Appendix 13.1

Navigational Risk Assessment

Dounreay Tri Floating Wind Demonstration Project

Marine Safety Navigational Risk Assessment

Report to Hexicon

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Abbreviations

ADCP	-	Acoustic Doppler Current Profiler
AfL	-	Agreement for Lease
AHTS	-	Anchor Handling Tug Supply Vessel
AIS	-	Automatic Identification System
ALARP	-	As Low As Reasonably Practicable
AoS	-	Area of Search
ATBA	-	Area To Be Avoided
BGS	-	British Geological Survey
BTA	-	British Tug Owners Association
CA	-	Cruising Association
CAA	-	Civil Aviation Authority
CAST	-	Coastguard Agreement for Salvage and Towage
EIA	-	Environmental Impact Assessment
EMP	-	Environmental Management Plan
ERCoP	-	Emergency Response Cooperation Plan
ERP	-	Emergency Response Plan
ES	-	Environmental Statement
ETVs	-	Emergency Towing Vessel
FMECA	-	Failure Modes and Effects Criticality Matrices
GPS	-	Global Positioning System
GRT	-	Gross Registered Tonnage
HAT	-	Highest Astronomical Tide
HIRA	-	Hazard Identification and Risk Analysis
HW	-	High Water
IALA	-	International Association of Lighthouse Authorities
ICES	-	International Council for the Exploration of the Seas
IMO	-	International Maritime Organisation
LAT	-	Lowest Astronomical Tide
MCA	-	Maritime and Coastguard Agency
MGN	-	Marine Guidance Note
MHWN	-	Mean High Water Neaps
MHWS	-	Mean High Water Springs
MLWN	-	Mean Low Water Neaps
MLWS	-	Mean Low Water Springs
MRCC	-	Maritime Rescue Coordination Centre
MRCC	-	Maritime Response and Co-ordination centre
MSL	-	Mean Sea Level
MW	-	Megawatt
NLB	-	Northern Lighthouse Board
Nm	-	Nautical Mile
NRA	-	Navigation Risk Assessment
NtM	-	Notices to Mariners
O&M	-	Operation and Maintenance
OFA	-	Orkney Fisheries Association
OIC	-	Orkney Islands Council
OREI	-	Offshore Renewable Energy Installation
PEXA	-	Practice and Exercise Area
PFOW	-	Pentland Firth and Orkney Waters
PHA	-	Preliminary Hazard Analysis

PLGR	-	Pre-Laying Grapnel Run
PLN	-	Port Letter Number
RIB	-	Rigid Hull Inflatable Boat
RNLI	-	Royal National Lifeboat Institution
RYA	-	Royal Yachting Association
SANAP	-	Strategic Area Navigational Appraisal
SAR	-	Search and Rescue
SCA	-	Scottish Canoe Association
SCADA	-	Supervisory Control and Data Acquisition
SFF	-	Scottish Fishermen’s Federation
SPV	-	Special Purpose Vehicle
SSEPD	-	Scottish and Southern Energy Power Distribution
TCE	-	The Crown Estate
UKC	-	Under Keel Clearance
UKHO	-	United Kingdom Hydrographic Office
VHF	-	Very High Frequency
VMS	-	Vessel Monitoring System
VTS	-	Vessel Traffic Service
WTG	-	Wind Turbine Generator

1 Introduction

1.1 Background

Aquatera Ltd (Aquatera) has been commissioned by Hexicon to carry out the Navigational Risk Assessment (NRA) of the proposed Dounreay Tri Project (referred to as 'the Project' and described in Section 4). The proposed Project will be located within an Area of Search (AoS) off the Caithness coast, shown as 'offshore site' in Figure 1.1. An area comprising the 'offshore site' and 'export cable corridor' (Figure 1.1) is referred to throughout this NRA as the 'Project area', while the immediate area taken up by the floating platform and its associated moorings, which is yet to be confirmed, is referred to as 'the site'.

The Project consists of a semi-submersible floating platform with two wind turbine generators (WTGs) attached. Power will be exported from the site via a static export cable to a landfall site located immediately to the west of the Dounreay restoration site within the export cable corridor and onwards overland to the national grid network. The floating platform covers a sea surface area of approximately 0.17km^2, while its moorings and anchors extend to an area approximately 2km^2 across the seabed. The applicant has studied an area which is purposefully larger than required, i.e. 25km^2, in order to maintain enough flexibility to move the platform, within this area, to avoid or offset potential conflicts. It is intended that routine maintenance be carried out onsite during suitable weather windows, however if significant repairs are required the floating platform will be towed to a suitable harbour in order to facilitate repairs.

The NRA forms part of the Environmental Impact Assessment (EIA) and is available for review as part of the Environmental Statement (ES). Guidance covering the preparation of an NRA is provided by the Maritime and Coastguard Agency (DECC/MCA 2013) and in MCA's Marine Guidance Note 543 (M+F) (MCA 2016).

The NRA is focused on assessing the marine navigational risk of the Project and demonstrating that sufficient risk controls are in place for the assessed risk to be judged as 'tolerable'. The submission also provides information on the proposed development and its potential impacts, in the context of the navigational activity and marine environment in the surrounding area.

1.2 Objectives

The main objective of the NRA is to demonstrate that sufficient risk controls are in place for the assessed risk to be considered broadly acceptable or tolerable. The objective is achieved by:

- Identifying key features of the marine environment around the Project, such as bathymetry, metocean conditions, port and harbour locations, navigational aids and restrictions;
- Describing the proposed Project and its associated vessel traffic;
- Assessing the level of vessel traffic in the vicinity of the Project using desk based data supplemented by detailed local consultation;
- Carrying out and reporting on a structured Hazard Identification and Risk Assessment (HIRA) process to identify and assess the safety risks associated with the Project. This process includes stakeholder consultation;
- Assessing the level of navigational safety risk for a Base Case (i.e. current environment) with, and without the Project. Qualitative analysis methods and expert judgement have been applied. A Future Case assessment has also been carried out including an assessment of possible cumulative and in-combination impacts;

- Reviewing significant hazards and proposing appropriate risk mitigation measures, and providing a 'risk claim supported by reasoned argument and justification' (in Section 2) to summarise the evidence and the claim that the Project's impacts on navigational safety are acceptable with the noted risk control measures; and
- Assessing Search and Rescue (SAR) provision and Emergency Response Coordination.

1.3 Scope and Boundaries

The scope of the NRA includes all phases of the Project: construction/installation, operation, maintenance and decommissioning.

An offshore site has been identified in waters deeper than 60m (Figure 1.1). The size of the offshore site is approximately 25km^2. It is anticipated that the actual development area including anchors and mooring lines would take up an area of the seabed approximately 2km^2. The footprint of the floating platform, including the 360° turn radius will take up an area of approximately 0.17km^2. The location of the floating platform in the offshore site is as of yet undefined. The final location of the development area will be subject to detailed assessment of geophysical and geotechnical data in conjunction and with agreement from stakeholders.

The boundaries of the Project area for this NRA include the offshore site together with an adjoining export cable corridor (see Figure 1.1), collectively referred to as the Project area. Currently the location of the operations and maintenance (O&M) base is undefined. Therefore, this NRA cannot consider the site specific navigational risks that could occur during transit routes to the O&M base.

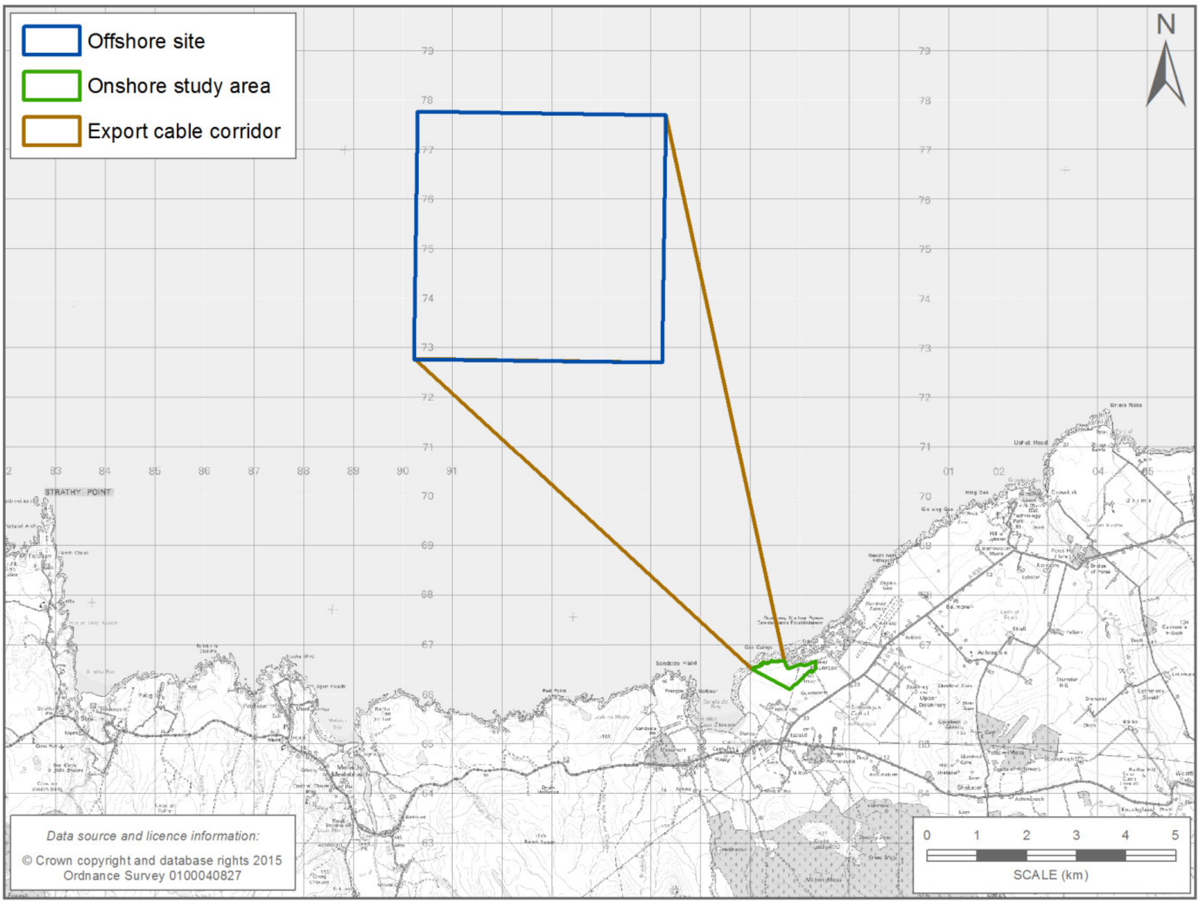


Figure 1.1 Chart of Dounreay site

1.4 Guidance and Proportionate Approach Overview

Guidance - the methodology used has followed the requirements and guidance noted below.

For guidance on the NRA process and reporting:

- DECC/MCA 'Methodology for Assessing the Marine Navigational Safety & Emergency Response Risks of Offshore Renewable Energy Installations (OREI)' (DECC/MCA 2013).

For guidance from MCA on navigational safety issues:

- MGN 543 (M+F) "Offshore Renewable Energy Installations – Guidance on UK Navigational Practice, Safety and Emergency Response". (MCA 2016)
- MGN 372 (M+F) 'Offshore Renewable Energy Installations (OREI) - Guidance to mariners operating in the vicinity of UK OREIs' (MVA 2008).

For guidance on formal safety assessment including the hazard identification and risk assessment (HIRA) methodology used for the NRA:

- Health & Safety Executive Offshore Technology Report on Marine Risk Assessment (H&SE 2001).
- DNV RP-H101- Risk Management in Marine and Subsea Operations (DNV 2003).

Proportionate approach – the DECC/MCA Guidance notes the value of a proportionate approach to NRAs for developments in areas where the potential risks are lower or a small-scale development. Such an approach at Level 1a and 1b was provisionally agreed with MCA. Level 1 assessments are qualitative using expert judgement. A list of key elements for such an approach is provided in Section 2.4.

1.5 Consultation

Consultation with statutory consultees, national organisations and local groups and individuals has provided invaluable information for this NRA. This has included, for example, the Royal Yachting Association's (RYA) valuable position paper on wind energy developments (RYA 2015).

The consultation process is described in Section 7.

2 Risk Claim Supported by Reasoned Argument and Evidence

2.1 Risk Claim

A navigational safety risk assessment (NRA) has been undertaken to assess the risks to navigation arising from the Project's development including all associated installation, operations, maintenance and decommissioning activities. The assessment concludes that the risks are considered to be tolerable with monitoring.

A formal safety assessment process has been used, i.e. a Hazard Identification and Risk Analysis process (Appendix A). Risks have been systematically identified and recorded in the hazard log (Appendix B) and control measures recorded in the Risk Control Log (Appendix C). No risks were identified in the 'Intolerable' category. All risks after application of the risk mitigation measures (noted in Appendix B) fall within the 'As Low As Reasonably Practicable' (ALARP) category or the low risk 'Broadly Acceptable' category. All risks will continue to be monitored and additional risk reduction measures introduced 'So Far As Is Reasonably Practicable'.

2.2 Supporting Reasoned Argument

The navigational safety hazards associated with the proposed development have been identified and assessed through the Hazard Identification and Risk Assessment (HIRA) process. This process is based on guidance from DECC/MCA (DECC/MCA 2013), from MCA (MCA 2016), from HSE (HSE 2001) and from other sources and is summarised below (see Section 2.4). The HIRA process has used evidence from a range of data sources summarised in Section 2.3, including marine traffic analysis of various types, local consultation and a Hazard Workshop.

All identified hazards/risk events have been identified in the hazard log (Appendix B). Significant findings (i.e. risks assessed as greater than 'Broadly Tolerable') are described individually in Section 9 'Navigational Hazards and Risk Assessment' and summarised in Section 13 'Major Hazards Summary'.

The key reasoned arguments for assessing the navigation risks as 'Tolerable' are based on a Level 1 approach, i.e. qualitative analysis and expert judgment of appropriate evidence together with consultation. These are listed below.

- The traffic analysis is judged to be current, comprehensive and resilient. It shows that the area of study carries a mix of commercial, fishing and recreational traffic which is of moderate to low density. Very little passenger vessel traffic has been observed;
- The Project-specific traffic analysis is consistent with recent strategic area studies of PFOW;
- Consultation locally has identified the small fishing vessel operators for assessing movements of vessels not tracked by AIS or VMS and for continuing liaison and notification;
- Consultation with recreational vessel organisations has identified typical traffic patterns, although these may vary. Liaison and notification networks have been developed;
- A hazard assessment engaged expert and local participants and generated a preliminary hazard listing, identification of 'Most Likely' and 'Worst Case' outcomes and discussion of mitigations. All hazards identified during the hazard assessments, during consultation and arising from vessel traffic analysis have been considered and assessed during the NRA;
- Mitigation measures which are either generally applicable or specifically targeted to particular risks have been described. With the existing mitigations taken into account, all identified hazards

lie within the ‘Tolerable with ALARP’ or ‘Broadly Acceptable’ zones. These risks will continue to be assessed for application of further mitigation measures;

- An important general mitigation which will be put in place is a comprehensive Safety Management System (see Section 12.1);
- The contact and collision risk levels for the Project are judged to be relatively low because of its location in an area of only moderate vessel traffic and the very small area extent of the floating platform (approximately 0.17km^2 within an offshore site of approximately 25km^2). This is surrounded by ample sea room for navigation around the floating platform both to seaward and landward;
- Historical information on incidents shows the general area to be of relatively low risk;
- It is essential, as far as is reasonably practicable, to avoid vessels entering the site. The floating platform is free to rotate 360° on its radius and any 3rd party vessel navigating near the site would be at risk of collision. Mariners will be strongly advised not to enter the site. The options for site designation, charting and lighting will continue to be discussed with MCA, NLB and UKHO;
- The potential risk of the floating platform, or part thereof, breaking free and becoming a hazard to other vessels is well mitigated by the position-monitoring and alarm systems to be fitted to the platform;
- Risks related to under-keel clearance are not considered in this NRA as the depth from the base of the floating platform to the clump weight will be approximately 80m and thus under-keel clearance is not considered to pose a risk to vessels passing over the sub-sea infrastructure associated with the floating platform (see Section 4.3 and Figure 4.6). Entanglement of fishing gear on subsea infrastructure (when the floating platform is not on station) will be mitigated by chart warning and continuing liaison with fishing operators;
- The risk assessment process has found that no risks lie within the ‘Intolerable’ zone. Those judged to lie within the ‘Tolerable with application of mitigation measures to ALARP’ are illustrated on risk criticality matrices for ‘Most Likely’ and ‘Worst Credible’ outcomes as requested in scoping responses.

2.3 Overview of Evidence

Vessel traffic analysis (Section 5) has drawn on evidence contained within the following three recently-published reports on the strategic area of PFOW:

- the ‘Shipping Study of PFOW’ (Marine Scotland 2012b) which recorded and analysed commercial and recreational vessel traffic (but not fishing vessel movements);
- the ScotMap Report on a Fishing Pilot Study in PFOW (Kafas et al., 2014) which included an assessment of small fishing vessels not necessarily tracked by AIS or VMS; and
- the Strategic Area Navigation Appraisal, or SANAP Report (Crown Estate 2013) which used information from the reports above and added fresh AIS track data. In particular the SANAP Report assessed traffic in the areas around each potential OREI development gathered in two 28 day periods in summer and winter 2012.

Further to this the following data was analysed to inform the Project:

- A Project-specific AIS track analysis was carried out for all vessels over a 28 day period and takes account of seasonal variations in traffic patterns and fishing operations by analysing 14 days in winter and 14 days in summer. This covered the offshore site and also the export cable corridor;

- In addition to AIS track analysis for the Project area, data supplied by Marine Scotland showing VMS location data for three years (2011-2013) has been analysed;
- An extensive programme of local consultation was carried outwith fishing and recreational vessel operators to identify small, non-AIS and non-VMS vessel activity;
- Taken together, the data and analysis are judged to be current, comprehensive and resilient; and
- Evidence on the history of incidents in a 10nm zone around the Project area was obtained from MAIB and RNLI for analysis.

Other evidence used in the traffic analysis, the analysis of cumulative and in-combination effects and risk assessment included:

- Description of Marine Environment (both current and predicted future cases);
- Project description and high-level sequence and plans for installation (moorings and the floating platform), operation, maintenance & decommissioning; and
- Hazard assessment meetings.

2.4 Tools and Techniques Used

Guidance from DECC/MCA (DECC/MCA 2013) notes the importance of proportionality in selecting appropriate tools and techniques for the NRA. Dounreay Tri Ltd has reviewed responses to the Project Scoping Report and its accompanying Preliminary Hazard Analysis (PHA) and has discussed an appropriate methodology with MCA. A methodology proportionate to a small scale development in a relatively low risk area is proposed.

The methodology used for the NRA is described in the DECC/MCA Guidance (DECC/MCA 2013) as a Level 1a and 1b assessment methodology. The approach is based on a hierarchy of appropriate assessment, which defines the subsequent level of assessment. For the purposes of this NRA, the process comprised an area traffic assessment of the strategic area (1a) and an area traffic assessment of the area local to the Project area (1b). This approach, using qualitative analysis and expert judgement was agreed in principle with MCA.

The key elements of the approach, covering both current and predicted future cases, are:

- Description of the marine environment (Section 3);
- Project scope and description (Section 4);
- Traffic analysis for both the area of study and the wider strategic area (Section 5);
- Review of historical incidents in the area (Section 6);
- Local consultation (Section 7);
- Formal safety assessment (Appendix A) generating a hazard log (Appendix B) using qualitative techniques such as expert judgment and Risk Control Register (Appendix C);
- Status of hazard log and Risk Control Register (Section 8);
- A narrative analysis of navigational hazards and risk analysis (Section 9);
- Search and Rescue preliminary overview (Section 10);
- Emergency Response preliminary overview (Section 11);
- Through-life safety management (Section 12); and
- Major hazards summary and conclusions (Section 13).

Using the sources of evidence noted above, hazards have been identified through discussions with Project personnel, professional mariners and stakeholders, including a HIRA Workshop. Each hazard was risk-assessed through consultation with Project personnel and expert mariners taking into consideration both mandatory/regulatory risk control measures and many committed additional measures firmly adopted by the developer. For some hazards potential additional risk control measures have been outlined for review and possible application in the future, but their potential benefits have not been assessed nor were they factored into the risk assessment.

The HIRA process, based on HSE's guidance on marine risk assessment (HSE 2001) is described in full in Appendix A. The following additional appendices support this:

Appendix B	The Hazard Log
Appendix C	Risk Control Register
Appendix D1	The assessed risks presented in matrix form for 'Most Likely' scenarios for each hazard.
Appendix D2	The assessed risks presented in matrix form for 'Worst Credible' scenarios for each hazard.

3 Description of the Marine Environment

3.1 Description of the Current Marine Environment

This includes a description of the natural features of the marine environment at and around the Project area followed by a description of key navigational features in the area.

3.1.1 Sources of information

Sources of information for this chapter include data from Marine Scotland Interactive, British Geological Survey (BGS), Seazone Solutions, UK Hydrographic Office and other published sources as cited and included in Section 14.

3.1.2 Natural marine environmental features of the Project area

Introduction

A full description of the natural environmental features present in the Project area is presented in Chapter 6 of the (ES) 'Physical and Coastal Processes'. The information presented here provides a summary of the key environmental aspects of the area.

Bathymetry

Water depths in the offshore Project area are in the range of 60m-110m. Water depth is greatest in the north-west corner of the offshore site and decreases gradually towards the south-east corner. Moving south along the export cable corridor the seabed shelves gently to the north-west at about 0.5°. Although not clear from data available for this location, submarine cliffs have been observed in the Orkney/north-east coast area at water depths of approximately 10m and 45m related to still stands occurring at around 7000 and 9500 years BP, respectively. The high resolution profile of the potential cable route indicates the presence of the 45 m cliff structure although the steepness of the slope was not able to be accurately determined.

Seabed conditions

The distribution of seabed sediments found off the north of Scotland's coast reflects both the glacial history of the area and the present hydrodynamic regime. The National Marine Landscape types present within the Project area are 'shelf sand plain' in the northern offshore section and 'shallow sand plain' in the south. The 'shallow sand plain' extends inshore to the coast along the potential cable route.

Seabed video survey collected in the area (Moore, C.G. 2015) indicated the presence of a predominantly sandy seabed with areas of slightly gravelly sand and other spots with muddier and rock pavement zones. The predominant sediment type is muddy sand which extends all the way inshore to the coastline.

The thickness of surface sediment deposits recorded in the Project area are variable and are expected to range from less than 3m to 28m (BGS 1989). Sediment thickness decreases to approximately 1m in the southernmost part of the Project area and at its shallowest reaches approximately 0.1m. Sediment thickness decreases towards the coast. Analysis of ripple marks and dunes indicate that considerable variation in the sediment thickness exists. Further analysis in the Project area demonstrates clearly that the sediments below wave base are current rippled sands and silts which have been derived from dynamic weathering of the Boulder clay and in particular the Shelly till member.

Tidal range

The annual mean spring tidal range across the Project area is 3.5 m – 4 m, with a corresponding neap range of 1.5 m – 2 m.

Table 3.1 lists selected tidal data for two locations located close to the development site. Tidal surges caused by storms may cause short-term modification to predicted water levels and under an extreme event (1 in 50-year return period) a surge in the order of 1.25 m could be encountered.

Table 3.1 Tidal ranges recorded in the vicinity of the development location (UKHO, 2011)

Tidal Parameter	Height in Metres Above Chart Datum
	Scrabster 58.37°N3.33°W
Mean High Water Spring (MHWS)	5.0
Mean High Water Neap (MHWN)	4.0
Mean Low Water Neap (MLWN)	2.2
Mean Low Water Spring (MLWS)	1.0
Mean Spring Tidal Range (MSTR)	4.0
Mean Neap Tidal Range (MNTR)	1.8

Tidal currents

The tidal currents in the Project area are generated by water moving between the North Atlantic and the North Sea through the Pentland Firth and flow from west to east on the flood tide and east to west on the ebb but may be modified to some extent by local conditions such as water depth and topography.

Although tidal currents within the Pentland Firth itself are very strong the Project area lies to the west and peak tidal current flow is relatively low at 0.5-0.75m/s for spring tides and 0.25-0.5m/s for neap tides.

The velocity and direction of tidal currents found in Admiralty chart tidal diamond F located near the Project area are provided in Table 3.2.

Table 3.2 Tidal current data (UKHO 2011) in vicinity of development area

Tidal State	Hours	Direction (°)	Average Velocity (m/s)	
			Spring	Neap
Before high water (Flood)	-6	262	0.9	0.5
	-5	245	1.8	1.0
	-4	223	1.8	0.8
	-3	158	0.8	0.5
	-2	134	0.8	0.4
	-1	111	0.9	0.5
High water	0	078	1.0	0.6
After high water (Ebb)	+1	052	1.1	0.6
	+2	032	1.1	0.6
	+3	030	0.8	0.4
	+4	017	0.5	0.3
	+5	299	0.4	0.2
	+6	267	0.8	0.4

Wind

Annual mean wind speeds at both 80m and 100m elevation are greatest at distances furthest offshore and are highest in the north-west corner of the Project area (up to 9-10m/s in the north-west and 8-9m/s in the north-east). Lowest wind speeds are present in much of the middle and south of the Project area at 80m elevation (7-8m/s). Similar wind speeds are present in the south-east section at 100m, but are greater in the south-west (8-9m/s) (ABPmer, 2008). Wind speed and direction has a major influence on wave and water current formation. The strength of wind and the frequency of wind directions vary considerably over time, but, in general, winds in the north of Scotland are predominantly from the south and west. The highest mean wind speeds and gusts are typically recorded during the winter months (December to February), with gusts of over 100mph not uncommon during winter storms.

Waves

Annual mean significant wave height (average height of the largest third of waves) across the majority of the Project area is 1.75-2.0m. To the south of the Project area annual mean significant wave height values are in the range 1.5-1.75m, decreasing closer to shore (ABPmer, 2008). Wave heights in the region are some of the highest in the UK, with waves of up to 17m recorded at EMECs grid connected wave test site approximately 50km north-east of the Project area.

Visibility

At Cape Wrath (approximately 19nm west of the Project area) fog (defined as visibility of less than 1km) is recorded on an average of 40 days per annum, predominantly during the summer months. Periods of restricted visibility due to precipitation will also occur. In the winter months, daylight can be restricted to a period of around 6-7 hours.

3.1.3 Navigational features of the surrounding Project area

Navigation

The Project area lies within the Pentland Firth and Orkney Waters (PFOW) strategic area but is outside the actual Pentland Firth lying approximately 14nm to the western boundary at Dunnet Head.

The Pentland Firth itself is subject to a voluntary ship reporting system whereby vessels are advised to contact the Aberdeen Coastguard one hour before entering the Firth and again on leaving. There are Admiralty Chart warnings about the very strong tidal streams within Pentland Firth. These warnings also specify an Area to be Avoided (ATBA), advising laden tankers not entering Scapa Flow to avoid the Pentland Firth in adverse weather or restricted visibility.

No navigational channels are marked on Admiralty Charts for the area surrounding this proposed development. However, the regional shipping appraisal, SANAP, (Crown Estate, 2014) records a higher density of shipping to the north of the Project area, most of which would be on a course from Cape Wrath to the middle of the Pentland Firth between Stroma and Swona (Crown Estate, 2014). The results of the vessel traffic analysis are presented in Section 5.

Orkney Vessel Traffic Service

The nearest vessel traffic service is operated by Orkney Harbour Authority, who operate a 24 hour service (Orkney VTS) for vessels navigating into Scapa Flow and Kirkwall Bay. The radar-based vessel traffic management system combines radar coverage with active interrogation by VHF of vessels entering the harbour area. Vessels under 12 m overall length do not need to report to the VTS. The service provides information on all aspects of port operations including pilotage, traffic movements, navigation warnings, weather forecasts and berth availability (OIC, 2015).

Navigational aids

Seven lighthouses are present along the north coast of the Scottish mainland and PFOW, namely Cape Wrath, Loch Eriboll, Strathy Point, Holburn Head, Dunnet Head, Stroma and Duncansby Head.

Aquaculture

There are no aquaculture sites in the immediate vicinity of the Project area. There are two salmon farms and one mussel farm in Loch Eriboll approximately 50km to the west of the Project area, which is also a classified shellfish harvesting area. The Kyle of Tongue approximately 36km west has two mussel farms and is also a classified shellfish harvesting area. The east coast of Hoy to the north-east has six active fish farms, the nearest of which is approximately 45km from the Project area.

Infrastructure

There are no subsea cables or pipelines that intersect with the offshore site or export cable corridor. There are two active telecommunication cables located east of the Project area; one from Dunnet Bay to Bay of Skaill on Orkney and another connecting Dunnet Bay to the Faroe Islands. Two active unburied power cables (a 33kV line and 33kV cable) also run north to Orkney, from Murkle Bay near Thurso to Rackwick Bay, Hoy, Orkney. All existing cables are at least 6nm (11km) east of the Project area.

New transmission infrastructure is required between Orkney and Caithness to enable the export of electricity from renewable energy generation in Orkney into the national grid. Scottish Hydro Electric-Transmission (SHE-T) is planning to develop a 70km 220kV sub-sea electricity transmission connection from the existing connection site at Dounreay to the Bay of Skaill on the west coast of Orkney (SHE-T, 2013). Construction of this new network is expected in 2018/19, however this is subject to the progress of current wave and tidal energy generation sites in Orkney and dependent on the submission of a needs case and approval by OFGEM. (See Chapter 17: Other Users of the Marine Environment).

Ports and harbours

The nearest industrial/fishing ports are Scrabster, Stromness and Lyness to the east and Kinlochbervie to the west. There are also small slipways along the north coast including (see Figure 3.1):

- Durness and Cape Wrath area: Keoldale West, Keoldale East, Rispond, Port Chamuill, Ard Neakie and Portnancon;
- Tongue and Bettyhill: Talmine, Skerray, Bettyhill and Kirtomy; and
- Strath Point to Thurso: Port Grant, Portskerra, Sandside, Scrabster and Thurso.

With the exception of the large port development at Scrabster, most of the harbour facilities across the north coast comprise small jetties, semi natural harbours, harbour walls and slipways. Use of these facilities includes dedicated passenger ferries (Keodale West and East), small scale fishing activities (Ard Neakie, Talmine, Port Grant, Portskerra), and small scale tourism (Skerray). Some jetties are no longer used commercially but may be used for ad hoc leisure or small scale fishing activities (Bettyhill, Kirtomy and Sandside). Several facilities are privately owned (Rispond and Portnancon). There are limited opportunities west of Scrabster for berthing medium sized vessels or marina facilities available until Kinlochbervie, south of Cape Wrath.

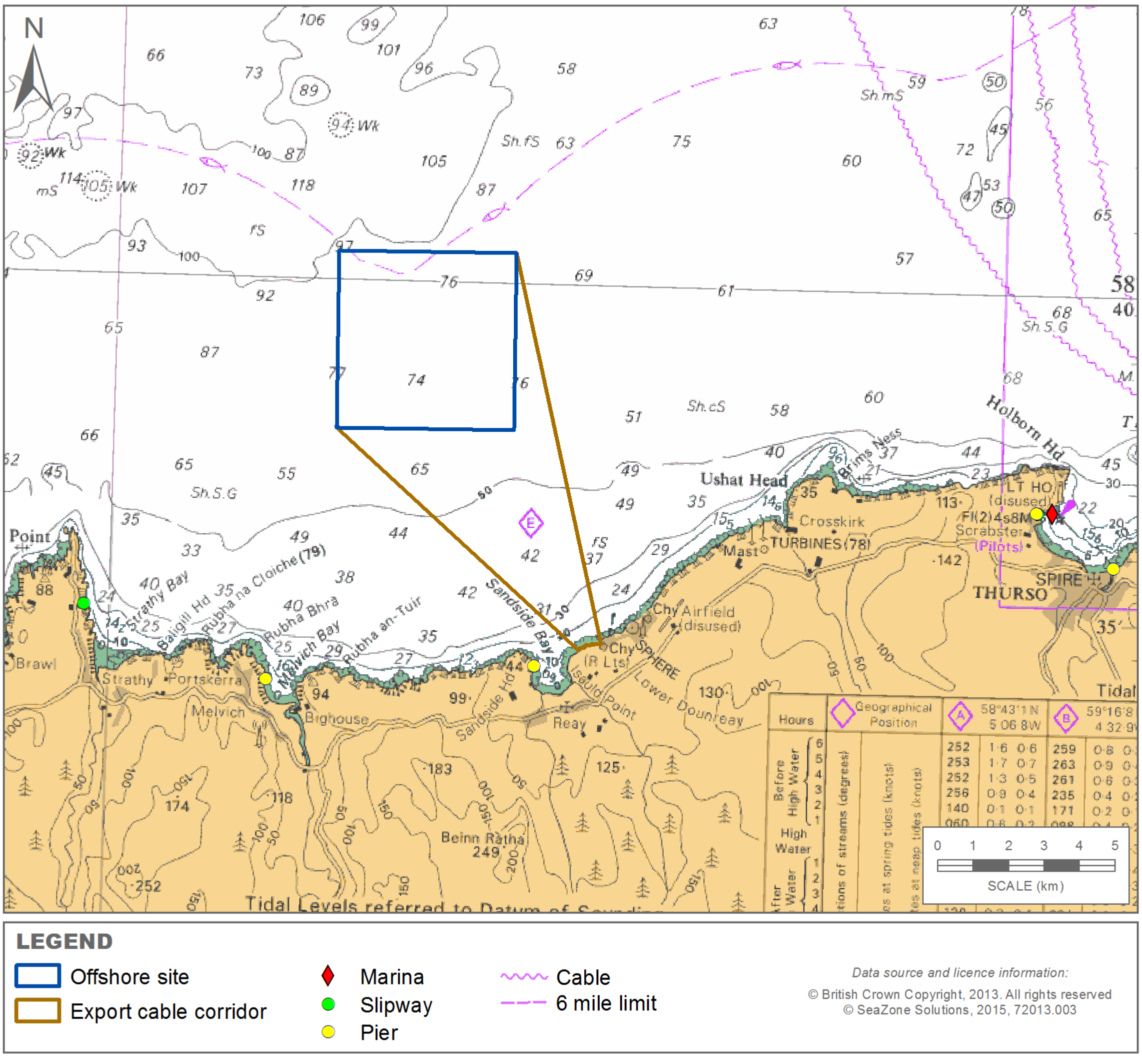


Figure 3.1 Site surrounding navigational features

Anchorages

There are no noted commercial or recreational vessel anchorages in the Project area.

Military practice areas

The Project area is located approximately 70km east of a military exercise area and Firing Danger Area at Cape Wrath. There is also a practice and exercise area (PEXA) within Loch Eriboll, Sutherland (within the Cape Wrath Firing Range area). Twice a year, Europe's largest military exercise, Joint Warrior is undertaken off the north, north-east and north-west coasts of Scotland. Joint Warrior involves the three Armed Forces and aircraft, navy vessels, submarines and army personnel and occurs in March/April and October each year over a period of 10 - 15 days.

Wrecks

There are no known surface piercing or partially submerged wrecks within the shipping lane or Project area that would present a navigational hazard.

Disposal sites

None are recorded in the area.

3.2 Description of Future Marine Environment

3.2.1 Marine renewables potential developments

Dounreay Tri floating wind demonstration Project

The current planned development is to complete installation of the moorings, anchors and export cable (anticipated to take 2-3 months, subject to weather), shortly before the platform tow and installation. This is to limit the amount of time the moorings are in place without the floating platform being installed, thus minimising the risk of e.g. fishing gear entanglement with the moorings etc. The floating platform will be towed to site from an as yet undefined port with two WTGs (max 6 MW capacity each) pre-installed, allowing swift connection of the floating platform to the moorings and export cable which is anticipated to take around five days.

Other marine renewables developments in PFOW

The Strategic Area Navigation Appraisal (SANAP) (Crown Estate 2014) charts the Areas for Lease granted by The Crown Estate for wave and tidal developments in PFOW (see Figure 3.2).

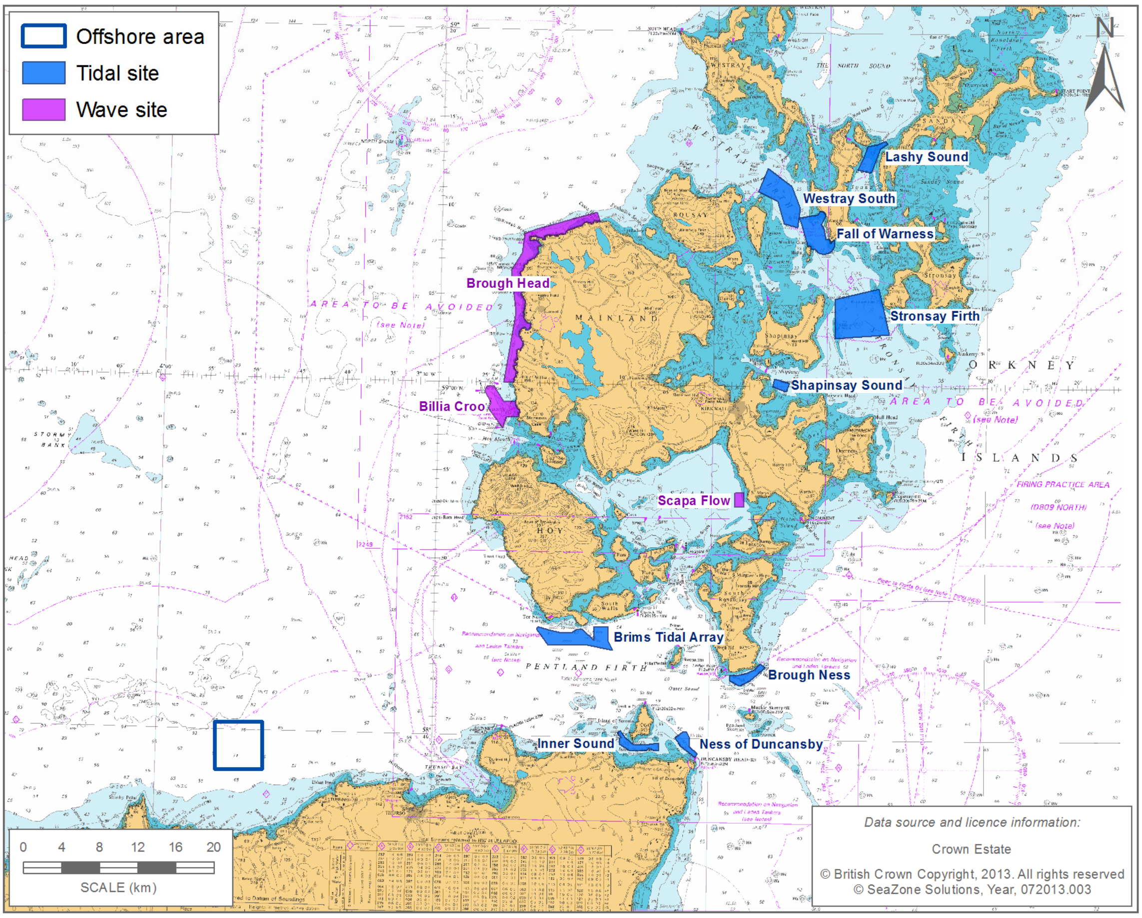


Figure 3.2 Dounreay tri floating wind demonstration Project area in context of other lease areas in the PFOW

3.2.2 Future marine traffic

One future change which is likely to increase vessel traffic slightly is marine renewable energy developments as reviewed in the SANAP (The Crown Estate 2014) strategic area study. Each will require several specialist survey and construction vessels during construction and a smaller number of support vessels in operation. The Project site is regarded as being well away from potential wave and tidal energy sites around Orkney and Stroma; however the proposed Dounreay Floating Wind

Demonstration Centre (DFWDC) will be in the vicinity of the Project and will result in an increase of vessel traffic if it is to go ahead.

It is possible that the presence of novel floating wind devices may attract visitors including media, industry or government representatives, as well as recreational vessels as observed in Strangford Loch in relation to tidal devices. Again, the remoteness of the Dounreay site and notification warnings of the hazards should minimise casual visits.

An activity which has grown in recent years is passenger cruise ship visits, particularly to Orkney. For 2016 approximately 110 cruise ship visits to Orkney are forecast but only a small proportion are likely to transit the Project area.

From stakeholder consultation, including Harbour Masters, no significant future growth in commercial or fishing traffic was noted. The port development in Scrabster and the development of hydrocarbon resources West of Shetland might lead to a small increase in traffic.

4 Project Description

4.1 Introduction

Hexicon is a Swedish design and engineering company that has developed a semi-submersible foundation for offshore wind power that hosts two Wind Turbine Generators (WTGs). Hexicon wishes to demonstrate this technology in Scottish waters.

In order to be eligible for 3.5 Renewable Obligation Certificates (ROCs) the Project must be commissioned and connected to the grid before the 1st October 2018. Accordingly, Hexicon has created a Special Purpose Vehicle (SPV) called 'Dounreay Trì Limited' for the sole purpose of developing, financing, constructing and demonstrating this technology within a site approximately 6 km off Dounreay, Caithness ('the site') (Figure 4.1).

Dounreay Trì Limited ('the Applicant') is proposing to demonstrate a floating offshore wind farm called Dounreay Trì ('the Project') which shall consist of:

- A two turbine offshore wind farm with an installed capacity of between 8 to 12 megawatts (MW), subject to final approval of The Crown Estate, approximately 6km off Dounreay, Caithness;
- A single export cable to bring the power to shore immediately to the west of the Dounreay Restoration site fence line; and
- Subject to a Connection Offer from Scottish and Southern Energy Power Distribution (SSEPD), the associated onshore electrical infrastructure to connect the Project at, or near, the existing Dounreay 132/33/11kV substation.

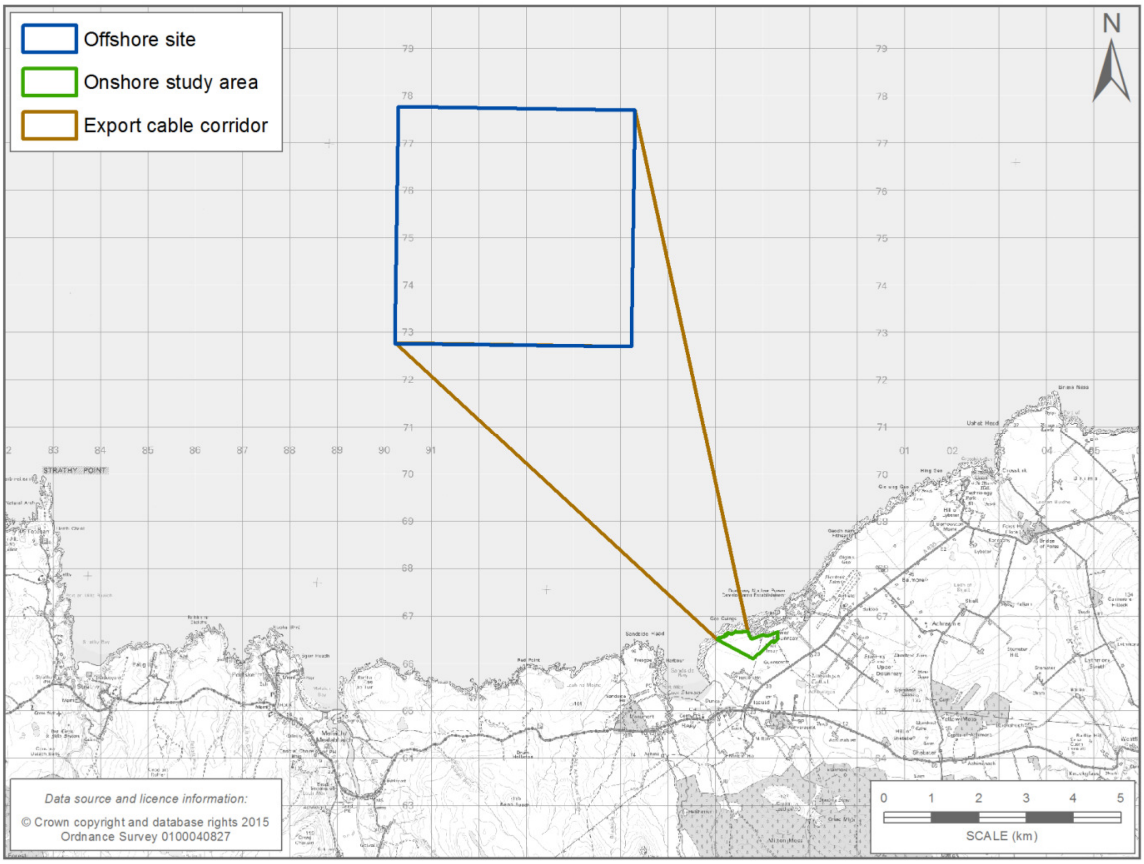


Figure 4.1 Offshore site, export cable corridor and onshore study area

Figure 4.1 depicts the offshore site, the export cable corridor and the onshore study area. Coordinates for the four corners of the offshore site are provided in Table 4.1.

Table 4.1 Offshore site coordinates

Corner	Northing	Westing
NW	$58^0$40’25.6”	$3^0$53’36.0”
NE	$58^0$40’27.7”	$3^0$48’25.7”
SE	$58^0$37’46.0”	$3^0$48’22.0”
SW	$58^0$37’44.0”	$3^0$53’31.9”

4.2 Site Selection and Consideration of Alternatives

Site selection – consideration of alternatives

In August 2014, Hexicon sought to locate a site in Scottish waters to demonstrate their multi-turbine platform. Marine Scotland (2014) had published the Potential Scottish Test Sites for Deep Water Floating Wind Technologies - Regional Locational Guidance (RLG). The Regional Locational Guidance identified eleven sites which were considered suitable for floating wind. Accordingly, each site was reviewed according to Hexicon’s criteria. Only three sites identified in the RLG met Hexicon’s criteria:

- North-east Aberdeen;
- North Coast (Dounreay); and
- Southern Moray Firth.

These three sites were examined in greater detail using publically available information and the results presented at a Site Selection Workshop, hosted by Marine Scotland and attended by Scottish marine stakeholders, in Edinburgh on the 10^{th} October 2014.

On the basis of the information available and feedback from the workshop, the Southern Moray Firth site appeared to be unsuitable for development. A deep trench lay landward of this site so it would be difficult to install the marine cable successfully. The Southern Moray Firth site is also intensively fished and is within an area which is designated for the protection of marine mammals.

The north-east Aberdeen site lay approximately 23km from shore, significantly increasing the length and cost of the export cable. Furthermore, the site and export cable corridor lay within ground that is fished by a range of gear types, including scallop dredgers. Scallop dredging could damage subsea cables, so presented a significant risk for a Project which is reliant on only one export cable.

Hexicon chose the Dounreay site which lies south of the shipping traffic. The Dounreay site was selected for the following reasons:

- The site has suitable water depths, close to shore thus reducing the export cable length and costs compared with other sites;
- The substrate is gravelly sand;
- The average wind speed is good and has been calibrated with data from the Forss Wind Farm;
- On the basis of discussions with Scottish Fishermen’s Federation (2014), the site lies outwith intensively fished areas; and
- Marine Scotland completed a detailed geophysical survey during the summer of 2014, including sub-bottom profile of the site. This information is publically available.

Project objectives

The Project has two key objectives:

- Technical: To test the performance of a multi-turbine floating wind platform in a real offshore environment; e.g. fatigue loading, power output, controls etc. and use these results to refine the platform for larger scale Projects overseas; and
- Economic: Verification of the economic return through this demonstration Project shall provide a base for more reliable estimations for utility scale Projects overseas. This full scale demonstration Project is an important step towards developing a commercially competitive product.

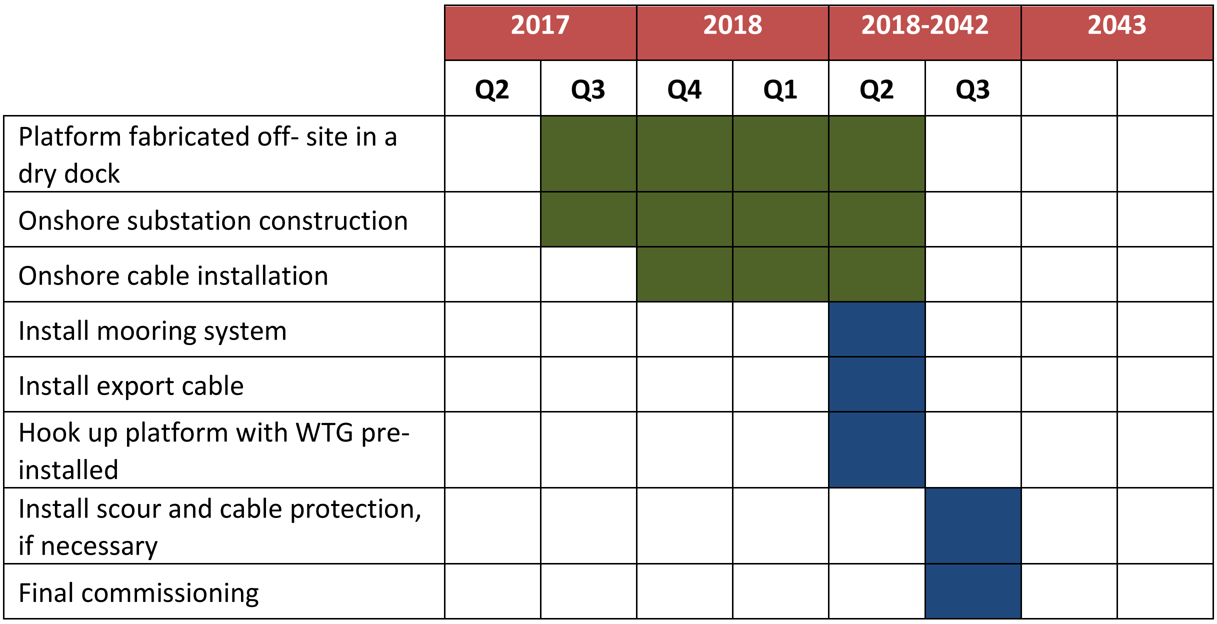
Design envelope

As set out further in Chapter 5: Environmental Impact Assessment Methodology, the ES will include a clearly defined 'Design Envelope'. The Design Envelope is also known in UK legal nomenclature as the Rochdale Envelope[1].

Key components of the Project are outlined below. At this early stage, the Design Envelope remains indicative and will be refined following environmental surveys, technical and engineering studies and in consultation with The Highland Council and other stakeholders.

Construction and operation programme

Figure 4.2 provides the indicative timeframe over which the Project will be constructed and operated.



[1] Case law (for example Rochdale MBC Ex. Parte C Tew 1999) has affirmed the legal principle that the content of any consent for development requiring EIA cannot exceed the scope of EIA. However, an enduring difficulty for the promoters of complex infrastructure Projects such as offshore wind farms is that it is not possible to be precise about each element of a development at the time of the submission of a consent application. A valid approach to this issue is to define a design envelope (known as a Rochdale envelope) comprising a series of realistic worst case scenarios for individual environmental or technical disciplines, which will define the scope of the EIA and in turn the scope of any consent or licence.

Operation								
Decommissioning								

Figure 4.2 Indicative construction and operation programme

4.3 Offshore Infrastructure

The main offshore components will include:

- Two offshore wind turbines;
- A semi-submersible foundation;
- Mooring clump weight;
- Mooring chain and/or steel lines;
- Drag embedment anchors;
- One cable to bring the renewable electricity ashore; and
- Scour protection for the anchors and the export cable, where necessary.

Turbine envelope

The turbine envelope sets maximum and minimum turbine dimensions against which the environmental impacts of this Project have been assessed. These minimum and maximum dimensions used to define the turbine envelope are based on current offshore wind turbine technology.

Table 4.2 Turbine envelope

Nominal Rating	Maximum Rotor Tip Height (m MHWS)	Maximum Number of Turbines	Maximum Rotor Diameter (m)	Maximum Hub Height (above MHWS)	Minimum Air Draft (above MHWS)
4MW	185	2	130	120	22
5MW	186	2	132	120	22
6MW	201	2	154	124	22

Each wind turbine operates automatically. Each turbine can yaw – the nacelle rotates to face the rotor blades into the wind. The rotor blades can also pitch – the blades can rotate into or out of the wind depending on the wind speed. Each turbine is self-starting when the wind speed reaches an average of about 3 to 5m/s (about 10 mph). The output increases with the wind speed until the wind speed reaches typically 10 to 13m/s (about 25mph). At this point, the power is regulated at rated (maximum) power. When the maximum operational wind speed is reached, typically 25 to 30m/s (about 60mph), the wind turbine will cut-out, either fully or gradually, in order to limit loading. If the high wind speed cut-out is gradual, the wind turbine will continue to generate some power through to higher wind speeds, the maximum being dependent on the wind turbine design. A SCADA (Supervisory Control and Data Acquisition) computer system monitors and controls the output from each wind turbine. An integrated alarm system will be triggered automatically in the event of a turbine fault.

Turbine installation

The wind turbines will be installed and commissioned at the fabrication port, prior to transit to the Dounreay site.

Safety requirements

The Project will be designed and constructed to satisfy the safety requirements of the Maritime and Coastguard Agency (MCA) as well as the marking, lighting and fog-horn specifications of the Civil Aviation Authority (CAA) and the Northern Lighthouse Board (NLB). At present, requirements specify that the turbines must be marked with lights that are visible from 2nm. The Project shall be marked on navigational charts.

When in operation, the platform shall be marked with clearly visible unique identification characters, which will be visible from all sides and comply with applicable requirements in Maritime and Coastguard Agency Marine Guidance Notice MGN 543. Currently these recommend that they should be visible from at least 150m from the structure and permanently lit by down lights to minimise light pollution. The colour scheme of the turbine tower, nacelle and blades is likely to be light grey RAL 7035, white RAL 9010 or equivalent.

The platform

The platform is a large, floating, semi-submersible platform supporting two WTGs. The exact size of the platform shall be determined by the rotor diameter of the turbines used. Table 4.3 sets out the indicative platform length and other dimensions in relation to the turbine envelope.

Table 4.3 Indicative platform dimensions

	Turbine Options		
Aspect	**4MW**	**5MW**	**6MW**
Length	195m	200m	230m
Width	105m	110m	135m
Height above water surface	15m	15m	15m
Draft (transit)	8.5m	8.5m	8.5m
Draft (operational)	15m	15m	15m
Total displacement	14100 Te	15200 Te	23000 Te

The topside of the platform would be painted yellow to improve visibility and provide corrosion protection. Figure 4.4 provides further illustration. Figure 4.3 provides indicative details of the platform dimensions and parameters when utilizing 6MW turbines with a rotor diameter of 154m. The platform including the 360^{o} turn radius and allowing for some lateral movement, would occupy a sea surface area of approximately 0.17km^2.

Figure 4.3 Floating platform concept

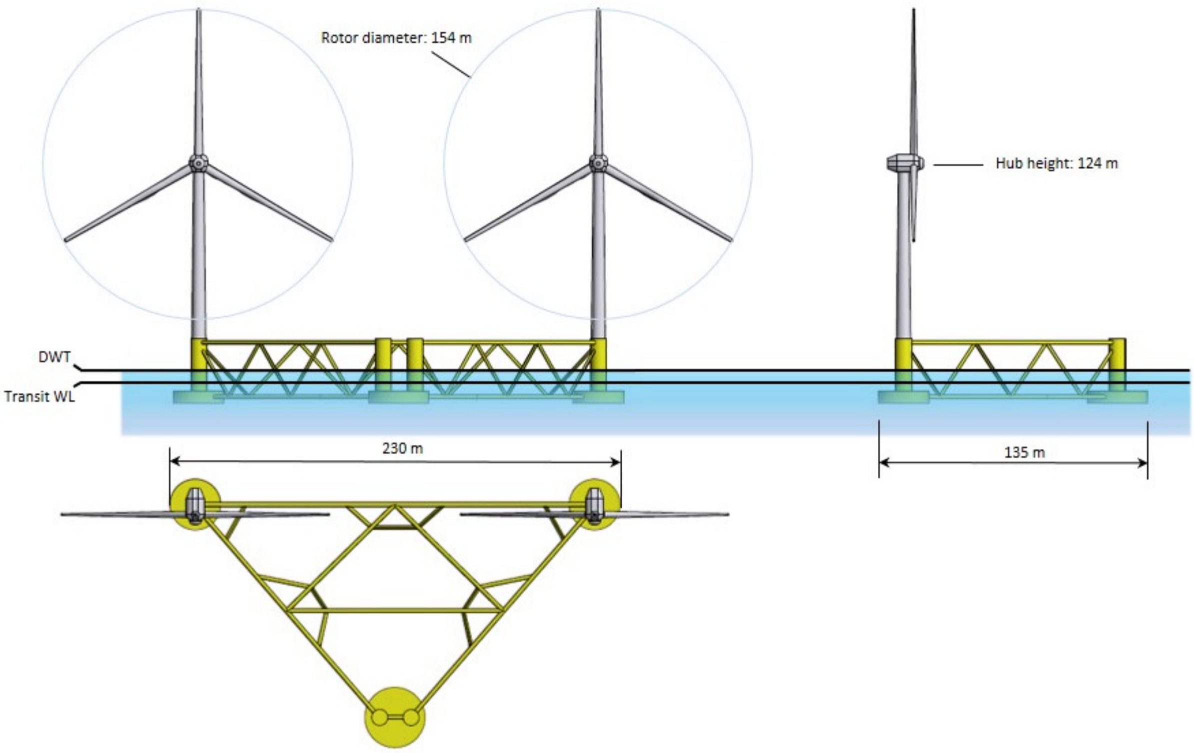


Figure 4.4 Indicative platform parameters (assuming 6MW turbines are used)

The process for the platform construction and installation shall be as follows:

- The steel is rolled at a steel yard;
- The buoyancy columns are fabricated at a steel or construction yard;
- The steel components are shipped by barge to a dry dock facility for fabrication;

- The turbines are shipped to the dry dock, hoisted onto the platform and are commissioned whilst in the dock;
- The platform, with turbines installed, is floated out of the dry dock and towed by up to 4 tugs to the offshore site;
- The platform is connected to the mooring system and export cable; and
- The Project undergoes final checks before exporting power.

The tow shall be completed by up to four anchor handling tugs with support and guard vessels (Table 4.4). The installation of the platform may require four anchor handling tugs to hold the platform in position with a dive support vessel onsite to connect the platform to the mooring lines and export cable. A Notice to Mariners would be promulgated to local ports and marine users prior to transit and installation works. Local vessels may be employed as guard vessels.

Table 4.4 Platform tow out and installation vessels

Installation Details	Requirement	Value
Tow out and positioning	Description	Up to 4 Anchor Handling Tug Supply (AHTS) vessels.
Connection of mooring system and export cable	Description	Up to 5 support vessels. This will include up to 4 crew transfer boats, 1 dive support vessel and up to 2 guard vessels

Safety zone

A declaration shall be sought from Scottish Ministers for a 500m safety zone around construction works within the offshore site.

Mooring system

The platform must rotate 360^o in order to reduce wake effects (i.e. turbulence) between the turbines. Wake effects can occur when one turbine is downwind of the other. The platform shall use a passive mooring system which aligns with the prevailing tidal, wind and wave conditions similar to the way a boat swings at anchor.

The mooring system shall consist of up to 8 mooring lines which are anchored to the seabed. The mooring lines shall pass through a 600 tonne clump weight (50m by 50m) which shall be suspended in the water beneath the platform. This clump shall hold the anchor lines taut in the water column beneath the platform. The clump weight shall act like a pendulum which dampens lateral movement.

The mooring system is shown in plan view in Figure 4.5 and in profile in Figure 4.6. There are up to 8 mooring lines for holding the platform in position.

The anchors would have a maximum radius of 800m from the platform centre and occupy an area of approximately 2km^2 on the seabed.

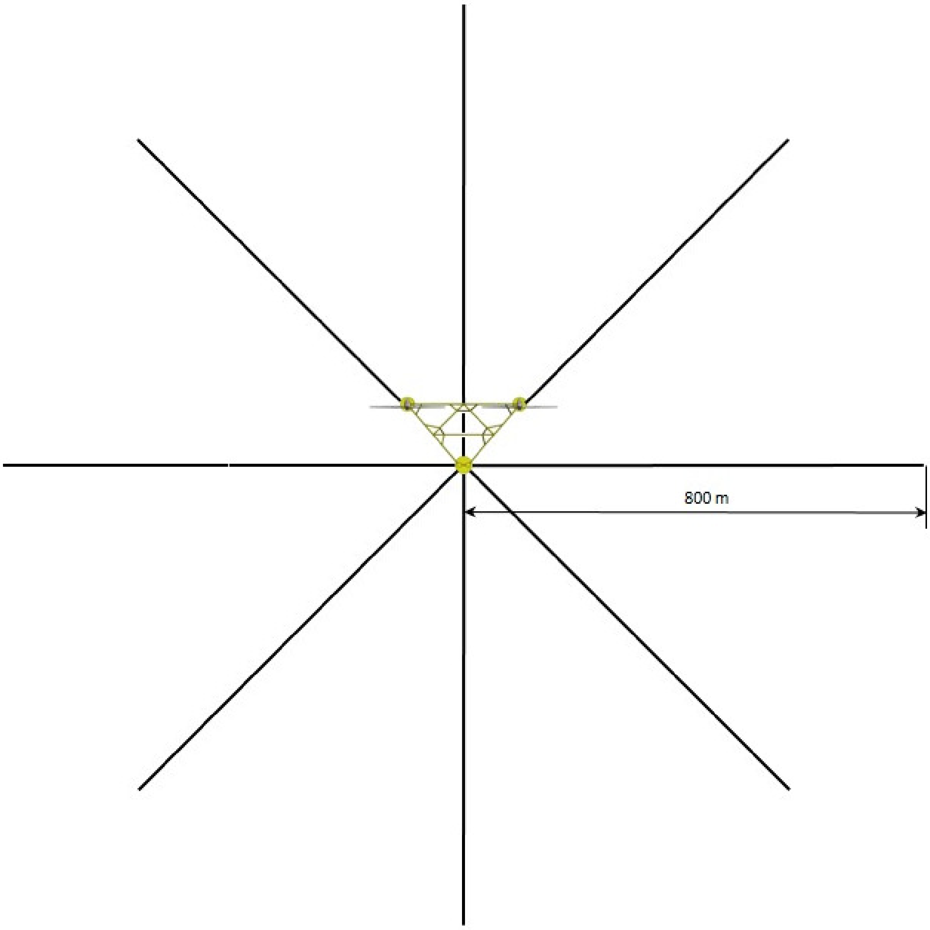


Figure 4.5 Mooring system plan

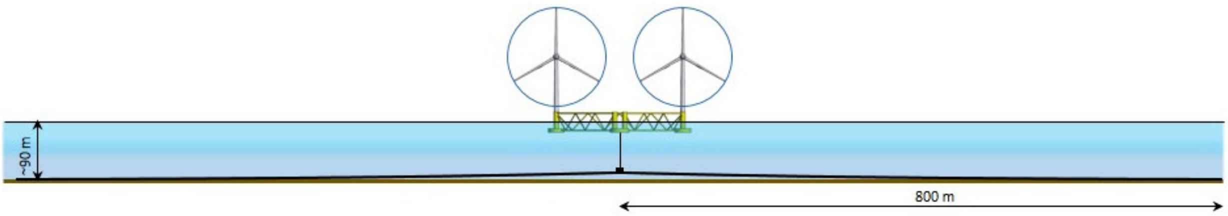


Figure 4.6 Mooring system (profile)

The clump weight shall be brought to site ahead of the platform. The clump weight shall be lowered on the seafloor, temporarily. Once the platform is in place then the clump weight shall be hoisted from the seafloor and remain suspended beneath the platform during operation.

The plinth for the clump weight may require dredging to level the seabed. Dounreay Trì Limited are currently (September 2016) conducting a geophysical survey within the site to determine the sediment depth and firmness within the Site. The plinth would measure approximately 70m by 70m and may need to be dredged to a maximum depth of 5m. The approximate volume of dredge material would be 24,500m3. The dredged material would be replaced by clean, crushed stone. The dredged material has not yet been characterised so a proper assessment cannot be made of its potential impacts on human health and the environment, consequently it shall not be disposed of at sea. The dredged material shall be disposed of at a licenced site onshore.

Dounreay Trì Limited shall require a separate Marine Licence to dredge an area beneath the platform, in order to level it. The need for dredging shall not be confirmed until the detailed design of the platform is complete. If dredging is required then Dounreay Trì Limited understands that sediment samples must be collected, analysed and provided to MS-LOT prior to support another Marine Licence application for dredging. Any dredging licence application would be made separately to this application and subject to additional consultation. Dounreay Trì Limited has considered the environmental effects associated with dredging in this Environmental Statement to the extent that is possible but Dounreay Trì Limited accepts that further environmental assessment would be necessary to support any additional Marine Licence for dredging.

Mooring lines

The mooring lines are most likely to be chain, steel wire or a combination thereof. Offshore grade mooring chains of 100mm to 160mm diameter may be used.

The 8 mooring lines are each approximately 800m long and may be slack. For the purposes of the assessment it is assumed that up to 75% of each mooring line could come into contact with the seabed.

Anchors

Drag embedment anchors shall be used. The holding capacity of a drag embedment anchor is generated by the resistance of the soil between the anchor and the platform. It is possible to add more than one anchor to each mooring line in order to increase the holding capacity. The platform may require up to two anchors on each mooring line so up to 16 drag embedment anchors in total. Each anchor shall be up to 9m long and 9m wide, assuming 30 ton Stevpris Mk 5 anchors are used (Figure 4.7). These drag embedment anchors are design to penetrate 10-15m into the seabed, subject to seabed conditions. The anchors would be installed by an Anchor Handling Tug Supply vessel.

Figure 4.7 Stevpris Mk 5 Drag Embedment Anchor (Image: www.vryhof.com)

Scour protection

Scour protection is designed to prevent structures being undermined by sediment processes and seabed erosion. The impacts of scour can be managed by protecting the seabed around the base of the anchors and the export cable. Several types of scour protection exist, including mattress protection, sand bags, grout-filled bags, stone bags and artificial seaweeds. However, the placement of large quantities of crushed rock around the base of the foundation structure is the most frequently used solution. The base case is that no scour protection is required; however if scour protection were to be used, then the foot print would extend no more than 20m out from the centre of the anchor and to a height of 2m above the seabed (Table 4.5).

Table 4.5 Scour protection details

Scour Protection	Unit	Measurement
Type of scour protection	-	Rock
Diameter of rocks used	m	0.06-0.65
Height of scour protection above original seabed	m	2
Extent of scour protection (from centre of anchor)	m	20
Seabed area take (per anchor)	m^2	1,260
Anticipated number of vessels required including support vessels	-	2
Vessel type	-	Dynamically positioned fall-pipe vessel Crew transfer vessel

Intra-array cables

Intra-array cables shall connect the two wind turbines. These cables shall be integrated into the top-side of the platform.

Export cable

The export cable shall be buried in the seabed between the site and the landfall. The export cable will make landfall in an area immediately to the west of the Dounreay restoration site (Figure 4.1). The export cable would be between 6 and 13.8km in length, depending on the final position of the platform within the site.

The marine cable shall include conductor cores and a fibre optic cable encased in one cable which is armoured. The copper or aluminium conductors are covered by an insulation of polyethylene (cross linked XLPE) or EPR (Ethylene Propylene Rubber). The insulation is contained within an insulation screen, a lead alloy sheath (to ensure no ingress of water into the insulation). The diameter of the cable would be a maximum of 0.5m.

The portion of the cable closest to the platform shall be dynamic so the platform can rise and fall without stretching or snapping the cable. A dynamic cable would typically be suspended in a "lazy-wave" (s-shape) acting like a flexible riser would on an oil and gas platform. Buoyancy elements lift the cable from the seabed and suspend it in the water column, well below the sea surface. The cable shall touchdown on the seabed approximately 250m beyond the platform. Approximately 20% (50m) of the dynamic cable may come into contact with the seabed as the platform moves. A small drag embedment anchor or clump weight shall stabilise the export cable touchdown. Thereafter the export cable will be buried under the seabed with a target burial depth of 1-2m.

Ploughing is the preferred cable installation method (see Figure 4.8 and Figure 4.9). Although jetting or vertical injection may be used where local sediments require. The export cable will be buried within a trench up to maximum 8m wide and up to 2m deep. Depending on seabed conditions along the export cable corridor it may not be possible to bury the full length of cable to the desired depth. Where it is not possible to bury the cable, rock may be required to protect the cable. As a worst case it is assumed that a maximum of (20%) 2.8km of cable may require protection.

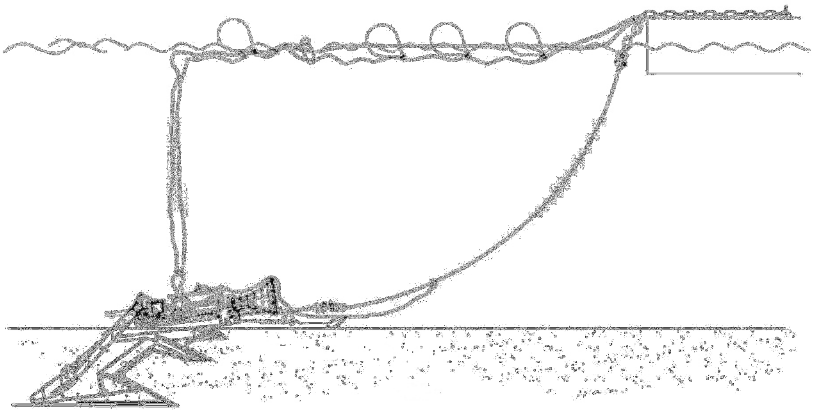


Figure 4.8 Plough towing arrangement

Figure 4.9 Example of a cable plough

The installation of the export cable is most likely to be carried out in one operation where the cable is laid and buried from the same vessel simultaneously.

The general procedure for the installation of the array cables is as follows:

- **Pre-Laying Grapnel Run**: Not long before the cables are laid, a Pre-Laying Grapnel Run (PLGR) will be carried out along the cable route. The main purpose of this is to ensure the cable routes are clear from shallow buried linear obstructions to burial such as old fishing gear or rope; and
- **Cable laying and pull through**: consisting of laying the cable from the shore to the platform and pulling the seaward end through the clump weight.

Indicative export cable burial values are provided in Table 4.6.

Table 4.6 Indicative export cable burial values

Cable Parameter	Requirement	Value
Specification	Range	AC Cable Diameter (including armour and insulation) – up to 0.5m
Length	Range	6 – 13.8km
Burial depth	Range	Generally the cable will be buried at 1 – 2m. In extreme cases this can be as high as 3m. Sections of the cables will be surface laid if soil conditions are hard and/or the risk of cable damage is very low.
Width of seabed affected per cable during burial	Max	1-8m depending on soil conditions and burial method
Burial spoil	Jetting	Jetting may cause sediment suspension. This volume of sediment suspension depends on the soil conditions. For the calculation of the maximum volume of the sediment suspension, it can be assumed that there is 100% sediment suspension along 95% of the total cable length from a trench up to 3m deep and 0.6m wide. It should be noted that this is based on burial with a jet and does not represent the actual shape of the trench which in reality could be wider and v-shaped. For the remaining 5%, it can be assumed that there is 100% sediment suspension from a trench up to 10m deep and 1m wide with straight sides. It should be noted that this is based on burial with a vertical injector and does not represent the actual shape of the trench which in reality could be wider and v-shaped.
	Ploughing	Ploughing will not result in substantive sediment suspension. Spoil will be pushed up out of the trench to lay in a berm on either side. A multi-pass plough will dig a v-shaped trench up to 2m deep and 3m wide. Spoil can be backfilled if required.
Type of cable protection	-	Rock
Diameter of rocks used	m	0.06-0.65
Height of cable protection above original seabed	m	2
Width of cable protection	m	8
Length of cable protection	m	2,800
Seabed area take	m^2	22,400
Anticipated number of vessels required including support vessels	-	2
Vessel Type	-	Dynamically Positioned Fall-pipe Vessel Crew transfer vessel

Cable crossings

There are no known active or inactive cables within either the offshore site or export cable corridor.

Offshore substation

This Project shall not require an offshore substation.

Offshore anemometer mast

This Project shall not require an offshore anemometer mast.

Fabrication and installation activities

The platform is a steel truss structure with welded steel joints. The basic premise of the fabrication and installation methodology is as follows:

- Rolling of steel and fabrication of sections of the platform, Scottish fabrication options are being explored;
- Joining of the sections of the platform in a dry dock;
- Turbine installation and commissioning in the dry dock;
- While the fabrication is taking place, the subsea cable, anchors, mooring lines and clump weight will be installed at the Dounreay site. The lines will be buoyed and marked as required, ready for installation of the platform. Anchor handling and installation can be carried out from a local port using local support vessels, where possible. Cable laying and particularly anchor installation will be done as late as possible prior to platform installation to minimise risks to the components and shipping. Scour protection for the anchors and cable may be required depending on the seabed conditions and the metocean conditions experienced at the site;
- Tow the platform to site and then hook up to the export cable and the anchor lines; and
- Final testing and export power.

The environmental management of construction activities will be carried out under the provisions of an Environmental Management Plan (EMP), which will be agreed with key stakeholders prior to construction. The provisions of an EMP typically include issues such as fuel and chemical handling, pollution prevention and control and storage of waste and effluent.

Programme of works (offshore)

Approximate durations for typical construction activities associated with individual components are provided below:

- Fabrication and turbine installation may take approximately 12 - 18 months. The platform shall be fabricated in a dry dock, off site; and
- Subsea cable, anchors and mooring lines would be installed at the Dounreay site, as will the anchors and mooring lines. This would take 2 - 3 months, subject to weather.

The overall programme of works would likely remain 12 - 18 months as the fabrication of the platform and installation of the cable, anchors and moorings would occur in parallel.

Operations and maintenance

Once operational, the Project will require regular inspections, servicing and maintenance throughout its lifetime. This will require technicians and support staff. Given the distance of the Project from shore and the Project size, it is assumed that an Operations and Maintenance (O&M) hub at an existing port may be required. The O&M hub would be shortlisted and selected during the consent determination period. O&M vessels would steam between the port and the Project. Operations and maintenance activities will be defined within the Design Envelope and addressed in the relevant technical chapters of the ES.

Turbine maintenance falls into two categories: Preventative maintenance and corrective maintenance. Preventive maintenance will be mostly undertaken using crew vessels (although helicopters could be used in certain circumstances) to access the turbine and includes tasks such as the replacement of consumables (filters and oil) as well as a general inspection of the turbine. Crew transfers from vessels are expected to be via boat landing whereas helicopter access will be via heli-hoist. Corrective maintenance includes minor repairs/restarts and major component replacements (such as generator, blades, etc.). This is required if the results of condition monitoring or preventive maintenance suggest it is necessary, or if monitoring alarms are triggered (some of which may result in the wind turbines being remotely shutdown). It is expected that on average up to eight visits per turbine, per year will be required for fault rectification and up to three per turbine, per year for major component replacement (these figures may vary significantly from year to year). Corrective maintenance will be carried out using crew boats, helicopter or specialised vessels depending on weather conditions and the details of the breakdown. Major component replacements (nacelle, blades etc.) may mean that the platform is towed to a deep water port or dry dock.

Foundation maintenance will be mostly undertaken using vessels to access the foundations and divers or ROVs for subsea inspections. Preventative maintenance operations will include routine inspections of the subsea and topside structures, along with confined space operations which may require specialised technicians. The structural integrity of the foundation structure and ancillary structure (access ladders, walkways etc.) will be assessed along with the level of corrosion and marine growth. Marine growth will be removed if it is causing excessive loading on the foundation structure or restricting access. Pressure washers (using high-pressure sea water with no additives) will most likely be used for general cleaning and removing marine growth on key areas such as access ladders and walkways.

Additionally, separate inspections (such as side-scan sonar or ROVs) will inspect the condition of the seabed and scour protection (if utilised) around the anchors and export cable.

Decommissioning

The design life of the turbines and other major components of the Project are likely to be 25 years. The Energy Act 2004 requires Dounreay Trì Limited to provide a decommissioning plan, supported by appropriate financial security, prior to constructing the Project. Decommissioning activities will comply with all relevant legislation at that time.

At the end of the operational lifetime of the Project, it is anticipated that there will be a requirement for all structures above the seabed to be completely removed. For the purposes of the EIA, the decommissioning of the wind farm is likely to be the reverse of the construction process. Decommissioning best practice and legislation will be applied at that time.

Decommissioning the platform

The removal and dismantling of the platform will largely be a reversal of the installation process and subject to the same constraints. Even though decommissioning may not require the same level of precision as installation, it will be undertaken in the same controlled manner and in accordance with a risk management plan to ensure the same level of safety and pollution control measures. Components will be reused or recycled, where possible.

Decommissioning the export cable

Relevant stakeholders and regulators will be consulted to determine which sections of the offshore cable will need to be removed. If there are no issues with stakeholders/regulators and the risk of the cable becoming exposed is minimal, then the cable may be left *in situ* to avoid disturbing the seabed unnecessarily. The ends of the cables will be cut as close to the seabed. The ends will be weighted down and buried (probably using an ROV) to ensure they do not interfere with trawling etc.

The sequence for removal of the cable is anticipated to be:

- Locate the cable using a grapnel and lift it from the seabed. Alternatively, or in addition, it may be necessary to use an ROV to cut and/or attach a lifting attachment to the cable so that it can be recovered to the vessel;
- Seabed material may need to be removed to locate the cable. This is likely to be carried out using a water jetting tool similar to that used during cable installation;
- The recovery vessel will either 'peel out' the cable as it moves backwards along the cable route whilst picking it up on the winch or cable engines, or, if the seabed is very stiff/hard it may first under-run the cable with a suspended sheave block to lift the cable from the seabed. The use of a suspended sheave block could be carried out before by a separate vessel such as a tug prior to the recovery vessel 'peeling out' the cable;
- The recovery vessel will either spool the recovered cable into a carousel or cut into lengths as it is brought aboard before transport to shore; and
- The cables will be recycled onshore.

Removal of scour protection

It may be preferable to leave the scour protection *in situ* to preserve the marine habitat that may have developed over 25 years. Relevant stakeholders and regulators will be consulted to establish what the best approach is. If removal is deemed necessary, the removal sequence is anticipated to be:

- For rock armour, the individual boulders are likely to be recovered using a grab vessel, and transferred to a suitable barge for transport to an approved onshore site for appropriate re-use or disposal; or
- The filter layer is likely to be dredged and transported to be re-used or disposed of at a licensed disposal area (this could be offshore or onshore).

5 Analysis of Marine Traffic

The purpose of the marine traffic analysis is to provide an assessment of current and potential future traffic densities within and adjacent to the Project area to inform the evaluation of navigational safety in relation to the Project proposals.

This section summarises the results of desk-based maritime traffic surveys and data gathered to inform the NRA. The analysis includes a combination of datasets comprising AIS, VMS and additional sources compiled by Marine Scotland and The Crown Estate. An overview of each dataset is provided and confidence and resilience of the data are discussed. The data are analysed by vessel type and the effects of the Project proposals on vessel traffic are discussed with consideration of predicted cumulative and in-combination effects.

5.1 Methodology

5.1.1 Appropriate level of traffic assessment

It has been proposed to and agreed with MCA that an appropriate and proportionate level of assessment for the NRA for this small Project located west of the Pentland Firth is at Level 1a and 1b as defined in the DECC/MCA Guidance (DECC/MCA 2013, p63).

The Level 1 (1a and 1b) Area Traffic Assessment requires the assessment of the marine environment, traffic densities and general navigational issues to predict the risk of collision, contact, grounding and stranding in relation to the proposed Project. The Level 1 assessments are qualitative using expert judgement. In comparison, the Level 2, Level 3 and Level 4 assessments require quantitative analysis, simulations and trials as appropriate for high traffic densities or higher risk scenarios.

The Level 1a traffic assessment is required to cover the regional area, for which both Project-gathered data and SANAP assessment (The Crown Estate 2014) is used. The Level 1b assessment is of the traffic around the Project area.

5.1.2 Project area

To cover all features of the proposed development, the Project area for this analysis as shown in Figure 1.1 includes the:

- Offshore site; and
- Export Cable corridor to Sandside Bay.

5.1.3 Vessel categories considered

The traffic analysis presented below starts with an overview section and continues with analysis for each of the main vessel categories in turn, i.e. cargo, tanker, passenger, tug, military, law enforcement, fishing and recreational is described in more detail utilising a range of data sources as described below.

5.2 Sources of Information

The following sources of information were used to inform this analysis of marine traffic (also see 0):

- AIS data gathered in summer 2015 and winter 2016 and analysed specifically for the Project (see Section 5.2.1);
- Vessel Monitoring System (VMS) data for the years 2011, 2012 and 2013 provided by Marine Scotland (see Section 5.2.2);

- Data on small fishing vessel movements from the ScotMap Pilot Study of Fishing in PFOW (Marine Scotland 2012a; see Section 5.2.3);
- AIS and other information to provide context to the Project data were gathered from the PFOW Strategic Area Navigation Appraisal (SANAP) (The Crown Estate 2014); (see Section 5.2.1);
- Information from the Shipping Study of PFOW (Marine Scotland 2012b);
- RYA UK Coastal Atlas (RYA 2009); and
- Consultation (see Section 5.2.5).

The sources used are described in more detail in the sections that follow and are summarised in 0.

5.2.1 Automatic Identification System (AIS) data

This analysis of marine traffic was informed by data gathered from vessels carrying AIS (Automatic Identification System) equipment. Those vessels in EU member states required to fit and use AIS are:

- All (non-fishing) vessels > 300 gross tonnes;
- All passenger ships regardless of size;
- All fishing vessels > 24m length by May 2012;
- All fishing vessels > 18m length by May 2013; and
- All fishing vessels >15m length by May 2014.

The main source of AIS data was Project-gathered AIS over 12 months for the region around and including the Project area. It was gathered for two weeks in summer (July 18th-31st 2015) and two weeks in winter (January 18th-31st 2016) by two receivers installed by EMEC (to monitor vessel activity at its wave and tidal test sites in Orkney) and by Orkney Harbours' Vessel Traffic Service (VTS). This AIS data was analysed to inform this NRA. EMEC's AIS receivers are situated at Black Craig on the West Mainland coast of Orkney and on the northern island of Eday. The spatial coverage of this AIS data ranges from the Minch in the west, to the Moray Firth in the east. The Orkney Harbours AIS receivers are based at Scapa, Wideford Hill (Kirkwall), Orphir and Sandy Hill (South Ronaldsay) and cover a minimum radius of 36nm.

The AIS data were converted to vessel tracks, and tracks were then investigated further within the Project area. Data are presented as the number and type of vessels.

AIS data from SANAP (The Crown Estate 2014) has been used to complement and corroborate the Project-AIS data. The SANAP AIS data was gathered over four weeks in January/February 2012 and four weeks in July 2012 for the PFOW. These data are referenced as an overview of traffic in PFOW and provide a comparison with the AIS data collected for this Project (as described above).

5.2.2 Vessel Monitoring System (VMS)

For observation and monitoring of Scottish fisheries, Marine Scotland operates a Vessel Monitoring System (VMS). This is a form of satellite tracking using transmitters on-board fishing vessels. The system is a legal requirement under EC Regulation 2244/2003 and Scottish SI 392/2004. All EU, Faroese and Norwegian vessels which exceed 15m overall length must be fitted with VMS units. From 2012, this changed to an overall length of 12m for EU vessels.

A basic VMS unit consists of a GPS receiver which plots the position of the vessel coupled with a communications device which reports the position at a minimum of every two hours.

The unit automatically sends the following data on a predetermined timescale:

- Vessel identification;
- Geographical position;
- Date/time (UTC) fixing of position; and
- Course and speed.

The data used for this analysis were point data provided by Marine Scotland for the Project area for the period April 2011 to March 2014. These data plot the exact positions of vessels; however the data are required to be anonymised so that individual vessels cannot be identified.

5.2.3 Scotmap

The main data source for the smaller fishing vessels (<15m) is the ScotMap Pilot study of Inshore Fishing (Kafas et al., 2014) based on local investigation.

The ScotMap methodology involved extensive interviews between June-October 2011 with skippers/owners of commercial fisheries vessels <15m registered in Kirkwall or Scrabster which were known to fish in the inshore waters within the PFOW strategic area. The interviews capture the spatial range of fishing activity between 2007-2011. Fishing areas were delineated as ‘polygons’ and information gathered for each. Although this information was gathered more than 4 years ago it is included with caution as a valuable source to support and corroborate information from Project consultation. The dataset, as of July 2013, is based on interviews of 1,090 fishermen who collectively identified 2,634 fishing areas or ‘polygons’, the majority of which relate to creel (pot) fishing.

The collated and analysed information reported for each polygon included the following:

- Value of landings – all vessel sizes;
- Number of unique vessels operating (all sizes); and
- Number of unique vessels operating (<10m).

The report notes that most vessels discussed were <15m and many <10m. Crab and lobster creeling were particularly important. The report, therefore, gives a good indication of small vessel activity in inshore waters which is complementary to the AIS analysis which captures the larger fishing vessels. However, there are two important caveats:

- Other vessels may enter the areas which are not registered in Orkney/Scrabster; and
- Individual vessels are not identified.

5.2.4 Recreational vessels data

Some information on sailing vessels is available from RYA in its UK Coastal Atlas (RYA 2009) which shows sailing routes by density of sailing vessel traffic. RYA noted during consultation that more recent data is available, notably the SANAP Report which overlays the original RYA routes with more recent AIS information for PFOW. In addition the Project-specific AIS data set is even more recent.

Local consultation with yachting and recreational kayaking/canoeing organisations will provide qualitative information on sailing and recreational vessel movements.

5.2.5 Consultation

A consultation programme was carried out with local stakeholders to gather essential local knowledge of vessel activity in the area; particularly with regards to smaller vessels and fishing activity. A full record of consultation is provided in Annex A of the Environmental Statement, and relevant responses summarised in Section 7 of the NRA.

A Hazard Identification and Risk Assessment Workshop was held (Section 7.3) to gather expert and local input, however, due to unforeseen circumstances the turnout was not a quorum. It was proposed to reschedule the HIRA event, however it became apparent that there wasn't enough interest to get a quorum and it was therefore decided to hold the HIRA remotely, via teleconference. An initial traffic analysis was provided as part of the discussions; this provided much useful local information which has been included.

5.2.6 Data resilience and confidence limits

MCA have noted the importance of understanding the confidence limits and the resilience of the data used. The combination of data sources used can be described as current and comprehensive but not exhaustive. The data and analysis used for this assessment represent the best practicable approach to achieving the necessary confidence that traffic patterns are understood, including small craft. This requires continuing and future liaison with stakeholders.

The confidence limitations arise, in part, from the variations in regulatory requirements for:

- Fitting of tracking equipment to different types and sizes of vessels; and
- Release to the public domain of the individual identities of fishing vessels' tracking data.

It is not practicable or proportionate to compile a truly exhaustive database of vessel movements. This would require, for example, prolonged and full radar coverage together with a method of identifying every vessel observed. A system such as the Orkney Vessel Traffic Service (VTS) requires vessels to report their identity, position and routing to a 24 hour control facility equipped with extensive radar monitoring. However, the VTS is limited to vessels >12m length overall or when carrying passengers.

The AIS data for this Project has been gathered and analysed for a 28 day (summer and winter) period to give a comprehensive view of the traffic.

The option to collect and analyse radar data was considered but not proposed for the Project for the following reasons:

- The Project is located off a relatively remote part of the north coast with no existing radar coverage which is available to the public;
- The Orkney VTS is the nearest radar-based coverage which requires active interrogation to identify vessels. Costs would be disproportionate to extend to the Project area. Furthermore, only certain vessel sizes and types are required to report and thus smaller vessels may not be captured;
- Installing new, temporary radar equipment for the Project is judged disproportionate to traffic levels and navigational risk in the area;
- Information tracked by radar is limited, in comparison to AIS, and although smaller vessels can be tracked, no information on vessel type or identity is gathered; and
- Information on the activity of smaller vessels can be gathered through local consultation with appropriate stakeholders.

Review of AIS robustness – downtime and aerial coverage

The figures below show the coverage of both the EMEC Black Craig AIS receiver and the Orkney Harbours AIS receiver.

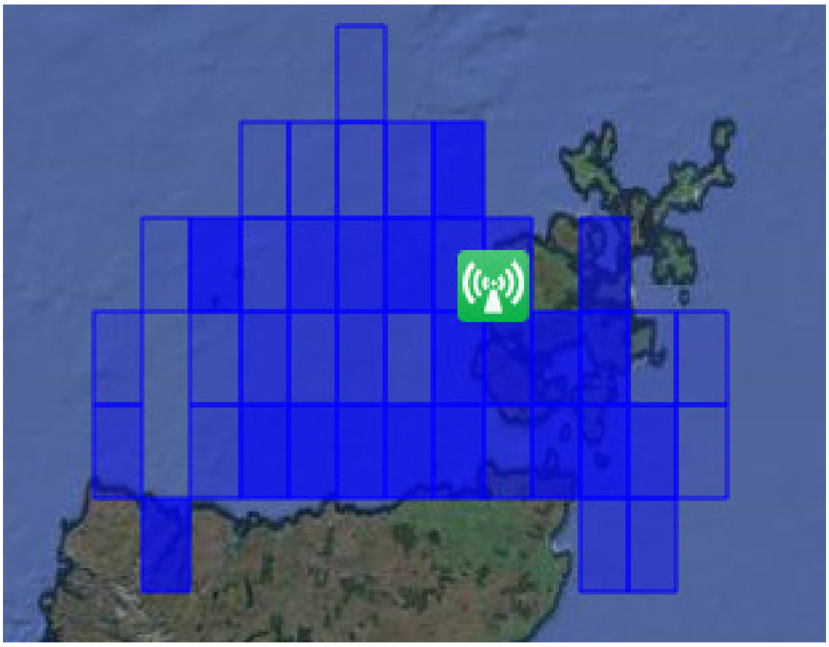


Figure 5.1 EMEC's Black Craig AIS receiver coverage

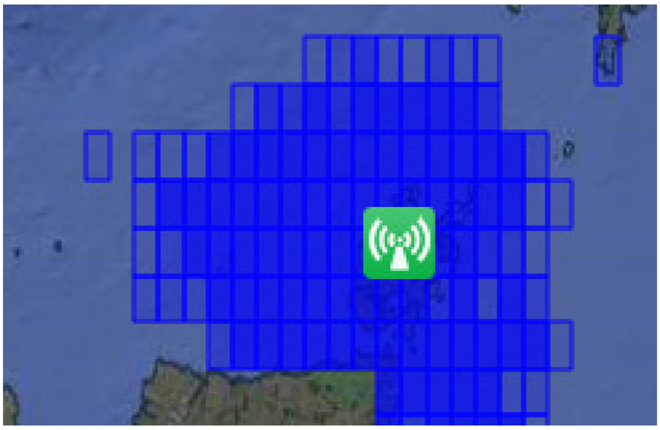


Figure 5.2 Orkney Harbour's Wideford Hill (Kirkwall) AIS receiver coverage

Over the two 14 day periods for which the AIS data were analysed, both stations were fully operational and coverage extended to approximately 100nm from each receiver, as shown in Figure 5.3, Figure 5.4, Figure 5.5 and Figure 5.6 below.

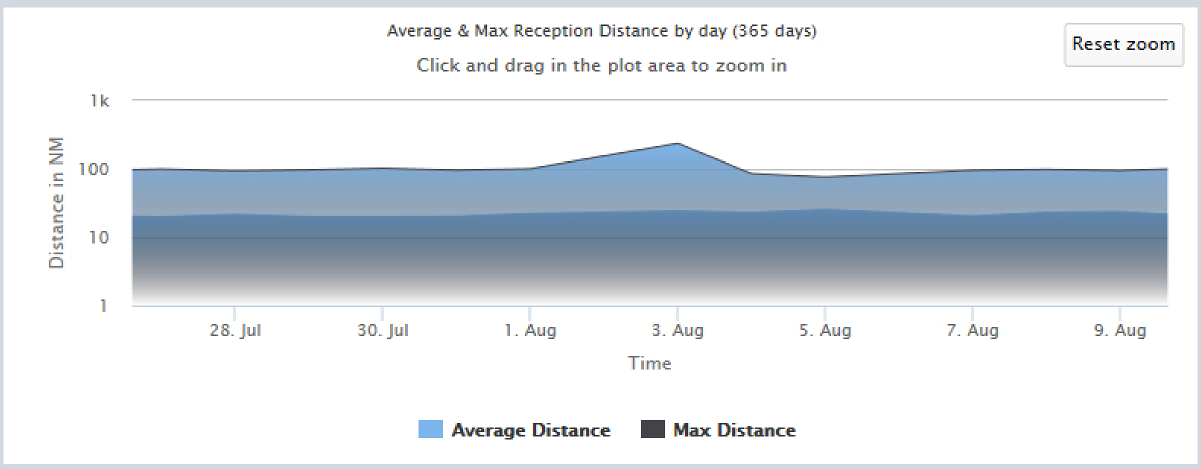


Figure 5.3 Black Craig reception distance for the 14 day summer period

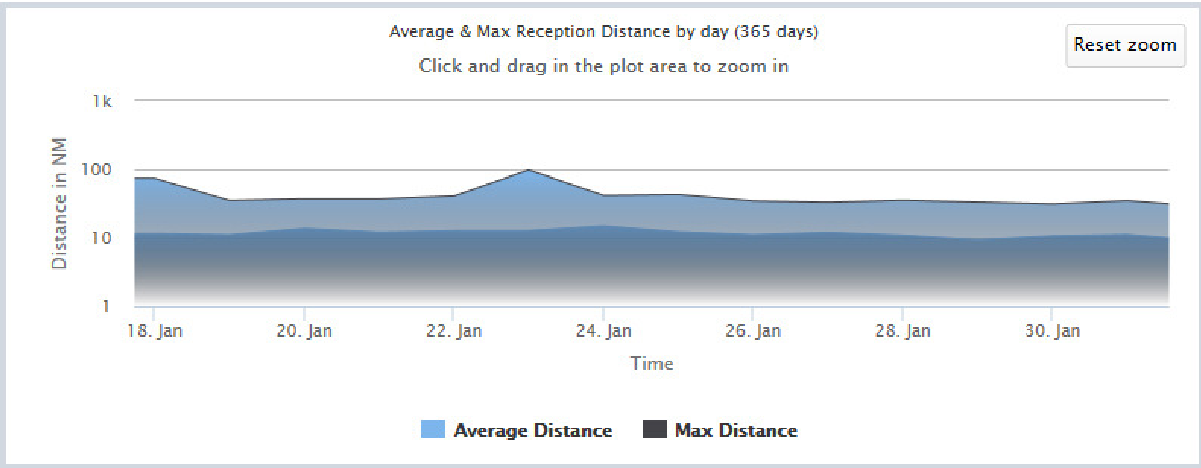


Figure 5.4 Black Craig reception distance for the 14 day winter period

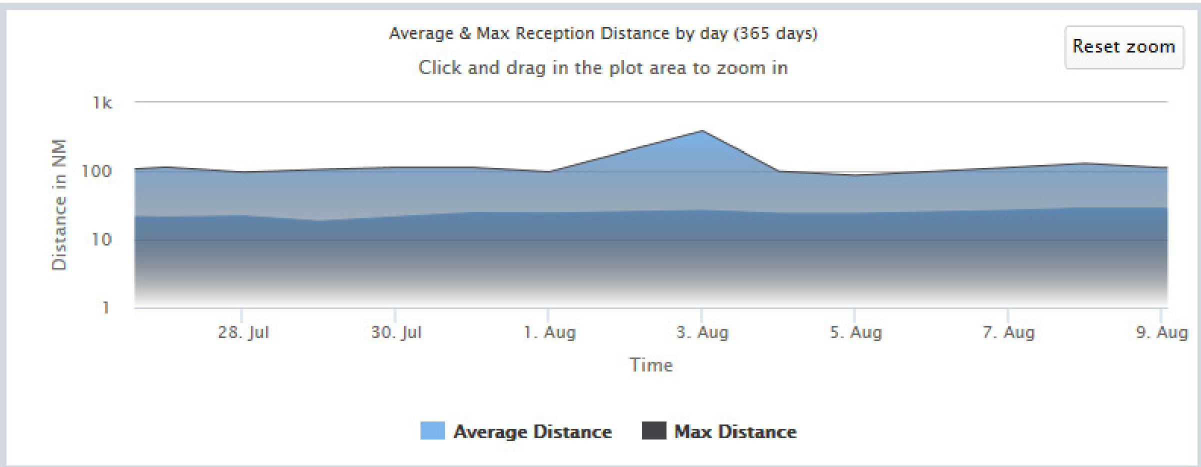


Figure 5.5 Wideford reception distance for the 14 day summer period

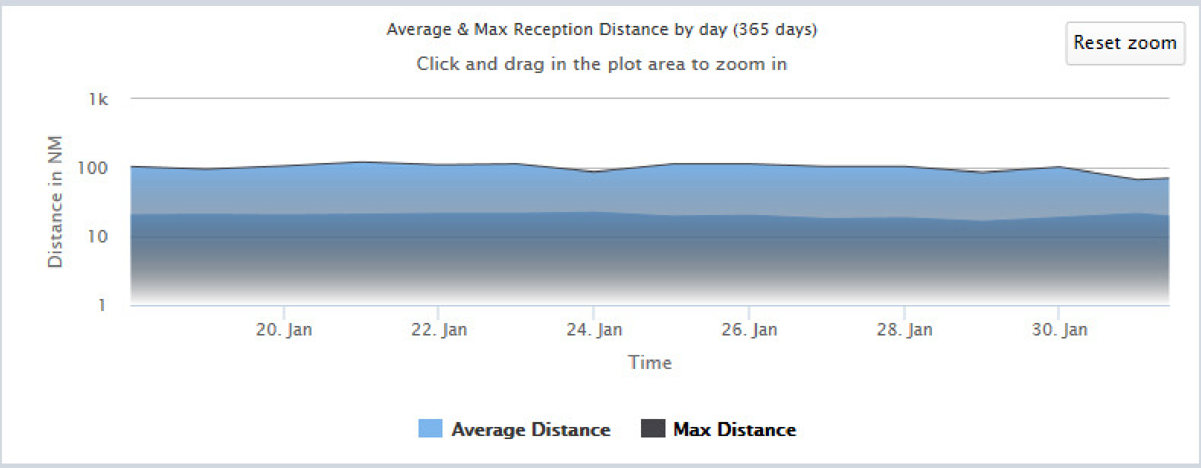


Figure 5.6 Wideford reception distance for the 14 day winter period

The 12 month data are consistent with the separate AIS surveys and analysis of two 28 day periods presented in the SANAP strategic area study (Crown Estate 2014).

In addition to the AIS data for fishing vessels fitted with AIS equipment, three successive years of VMS data provided by Marine Scotland have been assessed. Together AIS and VMS provide a comprehensive view of the larger fishing vessel movements. Neither AIS nor VMS equipment is required to be fitted to small vessels and for these the ScotMap analysis has been used and cross-checked successfully with local consultation.

Finally, as noted above the relatively recent strategic area reports for PFOW (SANAP and ScotMap) provide an important cross-check on the Project data and analysis used in the assessment.

A summary of the data sources used in the analysis of marine traffic is provided in Table 5.1.

Table 5.1 Summary of data sources

Data Source	Source	Temporal Coverage	Vessel Coverage (Category/Length)	Data Confidence and Resilience
AIS	EMEC AIS receivers situated at Black Craig and Eday Orkney Harbours AIS receivers at Scapa, Wideford Hill, Orphir and Sanday Hill	July 18th-31st 2015 and January 18th-31st 2016	All ships > 300 gross tonnes engaged on international traffic All ships >500 gross tonnes not engaged on international traffic All passenger ships regardless of size All fishing vessels > 24m length by May 2012 All fishing vessels > 18m length by May 2013 All fishing vessels >15m length by May 2014	Data have been gathered and analysed for two 14 day periods in summer and winter to give a comprehensive view of the traffic A review of downtime and aerial coverage has been carried out Data are consistent with the separate AIS surveys and analysis of two 28 day periods presented in the PFOW strategic area studies (Marine Scotland 2012b and The Crown Estate 2014). These reports note that AIS tracking can confidently be used to assess commercial traffic but is of less use for recreational vessels Fishing vessels and recreational vessels sized below the AIS size category must be assessed using other methods
VMS	Marine Scotland	April 2011 to March 2014	All EU fishing vessels which exceed 12m overall length from 2012[2] All Faroese and Norwegian fishing vessels which exceed 15m overall length	Data have been provided for each of the three years Analysis allows a quantitative estimate of numbers of vessels coming within the area of interest Data does not identify the vessel so cannot be analysed for repeat visits or for type of fishing vessel
Scotmap Pilot Study of Fishing in PFOW	Marine Scotland 2012a and Kafas et al.,	June-October 2011 information gathered looking back over period 2007-11	Smaller fishing vessels (<15m)	Data have been gathered by an authoritative body using an interview-based methodology (qualitative data) which does not utilise quantitative spatial data recorded directly from vessels

[2] From 2013 the EU Directive changed the requirement for VMS to an overall length of 12m for EU vessels. Approximately 18% of Scottish-registered vessels between 12-15m vessels were fitted by September 2013 and 71% by June 2014 (Fisheries Monitoring Centre Manager, Marine Scotland Compliance (personal communication, 15 July 2014).

Data Source	Source	Temporal Coverage	Vessel Coverage (Category/Length)	Data Confidence and Resilience
	2014	Data is based on interviews of 1,090 fishermen		The analysis for the area of interest does match closely the information gathered in detailed consultation
UK Coastal Atlas	RYA 2009	2008-9	Recreational sailing vessels	A qualitative and relatively old analysis of sailing vessel preferred routes Based on wide consultation by an authoritative organisation
Shipping Study of Pentland Firth and Orkney Waters	MS 2012b	2012	Commercial shipping and recreational vessels	Uses AIS data for commercial traffic which is consistent with SANAP AIS data and Project AIS data Uses AIS data for recreational vessels – but only a minority of sailing vessels are equipped with AIS Useful consultation with recreational vessel users and harbour masters to give a qualitative view of activity which updates the RYA Coastal Atlas Information is congruent with that gathered during Project consultation
Strategic Area Navigation Appraisal (SANAP)	(AIS) The Crown Estate 2014	4 weeks in January to early February 2012 (winter) and 4 weeks July 2012 (summer)	All ships > 300 gross tonnes engaged on international traffic All ships >500 gross tonnes not engaged on international traffic All passenger ships regardless of size All fishing vessels exceeding 24m overall length (by May 2012)	Uses AIS data for all vessel types Data gathered only over 2 x 28 day periods Analysis shows no seasonality except for fishing and recreational vessels AIS data closely matches the 12 month Project AIS data set
Consultation	HIRA and pers comm		All vessel types but with focus on local vessels and movements Fishing activity in the area of interest for both small local vessels and for larger visiting vessels	Qualitative information and not necessarily comprehensive High degree of internal congruence between the various local sources

Data Source	Source	Temporal Coverage	Vessel Coverage (Category/Length)	Data Confidence and Resilience
			Local recreational activity consultation with local and national yacht associations	
HIRA	Attendees described in Section 7.3.2		All navigational activity in and around the area of interest Focus on hazard identification and risk assessment	Expert participants from fishing, RYA, NLB Qualitative assessment and expert judgement

5.3 Overview of Traffic Analysis

The highest densities of marine traffic in the PFOW can be found along a shipping route running to the north of the Scottish mainland, along ferry routes between Orkney and the Scottish Mainland in the central and south of the PFOW area and ferry routes between Orkney and Shetland and the Scottish Mainland to the east. The 12 month AIS analysis for the Project and wider area shows the relative traffic densities (see Figure 5.7). It can be seen in Figure 5.7 that the offshore site has between 0.05 - 0.5 AIS tracks per day, much lower than the area located north of the Project area which clearly indicates vessels transiting east-west to and from the Pentland Firth shipping channel.

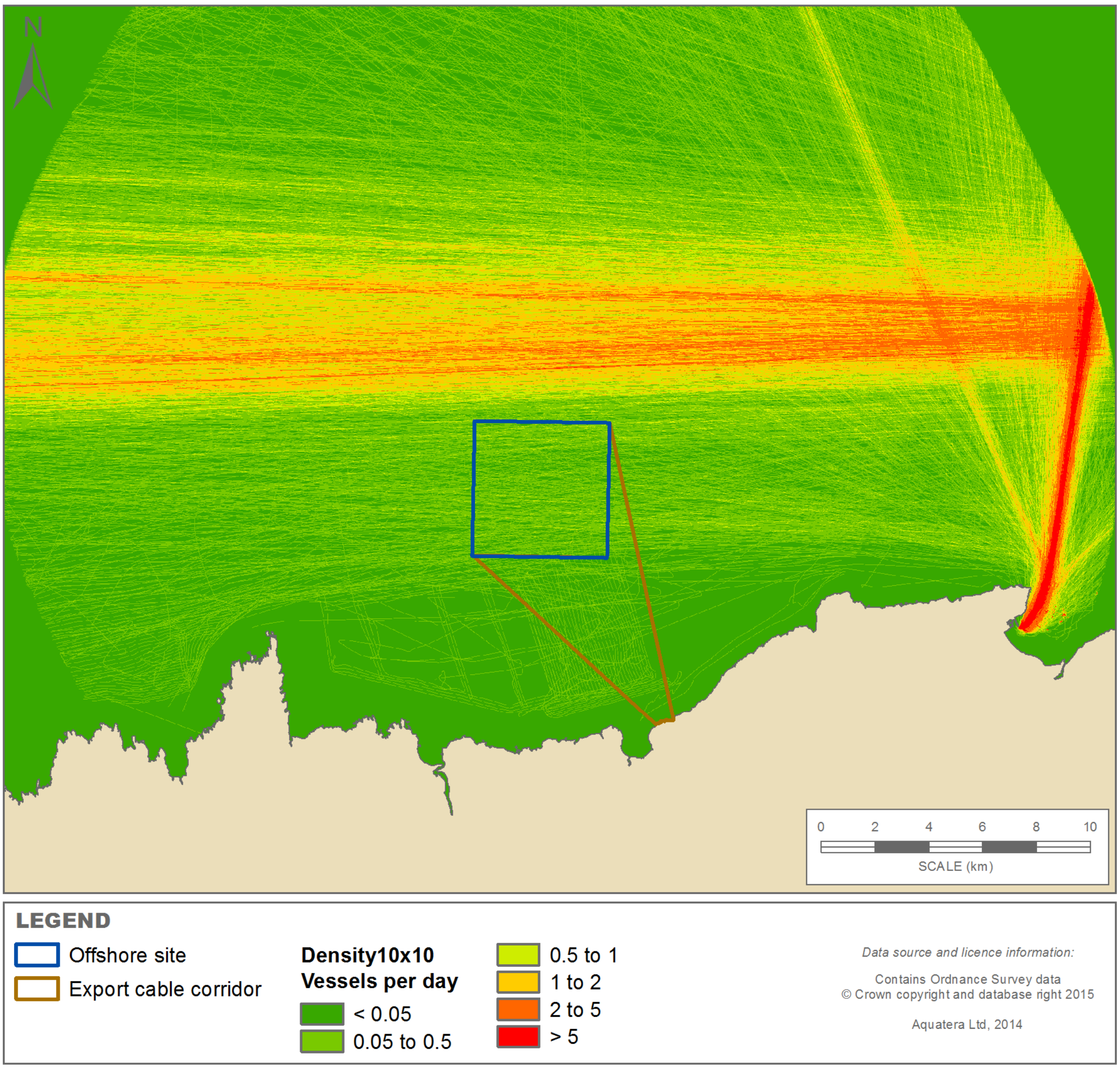


Figure 5.7 Vessel traffic densities for the Project area

In order to obtain more detail of the vessels passing through or close to the Project area, a zone containing the offshore site and export cable corridor was defined. The AIS tracks of vessels during two weeks in summer (July 18th – July 31st 2015) and two weeks in winter (January 18th – January 31st 2016) were plotted in this zone. Vessels are analysed by type in Sections 5.3 to 5.10.

Up to ten different types of vessels transited through or near to the Project area, including: cargo vessels, tankers, tugs, fishing vessels, passenger ferries, search and rescue, research vessels and recreational crafts.

The main seasonal variations are in passenger and offshore vessels, i.e. cruise ships, ferries, and oil and gas vessel movements which are all more frequent during summer. Apart from these there is no significant seasonal variation in AIS-tracked vessels. Variations in recreational vessel movements are described in the relevant section.

Within the overall PFOW area the east-west traffic through the Pentland Firth is clearly significant. The SANAP Report (The Crown Estate 2014, p37) describes this area:

> *"This southerly area between Orkney and mainland Scotland acts as a pinch point for the traffic, where the area available to navigate is reduced and offers less sea room. The hazard this can present may become exacerbated by heavy seas, strong tidal conditions and the frequency of crossing traffic".*

However, it is important to note that the area of interest around the Project area lies well to the west of the pinch point of the Pentland Firth. Vessels have greater sea room to manoeuvre and the vessel tracks visibly fan out to the west. There are no scheduled passenger vessel movements in the area and tidal currents are less strong.

The Project area is located between the north coast and the main shipping route. According to AIS data, fishing vessels accounted for the majority of vessels in the Project area (51%) most of which passed in the northern most section of the Project area (Figure 5.15).

Destinations of these vessels include UK and Eire ports and ports around the North Sea. As noted above there is no significant seasonal variation for AIS-tracked vessels and the SANAP report notes *"The density of commercial shipping, as indicated by AIS, is consistent throughout the year".* The seasonality of fishing and recreational activity is discussed within Sections 5.8.1 and 5.9.1 respectively.

Vessel traffic in the Project area in both the summer and winter analysis periods comprised of:
- 16 individual vessels; and
- All vessels transited on only one day of the study period.

The breakdown by category of vessels is shown in Table 5.2.

Table 5.2 Vessel type by distribution

Vessel Type	Number Recorded in Project Area
Fishing vessels	5
Cargo	6
Tankers	1
Search and rescue	1
Passenger ferries	0
Tugs	0
Recreational crafts	0
Dive vessel	1
Other (research, dredgers, survey and marine support vessels)	1

The AIS analysis of the wider area indicates that the Project area has low cargo traffic levels compared to the main Pentland Firth shipping channel to the north.

The analysis of fishing vessel activity is presented in Section 5.8 of this report but it is concluded that, on average, less than one fishing vessel transits per day occurs in the Project area.

Taken together the frequency of transits through the offshore site by commercial and fishing vessels is approximately 0.75 per day on average. This supports the view of the Project area as one of relatively low traffic density.

The most recent AIS data was gathered during two weeks in summer (July 18th – July 31st 2015) and two weeks in winter (January 18th – January 31st 2016).

The Project AIS data confirm the pattern of the shipping route lying to the north of the Project area (Figure 5.7). In terms of vessel type, fishing vessels (25%) and cargo vessels (44%) represent the majority of vessel transits through the Project area which also correlates with the SANAP findings. More detail on each of the types of vessel traffic in the Project area is provided in the following sections.

In overview, the proposed development area lies well to the west of the Pentland Firth pinch point so there is significantly greater sea room for manoeuvre. Traffic density is low and for all vessel types the average is less than 1 transit per day, although daily fluctuations are to be expected.

5.4 Cargo vessels

5.4.1 Analysis

Data utilised for the analysis includes:

- Project AIS
- Supported by SANAP report.

AIS data for both the summer and winter analysis periods show that that the majority of vessels transiting the Project area were cargo vessels, predominantly in the north of the Project area (Figure 5.8 & Figure 5.9). The distribution and density of cargo vessel transits is consistent with the surveyed analysis in the SANAP report.

The AIS analysis identifies a total of six cargo vessels passing through the Project area over summer and winter analysis periods, with two vessels transiting the offshore area on three occasions. See Appendix E for a summary of vessel transits and draughts.

The main shipping route is a major route from west to east and it is thought the vessels entering the Project area are relatively smaller vessels (draft below 5m) avoiding the busier route to the north.

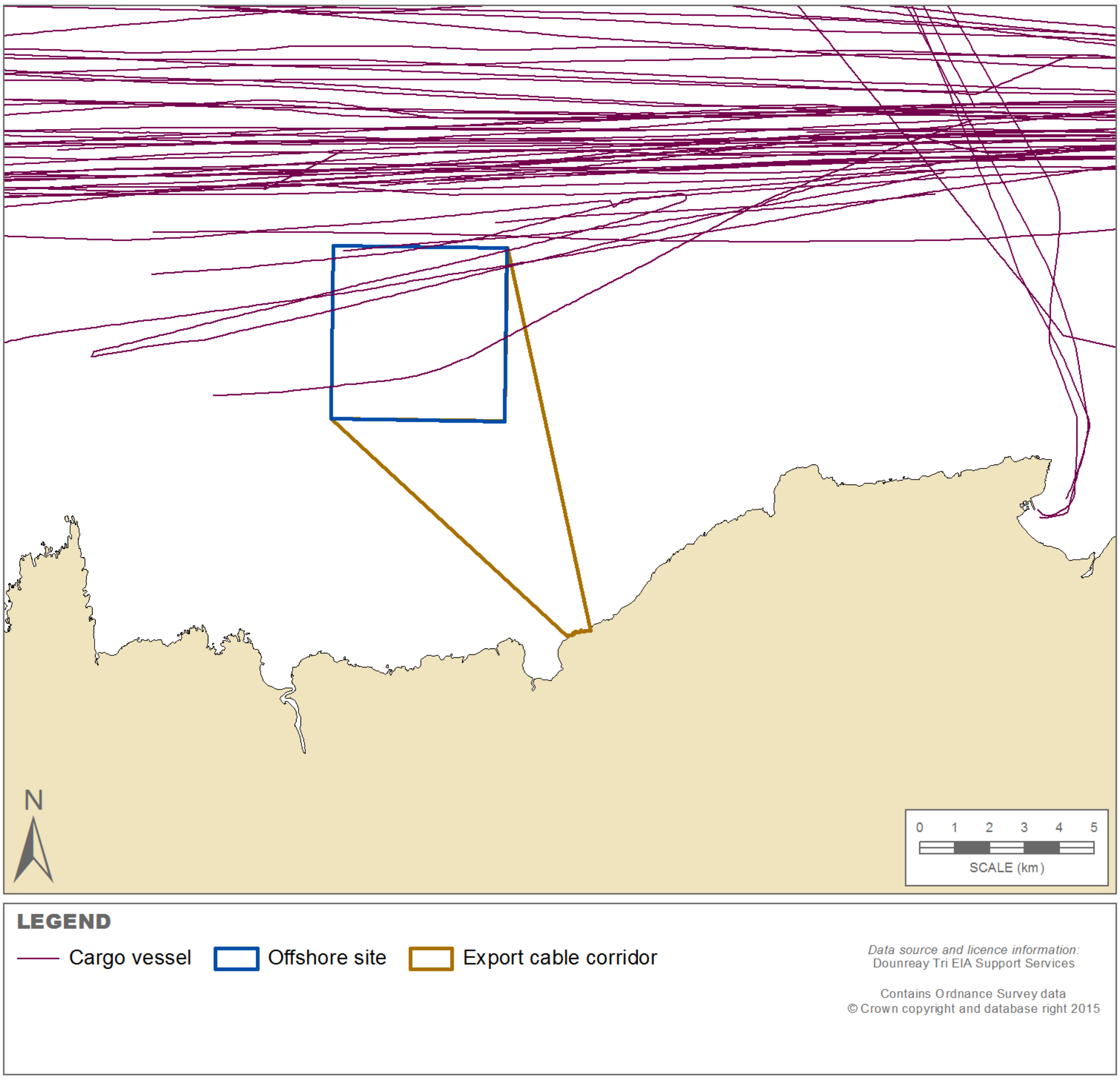


Figure 5.8 Cargo vessel tracks – January 18th-31st 2016 (AIS)

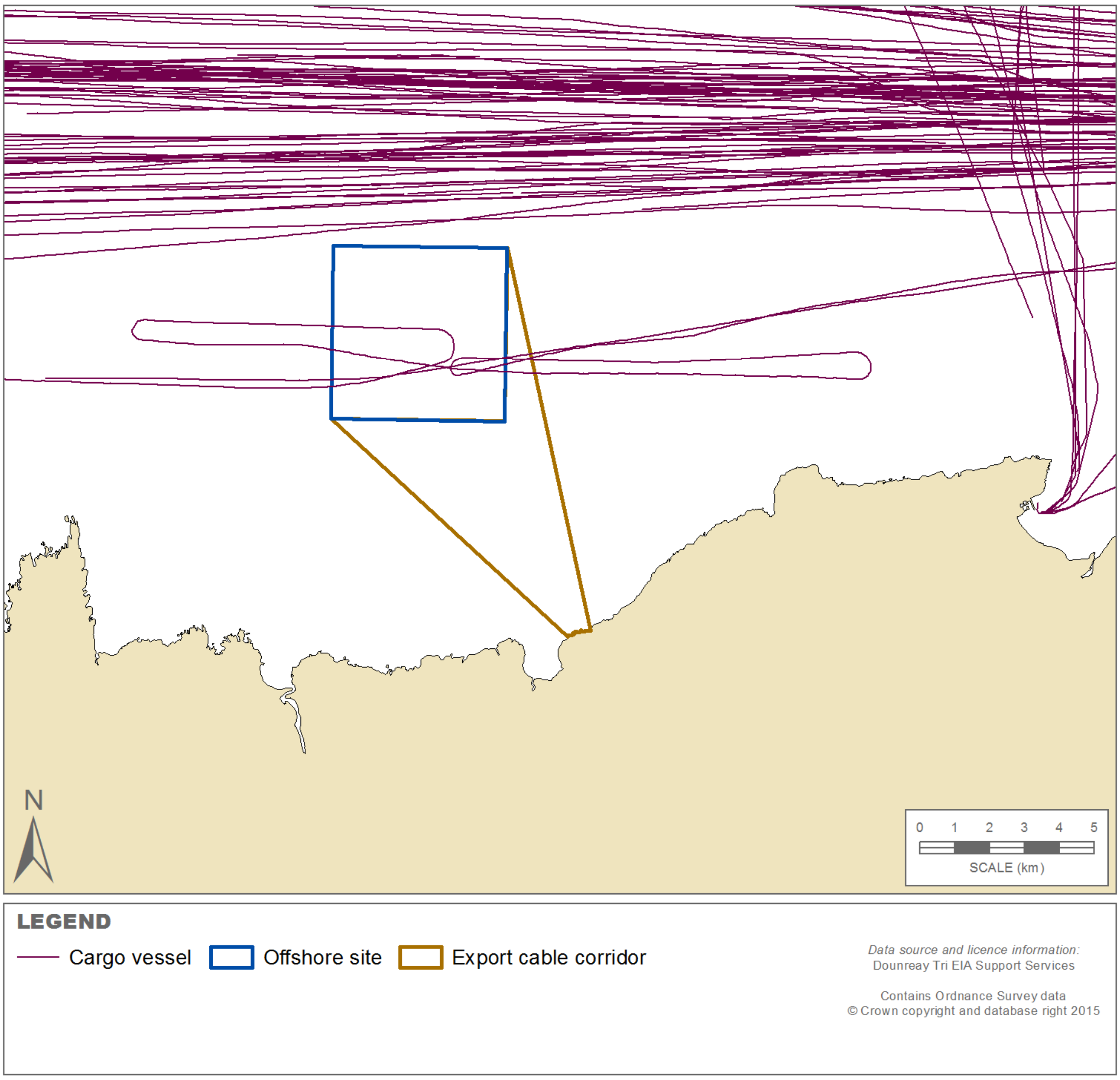


Figure 5.9 Cargo vessel tracks – July 18th-31st 2015 (AIS)

5.4.2 Data resilience and confidence

All ships over 300 tonne capacity are required to be fitted with an AIS transmitter, therefore all cargo ships are likely to be captured in the Project AIS analysis. These data are gathered within the last 12 months and are consistent with that presented within the SANAP study (The Crown Estate 2014). Therefore, the marine cargo vessel traffic data is judged to be recent, comprehensive and accurate.

5.5 Tanker Traffic

5.5.1 Analysis

Data utilised for the analysis includes:

- SANAP report; and
- Project AIS.

The Project AIS data shows that one oil product tanker transited the Project area throughout the study year (Figure 5.10 & Figure 5.11). The majority of tanker vessel traffic can be seen transiting north of the Project area through the Pentland Firth shipping channel and tend to avoid inshore waters. One transit route by the oil tanker *Sarnia Liberty* was observed in the proposed offshore site and export cable corridor. See Appendix E for a summary of vessel transits and draughts.

The analysis is consistent with the low level of tanker activity reported in the SANAP study.

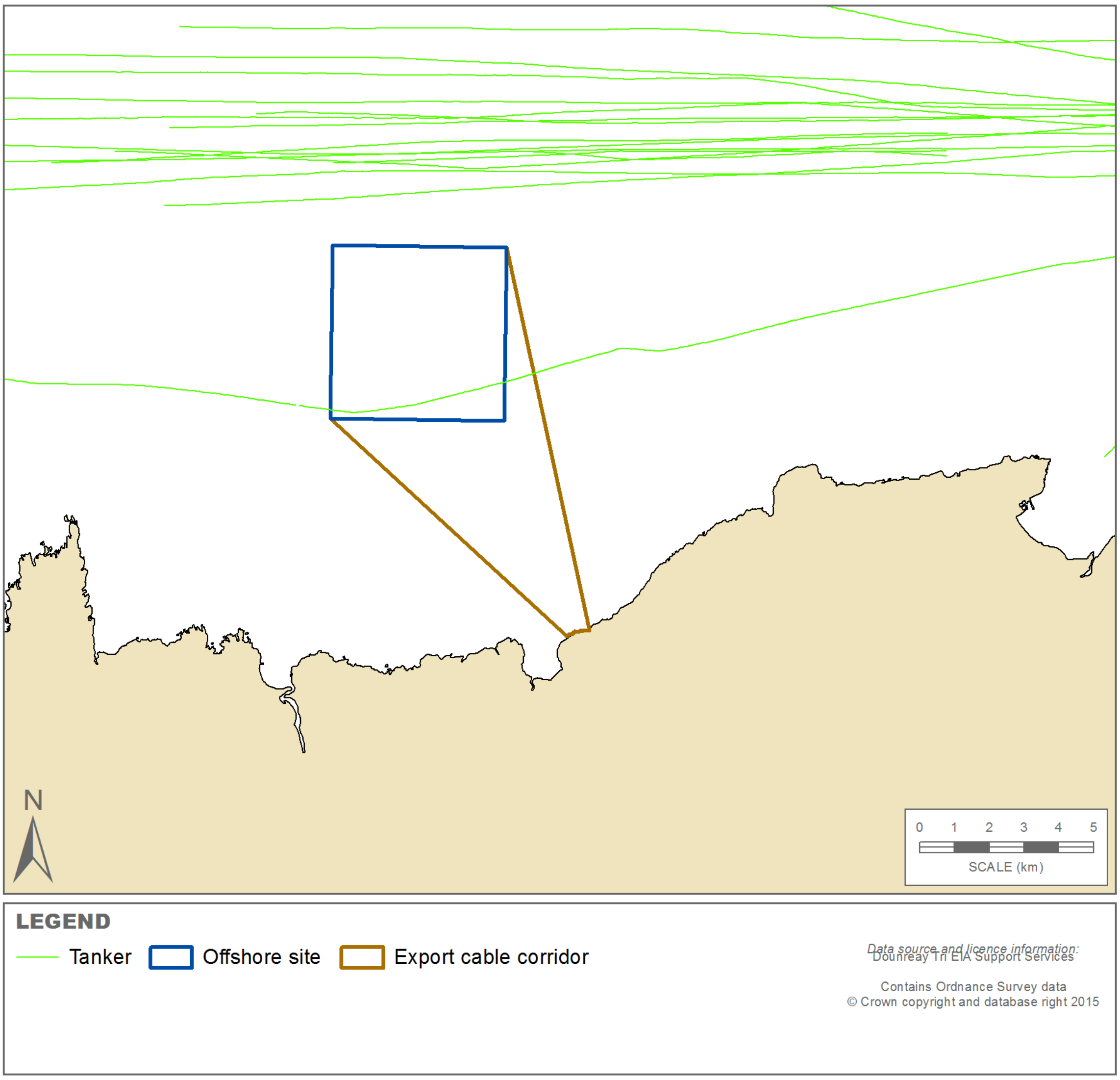


Figure 5.10 Tanker traffic tracks – January 18th-31st 2016 (AIS)

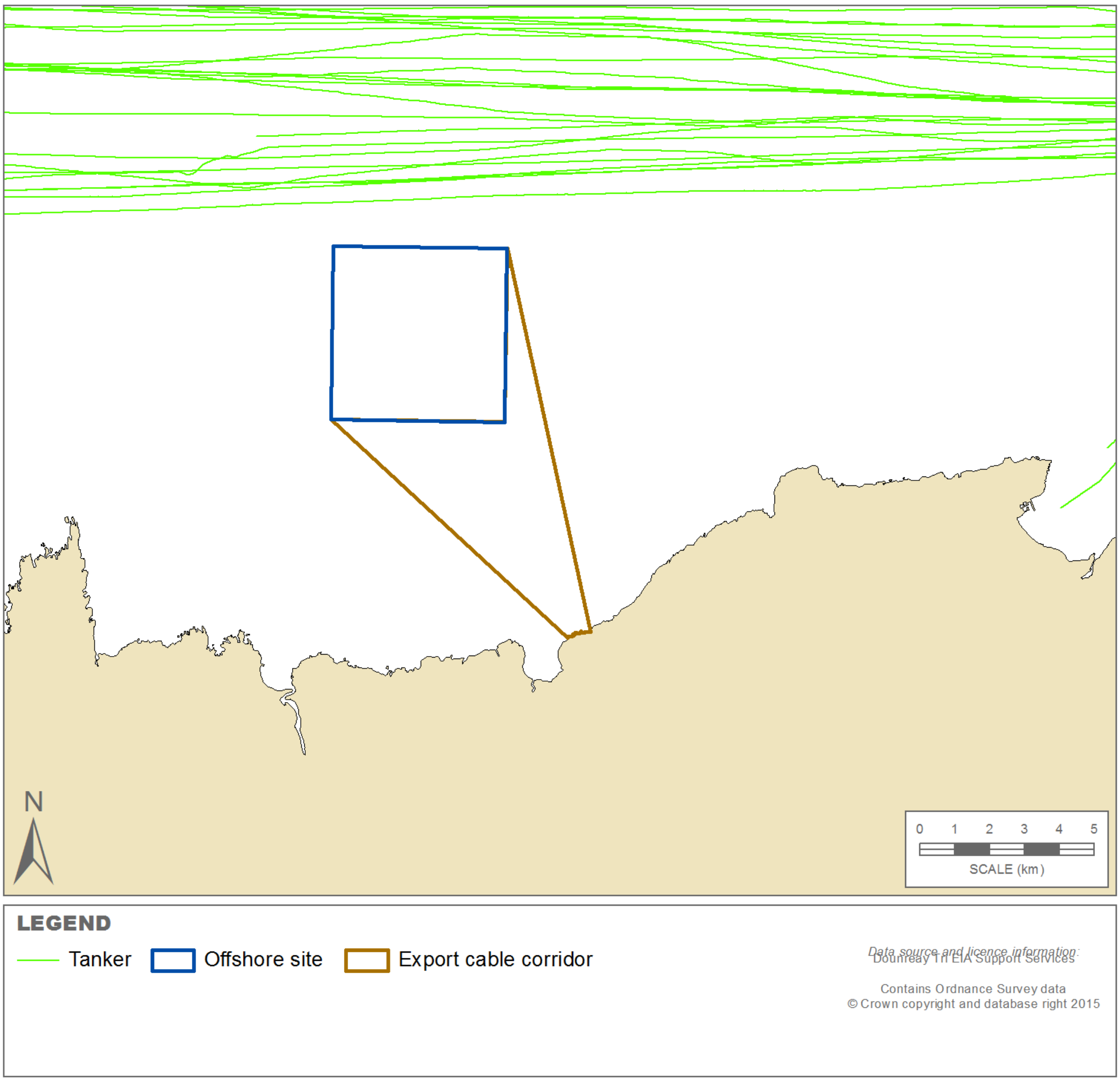


Figure 5.11 Tanker traffic – July 18th-July 31st 2015 (AIS)

Data resilience and confidence

All ships over 300 tonne capacity are required to be fitted with an AIS transmitter, therefore all tanker vessels will be captured in the Project AIS analysis. These data are gathered within the last 12 months and are consistent with those presented within the SANAP study (The Crown Estate 2014). Therefore, the tanker vessel traffic data is judged to be recent, comprehensive and accurate.

5.6 Passenger Vessel Traffic

5.6.1 Analysis

Data utilised for the analysis includes:

- SANAP report; and
- Project AIS.

The Project AIS analysis identifies zero passenger vessels transiting the Project area during the study period (Figure 5.12 & Figure 5.13). The majority of passenger vessel traffic in the Pentland Firth can be seen transiting in and out of Scrabster port (approximately 18km east of the site), most of which is likely to be the Scrabster to Stromness ferry service, and north of the offshore site through the Pentland Firth shipping channel.

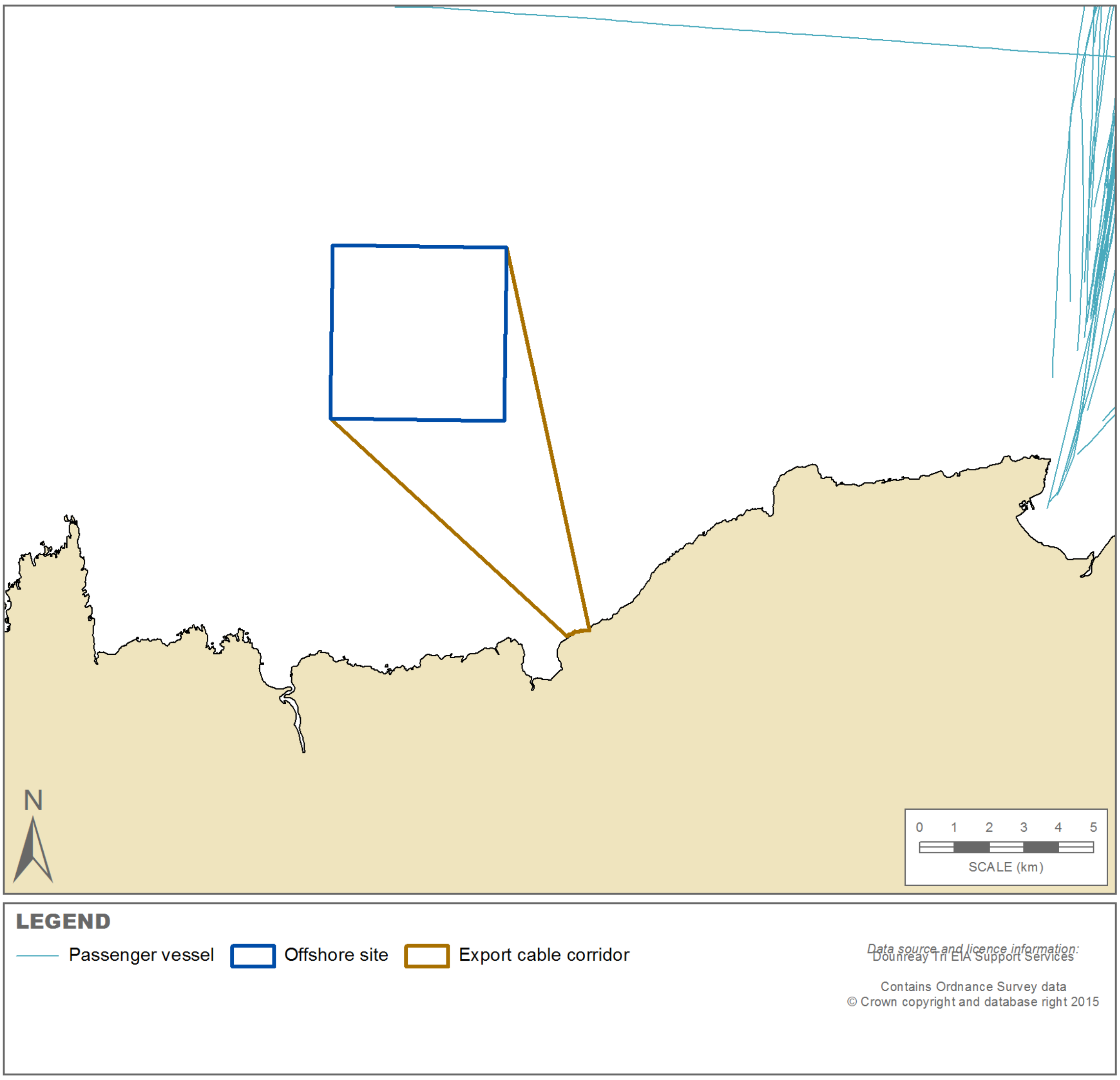


Figure 5.12 Passenger vessel tracks – January 18th-31st 2016 (AIS)

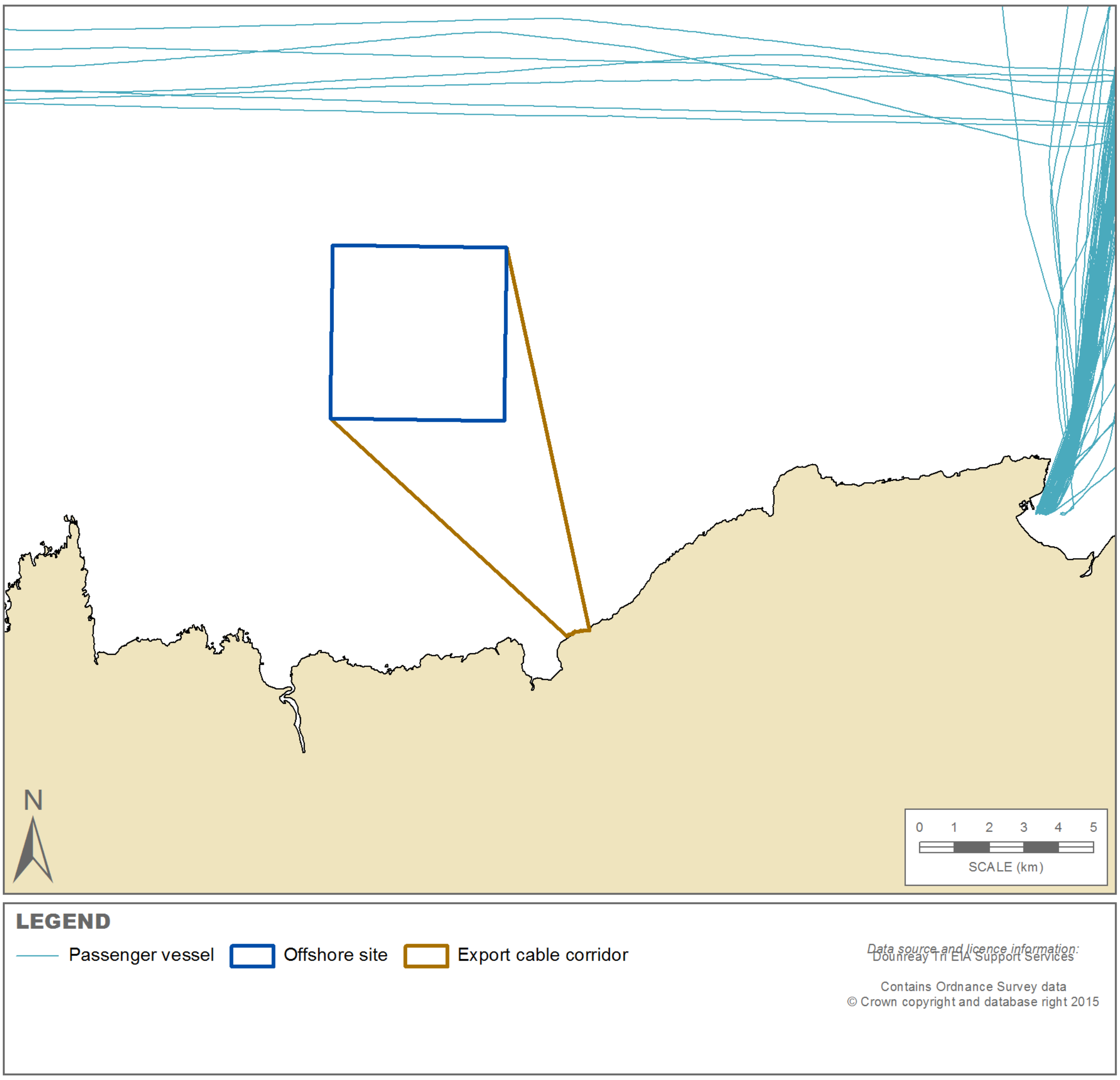


Figure 5.13 Passenger vessel tracks July 18th-31st 2015 (AIS)

5.6.2 Data resilience and confidence

All passenger ships carrying more than 12 passengers are required to be fitted with an AIS transmitter and would be expected to be captured in the Project AIS analysis. These data are gathered within the last 12 months and are consistent with those presented within the SANAP study (The Crown Estate 2014). Therefore the passenger vessel traffic data is judged to be recent, comprehensive and accurate.

5.7 Search and Rescue Vessels

Data utilised for the analysis is from Project AIS data.

Figure 5.14 shows RNLI search and rescue (SAR) vessel activity in and around the Project area during the summer analysis period (no SAR vessels were observed in the study area in the winter period). The nature of its activity is not clear; however a review of historical marine incidents in Section 6 will provide information as to whether any incidents occurred in the Project or wider area.

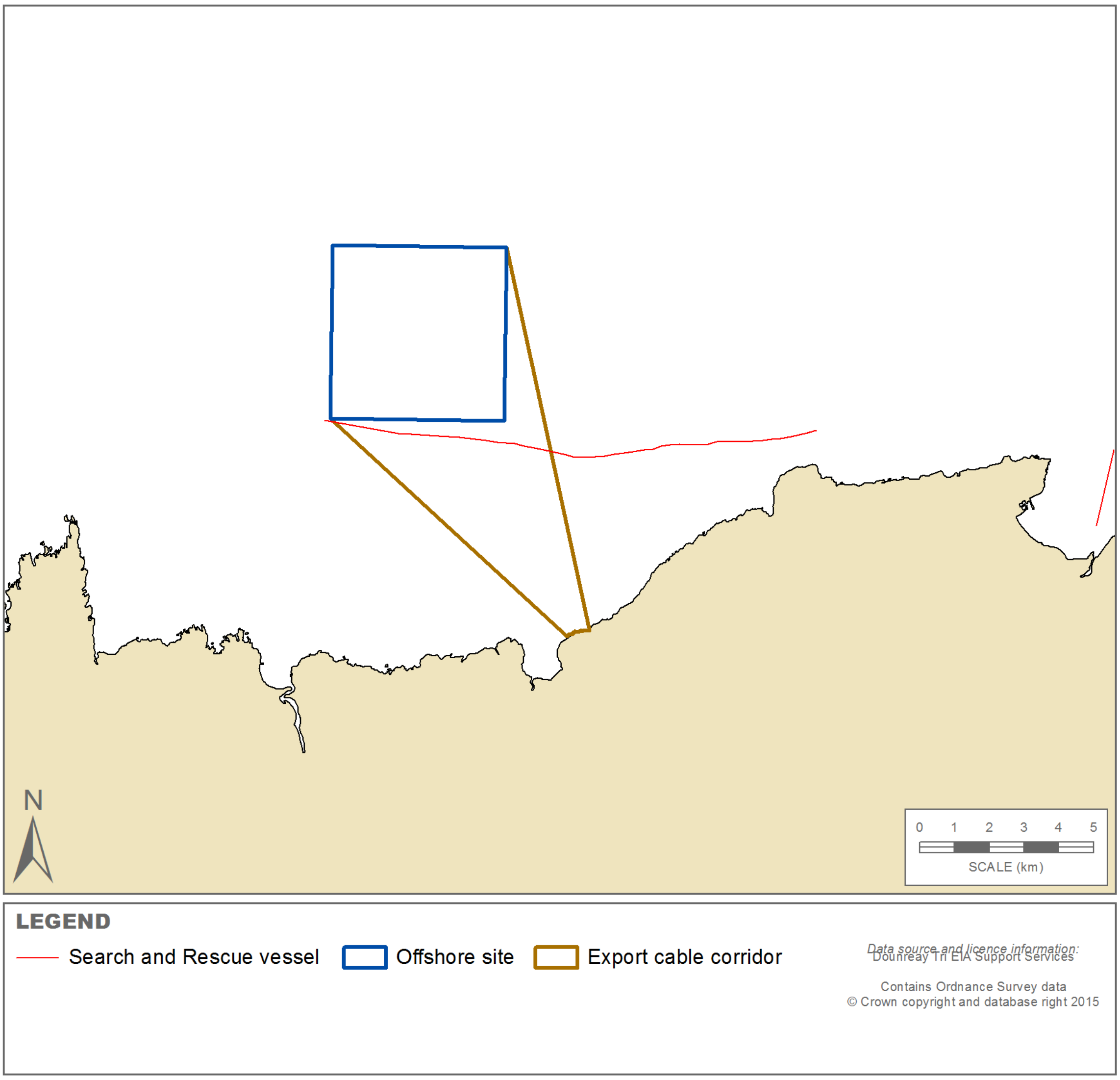


Figure 5.14 Search and rescue vessels – July 18th-July 31st 2015 (AIS)

All search and rescue vessels are fitted with an AIS transmitter and would be expected to be captured in the Project AIS analysis. These data are gathered within the last 12 months and are consistent with that presented within the SANAP study (The Crown Estate, 2014). Therefore the search and rescue vessel traffic data is judged to be recent, comprehensive and accurate.

5.8 Fishing Vessel Traffic

5.8.1 Analysis

Data utilised for the analysis includes:

- Project AIS;
- SANAP report;
- VMS;
- ScotMap; and
- Consultation.

Project AIS data

AIS tracks for the study period indicate that 33% of vessels (5 vessels) transiting the offshore site and export cable corridor were fishing vessels (Figure 5.15).

The fishing vessel tracks are sparse throughout the Project area. There are clear densities of traffic north of the Project area in the Pentland shipping channel (east to west) and transits between Scrabster Port and offshore fishing grounds further north and north-west. Thus, indicating that the area is not intensively fished by fishing vessels carrying AIS. See Appendix E for a summary of vessel transits and draughts.

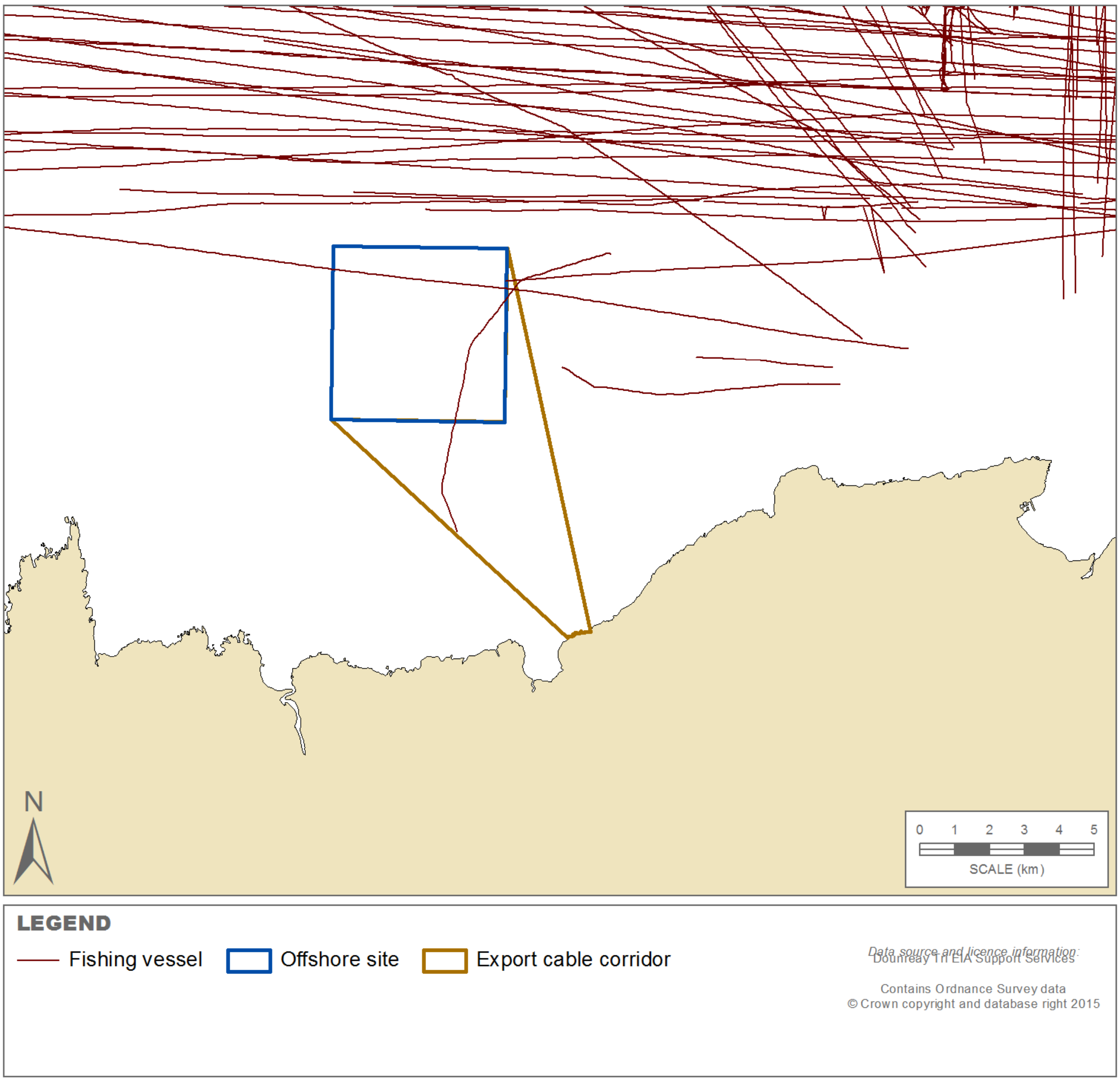


Figure 5.15 Fishing vessels – January 18th-31st 2016 (AIS)

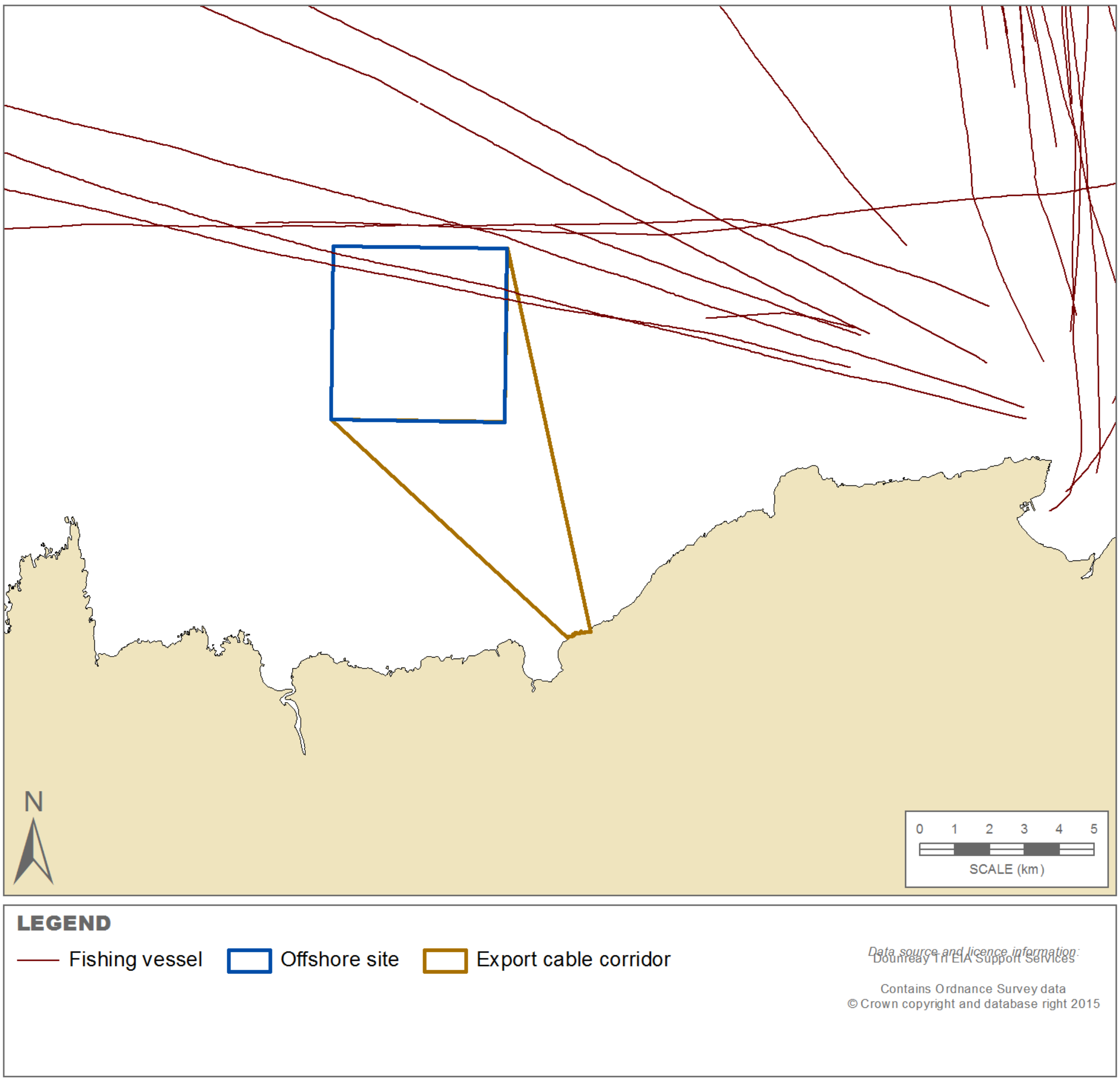


Figure 5.16 Fishing vessels – July 18th-31st 2015

VMS data

Marine Scotland operates a Vessel Monitoring System (VMS) to observe and monitor Scottish fisheries. This is a form of satellite tracking using transmitters on board fishing vessels. The system records:

- Vessel identification;
- Geographical position;
- Date/time (UTC) of fixing of position; and
- Vessel course and speed of vessel.

The VMS data capture vessels >15m (some vessels >12m from 2012[3]) overall length and indicate a moderately busy area for fishing vessels. The data analysed for the VMS area during 2011, 2012 and 2013 are shown in Figure 5.17.

[3] From 2013 the EU Directive changed the requirement for VMS to an overall length of 12m for EU vessels. Approximately 18% of Scottish-registered vessels between 12-15m vessels were fitted by September 2013 and 71% by June 2014 (Fisheries Monitoring Centre Manager, Marine Scotland Compliance (personal communication, 15 July 2014)

The speed of the vessels at the time of data capture is noted. A normal assumption would be that vessels travelling at 0-3 knots are fishing and those travelling at 3-6 knots may be fishing, depending on the gear type. Speeds >6 knots indicate vessels in transit. Table 5.3 summarises the number of vessel observations in total and those where the speed observed is <6 knots. All EU, Faroese and Norwegian vessels which exceed 15m overall length must be fitted with VMS units. From 2012, this changed to an overall length of 12m for EU vessels. Approximately 18% of Scottish-registered vessels between 12-15m vessels were fitted by September 2013 and 71% by 2014[4].

The data made available by Marine Scotland do not include the vessel identification or date in order to preserve anonymity and reports positions at least every two hours from vessels operating with VMS.

Data were analysed for the most recent three years available: 2011, 2012 and 2013.

Table 5.3 VMS observations 2011, 2012 and 2013

VMS 2011 Data	Total Vessel Observations	Observations at 0-5 Knots
Offshore site	104	63
Export cable corridor	23	12
VMS 2012 Data	**Total Vessel Observations**	**Observations at 0-5 Knots**
Offshore site	66	27
Export cable corridor	23	10
VMS 2013 Data	**Total Vessel Observations**	**Observations at 0-5 Knots**
Offshore site	114	42
Export cable corridor	39	16

The fishing vessel transit route is apparent through the Pentland Firth shipping lane and is consistent with the pattern identified in the Project AIS data and SANAP report.

By nature, commercial fishing activity is both spatially and temporally variable due to a range of factors including seasonality, weather conditions and market prices. Fishing activity is likely to fluctuate, to some degree, from year to year, as is demonstrated in Table 5.3.

In all study years there were a greater proportion of the slower vessels towards the inshore part of the Project area. This corresponds to local information that fishing with static gear predominates inshore waters of 60m depth. Further from shore in the northern portion of the area, a greater proportion of vessels were travelling at greater speed and therefore assumed to be in transit.

[4] Fisheries Monitoring Centre Manager, Marine Scotland Compliance (personal communication, 15 July 2014)

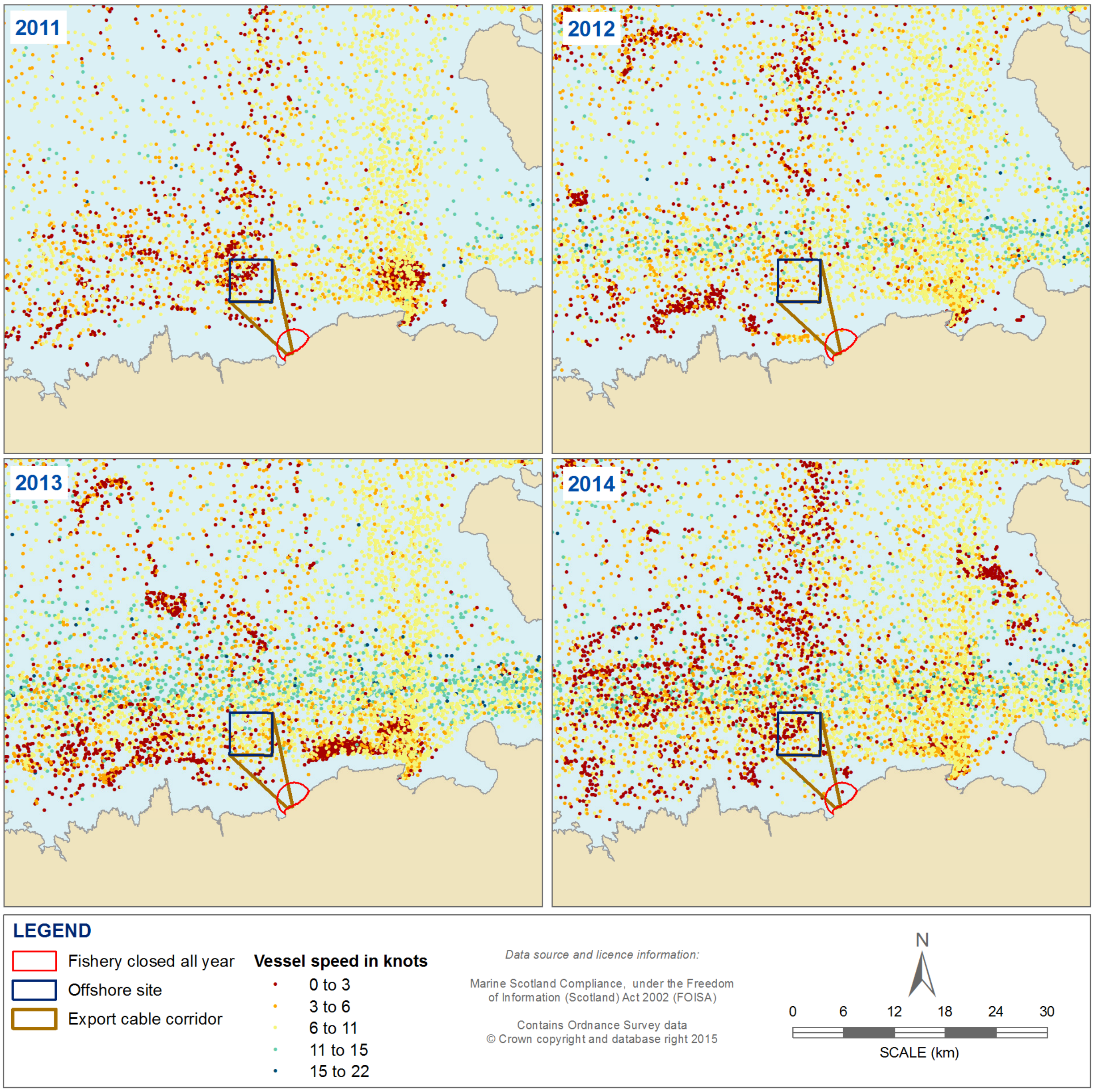


Figure 5.17 VMS data for 2011, 2012, 2013 and 2014

In 2011, sightings are most frequent in the west and north-west of the offshore site, with most showing vessel speeds of 0-3 knots and to a lesser extent 3-6 knots, indicating that vessels are likely to be fishing (Figure 5.17). Sightings on vessels at speeds greater than or equal to 6 knots are spread throughout the offshore site and are likely indicating vessels in transit, not fishing. There is less activity in the export cable corridor, most of which is concentrated in the northern half.

The level of activity is relatively widespread throughout the wider north coast area, while a greater intensity of activity is apparent approximately 2-4km north of Holburn Head and Scrabster. It is not possible however, to determine whether any number of these sightings relate to an individual or several vessels.

In 2012, the VMS requirement extended to vessels exceeding 12m overall length, however the roll out on vessels between 12m and 15m is likely to have been relatively low given that just 18% of Scottish-registered vessels were fitted towards the end of 2013[4].

Fishing activity appears to be more dispersed in the offshore site in 2012 and less frequent than that sighted in 2011. The main shipping channel through the Pentland Firth is apparent north of the offshore site and may be dispersed with some fishing activity. Areas of greatest fishing intensity are evident west, offshore from Strathy Point and Armadale with a pattern of potential fishing activity leading eastward towards the export cable corridor.

In 2013, fishing activity appears to be widespread in the offshore site with some activity in the northern half of the cable route corridor. The data may be representative of a proportion of the vessels between 12m and 15m overall length fitted with VMS; however it is not possible to identify individual vessels or size.

The level of activity within the Project area is relatively low compared to the wider north coast and a notable area of intense fishing activity to the east, approximately 2km north of Brims Ness and Holburn Head.

Scotmap data

AIS tracking and VMS do not provide a comprehensive database for vessels <15m given that neither is a requirement under respective EU Directives. The main data sources for smaller vessels are the ScotMap study of 'Inshore Fishing Study Pilot in PFOW' (Kafas et al., 2014) and local consultation. An analysis of these data shows the density of inshore fishing vessels <15m in the Project area (Figure 5.18) as ranging from one to six. This density is relatively low compared, for example, to inshore waters in the Pentland Firth itself or Orkney waters where densities in the range 11-20 were observed by ScotMap.

The ScotMap information shows that the Project area:

- Has between 1-3 fishing vessels under 15 m overall length operating in the offshore site and potentially up to 5 in the export cable corridor;
- Activity may be low in the Project area compared to the wider north coast, with vessel numbers greatest east of the site and further west off Armadale; and
- Main gear types are those with pots and creels, with a lower level of activity from towed dredges and no scallop diving activity in the Project area.

The importance of the ScotMap data is that it underlines the likely predominance of small vessel fishing activity, which will not necessarily be tracked by VMS or AIS, and the potential intensity of fishing activity in the Project area relative to the wider area.

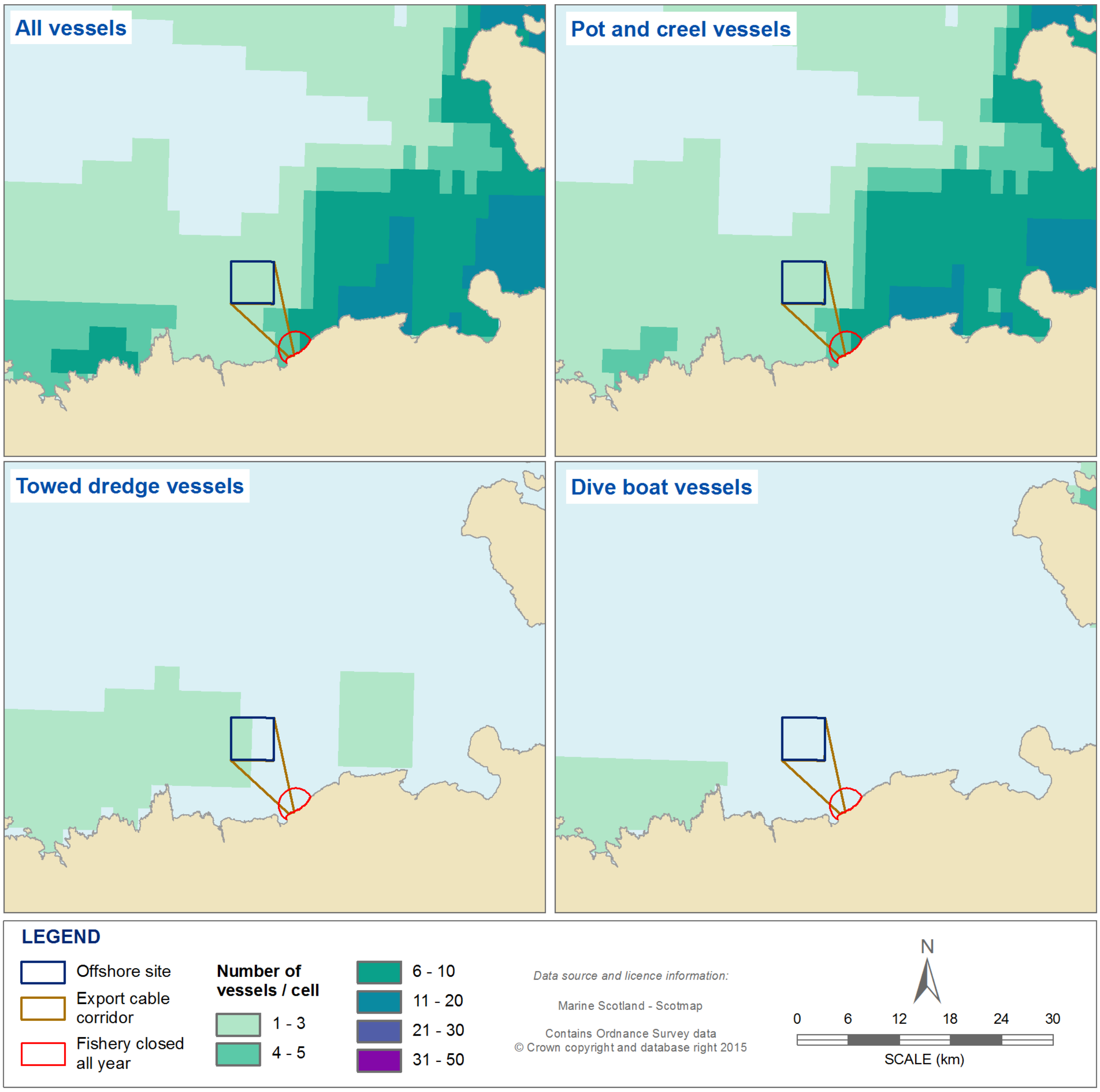


Figure 5.18 Scotmap data of inshore fishing vessels by type

Consultation

Initial consultations with Scottish Fishermen's Federation (SFF) during the site selection process indicated that the site is not intensively fished and that the southern extent avoids known fishing grounds (refer to Chapter 3: Site Selection and Engagement to Date).

Fisheries are restricted around the export cable corridor where there is a 2km fisheries exclusion zone (as shown by the red boundary in Figure 5.18). Anecdotal reports suggest that fishing by creel vessels occurs up to the boundary. The spatial distribution of vessels presented in Figure 5.18 indicates that the data are not highly accurate or may reflect the rendering process in presentation of the data and effort to anonymise individual fishing grounds.

A representative from Dounreay Site Restoration Limited (DSRL) confirmed that creel fishing occurs up to the boundary of the fishing exclusion zone (2km buffer from Dounreay Nuclear site's effluent pipe). DSRL, through local knowledge of the area, suggest that the exclusion zone may act as a 'nursery site' for target species and provide a good fishing resource up to the boundary of the exclusion zone.

5.8.2 Data resilience and confidence

It has been possible to link together the information from AIS, VMS and ScotMap data sources and local consultation to gather as comprehensive a view as practicable. However, two limitations are clear. Firstly, the VMS and ScotMap data do not provide vessel identification which has been obtained from local sources as far as is practicable. Secondly, activity may change from year to year as illustrated by the VMS data, and vessels from outside the local area may visit.

The VMS information indicates low levels of activity throughout the Project area. The activity level will vary depending on weather conditions and vessel operators' views on the prospects for fishing.

Together AIS and VMS provide a comprehensive view of the larger fishing vessel movements. Neither AIS nor VMS equipment is required to be fitted to small vessels and for these the ScotMap analysis has been used but cross-checked successfully with local consultation. Overall, the analysis of fishing vessel activity is judged as being comprehensive and resilient.

The value of this collated information is that it indicates that the overall level of fishing intensity is moderate, describes the range of fishing activities, and identifies many specific vessels/owners. This will inform the important risk mitigation measure of notifying and liaising with the owners as the proposed development proceeds.

5.9 Recreational Vessels

5.9.1 Analysis

The analysis follows the guidance from MCA (DECC/MCA 2013, MCA 2016 and MCA 2008). It also notes the important position paper on offshore wind energy developments and sailing craft researched and prepared by the RYA (RYA 2013) which highlights key areas of concern.

Data utilised for the analysis includes:

- Project AIS
- SANAP report;
- RYA Atlas; and
- Information gathered from consultation.
-

Recreational craft includes sailing vessels, pleasure craft and diving boats. Seven of these vessels were recorded in the Project area during the study year, each on one occasion (Figure 5.19). It should be noted that the majority of smaller recreational craft may not be fitted with AIS transmitters and therefore some activity may not be captured in the Project area.

AIS data for sailing vessels

An important issue concerns the proportion of sailing vessels actually carrying AIS. A survey, carried out by Marine Scotland (MS 2012b) found that the percentage of all yachts visiting Orkney harbours carrying AIS was around 10-20%. Vessels >10m were more likely to carry AIS (between 15-20%). Clearly, AIS only tracks a minority of sailing vessels and other sources are of great importance.

The Project AIS data for sailing vessel movements in the Project area shows light traffic compared to the wider PFOW area (Figure 5.19). No recreational vessels were observed in the Project area during the summer and winter analysis periods (Figure 5.19). All of these were observed in the offshore site and also transited through the north-east section of the export cable corridor. One dive vessel transited the offshore site on one occasion in January 2016 (Figure 5.20).

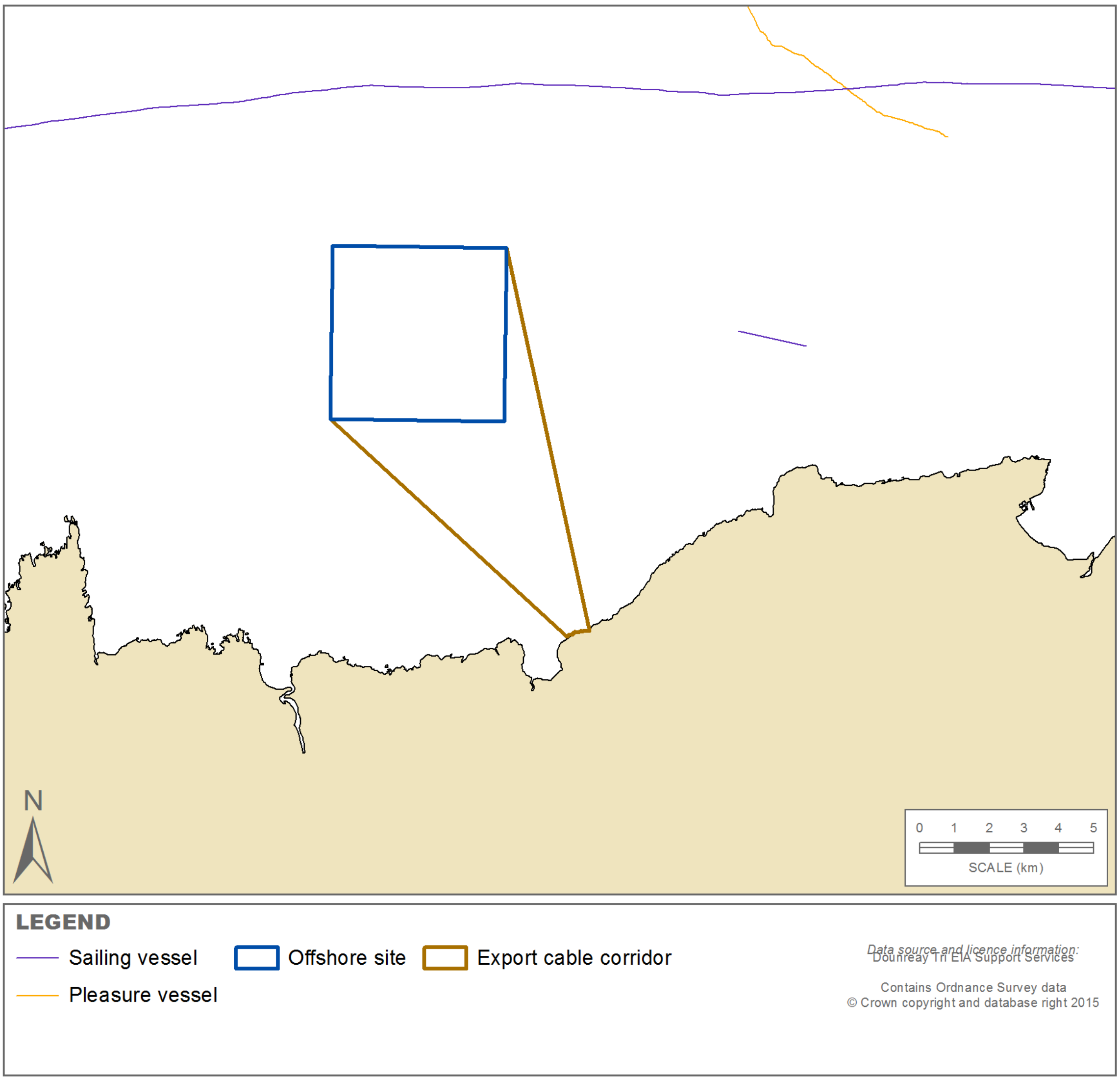


Figure 5.19 Recreational vessels – July 18th-31st 2015 (AIS)

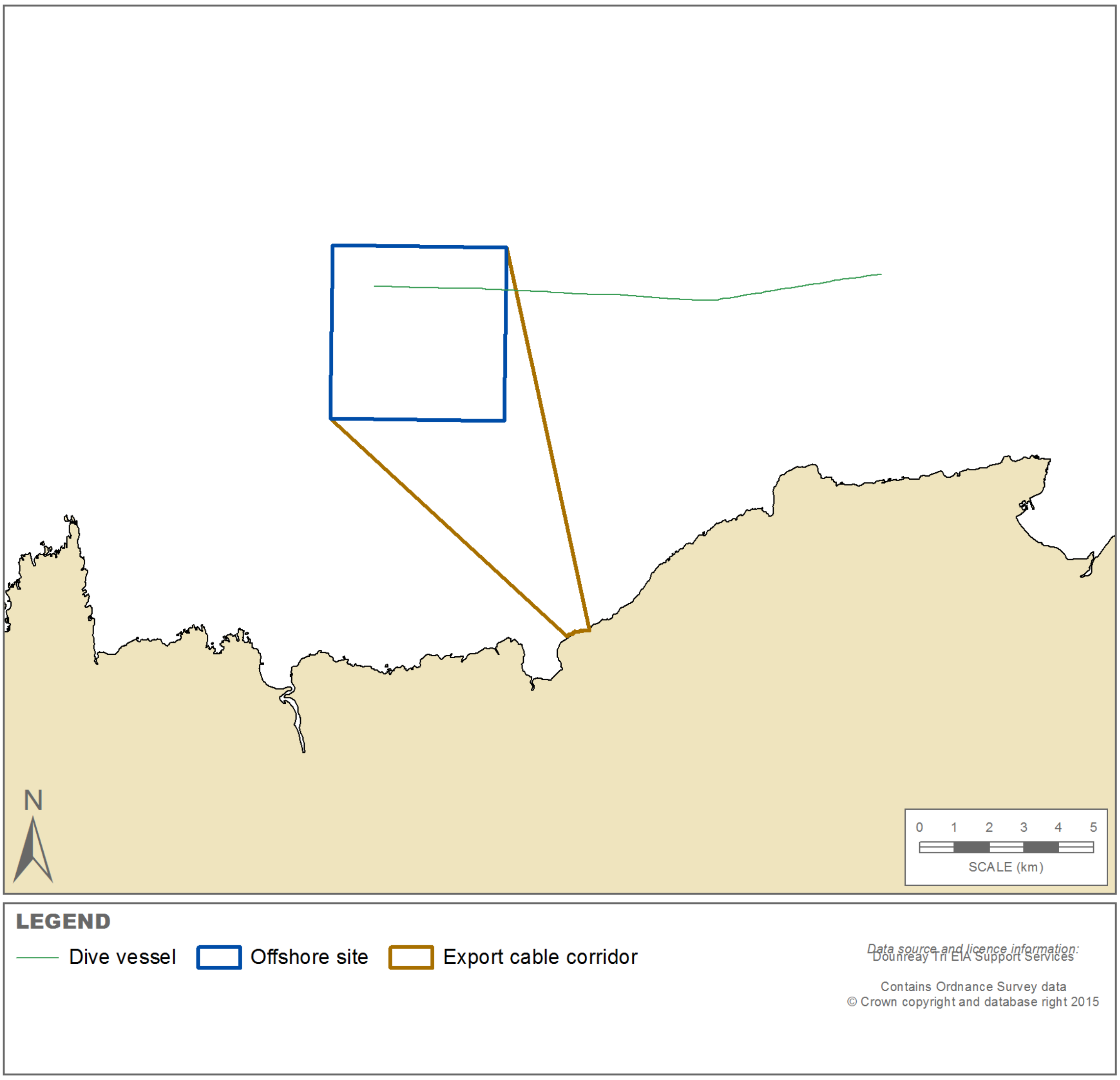


Figure 5.20 Dive vessel transits – January 18th-31st 2016 (AIS)

From the Project AIS data showing the wider area around the proposed development in Figure 5.7 and from data from the RYA Atlas (2009), five main recreational routes can be discerned:

- East-west transits offshore, e.g. vessels en-route Cape Wrath – Scrabster;
- East-west transits along the actual coastline;
- SW-NE transits heading from the north coast west of Eriboll across to Orkney;
- SW-NE transits from the anchorages at Loch Eriboll and Talmine (Loch Tongue) to Orkney; and
- S-N transits from Scrabster to Orkney, passing well to the east of the Project area.

This pattern fits well with the data and analysis from the RYA Atlas of Routes (RYA 2009) and from the SANAP report (The Crown Estate 2014) as described below.

Royal Yacht Association (RYA) and SANAP data

The RYA publishes a UK Atlas of Sailing and Recreational Cruising Routes (RYA 2009) which identifies routes as being of 'Light' 'Medium' or 'Heavy' usage. The atlas for PFOW shows 'Medium' and 'Light' routes for the area (Figure 5.21).

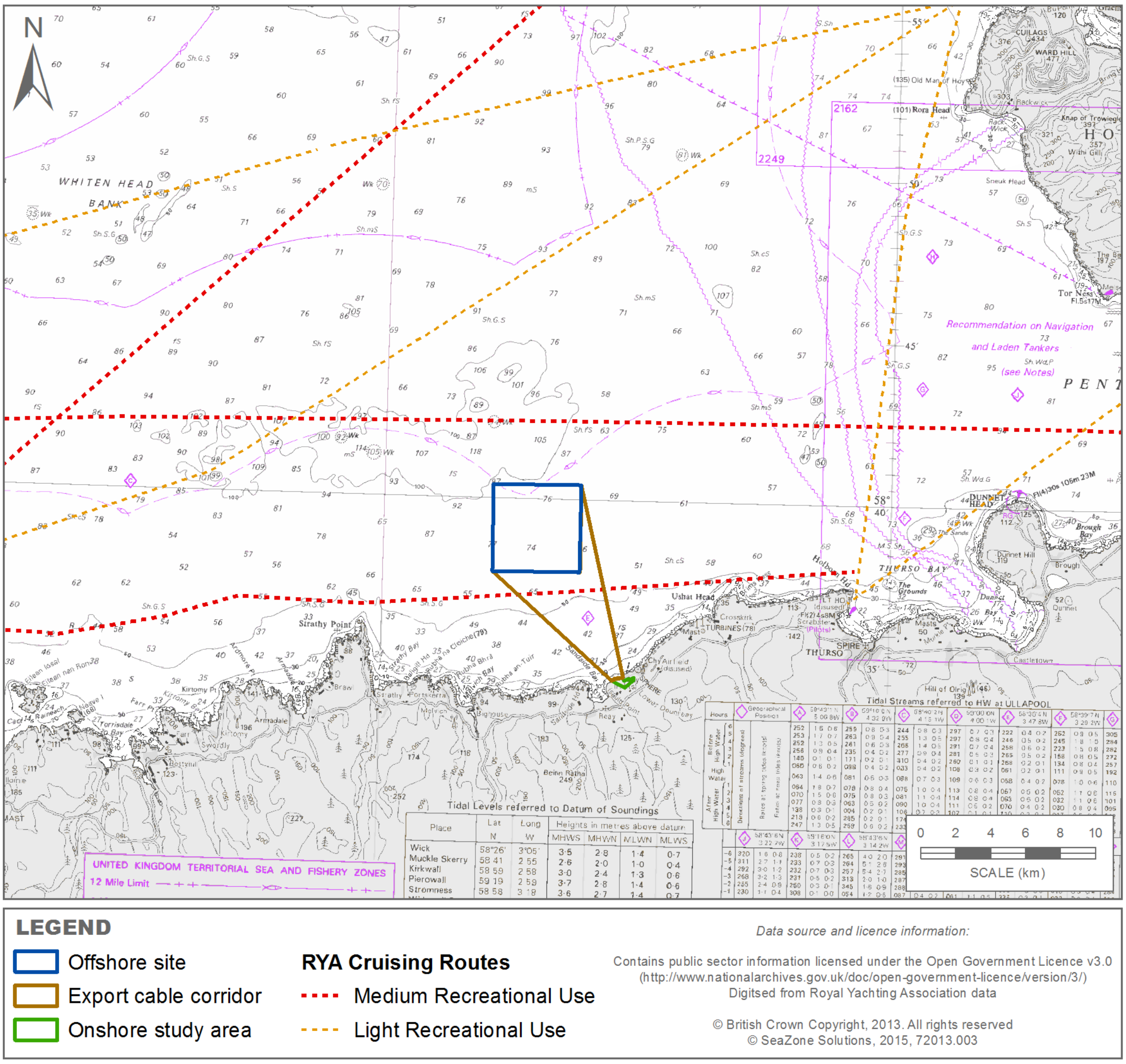


Figure 5.21 RYA Coastal Atlas – routes in PFOW

It can be seen that the RYA Atlas of Routes for the Project area corresponds reasonably with the Project AIS data. Considering the wider, regional area of the North Coast the SANAP report (The Crown Estate 2014) has overlaid the AIS track density for a 56-day period for recreational vessels onto the RYA chart (Figure 5.22). The SANAP data corresponds reasonably well for the Project AIS analysis for sailing vessels in the north coast region. As noted by RYA (RYA 2013) these routes should be regarded as 'corridors or lanes' rather than a single route along the centre line. This is well-illustrated in the figure by the green, medium density lane running from Loch Eriboll to Orkney.

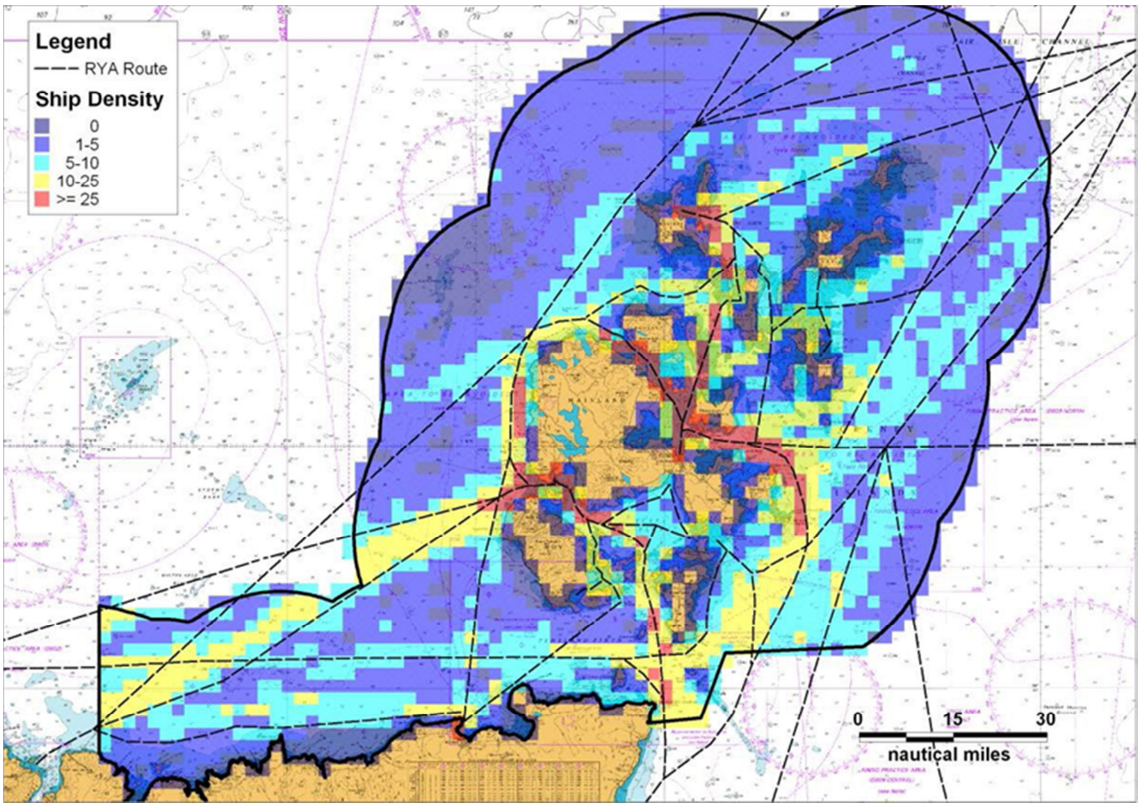


Figure 5.22 Recreational vessels AIS track density overlaid on RYA routes (Marine Scotland, 2012)

The degree of correspondence between the data from the RYA Atlas, from SANAP AIS data and from the Project AIS data is good and indicates that the analysis is robust.

Traffic information from consultation

Sea kayaking

The Shipping Study of PFOW (MS 2012b) included a review of sea kayaking activity. Four kayaking clubs were consulted for the PFOW study: Kirkwall Kayakers Club, Orkney Sea Kayaking Club, Caithness Kayak Club, and Pentland Canoe Club. Sea kayaking by clubs takes place on a weekly or fortnightly basis, mainly in the summer months. Generally groups of kayakers between 3 and 20 in size will combine to travel a pre-defined route. Directions are available for popular routes, e.g. 'north and east coasts of Scotland Sea Kayaking' (PESDA 2014), which describes a route across the Pentland Firth but has no other entries for the north coast. However, the clubs reported that there are regular group excursions along the north coast from Tongue to Duncansby Head, i.e. to the south and east of the Project area, and also within Loch Eriboll to the west.

During consultation, a response from the Pentland Canoe Club also noted that sea kayakers navigate along the north coast, but that the Project was sufficiently far offshore so as to not pose a problem as kayakers tend to hug the coast. Furthermore, it was also noted that the east side of Sandside Bay was not a particularly interesting area for kayaking.

Other recreational vessel activities

Local research identified additional recreational vessel activities, as listed in Table 5.4 below.

Table 5.4 Other recreational vessel activities

Vessel Name	Activity	Source
***MV* Stormdrift II**	Runs out of Scrabster Harbour, for	Boatdistrict 2014

	charter for sea anglers	
Wild Sea Charters	Operate wildlife and sailing trips out of Scrabster on renovated, ketch rigged 1960s fishing trawler	Boatdistrict 2014
MV *Freedom*	Operates out of Wick for charter by sea anglers	Where to fish 2014
Silver Line Sea Angling	Operates locally out of Scrabster using 'MV Silver Line' as charter angling boat	Silverline 2014

No information was available on the destinations of such vessels, however although the Project area is relatively close to Scrabster Harbour the small scale of the Project and the large amounts of sea room either side provide ample opportunity for avoidance.

5.9.2 Data resilience and confidence

The AIS data for this Project for recreational vessels has been gathered and analysed for a two week summer period and a two week winter period to give a comprehensive view of vessel traffic in the Project area. In addition, the AIS data are consistent with the separate AIS surveys and analysis of two 28 day periods presented in the SANAP strategic area study (Crown Estate 2014). Only a minority of recreational vessels carry AIS so these data sets can only give an indication of recreational vessel movements. The AIS analysis has been supplemented by consultation with the RYA and local sailing associations to gather an indication of overall vessel numbers and routes used. This local information broadly confirms the AIS data for the Project area and the findings of the SANAP report (Crown Estate 2014).

5.10 'Other' AIS-Carrying Vessels

Data utilised for the analysis includes:

- SANAP report; and
- Project AIS.

Other vessels carrying AIS equipment that were tracked include:

- Survey and research vessels;
- Marine support vessels;
- Dredgers; and
- Other unconfirmed vessels.

The tracks of 'Other' vessels carrying AIS equipment are shown in Figure 5.23 and Figure 5.24 indicate a low level of activity in contrast to the vessels transiting the Pentland Firth Shipping route. One vessel was recorded transiting through the Project area. The vessel *MRV Scotia* is a research vessel operated by Marine Scotland for fisheries stock assessment and environmental monitoring etc which transited back and forth in the Project area in January 2016. See Appendix E for a summary of vessel transits and draughts.

The results of the AIS analysis are consistent with the SANAP results which indicate a relatively low level of activity from 'other' vessels.

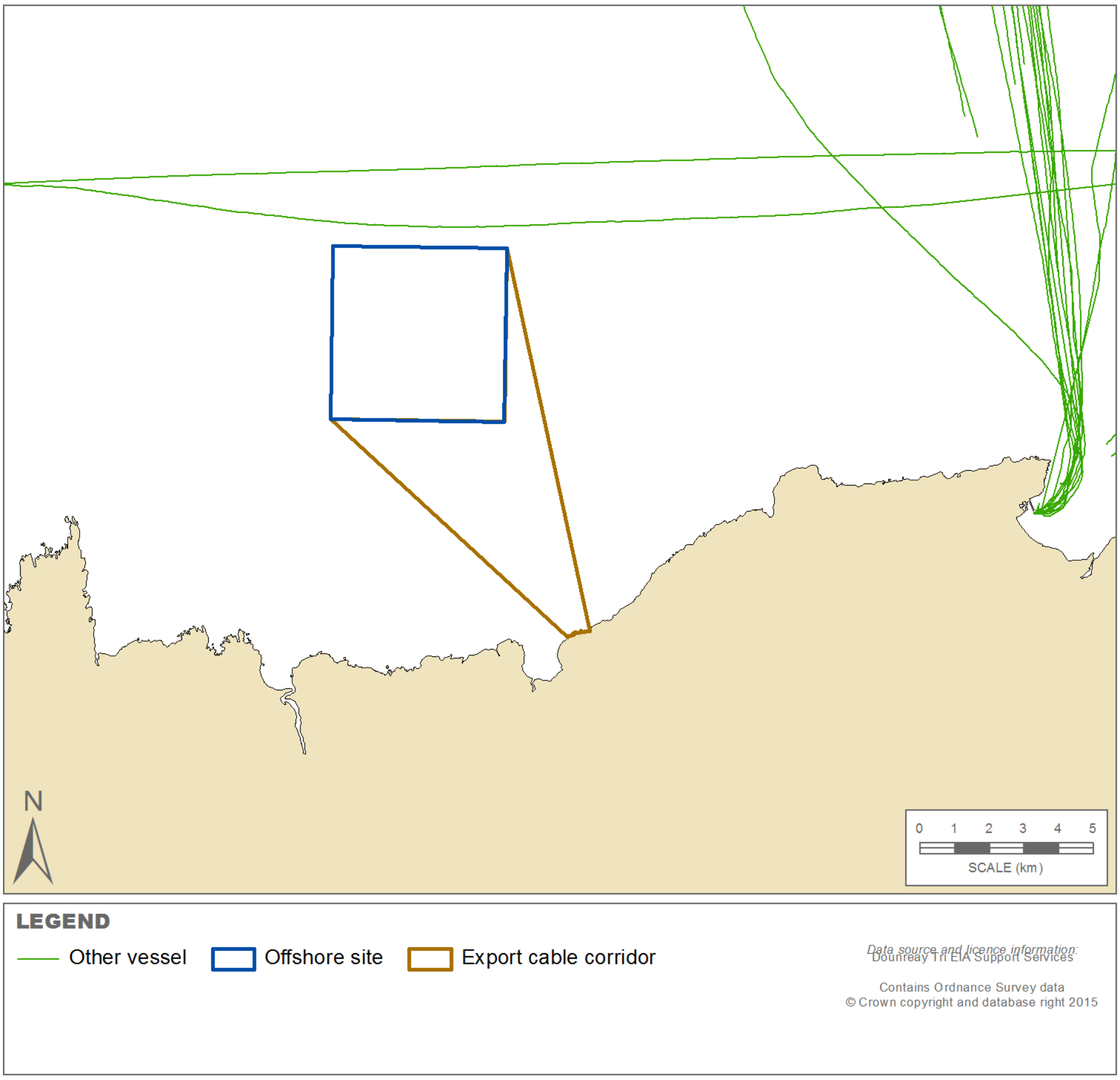


Figure 5.23 AIS vessel tracks classified as 'Other' July 18th-31st 2015

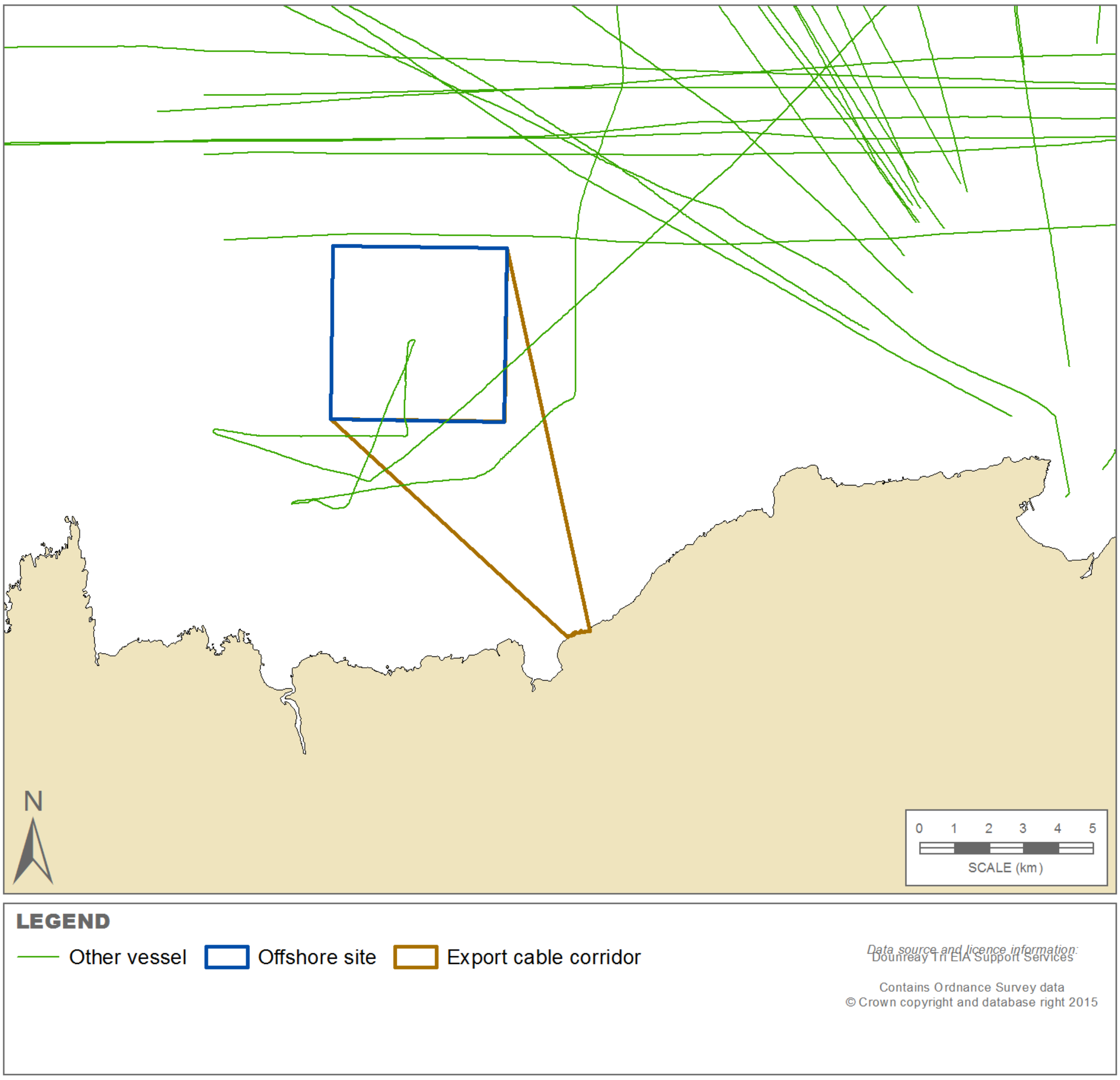


Figure 5.24 AIS vessel tracks classified as 'Other' January 18th-31st 2016

5.10.2 Data resilience and confidence

The majority of these vessel types would be expected to be fitted with an AIS transmitter and are therefore likely to be captured in the Project AIS analysis. These data are gathered within the last 12 months and are consistent with that presented within the SANAP study (The Crown Estate 2014). Therefore the 'other vessel' traffic data are judged to be recent, comprehensive and accurate.

5.11 Effects of Proposed Project on Vessel Traffic

5.11.1 Vessel traffic associated with the Project

Installation phase

The proposed installation phase methodology and schedule is contained within the Project Description and in Section 4. This section of the NRA focuses on the likely vessel traffic associated with the proposed development. See **Error! Reference source not found.** for vessel requirements and durations of key installation activities.

During the installation phase a small number of Project vessels will be in the area installing the export cable first then the anchors, mooring systems, inter-array cabling and finally the floating platform which will have two WTGs pre-installed. Given that only one structure is to be installed the additional vessel traffic movements will be relatively low and should not cause anything other than very minor avoidance by other traffic.

Following preparatory work to finalise site designation and charting, the anticipated sequence of installation activities is:

- Initiate the communications planned to alert other sea users (e.g. Kingfisher bulletin, Harbour Masters, local notices, direct contacts with known organisations and operators)
- Install site marking, notify UKHO and issue Notices to Mariners; and
- Lay static export cable.

For floating platform:

- Install anchors;
- Install mooring system;
- Connect mooring system to floating platform; and
- Connect array cable to export cable.

Table 5.5 Vessel requirements and durations of key installation activities

Key Activity	Vessel	Anticipated Duration	Comments
Export cable installation	Cable Lay Vessel plus 1 dive support	1 week	Options of surface-laid and trench/bury to be assessed
Positioning of mooring arrangement	1 Anchor Handling Tug Support (AHTS) vessel, 1 flat deck barge and 1 tug	1 week	Some activities may overlap, e.g. export cable installation
Platform tow (with turbines installed) to site	3 AHTS	3 days	-
Platform installation	4 AHTS , 1 dive support vessel and 1 workboat	5 days	-
Commissioning	Workboat	1 month	-

Operation & maintenance phase

The Project O&M strategy is to undertake the majority of maintenance activities on site. Any major repair work (e.g. turbine gearbox change) will be carried out offsite so the floating platform will need to be retrieved from site and towed to the specified O&M base for attention (or to other harbours as appropriate for carrying out the required tasks).

Three AHTS vessels will be required to tow the floating platform to site. The time taken will depend on the location of the Construction base, which is as yet undefined. Installation of the floating platform is expected to take around 5 days.

It is anticipated that the floating platform will need to be accessed for inspection or maintenance once every week throughout the initial operation phase. This is then likely to be carried out less frequently over time as operation of the Project becomes smoothed. These operations should not cause anything other than very minor avoidance by other vessels in the Project area, due to the small scale of the Project and the requirement for only one workboat during planned maintenance procedures.

It is important to note that when a machine is removed from site, the cables and mooring lines will be >15m below the sea surface. This is judged to be a safe depth to avoid under keel clearance concerns. However, the development area will be charted and vessels advised not to enter whether or not the floating platform is present.

A 24-hour watch system will be maintained when the floating platform is onsite to monitor the data output and, in particular, any alarms from the device. These include alarms should the floating platform move outside its normal watch circle which might indicate a partial mooring system failure.

It is expected that the O&M base will accommodate a suitable multi-cat vessel dedicated to servicing the Project. This vessel will normally be moored and would not be on 24 hour watch to respond to a VHF emergency call. However, although not available at immediate readiness, the vessel would be available to intervene at the site (or to provide assistance in other emergency situations) whenever possible.

Decommissioning phase

The level of activity will be similar to that in the installation phase with a similar risk profile and risk analysis.

5.11.2 Presence of wind farm

The offshore site (Figure 1.1) is restricted to water deeper than 60m, and covers around $25km^2$. Within that, the actual footprint of the floating platform and its anchors is anticipated to be within a maximum area of $2km^2$. Such a small area in open seas is very unlikely to require significant avoidance by existing traffic.

5.12 Predicted Future Traffic Densities and Types

A discussion of this topic was noted in Section 3.2

In brief, a potential source of traffic is the marine renewable energy traffic associated with EMEC's wave test site at Billia Croo. However, the Dounreay site is remote enough from the site that there is unlikely to be any significant disruption.

There is potential for an increase in marine traffic in the area due to the proposed construction of the Dounreay Floating Offshore Wind Development Centre (DFOWDC).

An activity which has grown in recent years is passenger cruise ship visits, particularly to Orkney. For 2016 approximately 117 cruise ship visits are forecast but only a small proportion are likely to transit the area.

5.13 Predicted Cumulative and In-Combination Effects

This assessment of cumulative effects considers the potential impacts that may potentially arise from development of the Dounreay Tri Ltd floating wind demonstration site, combined with existing baseline trends along with any future planned projects. An important factor for cumulative effects to shipping and navigation is which ports will be chosen as the construction and O&M base(s), for the proposed Projects. The following proposed Projects have the potential to result in cumulative effects to shipping and navigation receptors:

- SHE-T Orkney-Caithness interconnector cable;
- HIE Dounreay Demonstration Centre (DDC);
- Brims Tidal Array Limited, Brims Ness;
- Meygen, Inner Sound;
- Scotrenewables, Lashy Sound; and
- DP Energy, Westray South.

If one or more of the aforementioned Projects was to be constructed at the same time as the Dounreay Tri Ltd Project and the same port was used as a construction base there is potential for conflicts to arise. This could lead to congestion in and around the ports, leading to an increased collision risk. If ports such as Stromness and Lyness were chosen as the construction base for more than one project and construction was to be carried out simultaneously, the limited ability of these ports to accommodate large numbers of commercial vessels for construction activities, compared to, for example, Scrabster could lead to an increased risk of collision. Furthermore, increased activity by Project vessels in the Pentland Firth could lead to displacement or redirection of vessel traffic, e.g. commercial, fishing and recreational vessels, which could lead to an increased risk of collision.

Although the Projects highlighted in this cumulative impact assessment have the potential to increase the risk of collision between all vessels, it is unlikely that the construction periods of these projects will overlap. Furthermore, the floating platform will be constructed in a dry dock away from site and towed to position, before being hooked up to pre-installed mooring lines and export cable, which is anticipated to take a period of 5 days. This represents a small period of time over which the risk of collision will be increased, if one or more of these projects were to be constructed simultaneously. Good port management and liaison with harbour authorities will help mitigate against any potential conflicts were one or more of the aforementioned projects to be constructed at the same time and to use the same port.

The ability of the nearby ports, Scrabster, Stromness, and Lyness to accommodate the relatively small number of vessels required for O&M of the aforementioned projects, means any cumulative impact throughout the operational phase is unlikely to be significant. Any potential conflicts can be mitigated by good port management and liaison with harbour authorities.

6 Review of Historical Maritime Incidents

6.1 Introduction

It is useful to understand the history of maritime incidents in the area around the proposed development to judge whether it is, in general, a high or low-risk area and to check if there are occurrences or patterns which should be considered when:

- Assessing the risks arising from the development; or
- Assessing potential future impacts on SAR and emergency response coordination.

Data have been provided in January 2016 from the Marine Accident Investigation Board (MAIB) and from the Royal National Lifeboat Association (RNLI) which are summarised below.

6.2 Marine Accident Investigation Branch (MAIB) Information

All UK-registered vessels are required to report significant incidents to MAIB. Non-UK registered vessels must report incidents occurring within UK 12 mile territorial waters (which includes the proposed development location).

MAIB carried out a search in January 2016 of their database for incidents occurring within 10nm of the Project area over the past decade.

There were thirteen incidents logged, details of which are given in the following table.

Table 6.1 Review of historical incident data in the vicinity of the Project area over the last 10 years

Date	Type	Vessel	Latitude	Longitude	Outcome
13/02/ 2005	Heavy weather damage	UK Trawler, 57m, 783GRT	5847 N	347 W	Towed to port. No damage. No fatalities/injuries
08/02/ 2007	Machinery failure	UK fishing vessel, 18.2m, 150GRT	5846.6 N	343.8 W	Towed to port. No damage. No fatalities/injuries
01/06/ 2011	Machinery failure	UK twin rig trawler, 24m, 216GRT	5838.5 N	347.3 W	Towed to port. Minor damage. No fatalities/injuries.
03/12/ 2011	Cargo handling failure	Isle of Man timber cargo carrier, 91m, 2601GRT	5835 N	358.5 W	Partial loss of cargo. No fatalities/injuries.
10/12/ 2006	Machinery failure	UK fishing vessel	5481.5 N	337 W	Towed to port. No damage. No fatalities/injuries
14/05/ 2011	Machinery failure	UK pleasure craft, 14m	5834 N	347 W	Vessel towed to port. No damage. No fatalities/injuries

Date	Type	Vessel	Latitude	Longitude	Outcome
22/09/ 2005	Flooding /foundering	UK fishing vessel, 16.9m, 62GRT	5836.1 N	358.7 W	Ship initially grounded. Ship lost. No fatalities/injuries
05/05/ 2015	Occupational accident	Iceland survey vessel, 49.9m, 935GRT	5841.4 N	247.2 W	Survey technician sustained cut to hand. No damage. No fatalities. 1 injury
13/01/ 13	Casualty with a ship	UK dredger, 18m, 84GRT	5838 N	401 W	Towed to port. No damage. No fatalities/injuries
23/10/ 13	Casualty with a ship	UK trawler, 17m, 82GRT	5839 N	332 W	Towed to port. No damage. No fatalities/injuries
19/12/ 2014	Casualty with a ship	UK passenger, Ro-Ro, 112m, 8780GRT	5836 N	332 W	Vessel experienced berthing difficulties, when it was hit by a sudden heavy squall which damaged a section of the weld. Damage not significant and vessel continued to destined port. No fatalities. No injuries
03/01/ 2015	Occupational accident	UK fishing vessel, 17m, 119GRT	5836 N	333 W	Son of skipper fell over in fish hold. No fatalities. 1 injury
27/11/ 2015	Casualty with a ship	Dutch cargo vessel, 99m, 4015GRT	5847 N	333 W	Main engine failure which was able to be fixed and the vessel able to continue to its destination. No fatalities. No injuries

There were 13 incidents in ten years, an average rate of 1.3 incidents per year within a 10nm zone around the Project area, approximately 1900km^2.

The most serious outcomes were:

- A survey technician on an Icelandic vessel sustained a cut to hand; and
- A shipping vessel was initially grounded and was subsequently lost, but with no injuries.

Machinery failures on small vessels were the most common type of incident but there are no collision-related incidents.

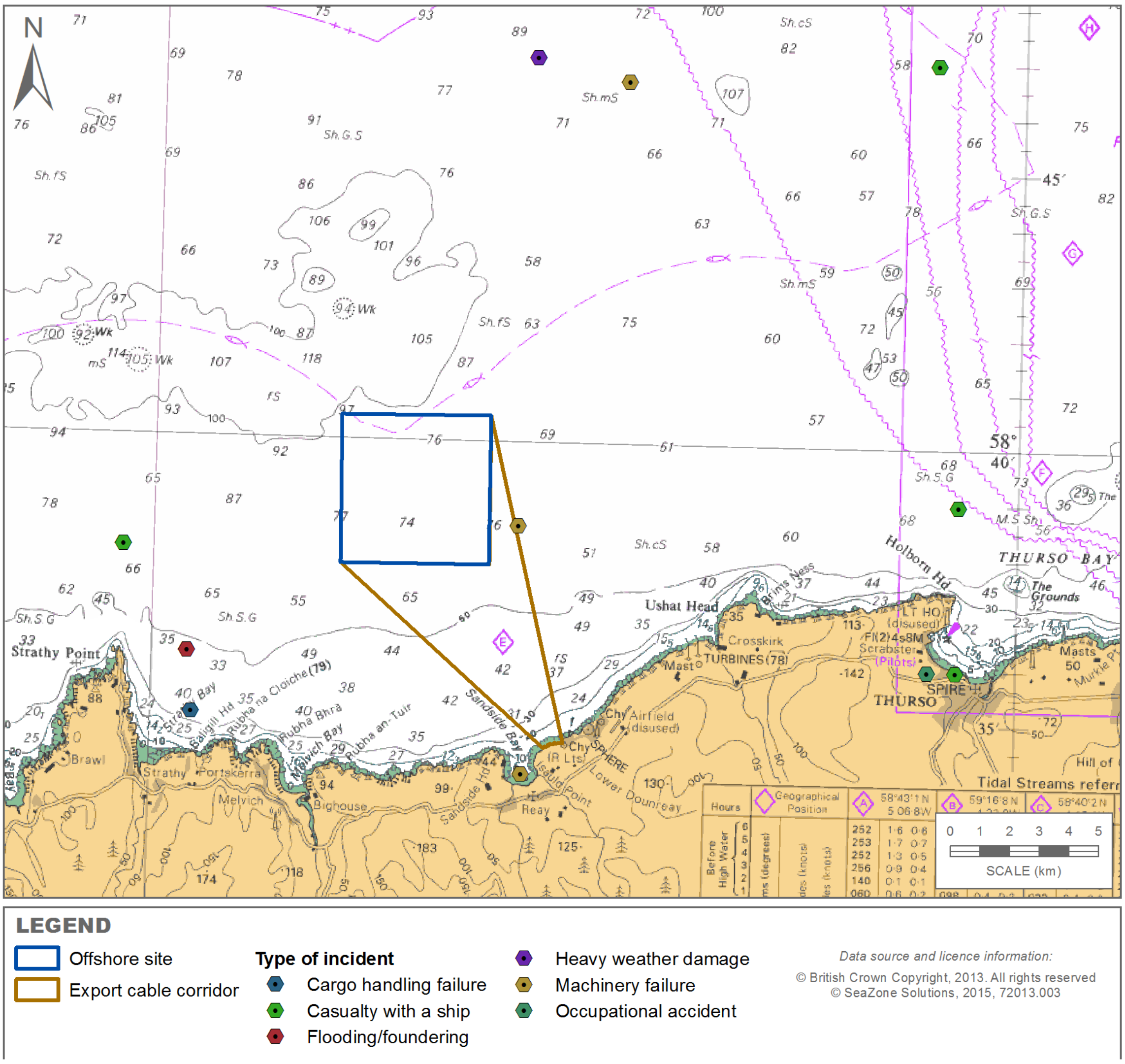


Figure 6.1 Locations of significant incidents reported to MAIB over the past decade

6.3 RNLI Information

RNLI provided listings in March 2016 of call outs from nearby RNLI stations for the five years 2011-2015. Those call outs within 10nm of the Project area are listed in Table 6.2. All incidents in the area were answered by Thurso RNLI station.

Table 6.2 List of Royal National Lifeboat Institution call outs 2011-2015 for the Project area + 10nm zone

Date	Incident
14/05/2011	Fouled propeller/impeller
22/05/2011	Adverse conditions
01/06/2011	Machinery failure
17/06/2011	Machinery failure
28/08/2011	Machinery failure
27/10/2011	Injured
28/11/2011	Vessel abandoned, derelict or adrift
09/02/2012	Person missing
07/04/2012	Machinery failure

Date	Incident
22/07/2012	Thought to be in trouble – false alarm
27/08/2012	Thought to be in trouble
25/09/2012	Stranding or grounding
13/01/2013	Machinery failure
06/07/2013	Thought to be in trouble
11/07/2014	Thought to be in trouble
14/07/2014	Injured
14/07/2014	Fouled propeller/impeller
09/08/2014	In danger of drowning
09/08/2014	In danger of drowning – false alarm
13/09/2014	Thought to be in trouble – false alarm
19/12/2014	Machinery failure
20/12/2014	Thought to be in trouble – false alarm
05/04/2015	In danger of drowning
07/04/2015	Injured
15/05/2015	Steering failure
23/05/2015	Machinery failure
09/07/2015	In danger of drowning – false alarm

There were 27 RNLI call outs over five years for the Project area + 10nm zone, an average of 5 per year.

Five incidents relating to fishing vessels with machinery failure, steering failure or which were grounded were recorded. One cargo vessel with machinery failure required assistance. There were three instances of yachts with engines, exhibiting machinery failure. Two of the call outs were related to a search for missing persons, both of which were unsuccessful. Six incidents were related to incidents where a person or persons were thought to be in trouble, with five of them related to surfers or inflatables and one response to a fishing vessel. Three of these incidents, including the response to the fishing vessel turned out to be false alarms. Three incidents were related to responses to people who were thought to be in danger of drowning, with two turning out to be false alarms. One incident was related to a power boat which had been abandoned or was derelict or adrift.

There was one incident involving a fishing vessel caught in adverse conditions which required assistance, however no incidents involved vessel collision.

6.4 Summary of Incident Data

Incidents reported by MAIB and RNLI were relatively few in number. In order to get a useful listing the area of search for incidents was extended from the usual 5nm zone around the Project area to a zone 10nm covering approximately 1900km^2. Even so, incidents were relatively few, perhaps reflecting the low volume of commercial, fishing and leisure craft. There was, on average, 1.3 incidents per year recorded by MAIB and around 5 callouts per year for RNLI.

The most common incidents involved fishing vessels or yachts disabled by machinery failure. These data are relevant to the hazard of a vessel, not under control, drifting into the floating platform, which takes up a very small area of 0.17km^2. The RNLI attended seven such callouts over five years in a 1900km^2 zone around the Project area.

7 Stakeholder Consultation and Hazard Review Workshop

7.1 Stakeholder consultation

Wide ranging consultation on navigation issues has been carried out during preparation for this NRA.

As a precursor to this NRA an Environmental Scoping Report including a Preliminary Hazard Analysis (PHA) was circulated to key stakeholders in order to:

- Provide stakeholders with outline information regarding the proposed Project;
- Identify the potential key interactions between the development and the receiving environment;
- Identify key marine safety issues in preparation for NRA;
- Provide a PHA; and
- Request feedback responses from stakeholders which have been used to inform the NRA.

All responses received from statutory bodies, advisors and other interested parties are recorded in the Scoping Opinion from Marine Scotland (Marine Scotland 2016).

This section focuses on those consultations relating to the NRA. Following scoping, further consultation was carried outwith consultees and stakeholders during preparation of this NRA. This included meetings with key stakeholders and interviews with local fishermen to gain a comprehensive assessment of local vessel activity not necessarily captured by AIS/VMS systems.

The consultation included a Hazard Identification and Risk Assessment (HIRA) workshop held in Caithness to the convenience of the local stakeholders, yet giving all other stakeholders adequate notice and information of the event. The invitee's included a range of national and local stakeholders, reported in Section 7.3. Unfortunately insufficient representation of stakeholders at this event led to a no quorum verdict. It was decided after much correspondence with all stakeholders to their convenience due to long travel and other working commitments (fisherman) to hold the HIRA remotely via a combination of email, and telephone conference. Organisations who responded to consultation on navigation issues were:

- Northern Lighthouse Board (NLB);
- Maritime and Coastguard Agency (MCA);
- Royal Yachting Association (RYA);
- Scottish Fishermen's Federation (SFF); and
- Orcades Marine Management Consultants (OMMC).

A brief summary of some of these consultations is presented, by organisation, below. In addition, specific feedback or information from consultees and stakeholders is referred to within the appropriate sections of this document. In addition, the HIRA event, held during preparation of this NRA, is described in Section 7.3.

7.2 Consultation Responses

A brief summary of pertinent consultations is presented below by organisation and topic.

7.2.1 Maritime and Coastguard Agency (MCA)

On 24 February 2016 a meeting with the MCA was held to discuss the planned scope of work for the NRA and seek MCA guidance on the topic of proportionality of the NRA to the scale of development and magnitude of risks.

The following points were noted:

- MCA agreed that a qualitative assessment is appropriate for the scale and type of development;
- Consider traffic data for all vessel types; and
- In the identification of vessels that don’t carry AIS, it was suggested radar data from the Orkney Harbour’s Authority could be used to identify the peak vessel movements and routes. In the event that this radar data was unsuitable it was agreed it may be possible to approach local users and harbours to provide qualitative data on vessel movements which could then be quantified via a radar survey, or similar, post consent. This quantitative revision of the NRA would be a condition of consent.

7.2.2 Northern Lighthouse Board (NLB)

In response to the scoping report the following was noted:

- As well as shipping density, it is important to take regard of type and cargo, draught and number of persons on board, to assess the likelihood and consequence of any shipping incident relating to the development or accumulation of developments being considered for the Pentland Firth area;
- NLB anticipate that the development site would be marked with Aids to Navigation based on International Association of Lighthouse Authorities (IALA) recommendations during the operational phase; and
- NLB will require additional information regarding the layout, mooring arrangement and deployment sequence in order to recommend marking and lighting that will provide safe warning through any transition from construction to operation.

7.2.3 UK Chamber of Shipping

In a response to the scoping opinion the following points were noted:

- Although the Project area is not a particularly busy area for commercial shipping, concerns over the proposed novel concept of floating turbine structures, particularly in contingency planning and safety zones were part of the structure to break free, were raised as these had not been considered in scoping (see Section 9.3.5 for consideration of this hazard);
- Suggested that the NRA should include details of the number and types of vessels transiting the zone in the past and present as well as any future increase in traffic due to potential projects in the wider area; and
- Highlighted that AIS and radar data alone will not necessarily provide a true picture of navigation in the region and therefore vessel operators, ports and coastguards should be consulted regularly in order to bridge any data gaps.

7.2.4 Royal Yachting Association (RYA)

In response to the scoping opinion the RYA indicated that the Project was unlikely to pose a huge risk to recreational vessels. It was noted that:

- The PFOW shipping study was able to provide better information, compared to the RYA coastal Atlas of Recreational Boating, which is currently being updated, by showing shipping routes as corridors rather than lines;
- Recreational vessels do pass through the Project area but that should not pose a problem provided the floating platform and WTGs are marked and lighted to NLB specifications;
- A floating wind farm is no more dangerous to recreational craft than an anchored vessel;
- The type of sailor who passes through the Pentland Firth is skilled in seamanship and knowledge of the COLREGS and is used to noticing and avoiding obstacles whether charted or not:
- This is the third floating wind site so experience has already been gained; and
- The RYA is opposed to safety zones except during construction.

7.2.5 Pentland Firth Yachting Club (PFYC).

- Noted that none of their members had expressed any concern and that, generally the club supports renewable energy projects.

7.2.6 Scottish Fishermen's Federation (SFF)

On 24 March 2016 a meeting with SFF was held to discuss the potential impact of the Project to fisheries, with a particular focus on navigational interests. SFF also represent Scottish Whitefish Producers Association and Scottish Pelagic Fishermen's Association. The following points were noted:

- The site is not intensively fished and the platform is small so fishermen may avoid the platform and anchors once installed;
- An AIS transmitter on the platform is essential so the platform remains clearly visible on electronic charts, regardless of sea conditions;
- Suggested that the site could be marked on charts as an operational "Advisory Zone" that extends 50m from the anchors and encompasses the whole mooring system. This advisory zone would be marked on the "Fish Safe" system and would trigger an alarm that there is a high risk of snagging when approaching the zone.

7.2.7 UK Hydrographic Office (UKHO)

- Noted that UKHO has a neutral position on such developments and that analysis of the largest scale chart of the Project area identified nothing charted that might impact on the Project.

7.3 Hazard Identification and Risk Analysis (HIRA) Workshop

7.3.1 Introduction

A HIRA workshop was arranged to be held in Thurso on 24 March 2016 to:

- Update stakeholders on Project development;
- Seek input from stakeholders on, e.g. traffic patterns for the different categories of vessels;
- Identify and define potential hazards and to generate a preliminary hazard List; and

- Discuss risk mitigation measures and generate a preliminary mitigation list.

Prior to the workshop the marine environment had been researched and data reviewed in relation to the activities likely to be undertaken with the proposed development. Additionally, traffic patterns in the areas around the Project had been reviewed. Future traffic densities had also been considered for potential interactions with the Project.

7.3.2 Attendees

Unfortunately there was not a quorum at this HIRA event and it was subsequently postponed. Invitations were sent to:

Table 7.1 People/organisations invited to take part in HIRA event

Organisation/Company	Person
Maritime and Coastguard Agency (MCA)	Nick Salter
MCA	Peter Lowson
RNLI Thurso	Andy Pearson W Munro
RNLI Lochinver	
Northern lighthouse Board (NLB)	Archie Johnstone, Peter Douglas
Local fisherman in the study area	David Fraser
Orkney Sailing Club	David Bruce
Orkney Sailing Club/Marinas	John Hinckley
MOD	Clifford Guy
MOD defence estates	
Highland Council General Manager (Harbours)	Tony Usher
Highland Council Marine Superintendent	Duncan Brown
RYA	Agnes Barclay
RYA	Graham Russell
RYA	Mike Grainger
Durness Development Group	Neil Fuller
Scottish Fishermen’s Federation	John Watt
Scottish Sea Farms	Richard Darbyshire
Moray Firth and North Coast inshore fisheries group	John Cox
National Inshore Fisheries Groups Secretariat	George White
Scottish Creel Fishermen’s federation	Ailsa McLellan
Scottish White Fish Producers Association (SWFPA)	Mike Park
Scottish Pelagic Fishermen's Association (SPFA)	Ian Gatt
Scottish Fisheries Federation	K Coull
Orkney Harbour Master	Brian Archibald
Kinlochbervie Harbour	Hugh Morrison
Wick Harbour	Malcolm Bremner
Scrabster Harbour trust	Jason Hamilton (harbour master)
Scrabster Harbour trust	Sandy Mackie
Gill’s Bay Harbour	B Mowat
Orcades	David Thomson
Highland Council Harbour	David Seddon
Scottish Fishermen's Federation	Malcolm Morrison

Organisation/Company	Person
Northern Lighthouse Board	Peter Douglas
Pentland Firth Yacht Club	Guy Newson
OIC Marine Services	Brian Archibald
PFOW developer i.e. MeyGen, BTAL, HIE	Michael Lewis (OpenHydro/BTAL) MeyGen Tim Hurst (HIE)
UK Chamber of shipping	Andrew Mundin
Orkney Fisheries Association	
Orkney Fishermen's Society	Fiona Mathieson
Orkney Sea Angling Association	
Scottish Creel Fisherman's Federation	
Sea Fish Industry Authority	

Local fisheries were contacted as part of the consultation process in order to try and get local fishermen to attend the HIRA event. This enabled one local fisherman to be identified, who expressed concern about the Project as his fishing vessel, which fishes using long-lines, was active in the Project area approximately every five weeks.

Consultation with this fisherman highlighted that as far as he was aware his was the only vessel that fished in the Project area. The operator of this vessel was invited to attend the HIRA event, but unfortunately was going to be offshore for a sustained period of time. It was agreed that he would attend the consultation event in Thurso on 9 April 2016, and speak to a representative from Renewable Energy Scotland (RES), who are acting on behalf of the developer. During this meeting the details of the Project including the potential risks to navigation were discussed and the results of which are presented below.

Discussions about the creation of an "advisory zone" extending out to 50m beyond the anchors to warn fishermen of the heightened snagging risk were held.

It was noted that the AoS for the Project was purposefully large to allow the developer flexibility in choosing a site in order to avoid or offset any conflicts. It was noted that the vessel uses long-lines in the north-west quadrant of the offshore site and the possibility of locating the floating platform away from the north-west quadrant was discussed as a potential mitigation. Consultation will continue with the vessel operator directly as the Project progresses.

As discussed it was agreed with all stakeholders and the MCA to hold the HIRA remotely, negating the need to travel long distances and also to engage more feedback from all parties. Consultees were each sent a copy of the hazard log (see Appendix B) and asked to review and provide comment, before a teleconference was to be held on 25th May 2016. All recommendations received were incorporated into the hazard log, and are set out in Section 7.3.3.

7.3.3 Hazards identified

Maritime hazards associated with the development were provided to consultees in the form of the hazard log together with appropriate risk control measures. The DECC/MCA guidance on Hazard Identification and an example hazard identification checklist were used in preparation of this hazard log. In the hazard log each phase of the proposed Project was described in turn. For each phase, the relevant categories of vessels (e.g. survey vessels, Project construction vessels, Project operations vessels, commercial vessels, fishing vessels and recreational vessels) were considered.

This enabled the identification of 'hazard scenarios' relevant to the Project. For each hazard scenario two cases were defined: 'Most Likely Outcome' and 'Worst Credible Outcome'.

The hazard scenarios identified were:

ID No.	Hazard Scenario
1	Survey vessel collision with other vessel
2	Survey gear entanglement
3	Construction vessel collides with 3rd party vessel
4	Construction vessel collides with another Project vessel
5	Attendant vessel collides with floating platform
6	Project vessel entangled with fishing gear/abandoned fishing gear
7	Project vessel experiences difficulties in the area
8	Attendant vessel collides with another attendant vessel in Project area
9	Attendant vessel towing floating platform collides with another vessel
10	Attendant vessel towing floating platform loses power and collides with floating platform
11	Attendant vessel loses tow to floating platform
12	Commercial vessel under control collides with floating platform
13	Fishing vessel under control collides with floating platform
14	Recreational vessel under control collides with floating platform
15	Vessel drifting and not under control collides with floating platform
16	Vessels navigating around Project site collide
17	Fishing vessel snags gear on export cable
18	Fishing vessel snags gear on floating platform/moorings/cables
19	Vessel snags anchor on export cable
20	Vessel snags anchor on floating platform mooring/substructure/cable
21	Floating platform breaks free and collides with vessel
22	Floating platform breaks free and runs aground
23	Man overboard
24	Naval vessel (submarine) under control collides with floating platform or subsea infrastructure
25	Access difficulties for SAR vessels
26	Unauthorised boarding of the platform for vandalism or theft

This list of potential hazards has been used as a preliminary hazard list as a basis for further review and development of the hazard log which is presented as Appendix B. To help understand the nature and potential risk severity of these hazards it was useful for stakeholders to be aware of vessel traffic patterns in the area, i.e. commercial vessels, naval vessels, fishing vessels and recreational vessels. This information was provided to stakeholders in the form of the PHA document. In general it was agreed that vessel traffic density was significant to the north of the offshore site and decreased steadily towards the southern part of the offshore site.

There were valuable inputs from contacted stakeholders specifically relating to the following:

RYA:
In relation to 'potential additional risk mitigation measures', for ID 14 'Recreational vessel under control collides with floating platform' it was noted that:

- About 20% of recreational vessels in these waters transmit an AIS signal and slightly more are likely to be able to receive one (indicating that a large percentage of recreational vessels will be reliant on sailing directions, sight and markings and lighting to see the floating platform);
- Recreational vessels can be difficult to spot using radar (the potential for live monitoring of traffic by AIS and radar is considered as a potential additional risk mitigation measure;
- The time taken for a Project vessel to reach the device in all conditions should be calculated – to enable response times to be calculated; and
- If a recreational vessel collides with the device will its crew be able to board the device – it was suggested that this would be a possibility.

In relation to 'risk mitigation measures considered when ranking' the RYA stated that:
- Notification of the Project to the Clyde Cruising Club for incorporation in their Sailing Directions and Anchorages would be required as this has recently been made a condition of recent Marine Licences.

It was also noted by the RYA, in agreement with the NLB, that IALA Recommendation 0-139 Edition 2 Dec 2013 in particular 2.3.2 'Marking of Floating Wind Structures' should be followed.

The RYA has suggested that in certain cases sailing between structures is possible, and therefore any navigational marking should be such that this cannot be considered as an option. It was also noted that due to long distances between ports and other places of refuge various weather and tidal conditions may occur whilst on passage. The RYA therefore suggested that it would be important that marking should be more than the minimum requirement.

The RYA investigated possible causes of hazard ID 14, suggesting that recreational sailors who typically reach the area concerned will be experienced and in a well maintained vessel. It was also suggested that vessels may approach the device from interest, tourism or simply as a navigational aid, but considered very unlikely that this would be close enough to risk collision. It was also highlighted that the floating platform is not much different to a vessel at anchor, yet there is no evidence that they pose a collision risk.

The specific linking of risk control measures to particular hazards is presented in the hazard log (Appendix B) and Risk Control Register (Appendix C).

7.3.4 Risk ranking process

The risk ranking process described in Appendix A was provided to consultees who were tasked to review and feedback comment hazard. This process has allowed potential hazards that were potentially missed to be identified, and for amendments to risk mitigation measures and risk rating to be made. This process was informed by other consultation input and the vessel traffic analysis data. This process is described in Section 9 Navigational Risk Assessment.

8 Status of Hazard Log and Risk Control Register

8.1 Status of Hazard log

The process used to generate the hazard log has been described in Appendix A. The risk assessment process including the proposed definitions of risk consequence, risk frequency and risk severity are also described in Appendix A. Hazards identified during consultation, the vessel traffic analysis and the HIRA activities were assessed for two cases, the 'Most Likely Outcome' and the 'Worst Credible Outcome'.

Risk assessment was based on the 'existing risk control measures' noted on the hazard log being in place. These include not just mandatory or regulatory requirements but also many additional measures to which the developer is committed. In some cases where the risk lies in the 'Tolerable with ALARP' region possible additional mitigation measures are noted separately in the hazard log (Appendix B).

All risks on the hazard log are ranked and assigned an ID Number. In brief, no hazards lie within the 'Intolerable' zone. The hazards noted in the hazard log, those which lie within the 'ALARP' zone, i.e. where the risk is assessed as greater than 'Broadly Acceptable', are listed below and are plotted on risk criticality matrices in Appendices D1 and D2.

For 'Most Likely' outcomes these are:

- ID 5 Attendant vessel collides with floating platform;
- ID 7 Project vessel in difficulties whilst at sea (e.g. fire, machinery failure, unexpected severe weather);
- ID 8 Attendant vessel collides with another attendant vessel within the development site;
- ID 12 Commercial vessel under control collides with floating platform;
- ID 13 Fishing vessel, under control, collides with floating platform;
- ID 14 Recreational vessel, under control, collides with floating platform;
- ID 15 Vessel drifting and not under control collides with floating platform;
- ID 17 Fishing vessel snags gear on export cable; and
- ID 18 Fishing vessel snags gear on floating platform /moorings/cables.

For the 'Worst Credible' scenarios they are:

- ID 3 Project construction vessel collides with 3rd party vessel (commercial, fishing or recreational) including when towing floating platform to site;
- ID 4 Project construction vessel collides with another Project vessel onsite;
- ID 7 Project vessel in difficulties at sea (e.g. fire, machinery failure, unexpected severe weather);
- ID 8 Attendant vessel collides with another attendant vessel within the Project area;
- ID 9 Attendant vessel on passage or towing floating platform collides with another vessel;
- ID 12 Commercial vessel under control collides with floating platform;
- ID 13 Fishing vessel, under control, collides with floating platform;
- ID 14 Recreational vessel, under control, collides with floating platform;
- ID 15 Vessel drifting and not under control collides with floating platform;
- ID 16 Vessels navigating around the development site collide; and

- ID 21 Floating platform breaks free from moorings and collides with vessel.

8.2 Status of Risk Control Register

The Risk Control Register will be used to track and audit the application of intended risk control measures and is presented in Appendix C.

All significant risks identified in the risk assessment process have been analysed and control measures adopted or developed to reduce all risks to the 'ALARP' or 'Broadly Acceptable' levels. This is also presented on risk criticality matrices in Appendix D1 for 'Most Likely' outcomes and D2 for 'Worst Credible' outcomes. All lie within the ALARP zone.

An audit on the application of risk mitigation measures will be carried out before construction starts. This will be combined with a systematic approach to monitoring the implementation and effectiveness of all the proposed mitigation measures throughout the lifecycle of the Project.

8.3 Overview of Mitigation Measures

Risk mitigation measures are noted against each hazard recorded in the hazard log (Appendix B). In summary, the mitigation measures taken into account for risk severity assessment include all the control measures required by regulation which include, but are not limited to:

- Compliance with COLREGS;
- Compliance with MCA/NLB requirements for marking and lighting the site;
- UKHO requirements for charting; and
- Requirements for issuing Notices to Mariners.

Also, the mitigation measures taken into account in this risk assessment include those to which the developer is committed, e.g. the requirements of the developers own management systems:

- Design management system including:
  - Change control procedure;
  - Failure Modes and Effects Criticality Analysis;
- Safety Management System;
- Project HSE Plan;
- Project Emergency Response Plan;
- Crew training programme including (but not limited to):
  - Personal Survival Techniques (STCW);
  - Deck Safety Awareness;
  - ENG 1 Medical;
- Operating Procedures including:
  - Task risk assessment; and
  - Tool box talks.

In addition to the control measures above, which apply across the Project activities, some specific control measures were identified through consultation. These are noted in the hazard log (Appendix B) and the Risk Control Register (Appendix C). They have also been taken into account during risk assessment. They include, for example:

- Continue to develop a comprehensive approach to notification/warning to all sea users;
- Discuss emergency response planning with Coastguard/RNLI including the presence, under normal circumstances, of the Project workboat based at the O&M base; and
- Consideration of export cable burial in relation to fishing activity and seabed survey.

8.4 Future Development of HIRA Process, Hazard Log and Risk Control Register

Future development of the HIRA process (for the Project planning and execution phase) will include more detailed Project planning and development of method statements. Further HIRA reviews will be held with the developer and Lead Contractor and other experts. These reviews will inform the Lead Contractor in the development of the final method statements. The HIRA process can be adjusted to focus more on risk management at an operational level. The Risk Control Register will be developed to list in detail the risk management and audit actions.

9 Navigational Hazards and Risk Assessment

9.1 Navigational Hazards – Cases to Consider

The guidance on preparation of a Navigational Risk Assessment (DECC/MCA 2013) suggests four cases should be considered:

- Base Case (no wind farm);
- Base Case with wind farm;
- Future Case without wind farm; and
- Future Case with wind farm.

Each case is reviewed with the main hazard descriptions and risk assessments presented within 'Base Case with wind farm'. The full listing of hazards identified is in the hazard log (Appendix B) and Risk Control Register (Appendix C) and the most significant risks for 'Most Likely' and 'Worst Credible' outcomes are shown in risk matrices (Appendices D1 and D2).

9.2 Base Case Without Wind Farm

The Base Case vessel traffic analysis has been described in detail in Section 5. In summary:

- The east-west commercial shipping channel runs to the north of the offshore site with some traffic passing through the offshore site, mainly in the northern sector;
- Fishing vessels transit the area, mainly east-west, and some actively fish the area. These include larger vessels tracked by AIS or VMS and smaller craft which have been identified by local consultation;
- Recreational vessels also pass through the area. Their general routings are shown in the RYA Routes Atlas (RYA 2009) and updated in SANAP (The Crown Estate 2014) (see Figure 5.21 and Figure 5.22 respectively); and
- Military exercises take place in the area.

Traffic in the Project area is subject to fewer hazards than in the Pentland Firth itself because:

- The east-west shipping channel has broadened out to the west of the pinch point of the Pentland Firth, reducing traffic density;
- No regular ferry services cross the area; and
- Tidal streams are much less strong with velocities ranging from approximately 0.5 – 0.75m/s during spring tides and 0.25 – 0.5m/s for neap tides (ABPmer 2008), compared to 4.1m/s in the Pentland Firth between Stroma and South Ronaldsay (ESRU 2014).

The historical marine incident data from RNLI and MAIB presented in Section 6 shows a small number of incidents with no collisions or vessels lost. The commonest type of incident requiring intervention was 'machinery failure'.

9.3 Base Case With Wind Farm

A list of hazards (event chains) was identified through HIRA and from expert input or vessel traffic analysis and included in the hazard log. All these hazards were assessed for risk severity for either 'Most Likely' or 'Worst Credible' outcomes as described in Appendix A. The risk severity assessment considers consequences for people/safety, environment, property/assets, and business.

Hazards giving rise to risks assessed as higher than 'Broadly Acceptable' for either 'Most Likely' or 'Worst Credible' scenarios are illustrated on risk criticality matrices in Appendices D1 and D2. These are listed below with their hazard log ID number:

- ID 3 Project construction vessel collides with 3rd party vessel (commercial, fishing or recreational) including when towing floating platform to site;
- ID 4 Project construction vessel collides with another Project vessel on- site;
- ID 5 Project vessel working within the site collides with floating platform;
- ID 7 Project vessel in difficulties whilst at sea (e.g. fire machinery failure, unexpected severe weather);
- ID 8 Attendant vessel collides with another vessel within the Project area;
- ID 9 Attendant vessel on passage or towing floating platform collides with another vessel;
- ID 10 Attendant vessel towing floating platform loses power and collides with floating platform;
- ID 11 Attendant vessel loses tow to floating platform;
- ID 12 Commercial vessel under control collides with floating platform;
- ID 13 Fishing vessel under control collides with floating platform;
- ID 14 Recreational vessel under control collides with floating platform;
- ID 15 Vessel drifting and not under control collides with floating platform;
- ID 16 Vessels navigating around wind farm collide;
- ID 17 Fishing vessel snags gear on export cable;
- ID 18 Fishing vessel snags gear on floating platform/moorings/cables; and
- ID 21 Floating platform breaks free from moorings and collides with vessel.

Risks identified and logged, but assessed as being in the 'Broadly Acceptable' zone are described in the hazard log but not discussed further in this section which focuses on risks assessed as greater than 'Broadly Acceptable'. This is with the exception of ID 22 'Man Overboard' which, although assessed as being broadly acceptable is still discussed to remain in line with DECC/MCA Guidance which requires attention to 'Other Navigation Risks' and 'Other Risks'.

Hazards are analysed below in related groups:

- **Installation (or decommissioning) impacts**

- ID 3 Project construction vessel collides with 3rd party vessel (commercial, fishing or recreational) including when towing floating platform to site; and
- ID 4 Project construction vessel collides with another Project vessel on- site.

- **Maintenance activity impacts**

- ID 7 Project vessel in difficulties whilst at sea (e.g. fire machinery failure, unexpected severe weather); and
- ID 22 Man Overboard.

- **Operations phase – vessel collisions and collisions with floating platform/infrastructure**

- ID 5 Project vessel working within the site collides with floating platform;
- ID 8 Attendant vessel collides with another vessel within the Project area;
- ID 9 Attendant vessel on passage or towing floating platform collides with another vessel;
- ID 10 Attendant vessel towing floating platform loses power and collides with floating platform;
- ID 11 Attendant vessel loses tow to floating platform;
- ID 12 Commercial vessel under control collides with floating platform;
- ID 13 Fishing vessel under control collides with floating platform;
- ID 14 Recreational vessel under control collides with floating platform;
- ID 15 Vessel drifting and not under control collides with floating platform;
- ID 16 Vessels navigating around wind farm collide; and
- ID 18 Fishing vessel snags gear on floating platform/moorings/cables.

- **Operations phase – fishing vessel snags gear on export cable**

- ID 17 Fishing vessel snags gear on export cable.

- **Operations phase – floating platform breaks free**

- ID 21 Floating platform breaks free from moorings and collides with vessel.

For each group of hazards the assessment methodology is to describe the activity, list the hazards being assessed, discuss relevant issues, describe the mitigations and summarise the residual level of risk.

9.3.1 Installation (or decommissioning) impacts

This section describes the activities associated with the installation phase, the specific hazards identified and particular issues around the hazards. Mitigations for each of the hazards are set out and described.

Activity

The activities associated with installation are deployment of:

- one static export cable;
- moorings and anchors for the floating platform; and
- connection of the floating platform to mooring lines and export cable.

The vessel activities for installation are provided in the project description with summary tables in Section 5 Analysis of Marine Traffic. It is anticipated that the laying of the export cable will take approximately seven days with a cable laying vessel and a dive support vessel at least being required.

The installation of moorings, anchors and cabling is expected to take 2 - 3 months with 1 - 2 vessels onsite at any one time. For the tow of the floating platform to site, the towing configuration is expected to utilise 3 AHTS vessels and the time for connection of the floating platform to the mooring lines and export cables is anticipated to take around five days. It is probable that the decommissioning programme would essentially be ‘reverse installation’ with a similar risk profile and risk analysis.

Hazards identified

- ID 3 Project construction vessel collides with 3rd party vessel (commercial, fishing or recreational) including when towing floating platform to site; and
- ID 4 Project construction vessel collides with another Project vessel on- site.

Issues

Sea room around the construction activities

The location of the development site will be at least 6km off the mainland coast in water deeper than 60m. The development site will not be greater than 0.17km^2 and therefore presents very little obstruction to other vessels during construction. Furthermore, the small size of the Project means smaller vessels will be easily able to avoid it without being pushed into the shipping lane to the north. This could be further mitigated by smaller vessels transiting the site on the landward side of the floating platform, for which there is large amounts of sea room available.

The site is not subject to strong tidal flows affecting vessel manoeuvrability, and installation activities will not be undertaken during adverse weather.

Safety zones during construction

The cable installation vessel will be a specialist vessel, most-likely a dynamically-positioned vessel, which needs to maintain course and speed and would normally broadcast a navigation warning requesting other vessels to stay clear of an appropriate safety zone around it.

The vessels used for installing the mooring system, anchors, export cable and the floating platform will be relatively static at the development site. The radius of a temporary safety zone around these should be minimised as far as possible whilst providing the necessary protection. Discussions will take place with MCA and contractors to agree the extent of safety zones. Working vessels will display appropriate marking and lighting and update their status on AIS. Notices to Mariners will be broadcast and local sea users informed.

Site charting, marking and lighting

All the provisions for charting the site to be agreed in detail with UKHO will be in place prior to site installation works. It will be proposed to UKHO that the chart will note that even if the floating platform is not on station, there will be submerged infrastructure still in place, i.e. mooring systems and cabling. The marking and lighting of the site will also be finalised with NLB prior to installation works. The marking and lighting will follow NLB recommendations and IALA requirements. The floating platform itself would be installed later and would be marked and lit appropriately following further discussion with NLB.

Guard vessel

It is not thought that a guard vessel stationed site during the construction phase would reduce risks to vessels navigating in the area because the construction vessels themselves will provide visible warning. However, the guard vessel option may be considered during detailed construction planning.

Mitigation

Safety zones during construction

It is normal practice for vessels engaged in construction to broadcast a request for a safety zone typically of 500 meters around them whilst they are working. It is recommended that safety zones required for construction activities on site and for installing the export cable from the site to landfall at Sandside Bay are reviewed. Consultation with MCA/NLB, will seek only the minimum size required to ensure the safety of the working vessels.

Notifications

All the regulatory requirements for charting the site will be followed and a comprehensive process will be implemented to:

(a) Inform vessels in transit using measures such as:

- Notices to Mariners;
- Navtex;
- Coastguard Safety broadcasts;
- Fishermen's notifications such as KIS-ORCA; and
- Port Notices.

(b) To inform local vessel operators of construction activities using the contacts built up during consultation.
(c) Updates to Kingfisher bulletins.
(d) Other notification processes to be agreed directly with key stakeholders.

Developer's Safety Management System

The developer is firmly committed to applying a comprehensive safety management system. Of particular relevance to the risks of vessel collision during construction are the commitments to contractor selection processes and vessel audit. In addition, development of a Project HSE Plan will take place in full consideration of the contractors' own HSE systems, procedures and expertise. A Project Emergency Response Cooperation Plan (ERCoP) will be developed in liaison with MCA and RNLI.

Hazard Review Process

The developer is firmly committed to a continuing programme of hazard identification and risk assessment during detailed design and planning of operations. The hazard reviews will involve the marine contractors and representatives from other sea users, MCA/Coastguard, RNLI, Harbour Masters and others as appropriate.

Task Risk Assessment and Tool Box Talks

Before any construction activity commences, the developer's safety management system will require that a task risk assessment is carried out to allow for personnel involved to discuss and agree the risk reduction measures to be implemented. Also, a tool box talk with operations personnel on the tasks, risks and mitigations will be held.

Level of risk

Given the application of the mitigation measures described above Hazard ID 3 'Project construction vessel collides with 3rd Party vessel (commercial, fishing or recreational) including towing floating platform to site' is assessed as lying within the ALARP zone. Similarly the level of risk for Hazard ID 4 'Project construction vessel collides with another Project vessel site' lies in the ALARP region. Risks lying within the ALARP zone are subject to further attention during detail planning for risk reduction.

9.3.2 Maintenance activity impacts

Activity

During the operational phase the marine operations at the Project site will generally be on-board inspection of the floating platform which will be accessed by workboat. Other more serious interventions will need to be carried out off- site. The floating platform will require unlatching onsite before being towed to the O&M base for maintenance (or to other harbours as appropriate for carrying out the required tasks, e.g. dry dock).

These activities require Project vessels to be at sea between the Project site and O&M base or other harbours.

Hazards identified

- ID 7 Project vessel in difficulties whilst at sea (e.g. fire, machinery failure, unexpected severe weather); and
- ID 22 Man Overboard.

Issues

Risk exposure of Project vessel

The main role of the Project vessel based at the O&M base will be to attend the site for visual inspection. This is estimated at once per week when the platform is installed. The potential hazards to the workboat and crew include machinery failure, fire and explosion, and unexpected severe weather.

Man overboard risks

Man overboard risks arise particularly during personnel transfer from vessel to vessel at sea or transfer from attendant vessel to the floating platform.

Mitigations

Mitigations and the hazards to which they apply within maintenance activities are described:

Safety management system

The key features of the Safety Management System (SMS) developed by the operator in conjunction with key contractors have been described earlier (see Section 9.3.1). Those of particular relevance to these hazards are the process for selecting contractors, carrying out vessel audits, requirements for crew training, and the development of detailed Project HSE and Project Emergency Response planning (including the Project Emergency Response Cooperation Plan). Also, detailed operating procedures and method statements will be developed and critically reviewed by a detailed HIRA process. These will be supplemented by task risk assessments and tool box talks immediately prior to operations.

These elements of the SMS together should facilitate a safe system of work using inspected vessels and trained crews following clear procedures and will effectively mitigate the risks for the hazard identified for this phase, i.e.:

- ID 7 Project vessel in difficulties whilst at sea (e.g. fire, machinery failure, unexpected severe weather); and
- ID 22 Man Overboard.

The application of a comprehensive SMS (including an Emergency Response Plan as described in Section 11) will also help reduce the levels of non-navigation risks to the vessel crews arising from deck operations, lifting operations, medical emergencies, etc.

O&M strategy

Once operational, the Project will require regular inspections, servicing and maintenance throughout its lifetime. This will require technicians and support staff. Given the distance of the Project from shore and Project size, it is assumed that an O&M hub at an existing port may be required. The O&M hub would be selected during the consent determination period. O&M vessels would steam between the port and the Project.

Turbine maintenance falls into two categories: Preventative maintenance and corrective maintenance. Preventive maintenance will be mostly undertaken using crew vessels (although helicopters could be used in certain circumstances) to access the turbine and includes tasks such as the replacement of consumables (filters and oil) as well as a general inspection of the turbine. Crew transfers from vessels are expected to be via boat landing whereas helicopter access will be via heli-hoist. Corrective maintenance includes minor repairs/restarts and major component replacements (such as generator, blades, etc.). This is required if the results of condition monitoring or preventive maintenance suggest it is necessary, or if monitoring alarms are triggered (some of which may result in the wind turbines being remotely shutdown). It is expected that on average up to eight visits per turbine, per year will be required for fault rectification and up to three per turbine, per year for major component replacement (these figures may vary significantly from year to year). Corrective maintenance will be carried out using crew boats, helicopter or specialised vessels depending on weather conditions and the details of the breakdown. Major component replacements (nacelle, blades etc.) may mean that the platform is towed to a deep water port or dry dock.

Foundation maintenance will be mostly undertaken using vessels to access the foundations and divers or ROVs for subsea inspections. Preventive maintenance operations will include routine inspections of the subsea and topside structures, along with confined space operations which may require specialised technicians. The structural integrity of the foundation structure and ancillary structure (access ladders, walkways etc.) will be assessed along with the level of corrosion and marine growth. Marine growth will be removed if it is causing excessive loading on the foundation structure or restricting access. Pressure washers (using high-pressure sea water with no additives) will most likely be used for general cleaning and removing marine growth on key areas such as access ladders and walkways.

Additionally, separate inspections (such as side-scan sonar or ROVs) will inspect the condition of the seabed and scour protection (if utilised) around the anchors and the export cable.

Operating procedures for tow management

It is expected that the majority of repairs be carried out onsite, with the floating platform able to be accessed by Project workers. However, in the event that major repair work is required the floating platform may have to be towed to an appropriate harbour in order to facilitate repairs. In order to mitigate the risks associated with towing the floating platform for maintenance, these operations will only be carried out during periods of forecast suitable weather conditions. The operating procedures include detailed procedures relating to tow management, including definition of weather window requirements and weather forecast checks, and contingency plans and equipment for loss of tow including back up tow line deployment.

These control measures mitigate the risks to Project vessels engaged in towing operations.

Level of Risk

For Hazard 'ID 7 Project vessel in difficulties whilst at sea (e.g. fire, machinery failure, unexpected severe weather)' the level of risk with the mitigations described in place is assessed as being in the ALARP zone

These are shown in Appendices D1 and D2. Further opportunities to reduce risk levels will be sought during Project development.

9.3.3 Operations phase – vessel collisions with floating platform or infrastructure

Activity

The base case vessel traffic analysis has been presented above (see Section 5) together with the intended plan to install the floating platform in a small section within an offshore site of 25km^2. The applicant has studied an area which is purposefully larger than required. The platform covers a sea surface area of approximately 0.17km^2. However, Hexicon has been studying an area of 25km^2 in order to maintain enough flexibility to move the platform, within this area, to avoid or offset potential conflicts.

Hazards identified

- ID 5 Project vessel working within the site collides with floating platform;
- ID 8 Attendant vessel collides with another vessel within the Project area;
- ID 9 Attendant vessel on passage or towing floating platform collides with another vessel;
- ID 10 Attendant vessel towing floating platform loses power and collides with floating platform;
- ID 11 Attendant vessel loses tow to floating platform;
- ID 12 Commercial vessel under control collides with floating platform;
- ID 13 Fishing vessel under control collides with floating platform;
- ID 14 Recreational vessel under control collides with floating platform;
- ID 15 Vessel drifting and not under control collides with floating platform;
- ID 16 Vessels navigating around wind farm collide; and
- ID 18 Fishing vessel snags gear on floating platform/moorings/cables.

Issues

Avoidance of the site by other sea users

The MCA have published in MGN 372 (MCA 2008) guidance to mariners operating in areas with offshore renewable energy installations (OREI), including wind, wave or tidal energy conversion machines. The guidance notes three broad options for mariners:

- Avoid the area completely;
- Navigate around the edge; or
- In the case of fixed and visible machines (wind farm) navigate with caution through the array.

As with other OREI sites, the development area will be marked on UKHO charts with a description of the features relevant to mariners. A recommendation for avoidance of the defined area by other sea users may be added subject to agreement with MCA, NLB and UKHO.

Sea users should avoid the area as they would avoid any other marked and charted navigational hazard. Vessels which require passage near the array, either fishing or in transit, should navigate around the edge, prudently on the downwind side. Non-Project vessels should be strongly advised not to enter the site as the floating platform is not static but moves in response to wind direction.

Further discussions will be held with MCA regarding site designation options.

Charting and notification

The site will be appropriately marked on charts in consultation with UKHO, MCA and NLB. It will be important to include in the charting description and notifications that during operation there may be periods when the floating platform is off site, but its associated moorings and cables remain as a potential hazard to fishing gear entanglement.

As a complementary activity, a comprehensive plan to alert and notify all sea users will be developed and implemented in consultation with national, regional and local bodies for commercial shipping, fisheries and recreational users. This will include:

- UKHO charting with site description;
- Notices to Mariners;
- Navtex;
- Notification to fishermen via KIS-ORCA;
- Notification to recreational vessel associations (both sailing and kayaking);
- Local liaison with fishermen;
- Local liaison with Harbour Masters; and
- Other methods as agreed with consultees.

Site marking and lighting

The marking of the site will accord with current regulatory requirements (IALA Recommendation O-139 Section 2.4). Further consultation with NLB at the NRA HIRA will confirm approved method. Further detailed consultation with NLB is planned regarding site marking and lighting.

Array location and layout

The actual location of the 2km^2 development area (including floating platform and associated moorings and anchors) is yet to be defined and is influenced by several factors. However, it is noted that a location away from the northern edge of the offshore site would benefit from lower transiting vessel density.

Mitigations

The main mitigations for this group of hazards taken together are:

- **site designation**

Discussions will continue with MCA on the site designation and how best to ensure non-Project vessels do not enter the site. These discussions will include the appropriate description of the site and recommendations to mariners on charts.

- **charting and notification**

A comprehensive approach will be taken to discussion and notification not just to UKHO but also to KIS-ORCA for fisheries, Notice to Mariners and Navtex, and all relevant national and local stakeholders whether commercial, fisheries or recreational.

- **site marking and lighting**

This will be in compliance with regulatory requirements and ongoing consultation with MCA and NLB.

- **site location within the Project area**

The actual development site is small compared to the AoS. Its location has yet to be decided and is subject to a range of factors. However, locating the development away from the northern boundary of the AoS would place it in an area of lower vessel traffic density.

- **site monitoring**

A potential additional mitigation for vessel collisions with the floating platform would be to monitor the site to detect, for example by AIS surveillance, vessels intruding into the development site. Options including Orkney VTS will be discussed with MCA.

- **safety management system**

As noted above, this will be of particular importance in reducing risks for all Project operations.

Specific mitigations for each of the individual hazards considered in this section are noted below:

ID 5 'Project attendant vessel collides with floating platform' and ID 8 'Attendant vessel collides with another attendant vessel within the Project area'

It is anticipated that the Project operations support vessel may attend the Project site frequently, maybe up to 50 times in its first year. Hexicon will develop a SMS and operations procedure to control risks. The safety management system will, as noted earlier, mitigate the risk by requiring proper detailed planning of operations, selection of vessels audited to IMCA standards, passage planning, trained crew, task risk assessment and tool box talks with the crew.

Project vessels will be familiar with the site layout and will only operate within it at a low speed, thus minimising the risk of a heavy collision. Similarly, the operation of towing the floating platform is controlled under specific tow management procedures and contingency measures defined by Hexicon and the marine contractor.

ID 12 'Commercial vessel under control collides with floating platform'

The vessel traffic analysis shows a moderate traffic density of commercial vessels and fishing vessels generally transiting east-west to the north of the offshore site and within the offshore site; particularly in its northern part. It is noted that the actual area of the floating platform will be only $0.17km^2$ of the full area for which consent is sought (i.e. one floating platform). This was judged to be easy to avoid from previous consultations with mariners, either making a small diversion to offshore or (for vessels desiring an inshore track) to the inshore side where there is a minimum of 6km distance to shore.

ID 13 'Fishing vessel under control collides with floating platform' and ID 18 'Fishing vessel snags gear on floating platform/moorings/cables'

Fishing activity as described in the traffic analysis broadly divides into offshore fishing beyond the 60 meter depth contour by vessels coming to trawl for squid or herring or to dredge for scallops, and local vessels using static gear. The scope of these operations has been established through consultation with local, regional and national organisations which will facilitate further discussion on the Project development.

A member of the Hexicon team or RES will continue to ensure all operators are aware of the site location, designation and the timing of activities onsite. A Fisheries Management Plan will be developed to ensure liaison is inclusive of key ports, harbours and trade associations. It will be emphasised specifically that the site is potentially hazardous not only when the floating platform is installed but also when the subsea infrastructure of mooring systems and electrical cabling is in place and the floating platform is off site. This infrastructure would certainly pose a risk to fishing gear entanglement, whether trawling, dredging or static gear. It is important that all chart descriptions and warning notifications advise this.

ID 14 'Recreational vessel under control collides with floating platform'
During the HIRA the collision risk to yachts has been considered and feedback from the RYA received. The RYA has suggested any navigational marking should be carefully considered to prevent a sailor attempting to sail in-between the structures.

Consultation with RYA highlighted that *"a floating wind farm is no more dangerous to recreational craft than an anchored vessel".* It was also suggested that the type of sailor who passes through the Pentland Firth is skilled in seamanship and knowledge of the COLREGS and is used to noticing and avoiding obstacles whether charted or not.

ID 15 'Vessel drifting or not under control collides with floating platform'
Vessels losing propulsion or control are at risk of collision with the floating platform or any other natural hazard to navigation. The analysis of previous marine incidents from MAIB and RNLI does highlight that whilst no severe weather-related or collision, grounding or foundering incidents occurred over ten years there were several incidents of machinery failure affecting fishing and recreational vessels. The MAIB/RNLI data shows 34 incidents in ten years in a zone 10nm (18.5km) around the Project area, a sea area of approximately 1900km^2. The size of the floating platform at 0.17km^2 constitutes a very small proportion of this area. Therefore, the probability of machinery failure nearby the floating platform is very small and the actual collision risk even smaller.

ID 16 'Vessels navigating around the wind farm collide'
The traffic density is moderate and the small size of the development requires only minor deviations so collision risks between vessels avoiding the array are small. Vessels are assumed to comply with COLREGS to avoid collision. The potential additional mitigation of locating the development area away from the northern edge of the offshore site would reduce the number of vessels passing nearby and needing to navigate around the array.

Level of risk
Hazards relating to collisions with the floating platform or fishing gear entanglement with the subsea infrastructure are:

- ID 5 Attendant vessel collides with floating platform;
- ID 8 Attendant vessel collides with another attendant vessel within the development site;
- ID 9 Attendant vessel on passage or towing floating platform collides with another vessel;
- ID 10 Attendant vessel towing floating platform loses power and collides with floating platform;
- ID 11 Attendant vessel loses tow to floating platform;
- ID 12 Commercial vessel under control collides with floating platform;
- ID 13 Fishing vessel under control collides with floating platform;
- ID 14 Recreational vessel under control collides with floating platform;
- ID 15 Vessel drifting or not under control collides with floating platform;

- ID 16 Vessels navigating around the wind farm collide; and
- ID 18 Fishing vessel snags gear on floating platform/ moorings/cables.

Given the application of the mitigation measures described above all these risks lie within the ALARP zone. Further attention to risk reduction will be applied during the detailed planning and design.

9.3.4 Operations phase – fishing vessel gear snags on export cable

Activity

The area within which the export cable will lie is frequented on occasion each year by trawlers, scallop dredgers and local creel fisheries, the latter of which accounts for the most fishing activity in the area.

Hazards identified

ID 17 'Fishing vessel snags gear on export cable'

A fishing vessel (particularly scallop trawlers and dredgers) may entangle its gear on a surface-laid cable or become snagged/damaged on cable protection materials (aggregate or mattresses).

Issues

Cable routing and installation

The route which the cable will take will be influenced by a number of factors including geophysical make-up of the seabed, seabed topology, distance, appropriate landing point at the landward grid connection point and environmental factors and other sea users.

The cable will be landed at the east side of Sandside Bay. The length of cable is likely to be 6 to 13.8km. It will be a single cable with a maximum diameter of 0.5m.

Ploughing is the preferred cable installation method, although jetting or vertical injection may be used where local sediments require. The export cable will be buried within a trench up to a maximum of 8m wide and 2m deep. The cable will not be trenched for the entire route, but is likely to be buried or drilled for a short distance in the near-shore area. The risk assessment has assumed partial burial in the near-shore area. Depending on seabed conditions along the export cable corridor it may not be possible to bury the full length of cable to the desired depth. Where it is not possible to bury the cable, rock may be required to protect the cable. As a worst case it is assumed that a maximum of (20%) 2.8km of cable may require protection.

Anchorages

There are no anchorages in close proximity to Sandside Bay and consequently risks identified at the HIRA workshop relating to a vessel snagging its anchor on the export cable were judged to be minimal and Broadly Acceptable.

Mitigations

The main mitigations would be:

- Burial in part or whole of the cable or application of suitable protective covering;
- Charting on UKHO and KIS-ORCA charts; and
- Providing coordinates directly to local fishermen to enter on their chart plotters.

Level of risk

For Hazard ID 17 'Fishing vessel snags gear on export cable' the level of risk is assessed as being in the ALARP zone.

For sections of export cable which are laid on the seabed there will be a risk of fishing gear snagging. The risk analysis assumes partial burial or protection and indicates a risk in the ALARP zone. Risk mitigation will continue to assess route selection and installation methods, continuing discussion with fisheries organisations and provision of accurate as-laid survey information for charts and notifications.

9.3.5 Operations phase - floating platform breaks free from moorings

Activity

The floating platform will be installed with the intention that it remains securely moored except for planned removal for maintenance.

Hazard identified

ID 21 'Floating platform breaks free from moorings and collides with vessel'

If the floating platform was to break free it would pose a significant moving hazard to shipping in the area.

Mitigations

Design safety analysis

Failure modes which may impact the environment and/or other sea users will be comprehensively risk assessed and recorded. These assessments include a series of Failure Modes Effects and Criticality Analysis (FMECA) carried out on the main components, including the platform's structural integrity and mooring system integrity.

The body of design assessment work will facilitate Hexicon obtaining 3rd party design verification (TPV) in due course. This provides an independent view of the integrity of the design, its compliance with relevant codes and standards and its robustness for key safety issues.

Design safety measures

Two groups of design safety measures have been incorporated to guard against the floating platform breaking free. Firstly, the mooring system design is robust for extreme weather conditions. Also, the mooring system is designed so that a single-point failure in the mooring is not sufficient to allow the floating platform to break free.

Secondly, the control system generates detailed information on the floating platform's health, including location, based on GPS receivers. An alarm system will operate should the floating platform move outwith a pre-defined watch radius. In the event of a single mooring element failure the floating platform would be retained on its moorings but with greater movement. This would be detected and an alarm raised to alert operations control, coastguard, local mariners etc.

Recovery measures

The probability of the floating platform or a part of it breaking free is low and any excursion of the floating platform outside its normal watch circle will be detected by the control system and an alarm raised immediately for the 24 hour operations control personnel. This would prompt an intervention at site by the coastguard, emergency towing vessel (ETV) or any other vessel with tow capabilities to avoid the floating platform drifting into the main shipping channel.

If the floating platform was to break free duty personnel will initiate the following response plan:

1. Review weather forecast and commission suitable vessels;
2. Inform the coastguard;
3. Inform other local stakeholders;
4. Mobilise vessels to the site to facilitate recovery; and
5. If possible attempts will be made to rectify the fault onsite. If this is not possible the floating platform will be towed to a suitable harbour for repair.

The scenario will be included in the Project emergency response planning and refined during development of the ERCoP in conjunction with the Coastguard and RNLI.

Level of risk

For hazard ID 21 'Floating platform breaks free from moorings and collides with vessel' the risk is assessed as being in the ALARP zone.

Whilst the probability of the floating platform breaking free is very low the potential worst case consequence involving a collision with a 3rd party vessel is high. The risk is assessed as being in the ALARP zone.

9.4 Future Case Without Wind Farm

Within the strategic studies of vessel, port and renewables activity in PFOW, i.e. Shipping Study of PFOW (Marine Scotland 2012b) and SANAP (Crown Estate 2014) there are no forecasts of future traffic growth except growth in renewables activity. Therefore, risks to navigation for the Future Case without the wind farm are judged to remain as for the Base case without wind farm.

9.5 Future Case With Wind Farm – Cumulative and In-Combination Effects

Consent will be sought for a 12MW array containing two wind turbine generators (WTGs) and the associated infrastructure.

This assessment of cumulative effects considers the potential impacts that may potentially arise from development of the Dounreay Tri Ltd floating wind demonstration site, combined with existing baseline trends along with any future planned projects. An important factor for cumulative effects to shipping and navigation is which ports will be chosen as the construction and O&M base(s), for the proposed projects. The following proposed projects have the potential to result in cumulative effects to shipping and navigation receptors:

- SHE-T Orkney-Caithness interconnector cable;
- HIE Dounreay Demonstration Centre (DDC);
- Brims Tidal Array Limited, Brims Ness;
- Meygen, Inner Sound;
- Scotrenewables, Lashy Sound; and
- DP Energy, Westray South.

If one or more of the aforementioned projects was to be constructed at the same time as the Dounreay Tri Ltd Project and the same port was used as a construction base there is potential for conflicts to arise. This could lead to congestion in and around the ports, leading to an increased collision risk. If ports such as Stromness and Lyness were chosen as the construction base for more than one project and construction was to be carried out simultaneously, the limited ability of these ports to accommodate large numbers of commercial vessels for construction activities, compared to, for example, Scrabster could lead to an increased risk of collision. Furthermore, increased activity by project vessels in the Pentland Firth could lead to displacement or redirection of vessel traffic, e.g. commercial, fishing and recreational vessels, which could lead to an increased risk of collision.

Although the projects highlighted in this cumulative impact assessment have the potential to increase the risk of collision between all vessels, it is unlikely that the construction periods of these projects will overlap. Furthermore, the floating platform will be constructed in a dry dock away from site and towed to position, before being hooked up to pre-installed mooring lines and export cable, which is anticipated to take a period of 5 days. This represents a small period of time over which the risk of collision will be increased, if one or more of these projects were to be constructed simultaneously. Good port management and liaison with harbour authorities will help mitigate against any potential conflicts were one or more of the aforementioned projects to be constructed at the same time and to use the same port.

The ability of the nearby ports, Scrabster, Stromness, and Lyness to accommodate the relatively small number of vessels required for O&M of the aforementioned projects, means any cumulative impact throughout the operational phase is unlikely to be significant. Any potential conflicts can be mitigated by good port management and liaison with harbour authorities.

Having considered the information presently available in the public domain on the projects for which there is potential for cumulative impacts, and due to the localised nature of potential impacts associated with this Project, it is considered that from a shipping and navigation perspective there will be no significant cumulative impact from any of these projects.

9.6 Other Navigation Risks and Other Risks

In addition to General Navigation Risks the DECC/MCA Guidance requires attention to 'Other Navigation Risks' and 'Other Risks':

- Vessel and fishing gear interactions with cables were considered in Section 9.3.4;
- Floating platform breaking free as a hazard to navigation has been considered in Section 9.3.5; and
- Risks to personnel from Man Overboard have been considered in Section 9.3.2.

9.6.1 Impact on marine systems

The following summarises the potential impacts of the different communications and position fixing devices used in and around offshore wind farms (GPA, VHF, AIS). The basis for the assessment is the trials carried out by the MCA at North Hoyle and experience of personnel/vessels operating in and around other offshore windfarm sites.

VHF communications (including digital selective calling)

Vessels operating in and around offshore wind farms have not noted any noticeable effects on VHF (including voice and Digital Selective Calling (DSC) communications). No significant impact is anticipated at the Project.

Navtex
The Navtex system is used for the automatic broadcast of localised Maritime Safety Information (MSI). The system mainly operates in the medium frequency radio band just above and below the old 500 kilohertz (kHz) Morse Distress frequency. No significant impact has been noted at other sites and none are expected at the Project site.

VHF direction finding
During the North Hoyle trials, the VHF direction equipment carried in the lifeboats did not function correctly when very close to turbines (within about 50 metres). This is deemed to be a relatively small scale impact and provided the effect is recognised, it should not be a problem in practical search and rescue.

Automatic identification systems
In theory there could be interference when there is a structure located between the transmitting and receiving antennas (i.e. blocking line of sight). This was not evident in the trials carried out at the North Hoyle site and no significant impact is anticipated for AIS signals being transmitted and received at the Project site, especially as there are only five turbines.

Global positioning systems
No problems with basic GPS reception or positional accuracy were reported during the trials at North Hoyle and this has been confirmed from other vessels which have been inside offshore wind farms. Consideration will require to be given to any potential degradation of DGPS signals being used to position construction equipment when close to a tower.

Electromagnetic interference on navigation equipment
Based on the findings of the trials at the North Hoyle Offshore Wind Farm (MCA & QinetiQ, 2004), the wind farm generators and their cabling, inter-turbine and onshore, did not cause any compass deviation during the trials. However, it is stated that as with any ferrous metal structure, caution should be exercised when using magnetic compasses close to turbines. It is noted that all equipment and cables will be rated and in compliance with design codes. In addition the cables associated with the wind farm will be buried (where practicable) and any generated fields are expected to be very weak and will have no significant impact on navigation or electronic equipment.

9.6.2 Noise impacts

The MCA notes (in MGN 543) that consideration should be given to the possibility of noise emanating from OREIs masking the sound signals required for ships whistles and fog alarms.

Acoustic noise masking sound signals
A concern which must be addressed under MGN 543 is whether acoustic noise from the Project could mask prescribed sound signals. Industry research has indicated that the sound level from a wind farm at a distance of 350m is below background sound level so it is not expected that wind farm noise will be an issue for most mariners.

The International Regulations for Preventing Collisions at Sea 1972 (COLREGS), ANNEX III, entered into force by the IMO, specifies the technical requirements for sound signal appliances on marine vessels. Frequency range and minimum decibel level output is specified for each class of ship (based on length).

A ship's whistle for a vessel of 75m should generate in the order of 138 decibels (dB) and be audible at a range of 1.5nm. Therefore, this should be heard above the background noise of the wind farm.

Foghorns will also be audible over the background noise of the wind farm. Therefore, there is no evidence that the sound level of the wind farm will have any significant influence on marine safety.

Noise impacting sonar
Once in operation it is not believed that the subsea acoustic noise generated by the wind farm will have any significant impact on sonar systems.

9.6.3 Coastal processes

These are considered within Chapter 6: Physical and Coastal Processes of the Environmental Statement. It was concluded that the impact of the Project on coastal processes will be negligible.

10 Search and Rescue (SAR)

10.1 Overview

MCA/HM Coastguard co-ordinates all search and rescue activities in the UK. Each area of coastal waters is controlled by a Maritime Response and Co-Ordination Centre (MRCC).

The MRCC covering the area around the Project is Shetland. HM Coastguard is responsible for requesting and tasking SAR resources made available by other authorities and for co-ordinating the subsequent SAR operations (unless they fall within military jurisdiction) (see Figure 10.1).

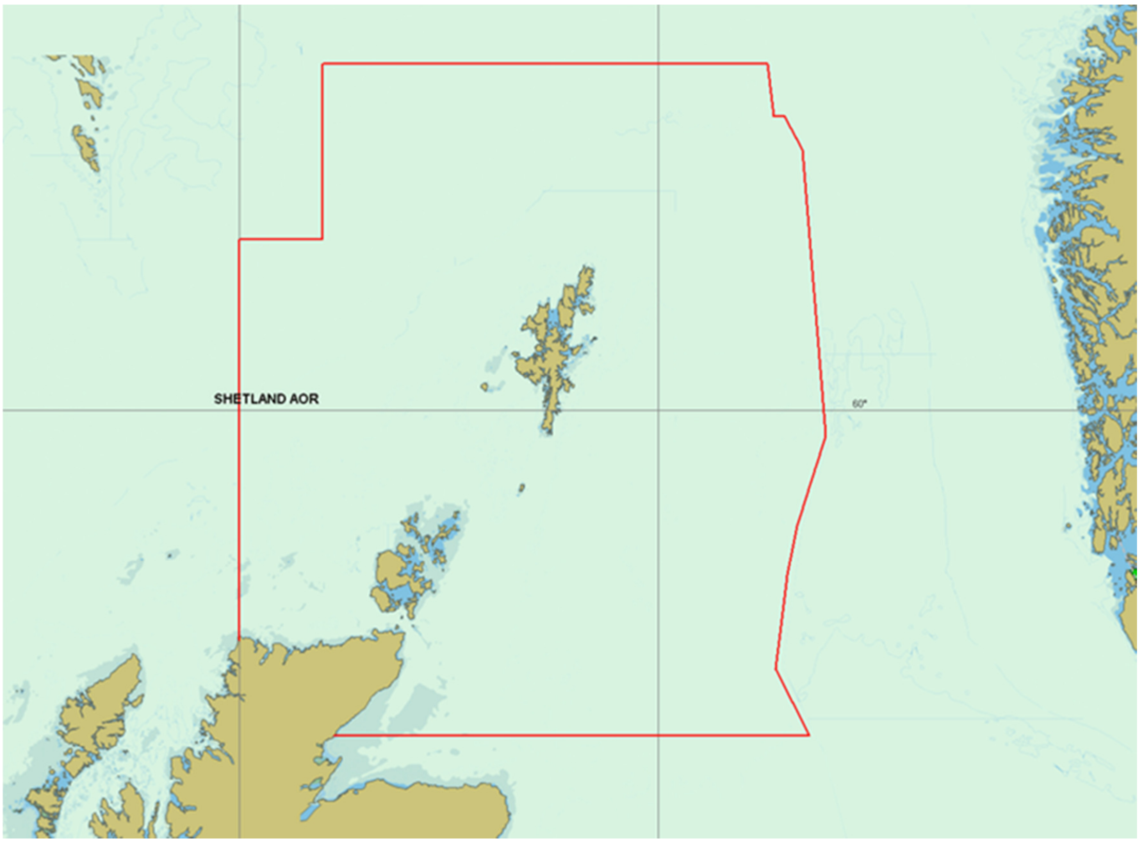


Figure 10.1 Shetland SAR area

10.2 Resources

10.2.1 SAR helicopters

The current SAR helicopter capability for the area is delivered from bases at Sumburgh, Stornoway and Lossiemouth, which are in range of the site. The aircraft used (S-92) has an automatic Flight Control System and Auto Hover and has a speed of 0-139 knots long range, 0-153 knots cruise and 0-165 knots and has a radius of approximately 250nm. Wind limitations of the SAR helicopter are as follows: Start/shutdown 45 knots any direction, for the hover in side/tailwind, limits are 35 knots any direction. The aircraft has all-weather, full capability to carry out night SAR with thermal imaging. It carries hoists as rescue equipment together with a comprehensive inventory of first aid equipment and can deploy a 10-person droppable life raft.

10.2.2 RNLI lifeboats – locations and equipment

Lifeboats are operated by the Royal National Lifeboat Institution (RNLI), along with the other nominated inshore rescue services. Crew and lifeboats are available from Thurso, Longhope, Stromness and Lochinver on a 24-hour basis throughout the year.

The RNLI stations at Thurso, Stromness and Lochinver use the Severn class lifeboat capable of a speed of 25 knots with a range of 250nm which can operate in all weather. The Longhope lifeboat is a Tamar class vessel.

The approximate distances of RNLI stations from the Project are given in Table 10.1.

Table 10.1 RNLI distance to site

Lifeboat Station	Distance (nm)
Thurso	10
Stromness	25
Longhope	26
Wick	39
Lochinver	73

10.2.3 Medical facilities

If a medical emergency occurs at sea, the nearest MRCC (Shetland Coastguard) will assist until help arrives. An MRCC centre can provide medical advice over the radio to ensure the safety of the casualty until a lifeboat or helicopter arrives to assist, or the casualty has arrived safely back to shore. The MRCC will then call an ambulance ready for the casualty arriving on land.

10.2.4 Salvage – Emergency Towing Vessel availability

The MCA charters four Emergency Towing Vessels (ETVs) to provide emergency towing cover in winter months in the areas thought to pose the highest risk of a marine accident. These include the Western Isles and the Northern Isles, and these tugs would be within range of the Project. However, response time would depend on the tugs' particular locations. The contract for these ETVs was due to end in February 2012 but has been extended until further notice.

Each MRCC also holds a comprehensive database of harbour tugs available locally. Procedures are also in place with Brokers and Lloyd's Casualty Reporting Service to quickly obtain information on towing vessels that may be able to respond to an incident.

MCA has an agreement with the British Tug-owners Association (BTA) for emergency chartering arrangements for harbour tugs. The agreement covers activation, contractual arrangements, liabilities and operational procedures, should MCA request assistance from any local harbour tug as part of the response to an incident. The nearest participant in PFOW strategic area is Orkney Towage, based at Scapa, Orkney, which has three 55 tonne bollard pull tugs.

10.2.5 Coastguard rescue teams

The Coastguard Rescue Service (CRS) is a network of volunteer teams around the coast who are equipped to deal with incidents and rescues appropriate to the local area. These teams will be sent to rescues by the local MRCC, and can respond to a variety of emergency situations. The nearest teams to the Project activities are located at Melvich, Scrabster and Duncansby.

10.3 SAR liaison for Dounreay Tri Development

The developer will consult with MCA, local RNLI stations and local Coastguard stations to provide information which might assist planning and execution of SAR services.

This would include:

- Project description;
- Device description;
- Location details; and
- Emergency contact details.

In addition, the presence and capability, under normal circumstances, of the Project workboat located at the O&M base will be discussed and described in the Project's Emergency Response Plan.

10.4 Assessment of Potential Impacts and Demands on Search and Rescue Services

The Project covers a very small area adjacent to, but not actually within the main shipping lane along the north coast. Therefore it is unlikely to pose any significant hazard to SAR operations.

Additionally, because the scale of the Project's construction, operation and maintenance activities is small it is unlikely that they will add significantly to the existing load on SAR services in the area. The historical number of incidents recorded by MAIB and RNLI is relatively low within 10nm of the Project area.

11 Emergency Response Overview and Assessment

11.1 Overview

A Project Emergency Response Plan (ERP) will be developed and dove tailed with the safety management systems and emergency response procedures of the main contractors. An Emergency Response Cooperation Plan (ERCoP) will be developed in conjunction with the appropriate MRCC.

The ERP will be developed for each phase of the Project and will specifically take into account the nature of the works, the significant risks identified in the hazard log (Appendix B) together with risk management processes. At each stage there will be:

- Clear lines of command and control defined within the Project organisation;
- Clear definitions of roles and responsibilities; and
- Clear communications procedures to contact emergency response services.

For each of the major hazards noted the Emergency Response Plan will address:

- Action to be taken;
- Communication;
- Event time line; and
- Resources available.

The ERCoP will be developed following guidance and input from MCA and RNLI through the Maritime Rescue Coordination Centre.

11.2 Developer's Own Contingency Plans for its Personnel and Assets

The developer will develop a full Project HSE Plan and a full Project Emergency Response Plan.

A suitable workboat will be based at the O&M base for the purpose of attending the floating platform. This vessel will also be available for unplanned interventions. More widely, all Project personnel involved in marine operations will receive appropriate training and certification in key aspects of the operations such STCW Personal Survival Techniques – Deck Safety Awareness and pass ENG 1 Medical.

As the Project operations become fully defined, detailed method statements will be prepared. These will then be subject to a detailed HIRA analysis and Operational Risk Analysis which will generate appropriate risk control measures such as preparation of procedures, competence assessment and training.

12 Through Life Safety Management

12.1 Developer's Safety Management System

A mature and comprehensive safety management system will be developed to meet the requirements of the Project. Key elements of the safety management systems when applied to a particular Project include:

At company level:
- Safety Policy Statement; and
- Safety Management System.

Project-specific HSE planning
- Project-specific HSE Plan which bridges across to the main and sub-contractor safety management systems;
- Project-specific Emergency Response Plan which links with main and sub-contractor ERPs;
- Project-specific Emergency Response Cooperation Plan (ERCoP) developed with MCA/RNLI through the appropriate Maritime Rescue Coordination Centre (MRCC);
- 3rd party verification of key design elements;
- Management of Change Procedure; and
- Preparation for meeting requirements of the Construction Design and Maintenance Regulations (CDM).

Project execution planning:
- Project Execution Plan and HIRA process.

Operational level planning:
- Method statements and HIRA process;
- Operating Procedures;
- Task risk assessment procedures; and
- Tool box talk procedures.

This Project specific NRA describes hazards and risk mitigations relevant to the installation, operation, maintenance and decommissioning of the floating platform and its infrastructure. It will accompany the license applications required for Project consents and provide useful input to the Project Health and Safety Plan. The NRA will also be used in conjunction with Hexicon's risk identification and management processes in developing the operational plans for the Project to ensure that all navigational risks are considered through the life of the Project.

12.2 Updating Risk Assessments

All risk registers will be updated regularly and prior to key stages of the Project. The methodology used will continue to follow the pattern of holding workshops/teleconferences with those involved in managing and supervising the activities and where appropriate, with stakeholders and other sea users in the area affected by the Project.

Where gaps in the assessments are present or become apparent then appropriate investigation, analysis and additions will be made.

12.3 Through Life Review

Following initial deployment a review will be carried out by the developer to identify any lessons learned. This will be particularly valuable when assessing the installation, operation and maintenance outcomes and experience gained from the initial deployment to assist in optimising subsequent deployments.

12.4 Compliance and Assurance

12.4.1 Safety management

The developer will comply with regulatory requirements and the requirements of its company safety policy. Assurance of this will be provided to regulatory organisations by applying its Safety Management System and Project HSE Plan which will include key elements such as:

- Leadership and engagement of Project delivery team;
- Structured audit programme;
- CDM Co-ordinator will review and maintain the CDM Safety File;
- Recurring Project safety and environment risk reviews with contractors and sub-contractors;
- Maintenance and updating of hazard logs and Hazard Identification Risk Assessment (HIRA);
- Maintenance and updating of a Risk Control Register; and
- Development of detailed operating procedures for all key operations and tasks.

12.4.2 Emergency response management

The developer will develop and maintain emergency response plans, management systems and necessary equipment to comply with MCA’s MGN 543 (M+F), (MCA 2016). This will be achieved by coordination with MCA and RNLI through the appropriate MRCC in developing the necessary ERCoP.

13 Major Hazards Summary & Conclusions

13.1 Hazards

The full listing of all hazards identified through stakeholder consultation, HIRA and arising from vessel traffic analysis and Project activity analysis is contained in Appendix B, the hazard log. Each hazard is assigned an ID No.

13.2 Risk Assessment

The hazards have been risk assessed for 'Most Likely' and 'Worst Credible' scenarios, taking into account not just the minimum regulatory mitigations but also additional mitigations set out in Appendix B. The risk assessment methodology is described in Appendix A. This includes the definitions of risk event frequency and risk consequence severity used in the assessment. For each hazard two risk event scenarios were considered, i.e. 'Most Likely Outcome' and 'Worst Credible Outcome'. The risk assessment has taken into account not only mandatory mitigations but also additional operational mitigations, such as the application of a comprehensive Safety Management System. For each of these outcome scenarios a risk criticality matrix is shown in Appendices D1 and D2 plotting qualitative expert judgment of risk severity and risk likelihood. These are divided into zones of low risk ('Broadly Acceptable'), of tolerable risk providing continuing practicable mitigation effort is applied ('ALARP') and 'Intolerable'. The matrices show those risks assessed as greater than 'Broadly Acceptable'.

No risks identified were assessed as being within the 'Intolerable' zone. Those which lie within the 'ALARP' zone have been discussed (together with mitigation measures and one 'Broadly Acceptable' risk) in Section 9. This is in narrative form linking each risk to the identified mitigations. The risks identified as being within the 'ALARP' zone are summarised below by phase or type of activity as in Section 9.

13.3 Significant Hazards Summary

- No hazards have been identified either before or after mitigation at the intolerable level of risk.
- A total of 26 specific hazards have been identified for this development with regards to navigational safety.
- The hazards have been individually risk assessed for the most likely consequence as well as worst credible consequence.
- There are 9 hazards identified under the most likely occurrence for consequence assessment that are tolerable - only if the mitigation measures are put into practice to reduce the likelihood of the hazard occurring.
- There are 14 hazards identified under the worst credible occurrence for consequence assessment that are tolerable – only if the mitigation measures are put into practice to reduce the likelihood of the hazard occurring.

13.4 Mitigations

In overview the mitigation measures taken into account for risk severity assessment include all the control measures required by regulation which include, for example, but not limited to:

- Compliance with COLREGS;
- Compliance with MCA/NLB requirements for marking and lighting the site;
- UKHO requirements for charting; and

- Requirements for issuing Notices to Mariners.

The mitigation measures taken into account in risk assessment include additional measures set out in Section 9.

- Vessel/operators shall be assessed and audited prior to hire;
- Dual propulsion system vessels as minimum standard;
- Employment of Independent Verification Body (IVB) American Bureau of Shipping (ABS) who will ensure the floating platform complies with floating wind design standards;
- Weather risk mitigated with forecasts and planning to include weather uncertainties;
- Local tugs will be on stand-by for the duration of the towage to ensure that vessels can assist, if required;
- Confirmation by 3rd party undertaking Tow Warranty Survey that if one vessel was to lose a tow the remaining vessels would be of sufficient capability to undertake tow in poor conditions;
- Project vessel based at the O&M base would be available to respond in an emergency;
- Floating platform will have AIS so will be visible to all vessels with AIS;
- Project control centre can shut down or feather the turbines to control the platforms movement, if necessary;
- Export cable will be buried where practical or alternative cable protection measures will be used i.e. rock mattresses;
- Hazard warning will emphasise that even when the floating platform is not on station the moorings and cabling onsite is a risk to fishing gear entanglement;
- The mooring system will be designed to extreme load cases as specified by the design standards;
- The platform shall have batteries to ensure navigational safety systems remain operational in the event that either the electrical or mooring system fails;
- Crew transfers to the floating platform will be limited to ~1.5 m significant wave height; and
- Consider fitting subsea acoustic transponder to make the platform visible to submarines in the area.

Project hazard log
Risk mitigation measures are noted against each hazard recorded in the hazard log (Appendix B) and are discussed in narrative form in Section 9.

13.5 Conclusions

A Navigation Risk Assessment has been carried out for the Project proposal using a proportionate approach combining qualitative analysis and expert judgement with information from consultation.

Key conclusions are listed below:
- The development is relatively small scale in the context of the available sea area for vessels to navigate around safely.
- The development is located in an area of low marine traffic, being out of the main east-west commercial shipping channel of the Pentland Firth, being a low priority fishing area and being isolated enough to not see regular recreational vessel activities.
- The marine traffic analysis is current and comprehensive and it shows the area carries a mix of commercial, fishing and recreational traffic of low density with little passenger vessel traffic.
- Local consultation within the marine community has identified a fishing vessel operator not tracked by AIS or VMS and continuing liaison and notification for this vessel will be implemented.
- Consultation with recreational vessel organisations has identified traffic patterns which are expected, although these may vary.

- A HIRA engaged all relevant local and national stakeholders and all hazards identified during the HIRA arising from the development have been considered and assessed during the NRA.
- Mitigation measures which are either generally applicable or specifically targeted to particular risks have been described. With the existing mitigations taken into account all identified hazards lie within the ‘Tolerable with ALARP’ or ‘Broadly Acceptable’ zones. These risks will continue to be assessed for application of further mitigation measures.
- The contact and collision risk levels for the Project tend to be low because of its location in an area of low vessel traffic and the small area of the proposed development, which is surrounded by sufficient sea room for navigation around the platform both to seaward and landward.
- Historical information on incidents shows the general area to be of relatively low risk.
- It is essential, as far as is reasonably practicable, to avoid vessels entering the site. The platform is free to weathervane and any 3rd party vessel navigating through the site would be at risk of collision. Mariners will be advised not to enter close to the site. The options for site designation, charting and lighting will continue to be discussed with MCA, NLB and UKHO.
- The potential risk of a platform, or part thereof, breaking free and becoming a hazard to other vessels is well mitigated by the position-monitoring systems to be fitted to the machines as well as AIS and lighting.
- The risk assessment process has found that no risks lie within the ‘Intolerable’ zone. Those judged to lie within the ‘Tolerable with application of mitigation measures to ALARP’ are illustrated on risk criticality matrices for ‘Most Likely’ and ‘Worst Credible’ outcomes.

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Appendix A – Formal Safety Assessment Process

The risk assessment process is described here and illustrated with a worked example.

A Hazard log is developed using the sources of information and workshop reviews as noted in Section 2.3 and contains the information noted in Table A-1.

Table A-1 Hazard log entry content

Field in Hazard Log	Information
Hazard ID	Hazard Identification number
Title	Title of hazardous event
Event Description	Description of the hazardous event
Category	General hazard category, e.g. General Navigational Safety
Sub-Category	Hazard sub-category, e.g., collision
Area	Location of hazardous event
Phase	Phase(s) of operation e.g. Pre-Installation, Construction, Operation, Maintenance and Decommissioning. (Maybe more than one)
Causes	List the identified potential causes of the hazard
'Most likely' Outcome	Description of the 'Most Likely' outcome should the hazard occur
'Worst Credible' Outcome	Description of the 'Worst Credible' outcome should the hazard occur
Frequency (Most likely Outcome)	Estimates the frequency of the 'Most Likely' outcome occurring.
Frequency (Worst Credible Outcome)	Estimates the frequency of the 'Worst Credible' event occurring
Consequence (Probable Outcome)	Estimates the probable outcome should the event occur in terms of consequence to People/Safety, Environment, Property, Business and overall average.
Consequence (Worst Credible Outcome)	Estimates the worst credible outcome should the event occur in terms of consequence to People, Environment, Asset, Business and overall average
Risk Estimate (Probable Outcome)	Combines the frequency and (average) consequence to estimate the risk level for probable event
Risk Estimate (Worst Credible Outcome)	Combines the frequency and (average) consequence to estimate risk level for the worst credible event

Field in Hazard Log	Information
Risk Reduction Measures	Documents the potential mitigation measures which will aid in the reduction of risk or in the management of the hazardous event

Each identified hazard is assessed using the Risk Assessment Process to determine the frequency, consequence and risk level for each hazard.

The definitions used to assess frequency are shown in Table A-2.

Table A-2 Frequency Definitions

Weighting	Category	Description
1	Negligible	< 1 occurrence per 1000 years
2	Extremely Unlikely	1 occurrence per 100-1000 years
3	Remote	1 occurrence per 10-100 years
4	Reasonably Probable	1 occurrence per 1-10 years
5	Frequent	1 or more occurrence per year

The definitions used to assess consequence categories are shown in Table A-3.

Table A-3 Consequence severity definitions

Category	Health & Safety	Environment	Property	Business
5 (Major)	Multiple fatalities	Total change to total ecosystems and indeterminate recovery period	Loss of property value > £10m	Loss of business > £10m
4 (Serious)	Single fatality	High toxicity, geographical spread, 5-10 yr recovery	Loss of property value £1-10m	Loss of business £1-10m
3 (Moderate)	LTI or multiple medical attention	Local geographical effect and/or 1-5 yr recovery	Loss of property value £100k-£1m	Loss of business £100k- £1m
2 (Minor)	Single medical attention or > 1 first aid	Similar to natural variation and/or localized to adjacent area with < 1 yr recovery	Loss of property value £10-100k	Loss of business £10-100k
1 (Negligible)	No injury or single first aid	Within natural variability and limited to vicinity of operations	Loss of property < £10k	Loss of business < £10k

The Frequency and Severity weightings (from 1-5 in each case) are combined in a Risk Severity Matrix:

Table A-4 Risk matrix

		Frequency Severity				
		1. Extremely unlikely (<1 per 1000yr)	2. Very unlikely (1 per 100-1000 yr)	3. Unlikely (1 per 10-100 yr)	4. Quite likely (1 per 1-10 yr)	5. Very likely (>1 per yr)
Consequence	5. Major					
	4. Serious				Intolerable	
	3. Moderate			Tolerable with ALARP		
	2. Minor		Broadly acceptable			
	1. Negligible					

The level of risk severity is described in Table A-5.

Table A-5 Risk severity definitions

Broadly Acceptable	Risks regarded as low and adequately controlled.
Tolerable with ALARP	Tolerable only if mitigation measures to achieve ALARP are implemented and the analysis team has found the residual risk tolerable.
Intolerable	Unacceptable risk whatever the level of benefit. Requires further mitigation or radical change to reduce to Tolerable status.

Worked example
A worked example illustrates the process.

NB: The hazard (or risk event) is assessed for Consequence and likely Frequency taking into account not only the minimum mandatory risk control measures (e.g. COLREGS) but also the risk mitigation measures which have been committed. These are listed in the hazard log and Risk Control Register. Where further risk mitigation measures are potentially applicable these are noted separately in the hazard log.

The process is applied to a 'Most Likely Outcome' and to a 'Worst Credible Outcome' for each hazard.

Hazard Title	Attendant Vessel Collides With Floating Platform
Possible Causes	Human error, machinery failure, poor visibility, bad weather, poor passage planning
Most Likely Outcome (consequence)	Low speed collision with slight damage to vessel and floating platform. More than one first aid case. No pollution. Property and Business Loss £10-100k
Frequency of Probable Consequence	Possible, maybe 1 occurrence per 1-10 years (Frequency Level 4)
Worst Credible Consequences	Collision at speed, vessel sinks, potential fatalities, fuel oil pollution, floating platform badly damaged
Frequency of Worst Credible Outcome	Very Unlikely, 1 per 100-1000yr (Frequency Level 2)
Risk reduction measures applied	All regulatory requirements Developer's Safety Management System in place, which includes: Marine Operating Procedures in place for vessels attending site Passage Plan mandatory with bad weather/poor visibility procedures Task Risk Assessment and Tool Box Talks

Taking the 'Most Likely' outcome and assessing the severity for each of Health & Safety, Environment, Property and Business generates 4 risk matrices:

Consequence People/ Safety						
	5					
	4					
	3					
	2				X	
	1					
		1	2	3	4	5
		Frequency				

Consequence Environment						
	5					
	4					
	3					
	2					
	1				x	
		1	2	3	4	5
		Frequency				

Consequence Property						
	5					
	4					
	3				x	
	2					
	1					
		1	2	3	4	5
		Frequency				

Consequence Business						
	5					
	4					
	3				X	
	2					
	1					
		1	2	3	4	5
		Frequency				

For the probable outcome the overall risk severity is the average of 4 consequences (2+1+2+2) / 4 = 2.25. The frequency is assessed at level 4. This determines where the risk lies when plotted onto the overall Severity vs Frequency matrix for 'Most Likely' outcomes (Appendix D1). This example lies in the ALARP zone.

During the detailed planning of the Project Hexicon will seek further mitigation measures to further reduce risk levels.

Each identified Hazard is logged in the hazard log (Appendix B) and colour-coded to show its position as assessed on the ‘Most Likely’ outcome and ‘Worst Credible’ scenario.

Appendix B - Hazard Log

No.	Phase	Category	Hazard Title	Hazard (Event Chain) Description	Possible Causes	Risk Mitigation Measures Considered When Ranking	Most Likely Consequence	Safety Severity	Environment Severity	Property Severity	Business Severity	Average Severity	Frequency	Risk Zone on matrix (Most likely)	Worst Credible Consequence	Safety Severity	Environmental Severity	Property Severity	Business Severity	Average Severity	Frequency	Risk Zone on matrix (Worst credible)	Potential Additional Risk Mitigation Measures	Comments
1	Survey	Navigation	Survey Vessel collision with other vessel	Collides with other vessel	Human error: Little experience for vessel operation, task and sea area; not competent non-compliance; fatigue. Bad weather/poor visibility, equipment failure	Apply all normal navigational risk control measures, e.g. COLREGS, watch keeping. Contractor selection procedure applied Notice to Mariners (NtM)	Damage to vessels possible injuries to crews	3	1	3	3	2.5	2		Loss of vessel, pollution, possible fatalities	5	3	4	4	4	2		Vessels / operators shall be assessed and audited prior to hire.	
2	Survey	Navigation	Survey gear entanglement	Survey towed gear becomes entangled with survey vessel itself or another vessel or with seabed fishing gear (creels etc.)	Human error: Little experience for vessel operation, task and sea area; not competent non-compliance; fatigue. Lack of awareness of presence of seabed fishing gear	Apply all normal navigational risk control measures, e.g. COLREGS, watch keeping. Contractor selection procedure applied plus task risk assessment and pre-job briefing Notice to Mariners for survey operations	Damage to towed gear and/or seabed fishing gear	1	1	2	2	1.5	2		Loss of towed gear Fouled vessel propulsion Loss of vessel control	1	1	3	3	2	2		Vessels / operators shall be assessed and audited prior to hire. Dual propulsion system vessels as minimum standard	
3	Installation and Operation	Navigation	Project construction Vessel collides with 3rd party vessel (commercial, fishing or recreational) including when towing floating platform to site	Project construction vessel collides with 3rd party vessel (including the case of tow to site)	Human error: Little experience for vessel operation, task and sea area; not competent non-compliance; fatigue. bad weather/poor visibility, DP run off, equipment or GPS failure	Apply all normal navigational risk control measures, e.g. COLREGS, watch keeping. Notice to Mariners (NtM) to request safety zone around large construction vessels. Plan simultaneous operations (SIMOPS) very carefully. Apply developer's Safety Management System in selecting competent contractors, vessel audit, detailed task risk assessment (TRA) and Tool Box Talks (TBT) Project Emergency Response Plan in place	Damage to vessels possible injuries to crews	3	1	3	3	2.5	2		Loss of large vessel, pollution, fatalities	5	4	5	4	4.5	2			
4	Installation and Operation	Navigation	Project construction Vessel collides with another Project vessel at site.	Project construction vessel collides with another Project vessel at site	Human error: Little experience for vessel operation, task and sea area; not competent non-compliance; fatigue. Bad weather/poor visibility, DP run off, equipment or GPS failure	Apply all normal navigational risk control measures, e.g. COLREGS, watch keeping. NtM to request safety zone around large construction vessels. Plan simultaneous operations (SIMOPS) very carefully. Apply Developer's Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) Project Emergency Response Plan in place	Low speed collision. Minor damage to vessels and minor injuries to crews	3	1	3	3	2.5	2		Loss of large vessel, pollution, fatalities	5	3	5	4	4.25	2			

No.	Phase	Category	Hazard Title	Hazard (Event Chain) Description	Possible Causes	Risk Mitigation Measures Considered When Ranking	Most Likely Consequence	Safety Severity	Environment Severity	Property Severity	Business Severity	Average Severity	Frequency	Risk Zone on matrix (Most likely)	Worst Credible Consequence	Safety Severity	Environmental Severity	Property Severity	Business Severity	Average Severity	Frequency	Risk Zone on matrix (Worst credible)	Potential Additional Risk Mitigation Measures	Comments
5	Installation and Operation	Navigation	Attendant vessel collides with floating platform	Project vessel working within the site collides with floating platform	Human error: Little experience for vessel operation, task and sea area; not competent non-compliance; fatigue. bad weather , poor visibility, equipment failure	Apply Developer's Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) Dounreay Tri Ltd will be subject to FMECA during design development (see Comments) Project Emergency Response Plan in place	Low speed collision minor damage but vessel and floating platform remain afloat. Some first aid cases. No pollution	2	1	3	3	2.25	4		Collision at passage speed. Vessel sinks. Multiple fatalities. Pollution	5	3	4	4	4	2		FMECA process for survivability will be carried out, considers: collision risk, partial flooding and consequential damage. Design has been developed so that a low speed impact by a typical workboat or local fishing vessel will not sink the floating platform. Dounreay Tri Ltd has employed an Independent Verification Body (IVB) American Bureau of Shipping (ABS) who will ensure the floating platform complies with floating wind design standards.	
6	Installation and Operation	Navigation	Project vessel entangled with fishing gear/ abandoned fishing gear.	Vessel working within or near the Project site on installation or operations becomes entangled with fishing gear	Lack of awareness of presence of fishing gear in area	Liaison with fisheries to identify key fishing areas and learn of any lost or abandoned gear. Liaison with S&N stakeholders to confirm final location of the platform and export cable within the site and export cable corridor. The platform will occupy a sea surface area of 0.17km². The final location of the platform and cable will be marked on charts	Minor damage to vessel propulsion and fishing gear	1	1	2	2	1.5	2		Vessel propulsion system failure, vessel drifts and collides with floating platform or other vessel. Low speed impact	2	1	3	3	2.25	2		Dual propulsion vessel, selected as minimum standard	
7	Installation and Operation	Navigation & Other safety	Project vessel in difficulties whilst at sea (e.g. fire, machinery failure, unexpected severe weather)	Project vessel en route to site or at site experiences difficulties, e.g. fire, explosion, unexpected bad weather, deck operations incident (no other vessel or floating platform involved)	Fire or explosion machinery failure, equipment failure, unexpected bad weather.	Apply contractors Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) Project Emergency Response Plan in place	Minor incident resolved without assistance but minor damage to vessel and minor injuries to crew.	3	1	2	2	2	4		Vessel lost due to fire, foundering or grounding. Fatalities and pollution	5	3	4	4	4	2		Weather risk mitigated with forecasts and planning to include weather uncertainties.	
8	Installation and Operation	Navigation	Attendant vessel collides with another attendant vessel within the Project area	Vessels working within the Project area on installation or operations collide.	Human error: Little experience for vessel operation, task and sea area; not competent non-compliance; fatigue. bad weather , poor visibility	Apply Developer's Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) Project Emergency Response Plan in place	Low speed collision minor damage and some first aid cases. No pollution	2	1	3	3	2.25	4		Collision at passage speed. Vessel sinks. Multiple fatalities. Pollution	5	3	4	4	4	2		Skipper and crew experience is a determining factor in personnel assignment to particular tasks. Weather risk mitigated with forecasts and planning to include weather uncertainties.	
9	Installation and Maintenance	Navigation	Attendant vessel on passage or towing floating platform collides with another vessel	Project vessel on passage or towing floating platform to or from site for installation or maintenance collides with another vessel	Human error: Little experience for vessel operation, task and sea area; not competent non-compliance; fatigue. Poor tow passage planning. Restricted manoeuvrability, weather conditions, immobilisation due to machinery failure or tow entanglement.	Apply Developer's Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) Project Emergency Response Plan in place Tow warranty survey (carried out on behalf of insurers) Request Coastguard broadcasts during tow-out to site, especially passage through the Pentland Firth	Medium speed collision, moderate damage and some injuries. No pollution	3	1	3	3	2.5	3		Collision at passage speed. Vessel sinks. Multiple fatalities. Pollution	5	3	4	4	4	2		Project vessels maintain an appropriate watch. Weather risk mitigated with forecasts and planning to include weather uncertainties.	

No.	Phase	Category	Hazard Title	Hazard (Event Chain) Description	Possible Causes	Risk Mitigation Measures Considered When Ranking	Most Likely Consequence	Safety Severity	Environment Severity	Property Severity	Business Severity	Average Severity	Frequency	Risk Zone on matrix (Most likely)	Worst Credible Consequence	Safety Severity	Environmental Severity	Property Severity	Business Severity	Average Severity	Frequency	Risk Zone on matrix (Worst credible)	Potential Additional Risk Mitigation Measures	Comments
10	Installation and Maintenance	Navigation	Attendant vessel towing floating platform loses power and collides with floating platform	One of the four vessels towing floating platform loses power	Machinery failure or tow entanglement causes loss of control	Apply Developer's Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) highlights this particular risk FMECA will be applied (see Comments) Project Emergency Response Plan in place Tow warranty survey (carried out on behalf of insurers)	Tow is detached and floating platform is towed using the three vessels with power. Another workboat / tug is summoned to rescue stricken vessel. No pollution	2	1	1	1	1.25	3		Floating platform collides with drifting vessel causing vessel loss, with fatalities and pollution	5	3	4	4	4	2		Local tugs will be on stand-by for the duration of the towage to ensure that vessels can assist, if required.	FMECA process will identify the risk and if penetrated the floating platform will not sink which avoids any further danger to towing vessel.
11	Installation and Maintenance	Navigation	Attendant vessel loses tow to floating platform	One of the three vessels towing floating platform to or from site loses tow.	Human error: Little experience for vessel operation, task and sea area; not competent non-compliance; fatigue. Unexpected bad weather. Failed equipment	Apply Developer's Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) highlights this particular risk Tow vessel and floating platform are equipped to assist applying an emergency tow line. Project Emergency Response Plan covers this hazard. Tow warranty survey (carried out on behalf of insurers)	Delay whilst tow is re-secured	2	1	1	1	1.25	3		Loss of one towing vessel and worsening weather could make tow unmanageable and ultimately cause grounding	5	3	4	4	4	2		Confirmation by 3rd party undertaking the Tow Warranty Survey that if one vessel was to lose a tow the remaining vessels would be of sufficient capability to undertake tow in poor conditions. Local tugs will be on stand-by for the duration of the towage to ensure that vessels can assist, if required.	
12	Operation	Navigation	Commercial vessel under control collides with floating platform	Commercial vessel under control collides with floating platform.	Human error: Little experience for vessel operation, task and sea area; not competent non-compliance; fatigue. Navigation error, poor visibility.	Commercial vessel should comply with COLREGS. This phase of development occupies an area of only approximately 0.17km² within the offshore site area of 25km². It is a very small obstacle. Project Emergency Response Plan covers this risk. Fully comply with requirements for marking and lighting the site and the floating platform and Wind Turbine Generators (WTGs). Liaise with UKHO on detail/timely addition of chart notification. Apply comprehensive approach to notification/warnings to all sea users. Request Coastguard broadcasts whenever significant work taking place site	Collision. Major damage and some first aid cases. Pollution	3	1	4	4	3	3		Collision at passage speed. Vessel sinks. Multiple fatalities. Pollution	5	4	5	5	4.75	2		NTM's. Consider possible live traffic monitoring by radar or AIS. VHF coverage onsite is satisfactory. Project vessel based at O&M base would respond in emergency. Floating platform will have AIS so will be visible to vessels carrying AIS.	
13	Operation	Navigation	Fishing vessel under control collides with floating platform	Fishing vessel engaged in fishing collides with floating platform	Human error: Little experience for vessel operation, task and sea area; not competent non-compliance; fatigue. navigation error, lack of awareness of site.	Fully comply with requirements for marking and lighting the site and the floating platform and WTGs. Liaise with UKHO on detail/timely addition of chart notification. Apply comprehensive approach to notification/warnings to all sea users. Disseminate information about the site via Kingfisher (KIS ORCA) and follow Crown Estate FLOWW guidance, including ongoing liaison with local fishing communities	Collision. Small fishing boat damaged and requires assistance. Some injuries. No pollution	3	1	4	4	3	3		Fishing vessel sinks, fatalities. Limited pollution	5	3	5	5	4.5	2		NTM's. Consider possible live traffic monitoring by radar or AIS. VHF coverage onsite is satisfactory. Project vessels based at O&M base would respond in emergency. Floating platform will have AIS so will be visible to fishing vessels.	

No.	Phase	Category	Hazard Title	Hazard (Event Chain) Description	Possible Causes	Risk Mitigation Measures Considered When Ranking	Most Likely Consequence	Safety Severity	Environment Severity	Property Severity	Business Severity	Average Severity	Frequency	Risk Zone on matrix (Most likely)	Worst Credible Consequence	Safety Severity	Environmental Severity	Property Severity	Business Severity	Average Severity	Frequency	Risk Zone on matrix (Worst credible)	Potential Additional Risk Mitigation Measures	Comments
14	All phases	Navigation	Recreational vessel under control collides with floating platform	Recreational vessel under control collides with floating platform	Human error: Little experience for vessel operation, task and sea area; not competent non-compliance; fatigue. Navigation error, lack of awareness of site. Increased interest or tourism bringing vessels closer to site	Fully comply with requirements for marking and lighting the site, floating platforms and WTGs. Liaise with UKHO on detail/timely addition of chart notification. Apply comprehensive approach to notification/warnings to all sea users. Disseminate information about the site via RYA, local yachting and recreational craft organisations. Notifications via appropriate magazines. Notification via Harbour Masters. Request Coastguard broadcasts whenever significant activity at site	Collision. Small boat damaged and requires assistance. Some injuries. No pollution	3	1	4	4	3	3		Recreational vessel sinks, fatalities	5	3	4	4	4	2		NTM's. Consider possible live traffic monitoring by radar or AIS. VHF coverage onsite is satisfactory. Project vessel based at O&M base would respond in emergency. Floating platform will have AIS so will be visible to vessels carrying AIS.	
15	Operation	Navigation	Vessel drifting and not under control collides with floating platform	Vessel drifting and not under control collides with floating platform	Machinery or propulsion failure causes loss of control and vessel drifts and collides with floating platform	All of the charting, marking and lighting would alert vessels to presence of the floating platform and its associated components and stimulate vessel to request assistance. Coastguard will coordinate SAR and RNLI and Emergency Towing Vessel if needed	Low speed collision. Damage to vessel and floating platform. Medical attention injuries. No pollution	3	1	4	4	3	3		Low speed collision but small vessel sinks, fatalities. Limited pollution	5	3	4	4	4	2		Project vessels at O&M base would respond in an emergency (provide support to SAR operations). Project to inform coastguard of its capability for responding. Project control centre can shut down or feather the turbines to control the platforms movement, if necessary.	
16	Operation	Navigation	Vessels navigating around Project site collide.	Vessels navigating around Project site collide because of increased congestion or avoidance of restricted area	Human error: Little experience for vessel operation, task and sea area; not competent non-compliance; fatigue. Navigation error, poor visibility.	Commercial vessel should comply with COLREGS. This phase of development will occupy a box of only approximately 0.17km² within the offshore site area of 25km². So course deviations required are very slight. Full implementation of charting, warning, lighting measures will minimise chance of surprise and sudden evasive course changes	Contact with minor damage. Medical attention injuries. No pollution	3	1	4	4	3	2		Collision at passage speed. Vessel sinks. Multiple fatalities. Pollution	5	4	5	5	4.75	2			Traffic density is low therefore the increase in collision risk attributable to presence of the Project is very slight.
17	Operation	Navigation	Fishing vessel snags gear on export cable	Fishing vessel whilst fishing outside the marked development box snags its gear on the export cable running between the Project site and the coast.	Lack of awareness of cable position and cable not buried	Cable route will be marked on charts. Current base case is that the cable is buried to a target depth of 2m offshore and for Horizontal Direct Drilling (HDD) in the intertidal area.	Damage to fishing gear and to cable	1	1	4	4	2.5	3		Gear snags and causes fishing vessel to capsize with fatalities	5	3	4	4	4	2		Seabed type survey to be carried out. Export cable will be buried where practical or alternative cable protection measures will be used. ROV surveys at appropriate intervals to ensure it is still buried. If clay, flatten with trawler towed chain mat to remove obstacles to fishing gear.	

No.	Phase	Category	Hazard Title	Hazard (Event Chain) Description	Possible Causes	Risk Mitigation Measures Considered When Ranking	Most Likely Consequence	Safety Severity	Environment Severity	Property Severity	Business Severity	Average Severity	Frequency	Risk Zone on matrix (Most likely)	Worst Credible Consequence	Safety Severity	Environmental Severity	Property Severity	Business Severity	Average Severity	Frequency	Risk Zone on matrix (Worst credible)	Potential Additional Risk Mitigation Measures	Comments
18	Operation	Navigation	Fishing vessel snags gear on floating platform /moorings/cables	Fishing vessel strays into Project site, possibly when the floating platform is not on station, and snags gear on moorings and electrical cabling	Lack of awareness that moorings and electrical cabling lies beneath the surface	All charting and notifications will emphasise the presence within the Project site of subsea mooring lines and electrical cables that pose risk of entanglement to fishing gear - and will emphasise that this risk is present even if the floating platform has been removed for maintenance	Damage to fishing gear and to moorings/cabling	1	1	4	4	2.5	3		Gear snags and causes fishing vessel to capsize with fatalities	5	3	4	4	4	2		NTM's. Consider possible live traffic monitoring by radar or AIS. VHF coverage onsite is satisfactory. Project vessels based at O&M base would respond in emergency. Hazard warning needs to emphasise that even when the floating platform is not on station the moorings and cabling onsite is a risk to fishing gear entanglement. Ask UKHO to consider referencing underwater hazards as a marked obstruction.	
19	Operation	Navigation	Vessel snags anchor on export cable	Vessel drops anchor and snags export cable	Need to deploy anchor unexpectedly or not aware of cable location	Cable route will be marked on charts.	Damage to cable	1	1	4	4	2.5	1		A small vessel anchor snags cable and vessel requires assistance	1	1	4	4	2.5	2			No anchorages in area
20	Operation	Navigation	Vessel snags anchor on floating platform / mooring / substructure / cable	Vessel drops anchor and snags subsea moorings or cabling within the Project site	Need to deploy anchor unexpectedly or not aware of cable location	Project site marked and charted as noted	Damage to moorings or cabling	1	1	4	4	2.5	1		A small vessel anchor snags moorings or cable and vessel requires assistance	1	1	4	4	2.5	2		NTM's. Consider possible live traffic monitoring by radar or AIS. VHF coverage onsite is satisfactory. Project vessel based at O&M base would respond in emergency. NTM's. Consider possible live traffic monitoring by radar or AIS. VHF coverage onsite is satisfactory. Project vessel based at O&M base would respond in emergency.	Location is excessively deep for planned anchoring events for small or large vessels (50-60 metres) and would not normally anchor
21	Operation	Navigation	Floating platform breaks free from moorings and collides with vessel	Floating platform breaks free from moorings and drifts into shipping route	Mooring failure	Project will use FMECA to refine the design to include redundancy to prevent this event. In addition the design links GPS detection to the Project SCADA system so that any single mooring failure causes excursion outside normal watch circle triggers alarm to 24hr duty holder. Project Emergency Response Plan considers this risk and response. Project vessels at O&M base normally available to intervene (acting as temporary guard vessel) Lighting on floating platform and WTGs not affected. Coastguard warnings to shipping Other local stakeholders notified	Appropriate vessels mobilised to the site to facilitate search and recovery	1	1	3	3	2	2		Multiple mooring line failures cause the floating platform to break free. Floating platform and WTGs still lit and has radar reflectors but collides with vessel. Vessel lost with fatalities and pollution	5	4	5	5	4.75	2		The mooring system will be designed to extreme load cases as, specified by the design standards. The platform shall have batteries to ensure navigational safety systems remain operational in the event that either the electrical or mooring system fails. . Local tugs will be on call-off contract to ensure that vessels can assist, if required.	FMECA and 3rd party verification will be available.

No.	Phase	Category	Hazard Title	Hazard (Event Chain) Description	Possible Causes	Risk Mitigation Measures Considered When Ranking	Most Likely Consequence	Safety Severity	Environment Severity	Property Severity	Business Severity	Average Severity	Frequency	Risk Zone on matrix (Most likely)	Worst Credible Consequence	Safety Severity	Environmental Severity	Property Severity	Business Severity	Average Severity	Frequency	Risk Zone on matrix (Worst credible)	Potential Additional Risk Mitigation Measures	Comments
22	Operation	Navigation	Floating platform breaks free and runs aground	Floating platform breaks free from moorings and runs aground	Mooring failure	Project will use FMECA to refine the design to include redundancy to prevent this event. In addition the design links GPS detection to the Project SCADA system so that any single mooring failure causes excursion outside normal watch circle triggers alarm to 24hr duty holder. Project Emergency Response Plan considers this risk and response. Project vessels at O&M base normally available to intervene (acting as temporary guard vessel). Lighting on floating platform and WTGs not affected. Coastguard warnings to shipping Other local stakeholders notified	Appropriate vessels mobilised to the site to facilitate search and recovery	1	1	3	3	2	2		Multiple mooring line failures cause the floating platform to break free. Floating platform and WTGs still lit and has radar reflectors. Floating platform runs aground	3	3	5	3	3.75	2		The mooring system will be designed to extreme load cases as specified by the design standards. The platform shall have batteries to ensure navigational safety systems remain operational in the event that either the electrical or mooring system fails. . Local tugs will be on call-off contract to ensure that vessels can assist, if required.	
23	Operation	Other	Man overboard	Man overboard during personnel transfer to floating platform. Man overboard during personnel transfer during construction phase.	Personnel transfer at sea	During construction personnel transfers may take place but only after review with Project management. Task risk assessment and tool box talks will assess risks and apply risk control measures	Person in water recovered by vessel. Medical attention needed.	3	1	1	2	1.75	3		Person overboard lost - fatality	4	1	1	4	2.5	2		Crew transfers limited to ~1.5m wave height.	
24	Installation and Operation	Navigation	Naval vessel (submarine) under control collides with floating platform or subsea infrastructure	Naval vessel (submarine) under control collides with floating platform or associated subsea infrastructure	Human error, navigation error, lack of awareness of site Military operations	Fully comply with requirements for marking and lighting the site. floating platform and WTGs Liaise with UKHO on timely addition of chart notification. Apply comprehensive approach to notifications/warnings to all sea users	Contact with floating platform or subsea infrastructure. Minor damage. No pollution	1	1	2	2	1.5	3		Collision with floating platform or subsea infrastructure. Damage and injuries. No pollution	3	1	2	2	2	2		NTM's. Consider possible live traffic monitoring by radar or AIS. VHF coverage onsite is satisfactory. Project vessels based at O&M base would respond in emergency. Also consider fitting subsea acoustic transponder	
25	Installation and Operation	Other	Access difficulties for SAR vessels	Difficulties in access for SAR personnel to rescue injured party	Rough sea/weather conditions. New structure with which the SAR crew might not be experienced in accessing	Project vessel crew trained in platform evacuation. Potential to use helicopter for evacuation	SAR crew able to board floating platform after delay, with assistance from maintenance crew	2	1	1	1	1.25	2		SAR personnel unable to access floating platform – potential fatality	4	1	1	1	1	2			
26	Operation	Other	Unauthorised boarding of the platform	Unauthorised boarding of the platform for vandalism or theft	N/A	Electrical infrastructure and turbine access points will be locked when maintenance crew are off site	Unauthorised boarding, get bored and then leave.	2	1	1	1	1.25	3		Gain access to locked electrical infrastructure or turbine – potential fatality	4	1	1	1	1	2			

Appendix C - Risk Control Log

No.	Hazard (Event Chain)	Consequence (Most Likely/Worst Credible)	Frequency (Most Likely/Worst Credible)	Risk Level on Most Likely Matrix (Appendix D1)	Risk Level on Worst Credible Matrix (Appendix D2)	Risk Control Measures Applied and Taken Account of in Risk Ranking	Potential Additional Control Measures Not Taken Account of in Risk Ranking	Compliance Required	Relevant Documents	Responsible Person	Action Due Date	Verification Date
1	Survey Vessel collision with other vessel	2.5/4.0	2.0/1.0			Apply all normal navigational risk control measures, e.g. COLREGS, watch keeping	Vessels/operators shall be assessed and audited prior to hire	Yes	To be advised	To be advised	TBA	TBA
2	Survey gear entanglement	1.5/2	2.0/1.0			Apply all normal navigational risk control measures, e.g. COLREGS, watch keeping	Vessels/operators shall be assessed and audited prior to hire Dual propulsion vessels as minimum standard	Yes	To be advised	To be advised	TBA	TBA
3	Construction Vessel collides with 3rd party vessel	2.5/4.5	2.0/1.0			Apply all normal navigational risk control measures, e.g. COLREGS, watch keeping. Notice to Mariners (NtM) to request safety zone around large construction vessels. Plan simultaneous operations (SIMOPS) very carefully. Apply developer's Safety Management System in selecting competent contractors, vessel audit, detailed task risk assessment (TRA) and Tool Box Talks (TBT) Project Emergency Response Plan in place		Yes	To be advised	To be advised	TBA	TBA
4	Construction Vessel collides with another Project vessel	2.5/4.25	2.0/1.0			Apply all normal navigational risk control measures, e.g. COLREGS, watch keeping. Notice to Mariners (NtM) to request safety zone around large construction vessels. Plan simultaneous operations (SIMOPS) very carefully. Apply Developer's Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) Project Emergency Response Plan in place		Yes	To be advised	To be advised	TBA	TBA
5	Attendant vessel collides with floating platform	2.25/4.0	4.0/1.0			Apply Developer's Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) Hexicon will be subject to FMECA during design development (see Comments) Project Emergency Response Plan in place	FMECA process for survivability will be carried out and will consider: collision risk, partial flooding and consequential damage. Design has been developed so that a low speed impact by a typical workboat or local fishing vessel will not sink the floating platform	Yes	To be advised	To be advised	TBA	TBA
6	Project vessel entangled with fishing gear/ abandoned fishing gear.	1.5/2.25	2.0/1.0			Liaison with fisheries to learn of and prevent deployment of fishing gear within the development area		Yes	To be advised	To be advised	TBA	TBA
7	Project vessel experiences difficulties in the area	2.0/4.0	4.0/2.0			Apply Developer's Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) Project Emergency Response Plan in place				To be advised		
8	Attendant vessel collides with another attendant vessel in Project area	2.25/4.0	4.0/2.0			Apply Developer's Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) Project Emergency Response Plan in place	Skipper and crew experience is a determining factor in personnel assignment to particular tasks	Yes	To be advised	To be advised	TBA	TBA
9	Attendant vessel towing floating platform collides with another vessel	2.5/4.0	3.0/2.0			Apply Developer's Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) Project Emergency Response Plan in place	Project vessels maintain an appropriate watch Weather risk mitigated with forecasts and planning to include weather uncertainties	Yes	To be advised	To be advised	TBA	TBA

No.	Hazard (Event Chain)	Consequence (Most Likely/Worst Credible)	Frequency (Most Likely/Worst Credible)	Risk Level on Most Likely Matrix (Appendix D1)	Risk Level on Worst Credible Matrix (Appendix D2)	Risk Control Measures Applied and Taken Account of in Risk Ranking	Potential Additional Control Measures Not Taken Account of in Risk Ranking	Compliance Required	Relevant Documents	Responsible Person	Action Due Date	Verification Date
10	Attendant vessel towing floating platform loses power and collides with floating platform	1.75/4.0	3.0/1.0			Apply Developer's Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) highlights this particular risk FMECA will be applied (see Comments) Project Emergency Response Plan in place	Local tugs will be on stand-by for the duration of the towage to ensure that vessels can assist, if required FMECA process for survivability will be carried out and will consider: collision risk, partial flooding and consequential damage	Yes	To be advised	To be advised	TBA	TBA
11	Attendant vessel loses tow to floating platform	1.0/4.0	3.0/1.0			Apply Developer's Safety Management System to all Project contractors with IMCA vessel audit, marine operating procedures in place. Detailed task risk assessment (TRA) and Tool Box Talks (TBT) highlights this particular risk Tow vessel and floating platform will be equipped to assist in applying an emergency tow line. Project Emergency Response Plan covers this hazard	Confirmation by third party undertaking the Tow Warranty Survey that if one vessel was to lose a tow the remaining vessels would be of sufficient capability to undertake tow in poor conditions Local tugs will be on stand-by for the duration of the towage to ensure that vessels can assist, if required	Yes	To be advised	To be advised	TBA	TBA
12	Commercial vessel under control collides with floating platform	3.0/4.75	3.0/2.0			Commercial vessel should comply with COLREGS. The floating platform occupies an area of only approximately 0.17km^2 within the offshore site area of 25km^2. It is a very small obstacle. Project Emergency Response Plan covers this risk. Fully comply with requirements for marking and lighting the site, floating platform and WTGs. Liaise with UKHO on detail/timely addition of chart notification. Apply comprehensive approach to notification/warnings to all sea users. Request Coastguard broadcasts whenever significant work taking place site	NTM's. Floating platform will have AIS on-board VHF coverage onsite is satisfactory. Project vessel based at O&M base would respond in emergency	Yes	To be advised	To be advised	TBA	TBA
13	Fishing vessel under control collides with floating platform	3.0/4.75	3.0/2.0			Fully comply with requirements for marking and lighting the site, floating platform and WTGs. Liaise with UKHO on detail/timely addition of chart notification. Apply comprehensive approach to notification/warnings to all sea users. Disseminate information about the site via Kingfisher (KIS ORCA) and follow Crown Estate FLOWW guidance, including ongoing liaison with local fishing communities	NTM's. Floating platform will have AIS on-board. VHF coverage onsite is satisfactory. Project vessel based at O&M base would respond in emergency	Yes	To be advised	To be advised	TBA	TBA
14	Recreational vessel under control collides with floating platform	3.0/4.0	3.0/2.0			Fully comply with requirements for marking and lighting the site, floating platform and WTGs. Liaise with UKHO on detail/timely addition of chart notification. Apply comprehensive approach to notification/warnings to all sea users. Disseminate information about the site via RYA, local yachting and recreational craft organisations. Notifications via appropriate magazines. Notification via Harbour Masters. Request Coastguard broadcasts whenever significant activity site	NTM's. Floating platform will have AIS on-board. VHF coverage onsite is satisfactory. Project vessel based at O&M base could respond in emergency. Project to inform Coastguard of its capability for responding	Yes	To be advised	To be advised	TBA	TBA

No.	Hazard (Event Chain)	Consequence (Most Likely/Worst Credible)	Frequency (Most Likely/Worst Credible)	Risk Level on Most Likely Matrix (Appendix D1)	Risk Level on Worst Credible Matrix (Appendix D2)	Risk Control Measures Applied and Taken Account of in Risk Ranking	Potential Additional Control Measures Not Taken Account of in Risk Ranking	Compliance Required	Relevant Documents	Responsible Person	Action Due Date	Verification Date
15	Vessel drifting and not under control collides with floating platform	3.0/4.0	3.0/2.0			All of the charting, marking and lighting would alert vessel to presence of Project components and stimulate vessel to request assistance. Coastguard will coordinate SAR and RNLI and Emergency Towing Vessel if needed	Project vessel at O&M base could be first response. Project to inform coastguard of its capability for responding. Project control centre can shut down or feather the turbines to control platform movement, if necessary	Yes	To be advised	To be advised	TBA	TBA
16	Vessels navigating around Project site collide.	3.0/4.75	2.0/2.0			Commercial vessel should comply with COLREGS. This phase of development will occupy a box of only approximately 0.17km² within the offshore site area of 25km². So course deviations required are very slight. Full implementation of charting, warning, lighting measures will minimise chance of surprise and sudden evasive course changes		Yes	To be advised	To be advised	TBA	TBA
17	Fishing vessel snags gear on export cable	2.5/4.0	3.0/1.0			Cable route will be marked on charts. Current base case is surface-laid cable (but see Possible additional measures)	Seabed type survey to be carried out. Export cable will be buried where practical or alternative cable protection measures will be used. ROV surveys to ensure it is still buried, every 6-12 months. If clay, flatten with trawler towed chain mat to remove obstacles to fishing gear	Yes	To be advised	To be advised	TBA	TBA
18	Fishing vessel snags gear on floating platform / moorings / cables	2.5/4.0	3.0/1.0			All charting and notifications will emphasise the presence within the Project area of subsea mooring lines and electrical cables that pose risk of entanglement to fishing gear - and will emphasise that this risk is present even if the floating platform has been removed for maintenance. Cardinal buoys remain in place at all times	NTM's. Floating platform will have AIS on-board VHF coverage onsite is satisfactory. Project vessel based at O&M base would respond in emergency. Hazard warning needs to emphasise that even when the floating platform is not present the moorings and cabling onsite is a risk to fishing gear entanglement. Ask HO to consider referencing underwater hazards as a marked obstruction	Yes	To be advised	To be advised	TBA	TBA
19	Vessel snags anchor on export cable	2.5/2.5	1.0/1.0			Cable route will be marked on charts.	No anchorages in the Project area	Yes	To be advised	To be advised	TBA	TBA

No.	Hazard (Event Chain)	Consequence (Most Likely/Worst Credible)	Frequency (Most Likely/Worst Credible)	Risk Level on Most Likely Matrix (Appendix D1)	Risk Level on Worst Credible Matrix (Appendix D2)	Risk Control Measures Applied and Taken Account of in Risk Ranking	Potential Additional Control Measures Not Taken Account of in Risk Ranking	Compliance Required	Relevant Documents	Responsible Person	Action Due Date	Verification Date
20	Vessel snags anchor on floating platform mooring/substructure/cable	2.5/2.5	1.0/1.0			Project site marked and charted as noted	NTM's. Floating platform will have AIS on-board VHF coverage onsite is satisfactory. Project vessel based at O&M base would respond in emergency. Location is excessively deep for planned anchoring events for small or large vessels (50-60 metres) and would not normally anchor	Yes	To be advised	To be advised	TBA	TBA
21	Floating platform breaks free and collides with vessel	2/4.75	2.0/1.0			Project will use FMECA to refine the design to include multiple layers of redundancy to prevent this event. In addition the design links GPS detection to the Project SCADA system so that any single mooring failure causes excursion outside normal watch circle triggers alarm to 24hr duty holder. Project Emergency Response Plan considers this risk and response. Project vessel at O&M base normally available to intervene Lighting not affected	The mooring system will be designed to extreme load cases as specified by the design standards The platform shall have batteries to ensure navigational safety systems remain operational in the event that either the electrical mooring system fails Local tugs will be on call-off contract to ensure that vessels can assist, f required	Yes	To be advised	To be advised	TBA	TBA
22	Floating platform breaks free and runs aground	2.0/3.75	2.0/2.0									
23	Man overboard	1.75/2.5	3.0/2.0			During Construction personnel transfers may take place but only after review with Project management. Task risk assessment and tool box talks will assess risks and apply risk control measures	Crew transfers limited to ~1.5 m significant wave height	Yes	To be advised	To be advised	TBA	TBA
24	Naval vessel (submarine) under control collides with floating platform or subsea infrastructure	1.5/2.0	3.0/2.0			As for Hazard ID 12 Fully comply with requirements for marking and lighting the site, floating platform and WTGs Liaise with UKHO on timely addition of chart notification. Apply comprehensive approach to notifications/warnings to all sea users	NTMs Consider possible live traffic monitoring by radar AIS Fit subsea acoustic transponder VHF coverage on- site is satisfactory Project vessels based at O&M base would respond in an emergency	Yes	To be advised	To be advised	TBA	TBA
25	Access difficulties for SAR vessels	1.25/1.0	2.0/2.0			Project vessel crew trained in platform evacuation. Potential to use helicopter for evacuation		Yes	To be advised	To be advised	TBA	TBA
26	Unauthorised boarding of the platform for vandalism or theft	1.25/1.0	3.0/2.0			Electrical infrastructure and turbine access points will be locked when maintenance crew are off site			To be advised	To be advised	TBA	TBA

Appendix D1 Risk Matrix for Most Likely Outcomes

This matrix shows those risks from the hazard log (as assessed for 'Most Likely' outcome) which lie above the Broadly Acceptable zone.

Haz Log ID No.	Description	Summary of 'Most Likely' Outcome
5	Attendant vessel collides with the floating platform	Low speed collision, minor damage to vessel, some first aid cases, no pollution
7	Project vessel in difficulties at sea (e.g. fire, machinery failure, unexpected severe weather)	Minor damage and minor injuries to crew, no pollution
8	Attendant vessel collides with another attendant vessel within development area	Low speed collision, minor damage to vessels, some injuries to crew members, no pollution
12	Commercial vessel, under control, collides with floating platform	Low speed collision, minor damage, minor injuries, no pollution
13	Fishing vessel, under control, collides with floating platform	Low speed collision, some damage to small vessel, minor injuries, no pollution
14	Recreational vessel, under control, collides with floating platform	Low speed collision, some damage to small vessel, minor injuries, no pollution
15	Vessel, drifting or not under control, collides with floating platform	Low speed collision, minor damage, some damage to vessel, minor injuries, no pollution
17	Fishing vessel snags gear on export cable	Damage to fishing gear and cable, business impact.
18	Fishing vessel snags gear on floating platform /moorings/cables	Damage to fishing gear and cable, business impact.

Table D-1 Risk Matrix for Most Likely Outcomes

		Frequency Severity				
		1. Extremely unlikely (<1 per 1000yr)	2. Very unlikely (1 per 100-1000 yr)	3. Unlikely (1 per 10-100 yr)	4. Quite likely (1 per 1-10 yr)	5. Very likely (>1 per yr)
Consequence	5. Major					
	4. Serious				Intolerable	
	3. Moderate			Tolerable with ALARP **12(ML)** **13(ML)** **14(ML)** **15(ML)** **17(ML)** **18(ML)**	**5(ML) 8(ML)**	
	2. Minor		Broadly acceptable		**7(ML)**	
	1. Negligible					

Appendix D2 Risk Matrix for Worst Credible Outcomes

This matrix shows those risks from the hazard log (as assessed for 'Worst Credible' outcome) which lie above the Broadly Acceptable zone.

HazLog ID No.	Description	Summary of 'Worst Credible' Outcome
3	Project construction Vessel collides with 3rd party vessel (commercial, fishing or recreational) including when towing floating platform to site	Loss of a vessel, fatalities, pollution.
4	Project construction Vessel collides with another Project vessel site	Loss of a vessel, fatalities, pollution.
7	Project vessel in difficulties whilst at sea (e.g. fire, explosion, machinery failure, unexpected severe weather)	Loss of a vessel due to fire, foundering or grounding, fatalities, pollution.
8	Attendant vessel collides with another attendant vessel in the Project area	Collision at passage speed, loss of vessel, fatalities, pollution
9	Attendant vessel on passage or	Collision at passage speed, loss of a vessel,

	towing floating platform collides with another vessel	fatalities, pollution
12	Commercial vessel, under control, collides with floating platform	Collision at passage speed, loss of a vessel, fatalities, pollution.
13	Fishing vessel, under control, collides with floating platform	Collision at passage speed, loss of a vessel, fatalities, pollution.
14	Recreational vessel, under control, collides with floating platform	Loss of a vessel, fatalities.
15	Vessel, drifting or not under control, collides with floating platform	Loss of a vessel, fatalities, pollution.
16	Vessels navigating around development site collide	Collision at passage speed, loss of a vessel, fatalities, pollution.
21	Floating platform breaks free from moorings and collides with vessel	Loss of a vessel, fatalities, pollution

Table D-2 Risk Matrix for Worst Credible Outcomes

		Frequency Severity				
		1. Extremely unlikely (<1 per 1000yr)	2. Very unlikely (1 per 100-1000 yr)	3. Unlikely (1 per 10-100 yr)	4. Quite likely (1 per 1-10 yr)	5. Very likely (>1 per yr)
Consequence	5. Major	**3(WC)** **4(WC)** **21(WC)**	**12(WC)** **13(WC)** **16(WC)**			
	4. Serious		**7(WC)** **8(WC)** **9(WC)** **10(WC)** **11(WC)** **14(WC)** **15(WC)**		Intolerable	
	3. Moderate			Tolerable with ALARP		
	2. Minor		Broadly acceptable			
	1. Negligible					

Appendix E – Summary of Vessel Transits – AIS

Estimates for crew numbers in the following tables are taken from an ILO survey of seafarers during 1998-99 (International Labour Organisation, 2001), the average commercial vessel had a crew of 17. For other (non-commercial vessels) such as naval craft and RNLI lifeboats the average crew has been estimated to be 20. On-board fishing vessels and pleasure craft the average crew has been estimated to be 5.

Cargo Winter

Ship Name	Draught	No. of transits	Average number of crew
Fri Stream	3.5	1	17
Victress	3.8	3	17
Lehmann Sprinter	3.2	1	17
Fame	3.9	1	17

Cargo Summer

Ship Name	Draught	No. of transits	Average number of crew
Fri Tide	3.4	3	17
Carly	- (looks flat)	1	17

Tanker Winter

Ship Name	Draught	No. of transits	Average number of crew
Sarnia Liberty	5.1	1	17

Search and Rescue Summer

Ship Name	Draught	No. of transits	Average number of crew
RNLI Lifeboat 14-22	1.1	1	20

Fishing Vessel Winter

Ship Name	Draught	No. of transits	Average number of crew
Magan D	5.0	1	5
Kemarvin WK814	1.8	1	5
Northern Quest	-	1	5

Fishing Vessel Summer

Ship Name	Draught	No. of transits	Average number of crew
Kingfisher	3.5	1	5
Boy Shane	4.5	1	5

Dive Vessel Winter

Ship Name	Draught	No. of transits	Average number of crew
Ocean Dragon	2.3	1	17

Other Vessel Winter

Ship Name	Draught	No. of transits	Average number of crew
Scotia	6	1 back and forth	17

International Labour Organisation, (2001). The Impact on Seafarers' Living and Working Conditions of Changes in the Structure of the Shipping Industry, Geneva 2001, JMC/29/2001/3.