated with the requirement for third party vessels being required to render assistance are therefore considered negligible and ALARP.

22.13.3.7 Given the 1,000 m spacing between structures within the Hornsea Three array area, it is assessed (based on known manoeuvring and expert opinion) that navigational safety within the Hornsea Three array area will be improved compared to other consented, under-construction, or operational wind farms. Table 22.1 presents the minimum spacing from consented wind farms or wind farms that are within the consent process with MCA and TH approval. It is noted that the minimum internal spacing committed to is significantly larger than other Round Three developments giving vessels more sea room to navigate and manoeuvre within the Hornsea Three array area (when considering turning circles and rate of turn).

Table 22.1: Minimum spacing at other offshore wind farm projects.

Project	Minimum spacing used within the NRA (m)	Increase in spacing at Hornsea Three (minimum of 1,000 m)
Hornsea Project One	878	13.9%
Hornsea Project Two	924	8.23%
East Anglia One	675	48.2%
East Anglia Three	675	48.2%
Rampion	600	66.7%
London Array (Round Two wind farm)	650	53.9%

Experience at an existing offshore wind farm

22.13.3.8 London Array offshore wind farm is an example of a wind farm that was consented, constructed and is currently operational with recreational and fishing activity. It was consented within a busy and seasonal area for small craft and a specific buoyed navigation channel (Fouglars Gat) was designed (in the position of an existing preferred route).

22.13.3.9 Fishing and recreational vessels were identified from AIS data collected between 1 March 2016 and 28 February 2017 (365 days) within the London Array offshore wind farm site boundary. During this period 140 unique recreational transits were recorded, with only eight vessels not using Fouglars Gat for the majority of their transit. Of those eight tracks and those that did not fully stay within Fouglars Gat it was seen that they also do not opt to remain fully within the available straight lines of orientation.

22.13.3.10 During the 12 month period only 32 unique fishing vessel transits were recorded within the site boundary. Of the 49 tracks recorded, 23 broadcast a navigational status of "engaged in fishing", with these near the southern boundary; the remaining 26 consisted of passages through the array, with vessels not, in the majority, following the main lines of orientation.

22.13.3.11 Similar buoyed channels or additional international Aids to Navigation for use by recreational users and other small craft could be considered at Hornsea Three in consultation with the MCA, TH and key recreational users dependant on the final layout selected.

22.13.3.12 Turbines have the potential to affect vessels under sail when passing through the Hornsea Three array area from effects such as wind shear, masking and turbulence. From previous studies of offshore wind farms it was concluded that turbines do reduce wind velocity by an order of 10% downwind of a turbine (RYA, 2015). The limited spatial extent of the effect is not considered to be significant, and similar to that experienced when passing a large vessel or close to other large structures (e.g. bridges) or the coastline. In addition, practical experience to date from RYA members taking vessels into other offshore wind farm sites indicates that this is not likely to be a significant issue.

22.13.3.13 Given mitigation measures adopted as part of Hornsea Three and the potential for additional Aids to Navigation, the impact on internal navigation is considered **tolerable with mitigation** (Development Principles) and ALARP.

Increased internal allision for commercial fishing vessels and recreational craft

22.13.3.14 Presence of infrastructure within the Hornsea Three array area may increase vessel to structure allision risk for commercial fishing vessels navigating internally within the turbine array. The estimated allision frequencies of one every 5.74 years could be considered high when compared to other allision assessments carried out on developments within UK waters. However the model and the results reflect the significant maximum surface area assumed for all the structures that could be developed within the Hornsea Three array area against the medium density of fishing activity. The fishing allision model assumes that the fishing vessel density following development will remain the same as current levels; however in reality it is likely both that fishing activity will decrease and/or fishing vessels will adapt to the layout and continue to fish between the turbines (as seen at existing operational developments). The model does not assume what type of allision incident will occur and in reality the most likely would be a minor or low energy impact resulting in little or no damage to the vessels.

22.13.3.15 During consultation, the Dutch Fishing Association VISNED also noted that in good weather fishing vessels are likely to transit through the wind farm. All foundation types including the jacket foundations considered in the maximum design scenario are assumed to be ALARP based on the minimum 1,000 m spacing and designed in measures in place to ensure that fishing vessels are able to safely passage plan transits and activity within the Hornsea Three array area. Further information is contained within volume 2, chapter 6: Commercial Fisheries.

22.13.3.16 As with fishing vessels it is considered likely that recreational craft will adapt to navigating within Layout A given the minimum spacing of 1,000 m; recreational traffic levels are also very low within the Hornsea Three array area and negligible levels of recreational transits are likely to be seen.

22.13.3.17 As noted MCA guidance states "*that in order to minimise risks to surface vessels and/or SAR helicopters transiting through an OREI [sic], structures (turbines, substations etc.) should be aligned and in straight rows or columns*" and "*the developers (the Applicant) should plan for at least two lines of orientation unless they can clearly demonstrate that fewer is acceptable*" (MCA, 2016).

22.13.3.18 Following consultation feedback as part of Section 42, the final layout will meet the Development Principles, including maintaining a single line of orientation, as referenced in section 9.5.

22.13.3.19 Looking at the issue of surface craft navigating within the array, the following factors gathered from consultation, the Hazard Workshop and marine traffic survey results make the case that Layout A will be **tolerable with mitigation** (Development Principles):

- Predicted levels of transiting vessels (recreational and commercial fishing) will be low compared to other constructed and/or consented wind farms;
- While levels of fishing activity are high within some areas of the Hornsea Three array area, this will vary seasonally and annually. Some commercial fisheries representatives have indicated that their main concerns are over the foundation type used (minimal snagging risks) and minimum spacing rather than the alignment. Overall, the majority of risk associated with internal navigation is related

to vessels engaged in fishing rather than transiting, noting that during consultation the MCA confirmed that vessels engaged in fishing are out with the MCA's navigational safety remit;

- Demersal trawlers active within the array area are expected to target specific fishing grounds, meaning that it is unlikely that the skippers would choose to fish along fixed lines of orientation;
- Consultation indicates that commercial vessels (in transit), other than commercial fishing vessels, will not navigate through the Hornsea Three array area;
- The RYA stated that, given the very low level of recreational traffic within the Hornsea Three array area, they had no express concerns with the PEIR layouts and did not raise any further concerns during section 42 consultation;
- With regards to the PEIR layouts the CA confirmed their general policy that wind farms should have "straight see-through channels between the turbines" while recognising that the Hornsea Three array is in an area of very light yachting and recreational traffic. The CA confirmed that the penalty of not having straight see-through "channels" at Hornsea Three "may prove minimal and therefore acceptable to many" therefore is assumed that the single line of orientation is a further improvement on random layouts.
- The CA also noted that the penalty of extra time and distance incurred as a result of avoiding the Hornsea Three array area would mostly be minimal and thus it is likely that yachts and recreational craft may at the time of passage choose to avoid or be in a position where they should avoid the Hornsea Three array area;
- The CA stated a preference for additional Aids to Navigation to be provided within the array;
- Marine traffic survey data shows very low recreational vessel movements (especially when excluding the *500 Mile North Sea Race*) and those that were in the area would be well equipped and experienced (given the distance offshore);
- Aids to Navigation similar to those deployed at the London Array OWF could be used at the Hornsea Three array area to assist third party internal navigation this however would be decided by TH post consent;
- Visibility is generally good or very good at the Hornsea Three array area. Appendix C includes further detail on visibility. The total percentage of time that the visibility is below 2 km is around 1.3%;
- Cumulatively no other development will border the Hornsea Three array area;
- It is unlikely that third party vessels will be required to perform SOLAS obligations within the Hornsea Three array area, given that Hornsea Three vessels are likely to be present on site; and
- The Hornsea Three array area is largely out with the operational area for the RNLI and the MCA do not operate any surface craft assets within the southern North Sea.

22.13.3.20 SAR helicopters are considered separately in Appendix C.

22.13.3.21 Given that this NRA is only able to consider indicative layouts, the following table identifies elements that should be considered when assessing site layout post consent, again excluding consideration for helicopter-based SAR operations. Table 22.2 identifies potential issues identified, risk ranking for indicative maximum design scenario Layout A and proposed mitigation for layouts to bring the effects into ALARP parameters. The information presented in Table 22.2 can be used to inform post-consent layout designs.

22.13.3.22 Given that Hornsea Project One and Hornsea Project Two do not directly border the Hornsea Three array area, there are not anticipated to be any impacts with cumulative internal alignment.

Table 22.2: Effects associated with navigation internally within the Hornsea Three array area.

Issue	Receptor and frequency of receptor	Sources considered	Risk and proposed mitigation
Impact of 1,000 m minimum spacing for all structures on internal navigation	Recreational craft – low frequency user	No negative responses were received by recreational consultees. One thousand metre spacing would allow recreational craft to manoeuvre between structures given the maximum size of 24 m for recreational vessels (as per the Recreational Craft Regulations 2017 No. 737).). Identification methods for structures currently required by standard guidance were considered sufficient.	No further mitigation associated with minimum spacing required, draft DCO shall state minimum of 1,000 m between all structures.
Impact of 1,000 m minimum spacing for all structures on internal navigation	Commercial fishing vessels – medium frequency over the Hornsea Three array area	Commercial fishing consultees favoured fewer and larger turbines and noted that the separation between turbines is more important than the regularity of the layout.	No further mitigation associated with minimum spacing required, draft DCO shall state minimum of 1,000 m between all structures.
Impact of no maximum spacing for structures on internal navigation	Recreational craft – low frequency user	At greater than 1,000 m spacing recreational craft may not be able to identify low level ID lighting of the next turbine that they are approaching. Therefore additional aids should be considered. Given the increased spacing and navigational information that will be provided for Hornsea Three, recreational vessels will have greater navigational knowledge, as well as space to sail and manoeuvre. Based on the shipping template within MGN 543, the turbines will be more visible with fewer echoes on marine Radar systems. Consultation raised no concerns about maximum spacing.	No further mitigation associated with maximum spacing required, draft DCO shall state no maximum spacing.

Issue	Receptor and frequency of receptor	Sources considered	Risk and proposed mitigation
Impact of no maximum spacing for structures on internal navigation	Commercial fishing vessels – medium frequency over the Hornsea Three array area	Given the large spacing and increased navigational information that will be provided for Hornsea Three commercial vessels, they will have access to greater knowledge about the site and space to fish and manoeuvre. Consultation noted that fishing vessels prefer the largest spacing possible.	No further mitigation associated with maximum spacing, required, draft DCO shall state no maximum spacing.
Impact of exposure to turbines	Recreational craft – low frequency user	Exposure is defined when a vessel is on a transit with turbines on either side of it within a "row" that will then potentially create effects as identified within the shipping template (Radar impacts within 1 nm). Time spent within the Hornsea Three array area and in proximity to structures will increase risk to vessels. At greater than1,000 m spacing exposure and thus effects will be significantly reduced compared to transits through existing wind farms with smaller spacing.	The greater the spacing and non-alignment of turbines the lower the exposure time.
Impact of exposure to turbines	Commercial fishing vessels – medium frequency user over the Hornsea Three array area		
Impact of structure (including turbine) alignment	Recreational craft – Low frequency user	Non-alignment within a row is considered to be a non-grid layout where turbines are converging or diverging. RYA noted no concerns regarding the misaligned turbines that comprise the PEIR Layouts given the low frequency. CA noted that they preferred alignment but agreed with the low frequency. The CA section 42 consultation response also notes that increased spacing mitigates some of their concerns over alignment. Non-alignment can create confusion / disorientation within the Hornsea Three array area. Hornsea Three will provide navigational information via its Marine Coordination Centre to assist. Stakeholders did not raise any concern between alignment and allision risk. Given the increased size of other structures (such as substations and accommodation platforms), there are not anticipated to be any impacts from these structures being out of alignment, given that they will provide good Aids to Navigation for surface craft and be visible from a greater distance.	No further mitigation required. Increased spacing inversely decreases the impact of misalignment. Recreational vessels are very low frequency within Hornsea Three and therefore the risk of a vessel becoming disorientated (when considering measures adopted as part of Hornsea Three) is negligible. There is no evidence to suggest that misalignment will directly affect allision risk but that misalignment could cause inconvenience by vessel operators becoming disorientated. Therefore if additional mitigations are in place to aid navigation the change in safety risk is assumed negligible.
Impact of structure (including turbine) alignment	Commercial fishing vessels – medium frequency over the Hornsea Three array area	Fishing consultation noted that fishing, including trawling and fly-shooting, would be possible in amongst the indicative layouts shown in the PEIR if the weather was suitable and the fish are present. For fishing, the separation between turbines is more important than the regularity of the layout. Given the increased size of other structures, there are not anticipated to be any impacts from these structures being out of alignment, given than they will provide good Aids to Navigation for surface craft.	As with recreational craft, increased spacing inversely decreases the impact of misalignment.

22.14 Gear snagging (navigational safety risk)

22.14.1 Construction and decommissioning phases

Hornsea Three array area, offshore cable corridor and offshore HVAC booster station(s)

22.14.1.1 The presence of partially installed cables (which may be exposed or partially buried) and other subsea infrastructure may present an increased risk of gear snagging for commercial fishing vessels with worst case consequences associated with vessel foundering, and realistic consequence of gear loss.

22.14.1.2 A foundering is considered to be when a vessel suffers structural failure and sinks. This type of incident has the potential to damage a subsea cable if the vessel sinks over the cable. It is noted that this type of incident is considered to have a very low frequency based on historical incident data for the UK (between 1994 and 2014 approximately 6% of MAIB incidents occurring within UK waters (excluding incidents occurring in ports/harbours and rivers/canals) were listed as flooding/foundering).

22.14.1.3 The presence of mitigation measures adopted as part of Hornsea Three mean that the risk is assessed as **broadly acceptable.**

22.14.1.4 Mitigation measures adopted as part of Hornsea Three (section 23) include:

- Buoyed construction (or decommissioning) area clearly identifying the location of construction (or decommissioning) works and vessels;
- 500 m construction and 50 m pre commissioning safety zones;
- The Marine Coordination Centre will fully manage vessels movements associated with Hornsea Three (although command of each vessel remains with each individual Master);
- Extensive promulgation of information;
- Guard vessel to protect exposed cable; and

- Minimum safe passing distance for installation and construction vessels promulgated by Notice to Mariners, VHF broadcasts and other standard marine methods of communication.

22.14.1.5 Any areas of temporarily exposed cable or sand/gravel berms should be additionally marked and promulgated in consultation with the MCA and TH.

22.14.1.6 During decommissioning any cables that are left in situ must be risk assessed to ensure that they will not pose any continued impact to vessels engaged in fishing.

22.14.2 Operation and maintenance phase

Hornsea Three array area, offshore cable corridor and offshore HVAC booster station(s)

22.14.2.1 Presence of cables (if exposed at seabed) and other subsea infrastructure may present a gear snagging risk for fishing vessels.

22.14.2.2 Any risks associated with the export cables shall be assessed as part of the cable burial assessment. Periodic follow-on monitoring will confirm whether the export cables remains buried and/or protected from fishing activity within the area.

22.14.2.3 Using site-specific marine traffic survey data as an input to Anatec's COLLRISK fishing risk model, the annual fishing vessel to structure allision frequency was estimated for Layout A. The annual fishing vessel to structure allision frequency was 1.74×10^{-1}, corresponding to an estimated allision return period of one in 5.74 years. The output of the fishing model is considered to be conservative as it assumes that fishing activity will not change post consent.

22.14.2.4 Gear snagging during operation is assessed to be **broadly acceptable.**

22.15 Anchor snagging

22.15.1 All phases

Hornsea Three array area, offshore cable corridor and offshore HVAC booster station(s)

22.15.1.1 There were no vessels anchoring within the Hornsea Three array area during the marine traffic surveys, and therefore the potential for a vessel to anchor in the array area is considered to be low; impacts on vessels anchoring are expected to be negligible.

22.15.1.2 For the Hornsea Three offshore cable corridor lessons learnt show that anchoring has the potential to damage a subsea cable if a vessel drops anchor on the cable or drags anchor over the cable. The damage caused depends on the penetration depth of the anchor (which depends on vessel size and type of anchor), the type of seabed and the cable burial depth. It is considered that anchor interaction with a subsea cable will be similar to that of fishing gear interaction, based on impact, pull over and potential snagging phases.

22.15.1.3 Anchoring can take place for a number of reasons, including:

- Adverse weather anchoring (e.g. seeking refuge in a safe haven).
- Machinery failure (e.g. to slow drift speed/stop and/or to carry out repairs); and
- Subsea operations/survey vessel.

22.15.1.4 It is noted that when the cable is installed and charted, the probability of planned anchoring in close proximity to the cable route is reduced. Only one vessel was recorded anchoring within the Hornsea Three offshore cable corridor during the marine traffic survey.

22.15.1.5 Given mitigations measures adopted as part of Hornsea Three, the low frequency of anchoring within the Hornsea Three array area, the offshore cable corridor and the nearshore area the impact is assessed to be **broadly acceptable.**

22.15.1.6 Mitigation measures adopted as part of Hornsea Three (section 23) include:

- Cable burial assessment;
- Guard vessel during the construction or decommissioning phase if exposed cable is identified;
- Post installation assessment;
- Effective monitoring and maintenance during operation;
- Post decommissioning survey assuming cables are left in situ;
- Effective promulgation of information; and
- Charting of cables on UKHO charts (in consultation with the UKHO).

22.16 Emergency Response

22.16.1 Construction and decommissioning phases

Hornsea Three array area, offshore cable corridor and offshore HVAC booster stations

22.16.1.1 Construction (and decommissioning) activities associated with Hornsea Three may diminish emergency response capability (including SAR) within the Hornsea Three array area and offshore cable corridor. This is due to the increased number of vessels, personnel and aircraft associated with the development that will increase the probability of an emergency response incident occurring. However it is likely, given lessons learnt, that emergency response incidents in the majority will be low consequence such as minor pollution, minor injury or minor vessel damage and will be manageable with on site resources.

22.16.1.2 As standard with offshore developments an ERCoP will be a measure adopted as part of Hornsea Three and enable the MCA and the Applicant to monitor and manage all incidents and resources effectively in cooperation.

22.16.1.3 As noted the Hornsea Three array area is towards the extremities of the RNLI chartered response area of 100 nm (section 13.3) and it is likely that the Applicant's own vessels will be the primary responder to both its own and third party incidents within and in proximity to the Hornsea Three array area.

22.16.1.4 The presence of the marine coordination function, offshore VHF aerials, AIS receivers and the presence of on site construction (and decommissioning) vessels will result in a positive effect for communication, monitoring and SAR.

22.16.1.5 All offshore personnel associated with Hornsea Three will wear appropriate personal protection equipment (PPE) for their area and type of task. Where there is a risk of falling into water this will include survival suits and personal locator beacons (PLBs).

22.16.1.6 This impact is assessed to be **broadly acceptable** given the presence of support vessels on site and the high level of health and safety standards that will be deployed.

22.16.2 Operation and maintenance phase

Hornsea Three array area, offshore cable corridor and offshore HVAC booster stations

22.16.2.1 Operation and maintenance activities may diminish emergency response capability (including SAR asset access) within the Hornsea Three array area and offshore cable corridor.

22.16.2.2 Due to the increased presence of vessels, personnel and aircraft associated with the development it is likely that there will be a rise in the probability of an emergency response incident occurring. However, it is likely, given lessons learnt, that emergency response incidents will in the majority be of low consequence such as minor pollution, minor injury or minor vessel damage and will be manageable with the extensive on site resources that will be in place.

22.16.2.3 Aside from the likelihood of an emergency response incident occurring there is also the matter of whether the capability of the emergency providers may be impacted, and as raised in consultation, whether the presence of structures may alter the approach of SAR assets within the Hornsea Three array area.

22.16.2.4 Impacts that could potentially be associated with the presence of the Hornsea Three offshore HVAC booster stations, and any vessels that may be required to maintain the Hornsea Three export cables, are not deemed to be significant and are not considered further within this assessment.

22.16.2.5 It is likely that the Hornsea Three array area will be manned throughout the majority of the operation and maintenance phase and a range of equipment and facilities (including an OSV, other support vessels, personnel transfer helicopters, the Marine Helicopter Coordination Centre (MHCC), AIS receivers, VHF aerials) may also be able to provide information that supports the planning phase.

22.16.2.6 The presence of this equipment and facilities will likely mean a positive impact for communication, monitoring and SAR for all sea users (including third party vessels). Hornsea Three offshore personnel (expected to be the predominant user of the Hornsea Three array area) will also be equipped with appropriate PPE for their area and type of task; as well as risk assessments and method statements put in place. Where there is a risk of falling into the water this will include survival suits and PLBs. Also, as standard with offshore developments and as a recommendation contained within MGN 543, an ERCoP will be a measure adopted as part of Hornsea Three and will enable the MCA and the Applicant to monitor and manage all incidents and resources, including SAR assets, effectively.

22.16.2.7 Commercial shipping is expected to avoid transiting through the Hornsea Three array area. Furthermore, given the likely passing distances (at least 1 nm) and expected drift speeds, it is unlikely that a commercial vessel NUC, or a person that has fallen into the water from a commercial vessel, will drift into the Hornsea Three array area. However, fishing vessels and low levels of recreational sailing vessels are expected to be present within the Hornsea Three array area alongside Hornsea Three operation and maintenance vessels.

22.16.2.8 It is therefore likely that the Hornsea Three operation and maintenance vessels will be the primary responder to both its own and lower probability third party incidents within and in proximity to the Hornsea Three array area, given the time taken for an asset to be mobilised and reach the incident location. As a result SAR response times will be improved as the MCA will use resources under the ERCoP (on site) and SOLAS (IMO, 1972) obligations to respond quickly and effectively in a previously open sea area with low levels of third party activity (base case).

22.16.2.9 The initial phase of a SAR operation is the planning phase. The planning phase will commence as soon as the potential requirement to mobilise a SAR asset has been identified. Given the distance between the Hornsea Three array area and the nearest SAR asset base (Humberside Airport), it is likely that the SAR crew will undertake the majority of the planning phase aboard the SAR asset as it transits to the scene of the incident. For more information regarding SAR assets and their operation see section 12 and Appendix C of the NRA.

22.16.2.10 The presence of the infrastructure located within the Hornsea Three array area may introduce some complication to the planning phase; however the layout will have been agreed with the MCA and in line with the Development Principles noted in section 9.5 and contained within volume 4, annex 3.7: Layout Development Principles. This means that the layout will maintain one line of orientation (SAR Access Lanes) and include a Helicopter Refuge Area if the SAR Access Lanes are over 10 nm in length to further facilitate SAR helicopter planning. The SAR asset crews are highly competent and experienced with regard to planning and undertaking SAR operations with information provided via nautical charts, aeronautical charts and the project specific ERCoP held by the CGOCs.

22.16.2.11 Considering emergency response capability in general the impact is predicted to be of regional spatial extent (given the impact on North Sea response as a whole), medium term duration, intermittent and could be reversible if Hornsea Three resources were found to have a positive impact on SAR responses within the previously open sea area (emergency response will be improved rather than diminished). It is predicted that the impact will affect the receptor both directly and indirectly. This impact is assessed to be **tolerable with mitigation** (section 23) given the presence of support vessels on site and the high level of health and safety standards that will be deployed.

23. Measures Adopted as Part of Hornsea Three

23.1 Overview of measures adopted as part of Hornsea Three

23.1.1.1 As part of the Hornsea Three design process, a number of mitigation measures adopted by Hornsea Three have been proposed to reduce the potential for impacts on shipping and navigation. These measures are considered standard industry practice for this type of development and are summarised in Table 23.1.

Table 23.1: Mitigation measures adopted as part of Hornsea Three with respect to shipping and navigation.

Industry standard mitigation measure	Description
Advisory safe distances	A 1,000 m advisory safe passing distance around work areas will be requested during construction and decommissioning phases, and up to 1,000 m advisory safe distances around cable installation/removal or maintenance vessels. These are advisory and are not enforceable; however vessels will also be displaying Restricted in Ability to Manoeuvre lights under COLREGs.
Aid to Navigation Management Plan	An Aid to Navigation Management Plan is required to mitigate risk associated with extinguished lights and sound signals throughout all phases of Hornsea Three.
Application and use of safety zones of up to 500 m during construction/maintenance and decommissioning phases	With regard to the application for and use of safety zones to protect the development site, Section 95 of the Energy Act 2004 states that where there is a proposal to construct or operate a renewable energy installation such as turbines and associated infrastructure, a notice may be issued declaring specific areas around the installation to be safety zones in order to secure the safety of, in the case of the Hornsea Three array area, the turbines, offshore HVDC converter substations, offshore HVAC transformer substations, accommodation platforms and offshore HVAC booster station(s). Schedule 16 of the Energy Act 2004 and The Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007 provide details of the application process. Five hundred metre safety zones for the construction, major maintenance and eventual decommissioning phases of a turbine, offshore HVDC converter substation, offshore HVAC transformer substation, accommodation platform and offshore HVAC booster station's life will be applied for. These will cover only those parts of the total site in which such activities are actually taking place at a given time in order to reduce the amount of time that mariners and other users of the sea will be required to deviate around the safety zones. Once the activity has been completed in that specific location, the 500 m safety zone will then be removed (or reduced to 50 m in the case of partially complete works) at that location. During the operation and maintenance phase, it is unlikely that adjacent turbines will undergo major maintenance at the same time, and therefore that safety zones may be present around adjacent turbines, however this may be required in exceptional circumstances. As above, safety zones with a radius of up to 50 m around turbines, substations and platforms where installation has finished but other work is on-going (pre commissioning) may also be applied for.
Application and use of safety zones of up to 500 m during operation for manned platforms	Operational safety zones of 500 m will be applied for around accommodation platforms. Given that these would be required over the life of the project, these safety zone applications will need to include a safety case.
Blade clearance	Turbines will be constructed to ensure that the minimum rotor blade clearance is 34.97 m above LAT.
Bridge links	Consideration will be given to navigational safety when designing the height and location of bridge links within the Hornsea Three array area (e.g. avoiding higher risk locations such as at the periphery of the array) and the bridge links will be designed in line with MCA and TH requirements as per experience within the oil and gas industry.
Buoyed construction area	Buoys will be deployed around construction work in line with TH requirements. These will include a combination of cardinal and/or safe water marks.

Industry standard mitigation measure	Description
Cable burial assessment and periodic surveys	Cables will be buried where seabed conditions allow, and cable protection measures will be employed to mitigate risks associated with anchor interaction where necessary. The subsea cables will be subject to periodic inspection in order to confirm they remain buried or protected and do not become a hazard to marine navigation. This will include ad hoc inspections after any reported actual anchor interactions. A cable specification and installation plan, and a scour protection management and cable armouring plan, including details on any cable protection, will be submitted to the MMO at least four months prior to the construction of the wind farm, along with a cable burial assessment.
Charting of Hornsea Three array area and offshore HVAC booster station(s)	The Hornsea Three array area will be marked on relevant UKHO Admiralty charts. These areas have generally been marked as "submarine power cable area" as well as with wind farm symbology. The Hornsea Three offshore HVAC booster station(s) shall also be charted.
Charting of export cables and array cables	Cables will be marked on nautical charts in line with UKHO standards. Note that depending upon the scale of the chart, array cabling may not be shown and it may only be the export cables that are visible.
Compliance with UK and Flag State regulations and IMO conventions including COLREGs and SOLAS	Compliance to ensure that standard levels of navigation and vessel safety continue to be adhered to by all project related vessels during all phases.
Electromagnetic interference minimisation	A Cable Specification and Installation Plan will be prepared as part of the Code of Construction Practice. This will include the technical specification of offshore electrical circuits, and a desk-based assessment of attenuation of electro-magnetic field strengths, shielding and cable burial depth in accordance with industry good practice.
ERCoP	An ERCoP will be developed and implemented for the construction, operation and maintenance and decommissioning phases of the project.
Guard vessels	Guard vessel(s) will be present within the Hornsea Three array area and along the export cable route during key periods of construction and potentially during certain maintenance activities within the operation and maintenance-phase.
IALA guidance and Aids to Navigation	Structures within the wind farm will be marked and lit in accordance with IALA Recommendation O-139 on the Marking of Man-Made Offshore Structures (IALA, 2013). Other visual and auditory Aids to Navigation may also be implemented. Under a requirement of the DCO, the placement and standard of Aids to Navigation will be agreed with TH prior to the construction of the wind farm. See section 23.2 for more detail.
Marine coordination	Appropriate marine coordination will be in place to ensure that project vessels do not present an unacceptable risk to each other or to transiting vessels.
Marine pollution contingency planning	Creation of an ERCoP in line with guidance, from the construction phase onwards is proposed. This will include interfaces with the UK National Contingency Plan. Measures will be adopted to ensure that the potential for release of pollutants from construction and operation and maintenance activities is minimised, which will include planning for accidental spills and responding to all potential contaminant releases.
MGN 543 (as of April 2018)	The individual turbine structures will have functions and procedures in place for generator shut down in emergency situations.

Industry standard mitigation measure	Description
Monitoring by AIS	Vessel traffic monitoring by AIS for the duration of the construction period. A report will be submitted to the MMO and the MCA at the end of each year of the construction period (28 day period per year). Monitoring during the operation and maintenance phase will also be required for a minimum of one year. This is as per the relevant DCO condition.
PPE	All personnel will wear the correct PPE suitable for the location and role at all times, as defined by the relevant Quality, Health, Safety and Environment (QHSE) documentation. This will include the use of PLBs.
Promulgation of information	Information and warnings will be distributed via Notices to Mariners and other appropriate media (e.g. Admiralty Charts and fishermen's awareness charts) to enable vessels to effectively and safely navigate around the Hornsea Three array area and offshore cable corridor. This may include additional consultation above and beyond the minimum standard required.
QHSE documentation	Marine QHSE documentation will ensure safe operation on a daily basis, including work vessel operations.
Self Help capabilities	Provision of self-help capabilities to deal with wind farm associated emergencies. Consideration shall be given to towage, pollution response and man overboard.
Surface buoy	A surface buoy (likely per structure) will be required at the location of subsea HVAC booster station(s) where the under keel clearance is less than 30 m, as indicated by TH.
Temporary Aids to Navigation	Consultation with TH on the implementation of temporary Aids to Navigation for construction activities.
Vessel health and safety requirements	As industry standard mitigation, the Applicant will ensure that all project related vessels meet both IMO conventions for safe operation as well as HSE requirements, where applicable. This shall include the following good practice: • Wind farm associated vessels will comply with IMO Regulations; • All vessels, regardless of size, will be required to carry AIS equipment on board; • All vessels engaged in activities will comply with relevant regulations for their size and class of operation and will be assessed on whether they are "fit for purpose" for activities they are required to carry out; and • All marine operations will be governed by operational limits, tidal conditions, weather conditions and vessel traffic information. • Walk to work solutions will be utilised.

23.2 Marine aids to navigation

23.2.1.1 Throughout the construction and operation and maintenance of Hornsea Three, Aids to Navigation will be provided in accordance with TH and MCA requirements, with consideration being given to IALA standard O-139 on the Marking of Offshore Wind Farms (IALA, 2013), the BEIS Standard Marking Schedule for Offshore Installations (2011) and MGN 543 (MCA, 2016).

23.2.2 Construction and decommissioning markings

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

23.2.2.2 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.

23.2.3 IALA guidance on the marking of groups of structures (wind farms)

23.2.3.1 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 SPS and Intermediate Peripheral Structures (IPS). Given the distance offshore and the minimum spacing, variations to the standard guidance may be required in consultation with the statutory stakeholders.

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

23.2.3.3 The surface Hornsea Three offshore HVAC booster station(s) will be marked as isolated structure(s); regardless of how far apart they are located. Subsea HVAC booster stations will be marked by a surface navigational aid (following consultation by TH) where clearance is less than 30 m.

23.2.3.4 Relevant guidance from the MCA and 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.

23.3 Other lighting and marking considerations

23.3.1.1 The following section identifies additional measures that are requirements or are currently being considered by Hornsea Three but will require final consultation post consent.

23.3.2 Low level lighting on foundations

23.3.2.1 Use of low level lighting and retro reflective areas on signage, access platforms and ladders.

23.3.3 Day marks

23.3.3.1 The tower of every turbine (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 in height and separation.

23.3.4 Location of lights

23.3.4.1 The Aids to Navigation on the structure of a turbine should 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 the level of HAT.

23.3.5 Use of AIS transmitters, virtual buoys or Radar Beacons

23.3.5.1 The use of AIS transmitters, virtual buoys or Radar Beacons (Racon) may be used following consultation with TH. These will be placed on the periphery of the array to assist safe navigation particularly in reduced visibility and could provide a modern mitigation for the proposed navigational corridor. AIS transmitters or virtual buoys could also be considered internally to assist with navigation within the Hornsea Three array area.

23.3.6 Sound signals

23.3.6.1 Provision of sound signals 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.

23.3.7 Spurious white lights

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

23.3.8 Aviation lighting

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

23.3.9 Remote monitoring and sensors

23.3.9.1 Remote monitoring and sensors (SCADA) should be included as part of the lighting and marking scope to ensure a high level availability for all Aids to Navigation.

23.3.10 Numbering of structures

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

23.4 Offshore renewable energy installation design specifications noted as per Marine Guidance Note 543

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

24. Additional Mitigation Measures Required to Bring Risks to As Low As Reasonably Practicable Parameters

24.1.1.1 As part of the Hornsea Three design process a number of additional mitigation measures have been proposed to reduce the potential for impacts on shipping and navigation. This is summarised in Table 24.1.

Table 24.1: Additional mitigation measures to be adopted as part of Hornsea Three with respect to shipping and navigation secured within the NRA.

Additional mitigation measure	Description
Additional Aids to Navigation to assist internal navigation	Following consultation with recreational users the Applicant will consult with TH and MCA to consider internal Aids to Navigation.
Additional means of communication to assist third parties	Marine coordination facilities, offshore VHF aerials, AIS transceivers/receivers and the on site vessels shall be used to mitigate risk to third party vessels transiting internally within the array area.
Additional peripheral Hornsea Three array area Aids to Navigation	Given the potential for increased maximum spacing on the periphery of the Hornsea Three array area TH and CAA may require additional aids or increased intensity of lights.
Cumulative lighting on the western periphery.	Full consideration should be given to the use of lighting sequences such as different light characters and varied light ranges. Lighting and marking will be discussed with TH in conjunction with the relevant guidance (IALA, 2013). The applicant may be required to liaise directly with the developers of Hornsea Project One and Hornsea Project Two.
Minimisation of buoyed construction area for the Hornsea Three array area.	The placement of cardinal buoys during the construction of the western extent of Hornsea Three will give rise to consideration of the long term usability of the proposed navigational corridor, i.e. buoy placements should not adversely impact the usability of the proposed navigational corridor for significant periods.
Peripheral Aids to Navigation within the corridor	Following agreement on the final layout post consent a user group should be established to identify Aids to Navigation, in consultation with TH, that best aid navigation within the proposed navigational corridor.
Placement of turbines on western peripheral edge in cumulative scenario	In order to facilitate vessel transits within the proposed navigational corridor, turbines adjacent to the proposed navigational corridor must be approximately aligned as per the indicative Layout A. Where feasible, options for sequences of lighting and marking (of the proposed navigational corridor) with the Hornsea Three array area and Hornsea Project One and Hornsea Project Two array areas may be considered. It is noted that significant concave or convex sections can cause negative effects on marine Radar and visual navigation by obscuring or preventing position fixing. When defining layouts the Applicant will give full consideration to cumulative issues caused by structures along the edge of the proposed navigational corridor.

Additional mitigation measure	Description
Placement of the Hornsea Three offshore HVAC booster station(s)	If the maximum number of subsea offshore HVAC booster stations is built they should be aligned or grouped so as to be sympathetic to shipping. Following this assessment of maximum design scenario locations further consultation will be required with the MCA and TH to agree final locations. This should include under keel allision risk modelling. The subsea offshore HVAC booster station(s) will require further Aids to Navigation (in consultation with TH) in water depths giving less than 30 m under keel clearance.
Subsea HVAC booster station marker buoys	Subsea offshore HVAC booster stations will require marker buoys (in consultation with TH) in water depths giving less than 30 m under keel clearance. This is noted as likely given the water depths but will be dependent on the final dimensions.
Temporary restrictions on shipping using the proposed navigational corridor during construction and decommissioning phases.	If there is significant overlap from construction in the Hornsea Three array area into the proposed navigational corridor there may need to be temporary restrictions on shipping, in consultation with the MCA and TH, to ensure that any works do not adversely impact the safety of third party vessels by increasing the risk of encounters.

24.2 Cost benefit analysis

24.2.1.1 The FSA Guidelines require a process of CBA to rank the proposed mitigation (risk control) options in terms of risk benefit related to life cycle 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.

24.2.1.2 Until the layout and associated mitigation measures are defined, a review of CBA cannot be undertaken; however Hornsea Three is committed to implementing mitigation measures that 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.

24.2.1.3 Further work will be undertaken post-consent once final mitigation measures are known in line with standard industry practice.

25. Through Life Safety Management

25.1 Quality, health, safety and environment

25.1.1.1 QHSE documentation including a Safety Management System will be in place for the project and will be continually updated throughout the development process. The following sections provide an overview of documentation and how it will be maintained and reviewed with reference, where required, to specific marine documentation.

25.1.1.2 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.

25.2 Incident reporting

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

25.2.1.2 Hornsea Three shall maintain records of investigations and analyse incidents in order to:

- Determine underlying deficiencies and other factors that might 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.

25.2.1.3 All investigations shall be performed in a timely manner.

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

25.2.1.5 When appropriate, the designated person (noted within the 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.

25.3 Review of documentation

25.3.1.1 Hornsea Three will be responsible for reviewing and updating all documentation including the risk assessments, ERCoP, Safety Management System and, if required, Hornsea Three will convene a review panel of stakeholders to quantify risk.

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

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

25.3.1.3 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.

25.4 Inspection of resources

25.4.1.1 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.

25.5 Audit performance

25.5.1.1 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 Three will carry out audits and periodically evaluate the efficiency of the marine safety documentation.

25.5.1.2 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.

25.6 Future monitoring

25.6.1.1 Hornsea Three will manage the risks associated with the activities undertaken at the Hornsea Three array area, offshore cable corridor and offshore HVAC booster station(s). 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 Coordination Centre (as per the Lighting And Marking and the Aids to Navigation Management Plan).

25.7 Future monitoring of marine traffic

25.7.1.1 Whilst no Radar monitoring of vessel movements has been proposed for the Hornsea Three 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 Three array area.

25.8 Decommissioning plan

25.8.1.1 A decommissioning plan will be developed. With regards to impacts on shipping and navigation this will also include consideration of the scenario where upon decommissioning and completion of removal operations, an obstruction is left on site (attributable to the wind farm) which is considered to be a danger to navigation and which it has not proved 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.

26. Summary

26.1.1.1 Following a review of the base case environment, an NRA for Hornsea Three has been undertaken. The assessment has included collision and allision risk modelling and an FSA for all phases of the development (construction, operation and maintenance and decommissioning) as well as an assessment of cumulative effects.

26.2 Consultation

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

- MCA;
- TH;
- CA;
- CoS;
- RYA;
- Hazard Workshop attendees; and
- Extensive regular operator consultation.

26.2.1.2 Responses to the consultation effort were low based on experience at other offshore wind farms; however the majority of responses focused on the cumulative scenario and layouts.

26.3 Marine traffic

26.3.1.1 The Hornsea Three array area marine traffic survey consists of 40 days AIS, Radar and visual observation data recorded during surveys between 6 June and 4 July 2016 (26 days summer) and 10 November and 3 December 2016 (14 days winter). The surveys were carried out by the *Neptune* (summer only) and *RV Aora* (winter only).

26.3.1.2 The offshore cable corridor marine traffic survey consists of 40 days AIS data recorded during the same periods as for the Hornsea Three array area marine traffic survey. The survey consists of shore based AIS survey data combined with Hornsea Three array area marine traffic survey data.

26.3.1.3 The Hornsea Three offshore HVAC booster station marine traffic survey consists of 28 days AIS, Radar and visual observation data recorded during surveys between 16 and 29 September 2016 (14 days summer) and 17 November and 15 December 2016 (14 days winter). The surveys were carried out by the *Willing Lad* (summer only) and *RV Aora* (winter only).

26.3.1.4 The data was assessed to identify the main user types and operators' within the Hornsea Three array area, offshore cable corridor and offshore HVAC booster station search area shipping and navigation study areas.

26.3.1.5 For the 26 days analysed in summer 2016, there were an average of 42 unique vessels per day passing within the Hornsea Three array area shipping and navigation study area, recorded on AIS, visual and Radar. In terms of vessels intersecting the Hornsea Three array area, there was an average of 15 unique vessels per day. Throughout the summer period, the majority of tracks were cargo vessels (33% within Hornsea Three) and fishing vessels (30%). Throughout the winter period the majority of tracks were cargo vessels (45% in Hornsea Three) and tankers (21%).

26.3.1.6 Throughout the combined summer and winter survey period, five regular commercial ferry routes were identified. The most frequently transited route was a DFDS Seaways ferry route between Immingham (UK) and Esbjerg (Denmark), with the *Ark Dania*, *Primula Seaways* and *Ark Germania* making 74 transits between them within the Hornsea Three array area shipping and navigation study area throughout the summer and winter survey periods. Two other DFDS Seaways ferry routes were also relatively prominent, with these both being between Immingham and Cuxhaven (the *Hafnia Seaways* and *Jutlandia Seaways* each made 18 transits within the Hornsea Three array area shipping and navigation study area throughout the summer and winter survey periods).

26.3.1.7 For the purposes of the NRA, recreational activity includes sailing and motor craft (including those undertaking dive / fish excursions) of between 2.4 and 24 m length. Throughout the combined summer and winter survey period, an average of one unique recreational vessel passed within the Hornsea Three array area shipping and navigation study area per day. A medium level of fishing vessel activity was recorded within and in proximity to the Hornsea Three array area, with vessels tracked transiting through the area as well as actively engaged in fishing.

26.3.1.8 AIS data collected for the Hornsea Three offshore cable corridor between 6 June and 4 July 2016 (26 days summer) and between 10 November and 15 December 2016 (14 days winter) have been analysed. The Hornsea Three offshore cable corridor is crossed by a number of dense traffic routes.

26.3.1.9 Throughout June and July 2016 (summer) the majority of tracks were cargo vessels (approximately 52% within the Hornsea Three offshore cable corridor) and tankers (20%). Throughout November and December 2016 (winter) the majority of tracks were also cargo vessels (57%) and tankers (21%).

26.3.1.10 Throughout the combined summer and winter survey period, an average of one to two unique recreational vessels passed within the Hornsea Three offshore cable corridor shipping and navigation study area per day. The majority of fishing vessels recorded within the Hornsea Three offshore cable corridor shipping and navigation study area were either on passage in a north-south direction or actively engaged in fishing activities in the vicinity of the Hornsea Three array area or the shore.

26.3.1.11 Throughout the 40 day period analysed, only one vessel was recorded broadcasting "at anchor" with this being a wind farm support vessel.

26.3.1.12 For the 14 days analysed in summer 2016, there were an average of six unique vessels per day passing within the offshore HVAC booster station search area shipping and navigation study area, recorded on AIS, visual and Radar. In terms of vessels intersecting the Hornsea Three offshore HVAC booster station search area, there was an average less than one unique vessel per day.

26.3.1.13 Throughout the survey periods the majority of tracks were oil and gas affiliated vessels (67% within the Hornsea Three offshore HVAC booster station search area) followed by cargo vessels and tankers (both 13%).

26.3.1.14 Throughout the survey periods the levels of recreational and fishing vessel activity within the Hornsea Three offshore HVAC booster station search area shipping and navigation study area was low, with only a small number of tracks recorded.

26.4 Collision and allision risk modelling

26.4.1.1 Deviations would be required, due to the presence of the Hornsea Three array area, for eight of the 16 main routes identified, with the level of deviation required varying between 5.59 nm for route 15 (eastbound) and 0.2 nm for route 2 (eastbound). For the deviated routes, the maximum increased distance was 5.48% of the total length of route 15, followed by 2.69% of the total length of route 16. The increased distance of the total length of all others routes was less than 2% of the total journey length.

26.4.1.2 An assessment of current vessel to vessel encounters was carried out by replaying at high speed 40 days of AIS, visual and Radar data from the marine traffic surveys. There were 365 encounters observed throughout the 40 day period, corresponding to an average of nine encounters per day. The day with the most vessel encounters was 7 June 2016 with 43 unique encounters observed. In contrast there were no encounters observed on 26 November 2016.

26.4.1.3 The annual vessel to vessel collision frequency following the installation of Hornsea Three was 6.59×10^{-3}, corresponding to a major collision return period of one in 152 years. This represents a 21.4% increase in collision frequency compared to the pre-wind farm result.

26.4.1.4 Based on modelling of the revised routeing, Layout A and local Metocean data, the annual powered vessel to structure allision frequency was 7.51×10^{-4}, corresponding to an allision return period of one in 1,331 years.

26.4.1.5 After modelling each of the drift scenarios it was established that wind-dominated drift produced the worst case results. The annual NUC vessel to structure allision frequency for the wind-dominated drift was 6.39×10^{-4}, corresponding to an allision return period of one in 1,564 years. The majority of the annual NUC vessel allision frequency is associated with those structures located on the western and southern boundaries of the Hornsea Three array area since the prevalent wind direction in the region is from the southwest.

26.4.1.6 An indicative location was modelled for the Hornsea Three offshore HVAC booster station(s) based on a tightly packed layout. Based on the vessel routeing identified for the region, the anticipated change in routeing due to the Hornsea Three offshore HVAC booster station(s), and assumptions that effective mitigation measures are in place, the frequency of an errant vessel under power deviating from its route (to the extent that it comes into proximity with a Hornsea Three offshore HVAC booster station) is not considered to be a probable occurrence. At the indicative location the annual powered vessel to structure allision frequency was 1.06×10^{-4}, corresponding to an allision return period of one in 9,435 years, and the annual NUC vessel to structure allision frequency was 2.48×10^{-6} (based on an ebb tide-dominated drift scenario since this drift scenario produced the worst case results), corresponding to an allision return period of one in 403,170 years.

26.4.1.7 Using site-specific data as an input, the annual fishing vessel to structure allision frequency was estimated for Layout A. The annual fishing vessel to structure allision frequency was 1.74×10^{-1}, corresponding to an estimated allision return period of one in 5.74 years.

26.4.1.8 Mitigation and safety measures have been identified as suitable for application within Hornsea Three appropriate to the level and type of risk determined within the EIA process. The specified measures to be employed will be selected in consultation with the MCA, TH and other relevant statutory stakeholders.

26.4.1.9 Following this assessment it is noted that surface navigational safety impacts associated with the development of Hornsea Three can meet ALARP principles through identified mitigation measures and continual consultation with navigational stakeholders.

26.4.1.10 Impacts associated with helicopter SAR operations have been assessed by a separate specialist consultancy within Appendix C of this NRA.

26.5 Summary of impacts for the Environmental Statement

26.5.1.1 Table 26.1 shows which impacts identified as part of this NRA will be assessed within the Environmental Statement.

Table 26.1: Impacts to be assessed within the Environmental Statement.

Impact identified	FSA ranking	Assessed within Environmental Statement
Deviations due to the Hornsea Three array area (excluding commercial ferries) – all phases	Broadly acceptable	No – broadly acceptable and no safety implications
Deviations due to the Hornsea Three offshore cable corridor and offshore HVAC booster station(s) (excluding commercial ferries) – all phases	Broadly acceptable	No – broadly acceptable and no safety implications
Deviations due to the Hornsea Three array area (commercial ferries) – all phases	Broadly acceptable	No – broadly acceptable and no safety implications
Deviations due to the Hornsea Three offshore cable corridor and offshore HVAC booster station(s) (commercial ferries)– all phases	No impact identified	No
Adverse weather route impacts due to the Hornsea Three array area (excluding commercial ferries) – all phases	Broadly acceptable	Yes
Adverse weather route impacts due to the Hornsea Three offshore cable corridor and offshore HVAC booster station(s) (excluding commercial ferries) – all phases	No impact identified	Yes
Adverse weather route impacts due to the Hornsea Three array area (commercial ferries) – all phases	Broadly acceptable	Yes
Adverse weather route impacts due to the Hornsea Three offshore cable corridor and offshore HVAC booster station(s) (commercial ferries) – all phases	No impact identified	No
Cumulative adverse weather route impacts – all phases	Broadly acceptable	Yes
Cumulative deviations due to the Hornsea Three array area – all phases	Tolerable with mitigation	Yes
Cumulative deviations due to the Hornsea Three offshore cable corridor and offshore HVAC booster station(s) – all phases	Negligible impact	No
Increased encounters and collision risk due to the Hornsea Three array area– construction and decommissioning phases	Broadly acceptable	No – broadly acceptable and effective measures adopted as part of Hornsea Three
Increased encounters and collision risk due to the Hornsea Three offshore HVAC booster station(s) - construction and decommissioning phases	Broadly acceptable	No – broadly acceptable and effective measures adopted as part of Hornsea Three
Increased encounters and collision risk due to the Hornsea Three offshore cable corridor – construction and decommissioning phases	Negligible impact	No
Increased encounters and collision risk due to the Hornsea Three array area – operation and maintenance phase	Broadly acceptable	Yes
Increased encounters and collision risk due to the Hornsea Three offshore cable corridor – operation and maintenance phase	Negligible impact	No
Increased encounters and collision risk due to the Hornsea Three offshore HVAC booster station(s) – operation and maintenance phase	Broadly acceptable	Yes
Cumulative increased encounters and collision risk – all phases	Tolerable with mitigation	Yes
Increased external allision due to the Hornsea Three array area – construction and decommissioning phases	Broadly acceptable	Yes
Increased external allision due to the Hornsea Three array area – operation and maintenance phase	Broadly acceptable	Yes
Increased external NUC allision risk – all phases	Broadly acceptable	Yes
Increased allision risk due to the Hornsea Three offshore HVAC booster station(s) – construction and decommissioning phases	Broadly acceptable	Yes
Increased allision risk due to the Hornsea Three offshore HVAC booster station(s) – operation and maintenance phase (surface structures)	Broadly acceptable	Yes
Increased allision risk due to the Hornsea Three offshore HVAC booster station(s) – operation and maintenance phase (subsea structures)	Tolerable with mitigation	Yes
Cumulative increased external allision risk – all phases	Tolerable with mitigation	Yes
Increased internal Hornsea Three array area allision risk – construction and decommissioning (recreational vessels and fishing vessels)	Broadly acceptable	Yes
Increased internal Hornsea Three array area allision risk – operation and maintenance (recreational vessels and fishing vessels)	Tolerable with mitigation	Yes
Cumulative increased internal Hornsea Three array allision risk – all phases	No identified impact	No
Increased risk of gear snagging – construction and decommissioning phases	Broadly acceptable	Yes
Increased risk of gear snagging – operation and maintenance phase	Broadly acceptable	Yes
Increased risk of anchor snagging – all phases	Broadly acceptable	No – broadly acceptable, low frequency and effective measures adopted as part of Hornsea Three
Impacts on emergency response – construction and decommissioning	Broadly acceptable	No
Impacts on emergency response – operation and maintenance	Tolerable with mitigation	Yes – given effects on SAR assets.

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Appendix A Consequences Assessment

A.1 Introduction

A.1.1.1 This appendix presents an assessment of the consequences of collision and allision incidents, in terms of people and the environment, due to the impact of the wind farm structures.

A.1.1.2 The significance of the impact of the Hornsea Three array area is also assessed based on risk evaluation criteria and comparison with historical accident data in UK waters.

A.2 Risk evaluation

A.2.1 Risk to people

A.2.1.1 With regard to the assessment of risk to people, two measures are considered, namely:

- Individual risk; and
- Societal risk.

Individual risk (per year)

A.2.1.2 This measure considers whether the risk from an accident to a particular individual changes significantly due to the presence of the wind farm structures. Individual risk considers not only the frequency of the accident and the consequence (likelihood of death), but also the individual's fractional exposure to that risk, (the probability of the individual being in the given location at the time of the accident).

A.2.1.3 The purpose of estimating the individual risk is to ensure that individuals who may be affected by the presence of the wind farm structures are not exposed to excessive risks. This is achieved by considering the significance of the change in individual risk resulting from the presence of the wind farm relative to the background individual risk levels.

A.2.1.4 Annual individual risk levels to crew (the annual fatality risk of an average crew member) for different vessel types are presented in Figure A.1. This figure also highlights the upper and lower bounds for risk acceptance criteria as suggested in IMO Maritime Safety Committee (MSC) 72/16. The annual individual risk level to crew falls within the ALARP region for each of the vessel types presented.

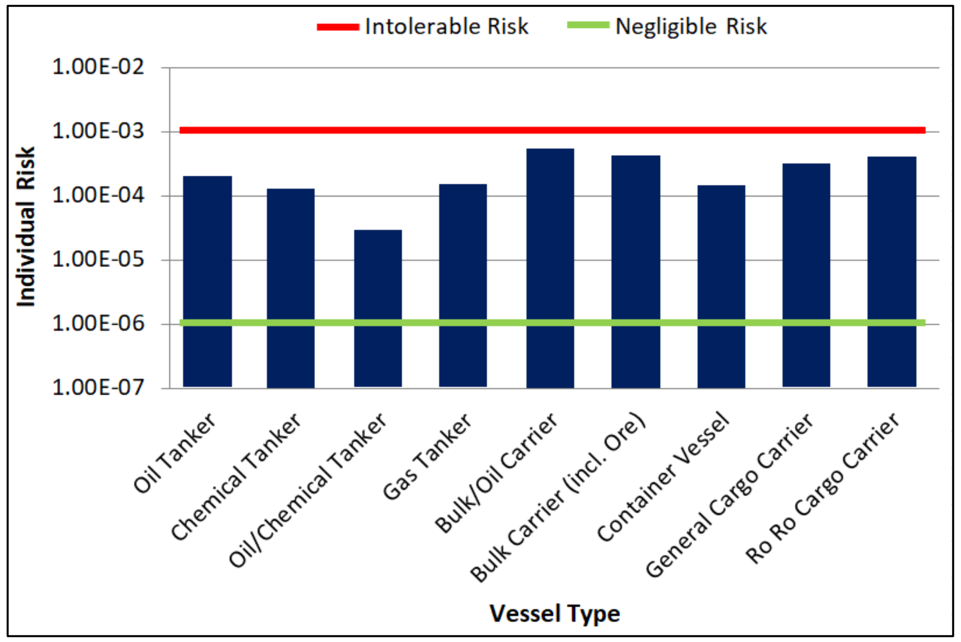

Figure A.1: Individual risk levels and risk acceptance criteria per vessel type.

A.2.1.5 Typical bounds defining the ALARP regions for decision making within shipping are presented in Table A.1.

Table A.1: Individual risk ALARP criteria.

Individual	Lower bound for ALARP	Upper bound for ALARP
To crew member	10^{-6}	10^{-3}
To passenger	10^{-6}	10^{-4}
Third party	10^{-6}	10^{-4}
New vessel target	10^{-6}	Above values reduced by one order of magnitude

A.2.1.6 On a UK basis, the MCA website presents individual risks for various UK industries based on HSE data from 1987 to 1991. The risks for different industries are presented in Figure A.2.

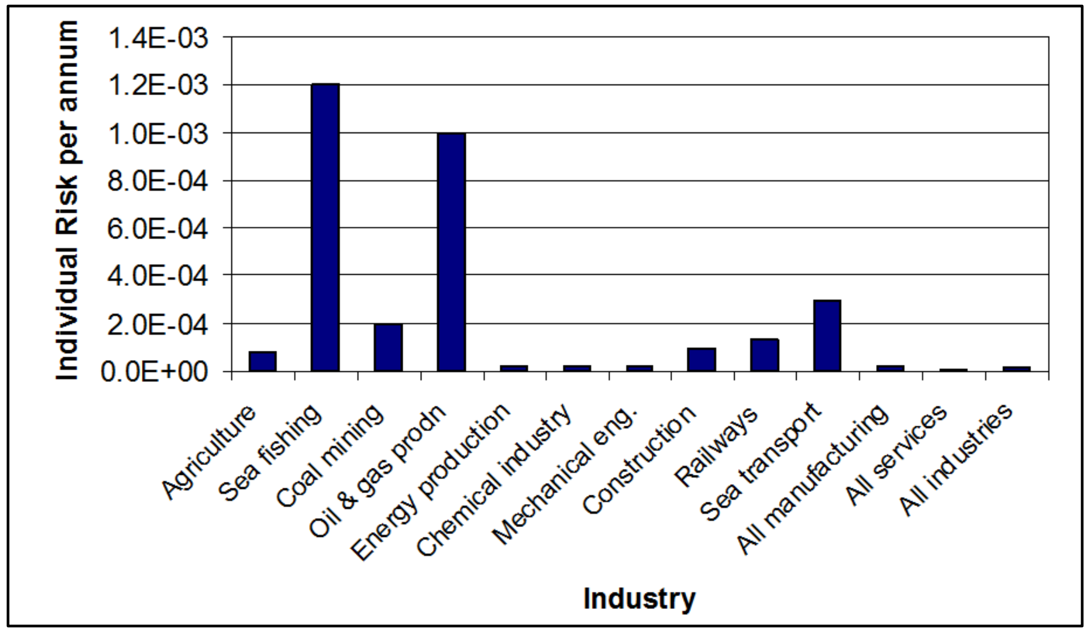

Figure A.2: Individual risk per year for various UK industries.

A.2.1.7 The individual risk for sea transport of 2.9×10^{-4} per year is consistent with the worldwide data presented in Figure A.1, whilst the individual risk for sea fishing of 1.2×10^{-3} per year is the highest across all of the industries included.

Societal risk

A.2.1.8 Societal risk is used to estimate risks of accidents affecting many persons (catastrophes), and acknowledging risk averse or neutral attitudes. Societal risk includes the risk to every person, even if a person is only exposed on one brief occasion to that risk. For assessing the risk to a large number of affected people, societal risk is desirable because individual risk is insufficient in evaluating risks imposed on large numbers of people.

A.2.1.9 Within this assessment societal risk (navigation based) can be assessed for the Hornsea Three array area, giving account to the change in risk associated with each accident scenario caused by the installation of the wind farm structures. Societal risk may be expressed as:

- Annual fatality rate where frequency and fatality are combined into a convenient one-dimensional measure of societal risk. This is also known as PLL; and
- FN-diagrams showing explicitly the relationship between the cumulative frequency of an accident and the number of fatalities in a multi-dimensional diagram.

A.2.1.10 When assessing societal risk this study focuses on PLL, which takes into account the number of people likely to be involved in an incident (which is higher for certain vessel types), and assesses the significance of the change in risk compared to background risk levels for the UK.

A.2.2 Risk to environment

A.2.2.1 For risk to the environment the key criteria considered in terms of the effect of the wind farm is the potential amount of oil spilled from a vessel involved in an incident.

A.2.2.2 It is recognised there will be other potential pollution (such as hazardous containerised cargoes) but oil is considered the most likely pollutant and the extent of predicted oil spills will provide an indication of the significance of pollution risk due to the wind farm compared to background pollution risk levels for the UK.

A.3 Marine Accident Investigation Branch incident analysis

A.3.1 All incidents

A.3.1.1 All UK commercial vessels are required to report accidents to the MAIB. Non-UK vessels do not have to report unless they are in a UK port or within 12 nm territorial waters and carrying passengers to a UK port. There are no requirements for non-commercial recreational craft to report accidents to the MAIB; however a significant proportion of these incidents are reported and investigated by the MAIB.

A.3.1.2 Only incidents occurring in UK waters have been considered within this assessment for which the MAIB data is most comprehensive. It is also noted that incidents occurring in ports/harbours and rivers/canals have been excluded since the causes and consequences may differ from an accident occurring offshore, which is the location of most relevance to Hornsea Three.

A.3.1.3 Applying these criteria, a total of 13,374 accidents, injuries and hazardous incidents were reported to the MAIB between 1994 and 2014 involving 15,212 vessels (some incidents such as collisions involved more than one vessel).

A.3.1.4 The locations of all incidents reported in the vicinity of the UK are presented in Figure A.3, colour-coded by type. It is noted that the MAIB aim for 97% accuracy in reporting the locations of incidents.

A.3.1.5 The distribution of all incidents by year is presented in Figure A.4.

A.3.1.6 The average number of incidents per year was 637. It can be seen that generally there is a fluctuating trend in incidents over the 21 year period.

A.3.1.7 The distribution of all incidents by incident type is presented in Figure A.5.

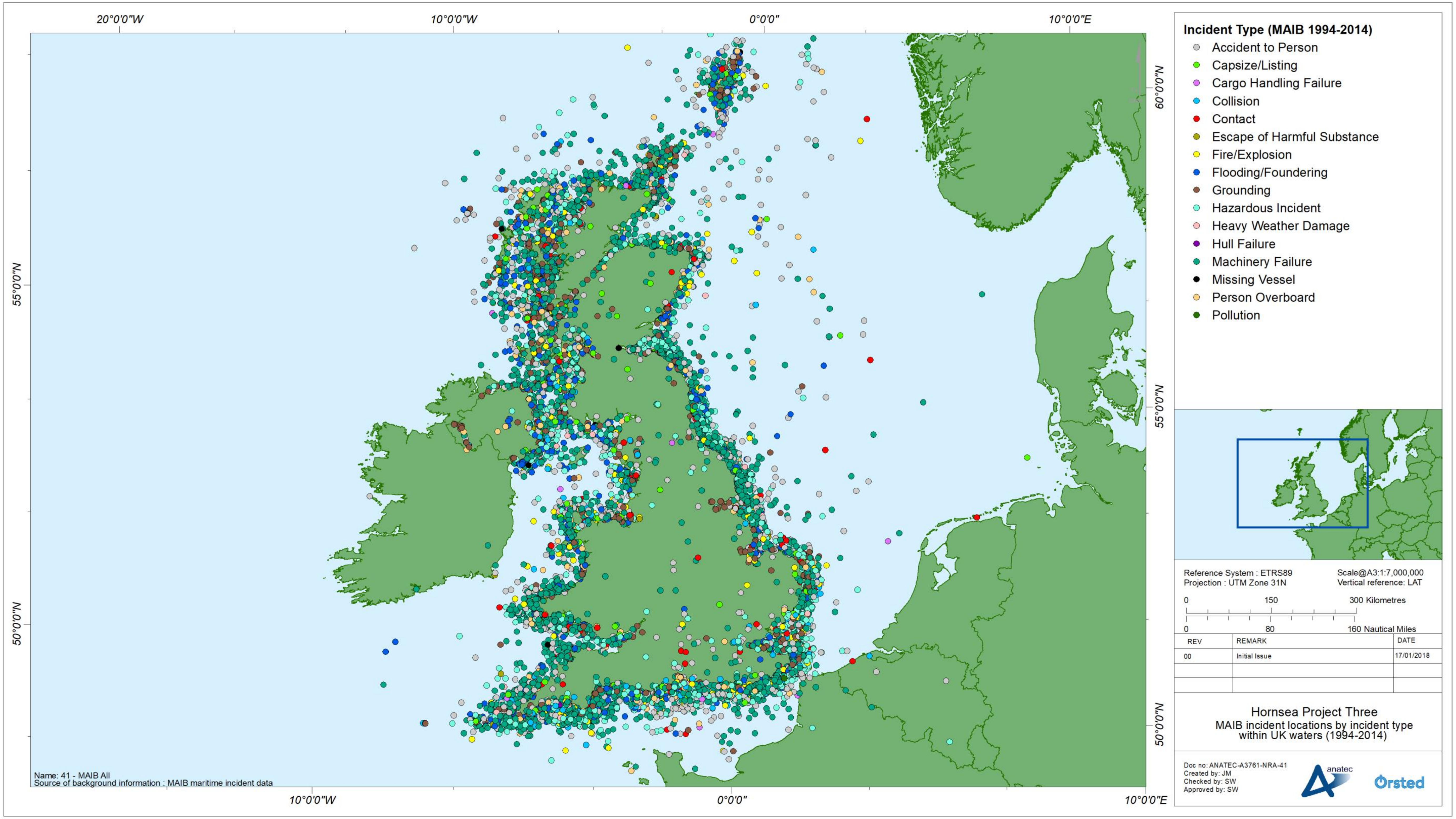

Figure A.3: MAIB incident locations by incident type within UK waters (1994–2014).

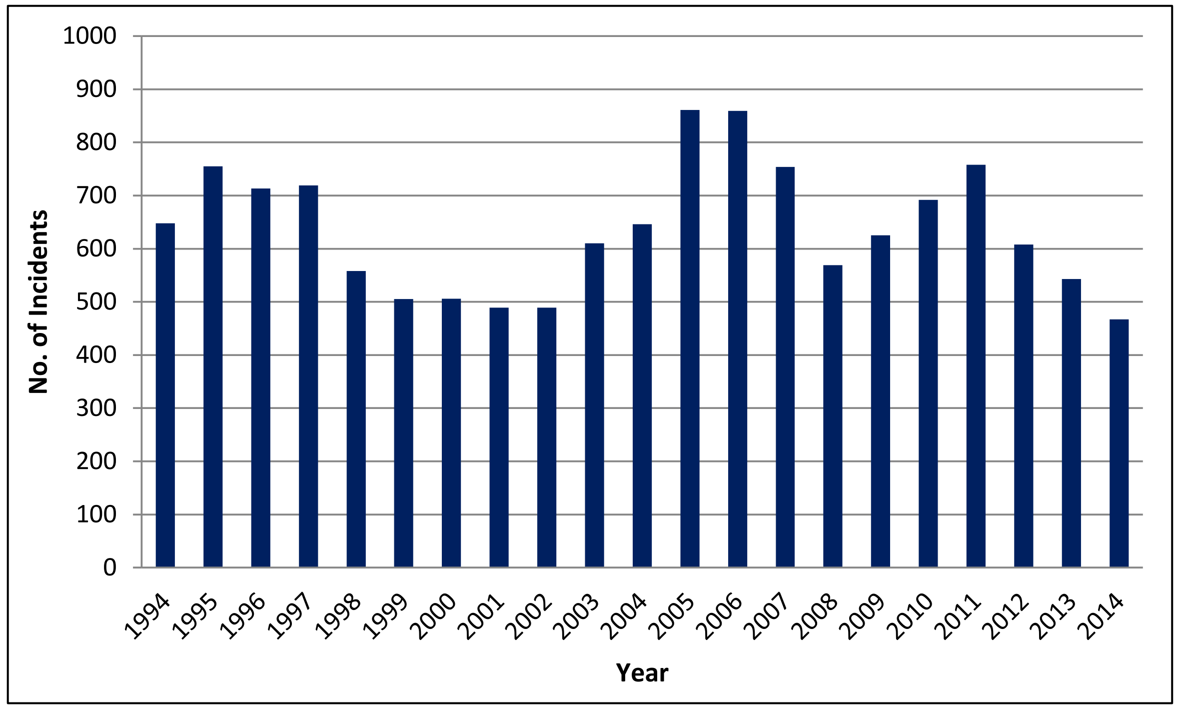

Figure A.4: MAIB incidents per year within UK waters (1994–2014).

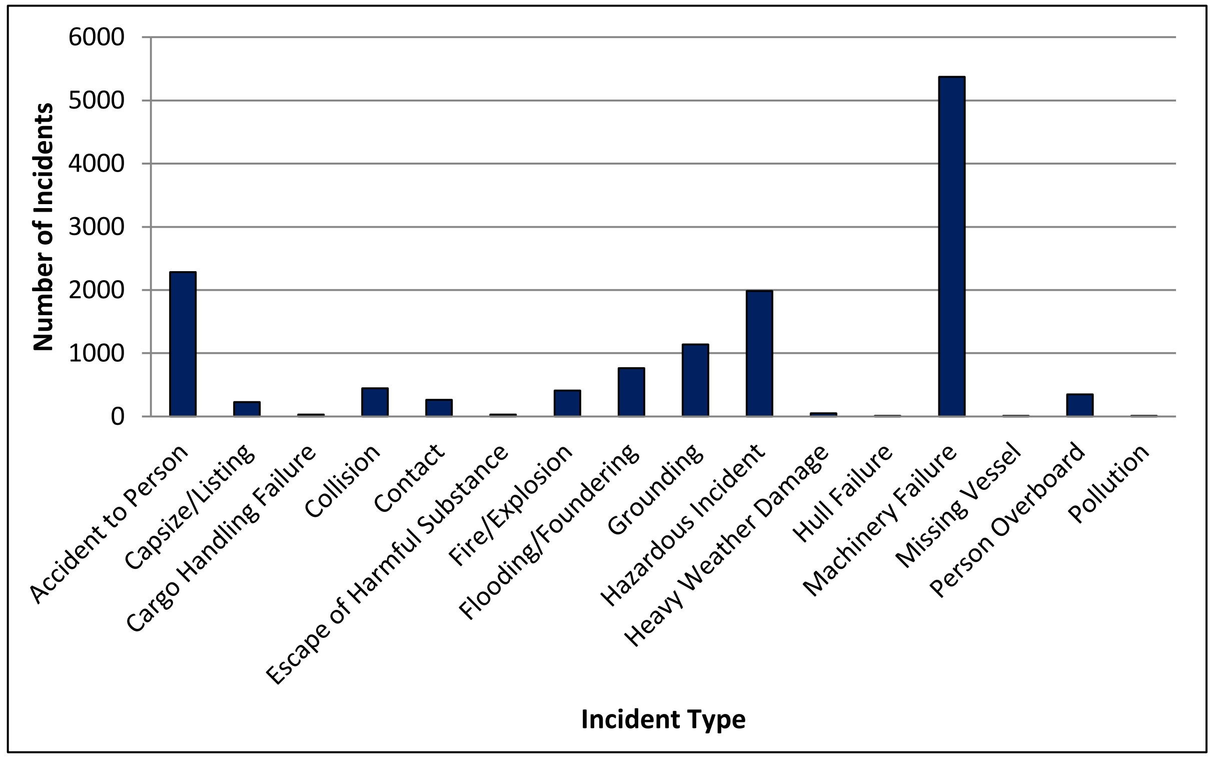

Figure A.5: MAIB incidents by incident type within UK waters (1994–2014).

A.3.1.8 The most common incident types were "Machinery Failure" (40%), "Accident to Person" (17%) and "Hazardous Incident" (15%). "Collisions" and "Contacts" represented 3% and 2% of the total incidents, respectively.

A.3.1.9 The distribution of incidents by vessel type is presented in Figure A.6.

A.3.1.10 The most common vessel types involved in incidents were fishing vessels (48%), other commercial vessels (17%) (which include oil and gas affiliated vessels, tugs, workboats and pilot vessels) and dry cargo vessels (11%).

A.3.1.11 The total number of fatalities reported in MAIB incidents within UK waters between 1994 and 2014 was 428, giving an average of 20 fatalities per year.

A.3.1.12 The distribution of fatalities in UK waters by vessel type and person category (namely crew, passenger and other) are presented in Figure A.7.

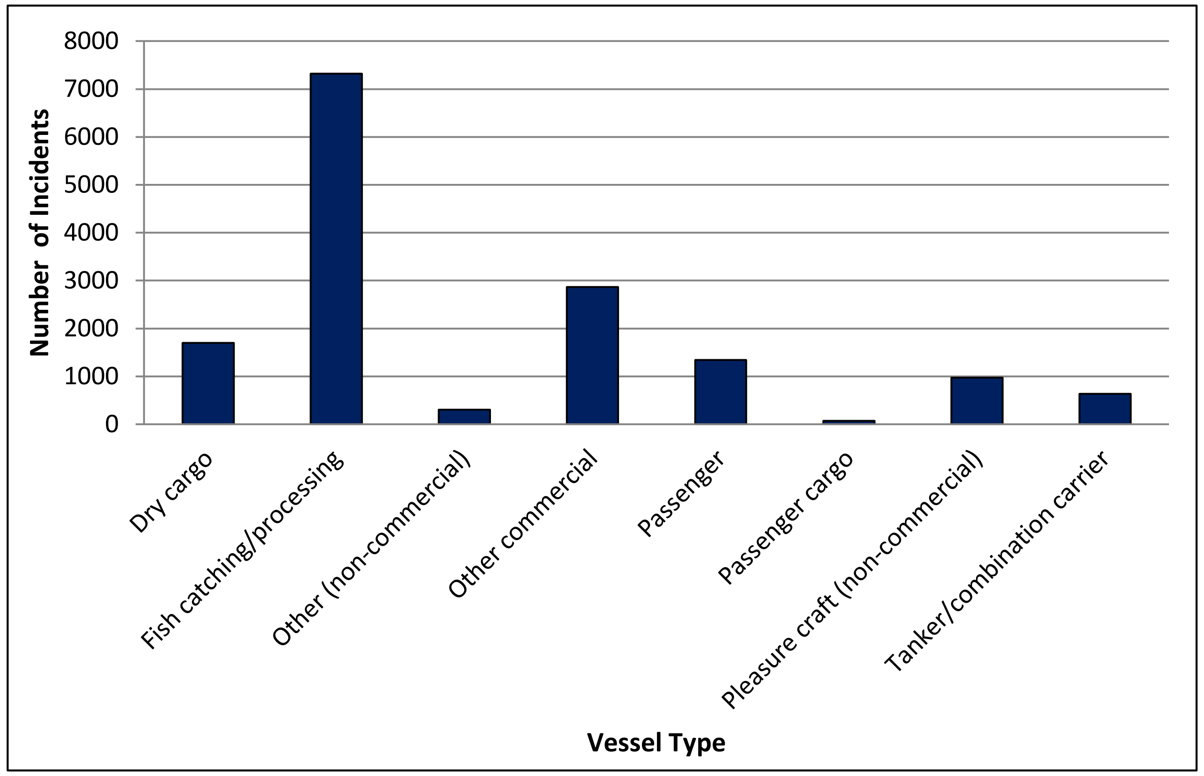

Figure A.6: MAIB incidents by vessel type within UK waters (1994–2014).

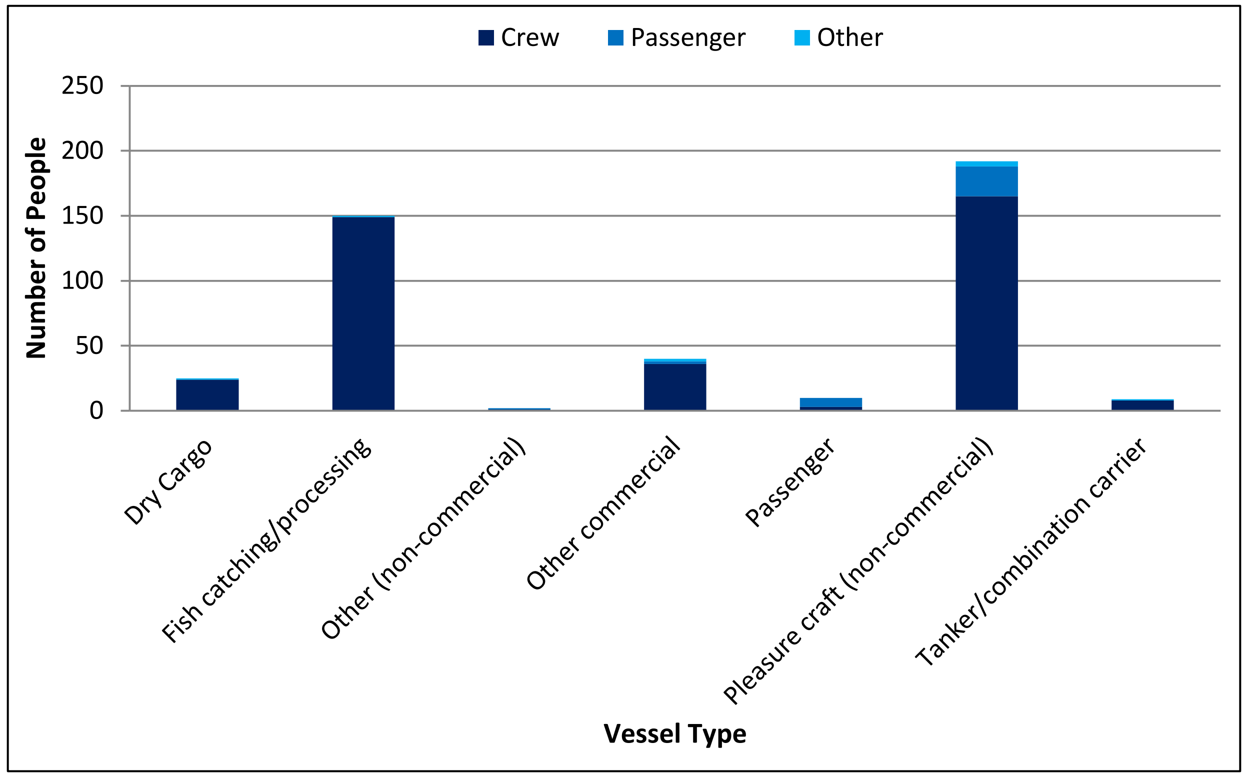

Figure A.7: Fatalities by vessel type for MAIB incidents within UK waters (1994–2014).

A.3.1.13 It can be seen that the majority of fatalities in the UK occurred to fishing vessels and pleasure craft, with crew members the main people involved.

A.3.2 Collision incidents

A.3.2.1 The MAIB define a collision incident as when "a vessel hits another vessel that is floating freely or is anchored (as opposed to being tied up alongside)".

A.3.2.2 A total of 447 collision incidents were reported to the MAIB in UK waters between 1994 and 2014 involving 889 vessels (in a small number of cases the other vessel involved was not logged).

A.3.2.3 The locations of collision incidents reported in the vicinity of the UK are presented in Figure A.8.

A.3.2.4 The distribution of collision incidents by year is presented in Figure A.9.

A.3.2.5 The average number of vessels involved in a collision per year was 42. It can be seen that there has been an overall increasing trend in collision incidents over the 21 year period, which may be due to better reporting of less serious incidents in recent years.

A.3.2.6 The distribution of collision incidents by vessel type is presented in Figure A.10.

A.3.2.7 The most common collision incident vessel types were other commercial vessels (31%), fishing vessels (24%), non-commercial pleasure craft (24%) and dry cargo vessels (10%),

The total number of fatalities per year reported in MAIB collision incidents within UK waters between 1994 and 2014 when excluding those incidents occurring in ports and harbours was four. Details of each of these fatal incidents reported by the MAIB are presented in Table A.2.

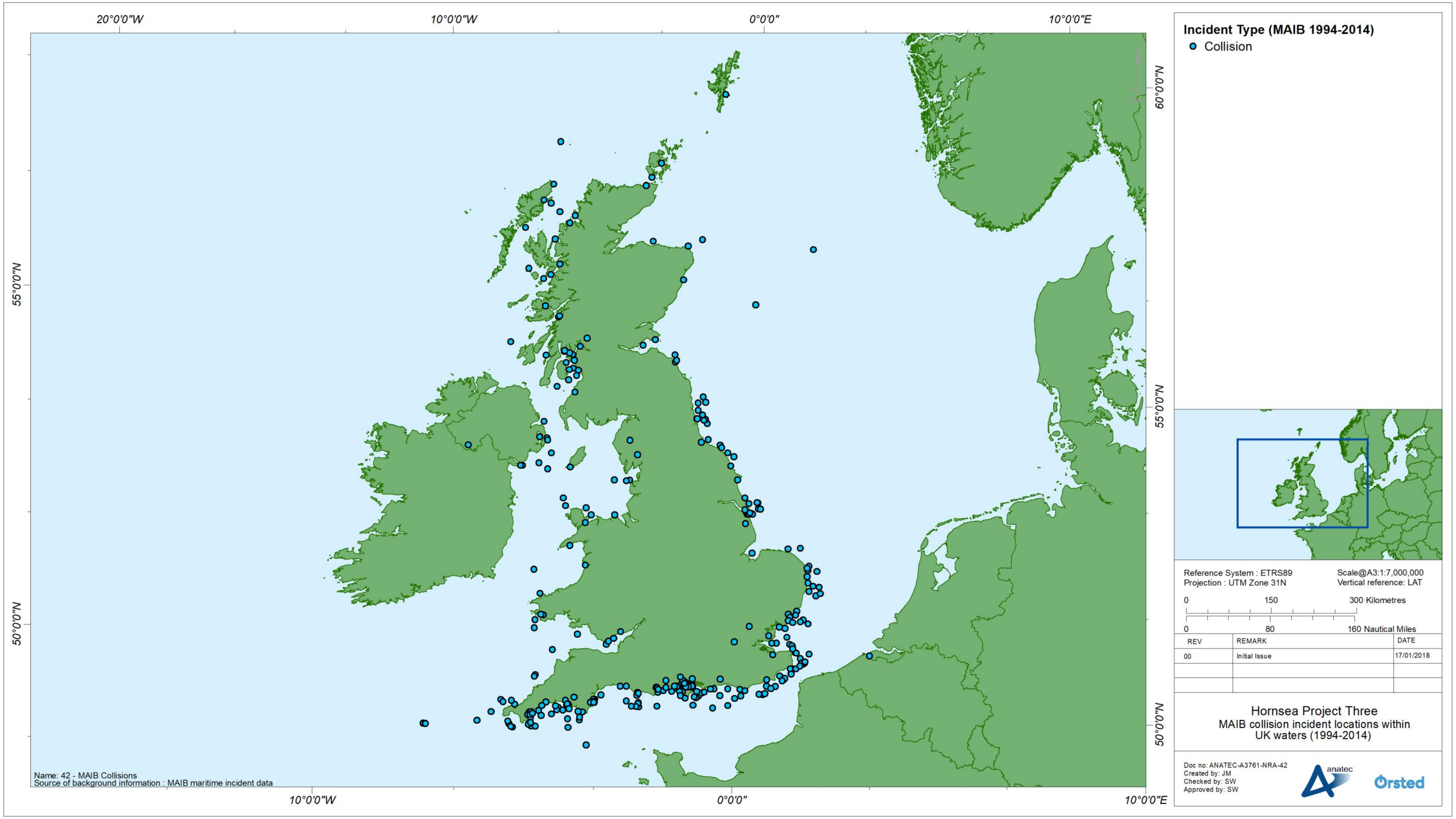

Figure A.8: MAIB collision incident locations within UK waters (1994–2014).

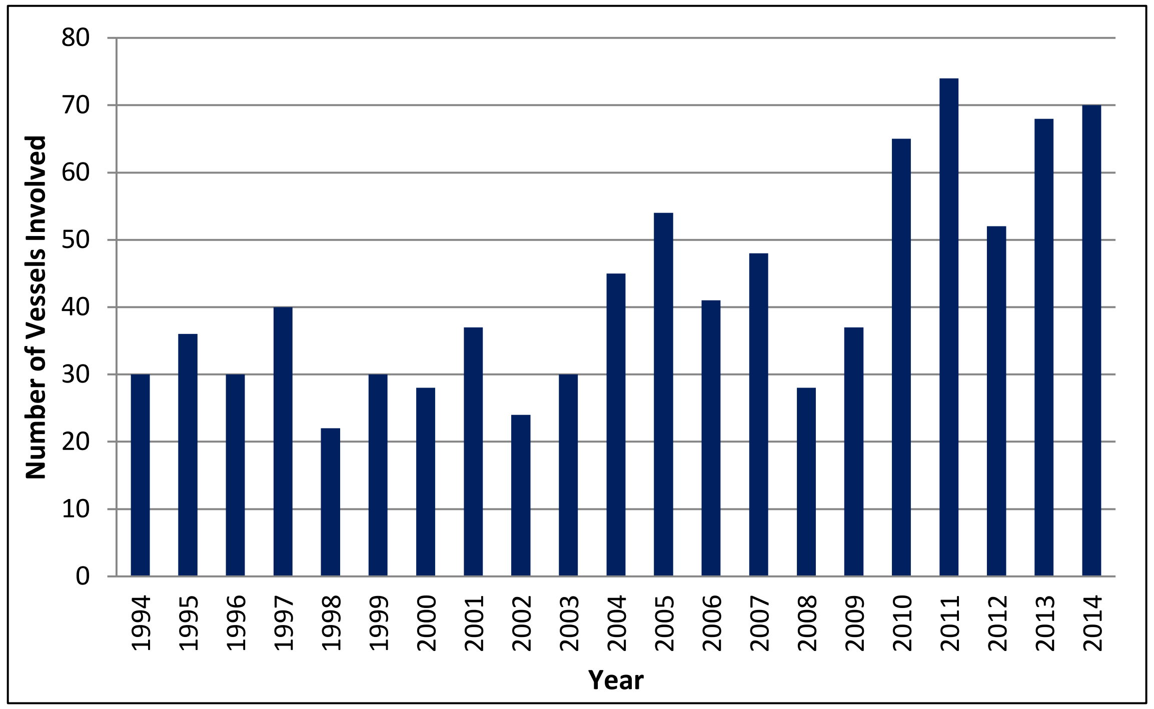

Figure A.9: MAIB collision incidents per year within UK waters (1994–2014).

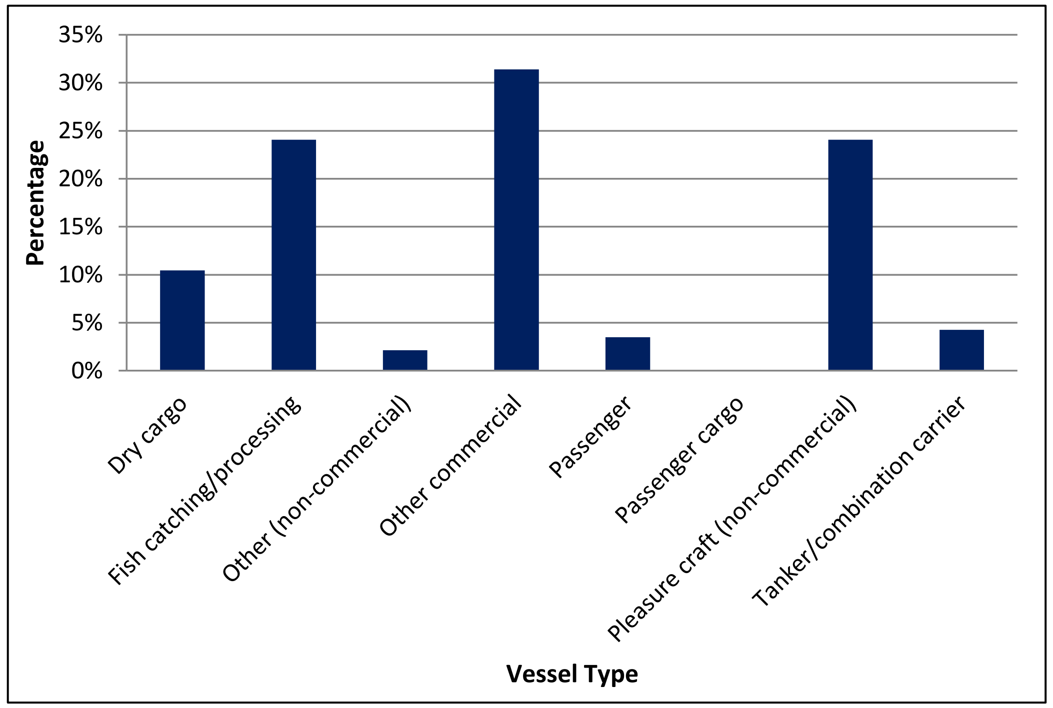

Figure A.10: MAIB collisions by vessel type within UK waters (1994–2014).

Table A.2: Summary of fatal MAIB collision incidents (1994–2014).

Date	Description	Fatalities
October 2001	A dry cargo vessel and a chemical tanker collided in the southwest traffic lane of the Dover Strait TSS to the southeast of Hastings. Although the weather and visibility were good, both watchkeepers were too late to take effective avoiding action. The collision resulted in the sinking of the dry cargo vessel from which five out of six crew members were rescued.	1
August 2002	Two speedboats collided resulting in one fatality and one injury. The visibility was good and the weather was calm. Police were called to the scene and both drivers were arrested.	1
July 2005	A collision between two powerboats near Castle Point, St. Mawes resulted in the death of one of the helmsmen. The incident occurred during the night with both vessels unlit whilst transiting through the area. Both helmsmen had consumed alcohol prior to the incident which is suspected to have caused reduced peripheral vision, deterioration of judgment and slower reaction times from both helmsmen, resulting in the collision.	1
August 2010	An Italian registered Ro Ro passenger ferry collided with a UK registered fishing vessel around four miles off St Abb's Head. As a result of the collision, the fishing vessel sank. The skipper was recovered from the sea but, despite an extensive search by the rescue services and a large number of local fishing vessels, the remaining crew member was lost.	1

A.3.3 Contact incidents

A.3.3.1 The MAIB define a contact incident as when "a vessel hits an object that is immobile and is not subject to the collision regulations e.g. buoy, post, dock (too hard), etc. Also, another vessel if it is tied up alongside. Also floating logs, containers etc."

A.3.3.2 A total of 262 contact incidents were reported to the MAIB between 1994 and 2014 involving 294 vessels (in approximately 12% of cases a moving vessel contacted a stationary vessel).

A.3.3.3 The locations of contact incidents reported in the vicinity of the UK are presented in Figure A.11.

A.3.3.4 The distribution of contact incidents by year is presented in Figure A.12.

27.1.1.1 The average number of contact incidents per year was 13. As with collision incidents, it can be seen that there has been an overall increasing trend over the 21 year period, which may be due to improved reporting of less serious incidents in recent years.

A.3.3.5 The distribution of contact incidents by vessel type is presented in Figure A.13.

A.3.3.6 The most common contact incident vessel types were other commercial vessels (36%), dry cargo vessels (22%) and fishing vessels (18%).

A.3.3.7 There were no fatalities in any of the contact incidents recorded by the MAIB within UK waters between 1994 and 2014 when excluding those incidents occurring in ports and harbours.

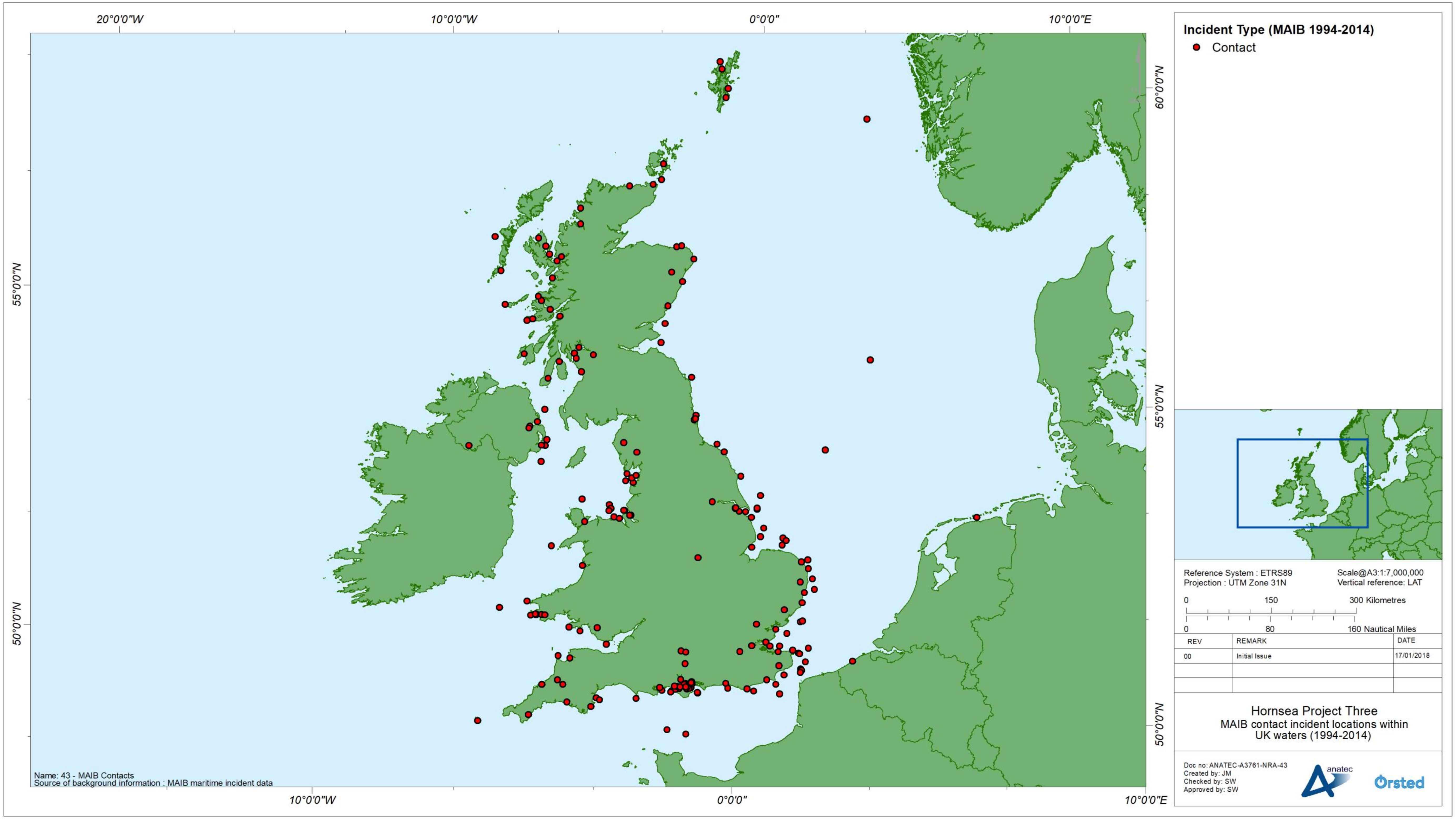

Figure A.11: MAIB contact incident locations within UK waters (1994–2014).

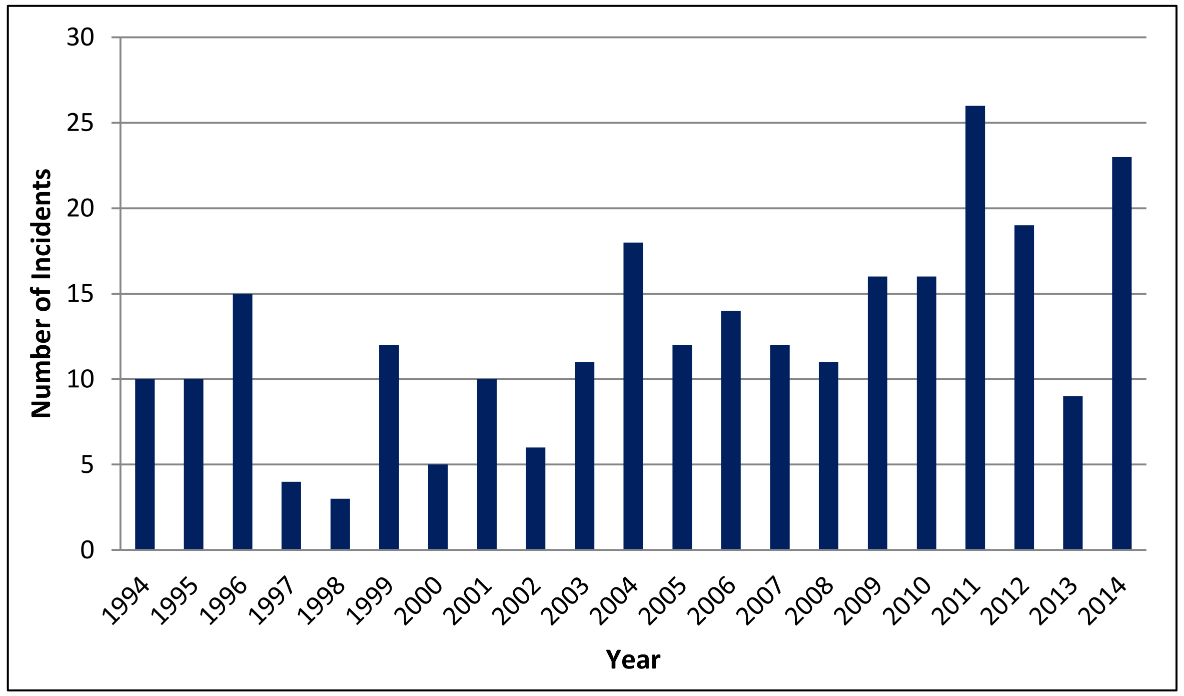

Figure A.12: **MAIB contact incidents per year within UK waters (1994–2014).**

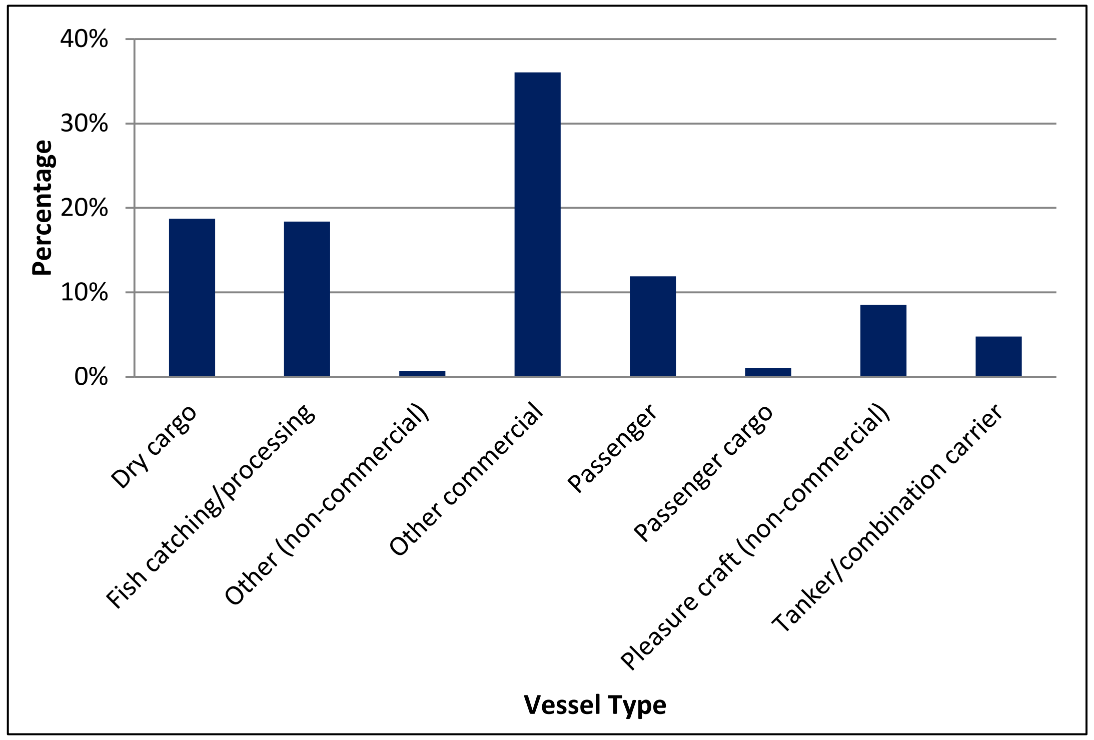

Figure A.13: **MAIB contact incidents by vessel type within UK waters (1994–2014).**

A.4 Fatality risk

A.4.1 Overview

A.4.1.1 This section uses the MAIB incident data reported in section A.3 along with information on average manning levels per vessel type to estimate the probability of fatality in a marine incident associated with Hornsea Three.

A.4.1.2 The wind farm structures are assessed to have the potential to affect the following incidents:

- Vessel to vessel collision;
- Powered vessel to structure allision;
- NUC vessel to structure allision; and
- Fishing vessel to structure allision.

A.4.1.3 Of these incidents, only vessel to vessel collisions match the MAIB definition of collisions and hence the fatality analysis presented in section A.3.2 is considered to be directly applicable to these types of incidents.

A.4.1.4 The other scenarios of powered vessel to structure allision, NUC vessel to structure allision and fishing vessel to structure allision are technically contacts since they involve a vessel striking an immobile object in the form of a turbine or other wind farm structure. From section A.3.3 it can be seen that none of the 262 contact incidents reported by the MAIB in UK waters between 1994 and 2014 resulted in fatalities.

A.4.1.5 However, as the mechanics involved in a vessel contacting a turbine may differ in severity from hitting, for example, a buoy, quayside or moored vessel, the MAIB collision fatality risk rate has also been conservatively applied for these incidents.

A.4.2 Fatality probability

A.4.2.1 Four of the 447 collision incidents reported by the MAIB in UK waters between 1994 and 2014 resulted in one or more fatalities. This gives a 0.89% probability that a collision incident will lead to a fatal accident.

A.4.2.2 To assess the fatality risk for personnel on-board a vessel (crew, passenger or other) the number of persons involved in the incidents needs to be estimated. From analysis of the MAIB incident data, the average commercial passenger vessel had approximately 193 persons on board (POB) (total of crew and passengers). For commercial cargo/freight vessels there was an average of approximately 14 POB. For fishing vessels the average POB was approximately 3.3 and for pleasure craft the average POB was approximately 6.4.

A.4.2.3 It is recognised that these numbers can be substantially higher or lower on an individual vessel basis depending upon the likes of size and subtype, but applying reasonable averages is considered sufficient for this analysis.

A.4.2.4 Using the average number of persons carried along with the vessel type information involved in collision incidents reported by the MAIB (see section A.3.2), there were an estimated 12,966 personnel on-board the vessels involved in the collision incidents.

A.4.2.5 Based on four fatalities, the overall fatality probability in a collision for any individual on-board is approximately 3.1×10^{-4} per collision.

27.1.1.2 It is considered inappropriate to apply this rate uniformly as the statistics indicate that the fatality probability associated with smaller craft, such as fishing vessels and recreational vessels, is higher. Therefore the fatality probability has been subdivided into three categories of vessel as presented in Table A.3.

A.4.2.6 It can be seen that the risk is approximately one order of magnitude higher for people on-board small craft compared to larger commercial vessels.

Table A.3: Fatality probability per incident per vessel category (1994–2014).

Vessel category	Vessel sub categories	Fatalities	People involved	Fatality probability
Commercial	Dry cargo vessels, passenger vessels, tankers, etc.	1	9,718	1.0×10^{-4}
Fishing	Trawler, potter, dredger, etc.	1	708	1.4×10^{-3}
Pleasure craft	Yacht, small commercial motor vessel, etc.	2	2,540	7.9×10^{-4}

A.4.3 Fatality risk due to Hornsea Three array area

A.4.3.1 The base case and future case annual collision and allision frequency levels without and with the wind farm are summarised in Table A.4.

A.4.3.2 Table A.5 presents the estimated average number of POB for the local vessels operating in the vicinity of the Hornsea Three array area.

A.4.3.3 From the detailed results of the collision and allision frequency modelling, the distribution of the predicted change in annual collision and allision frequency by vessel type due to the wind farm for the base and future cases are presented in Figure A.14.

A.4.3.4 For clarity, the same distribution is presented in Figure A.15 with the proportion of the change in annual collision and allision frequency attributed to fishing vessels excluded.

Table A.4: Summary of annual collision and allision frequency levels at Hornsea Three array area.

Allision and collision scenario	Base case			Future case		
	Without Hornsea Three array area	With Hornsea Three array area	Change	Without Hornsea Three array area	With Hornsea Three array area	Change
Vessel to vessel collision	5.18×10^{-3}	6.59×10^{-3}	1.41×10^{-3}	5.70×10^{-3}	7.25×10^{-3}	1.55×10^{-3}
Powered vessel to structure allision	0.00×10^{0}	7.51×10^{-4}	7.51×10^{-4}	0.00×10^{0}	8.27×10^{-4}	8.27×10^{-4}
NUC vessel to structure allision	0.00×10^{0}	6.39×10^{-4}	6.39×10^{-4}	0.00×10^{0}	7.03×10^{-4}	7.03×10^{-4}
Fishing vessel to structure allision	0.00×10^{0}	1.74×10^{-1}	1.74×10^{-1}	0.00×10^{0}	1.92×10^{-1}	1.92×10^{-1}
Total	**5.18×10^{-3}**	**1.82×10^{-1}**	**1.77×10^{-1}**	**5.70×10^{-3}**	**2.00×10^{-1}**	**1.95×10^{-1}**

Table A.5: Number of POB by vessel type and collision and allision incident.

Vessel type	Collision and allision incidents	Average POB
Cargo/offshore	Vessel to vessel collision, powered vessel to structure allision, NUC vessel to structure allision.	25
Tanker	Vessel to vessel collision, powered vessel to structure allision, NUC vessel to structure allision.	20
Passenger	Vessel to vessel collision, powered vessel to structure allision, NUC vessel to structure allision.	2,700
Fishing	Vessel to vessel collision, fishing vessel to structure allision.	6
Recreational Vessel	Vessel to vessel collision.	4

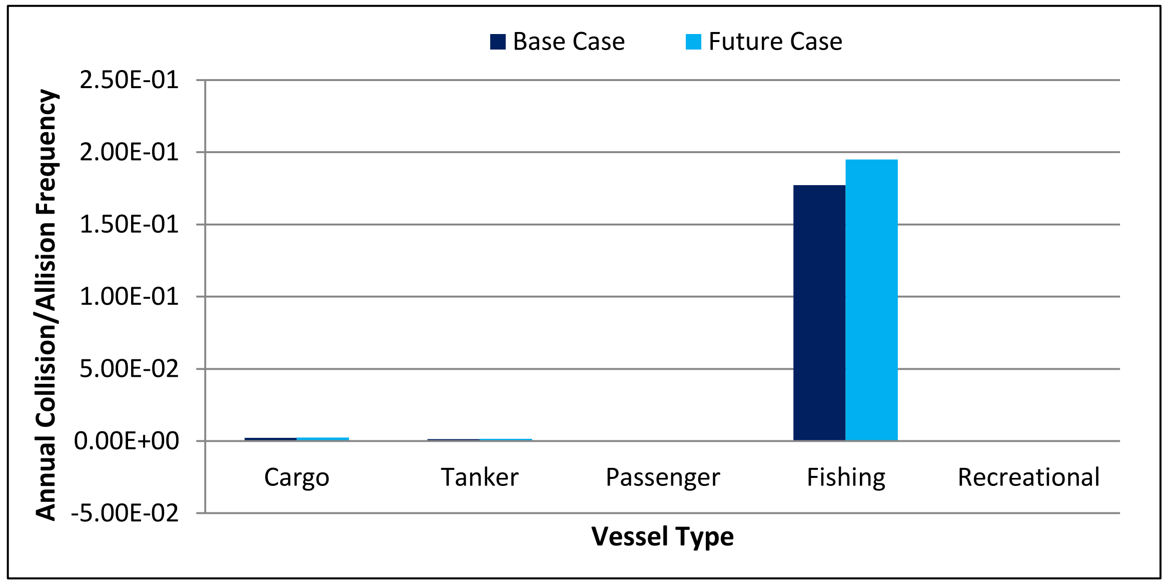

Figure A.14: Change in annual collision and allision frequency by vessel type.

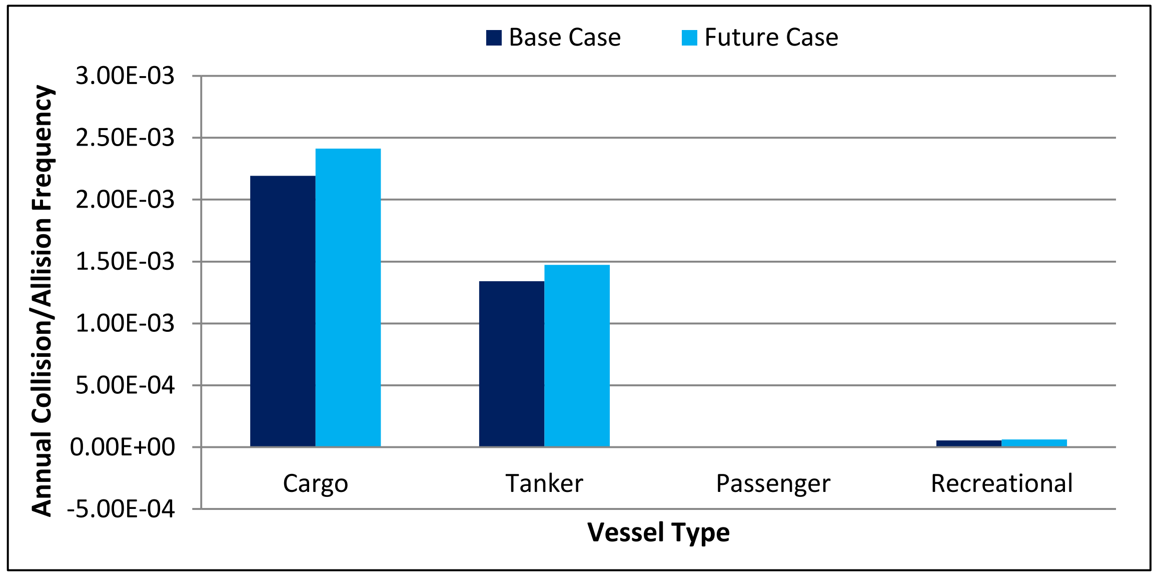

Figure A.15: Change in annual collision and allision frequency by vessel type excluding fishing vessels.

A.4.3.5 It can be seen that the change in annual collision frequency is dominated by fishing vessels. The change in frequency is lowest for passenger vessels for which the change in annual collision and allision frequency was negative. This is due to the majority of passenger vessel traffic within the vicinity of the Hornsea Three array area transiting the Off Botney Ground TSS which is located approximately 6.5 nm from the Hornsea Three array area. Therefore the impact of vessel to structure allision (both powered and NUC vessels) for passenger vessels is low. In addition, the re-routeing of non-TSS commercial traffic in the vicinity of the TSS which was affected by the installation of the wind farm resulted in the duration of such traffic in the vicinity of the TSS being lower; hence the decrease in annual collision frequency for traffic using the TSS, including passenger vessels.

A.4.3.6 Combining the annual collision frequency, the estimated number of POB each vessel type (see section A.4.3) and the estimated fatality probability for each vessel category (see section A.4.2), the annual increase in PLL due to the impact of the wind farm for the base case is estimated to be 1.54×10^{-3}, which equates to one additional fatality in 649 years. The annual increase in PLL due to the impact of the wind farm for the future case is estimated to be 1.70×10^{-3}, which equates to one additional fatality in 590 years. In comparison to MAIB statistics, which indicate an average of 20 fatalities per year in UK territorial waters, this is a small change. It is noted that these values are based on maximum design scenarios for Hornsea Three as well as indicative parameters for vessel type and POB.

A.4.3.7 The estimated incremental increases in PLL due to the wind farm, distributed by vessel type for the base and future cases, are presented in Figure A.16. For clarity, the same incremental increases in PLL are presented in Figure A.17 with the proportion of the PLL attributed to fishing vessels excluded.

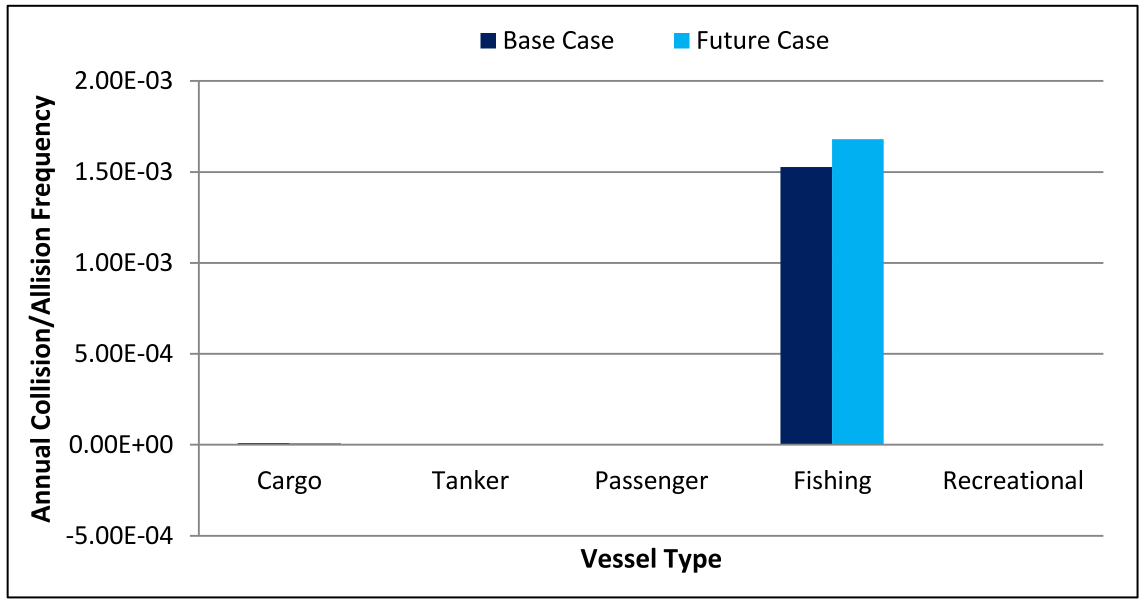

Figure A.16: Estimated change in annual PLL by vessel type.

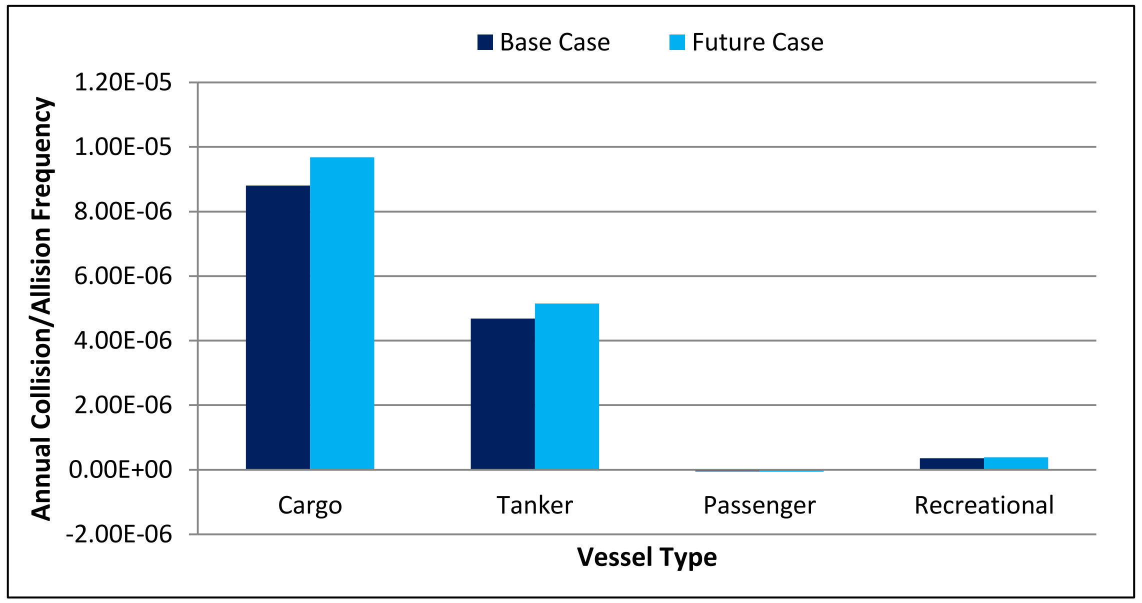

Figure A.17: Estimated change in annual PLL by vessel type excluding fishing vessels.

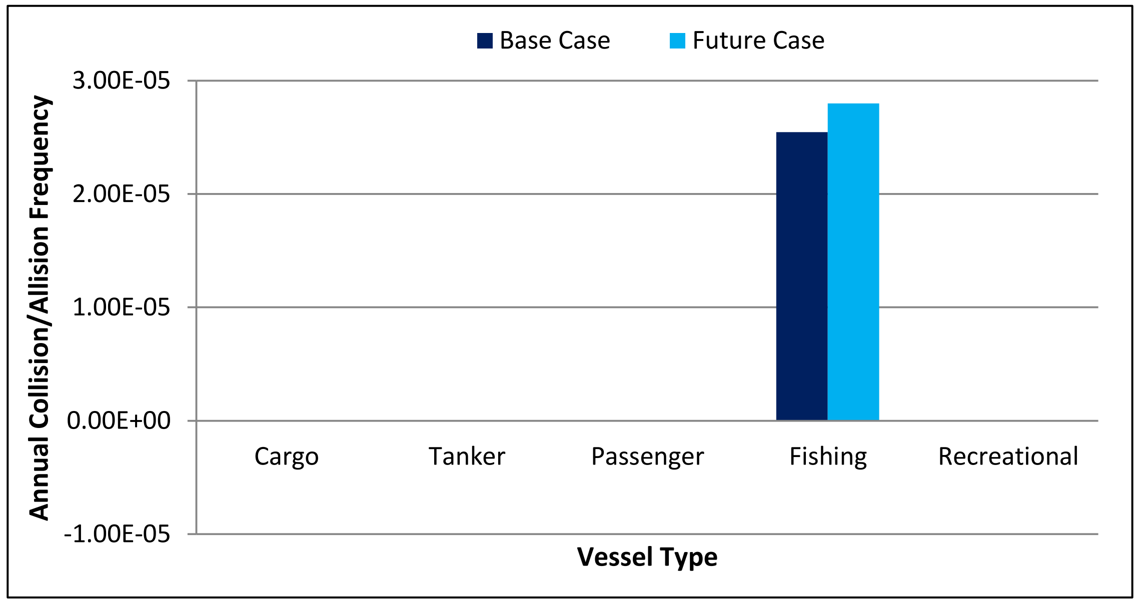

Figure A.18: Estimated change in individual risk by vessel type.

A.4.3.8 As with the change in annual collision frequency, it can be seen that the change in annual PLL is dominated by fishing vessels, which historically have a higher fatality probability than commercial vessels.

A.4.3.9 Converting the PLL to individual risk based on the average number of people exposed by vessel type, the results are presented in Figure A.18. For clarity, the same changes in individual risk are presented in Figure A.19 with the proportion of the individual risk attributed to fishing vessels excluded.

A.4.3.10 It can be seen that the individual risk is highest for people on fishing vessels, which is related to the higher probability of fatalities occurring in the event of an incident.

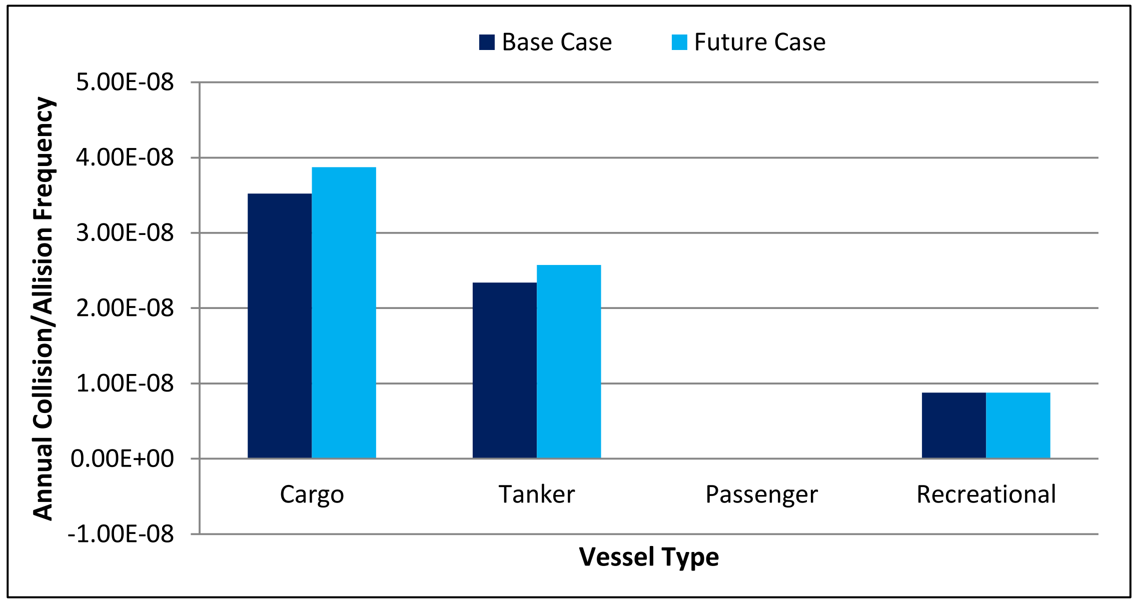

Figure A.19: Estimated change in individual risk by vessel type excluding fishing vessels.

A.4.4 Significance of increase in fatality risk due to Hornsea Three array area

A.4.4.1 The overall increase in PLL estimated due to the wind farm is 1.54×10^{-3} fatalities per year (base case), which equates to one additional fatality in 649 years. This is a small change compared to MAIB statistics which indicate an average of 20 fatalities per year in UK territorial waters.

A.4.4.2 In terms of individual risk to people, the incremental increase for commercial vessels (approximately 5.86×10^{-8} for the base case) is low compared to the background risk level for the UK sea transport industry of 2.9×10^{-4} per year.

A.4.4.3 Similarly for fishing vessels, whilst the change in individual risk attributed to the development is significantly higher than for commercial vessels (approximately 2.55×10^{-5} for the base case), it is low compared to the background risk level for the UK sea fishing industry of 1.2×10^{-3} per year.

A.5 Pollution risk

A.5.1 Historical analysis

A.5.1.1 The pollution consequences of a collision in terms of oil spill depend upon the following:

- Spill probability (likelihood of outflow following an accident); and
- Spill size (amount of oil).

A.5.1.2 Two types of oil spill are considered in this assessment:

- Fuel oil spills from bunkers (all vessel types); and
- Cargo oil spills (laden tankers).

A.5.1.3 The research undertaken as part of the DfT's MEHRAs project (DfT, 2001) has been used as it was comprehensive and based on worldwide marine spill data analysis.

A.5.1.4 From this research, the overall probability of a spill per accident was calculated based on historical accident data for each accident type as presented in Figure A.20.

A.5.1.5 Therefore, it was estimated that 13% of vessel collisions result in a fuel oil spill and 39% of collisions involving a laden tanker result in a cargo oil spill.

A.5.1.6 In the event of a bunker spill, the potential outflow of oil depends upon the bunker capacity of the vessel. Historical bunker spills from vessels have generally been limited to a size below 50% of the bunker capacity, and in most incidents much lower. For the types and sizes of vessels exposed to the wind farm, an average spill size of 100 tonnes of fuel oil is considered to be a conservative assumption.

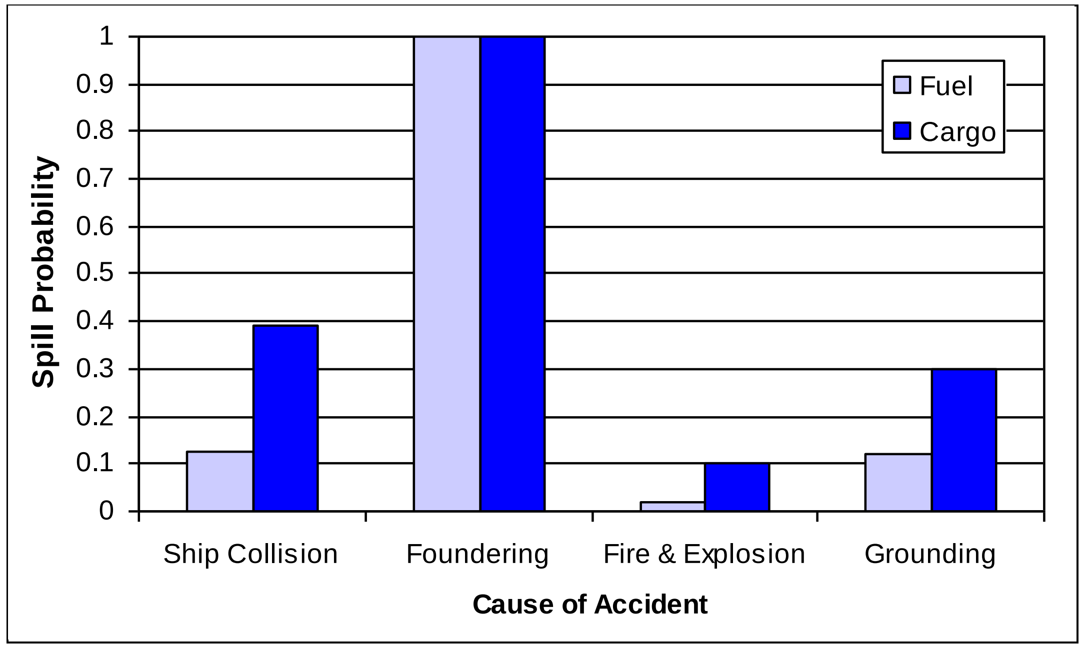

Figure A.20: Probability of an oil spill resulting from an accident.

A.5.1.7 For cargo spills from laden tankers, the spill size can vary significantly. The International Tanker Owners Pollution Federation (ITOPF) report the following spill size distribution for tanker collisions between 1974 and 2004:

- 31% of spills below seven tonnes;
- 52% of spills between seven and 700 tonnes; and
- 17% of spills greater than 700 tonnes.

A.5.1.8 Based on this data and the tankers transiting the area in proximity to the Hornsea Three array area, an average spill size of 400 tonnes is considered conservative.

A.5.1.9 For fishing vessel collisions, comprehensive statistical data is not available. Consequently it is conservatively assumed that 50% of all collisions involving fishing vessels will lead to an oil spill with the quantity spilled being on average five tonnes. Similarly for recreational vessels, due to a lack of data 50% of collisions are assumed to lead to a spill with an average size of one tonne.

A.5.2 Pollution risk due to Hornsea Three array area

A.5.2.1 Applying the above probabilities to the annual collision and allision frequency by vessel type and the average spill size per vessel, the estimated amount of oil spilled per year due to the impact of the wind farm would equate to 0.72 tonnes of oil per year for the base case and 0.79 tonnes of oil per year for the future case. It is noted that these values do not indicate that 0.72 tonnes of oil would consistently be spilt each year but rather that 0.72 tonnes of oil would be the average amount of oil spilled per year if the estimated annual collision frequency materialised. The breakdown of the estimated change in pollution by vessel type is presented in Figure A.21. It is noted that this pollution risk assessment is based on conservative parameters and in reality the amount indicated would be negligible. The conservative assumptions assume that particular elements occur i.e. a vessel is involved in an allision, that the allision contains enough energy to puncture the hull and a tank containing an oil or fuel substance. The model inputs are also based on real incidents and are influenced by severe spills within UK waters including the *Sea Empress*.

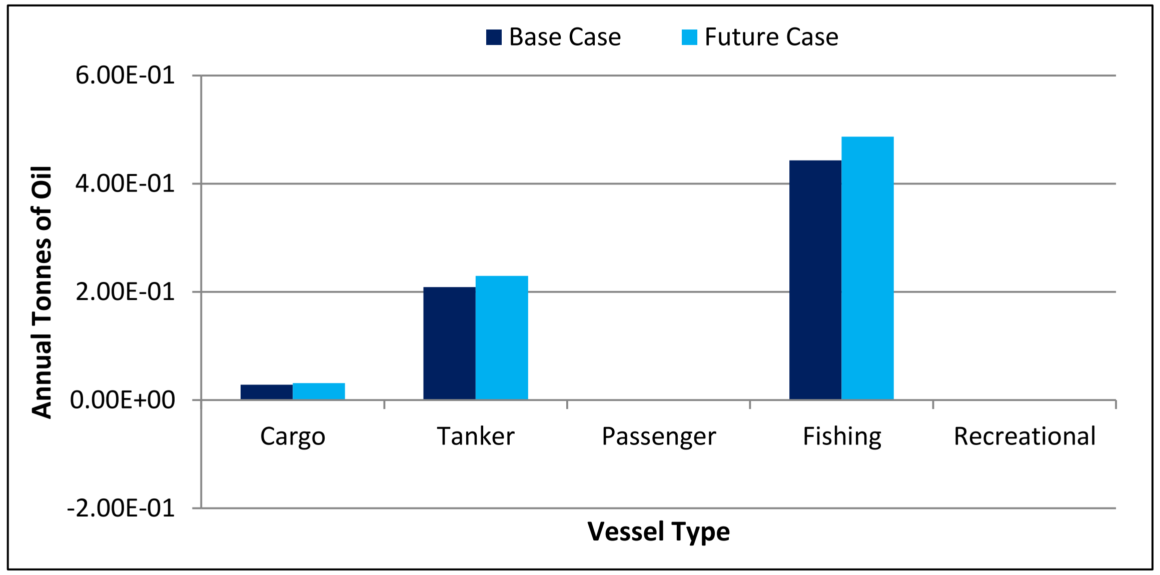

Figure A.21: Estimated change in pollution by vessel type.

A.5.2.2 It can be seen that fishing vessels contribute the majority of the overall risk of oil spills despite tankers having the potential to spill both fuel and cargo oils. However tankers do make up a greater proportion of the overall risk of oil spills than they do with regards to the fatality risk (see section A.4).

A.5.3 Significance of increase in pollution risk due to Hornsea Three array area

A.5.3.1 To assess the significance of the increased pollution risk from marine vessels caused by the wind farm, historical oil spill data for the UK has been used as a benchmark.

A.5.3.2 From the MEHRAs research (DfT, 2001); the annual average tonnes of oil spilled in the waters around the British Isles due to marine accidents in the ten year period from 1989 to 1998 was 16,111. This is based on a total of 146 reported oil pollution incidents of greater than one tonne (smaller spills are excluded as are incidents which occurred within port and harbour areas or as a result of operational errors or equipment failure). Commercial vessel spills accounted for approximately 99% of the total while fishing vessel incidents accounted for less than 1%.

A.5.3.3 The overall increase in pollution estimated due to the wind farm of 0.004% for the base case is very low compared to the historical average pollution quantities from marine accidents in UK waters.

A.6 Conclusions

A.6.1.1 The quantitative risk assessment indicates that the impact of the wind farm on people and the environment is relatively low compared to the existing background risk levels in UK waters.

A.6.1.2 However, it is recognised that there is a degree of uncertainty associated with numerical modelling. For example, the model does not consider the potential Radar interference from turbines which may have an influence on the risk of vessel to vessel collisions, especially in reduced visibility where one or both of the vessels involved is not carrying AIS. Therefore, conservative assumptions have been applied in this analysis and the overall project is being carried out based on the principle of ALARP to ensure the risks to people and the environment are managed to a level that is ALARP.

A.6.1.3 It should also be noted that this is the localised impact of a single project and there will be additional maritime risks associated with other offshore wind farm projects in the southern North Sea and the UK as a whole.

Appendix B Hazard Log

B.1.1.1 The complete hazard log for Hornsea Three is presented in Table B.1.

Table B.1: Hornsea Three hazard log.

Hazard type	Hazard title	Receptor	Phase (C/O/D)	Industry standard risk reduction measures (assumed in place)	Possible causes	Most likely consequences	Realistic most likely consequences							Worst case consequences	Realistic worst case consequences							Risk reduction measures	Additional comments
								Consequences								Consequences							
							Frequency	People	Environment	Property	Business	Average consequence	Risk		Frequency	People	Environment	Property	Business	Average consequence	Risk		
Commercial vessels																							
Deviation	Activities within the Hornsea Three array area and offshore cable corridor may cause commercial vessels to be deviated.	Commercial vessels	C/D	Promulgation of information, consultation with vessel operators.	Presence of construction or decommissioning activities, buoyed construction areas and safety zones may cause commercial vessels to be displaced from historical routes.	Increased journey time and distance.	5	1	1	1	2	1.3	Tolerable	Increased journey time and distance affecting operational schedules.	3	1	1	1	2	1.3	Broadly Acceptable	Ensure buoyed construction areas are appropriate to the size of the development. Construction safety zones must roll with the activity.	From a cumulative perspective it was noted that the construction buoys must take account of the presence of Hornsea Project One and Hornsea Project Two, i.e. do not significantly narrow the proposed navigational corridor for an extended period of time.

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Deviation	Activities within the Hornsea Three array area and offshore cable corridor may cause commercial vessels to be deviated during adverse weather.	Commercial vessels	C/D	Promulgation of information, consultation with vessel operators.	Presence of construction or decommissioning activities, buoyed construction areas and safety zones may cause commercial vessels to be displaced from historical adverse weather routes.	Increased journey time and distance in adverse weather.	3	1	1	1	2	1.3	Broadly Acceptable	Inability to transit during adverse weather as a safe alternative cannot be found.	1	1	1	1	3	3.0	Broadly Acceptable	Additional consultation with users to identify adverse weather routes.	Commercial vessel operators noted that adverse weather routes were not important for them given they did not carry passengers or sensitive cargoes.
Collision	Activities within the Hornsea Three array area and offshore cable corridor may cause commercial vessels to be deviated, increasing encounters and thus the risk of vessel to vessel collision.	Commercial vessels including commercial ferries	C/D	Compliance with international and Flag State regulations, MGN 372, promulgation of information.	Presence of construction or decommissioning activities, buoyed construction areas and safety zones may cause commercial vessels to be deviated creating new areas of high density traffic or congestion points for third party vessels. This impact could also include causes associated with navigational error, human error or adverse weather.	Increased encounters and therefore more collision avoidance action required by vessels as per COLREGS but does not result in a collision.	5	1	1	1	1	1.0	Tolerable	Collision between vessels due to deviations associated with the Hornsea Three array area and offshore cable corridor during construction or decommissioning.	2	4	3	3	3	3.3	Broadly Acceptable	Ensure buoyed construction areas are appropriate to the size of the development. Construction safety zones must roll with the activity. Increased level of promulgation of information on the development so that all vessels can effectively passage plan.	From a cumulative perspective it was noted that vessel to vessel encounters would increase within the proposed navigational corridor during the construction of Hornsea Three (assuming that Hornsea Project One and Hornsea Project Two are constructed or under construction) and that additional mitigation such as routeing measures or fairway buoys may be required. A particular risk associated with small craft crossing the channel was noted, whom may not be fully aware of or be compliant with rule 9 of COLREGS.

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Interaction	Activities within the Hornsea Three array area and offshore cable corridor may create interactions between a third party commercial vessel and a project construction or decommissioning vessel.	Commercial vessels including commercial ferries	C/D	Compliance with international and Flag State regulations, MGN 372 and 543, promulgation of information, marine coordination, monitoring by AIS.	Presence of additional vessels within the area associated with Hornsea Three activities may increase the potential for encounters and therefore the potential for collisions. This impact could also include causes associated with navigational error, human error or adverse weather.	Increased encounters with Hornsea Three construction or decommissioning vessels and therefore more collision avoidance action required by vessels as per COLREGS but does not result in a collision.	5	1	1	1	1	1.0	Tolerable	Collision between a Hornsea Three construction or decommissioning vessel and a third party vessel.	1	4	3	3	3	3.3	Broadly Acceptable	Project standard vessel health and safety requirements including competency assessments and audits.	
Allision	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor may cause increased allision risk for commercial vessels.	Commercial vessels	C/D	Buoyed construction areas, safety zones, temporary navigational marks, marine coordination, promulgation of information, monitoring by AIS.	Presence of newly installed infrastructure within the Hornsea Three array area and offshore cable corridor poses an allision risk to vessels. The risk could be associated with lack of or failure of navigational marking, navigational error, human error or adverse weather.	Near miss or entrance into safety zone by third party vessel.	3	1	1	1	1	1.0	Broadly Acceptable	Vessel allides with a newly installed structure.	2	4	3	3	3	3.3	Broadly Acceptable	No further mitigation required.	

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Allision (NUC)	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor may increase allision risk to commercial NUC vessels in an emergency situation (including machinery related problems or navigational system errors).	Commercial vessels	C/D	Buoyed construction areas, safety zones, temporary navigational marks, marine coordination, promulgation of information, monitoring by AIS.	Presence of newly installed infrastructure within the Hornsea Three array area and offshore cable corridor poses a risk specifically to a NUC vessel (likely due to mechanical failure).	NUC vessel is on a closing point of approach with a structure but no allision occurs due to the vessel regaining power or other evasive action.	2	1	1	1	1	1.0	Broadly Acceptable	NUC vessel is on a closing point of approach with a structure and an allision occurs.	1	4	3	3	4	3.5	Broadly Acceptable	No further mitigation required.	
Deviation	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor may displace commercial vessels leading to increased journey times or distances for commercial vessels.	Commercial vessels	O	Promulgation of information. Consultation with vessel operators.	Presence of the Hornsea Three array area and offshore cable corridor may cause commercial vessels to be displaced from historical routes.	Increased journey time and distance.	5	1	1	1	2	1.3	Tolerable	Increased journey time and distance affecting operational schedules.	3	1	1	1	2	1.3	Broadly Acceptable	Continued promulgation of information noting when maintenance activities are occurring.	
Deviation	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor may displace commercial vessels leading to increased journey times or distances for commercial vessels during adverse weather.	Commercial vessels	O	Promulgation of information, consultation with vessel operators.	Presence of the Hornsea Three array area and offshore cable corridor may cause commercial vessels to be displaced from historical adverse weather routes.	Increased journey time and distance in adverse weather.	3	1	1	1	2	1.3	Broadly Acceptable	Inability to transit during adverse weather as a safe alternative cannot be found.	1	1	1	1	3	1.5	Broadly Acceptable	No further mitigation required.	

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Collision	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor may cause commercial vessels to be deviated, increasing encounters and thus the risk of vessel to vessel collision.	Commercial vessels including commercial ferries	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information.	Structures will cause commercial vessels to be deviated creating new areas of high density traffic or congestion points for third party vessels. This impact may also include causes associated with navigational error, human error or adverse weather.	Increased encounters and therefore more collision avoidance action required by vessels as per COLREGS but does not result in a collision.	4	1	1	1	1	1.0	Broadly Acceptable	Collision between vessels due to deviations associated with the Hornsea Three array area and offshore cable corridor.	1	4	3	3	3	3.3	Broadly Acceptable	No further mitigation required.	From a cumulative perspective it was noted that vessel to vessel encounters would increase within in the proposed navigational corridor during the operation of Hornsea Three (assuming that Hornsea Project One and Hornsea Project Two are constructed) and that additional mitigation such as routeing measures or fairway buoys may be required. A particular risk associated with small craft crossing the channel was noted, whom may not be fully aware of or be compliant with rule 9 of COLREGS.
Interaction	Operation and maintenance activities within the Hornsea Three array area and offshore cable corridor may create interactions between third party vessel and project operation and maintenance vessels.	Commercial vessels including commercial ferries	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS, marine pollution contingency planning.	Presence of additional vessels within the area associated with Hornsea Three activities will increase the potential for encounters and therefore the potential for collisions. This impact may also include causes associated with navigational error, human error or adverse weather.	Increased encounters with Hornsea Three operation and maintenance vessels and therefore more collision avoidance action required by vessels as per COLREGS but does not result in a collision.	3	1	1	1	1	1.0	Broadly Acceptable	Collision between a Hornsea Three operation and maintenance vessel and a third party vessel.	1	4	3	3	3	3.3	Broadly Acceptable	Vessel Health and Safety Requirements including competency assessments and audits.	

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Allision	Presence of infrastructure located within the Hornsea Three array area may increase vessel to structure allision risk external to the array for commercial vessels.	Commercial vessels including commercial ferries	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS, permanent aids to navigation, marine pollution contingency planning.	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor poses an allision risk to vessels. The risk could be associated with lack of or failure of navigational marking, human error, adverse weather, navigational error.	Near miss of structure by third party vessel on the periphery of the site.	4	1	1	1	1	1.0	Broadly Acceptable	Allision with structure by third party vessel on the periphery of the site.	2	4	3	3	3	3.3	Broadly Acceptable	Consideration for peripheral site design to ensure Aids to Navigation are effective. Additional aids to navigation including the potential for permanent floating aids.	It was noted in the Hazard Workshop that large non turbine structures should not be placed on the periphery. Also, it was agreed that generally the array area would not be used for transiting by commercial vessels.
Allision (NUC)	Presence of infrastructure within the Hornsea Three array area may increase vessel to structure allision risk external to the array for NUC vessels in an emergency situation (including machinery related problems or navigational system errors).	Commercial vessels including commercial ferries	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS, permanent aids to navigation, marine pollution contingency planning.	Presence of newly installed infrastructure within the Hornsea Three array area and offshore cable corridor poses a risk specifically to a NUC vessel (likely due to mechanical failure).	NUC vessel is on a closing point of approach with a structure but no allision occurs due to the vessel regaining power or other evasive action.	3	1	1	1	1	1.0	Broadly Acceptable	NUC vessel is on a closing point of approach with a structure and an allision occurs.	2	4	3	3	4	3.5	Broadly Acceptable	No further mitigation required.	

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Allision	Presence of Hornsea Three offshore HVAC booster stations within the offshore cable corridor may increase vessel to structure allision risk for commercial vessels.	Commercial vessels including commercial ferries	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS, permanent aids to navigation, marine pollution contingency planning.	Presence of surface HVAC booster station poses an allision risk to vessels. The risk could be associated with lack of or failure of navigational marking, human error, adverse weather or navigational error.	Near miss by third party vessel.	2	1	1	1	1	1.0	Broadly Acceptable	Vessel allides with a structure.	1	4	3	3	4	3.5	Broadly Acceptable	No further mitigation required.	
Under keel clearance	Presence of cable/scour protection and subsea HVAC booster stations may reduce navigable water depth for commercial vessels.	Commercial vessels including commercial ferries	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS, permanent aids to navigation, marine pollution contingency planning.	Presence of subsea HVAC booster station poses an allision risk to vessels. The risk could be associated with lack of or failure of navigational marking, human error, adverse weather or navigational error.	Near miss by third party vessel and under keel hazard.	2	1	1	1	1	1.0	Broadly Acceptable	Vessel allides with a structure causing damage to the keel.	1	1	3	3	4	2.8	Broadly Acceptable	No further mitigation required.	

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
							1	2	3	4	5	6	7		1	2	3	4	5	6	7		
Deviation	Activities within the Hornsea Three array area and offshore cable corridor may cause commercial ferries to be deviated.	Commercial ferries	C/D	Promulgation of information, consultation with vessel operators.	Presence of construction or decommissioning activities, buoyed construction areas and safety zones may cause commercial ferries to be displaced from historical routes.	Increased journey time and distance within manageable parameters for vessels on a timetabled service.	5	1	1	1	3	1.5	Tolerable	Increased journey time and distance out with manageable parameters for vessels on a timetabled service.	3	1	1	1	3	1.5	Broadly Acceptable	Further consultation with vessel operators to ensure that both their normal and adverse weather routes are considered. Ensure a buoyed construction area is appropriate to the size of the development. Construction safety zones must roll with the activity.	Noted that Hornsea Project One and Hornsea Project Two, both consented, already displace the same routes as Hornsea Three.
Deviation	Activities within the Hornsea Three array area and offshore cable corridor may cause commercial ferries to be deviated during adverse weather.	Commercial ferries	C/D	Promulgation of information, consultation with vessel operators.	Presence of construction or decommissioning activities, buoyed construction areas and safety zones will cause commercial ferries to be displaced from historical adverse weather routes.	Increased journey time and distance.	4	1	1	1	3	1.5	Broadly Acceptable	Inability to transit during adverse weather as a safe alternative cannot be found.	2	1	1	1	4	1.8	Broadly Acceptable	Additional consultation with users to identify adverse weather routes.	DFDS Seaways agreed to provide further information on adverse weather routes used. Noted the additional sensitivity due to the carriage of passengers and Ro Ro cargoes.
Deviation	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor may displace commercial ferries leading to increased journey times or distances for commercial ferries.	Commercial ferries	O	Promulgation of information, Consultation with vessel operators.	Presence of the Hornsea Three array area may cause commercial ferries to be displaced from historical routes.	Increased journey time and distance within manageable parameters for vessels on a timetabled service.	4	1	1	1	3	1.5	Broadly Acceptable	Increased journey time and distance out with manageable parameters for vessels on a timetabled service.	4	1	1	1	4	1.8	Broadly Acceptable	No further mitigation required.	

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Deviation	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor may displace commercial vessels leading to increased journey times or distances for commercial ferries during adverse weather.	Commercial ferries	O	Promulgation of information, Consultation with vessel operators.	Presence of the Hornsea Three array area may cause commercial ferries to be displaced from historical adverse weather routes.	Increased journey time and distance.	3	1	1	1	3	1.5	Broadly Acceptable	Inability to transit during adverse weather as a safe alternative cannot be found.	3	1	1	1	4	1.8	Broadly Acceptable	No further mitigation required.	
Recreational vessels																							
Collision	Activities within the Hornsea Three array area and offshore cable corridor may cause recreational vessels to be deviated, increasing encounters and thus the risk of vessel to vessel collision.	Recreational vessels	C/D	Promulgation of information.	Presence of construction or decommissioning activities, buoyed construction areas and safety zones may cause recreational vessels to be displaced from historical routes.	Increased encounters and therefore more collision avoidance action required by vessels as per COLREGS but does not result in a collision.	5	1	1	1	1	1.0	Tolerable	Collision involving recreational vessel due to deviations associated with the Hornsea Three array area and offshore cable corridor during construction or decommissioning phases.	2	5	3	3	3	3.5	Broadly Acceptable	Safety zones should roll with the activity and information on construction phasing should be clearly promulgated.	It was agreed by recreational representatives at the Hazard Workshop that recreational traffic was low and likely that mariners were highly skilled with better equipped vessels.
Interaction	Activities within the Hornsea Three array area and offshore cable corridor may create interactions between a third party recreational vessel and project construction vessels.	Recreational vessels	C/D	Compliance with international regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS.	Presence of additional vessels within the area associated with Hornsea Three activities may increase the potential for encounters and therefore the potential for collisions. This impact could also include causes associated with navigational error, human error or adverse weather.	Increased encounters with Hornsea Three construction or decommissioning vessels and therefore more collision avoidance action required by recreational vessels as per COLREGS but does not result in a collision.	4	1	1	1	1	1.0	Broadly Acceptable	Collision between a Hornsea Three construction or decommissioning vessel and a third party recreational vessel.	1	5	3	3	3	3.5	Broadly Acceptable	No further mitigation required.	

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Allision	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor may cause increased allision risk for recreational vessels external to the array.	Recreational vessels	C/D	Buoyed construction areas, safety zones, temporary navigational marks, marine coordination, monitoring by AIS, promulgation of information.	Presence of newly installed infrastructure within the Hornsea Three array area and offshore cable corridor poses an allision risk to vessels. The risk could be associated with lack of or failure of navigational marking, human error, adverse weather, navigational error.	Near miss or entrance into safety zone by third party recreational vessel.	3	1	1	1	1	1.0	Broadly Acceptable	Recreational vessel allides with a newly installed structure.	2	5	3	3	3	3.5	Broadly Acceptable	No further mitigation required.	
Allision (NUC)	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor may increase allision risk to recreational NUC vessels in an emergency situation (including machinery related problems or navigational system errors).	Recreational vessels	C/D	Buoyed construction areas, safety zones, temporary navigational marks, marine coordination, monitoring by AIS, promulgation of information.	Presence of newly installed infrastructure within the Hornsea Three array area and offshore cable corridor poses a risk specifically to a NUC recreational vessel (likely due to mechanical failure).	NUC recreational vessel is on a closing point of approach with a structure but no allision occurs due to the vessel regaining power or other evasive action.	2	1	1	1	1	1.0	Broadly Acceptable	NUC recreational vessel is on a closing point of approach with a structure and an allision occurs.	1	5	3	3	4	3.8	Broadly Acceptable	No further mitigation required.	

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Collision (internal)	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor may cause recreational vessels to be deviated, increasing encounters and thus the risk of a vessel to vessel collision internally within the array.	Recreational vessels	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS, permanent aids to navigation.	Recreational vessels navigating internally within the array may become disorientated or confused leading to potential collisions. This could also be caused by vessels being obscured from one another due to structures and turbines. This could be associated with turbine layout, human error, navigational equipment error or adverse weather.	Near miss between a recreational vessel and another vessel internally within the array.	2	1	1	1	1	1.0	Broadly Acceptable	Collision between a recreational vessel and another vessel internally within the array.	1	5	3	3	3	3.5	Broadly Acceptable	No further mitigation required.	
Allision (internal)	Presence of infrastructure within the Hornsea Three array area may increase vessel to structure allision risk internally within the array for recreational users.	Recreational vessels	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS, permanent aids to navigation, marine pollution contingency planning.	Recreational vessels navigating internally within the array may become disorientated or confused leading to potential allisions This could be associated with turbine layout, failure of Aids to Navigation, human error, navigational equipment error or adverse weather.	Near miss with a structure by third party recreational vessel.	2	1	1	1	1	1.0	Broadly Acceptable	Vessel allides with a structure	1	5	3	3	3	3.5	Broadly Acceptable	No further mitigation required.	It is possible to become disorientated within the array area, particularly at low speeds where tidal streams can affect a vessel's course. This is more relevant as spacing becomes larger, however it was agreed that the larger the spacing the less need for alignment.

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Allision	Presence of Hornsea Three offshore HVAC booster stations within the offshore cable corridor may increase vessel to structure allision risk for recreational users.	Recreational vessels	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS, permanent aids to navigation, marine pollution contingency planning.	Presence of surface HVAC booster station poses an allision risk to recreational vessels. The risk could be associated with lack of or failure of navigational marking, human error, adverse weather, navigational error.	Near miss by recreational vessel.	2	1	1	1	1	1.0	Broadly Acceptable	Recreational vessel allides with a structure	1	5	3	3	4	3.8	Broadly Acceptable	No further mitigation required.	
Under keel clearance	Presence of cable/scour protection and subsea HVAC booster stations may reduce navigable water depth for recreational vessels.	Recreational vessels	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS, permanent aids to navigation, marine pollution contingency planning.	Presence of subsea HVAC booster station poses an allision risk to recreational vessels. The risk could be associated with lack of or failure of navigational marking, human error, adverse weather, navigational error.	Near miss by recreational vessel.	2	1	1	1	1	1.0	Broadly Acceptable	Recreational vessel allides with a structure causing significant damage to the keel/founder.	1	4	3	3	4	3.5	Broadly Acceptable	No further mitigation required.	Recreational representative in the Hazard Workshop stated that subsea HVAC booster stations would be preferable to surface.

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Commercial fishing vessels																							
Collision	Activities within the Hornsea Three array area and offshore cable corridor may cause commercial fishing vessels to be deviated, increasing encounters and this risk of vessel to vessel collision.	Commercial fishing vessels (in transit/mobile gear)	C/D	Promulgation of information, consultation with vessel operators.	Presence of construction or decommissioning activities, buoyed construction areas and safety zones may cause commercial fishing vessels to be displaced from historical routes.	Increased encounters and therefore more collision avoidance action required by commercial fishing vessels as per COLREGS but does not result in a collision.	5	1	1	1	1	1.0	Tolerable	Collision involving commercial fishing vessel due to deviations associated with the Hornsea Three array area and offshore cable corridor during construction or decommissioning phases.	1	5	3	3	3	3.5	Broadly Acceptable	No further mitigation required.	
Interaction	Activities within the Hornsea Three array area and offshore cable corridor may create interactions between a third party commercial fishing vessel and a project construction vessel.	Commercial fishing vessels (in transit/mobile gear)	C/D	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS.	Presence of additional vessels within the area, associated with Hornsea Three activities may increase the potential for encounters and therefore the potential for collision. This impact could also include causes associated with navigational error, human error or adverse weather.	Increased encounters with Hornsea Three construction or decommissioning vessels and therefore more collision avoidance action required by commercial fishing vessels as per COLREGS but does not result in a collision.	5	1	1	1	1	1.0	Tolerable	Collision between a Hornsea Three construction or decommissioning vessel and a third party commercial fishing vessel.	1	4	3	3	3	3.3	Broadly Acceptable	No further mitigation required.	

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Allision	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor may cause increased allision risk for commercial fishing vessels.	Commercial fishing vessels (in transit/mobile gear)	C/D	Buoyed construction areas, safety zones, temporary navigational marks, promulgation of information, marine coordination, monitoring by AIS.	Presence of newly installed infrastructure within the Hornsea Three array area and offshore cable corridor poses an allision risk to commercial fishing vessels (including gear snagging). The risk could be associated with lack of or failure of navigational marking, human error, adverse weather or navigational error.	Near miss or entrance into safety zone by third party commercial fishing vessel.	3	1	1	1	1	1.0	Broadly Acceptable	Commercial fishing vessel allides with a newly installed structure.	2	4	3	3	3	3.3	Broadly Acceptable	No further mitigation required.	
Allision (NUC)	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor may increase allision risk to NUC commercial fishing vessels in an emergency situation (including machinery related problems or navigational system errors).	Commercial fishing vessels (in transit/mobile gear)	C/D	Buoyed construction areas, safety zones, temporary navigational marks, promulgation of information, marine coordination, monitoring by AIS.	Presence of newly installed infrastructure within the Hornsea Three array area and offshore cable corridor poses a risk specifically to an NUC commercial fishing vessel (likely due to mechanical failure).	NUC commercial fishing vessel is on a closing point of approach with a structure but no allision occurs due to the vessel regain power or other evasive action.	2	1	1	1	1	1.0	Broadly Acceptable	NUC commercial fishing vessel is on a closing point of approach with a structure and an allision occurs.	1	4	3	3	4	3.5	Broadly Acceptable	No further mitigation required.	

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Collision (Internal)	Presence of infrastructure within the Hornsea Three array area and offshore cable corridor may cause commercial fishing vessels to be deviated, increasing encounters and thus the risk of a vessel to vessel collision internally within the array.	Commercial fishing vessels (in transit/mobile gear)	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS, permanent Aids to Navigation, marine pollution contingency planning.	Fishing vessels navigating internally within the array may become disorientated or confused leading to potential collisions. This could also be caused by vessels being obscured from one another due to structures and turbines. This could be associated with turbine layout, human error, navigational equipment error or adverse weather.	Near miss between a commercial fishing vessel and another vessel internally within the array.	4	1	1	1	1	1.0	Broadly Acceptable	Collision between a commercial fishing vessel and another vessel internally within the array.	1	4	3	3	3	3.3	Broadly Acceptable	No further mitigation required.	
Allision (Internal)	Presence of infrastructure within the Hornsea Three array area may increase vessel to structure allision risk internally within the array for commercial fishing vessels.	Commercial fishing vessels (in transit/mobile gear)	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS, permanent Aids to Navigation, marine pollution contingency planning.	Commercial fishing vessels navigating internally within the array may become disorientated or confused leading to potential allisions. This could be associated with turbine layout, failure of Aids to Navigation, human error, navigational equipment error or adverse weather.	Near miss with a structure by third party commercial fishing vessel.	3	1	1	1	1	1.0	Broadly Acceptable	Commercial fishing vessel allides with a structure.	1	4	3	3	3	3.3	Broadly Acceptable	No further mitigation required.	

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Allision	Presence of Hornsea Three offshore HVAC booster stations within the offshore cable corridor may increase vessel to structure allision risk for commercial fishing vessels.	Commercial fishing vessels (in transit/mobile gear)	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS, permanent Aids to Navigation, marine pollution contingency planning.	Presence of surface HVAC booster station poses an allision risk to vessels. The risk could be associated with lack of or failure of navigational marking, human error, adverse weather or navigational error.	Near miss by third party commercial fishing vessel.	2	1	1	1	1	1	Broadly Acceptable	Commercial fishing vessel allides with a structure.	1	4	3	3	4	3.5	Broadly Acceptable	No further mitigation required.	
Under keel clearance	Presence of cable/scour protection and subsea HVAC booster stations may reduce navigable water depth for commercial fishing vessels.	Commercial fishing vessels (in transit/mobile gear)	O	Compliance with international and Flag State regulations, MGN 372, promulgation of information, marine coordination, monitoring by AIS, permanent Aids to Navigation, marine pollution contingency planning.	Presence of subsea HVAC booster station poses an allision risk to commercial fishing vessels. The risk could be associated with lack of or failure of navigational marking, human error, adverse weather or navigational equipment error.	Near miss by third party commercial fishing vessel.	2	1	1	1	1	1.0	Broadly Acceptable	Commercial fishing vessel allides with a structure causing significant damage to the keel.	1	4	3	3	4	3.5	Broadly Acceptable	No further mitigation required.	

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Snagging	Presence of partially installed cables (which may be exposed or partially buried / protected) and other subsea infrastructure may present an increased risk of gear snagging for commercial fishing vessels.	Commercial fishing vessels (mobile gear)	C/D	Cable burial assessment, compliance with international and Flag State regulations, use of guard vessels or temporary marks, promulgation of information (charting and KISORCA).	Presence of partially installed cables or structures could pose a risk to vessels fishing in proximity or near to current areas of operation. This could be associated with human error or navigational equipment error.	A vessel fishes (trawls) on an area of exposed /partially buried cable or partially completed structure but no interaction occurs.	3	1	1	1	1	1.0	Broadly Acceptable	A vessel fishes (trawls) on an area of exposed /partially buried cable or partially completed structure. This results in damage to the cable, gear or foundering of vessel.	2	5	4	3	4	4.0	Tolerable	A fishing plotter app developed for the oil and gas industry was mooted. Such software is viable as mitigation for the offshore HVAC booster stations.	It was noted during the Hazard Workshop that the type of foundation will significantly impact the risk.
Snagging	Presence of cables and other subsea infrastructure (including foundations) may present an increased gear snagging risk for commercial fishing vessels.	Commercial fishing vessels (mobile gear)	O	Cable burial assessment, compliance with international and Flag State regulations, promulgation of information (charting).	Presence of exposed cables or subsea structures could pose a risk to vessels fishing in proximity or near to current areas of operation. This could be associated with human error or navigational equipment error.	A vessel fishes (trawls) close to an area of exposed cable or subsea structure but no snagging interaction occurs.	5	1	1	1	1	1.0	Tolerable	A vessel fishes (trawls) on an area of exposed or partially buried cable or subsea structure. This results in damage to the cable, gear or foundering of vessel.	2	5	4	3	4	4.0	Tolerable	A fishing plotter app developed for the O&G industry was mooted. Such software is viable as mitigation for the HVAC booster stations.	During the Hazard Workshop it was noted that the design of the offshore HVAC booster stations was important with regards to the risk of gear snagging.
Anchored vessels																							
Snagging	Presence of partially installed cables (which may be exposed or partially buried / protected) and other subsea infrastructure may present an increased risk of anchor snagging for commercial vessels and commercial fishing vessels.	All vessels including commercial fishing vessels (not engaged in fishing).	C/D	Cable burial assessment, compliance with international and Flag State regulations, use of guard vessels or temporary marks, promulgation of information (charting).	Presence of partially installed cables or structures could pose a risk to vessels anchoring in proximity or near to current areas of operation. This could be associated with human error or navigational equipment error.	A vessel anchors on an area of exposed /partially buried cable or partially completed structure but no interaction occurs.	3	1	1	1	1	1.0	Broadly Acceptable	A vessel anchors on an area of exposed /partially buried cable or partially completed structure. This results in damage to the cable and/or anchor.	2	2	3	3	2	2.5	Broadly Acceptable	No further mitigation required.	

Hazard	Hazard title	Receptor	Phase	Industry	Possible causes	Most likely	Realistic most likely consequences							Worst case	Realistic worst case consequences							Risk	Additional
Snagging	Presence of cables and other subsea infrastructure may present an anchor snagging risk for commercial vessels and commercial fishing vessels.	All vessels including commercial fishing vessels (not engaged in fishing).	O	Cable burial assessment, compliance with international and Flag State regulations, promulgation of information (charting).	Presence of installed cables could pose a risk to vessels anchoring. This could be associated with human error, navigational equipment error or adverse weather.	A vessel anchors on an area of buried / protected cable but no interaction occurs.	4	1	1	1	1	1.0	Broadly Acceptable	A vessel anchors on an area of exposed or partially buried cable or subsea structure resulting in damage to the cable and/or anchor.	3	2	3	3	2	2.5	Broadly Acceptable	Monitoring and maintenance of cable burial.	Although not identified as a shipping and navigation impact it was noted by marine aggregate dredger representatives during the Hazard Workshop that potential for gear interaction with export cables should be mitigated against.

Appendix C Helicopter Search and Rescue Operations

C.1 Introduction

C.1.1.1 This appendix of the NRA has been adapted from work undertaken by Aviation Safety Consulting (ASC) Limited. It is intended to explain the basic principles, capabilities and limitations of offshore helicopter SAR operations in the UK by assessing the effects of the design, location and layout of wind turbines on such operations.

C.2 Background

C.2.1 SAR assets

C.2.1.1 SAR operations in offshore wind farms that are any significant distance from the coast are likely to be conducted principally by helicopters, due to the relatively long distances and the longer response and transit times of surface vessels unless they happen to be on site. In the case of the Hornsea Three array area, the closest SAR helicopter base is Humberside Airport. This base is operated by Bristow Helicopters on behalf of the MCA using the Sikorsky S92A SAR helicopter. The capability of the Sikorsky S92A is used as the basis for the analysis in this appendix since it is considered to be the most likely machine to be used for SAR operations in the Hornsea Three array area at present.

C.2.1.2 A typical SAR helicopter crew consists of two pilots, a winchman and a winch operator. The winchman is usually a fully trained paramedic.

C.2.2 SAR helicopter equipment

C.2.2.1 The Sikorsky S92A is fitted with highly specialised equipment for the SAR role. This includes:

- A 4-axis flight control system with autopilot which allows the aircraft to fly pre-programmed search patterns and descend to the hover for a recovery;
- A weather Radar system which can also be used to search for vessels and other contacts;
- A combined Forward Looking Infra-Red (FLIR) and Thermal Imaging (TI) sensor;
- A Chelton radio homer incorporating six independent receivers which allows the asset to home onto beacons transmitting on emergency frequencies as well as vessels transmitting on marine Digital Selective Calling (DSC) frequencies or any manually selected frequency;
- A dual rescue hoist;
- Ultra High Frequency (UHF), VHF Amplitude Modulation (AM), VHF Frequency Modulation (FM) and High Frequency (HF) radios and a satellite telephone;
- A lightweight stretcher; and
- Medical facilities including oxygen, Entonox and a defibrillator.

C.2.3 Capabilities and limitations

C.2.3.1 The Sikorsky S92A typically flies at a cruise speed of 145 kn and has an effective radius of action of approximately 200 nm, with sufficient fuel for 30 minutes on station at the limit of this range. This can be extended if refuelling facilities are available en route (for example, at a suitable offshore platform). The helicopter is equipped to fly in both Visual Meteorological Conditions (VMC) and Instrument Meteorological Conditions (IMC), by day and night. It has a clearance to fly in icing conditions up to 10,000 ft pressure altitude, but cannot fly in freezing rain or drizzle, which occur very rarely in the UK.

C.2.3.2 UK SAR helicopter crews are typically at 15 minutes notice to launch during the day and 45 minutes at night. The centre of the Hornsea Three array area is approximately 120 nm to the east of Humberside Airport. Therefore, at 145 kn, and assuming that the Humberside SAR asset has not been tasked elsewhere, the expected time on scene is 65 minutes during the day and 95 minutes at night.

C.2.3.3 The sensors and equipment of the Sikorsky S92A are tailored to the SAR role; the key limitations of these are as follows:

- Weather Radar:
  - 120° forward sweep sector;
  - Maximum range of 300 miles (mi.) (at altitude); and
  - Minimum blind range of 150 yards (yds) (240 yds in normal operation).
- Hoist cables – 290 ft long;
- Instrument Landing System (ILS): when conducting an instrument approach to an airfield in poor weather, the lowest permitted approach to a suitable runway before transferring to a visual approach is 200 ft;
- MCA guidance and Bristow's internal procedures do not allow a SAR helicopter to enter a lane between turbines that is less than 500 m wide (measured between blade tips that are transverse to the turbine lanes, unless the blades can be rotated away from the lane to increase the spacing to 500 m or more) in IMC or at night (MCA, 2016).

C.2.3.4 The MOD has recently committed to procure nine P8-A Poseidon Maritime Patrol Aircraft which will be introduced in 2019 and 2020 (MOD, 2016). One of the roles of the aircraft will be SAR. It will have the advantages of a suite of highly sophisticated sensors, a high search speed (approximately 440 kn), a long endurance and highly trained crews. The aircraft will be based at RAF Lossiemouth, approximately 300 nm from the Hornsea Three array area, about a 40 minute transit time from take-off.

C.3 Search and rescue operations

C.3.1 Search phase

Overview

C.3.1.1 The initial tasking for a SAR operation will be based upon the information available at the time of the dispatch. Typically this includes the nature of the emergency, details of the casualty(ies) (which may be vessels, aircraft or personnel), the source and time of the first alert. Location information may be limited, and may potentially consist of an area containing all possible survivor locations. The accuracy of the datum will vary: an initial detection by a Cospas-Sarsat satellite of an Emergency Position Indicating Radio Beacon (EPIRB) or PLB will give an accuracy within 5 nm, a second pass (usually within one hour) will reduce this to approximately 1 nm, and if the emergency locator transmitter (ELT) is GPS-enabled the position may be accurate to within 30 m, thus rendering any search unnecessary (assuming that the PLB is co-located with the casualty(ies)). However in many cases the exact location of the casualty will not be available and a search will therefore be required before assistance can be rendered. A search will therefore always be based upon a datum point, which is defined in the International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual(IMO, 2016) as a point, such as a reported or estimated position, at the centre of the area where it is estimated that the search object is most likely to be located.

C.3.1.2 The principal types of search, which may be used singly or in any combination, are as follows:

- Visual (by the naked eye during the day and using night vision goggles (NVG) at night);
- Radar;
- Electro-optical (FLIR and TI); and
- Radio.

C.3.1.3 The type of search pattern, altitude flown and track spacing used will depend on a number of factors which all affect the POD. These include:

- Type of search type;
- Size, colour and lighting of target (including Radar cross section);
- Meteorological conditions including cloud base and visibility;
- Time of day;
- Sea conditions (wind, swell and waves); and
- Sensitivity of equipment (Radar/FLIR/TI).

Search altitudes

C.3.1.4 Search altitude is a key consideration in search planning. A higher altitude provides a greater distance to the horizon, but a correspondingly reduced POD for a small object. For example, an altitude of 500 ft (152 m) corresponds to a horizon range of approximately 26 nm (48 km) whereas an altitude of 1,000 ft (305 m) corresponds to a horizon range of approximately 37 nm (69 km).

C.3.1.5 The altitude at which a SAR helicopter will conduct a Radar, visual and/or electro-optical search will depend upon a variety of factors, including:

- Number, size, colour and lights (if any) of a target;
- Time of day;
- Radar cross-section of any target(s);
- Sea state;
- Visibility;
- Cloud base; and
- Radar/radio horizon.

SAR crews will have access to tables providing guidance on optimum search altitudes and track spacing.

Table C.1 provides example sweep widths for a visual search for a variety of targets at multiple altitudes, assuming a visibility of 10 mi with no correction factor applied (IMO, 2016). It is noted that the data in

C.3.1.6 Table C.1 was developed before the advent of electro-optical search aids such as TI and FLIR.

Table C.1: Sweep widths for various targets and altitudes in 10 nm visibility.

Target	Sweep width (nm)		
	500 ft altitude	1,000 ft altitude	2,000 ft altitude
Person In water	0.1 [a]	0.1	0.0
4-person life raft	2.2	2.3	2.3
8-person life raft	2.8	2.9	3.0
15-person life raft	3.3	3.5	3.6
6 m power boat	4.3	4.4	4.5
15 m sailing boat	9.5	9.5	9.6
27 to 46 m vessel	12.2	12.2	12.2
>91 m vessel	14.3	14.3	14.3

a For search altitudes of 500 ft, the sweep width values for a person in the water may be multiplied by four if it is known that the person is wearing a personal flotation device.

Sweep width

C.3.1.7 The sweep width (which determines the track spacing for a search) will depend upon the sensor(s), the target and the environmental conditions outlined in section C.4, as well as the following factors:.

- Elevation of the sun or moon;
- Wind strength (which is allied to sea state);
- Field of view (FOV) of electro-optical equipment; and
- Radar “blind” ranges

C.3.1.8 Figure C.1 presents a probability distribution graph for the POD against the sweep width. It is worth noting that the area of 100% POD is very small, and that it is also possible to detect a target beyond the sweep width.

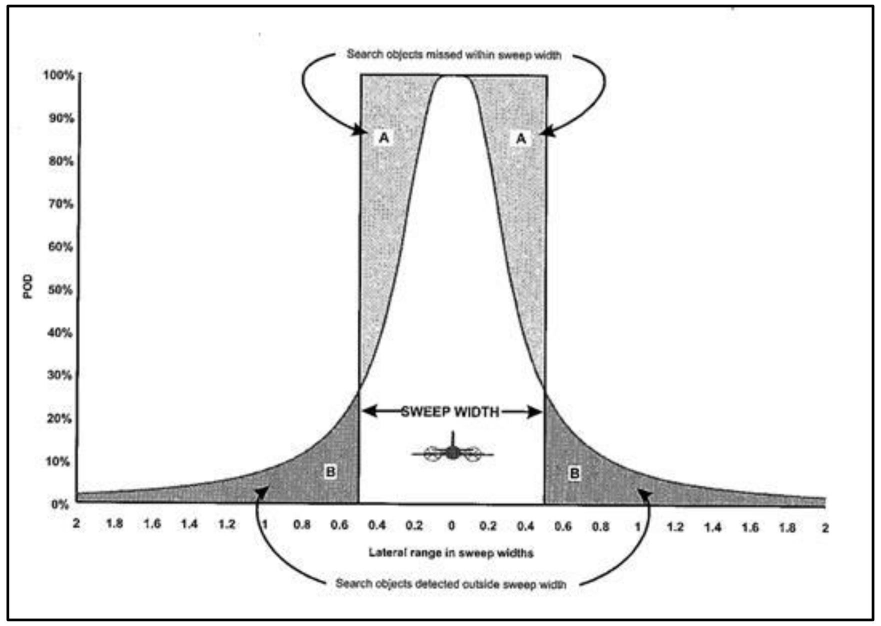

Figure C.1: Probability distribution for POD against sweep width.

Detection and identification

C.3.1.9 Sensors typically detect targets long before they are positively identified, either as a casualty or one that can be discounted. Positive identification is almost always achieved visually when the SAR helicopter has arrived on scene.

C.3.1.10 There are three key weather factors which will affect the POD during a search:

- Cloud base;
- Visibility; and
- Wind / Sea state.

C.3.2 Navigation, detection and identification within a wind farm

C.3.2.1 The SAR helicopter will be equipped with a Flight Management System (FMS) which contains a comprehensive database of obstruction information, though this is not used as the primary source of navigation information. If accurate positions of the wind turbines are provided to the compiler of the database as required by Annex 5 of MGN 543 (MCA, 2016), the crew will be able to navigate between the turbines by entering the appropriate waypoints and using the autopilot system to reduce the pilot workload. Individual turbines will be visually identifiable by markings on the base of the tower and the nacelle as outlined in MGN 543.

C.3.3 Recovery of a casualty within a wind farm

C.3.3.1 Once a target has been positively identified and the situation assessed by the crew, they will develop a strategy to recover any casualties. If the casualty is in the water, winching should be reasonably straightforward, using a “double lift” technique, where the winchman is lowered into the water to put the casualty into a strop and both are then lifted into the helicopter. If the casualty is on a vessel, the vessel will be directed to steer a suitable course if this is practicable within the wind farm; otherwise it may be necessary to exit the wind farm to conduct the transfer. The winchman will be lowered onto the vessel and perform a double lift, with a stretcher being used if necessary. The winchman has communication to the pilots via radio throughout, and the helicopter crew can also communicate with the vessel on marine VHF.

C.3.3.2 The presence of a turbine may constrain the choice of suitable courses for a vessel, but with minimum 1,000 m spacing between the turbines, this should not be a significant problem.

C.3.3.3 If the casualty is inside the turbine itself, it may be necessary to winch from the nacelle as described in MGN 543 (MCA, 2016). In this case, all turbines should be feathered (resulting in a very slow or no rotation) prior to helicopter entry into the field. This will minimise the turbulence downwind of a turbine.

C.3.3.4 A casualty close to the base of the turbine may be more difficult to extract, as the length of the winch wire may be insufficient. In such cases the casualty may need to be moved away from the turbine or a “high line transfer” technique employed.

C.4 Helicopter emergencies

C.4.1.1 As in any aviation activity, there is a small risk of equipment failure during SAR helicopter operations. In most cases, technical malfunctions will not affect the safety of the helicopter, though it may be necessary to abort the mission and return to base. In more serious cases, the crew may opt to land at the nearest suitable site, which may be an offshore platform or the nearest point of land. To achieve either of these outcomes, the helicopter will usually be able to climb safely out of a wind farm and transit to its destination at a safe altitude, although the captain may opt to exit the wind farm at low level prior to climbing.

C.4.1.2 In the event of an engine failure in transit at low speed or in the hover, the helicopter will need to accelerate to a safe speed to deal with the problem (as helicopters require less power to maintain height at 60-70 kn than at low or high airspeeds). An engine failure will also limit the helicopter’s rate of climb; thus, it may be preferable for a SAR helicopter experiencing an engine failure within a wind farm to exit while remaining at low level before climbing and returning to land. This is the rationale for the helicopter “refuge areas” mentioned in MGN 543 (MCA, 2016).

C.4.1.3 It is noted that a SAR helicopter’s ability to navigate safely within a wind farm may also be degraded by a GPS or Radar failure.

C.4.2 Probability of an engine failure

C.4.2.1 The Sikorsky S92A helicopter and its engines (General Electric CT-7) have been certified to civil standards by the European Aviation Safety Agency (EASA). While there are no quantifiable reliability requirements for certification, the EASA issued a Certification Memorandum in November 2016 which requires the Type Certificate holders of a rotorcraft (in this case, The Sikorsky Aircraft Corporation) and engine (General Electric) to perform a risk assessment by:

- Assessing the rates of engine In Flight Shut Down (IFSD) or power loss for the in-service fleet(s);
- Evaluating the potential consequences of the engine IFSD and power losses; and
- Proposing rate limits above which a potential unsafe condition may exist.

C.4.2.2 The rate limits over which a potentially unsafe condition may exist are known as “watch rates”: focussed attention is typically applied when they are reached or exceeded. “Global rates” (the actual rate of IFSD and power loss across the whole fleet, or sub-fleets if appropriate) are set at one event in 100,000 flying hours.

C.4.2.3 It is reasonable to assume, therefore, that in the absence of an Airworthiness Directive, which would be EASA’s response to watch rates above those being set, the anticipated rate of engine power loss or IFSD should be no more than one in 100,000 flying hours. The probability of this occurring while a helicopter is conducting a SAR operation within a wind farm is therefore extremely remote.

C.5 Weather in the vicinity of the Hornsea Three array area

C.5.1.1 The nearest comprehensive weather data available to the Met Office is that from Platform 62145 located approximately 40 mi. southeast of the centre of the Hornsea Three array area. On behalf of the applicant, ASC Ltd. commissioned an analysis of key weather data parameters available between 2010 and 2016.

C.5.1.2 For the purposes of this analysis, the highest value for the maximum blade tip height of a turbine in the Hornsea Three array area of 325 m has been assumed. A SAR helicopter could safely perform a visual, radio, Radar and electro-optical search whilst maintaining a safe distance above the turbines if the cloud base were at 460 m or above, though it might be necessary to descend below this height if the target and track spacing were small. Table C.2 shows that throughout the data period, the average percentage of time (measured hourly) with cloud detected below 460 m (for any level of visibility) is 28.1%. The total percentage of time that the visibility is below 2,000 m is 1.3%.

Table C.2: Percentage of time where cloud detected above and below 460 m against visibility.

Visibility (m)	Time with cloud detected below 460 m (%)	Time with cloud detected above 470 m (%)	Total time (%)
< 40	0.0	0.0	0.0
50–190	0.2	0.0	0.2
200–490	0.4	0.0	0.4
500–990	0.3	0.0	0.3
1,000–1,990	0.4	0.1	0.4
2,000–3,990	1.2	0.6	1.7
4,000–9,990	8.7	12.8	21.6
10,000–19,990	12.2	40.5	52.7
20,000–49,990	4.4	15.3	19.7
≥ 50,000	0.4	2.5	2.9
Total	**28.1**	**71.9**	**100.0**

Table C.3: Percentage cloud height versus visibility.

Visibility (m)	Time with cloud detected at specified height range (%)										
	< 40	50–90	100–190	200–290	300–590	600–990	1,000–1,490	1,500–1,990	2,000–2,490	≥ 2,500	Total
< 40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50–190	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
200–490	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
500–990	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
1,000–1,990	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
2,000–3,990	0.2	0.5	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.4	1.7
4,000–9,990	0.3	1.1	1.9	1.9	3.5	1.9	1.6	1.0	0.7	7.6	21.6
10,000–19,990	0.2	0.4	1.1	2.0	8.6	9.4	5.2	3.3	2.1	20.4	52.7
20,000–49,990	0.1	0.0	0.2	0.5	3.6	4.7	2.2	0.9	0.5	7.0	19.7
≥ 50,000	0.0	0.0	0.0	0.0	0.3	0.7	0.5	0.2	0.1	1.2	2.9
Total	**1.5**	**2.5**	**3.5**	**4.5**	**16.1**	**16.7**	**9.6**	**5.4**	**3.5**	**36.7**	**100**

C.5.1.3 Table C.3 gives further detail on cloud heights. Table C.3 shows that throughout the data period, the frequency of cloud detected below 200 m height is 7.5%. Cloud above this height would not restrict a SAR helicopter undertaking a visual/electro-optical search at 500 ft (152 m).

C.5.1.4 The other key parameters which will affect a search are wind and sea state. These are usually closely related, unless the wind speed is in the process of increasing or decreasing rapidly. Table C.5 gives a breakdown of the annual percentages of wind speed against wave height. Table C.5 shows that throughout the data period, the percentage of time that the wind speed is over 21 kn (Beaufort number 5) is 14.3% and the percentage of time that the wave height exceeds 2.5 m (moderate sea state) is 8.4%.

Table C.4: Percentage breakdown of wind speed against wave height.

Wave Height (m)	Time with cloud detected at specified wind speed range (%)													
	0	1–3	4–6	7–10	11–16	17–21	22–27	28–33	34–40	41–47	48–55	56–63	≥ 64	Total
0.1 – 0.5	0.1	1.9	3.6	4.1	3.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3
0.6 – 1.0	0.2	2.3	5.9	9.2	10.6	2.9	0.3	0.0	0.0	0.0	0.0	0.0	0.0	31.4
1.1 - 1.5	0.0	0.8	2.6	5.0	9.4	4.9	1.3	0.0	0.0	0.0	0.0	0.0	0.0	24.1
1.6 – 2.0	0.0	0.1	0.5	1.6	4.8	4.8	2.7	0.2	0.0	0.0	0.0	0.0	0.0	14.8
2.1 – 2.5	0.0	0.0	0.1	0.4	1.6	2.4	2.9	0.6	0.0	0.0	0.0	0.0	0.0	8.0
2.6 – 3.0	0.0	0.0	0.0	0.1	0.5	0.9	1.6	1.1	0.1	0.0	0.0	0.0	0.0	4.3
3.1 – 4.0	0.0	0.0	0.0	0.0	0.2	0.3	1.0	1.3	0.4	0.0	0.0	0.0	0.0	3.3
4.1 – 5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.7
5.1 – 6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
Total	**0.3**	**5.1**	**12.7**	**20.5**	**30.4**	**16.7**	**9.9**	**3.5**	**0.8**	**0.1**	**0.0**	**0.0**	**0.0**	**100.0**

C.6 Historical search and rescue incidents in the vicinity of the Hornsea Three array area

C.6.1 Location of searches

C.6.1.1 MOD statistics published on the Government website (MOD, 2017) which contains detailed data for SAR operations around the UK between 2011 and 2015 has been analysed and is presented in Figure C.10.

C.6.1.2 Over the five year period, a total of nine SAR operations were recorded within the Hornsea Three array area shipping and navigation study area. However, only one of these SAR operations was recorded within the Hornsea Three array area. All of the incidents recorded within the Hornsea Three array area shipping and navigation study area were medrescues conducted in the daytime and none involved a search.

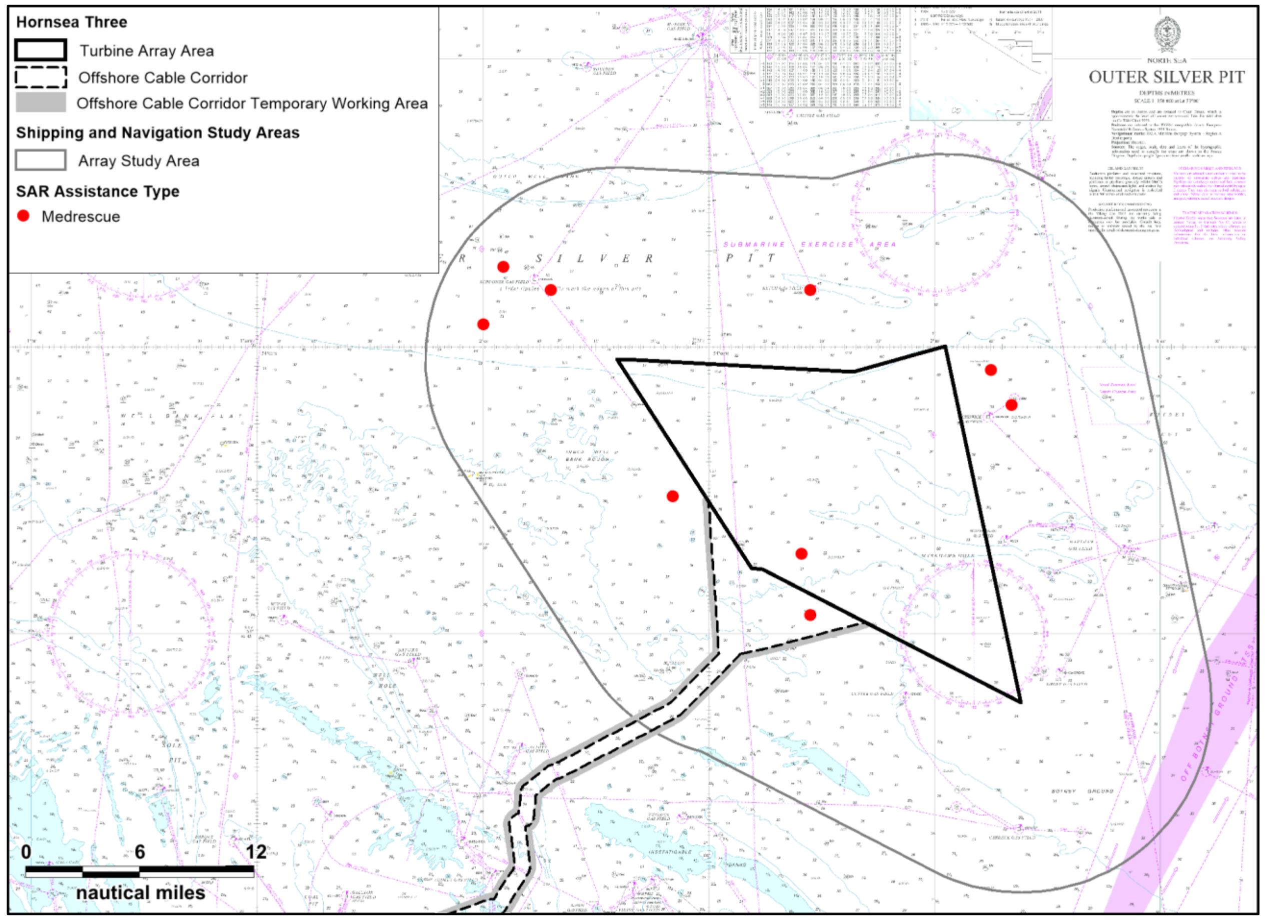

Figure C.2: Historic SAR incidents within the Hornsea Three array area shipping and navigation study area colour-coded by assistance type.

C.6.1.3 Table C.5 contains details of each of the incidents recorded within the Hornsea Three array area shipping and navigation study area.

Table C.5: SAR operations within the Hornsea Three array area shipping and navigation study area.

Incident date	Departure time	Unit name	Assistance type	Persons moved	Unit type	Latitude (WGS 84)	Longitude (WGS 84)
12 June 2012	10:50	RAF Wattisham	Medrescue	1	Sea King	53° 46' 00'' N	002° 29' 00'' E
15 July 2012	11:21	RAF Leconfield	Medrescue	1	Sea King	54° 03' 00'' N	002° 29' 00'' E
13 March 2013	09:14	RAF Wattisham	Medrescue	1	Sea King	53° 52' 12'' N	002° 16' 48'' E
8 July 2013	11:58	RAF Wattisham	Medrescue	1	Sea King	54° 01' 12'' N	002° 00' 00'' E
16 August 2013	13:41	RAF Wattisham	Medrescue	1	Sea King	53° 49' 12'' N	002° 28' 12'' E
26 September 2013	05:40	RAF Leconfield	Medrescue	1	Sea King	54° 03' 00'' N	002° 06' 00'' E
8 November 2013	14:20	RAF Leconfield	Medrescue	1	Sea King	53° 57' 00'' N	002° 46' 48'' E
24 May 2014	13:35	RAF Leconfield	Medrescue	2	Sea King	53° 58' 48'' N	002° 45' 00'' E
20 November 2014	15:44	H RAF Leconfield	Medrescue	1	Sea King	54° 04' 12'' N	002° 01' 48'' E

C.6.2 Frequency of searches

C.6.2.1 The MOD statistics for SAR operations around the UK between 2011 and 2015 include close to 9,000 SAR incidents (excluding units operating in Cyprus and the Falkland Islands). Of these incidents, 1,659 (18.5%) involved a search. However, historically a higher proportion of incidents over land or in coastal areas involve a search than those offshore. Therefore those incidents recorded at a location greater than 10 nm offshore were isolated; a total of 724 incidents such incidents were recorded, of which 46 (6.4%) required a search.

Appendix D Marine Guidance Note 543 Checklist

D.1 Marine Guidance Note 543 compliance checklist

Issue	Compliant (Yes/No)	Reference notes/remarks
Annex 1: Considerations on Site Position, Structures and Safety Zones		
1. Site and Installation Co-ordinates. Developers are responsible for ensuring that formally agreed co-ordinates and subsequent variations of site perimeters and individual OREI structures are made available, on request, to interested parties at relevant project stages, including application for consent, development, array variation, operation and decommissioning. This should be supplied as authoritative GIS data, preferably in Environmental Systems Research Institute (ESRI) format. Metadata should facilitate the identification of the data creator, its date and purpose, and the geodetic datum used. For mariners' use, appropriate data should also be provided with latitude and longitude co-ordinates in WGS84 (ETRS89) datum.		
2. Traffic Survey. Includes the following:		
All vessel types	✓	**Section 15: Marine Traffic Surveys** All vessel types are considered, with section 15.2.3 providing specific breakdowns by vessel type for the Hornsea Three array area marine traffic survey and section 15.4.3 providing specific breakdowns by vessel type for the Hornsea Three offshore HVAC booster station search area marine traffic survey. **Section 17: Future Case Marine Traffic** The predicted growth in future shipping densities is provided by vessel type. **Section 18: Collision and Allision Risk** Modelling and Assessment. **Appendix A: Consequences Assessment** Modelling considers collision and allision risk by vessel type including both commercial and non-commercial vessels.
At least 28 days duration, within either 12 or 24 months prior to submission of the Environmental Statement	✓	**Section 7: Marine Traffic Survey Methodology** For the Hornsea Three array area, 40 days of AIS, visual and Radar data (26 days in June and July 2016 and 14 days in November and December 2016) was recorded. The same period of data was collected for the Hornsea Three offshore cable corridor (AIS only). For the Hornsea Three offshore HVAC booster station search area, 28 days of AIS, visual and Radar data (14 days in September 2016 and 14 days in November and December 2016) was recorded.
Multiple data sources	✓	**Section 7: Marine Traffic Survey Methodology** **Section 15: Marine Traffic Surveys** The marine traffic surveys include AIS, visual and Radar data.
Seasonal variations	✓	**Section 7: Marine Traffic Survey Methodology** **Section 15: Marine Traffic Surveys** Marine traffic surveys were carried out in summer and winter periods to take account of seasonal variations in traffic patterns. **Section 18: Collision and Allision Risk Modelling and Assessment** Anatec's ShipRoutes database (which is used as modelling input) is compiled using marine traffic survey data which takes account of seasonal variations in traffic patterns.
MCA consultation	✓	**Section 4: Consultation** The MCA have been consulted as part of the NRA process. **Section 14: Overview of Key Consultation** Volume 4, annex 1.1: Hornsea Project One and Hornsea Project Two Consultation of Relevance to Hornsea Three includes issues raised by the MCA relevant to shipping and navigation during consultation for Hornsea Project One and Hornsea Project Two which is applicable to Hornsea Three. Table 14.2 includes issues raised by the MCA relevant to shipping and navigation during consultation for Hornsea Three. **Section 20: Hazard Workshop Overview** As shown in Table 20.1, the MCA attended the Hazard Workshop.
General Lighthouse Authority (TH) consultation	✓	**Section 4: Consultation** TH has been consulted as part of the NRA process. **Section 14: Overview of Key Consultation** Volume 4, annex 1.1: Hornsea Project One and Hornsea Project Two Consultation of Relevance to Hornsea Three includes issues raised by TH relevant to shipping and navigation during consultation for Hornsea Project One and Hornsea Project which is applicable to Hornsea Three. Table 14.2 includes issues raised by TH relevant to shipping and navigation during consultation for Hornsea Three.
CoS consultation	✓	**Section 4: Consultation** The CoS has been consulted as part of the NRA process. **Section 14: Overview of Key Consultation** Volume 4, annex 1.1: Hornsea Project One and Hornsea Project Two Consultation of Relevance to Hornsea Three includes issues raised by the CoS relevant to shipping and navigation during consultation for Hornsea Project One and Hornsea Project Two which is applicable to Hornsea Three. Table 14.2 includes issues raised by the CoS relevant to shipping and navigation during consultation for Hornsea Three. **Section 20: Hazard Workshop Overview** As shown in Table 20.1, the CoS attended the Hazard Workshop.

Issue	Compliant (Yes/No)	Reference notes/remarks
Recreational and fishing vessel organisations consultations	✓	**Section 4: Consultation** The RYA and CA have been consulted as part of the NRA process. **Section 14: Overview of Key Consultation** Volume 4, annex 1.1: Hornsea Project One and Hornsea Project Two Consultation of Relevance to Hornsea Three includes issues raised by the RYA and CA relevant to shipping and navigation during consultation for Hornsea Project One and Hornsea Project Two which is applicable to Hornsea Three. Table 14.2 includes issues raised by the RYA and CA relevant to shipping and navigation during consultation for Hornsea Three. **Section 20: Hazard Workshop Overview** As shown in Table 20.1, the CA attended the Hazard Workshop.
Port and navigation authorities consultation, as appropriate	✓	**Section 20: Hazard Workshop Overview** As shown in Table 20.1, the Lowestoft Port Authority, Peel Ports Great Yarmouth and Rotterdam Harbour Master were invited to the Hazard Workshop.
Assessment of the cumulative and individual effects of (as appropriate):		
i. Proposed OREI site relative to areas used by any type of marine craft.	✓	**Section 15: Marine Traffic Surveys** Summarises the results of the marine traffic surveys, including commercial and non-commercial traffic. **Section 18: Collision and Allision Risk Modelling and Assessment** Section 18.2.2 and section 18.5.2 consider the effects on vessel routeing of the Hornsea Three array area and offshore HVAC booster station(s) respectively. Section 18.3.2 considers the cumulative effect on vessel routeing of the Hornsea Three array area.
ii. Numbers, types and sizes of vessels presently using such areas.	✓	**Section 15: Marine Traffic Surveys** Summarises the results of the marine traffic surveys, including specific breakdowns by vessel numbers, types and sizes, for the Hornsea Three array area (section 15.2), offshore cable corridor (section 15.3) and offshore HVAC booster station search area (section 15.4). Section 15.3.3 provides an overview of recreational vessel activity in the southern North Sea based on the RYA recreational density grid in addition to marine traffic survey data. Section 15.2.10 provides an overview of fishing vessel activity based on MMO sightings and satellite data in addition to marine traffic survey data for the Hornsea Three array area.

Issue	Compliant (Yes/No)	Reference notes/remarks
iii. Non-transit uses of the areas, e.g. fishing, day cruising of leisure craft, racing, aggregate dredging, etc.	✓	**Section 10: Existing Environment** Section 10.6 provides an overview of aggregate dredging activity in the southern North Sea based on BMAPA transit routes. **Section 15: Marine Traffic Surveys** Section 15.3.3 provides an overview of recreational vessel activity in the southern North Sea based on the RYA recreational density grid in addition to marine traffic survey data. Section 15.2.10 provides an overview of fishing vessel activity based on MMO sightings and satellite data in addition to marine traffic survey data for the Hornsea Three array area.
iv. Whether these areas contain transit routes used by coastal or deep draught vessels on passage.	✓	**Section 10: Existing Environment** Section 10.4 provides an overview of IMO routeing measures used by deep draught vessels located within the vicinity of Hornsea Three. **Section 15: Marine Traffic Surveys** Summarises the results of the marine traffic surveys, including specific breakdowns by vessel numbers, types and sizes, for the Hornsea Three array area (section 15.2) and offshore HVAC booster station search area (section 15.4) which includes transit routes used by deep draught vessels on passage. Specific breakdowns by draught are also included within this section for both areas. **Section 18: Collision and Allision Risk Modelling and Assessment** Section 18.2.2 and section 18.5.2 consider the effects on vessel routeing of the Hornsea Three array area and offshore HVAC booster station(s) respectively, including transit routes used by deep draught vessels on passage. Section 18.3.2 considers the cumulative effect on vessel routeing of the Hornsea Three array area, including transit routes used by deep draught vessels on passage.
v. Alignment and proximity of the site relative to adjacent shipping lanes.	✓	**Section 15: Marine Traffic Surveys** Summarises the results of the marine traffic surveys, including current vessel routeing for the Hornsea Three array area (section 15.2.7) and offshore HVAC booster station search area (section 15.4.5). **Section 16: Adverse Weather Impacts on Routeing** Summarises alternative routeing used by Regular Operators during periods of adverse weather. **Section 18: Collision and Allision Risk Modelling and Assessment** Section 18.2.2 and section 18.5.2 consider the effects on vessel routeing of the Hornsea Three array area and offshore HVAC booster station(s) respectively. Section 18.3.2 considers the cumulative effect on vessel routeing of the Hornsea Three array area.

Issue	Compliant (Yes/No)	Reference notes/remarks
vi. Whether the nearby area contains prescribed routeing schemes or precautionary areas.	✓	**Section 10: Existing Environment** Section 10.4 provides an overview of IMO routeing measures and existing Aids to Navigation within the vicinity of Hornsea Three.
vii. Whether the site lies on or near a prescribed or conventionally accepted separation zone between two opposing routes	✓	**Section 10: Existing Environment** Section 10.4 provides an overview of IMO routeing measures within the vicinity of Hornsea Three.
viii. Proximity of the site to areas used for anchorage, safe haven, port approaches and pilot boarding or landing areas.	✓	**Section 10: Existing Environment** Section 10.2 provides an overview of ports within the vicinity of Hornsea Three. Section10.3 provides an overview of anchorage areas within the vicinity of Hornsea Three. The Hornsea Three array area is not located in proximity to any safe havens, port approaches or pilot boarding/landing areas.
ix. Whether the site lies within the jurisdiction of a port and/or navigation authority.	✓	**Section 10: Existing Environment** Section 10.2 provides an overview of ports within the vicinity of Hornsea Three. The Hornsea Three array area does not lie within the jurisdiction of a port and/or navigation authority.
x. Proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds.	✓	**Section 15: Marine Traffic Surveys** Section 15.2.10 and section 15.4.6 provide an overview of fishing vessel activity based on MMO sightings and satellite data in addition to marine traffic survey data for the Hornsea Three array area and offshore HVAC booster station search area respectively.
xi. Proximity of the site to offshore firing/bombing ranges and areas used for any marine military purposes.	✓	**Section 10: Existing Environment** Section 10.8 provides an overview of military exercise areas within the vicinity of Hornsea Three.
xii. Proximity of the site to existing or proposed offshore oil / gas platform, marine aggregate dredging, marine archaeological sites or wrecks, Marine Protected Area or other exploration/exploitation sites.	✓	**Section 10: Existing Environment** Section 10.5provides an overview of oil and gas infrastructure within the vicinity of Hornsea Three. Section 10.6 provides an overview of aggregate dredging areas within the vicinity of Hornsea Three. Section 10.9 provides an overview of MEHRAs within the vicinity of Hornsea Three. Section 10.10 provides an overview of charted wrecks within the vicinity of Hornsea Three.

Issue	Compliant (Yes/No)	Reference notes/remarks
xiii. Proximity of the site to existing or proposed OREI developments, in co-operation with other relevant developers, within each round of lease awards.	✓	**Section 21: Cumulative Overview** Section 21.3.1 provides an overview of offshore wind farm developments within the North Sea, with Table 21.1 summarising developments screened into the cumulative assessment. Section 21.3.2 provides details of the SNSOWF involving representatives from the UK Round Three wind farm zones located within the southern North Sea.
xiv. Proximity of the site relative to any designated areas for the disposal of dredging spoil or other dumping ground.	✓	N/A
xv. Proximity of the site to Aids to Navigation and/or VTS in or adjacent to the area and any impact thereon.	✓	**Section 10: Existing Environment** Section 10.4 provides an overview of existing Aids to Navigation within the vicinity of Hornsea Three.
xvi. Researched opinion using computer simulation techniques with respect to the displacement of traffic and, in particular, the creation of "choke points" in areas of high traffic density and nearby or consented OREI sites not yet constructed.	✓	**Section 18: Collision and Allision Risk Modelling and Assessment** Section 18.2.2 and section 18.5.2 consider the effects on vessel routeing of the Hornsea Three array area and offshore HVAC booster station(s) respectively. Section 18.3.2 considers the cumulative effect on vessel routeing of the Hornsea Three array area.
xvii. With reference to xvi. above, the number and type of incidents to vessels which have taken place in or near to the proposed site of the OREI to assess the likelihood of such events in the future and the potential impact of such a situation.	✓	**Section 13: Maritime Incidents** MAIB (section 13.2) and RNLI incidents (section 13.3) in the vicinity of the Hornsea Three array area and offshore HVAC booster station search area are analysed by incident type and vessel type. Table 13.1 summaries historical collision and allision incidents involving wind farm sites.
3. OREI Structures. The following should be determined:		
a. Whether any feature of the OREI, including auxiliary platforms outside the main generator site, mooring and anchoring systems, inter-device and export cabling could pose any type of difficulty or danger to vessels underway, performing normal operations, including fishing, anchoring and emergency response.	✓	**Section 9: Design Envelope** Summarises the Design Envelope including the number of structures. **Section 17: Future Case Marine Traffic** The predicted growth in future shipping densities is provided. **Section 18: Collision and Allision Risk Modelling and Assessment** Assesses the impact of the Hornsea Three array area on vessel to vessel collisions, vessel to structure allision (powered and NUC vessels), fishing vessel to structure allision and recreational vessel to structure allision. Assesses the impact of the Hornsea Three offshore HVAC booster stations on vessel to structure allision (powered and NUC vessels). **Appendix A: Consequences Assessment** Provides an assessment of the consequences of collision and allision incidents, in terms of people and the environment, due to the impact of the structures.

Issue	Compliant (Yes/No)	Reference notes/remarks
b. Clearances of wind turbine blades above the sea surface are not less than 22 m above Mean High Water Springs (MHWS).	✓	**Section 9: Design Envelope** Table 10.2 includes minimum blade tip height of 34.97 m above LAT.
c. Underwater devices: Changes to charted depth; Maximum height above seabed; and under keel clearance.	✓	**Section 18: Collision and Allision Risk Modelling and Assessment** **Section 22: Formal Safety Assessment** Assessment of impacts relevant to under keel clearance are in section 22.10.2. and section 18.4 which outlines an initial assessment into under keel clearance.
d. The burial depth of cabling and changes to charted depths associated with any protection measures.	✓	**Section 9: Design Envelope** A cable burial assessment will be carried out with the extent of cable burial dependent on the results (see section 9.7.5).
4. Assessment of Access to and Navigation Within, or Close to, an OREI. To determine the extent to which navigation would be feasible within the OREI site itself by assessing whether:		
a. Navigation within or close to the site would be safe: by all vessels, or by specified vessel types, operations and/or sizes; in specified directions or areas; and in specified tidal, weather or other conditions.	✓	**Section 14: Overview of Key Consultation** Table 14.1 summarises responses from Regular Operators identified during the marine traffic surveys. Volume 4, annex 1.1: Hornsea Project One and Hornsea Project Two Consultation of Relevance to Hornsea Three includes issues raised by stakeholders regarding navigation during consultation for Hornsea Project One and Hornsea Project Two which is applicable to Hornsea Three. Table 14.2 includes issues raised by stakeholders regarding navigation during consultation for Hornsea Three. **Section 16: Adverse Weather Impacts on Routeing** Summarises alternative routeing used by Regular Operators during periods of adverse weather. **Section 18: Collision and Allision Risk Modelling and Assessment** Assesses the impact of the Hornsea Three array area on vessel movement using a number of collision and allision models which take into account tidal and weather conditions. Assesses the impact of the Hornsea Three offshore HVAC booster station(s) on movement using allision models which take into account tidal and weather conditions. **Section 1919: Communication and Position Fixing** Summarises the potential impacts on navigation of the different communications and position fixing devices used in and around offshore wind farms. **Section 22: Formal Safety Assessment** Assesses impacts relevant to navigation, including adverse weather (section 22.5).

Issue	Compliant (Yes/No)	Reference notes/remarks
b. Navigation in and/or near the site should be: Prohibited by specified vessel types, operations and/or sizes; Prohibited in respect of specific activities; Prohibited in all areas or directions, or Prohibited in specific areas or directions, or Prohibited specified tidal or weather conditions, or simply Recommended to be avoided.	✓	**Section 18: Collision and Allision Risk Modelling and Assessment** Assesses the impact of the Hornsea Three array area on vessel movement using a number of collision and allision models to determine the level of risk to vessels. Assesses the impact of the Hornsea Three offshore HVAC booster stations on movement using allision models to determine the level of risk to vessels. **Section 19: Communication and Position Fixing** Summarises the potential impacts on navigation of the different communications and position fixing devices used in and around offshore wind farms. **Section 22: Formal Safety Assessment** Assesses impacts relevant to navigation, including the proposed navigational corridor. **Section 23: Mitigation Measures Adopted as Part of Hornsea Three** Table 23.1 includes a summary of the application and use of safety zones during construction, operation and maintenance and decommissioning phases. **Section 24: Additional Mitigation Measures Required to Bring Risks to ALARP Parameters**
c. Exclusion from the site could cause navigational, safety or routeing problems for vessels operating in the area e.g. by preventing vessels from responding to calls for assistance from persons in distress	✓	**Section 18: Collision and Allision Risk Modelling and Assessment** Assesses the impact of the Hornsea Three array area on vessel movement using a number of collision and allision models to determine the level of risk for vessels. Assesses the impact of the Hornsea Three offshore HVAC booster stations on movement using allision models to determine the level of risk to vessels.
d. Relevant information concerning a decision to seek a safety zone for a particular site during any point in its construction, extension, operation or decommissioning should be specified in the Environmental Statement accompanying the development application.	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Table 23.1 includes a summary of the application and use of safety zones during construction, operation and maintenance and decommissioning phases.

Issue	Compliant (Yes/No)	Reference notes/remarks
Annex 2: Navigation, Collision Avoidance and Communications		
1. The Effect of Tides and Tidal Streams. It should be determined whether:		
a. Current maritime traffic flows and operations in the general area are affected by the depth of water in which the proposed installation is situated at various states of the tide, i.e. whether the installation could pose problems at high water which do not exist at low water conditions, and vice versa.	✓	**Section 9: Design Envelope** Section 9.2 provides the range of water depths within the Hornsea Three array area. **Section 11: Metocean Data** Presents meteorological and oceanographic statistics for the Hornsea Three array area. **Section 15: Marine Traffic Surveys** Summarises the results of the marine traffic surveys, which account for a range of tidal conditions. **Section 18: Collision and Allision Risk Modelling and Assessment** Collision and allision models take into account tidal conditions.
b. The set and rate of the tidal stream, at any state of the tide, has a significant effect on vessels in the area of the OREI site.	✓	**Section 11: Metocean Data** Table 11.1 provides details of the various states of the tide within the area. **Section 18: Collision and Allision Risk Modelling and Assessment** Collision and allision models take into account tidal conditions.
c. The maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect.	✓	**Section 11: Metocean Data** Table 11.1 provides details of the various states of the tide within the area.
d. The set is across the major axis of the layout at any time, and, if so, at what rate.	✓	**Section 11: Metocean Data** Table 11.1 provides details of the various states of the tide within the area.
e. In general, whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream.	✓	**Section 11: Metocean Data** Table 11.1 provides details of the various states of the tide within the area. **Section 18: Collision and Allision Risk Modelling and Assessment** NUC vessel to structure allision model takes into account tidal conditions within the area and assesses whether machinery failure could cause recreational vessels to be set into danger.
f. The structures themselves could cause changes in the set and rate of the tidal stream.	✓	No effect found.
g. The structures in the tidal stream could be such as to produce siltation, deposition of sediment or scouring, affecting navigable water depths in the wind farm area or adjacent to the area	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Table 23.1 summarises the need for a scour protection management and cable armouring plan along with a cable burial assessment in order to mitigate the risk of scouring.

Issue	Compliant (Yes/No)	Reference notes/remarks
2. Weather. It should be determined whether:		
a. The site, in normal, bad weather, or restricted visibility conditions, could present difficulties or dangers to craft, including sailing vessels, which might pass in close proximity to it.	✓	**Section 11: Metocean Data** Presents meteorological and oceanographic statistics for the Hornsea Three array area. **Section 15: Marine Traffic Surveys** Assesses vessel routeing in close proximity to Hornsea Three array area and offshore HVAC booster station search area. **Section 16: Adverse Weather Impacts on Routeing** Summarises alternative routeing used by Regular Operators during periods of adverse weather. **Section 22: Formal Safety Assessment** Assesses impacts relevant to navigation, including adverse weather (section 22.5).
b. The structures could create problems in the area for vessels under sail, such as wind masking, turbulence or sheer.	✓	**Section 22: Formal Safety Assessment** Wind masking, turbulence and sheer is discussed in section 22.13.3.
c. In general, taking into account the prevailing winds for the area, whether engine failure or other circumstances could cause vessels to drift into danger, particularly if in conjunction with a tidal set such as referred to above.	✓	**Section 18: Collision and Allision Risk Modelling and Assessment** NUC vessel to structure allision model assesses whether vessels could drift into danger.
3. Collision Avoidance and Visual Navigation. It should be determined whether:		
a. The layout design will allow safe transit through the OREI by SAR helicopters and vessels.	✓	**Appendix C: Helicopter Search and Rescue Operations in Offshore Wind Farms**
b. The MCA's Navigation Safety Branch and Maritime Operations branch will be consulted on the layout design and agreement will be sought.	✓	**Section 14: Overview of Key Consultation** As seen in Volume 4, annex 1.1: Hornsea Project One and Hornsea Project Two Consultation of Relevance to Hornsea Three and Table 14.2, consultation has already taken place with the MCA regarding the layout design and will continue.
c. The layout design has been or will be determined with due regard to safety of navigation and Search and Rescue.	✓	**Appendix C: Helicopter Search and Rescue Operations in Offshore Wind Farms** **Section 22: Formal Safety Assessment** Surface navigation is considered within section 22.13.
d.i. The structures could block or hinder the view of other vessels under way on any route.	✓	**Section 18: Collision and Allision Risk Modelling and Assessment** Section 18.2.2 and section 18.5.2 consider the effects on vessel routeing of the Hornsea Three array area and offshore HVAC booster stations respectively.

Issue	Compliant (Yes/No)	Reference notes/remarks
d.ii. The structures could block or hinder the view of the coastline or of any other navigational feature such as Aids to Navigation, landmarks, promontories, etc.	✓	**Section 10: Existing Environment** Section 10.4 provides an overview of existing Aids to Navigation within the vicinity of Hornsea Three.
4. Communications, Radar and Positioning Systems. To provide researched opinion of a generic and, where appropriate, site specific nature concerning whether:		
a. The structures could produce radio interference such as shadowing, reflections or phase changes, and emissions with respect to any frequencies used for marine positioning, navigation and timing (PNT) or communications, including GMDSS and AIS, whether vessel borne, ashore or fitted to any of the proposed structures, to: Vessels operating at a safe navigational distance; Vessels by the nature of their work necessarily operating at less than the safe navigational distance to the OREI, e.g. support vessels, survey vessels, SAR assets; and Vessels by the nature of their work necessarily operating within the OREI.	✓	**Section 19: Communication and Position Fixing** Summarises the potential impacts on navigation of the different communications and position fixing devices used in and around offshore wind farms.
b. The structures could produce Radar reflections, blind spots, shadow areas or other adverse effects: Vessel to vessel; Vessel to shore; VTS Radar to vessel; Racon to/from vessel.	✓	**Section 19: Communication and Position Fixing** Summarises the potential impacts on navigation of the different communications and position fixing devices used in and around offshore wind farms.
c. The structures and generators might produce sonar interference affecting fishing, industrial or military systems used in the area.	✓	**Section 19: Communication and Position Fixing** Section 19.9 discusses sonar interference and related impacts.
d. The site might produce acoustic noise which could mask prescribed sound signals.	✓	**Section 19: Communication and Position Fixing** Section 19.10 discusses noise and related impacts.
e. Generators and the seabed cabling within the site and onshore might produce electro-magnetic fields affecting compasses and other navigation systems.	✓	**Section 19: Communication and Position Fixing** Section 19.7 discusses electromagnetic and related impacts.

Issue	Compliant (Yes/No)	Reference notes/remarks
5. Marine Navigational Marking. It should be determined:		
a. How the overall site would be marked by day and by night throughout construction, operation and decommissioning phases, taking into account that there may be an ongoing requirement for marking on completion of decommissioning, depending on individual circumstances.	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Summarises mitigation measures adopted as part of the Project, including how the Hornsea Three array area will be marked during the construction, operation and maintenance and decommissioning phases.
b. How individual structures on the perimeter of and within the site, both above and below the sea surface, would be marked by day and by night.	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Summarises mitigation measures adopted as part of the Project, including how the Hornsea Three array area will be marked during the construction, operation and maintenance and decommissioning phases
c. If the specific OREI structure would be inherently Radar conspicuous from all seaward directions (and for SAR and maritime surveillance aviation purposes) or would require passive enhancers.	✓	N/A
d. If the site would be marked by additional electronic means e.g. Racons	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Section 23.3.5 states that AIS transmitters, virtual buoys and Racons may be used following consultation with TH.
e. If the site would be marked by an AIS transceiver, and if so, the data it would transmit.	✓	**Section 24: Additional Mitigation Measures Required to Bring Risks to ALARP Parameters** Table 24.1 summarises additional means of communication to third parties which are proposed, including AIS transceivers.
f. If the site would be fitted with audible hazard warning in accordance with IALA recommendations	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Section 23.2.3 states that audible warnings are among the features under consideration for the operation and maintenance phase, as part of relevant guidance from the MCA and CAA.
g. If the structure(s) would be fitted with aviation lighting, and if so, how these would be screened from mariners or guarded against potential confusion with other navigational marks and lights.	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Section 23.2.3 states that aviation lighting will be used as per CAA requirements.
h. Whether the proposed site and/or its individual generators complies in general with markings for such structures, as required by the relevant GLA in consideration of IALA guidelines and recommendations.	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Section 23.2.3 states that variation from the standard IALA guidance may be required given the distance offshore, but any variation would be made at the request of TH.

Issue	Compliant (Yes/No)	Reference notes/remarks
i. The Aids to Navigation specified by the GLAs are being maintained such that the "availability criteria", as laid down and applied by the GLAs, is met at all times.	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Section 23.2 states that throughout the construction, operation and maintenance and decommissioning phases, Aids to Navigation will be provided in accordance with both TH and MCA requirements.
j. The procedures that need to be put in place to respond to casualties to the Aids to Navigation specified by the GLA, within the timescales laid down and specified by the GLA.	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Includes an Aid to Navigation Management Plan.
k. The ID marking will conform to a spreadsheet layout, sequential, aligned with SAR lanes and avoid the letters O and I.	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Section 23.3.10 states that the MCA will advise during the consent process on the specific requirements for Hornsea Three.
l. Working lights will not interfere with Aids to Navigation or create confusion for the Mariner navigating in or near the OREI.	✓	**Section 22: Formal Safety Assessment** Visual navigation is considered within 22.12.
6. Hydrography. In order to establish a baseline, confirm the safe navigable depth, monitor seabed mobility and to identify underwater hazards, detailed and accurate hydrographic surveys are included or acknowledged for the following stages and to MCA specifications		
i. Pre-consent: the site and its immediate environment extending to 500 m outside of the development area shall be undertaken as part of the licence and/or consent application. The survey shall include all proposed cable route(s).	✓	Will be provided by the Applicant.
ii. Post-construction: cable route(s).	✓	Will be provided by the Applicant.
iii. Post-decommissioning of all or part of the development: cable route(s) and the area extending to 500 m from the installed generating assets area.	✓	Will be provided by the Applicant.
Annex 3: MCA template for assessing distances between wind farm boundaries and shipping routes		
"Shipping route" template and interactive boundaries. Where appropriate, the following should be determined:		
a. The safe distance between a shipping route and turbine boundaries.	✓	**Section 17: Future Case Marine Traffic** Section 17.7 summarises that alternative routes following construction of Hornsea Three are assumed to maintain a minimum 1 nm distance from structures. This section also outlines details of evidence suggesting that vessels can and do pass consistently and safely within 1 nm of established wind farms.
b. The width of a corridor between sites or OREIs to allow safe passage of shipping.	✓	**Section 22: Formal Safety Assessment** Section 22.9 includes information regarding the proposed navigational corridor between Hornsea Three, Hornsea Project One and Hornsea Project Two.

Issue	Compliant (Yes/No)	Reference notes/remarks
Annex 4: Safety and mitigation measures recommended for OREI construction, operation and decommissioning		
Mitigation and safety measures will be applied to the OREI development appropriate to the level and type of risk determined during the EIA. The specific measures to be employed will be selected in consultation with the Maritime and Coastguard Agency and will be listed in the developer's Environmental Statement. These will be consistent with international standards contained in, for example, the SOLAS Convention - Chapter V, IMO Resolution A.572 (14) and Resolution A.671(16) and could include any or all of the following:		
i. Promulgation of Information and warnings through Notices to Mariners and other appropriate MSI dissemination methods.	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Table 23.1 includes details on the promulgation of Information as a mitigation measure adopted for Hornsea Three.
ii. Continuous watch by multi-channel VHF, including DSC.	✓	**Section 19: Communication and Position Fixing** Screened out based on lessons learnt at existing developments.
iii. Safety zones of appropriate configuration, extent and application to specified vessels	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Table 23.1 summarises the application and use of safety zones during construction, operation and maintenance and decommissioning phases as a mitigation measure adopted for Hornsea Three.
iv. Designation of the site as an area to be avoided (ATBA.	✓	N/A
v. Provision of Aids to Navigation as determined by the GLA	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Section 23.2 provides details of Aids to Navigation as required by TH and MCA, and in line with IALA requirements.
vi. Implementation of routeing measures within or near to the development.	✓	**Section 22: Formal Safety Assessment** Section 22.9.2 states that the MCA are currently considering the inclusion of a routeing measure for the proposed navigational corridor between Hornsea Three, Hornsea Project One and Hornsea Project Two.
vii. Monitoring by Radar, AIS, CCTV or other agreed means	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Section 23.3.5 states that AIS transmitters may be used following consultation with TH. CCTV and Radar are not considered as mitigation.
viii. Appropriate means for OREI operators to notify, and provide evidence of, the infringement of safety zones.	✓	N/A
ix. Creation of an ERCoP with the MCA's SAR Branch for the construction phase onwards.	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Table 23.1 summarises the development of an ERCoP for the construction, operation and maintenance and decommissioning phases as a mitigation measure adopted for Hornsea Three.
x. Use of guard vessels, where appropriate	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Table 23.1 summarises the use of guard vessels during the deployment of safety zones and other key periods of the construction phase as a mitigation measure adopted for Hornsea Three.

Issue	Compliant (Yes/No)	Reference notes/remarks
xi. Any other measures and procedures considered appropriate in consultation with other stakeholders.	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Table 23.1 includes further mitigation measures adopted as part of Hornsea Three. **Section 24: Additional Mitigation Measures Required to Bring Risks to ALARP Parameters** Table 24.1 includes additional mitigation measures proposed for Hornsea Three.
Annex 5: Standards procedures and operational requirements in the event of search and rescue, maritime assistance service counter pollution or salvage incident in or around an OREI, including generator/installation control and shutdown		
The MCA, through HM Coastguard, is required to provide Search and Rescue and emergency response within the sea area occupied by all offshore renewable energy installations in UK waters. To ensure that such operations can be safely and effectively conducted, certain requirements must be met by developers and operators.		
a. An ERCoP will be developed for the construction, operation and decommissioning phases of the OREI.	✓	**Section 23: Measures Adopted as Part of Hornsea Three** Table 23.1 summarises the development of an ERCoP for the construction, operation and maintenance and decommissioning phases as a mitigation measure adopted for Hornsea Three.
b. The MCA's guidance document Offshore Renewable Energy Installation: Requirements, Advice and Guidance for Search and Rescue and Emergency Response for the design, equipment and operation requirements will be followed.	✓	**Section 23: Measures Adopted as Part of Hornsea Three** The applicant will consider guidance within MGN 543.

D.2 Marine Guidance Note 543 general comments checklist

Issue	Compliant (Yes/No)	Reference notes/remarks
A1: Reference Sources - Lessons learned.	✓	**Section 6: Lessons Learnt**
B1: Base case traffic densities and types.	✓	**Section 15: Marine Traffic Surveys**
B2: Future traffic densities and types.	✓	**Section 17: Future Case Marine Traffic** **Section 18: Collision and Allision Risk Modelling and Assessment**
B3: The marine environment :		
B3.1 Technical & operational analysis	✓	**Section 9: Design Envelope**
B3.2 Generic Technical and Operational Analysis (TOA)	✓	**Section 18: Collision and Allision Risk Modelling and Assessment** **Section 22: Formal Safety Assessment**
B3.3 Potential accidents	✓	**Section 18: Collision and Allision Risk Modelling and Assessment** **Section 22: Formal Safety Assessment**
B3.4 Affected navigational activities	✓	**Section 22: Formal Safety Assessment**
B3.5 Effects of OREI structures	✓	**Section 18: Collision and Allision Risk Modelling and Assessment**
B3.6 Development phases	✓	**Section 9: Design Envelope**
B3.7 Other structures and features	✓	**Section 10: Existing Environment** **Section 21: Cumulative Overview**
B3.8 Vessel types involved	✓	**Section 15: Marine Traffic Surveys**
B3.9 Conditions affecting navigation	✓	**Section 11: Metocean Data** **Section 19: Communication and Position Fixing**
B3.10 Human actions	✓	**Section 22: Formal Safety Assessment**
C1: Hazard Identification	✓	**Section 22: Formal Safety Assessment** **Appendix B: Hazard Log**
C2: Risk Assessment	✓	**Section 22: Formal Safety Assessment** **Appendix B: Hazard Log**
C3: Influences on level of risk	✓	**Section 9: Design Envelope** **Section 10: Existing Environment** **Section 15: Marine Traffic Surveys** **Section 19: Communication and Position Fixing**
C4: Tolerability of risk	✓	**Section 22: Formal Safety Assessment** **Appendix B: Hazard Log**
D1: Appropriate risk assessment	✓	**Section 11: Metocean Data** **Section 13: Maritime Incidents** **Section 15: Marine Traffic Surveys** **Section 18: Collision and Allision Risk Modelling and Assessment** **Section 19: Communication and Position Fixing** **Section 22: Formal Safety Assessment** **Section 23: Measures Adopted as Part of Hornsea Three**
D2: MCA acceptance for assessment techniques and tools	✓	**Section 22: Formal Safety Assessment**
D3: Demonstration of results	✓	**Appendix B: Hazard Log**

Issue	Compliant (Yes/No)	Reference notes/remarks
D4: Area traffic assessment	✓	Section 9: Design Envelope Section 15: Marine Traffic Surveys Section 18: Collision and Allision Risk Modelling and Assessment Section 19: Communication and Position Fixing Section 21: Cumulative Overview Section 22: Formal Safety Assessment Appendix B: Hazard Log
D5: Specific traffic assessment	✓	Section 4: Consultation Section 9: Design Envelope Section 12: Emergency Response Overview and Assessment Section 18: Collision and Allision Risk Modelling and Assessment Section 22: Formal Safety Assessment Section 23: Measures Adopted as Part of Hornsea Three Appendix B: Hazard Log
E1: Risk control log	✓	Appendix B: Hazard Log
E2: Marine stakeholders	✓	Section 24: Additional Mitigation Measures Required to Bring Risks to ALARP Parameters
F1: Hazard identification checklist	✓	Appendix B: Hazard Log
F2: Risk control checklist	✓	Appendix B: Hazard Log

Appendix E Regular Operators Consultation

E.1.1.1 As part of the consultation process for Hornsea Three, Regular Operators identified (from the marine traffic surveys) that would be required to deviate their routes due to the Hornsea Three array area or offshore HVAC booster stations were consulted via electronic or hardcopy mail. An example of the email/letter sent to the Regular Operators in January 2017 is presented below.

anatec

DFDS Seaways
[redacted]

Anatec Ltd.,
Cain House
10 Exchange Street,
Aberdeen AB11 6PH
Tel: [redacted]
Fax: [redacted]
Email: [redacted]
Web: www.anatec.com

Date: Thursday 26th January 2017

Doc Ref: [redacted]

<u>Stakeholder Consultation on Navigation Impacts for the Proposed Hornsea Project Three Offshore Wind Farm</u>

Dear Stakeholder,

As you may be aware, DONG Energy UK Limited (DONG Energy) is the developer of the Hornsea offshore wind farms located off the East Riding of Yorkshire coast, having purchased control of the Hornsea Zone from SMartWind Limited in 2015.

The third offshore wind farm site being developed is called ‘Hornsea Project Three’ and consists of offshore wind turbines and associated infrastructure located in a defined area to the east of Hornsea Projects One and Two, as well as export cables to shore, and an onshore grid connection. The proposed Hornsea Project Three has an installed capacity of up to 2.4GW and covers an area of 203nm^2 (695km^2), with the closest point of the proposed offshore wind farm area from shore being 140km (76nm). Offshore construction is intended to commence in 2023 at the earliest. The location of the Hornsea Project Three offshore wind farm is presented in Figure E.1 alongside the soon to be under construction Hornsea Project One, and the recently consented Hornsea Project Two.

Anatec has been contracted by DONG Energy to provide technical support on navigation during the consenting process, and to coordinate the stakeholder consultations. Therefore, we are writing to you on behalf of DONG Energy to provide you with an outline of their proposals for developing Hornsea Project Three.

The Environmental Impact Assessment process requires DONG Energy to identify impacts that the development could potentially have on shipping and navigation, and to ensure that consultation is carried out in a comprehensive and consistent manner. In order to analyse shipping and navigation movements in the area, AIS and Radar data has been collected from vessel-based surveys which will feed into the Navigational Risk Assessment (NRA).

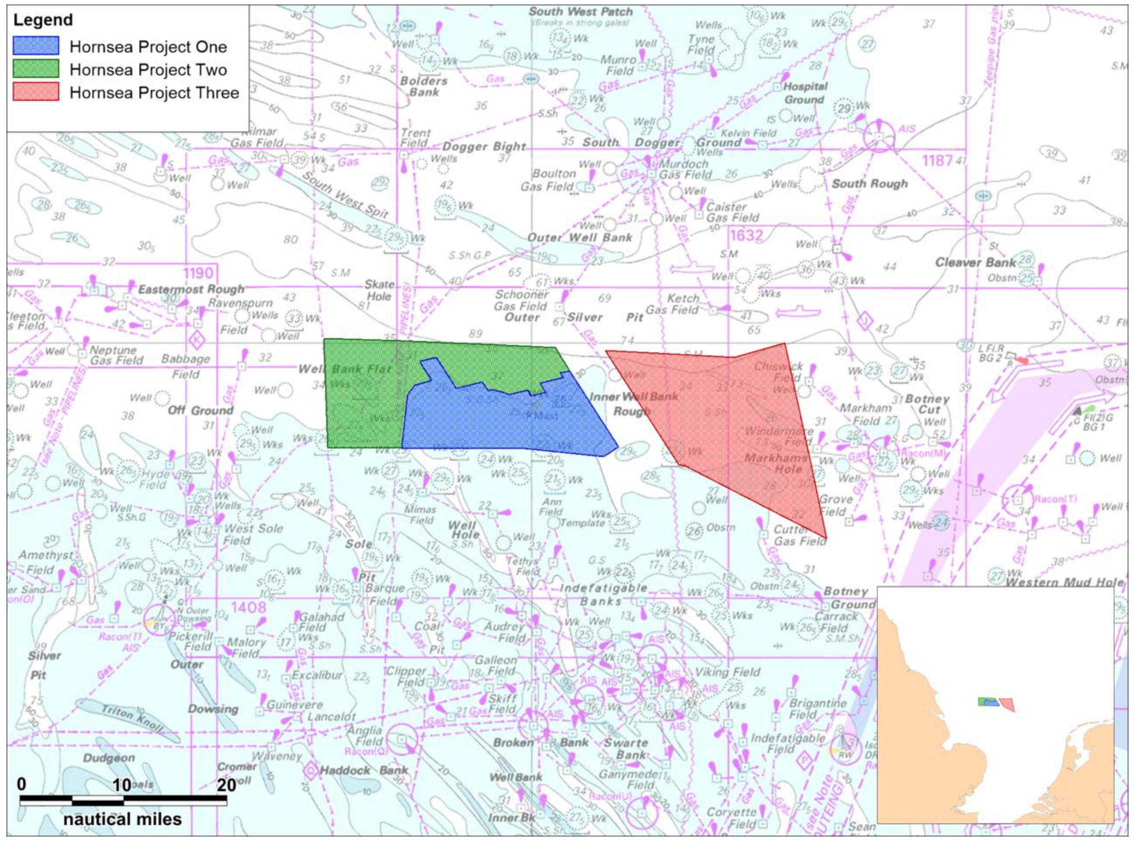

Figure E.1: Hornsea Offshore Wind Farm Projects.

Figure E.2 illustrates the dimensions of the corridor that exists between Hornsea Project Three on the east and the consented Hornsea Projects One and Two on the west. This corridor is intended as a route option that may enable shorter deviations for vessels travelling north – south.

Anatec has analysed the aforementioned AIS and Radar data and has observed that your organisation's vessel(s) have regularly navigated in the sea area shown in Figure E.3. As a result, your company has been identified as a potential Marine Stakeholder for Hornsea Project Three. We therefore invite your feedback on the potential development including any impact it may have on the navigation of vessels. To assist your review, Figure E.3 shows AIS plots of your vessels' movements over a period of 40 days in 2016 (26 days in June / July and 14 days in November / December). A 10 nm buffer has been placed around the wind farm boundary for context.

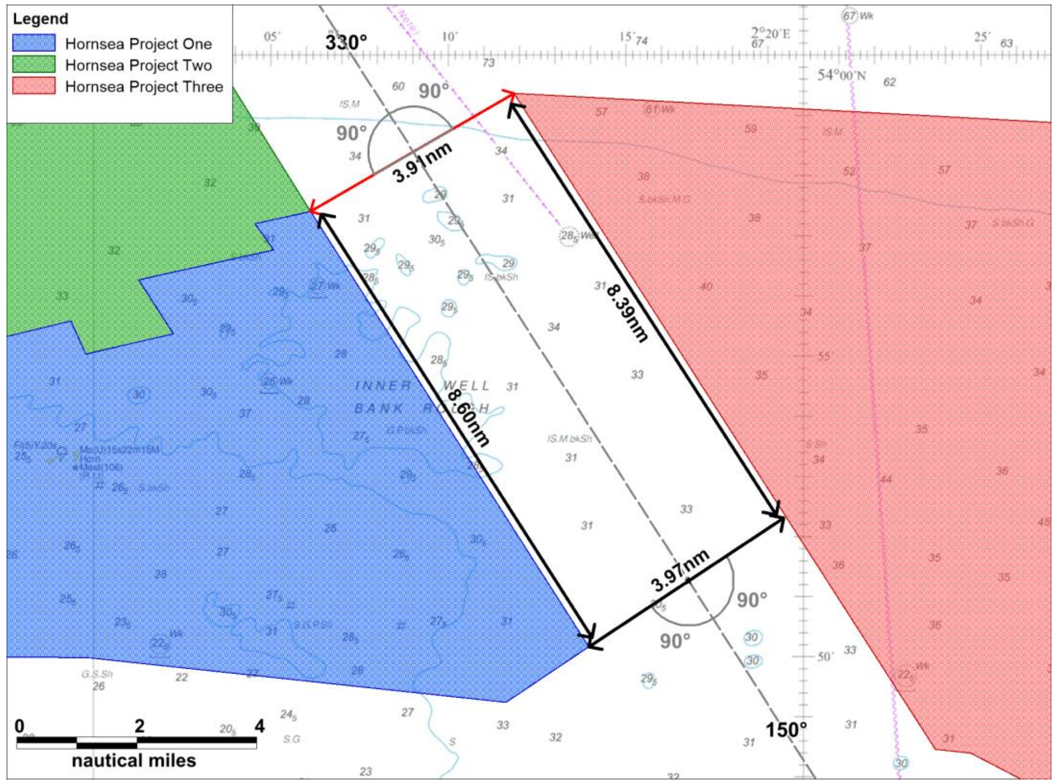

Figure E.2: Corridor Dimensions.

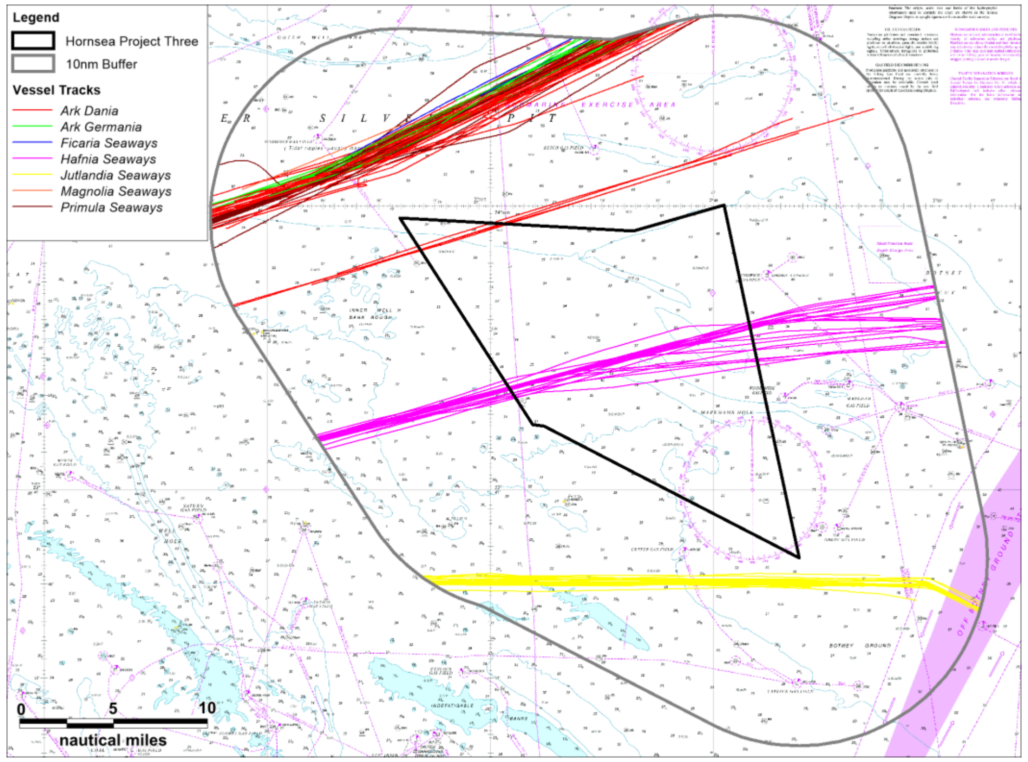

Figure E.3: 40 Days AIS & Radar Data for DFDS Seaways Vessels (June – December 2016).

Further project information is available at:
http://www.dongenergy.co.uk/uk-business-activities/wind-power/offshore-wind-farms-in-the-uk/hornsea-project-three-development
[Updated link (December 2017): http://hornseaproject3.co.uk/About-the-Project]

We would be grateful if you could review this letter and provide us with any comments or feedback that you may have by February 17th. 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 on to any vessel operators / owners you feel may be interested in commenting.

In particular, we are keen to receive comments on:

1. Whether the proposal to construct wind turbines and associated infrastructure within the Hornsea Project Three offshore wind farm area is likely to impact the routeing of any specific vessels;
2. Whether the development could pose any safety concerns for your organisation or members, including any adverse weather routeing;
3. The extent to which you would route through the corridor;
4. Whether you would like to be retained on our list of Marine Stakeholders and consulted throughout the NRA process: and
5. Whether you would like to attend a hazard workshop being held in central London on the 23rd February 2017.

Should you require any further information to support your review or additional information on the navigational consenting process in general, please do not hesitate to contact us. We look forward to receiving your response by February 17th.

Yours sincerely,

Anatec Ltd

Please send all responses and / or requests for further information via email [redacted] or in writing to:

Hornsea Project Three Stakeholder Feedback
Anatec Ltd