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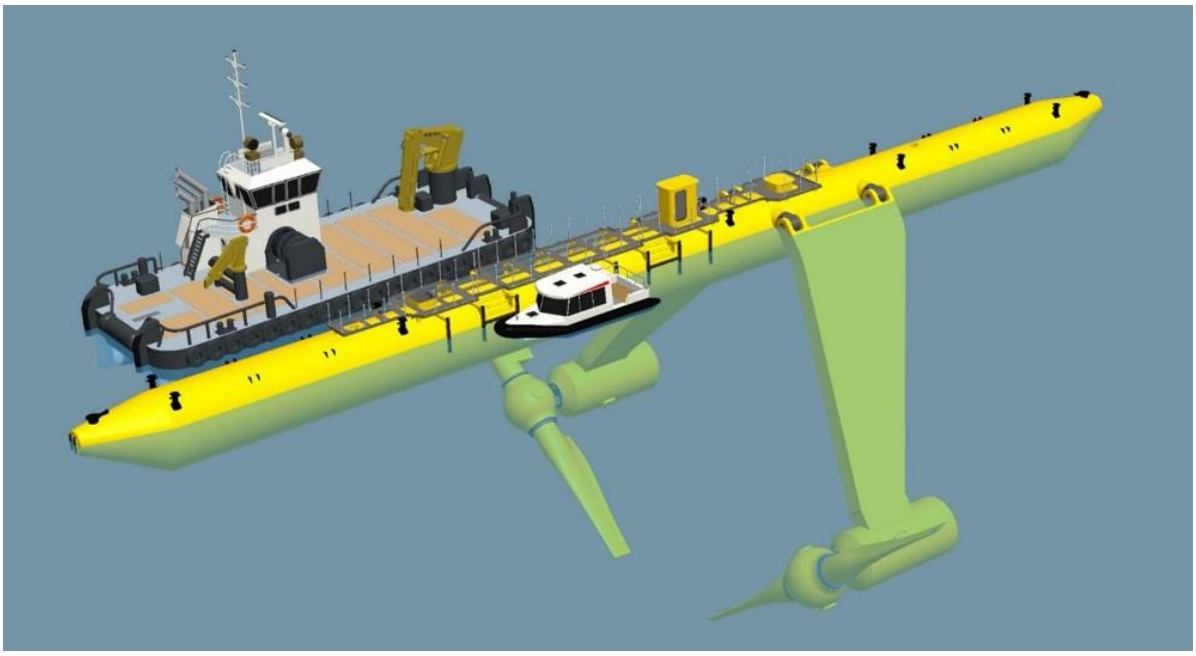
FALL OF WARNESS BERTH 5 EMEC NAVIGATION RISK ASSESSMENT



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MARINE AND RISK CONSULTANTS LTD

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FALL OF WARNESS BERTH 5 EMEC NAVIGATION RISK ASSESSMENT

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EXECUTIVE SUMMARY

The risk to navigation as a result of the installation of the Orbital O2 device at EMEC Berth 5 (Fall of Warness) has been assessed within this NRA. This included, the tow to (and from) location (with raised legs) and the presence of the device at Berth 5 during operation.

The device is 74m length-over-all, with a beam of 3.8m (with the legs lowered) and 60m blade tip to tip when legs are raised. The device has a power rating of 2MW produced from two 20m diameter rotors, arranged either side of the floating pontoon. The mooring system consists of four catenary mooring lines attached to the forward and aft ends of the hull, which are secured to the sea-bed by four separate anchors.

This assessment has been conducted to the assessment methodology of MGN 543 and MCA guidance on assessing OREIs. Consultation was conducted with regulators and local stakeholders to understand the activities of vessels in the area and their experiences with the existing EMEC devices.

Analysis of vessel traffic was undertaken to ascertain vessel activity in proximity to the device. Vessel traffic activity was found to be low, with the majority of vessels transiting in close proximity to the device being project support vessels. Few deep-draught vessels transited past the device or the Fall of Warness site, the majority of which were passenger vessels which are more active within the summer months. Eight incidents are recorded to have occurred within the study area between 1997 and 2015, of which, only one was navigationally significant – a near miss involving a site maintenance vessel.

A review of the impacts to navigation of the introduction of the device into service was conducted and show little impact on collision risk, contact risk, under keel clearance, search and rescue, or communications, radar and position systems.

The risk assessment assessed the likelihood and consequence of a number of applicable hazards to both the device while under tow to and from and while at the berth. All hazards were scored as Low Risk.

Risk controls, both embedded and additional, have been proposed and the adoption of which is recommended.

The installation and operation of the Orbital O2 device is, therefore, concluded to pose only Low Risk to navigation, with a minimal/negligible increase in risk to the baseline environment, providing that suitable risk controls are in place and remain effective.

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ABBREVIATIONS

Abbreviation	Detail
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
CHA	Competent Harbour Authority
DECC	Department of Energy and Climate Change
EMEC	European Marine Energy Centre
ERCOP	Emergency Response and Cooperation Plan
gt	Gross Tonnage
HSE	Health and Safety Executive
HW	High Water
IALA	International Association of Lighthouse Authorities
ICW	In Collision With
IMO	International Maritime Organisation
kt	Knot (unit of speed equal to nautical mile per hour, approximately 1.15 mph)
LAT	Lowest Astronomical Tide
LOA	Length Overall
LW	Low Water
m	Metre
MAIB	Marine Accident Investigation Branch
Marico Marine	Marine and Risk Consultants Ltd
MCA	Maritime and Coast Guard Agency
MGN	Marine Guidance Note
ML	Most Likely
MMO	Marine Management Organisation
NLB	Northern Lighthouse Board
nm	Nautical Mile
NRA	Navigation Risk Assessment
O&M	Operations and Maintenance
OREI	Offshore Renewable Energy Installation
PEC	Pilotage Exemption Certificate
RYA	Royal Yachting Association
SAR	Search and Rescue
SHA	Statutory Harbour Authority

Abbreviation	Detail
SMS	Safety Management System
STCW	Standards of Training Certification and Watchkeeping
VHF	Very High Frequency (radio communication)
VMS	Vessel Monitoring System
VTS	Vessel Traffic Service
WC	Worst Credible

1 INTRODUCTION

This study was commissioned by Orbital Marine Power (Orkney) Plc. to assess the impact to navigational safety of the installation of the Orbital O2 device, at the EMEC Berth 5 Fall of Warness test site, Eday, Orkney. This study is required to obtain a new marine licence from Marine Scotland under Section 20(1) of the Marine (Scotland) Act 2010 and considers two phases of the project:

1. Tow to and from Berth 5 of EMEC's Fall of Warness test site
2. Mooring at Berth 5 of EMEC's Fall of Warness test site (includes installation and decommissioning)

The study seeks to identify the level of risk to navigating vessels of all types resulting from the replacement of the existing SR1-2000 with the Orbital O2 device, and where necessary, identify risk controls that should be implemented to ensure the risk is at or less than As Low as Reasonably Practicable (ALARP).

This assessment was conducted to the Maritime and Coastguard Agency's MGN 543 standard for assessing Offshore Renewable Energy Installations (OREIs) as well as other guidance described in **Section 1.3**.

1.1 STUDY AREA

Figure 1-1 shows the study area for assessment in addition to the location and layout of the device. The water depth at the anchor locations is between 40m and 45m below CD.

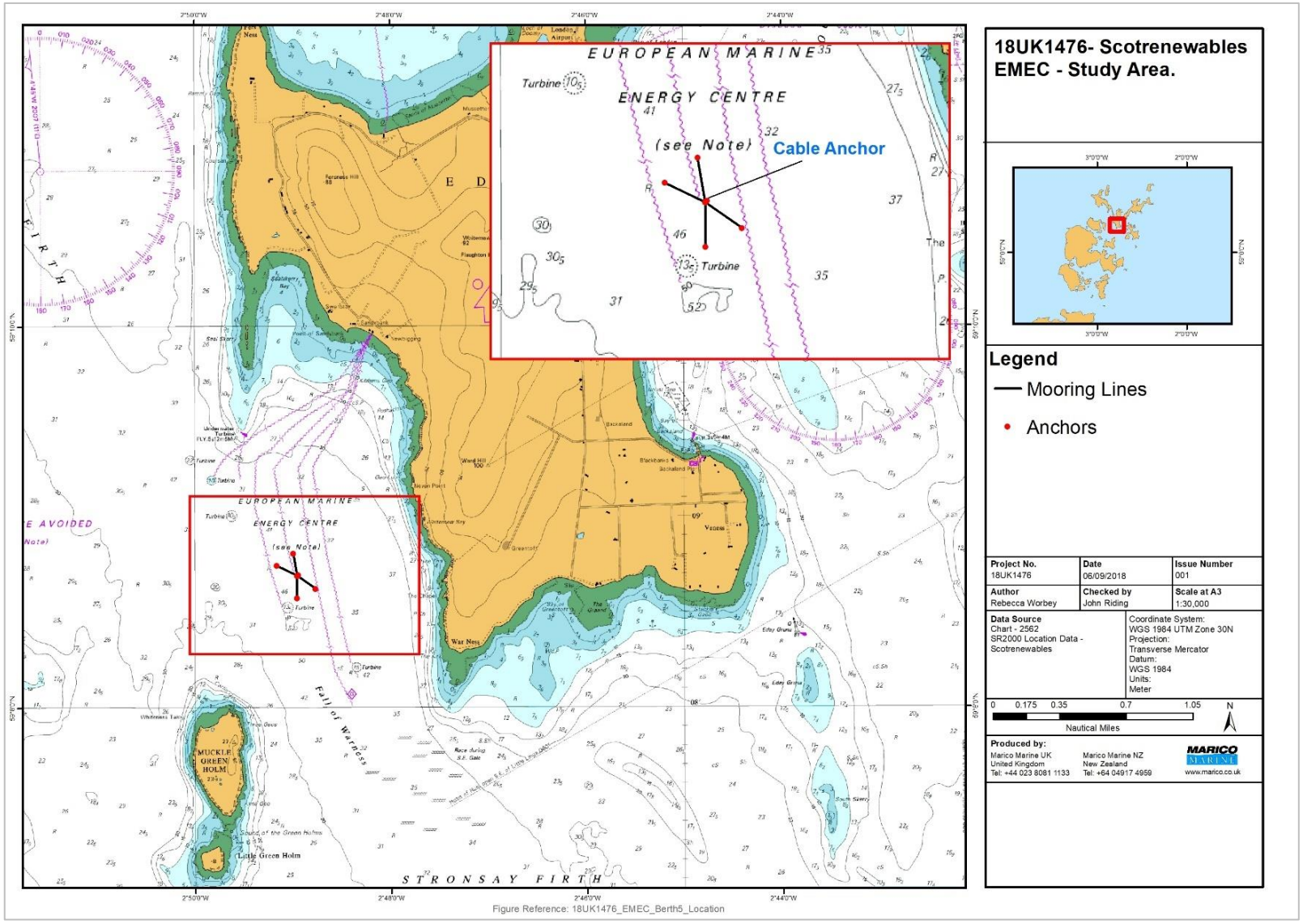

Figure 1-1: Berth 5 Study Area

1.2 SCOPE AND METHODOLOGY

The scope of this document is to:

1) Describe the Orbital O2 device; its layout, marking, construction methodology and towage to site.
2) Provide a description of the existing environment and activities within the study area; including:
    a. Local ports and harbours;
    b. MetOcean conditions;
    c. Existing vessel management plans;
    d. Other users of the area such as aquaculture, anchorages, military and renewable energy installations;
    e. Existing vessel traffic patterns, including frequency and types; and
    f. Existing risk profile for navigational incidents.
3) Identify and assess impacts of the development to shipping and navigation, including:
    a. Traffic routeing;
    b. Collision risk;
    c. Contact risk;
    d. Communications, Radar and Positioning Systems;
    e. Search and Rescue; and
    f. Cumulative and In-Combination Effects.
4) Undertake an NRA that identifies navigation hazards during the phases of the development. These hazards are then assessed, and risk controls identified to reduce the risk to ALARP; and
5) Make recommendations as to the safety of the development and what measures should be implemented to improve it.

1.3 GUIDANCE

Guidance on the assessment requirement was primarily sought from the Maritime Coastguard Agency Marine Guidance Note (MGN) 543 (M+F)[1]. This advises the correct methodology to evaluate

[1] (MGN) 543 (M+F) replaces MGN 371

navigational safety around OREIs, through traffic surveys. This report adheres to this standard accordingly. Guidance was also sought from a variety of other publications (**Table 1**).

Table 1: Guidance Document Table

Policy / legislation	Key provisions
MGN 543 Guidance on UK Navigational Practice, Safety and Emergency Response Issues	This MGN highlights issues to be considered when assessing the impact on navigational safety and emergency response, caused by OREI developments. Including traffic surveys, consultation, structure layout, collision avoidance, impacts on communications/ radar/ positioning systems and hydrography.
Department of Energy and Climate Change (DECC) Methodology for Assessing Marine Navigational Safety Risks of Offshore Wind Farms	The DECC document provides a template for preparing NRA's for offshore wind farms. This template has been used throughout to define the methodology of assessment and is read in conjunction with MGN 543.
MGN 372 Guidance to Mariners Operating in the Vicinity of UK OREIs	Issues to be considered when planning and undertaking voyages near OREI off the UK coast.
International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA AISM) 0-139 the Marking of Man-Made Offshore Structures.	Guidance to national authorities on the marking of offshore structures.
International Maritime Organisation (IMO) Formal Safety Assessment.	Process for undertaking marine navigation risk assessments.
Royal Yachting Association (RYA) Position on Offshore Energy Developments	Outlines recreational boating concerns for offshore renewable energy developments.
Regulatory expectations on moorings for floating wind and marine devices – HSE and MCA 2017	Guidance document on mooring arrangements for OREIs.

1.3.1 MGN 543 Compliance Table

The following table (**Table 2**) acts as an aid for developers when completing and submitting an NRA to ensure all guidance has been considered and addressed. The full compliance table can be found in **Annex A**.

Table 2: MGN 543 Compliance Table.

Annex 1		Report Section
1	An up to date traffic survey of the area.	**Section 5**
2	OREI Structures.	**Section 2**
3	Assessment of Access to and Navigation within, or close to, an OREI.	**Section 7**
Annex 2		**Report Section**
1	Effects of Tides and Tidal Streams.	**Section 3.1** and **Section 7.1**
2	Weather.	**Section 3.1 and Section 7.1**
3	Visual Navigation and Collision Avoidance.	**Section 7.7**
4	Communications, Radar and Positioning Systems.	**Section 7.8**
5	Marine Navigational Marking	**Section 2.2.2 and Section 8.2**
Annex 3		**Report Section**
1	OREI Risk Register and Risk Mitigation Measures for Development	**Section 8, Annex D, Annex E**

2 BERTH 5 ORBITAL O2 PROJECT

2.1 THE PROJECT

The Orbital O2 device will be connected to the existing EMEC cable via a riser umbilical cable and re-use some existing ballast from the SR1-2000 machine. The project is intended to operate until 2038 with decommissioning to occur in 2039. The Cauldale facility will be utilised as the project's onshore infrastructure base.

The project is comprised of the following components:

- Orbital Marine's commercial demonstrator turbine (Orbital O2)
- Anchoring and mooring system (including cable splice and umbilical line)
- Installation and maintenance vessel

The subsea cable connecting the device to the shore forms part of the EMEC facility and is therefore, not considered part of the project.

2.2 THE DEVICE

The Orbital O2 is a 74m in length and 3.8m diameter floating tidal stream energy generator, housing power conversion and auxiliary systems. Leg structures with nacelles mounted at their ends are hinged to the cylindrical hull such that they can be lowered via the use of actuation systems. The nacelles and 20m diameter contra-rotating rotors (1MW rated turbines) will be lowered to be positioned in the optimal part of the tidal stream and raised for maintenance and towing. Power will be exported via a dynamic cable from the device to the seabed where it connects to the seabed static cabling infrastructure utilised by multiple Fall of Warness tidal devices. The device will reach rated power of 2MW at current speed of 2.5m/s. A deck structure, bollards and fendering are attached to the outside for vessel and personnel interaction.

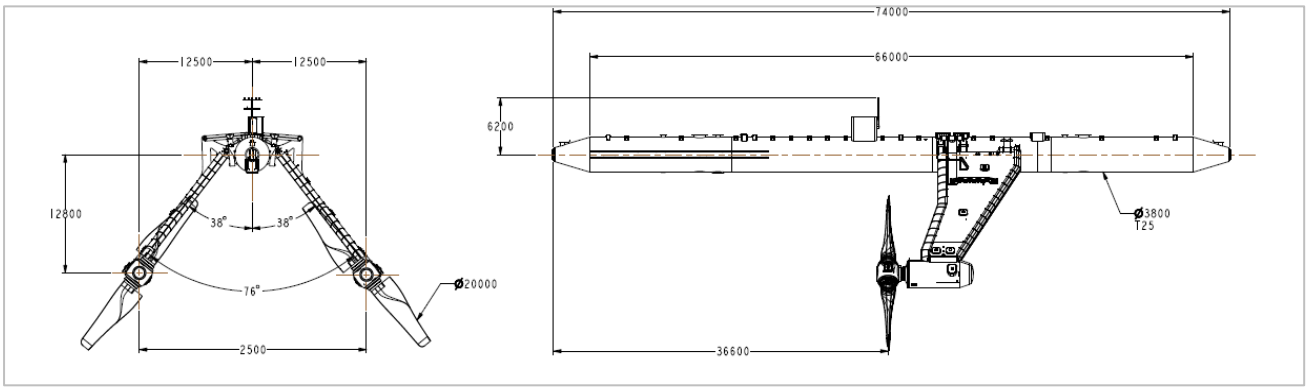

Figure 2-1: Schematic of Device - Legs Down (metres)

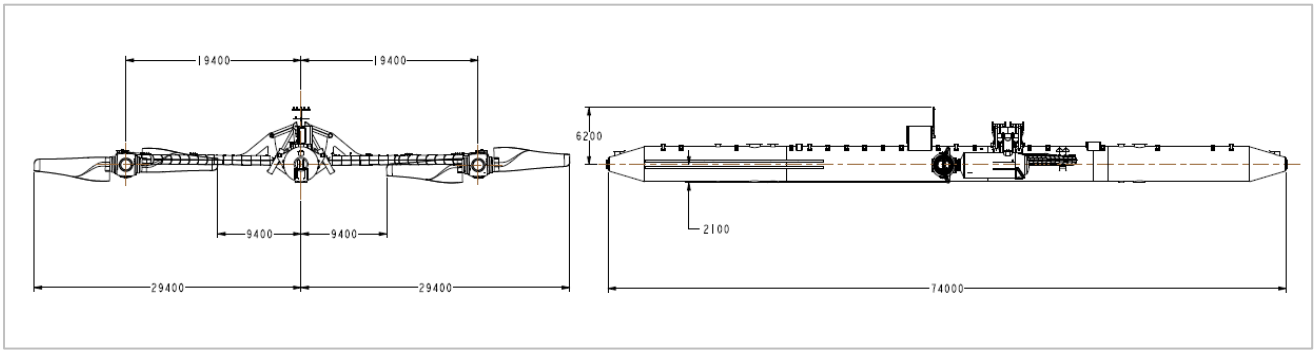

Figure 2-2: Schematic of Device - Legs Up (metres)

2.2.1 Moorings

The HSE and MCA (2017) guidance on the mooring of marine offshore renewable energy installation outlines the principles expected from mooring arrangements:

It can withstand such forces acting on it as are reasonably foreseeable;

Its construction, commissioning, operation, modification, maintenance and repair of the installation may proceed without prejudicing its integrity;

It may be decommissioned and dismantled safely; and

In the event of reasonably foreseeable damage to the installation or its moorings, it will retain sufficient integrity to enable action to be taken to safeguard the health and safety of persons on or near it.

The Orbital O2 mooring system consists of four catenary mooring lines attached to the forward and aft of the hull which are moored to the sea-bed via four separate anchors. The system complies with the DNV-OS-E301 Offshore Standard. The slack in the mooring lines will allow the turbine will move by up to 25m in all directions as the tide changes. Each mooring line will be composed of a stud-link mooring chain and will be approximately 225m in length. Any one mooring line is capable of holding the turbine should any one of the other mooring lines fail.

The maximum area occupied by the mooring spread will be 420m x 220m.

Table 3: Mooring Characteristics

Location	Description	Length (m)	Weight (kg/m)
A	95mm studlink chain	125m	200
B	115mm studlink chain	100m	315

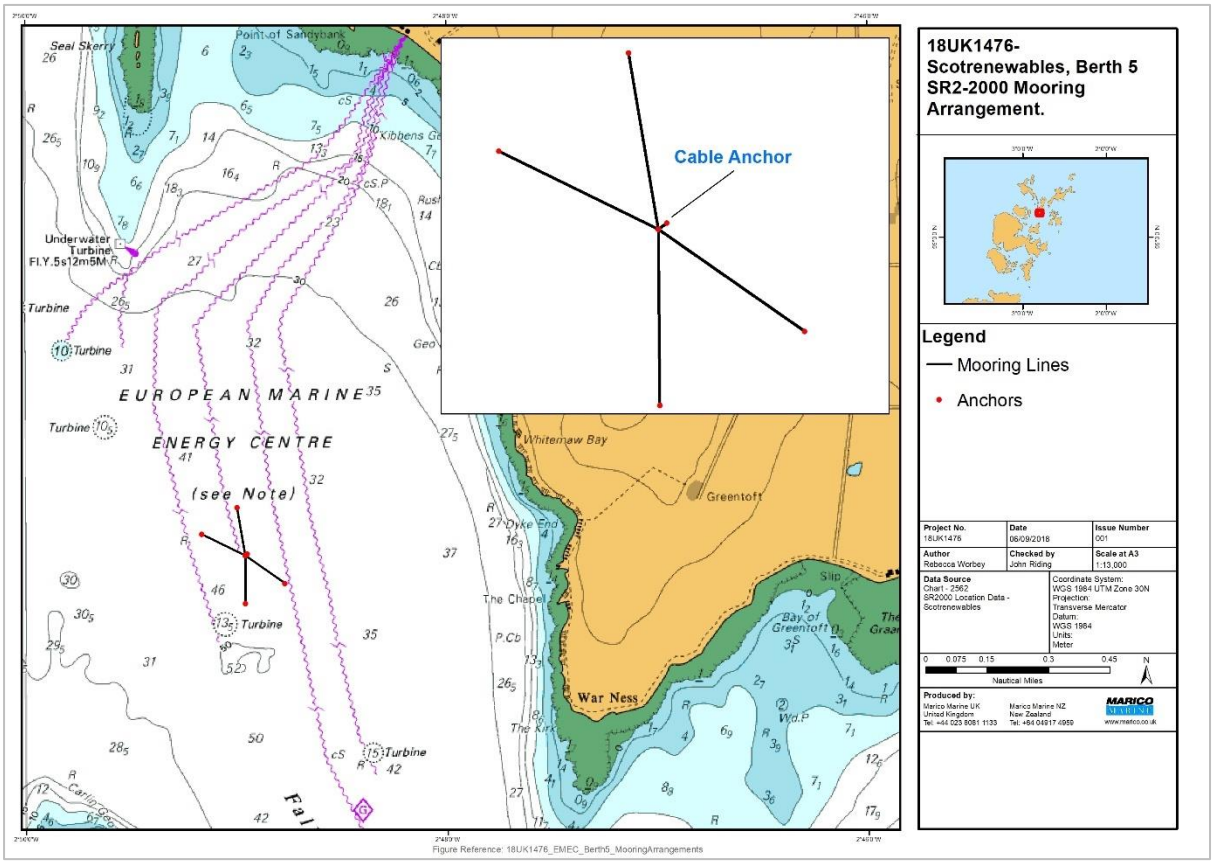

Figure 2-3: Planned Orbital O2 Mooring Arrangements

2.2.2 Anchors

The device will be held in place by four ballast filled steel basket gravity anchors composed of concrete modules, scrap steel chain or steel modules. Each anchor will weigh approximately 600T and will be 11m x 11m x 2.5m.

Up to eight 6m x 3m x 0.3m concrete mattresses will be placed around each anchor to prevent scour.

2.2.3 Marking and Lighting

The device will be yellow in colour above the water line and maroon below. The device will be fitted with a radar reflector and will be lit with two yellow lights with synchronised flashing every three seconds. The lights will have a range of 3nm and will be mounted at least 3m above the waterline.

2.3 CONSTRUCTION / DECOMMISSIONING PLAN

Approximately 60 multi-cat style vessel transits will be required throughout the duration of construction activities and a further 60 multi-cat transits estimated for decommissioning.

Activity	Location	Duration	Timescale
Mooring Installation	Berth 5	8 weeks	June/ July 2019
Dynamic Cable Installation	Berth 5	1 week	August 2019
Turbine Delivery to Orkney	Outwith EMEC area	5 days	December 2019
Turbine in water assembly Hatston Pier 10 days December 2019	Hatston Pier	10 days	December 2019
Mooring connection trails Berth 5 1-week December 2019	Berth 5	1 week	December 2019
Install on moorings Berth 5 2 days January 2020	Berth 5	2 days	January 2020
First Grid connection	Berth 5	2 days	January 2020
Commissioning	Berth 5	12 weeks	January – April 2020
Operation	Berth 5	18 years	2020 - 2038
Decommissioning	Berth 5	6 months	2039

2.4 TOW TO/ FROM BERTH 5

The device will be towed from Hatston Pier to the site. The assembled device is to be towed by a multi-cat style vessel with a minimum towing capability of 50 tonnes and a 90-tonne brake, 36mm wire and 500m length. It will meet the pilotage requirements for the Orkney pilotage regulations. Due consideration is to be given to the effect of the tidal stream during towing, to include sufficient fuel capacity. During the tow, the platform legs will be raised with rotors resting at the surface. A formal towage plan or passage plan for the route has not yet been agreed.

Figure 2-4: Example towage arrangement (SR1-2000).

2.5 OPERATION AND MAINTENANCE

Maintenance activities will be necessary during the life of the device, which will require approximately 12 rib vessel transits and 2 multi-cat vessel transits per year. During maintenance/ access nacelle mode the legs/ rotors would be raised and resting at the surface. The device is to remain on site during maintenance operations but may, in some rare cases, be disconnected in order to access a nacelle. In such a case, the device would be transported to a to be defined sheltered location, likely within the Eday area.

3 OVERVIEW OF THE BASELINE ENVIRONMENT

The Orkney Islands, a group of more than 50 islands, lie NNE of the NE extremity of mainland Scotland, north of the Pentland Firth. The Fall of Warness is located to the west of Eday and exhibits significant tidal flows.

3.1 METOCEAN CONDITIONS

3.1.1 Wind

The Admiralty Sailing Directions for the North Coast of Scotland give the days with gales per year as 50 in Kirkwall. This ranges from between one and nine per month, with gales most frequently in the winter months. **Figure 3-1** shows the wind directions and speeds for the Fall of Warness site.

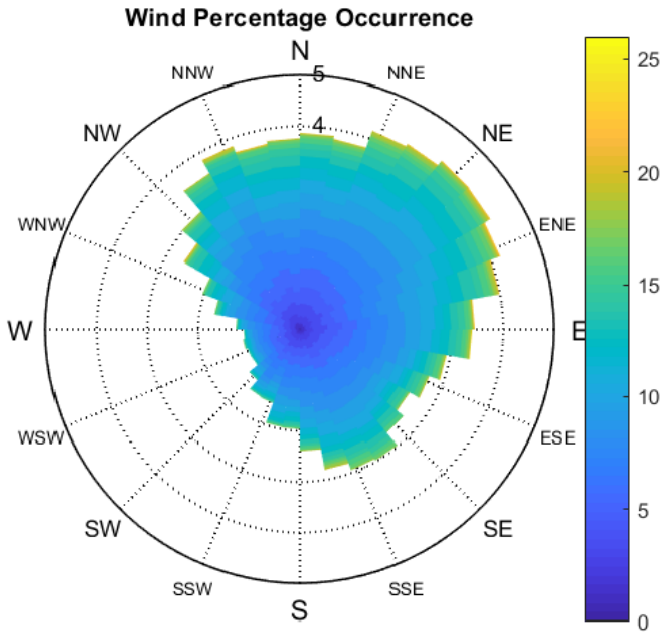

Figure 3-1: Percentage occurrence of wind directions (m/s) – Source TDK-MAG-MOOR-TR-001.

3.1.2 Wave

Figure 3-2 shows the wave rose for the project site, the predominant direction is north-westerly and south-easterly with the significant wave heights generally below two metres.

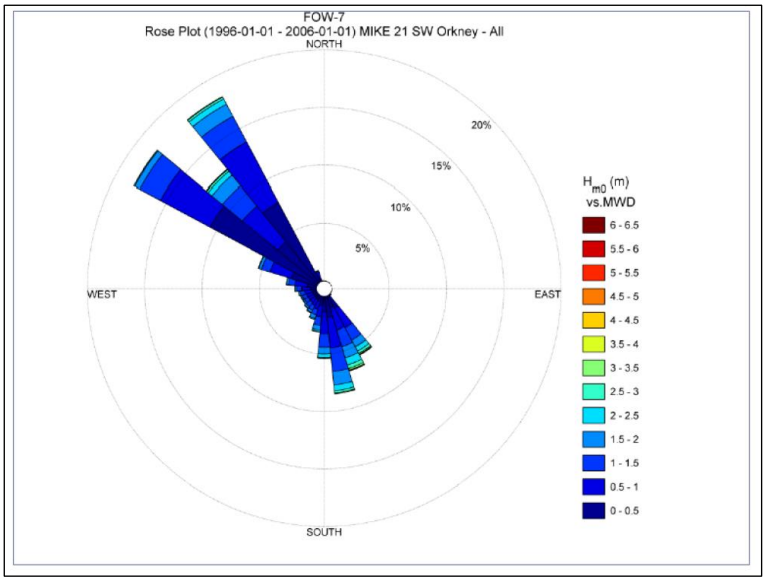

Figure 3-2: Wave rose plot for percentage occurrence with Hm0 and direction (EMEC Fall of Warness – Berth 1: MecOcean & Physical Description 2015).

3.1.3 Tide

Table 4 and **Table 5** give the tidal characteristics near to the project site. Spring tidal speeds are significant and can reach up to 7 knots, with neap flows being greater than spring tides compared to many other parts of the UK coastline.

Figure 3-3 gives a graphical model of tidal flows through the project site. The tide races in a north-westerly and south-easterly direction between Muckle Green Holm and Eday.

Table 4: Tidal Heights

Place	Lat N	Long W	HAT	MHWS	MHWN	MLWN	MLWS	LAT
Loth	59° 11	002° 42	3.5	3.1	2.5	1.5	0.9	0.3
Rapness	59° 15	002° 52	4.1	3.6	2.9	1.6	0.7	-0.1
Kirkwall	58° 59	002° 58	3.5	3.0	2.4	1.3	0.6	-0.1

Table 5: Admiralty Total Tide Predictions

Fall of Warness (59° 08.07'N 002° 48.40W)			
Tidal Hour	**Direction (deg)**	**Spring**	**Neaps**
-6	150	6.2	2.4
-5	144	7.2	2.8
-4	141	5.8	2.3
-3	116	2.8	1.1
-2	350	0.3	0.1
-1	308	3.8	1.6
HW	329	6.4	2.5
+1	329	6.5	2.5
+2	320	4.9	1.9
+3	325	3.8	1.7
+4	324	1.2	0.5
+5	160	1.7	0.7
+6	153	5.7	2.3

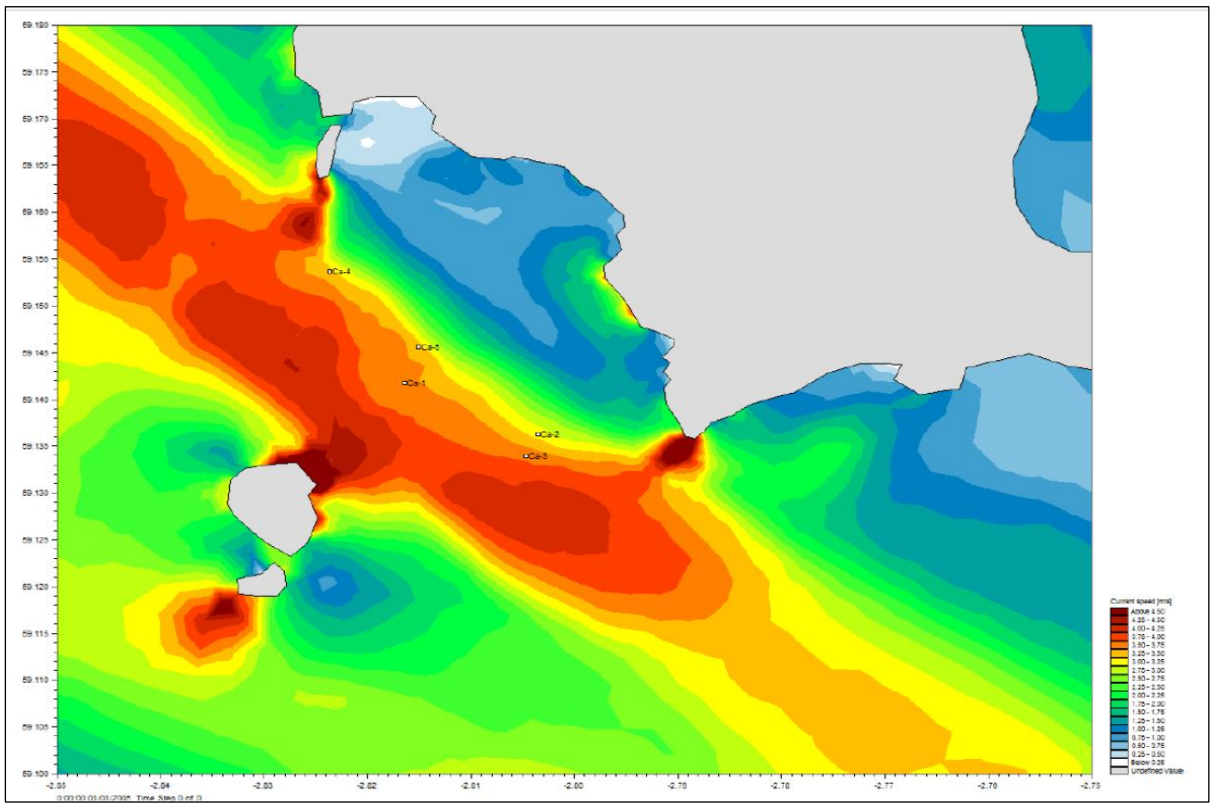

Figure 3-3:Maximum Tidal Flow for 2005 (EMEC Fall of Warness – Berth 1: MecOcean & Physical Description 2015).

3.1.4 Visibility

The Admiralty Sailing Directions for the North Coast of Scotland give the days with fog per year as 41 in Kirkwall. This ranges from between two and five per month, with fog most frequently in the summer months.

3.2 EXISTING VESSEL TRAFFIC MANAGEMENT

Within the Orkney Harbour Competent Harbour Authority (CHA) Area pilotage is compulsory for the following vessel types:

- Passenger vessels over 65m LOA;
- Other vessels over 80m LOA;
- Vessels under tow where the combined overall length of the towing vessel and the vessel being towed is over 65m; and
- Vessels over 300gt carrying persistent oils in bulk.

The Fall of Warness is not within the port limits.

3.3 SEARCH AND RESCUE

RNLI lifeboats are stationed in the Orkneys at Longhope, Stromness and Kirkwall. The Kirkwall lifeboat is a Severn class all weather lifeboat. This vessel is 17m LOA, has a crew of seven, is capable of 25 knots and has a range of 250 nm.

3.4 OTHER OFFSHORE ACTIVITIES

3.4.1 Aquaculture

Authorised marine farms of various types are numerous throughout the waters of the Orkney Islands with farms being added and removed on a continuous basis. Farms in proximity to shipping routes are marked by buoys. Other farms are marked by beacons (X topmark) and some are fitted with radar reflectors. Lights, when fitted, show flashing yellow.

Orkney Islands Council prohibits anchoring and diving close to marine farms within Orkney Harbour Areas and mariners are required to give as wide a berth as possible to the farms and to proceed with caution, consideration, and at slow speed in their vicinity.

There are no charted marine farms in the Fall of Warness.

3.4.2 Renewables

The EMEC development site is located in the Fall of Warness. Other development areas exist in the Orkney Islands but are well clear of the project sites. Proposals for subsurface tidal devices in the Westray South Tidal Site have not progressed for several years. Similarly, proposals for developments at Lashy Sound and Stronsay Firth have also not progressed.

3.4.3 Subsea Cables

The Fall of Warness has multiple subsea cables associated with the EMEC test facilities.

3.4.4 Anchorages

There are no anchorages near to the project site.

3.4.5 Military Exercise Areas

There are no military practice areas near to the project site.

3.4.6 Spoil Grounds

A spoil ground exists opposite Kirkwall but is well clear of the Fall of Warness test site.

4 CONSULTATION

Consultation was conducted with key stakeholders to gain local knowledge and insight on navigation. A list of stakeholder consultations undertaken is given in **Table 6**. Following each conversation or correspondence, summary notes were drafted and agreed – these are contained in **Annex C**.

The knowledge, themes and issues gained from the stakeholder consultations have been embedded in the assessment of navigation risk for this study.

Table 6: List of stakeholder consultation.

Organisation	Date Undertaken	Purpose
Maritime and Coastguard Agency	19/09/2018	Methodology and Guidance Documentation for Assessment Topics to be covered
Northern Lighthouse Board	14/09/2018	Marking and Lighting requirements
Orkney Ferries	30/08/2018	Background on Orkney Ferries Passages through study area Possible impacts of device Risk Control Measures
Orkney Marinas	30/08/2018	Background on Recreational Traffic Racing areas and cruising routes Risk Control Measures
Orkney Fisheries	29/08/2018	Background on Fishing in Orkneys Consideration of Impact on Fishing
Orkney Islands Council Marine Services	29/08/2018	Navigation of vessels through Fall of Warness Risk Control Measures

5 EXISTING VESSEL TRAFFIC AND RISK PROFILE

5.1 DATA SOURCES

The principal source of data for this assessment is AIS data recorded by EMEC for the following periods:

July 2017 – one full month to be representative of summer traffic;
January 2018 – one full month to be representative of winter traffic.
Additional information was obtained from stakeholders and secondary sources such as the RYA's boating intensity database and MMO data from the Vessel Monitoring System (VMS). Information on other activities was obtained through consultation (**Section 4**).

5.1.1 Requirement for Radar Survey

MGN 543 states that *"an up to date, traffic survey of the area should be undertaken within 12 months prior to submission of the Environmental Statement. This should include all the vessel types found in the area and total at least 28 days duration but also take account of seasonal variation in traffic patterns and fishing operations. (Note: AIS data alone will not constitute an appropriate traffic survey)."* MGN 543, page 7.

Under MCA guidance document: "*Methodology for Assessing the Marine Navigational Safety Risks of OREIs*", Section 3 considers the scope and proportionality of assessments. It states that the scope and depth of the assessment should be proportionate to the scale of the development, magnitude of the risks and should be considered on a case by case basis. It considers that a small scale or low risk development may require a less detailed assessment.

The Orbital O2 will be located in a licensed test site which has been host to another similar device and is well charted. This assessment has been conducted based on AIS data and l information provided by secondary sources and local consultees ensuring the activities of small craft are included in the assessment.

Whilst there may be an advantage in periodically undertaking assessments and traffic surveys of the full test site, the omission of a radar survey in this assessment would not compromise the validity of the results.

5.2 VESSEL TRAFFIC ANALYSIS

The Orbital O2 is located within the Fall of Warness site and is clear of the main routes used by ferries from Kirkwall to Eday (see **Figure 5-1**). A route through the Fall of Warness is used by some deeper draught vessels when the weather and tidal conditions are suitable (see **Figure 5-4**), particularly cruise ships. No tankers operate in this area and cargo transits are infrequent (see **Figure 5-2**).

Figure 5-3 shows the tracks of passenger vessels, which are split between the north-south route between Westray and Kirkwall, and an east-west route between Kirkwall and Eday. Whilst both of these routes are clear of the development site, ferries do on specific occasions transit through the Fall of Warness site, this is discussed in detail in **Section 7.1**.

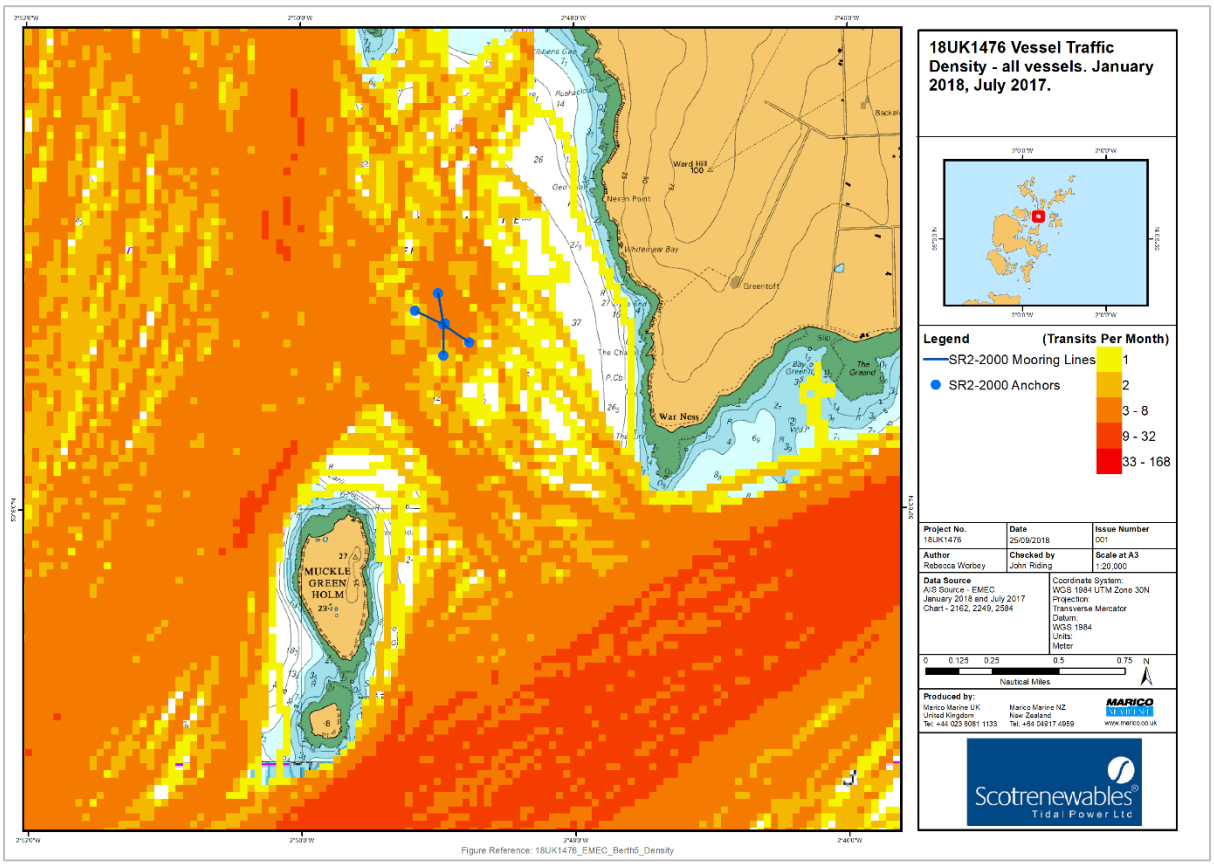

Figure 5-1: Vessel transit density in Proximity to Berth 5.

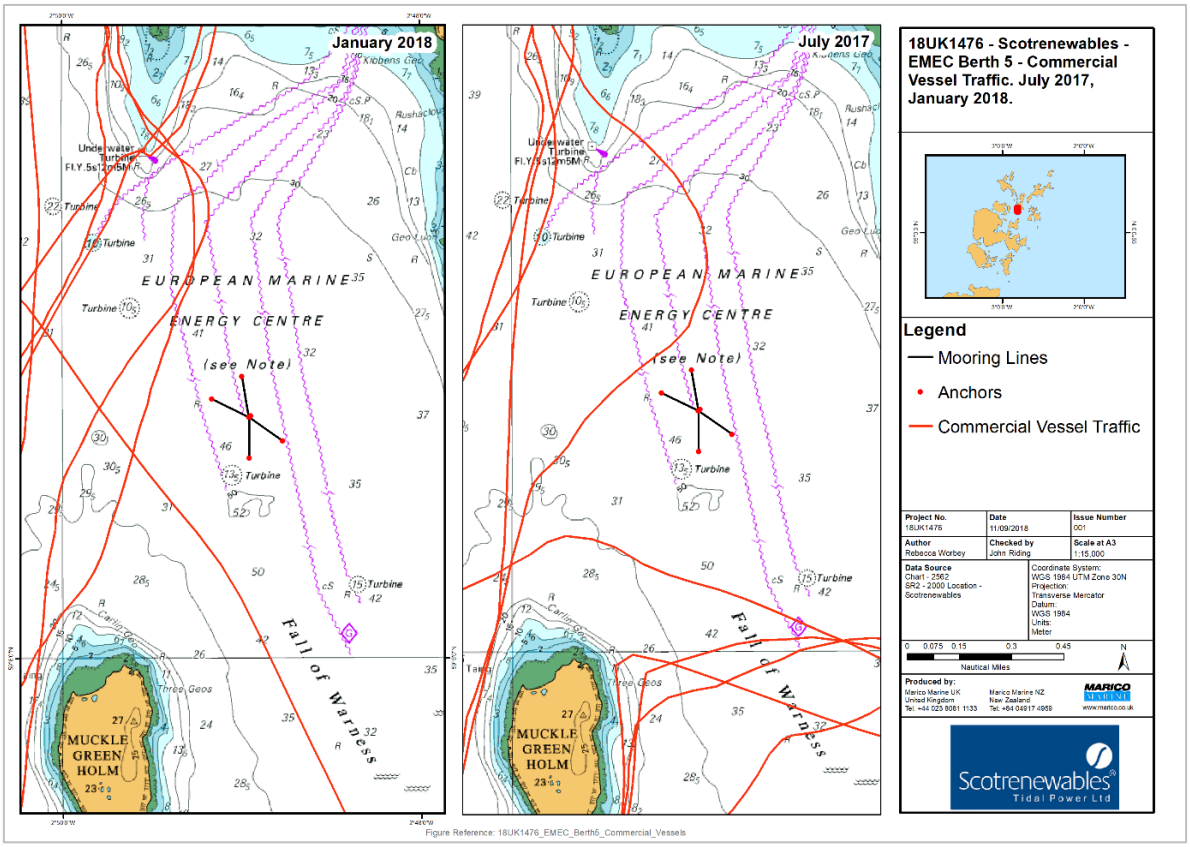

Figure 5-2: Commercial vessel transits in Proximity to Berth 5.

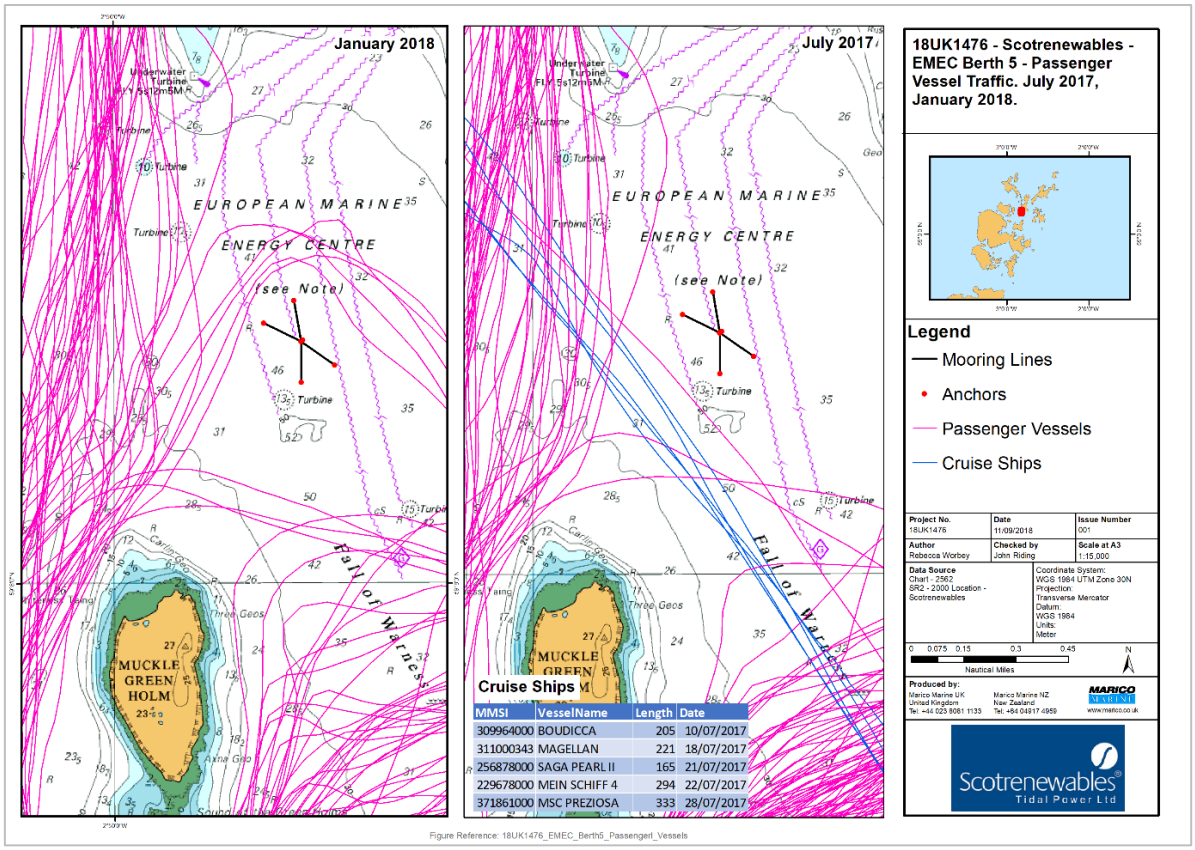

Figure 5-3: Passenger vessel transits in Proximity to Berth 5.

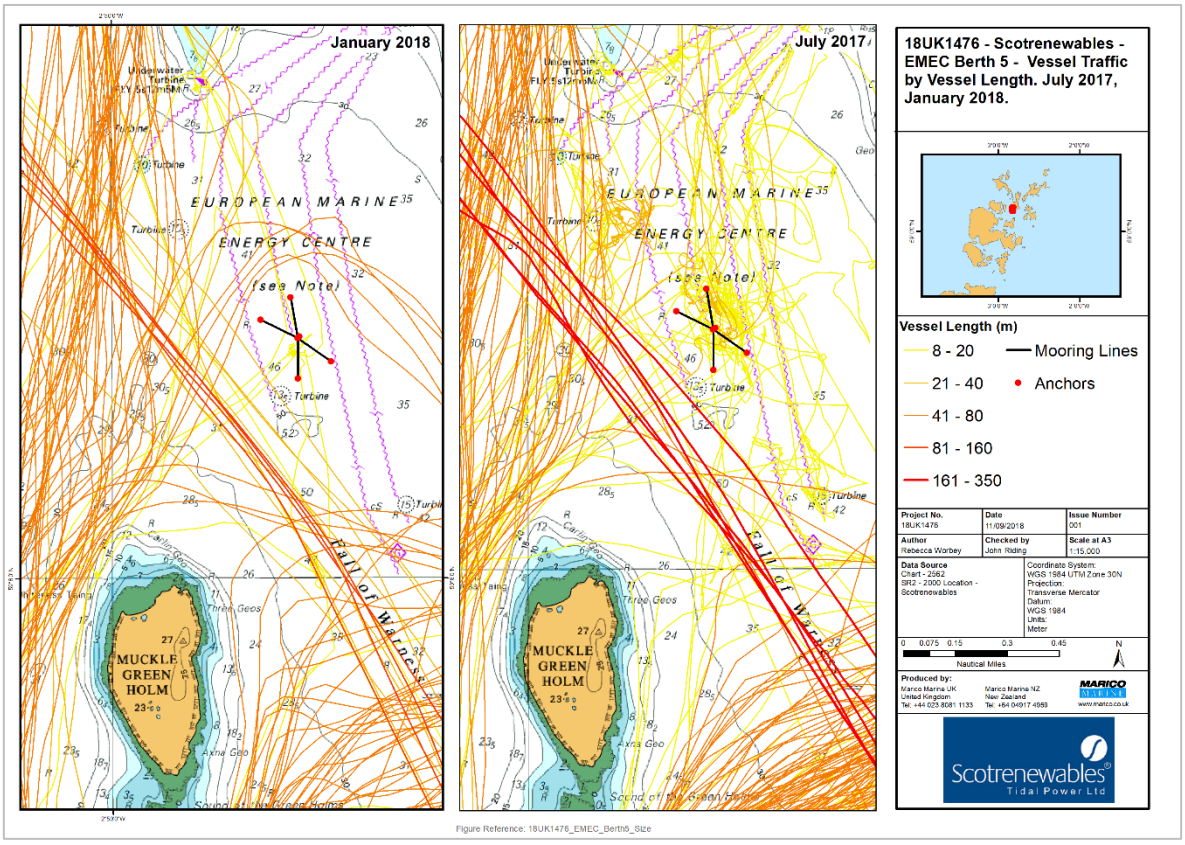

Figure 5-4: Vessel transits in Proximity to Berth 5 by size.

Fishing is sparse in the Fall of Warness, principally due to the presence of the EMEC test sites and the cables to the devices. Fishermen, therefore, generally avoid this area unless they are transiting through (**Figure 5-5**). As such, the impact is limited. Occasionally, scallop dredgers are known to operate in this area but would do so clear of the cables and devices.

Similarly, recreational yachts transit through this area (**Figure 5-6**) but would generally stay close inshore away from the device. Consultation recommended that an inshore route remained open to allow yachts to pass close to Eday. No small boat activity or racing takes place in the Fall of Warness and the device is located in an area of deep water and strong tides which would not be a suitable anchorage.

Tugs and service craft, including pilot boats, tugs, maintenance vessels and other workboats are shown in **Figure 5-7**. The majority of vessels in this category are EMEC site maintenance vessels, with few through transits.

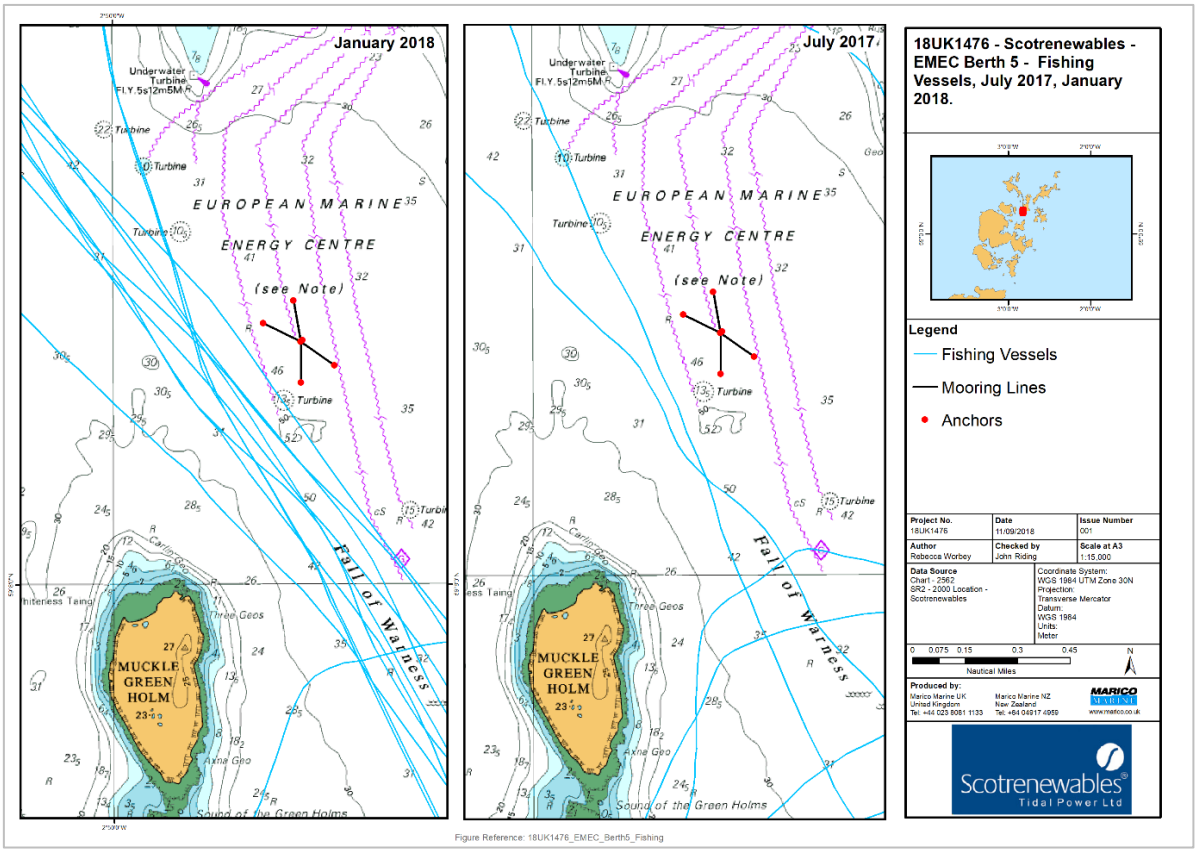

Figure 5-5: Fishing vessel transits in Proximity to Berth 5.

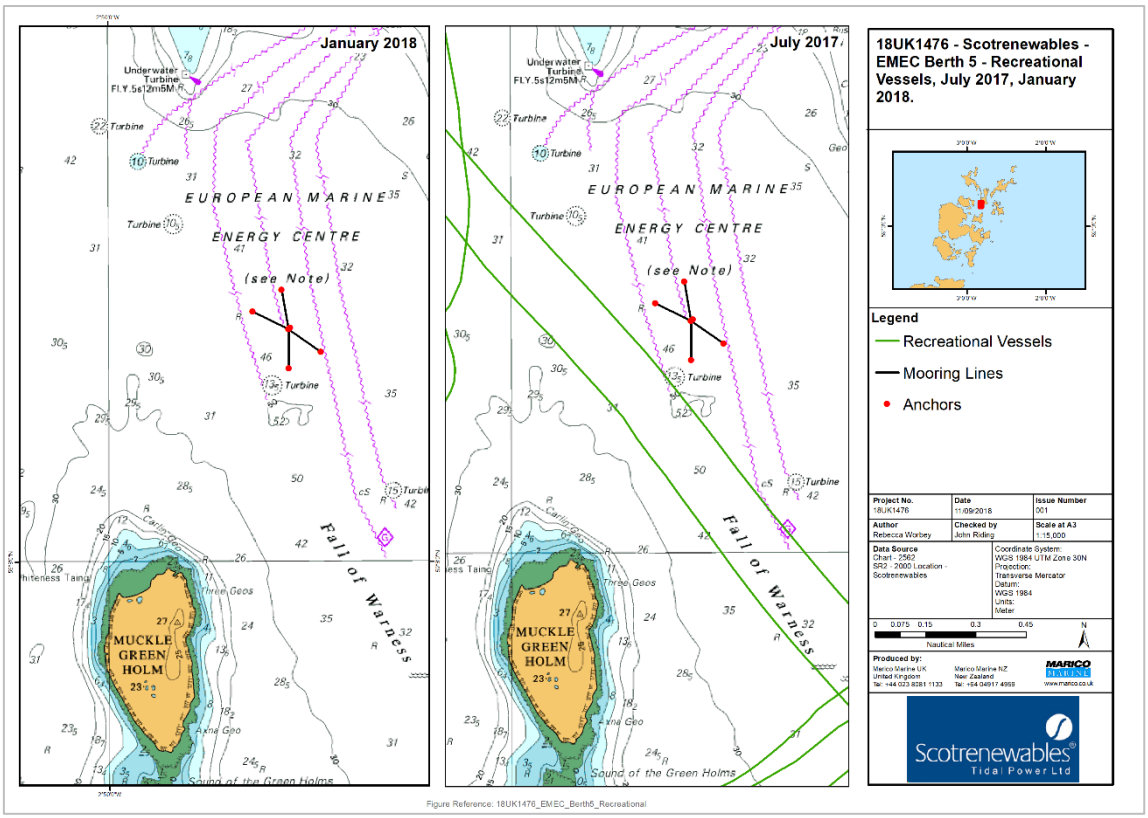

Figure 5-6: Recreational vessel transits in Proximity to Berth 5.

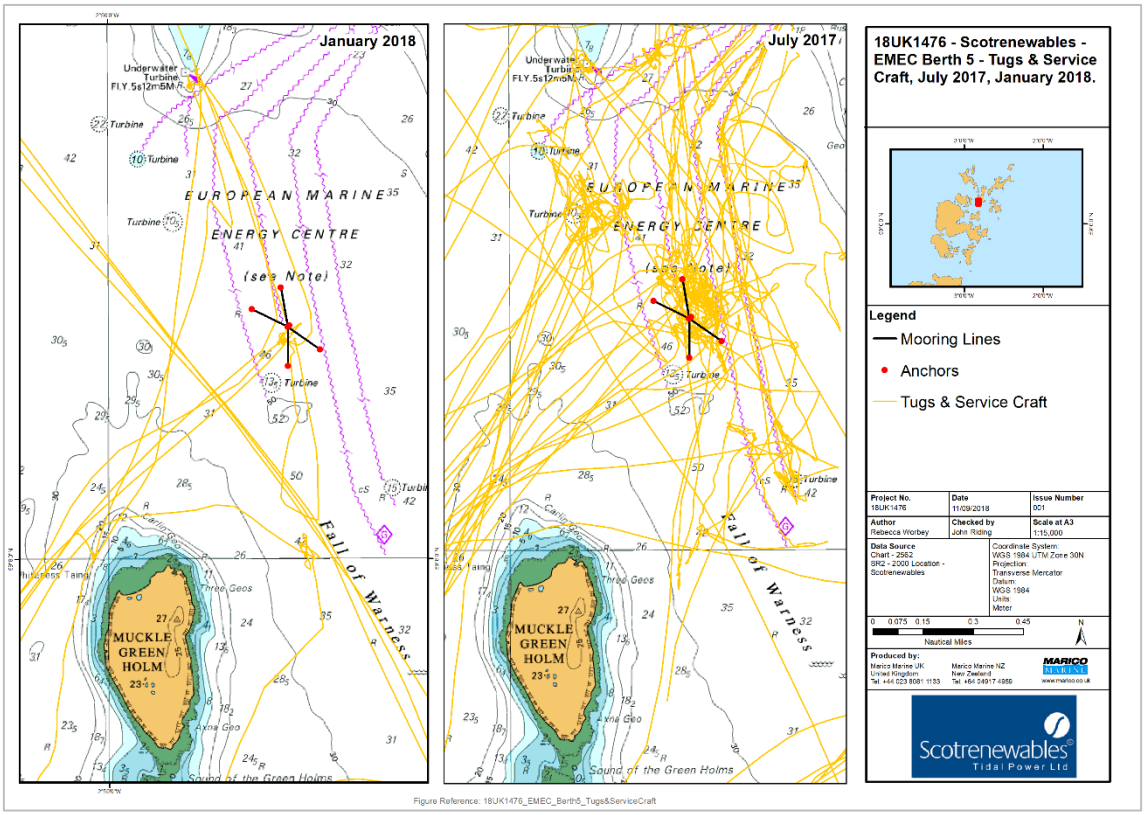

Figure 5-7: Tug and Service vessel transits in Proximity to Berth 5.

5.3 PROXIMITY ANALYSIS

Frequency and distribution analysis was undertaken to understand vessel movements near to the site. **Figure 5-8** shows the distribution of traffic (all vessels) passing Berth 5. Transits within 0.5nm were extracted and analysed below.

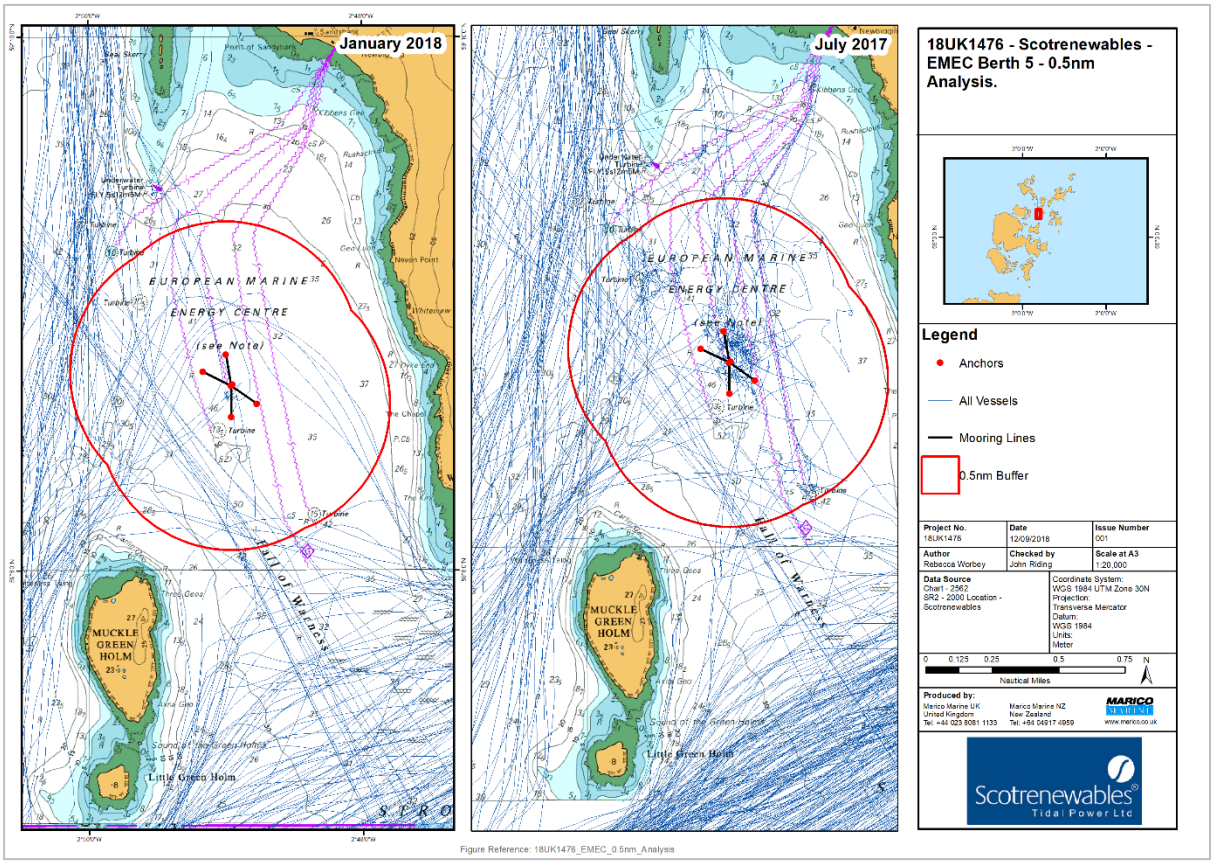

Figure 5-8: Vessel traffic at Berth 5.

Figure 5-9shows the number of transits per day past Berth 5 within summer and winter. 51 transits passed within 0.5nm of the device during summer and 48 in the winter, indicating seasonality is not a driving factor of vessel traffic levels within 0.5nm of the device.

Figure 5-10 shows transits by time of day. There is a more defined peak within the summer, likely reflecting the ferry timetable, than in winter, where peak distribution is more sporadic and of shorter duration.

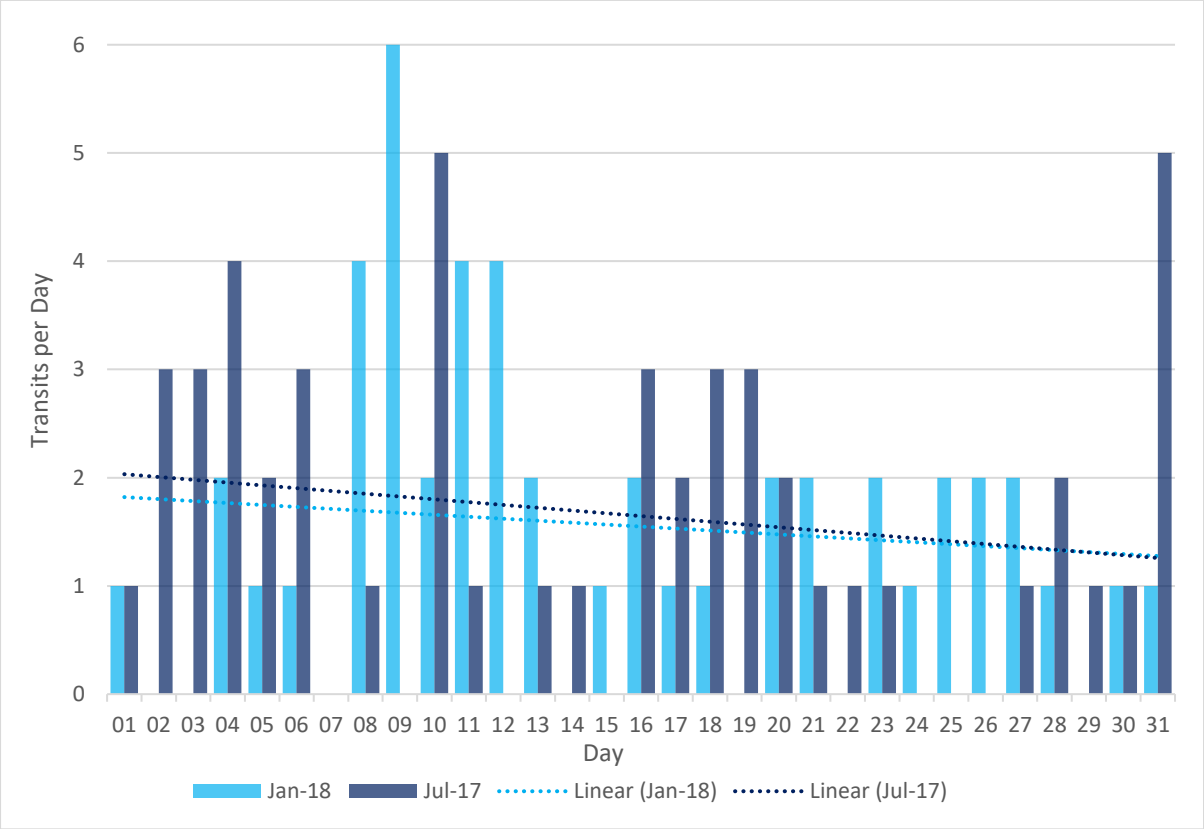

Figure 5-9: Vessel transits per day -July 2017, January 2018.

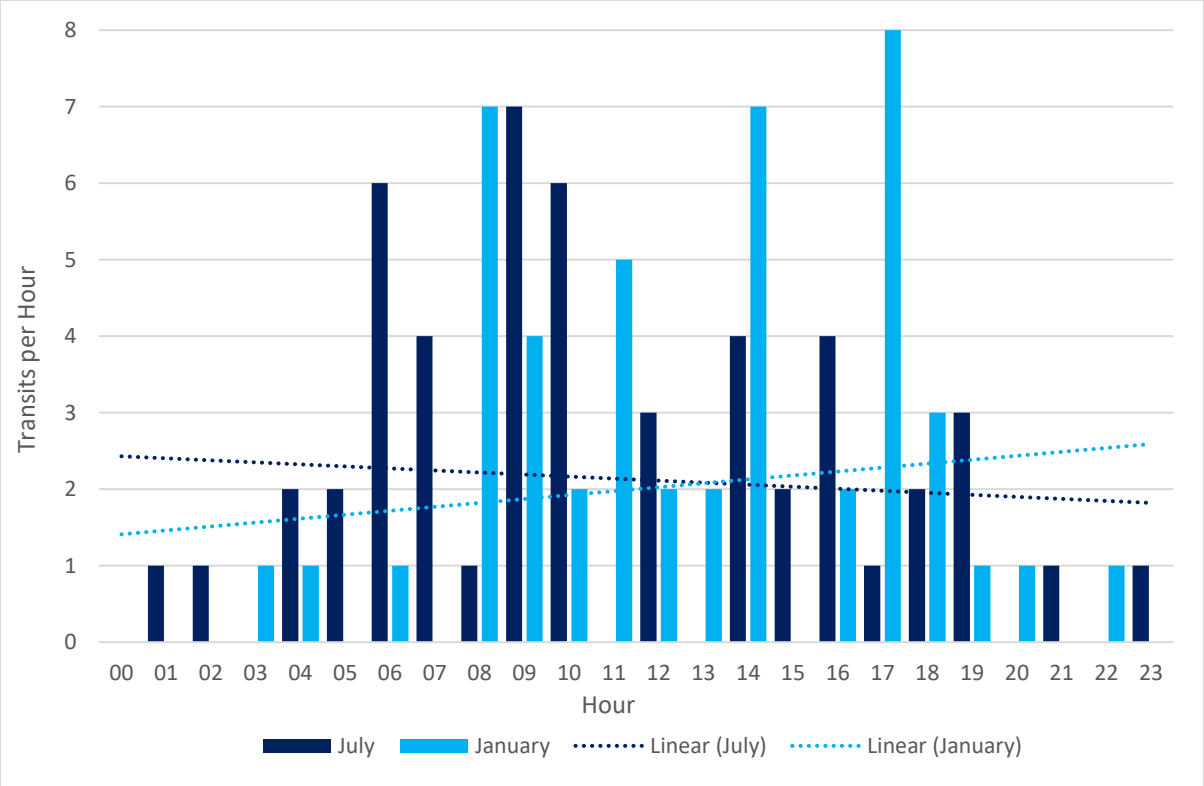

Figure 5-10: Transits by time of day -July 2017, January 2018.

Figure 5-11 and **Figure 5-12** show the type and sizes of vessels passing the device. Passenger vessels are the most numerous vessel type within both summer and winter. Workboats, engaged in maintenance at EMEC are next most numerous in summer followed by fishing boats, with fishing noticeably higher in winter than summer, when fishers seek more sheltered waters.

The most frequent size of vessel to transit within 0.5nm is between 40 and 60m LOA as shown in **Figure 5-12**. This category includes, ferries, workboats and fishing vessels as identified within **Figure 5-11.**

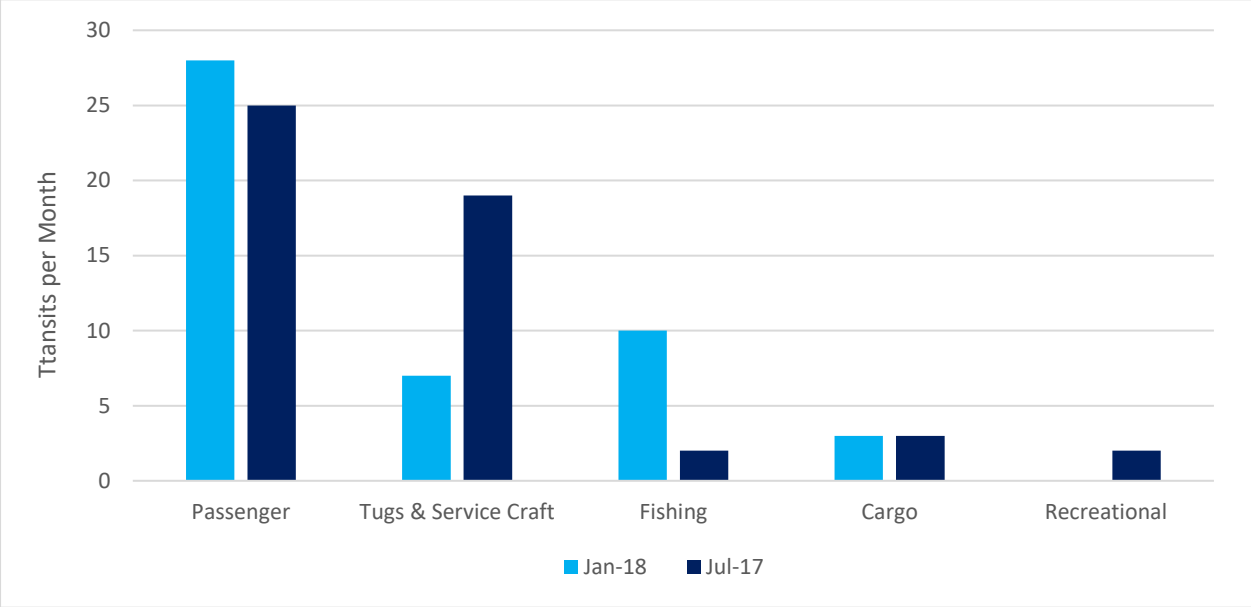

Figure 5-11: Transits by type.

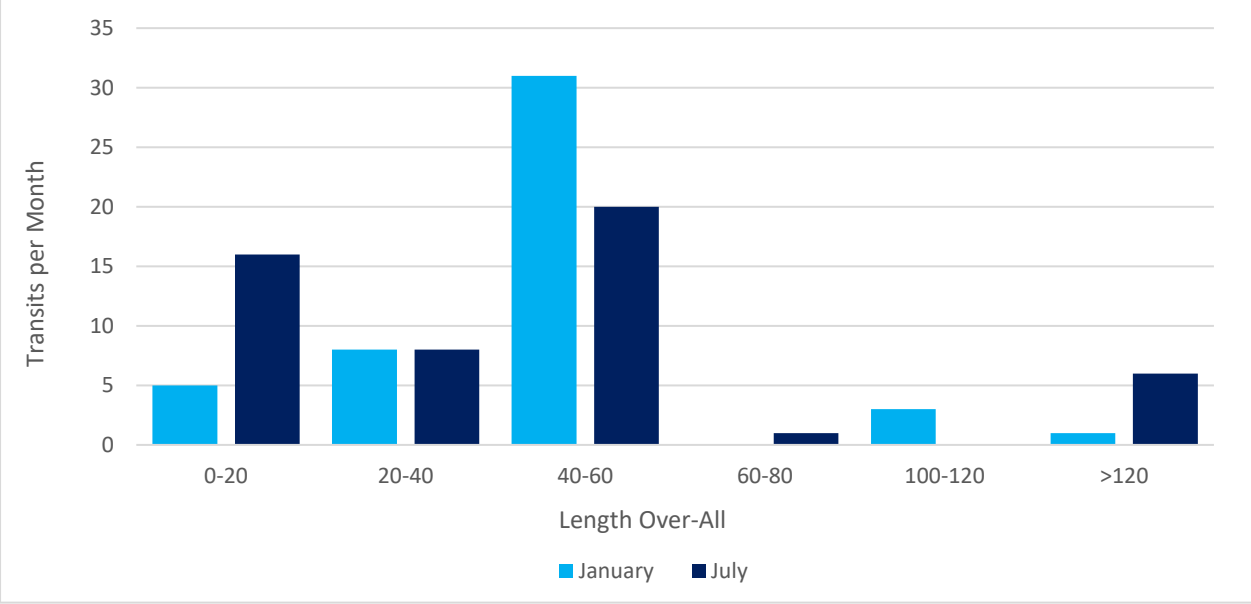

Figure 5-12: Transits by size.

5.4 HISTORICAL INCIDENTS

Analysis of MAIB incidents between 1997 and 2015 was conducted.

Within 3nm of the Fall of Warness, 8 incidents were recorded:

1 Accident to person on a fishing vessel;

3 groundings (involving 2 fishing vessels and a renewable maintenance vessel);

1 Flooding/Foundering of a fishing vessel;

1 Near miss involving a renewable maintenance vessel;

2 mechanical failures/loss of control/propulsion involving a fishing vessel and a renewable maintenance vessel.

The incident data for both sites suggests that the incident rate is low, particularly for collisions and contacts. There was however, a higher frequency of groundings, which given the tidal conditions in the area, was not unexpected.

6 FUTURE TRAFFIC PROFILE

6.1 ORKNEY COMMERCIAL TRAFFIC

The following information was captured from the Orkney Islands Council Harbour Authority Annual report 2016-2017:2

Pilotage movements to all facilities have increased from 453 in 2014-15, to 526 in 2015-2016, to 606 in 2016-2017. An increase over 3 years of 34%.

Serco Northlink Ferries Traffic on Kirkwall-Aberdeen-Lerwick route has stayed relatively steady between 2014 and 2017, increasing from 49,270 passengers to 49,825 passengers;

Demand for Orkney Ferries Ltd routes has increased from 96,610 passengers to 103,485 passengers between 2014 and 2017 for the outer islands, and from 223,867 to 225,799 during the same period for the inner islands.

Cruise ships calls increased significantly from 79 in 2014/2015 to 126 in 2016/2017. 141 are booked for 2018 and 127 are already booked for 2019. This increase is significant, but only a minority use the Fall of Warness route.

There are no known plans to increase the number of services in the area.

6.2 FISHING AND RECREATIONAL TRAFFIC

A review of the Scottish Sea Fisheries Statistics was undertaken from 2008 to 2016.[3]

The number of voyages by Scottish vessels has fluctuated from 3,613 in 2008 down to 2,570 in 2012 and then back up to 3,667 in 2016. Although the catch quantity increased year on year from 2,952 tonnes in 2008 through to 4,993 tonnes in 2016, the number of registered fishing vessels has declined from 142 in 2012 to 131 in 2016, mostly 10 metres and under used for creel fishing. 2.8% of employment in Eilean Siar, Orkney & Shetland is in fishing, which is down from 3.38% in 2012.

No figures were available for recreational activity in the Orkneys, there is a general decline in participation in yachting nationally. However, an assumption has been made that there would be no significant change in existing activity.

[2] https://www.orkneyharbours.com/port-authority/info/brochures

[3] http://www.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/PubFisheries

6.3 RENEWABLE ENERGY RELATED TRAFFIC

The EMEC devices are maintained by vessels from Kirkwall. The construction, maintenance and decommissioning of the Orbital O2 device, will increase small workboat activity in the area (as shown in **Section 2.3** and **2.5**). During the lifecycle of the Orbital O2 device other EMEC devices will be operating or being decommissioned in the Fall of Warness and this will result in some in combination effects and increased vessel activity. For example, the Magallanes Ocean 2G arrived at the EMEC Fall of Warness site in mid-September 2018 and will be in operation the time of Orbital O2 installation.

6.4 SUMMARY

It is not considered that the changes in the traffic profile discussed above will materially alter the risk profile around Berth 5 within the lifecycle of the device.

7 IMPACTS TO NAVIGATION

Based on consultation with stakeholders and a review of the traffic profile around the device, the following impacts were identified.

7.1 IMPACT ON VESSEL TRAFFIC ROUTEING

7.1.1 Deep Draught Vessels

Analysis of AIS identified that deep draught vessels occasionally transit through the Fall of Warness, to the east of the Muckle Green Holm. With the Orbital O2 device in place, a navigable corridor of 0.6nm exists between the shallows of Muckle Green Holm and the device. Comparatively, the ATIR platform, (under the Ocean_2G project) to the southwest, would reduce the navigable corridor to 0.45nm and subsequently, the Orbital O2 device will have limited impact on the navigability of the corridor.

The PIANC Harbour Design Guidelines (2014) give criteria for acceptable widths of channels. Given the considerable depth of water and the prevailing conditions being longitudinal rather than across the traffic flow, a 0.45nm fairway is considered to be sufficient and the probability of two vessels colliding is determined to be very low.

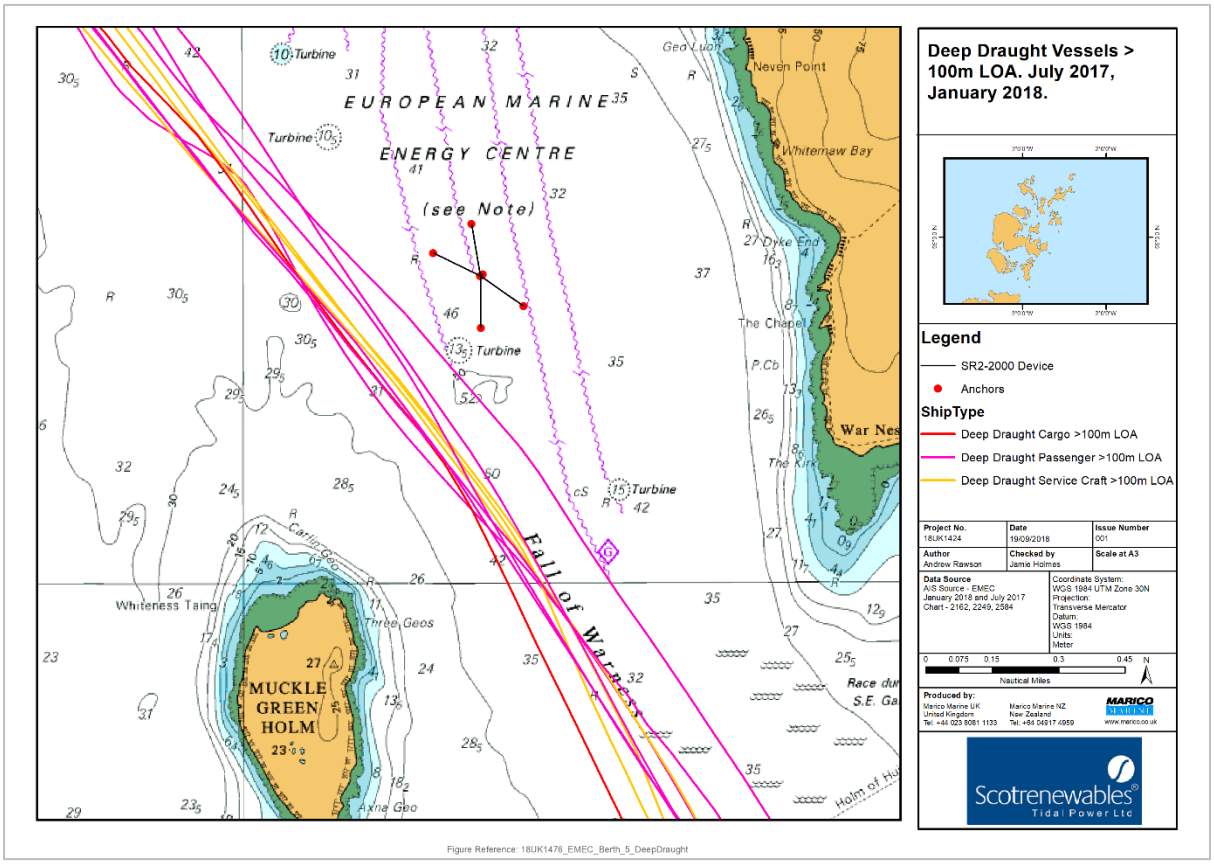

Figure 7-1: Transits of Deep Draught Vessels > 100m LOA.

7.1.2 Impact on Navigation during Significant Tidal Flows

Figure 7-2 and **Figure 7-3** show examples of the transits of regular runners when the tidal flows are at their peak in a north-westerly and south-easterly directions. It can be seen that, vessels take advantage of the lee behind the Muckle Green Holm when the tides are north-westerly. When the flow is from the south-east, vessels keep a wide berth from the Fall of Warness.

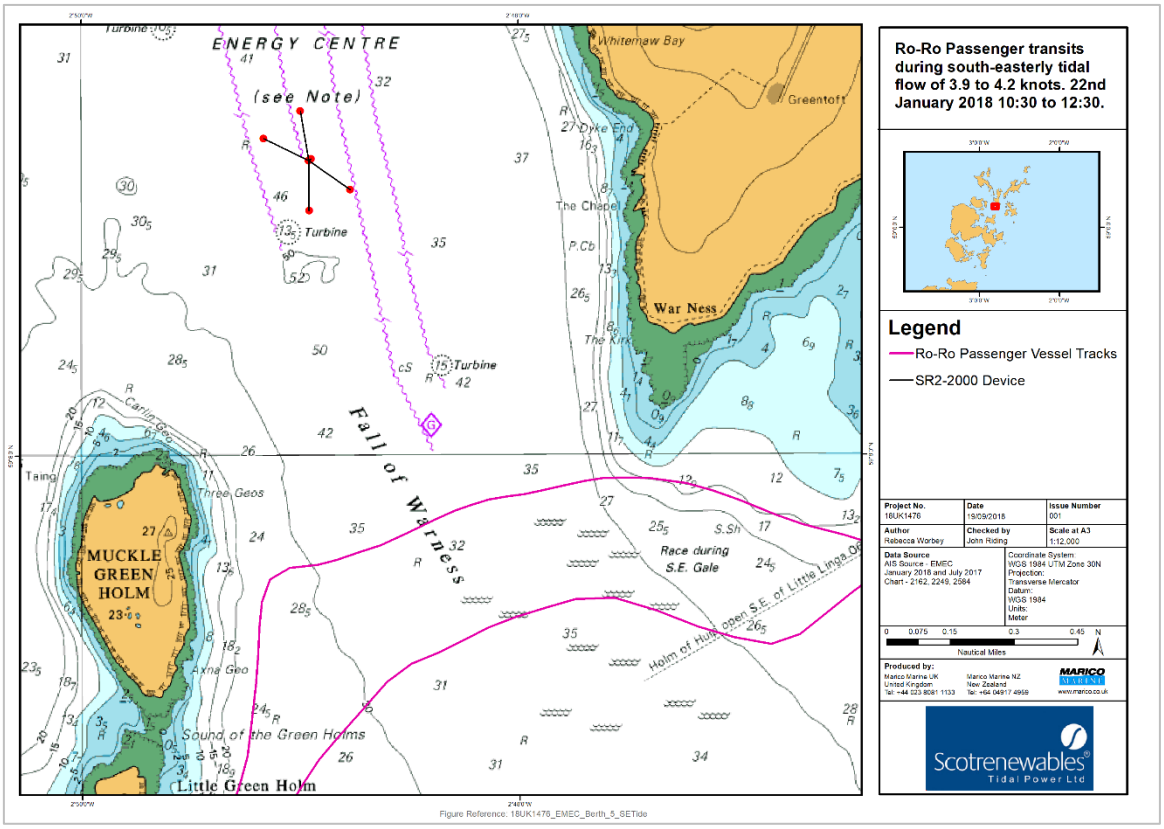

Figure 7-2: Ro-Ro Passenger Vessel transits during south-easterly tide.

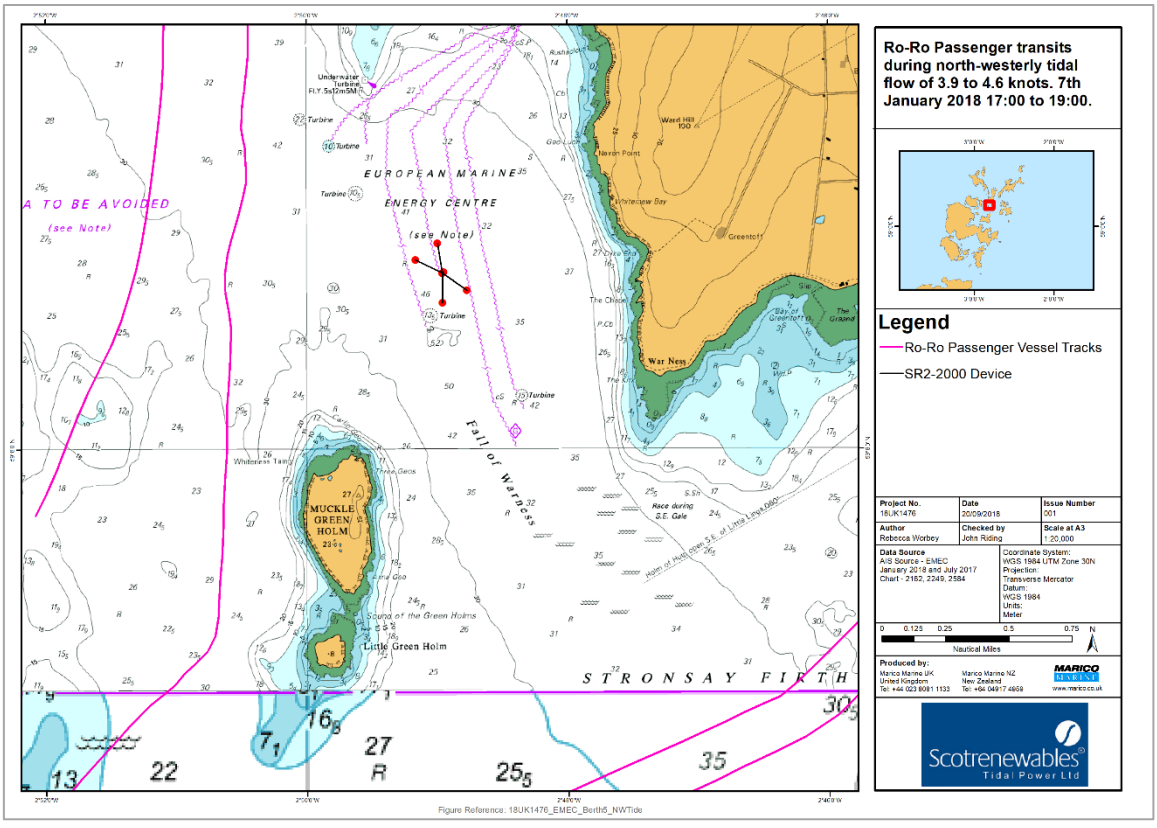

Figure 7-3: Vessel transits during sample north-westerly flows.

7.1.3 Navigating during Strong South-Easterly Winds

During consultation it was revealed the during bad weather it was common for ferries to come into the Fall of Warness site. During a strong south-easterly wind, significant overfalls, wave heights and a race can be expected to the south of Eday. Ferries would therefore pass to the east of Muckle Green Holm, come into the EMEC site passing to the north of the Orbital O2, before turning to come in close to the headland to the south-west of Eday. This allows the vessels some degree of shelter and means that they are not exposed beam on to the conditions. **Figure 7-4** shows an example of this activity.

Whilst this activity brings the vessels closer to the test berth, it was not considered a significant risk by Orkney Ferries during consultation as they are used to passing clear of the existing devices and have not previously encountered any issues.

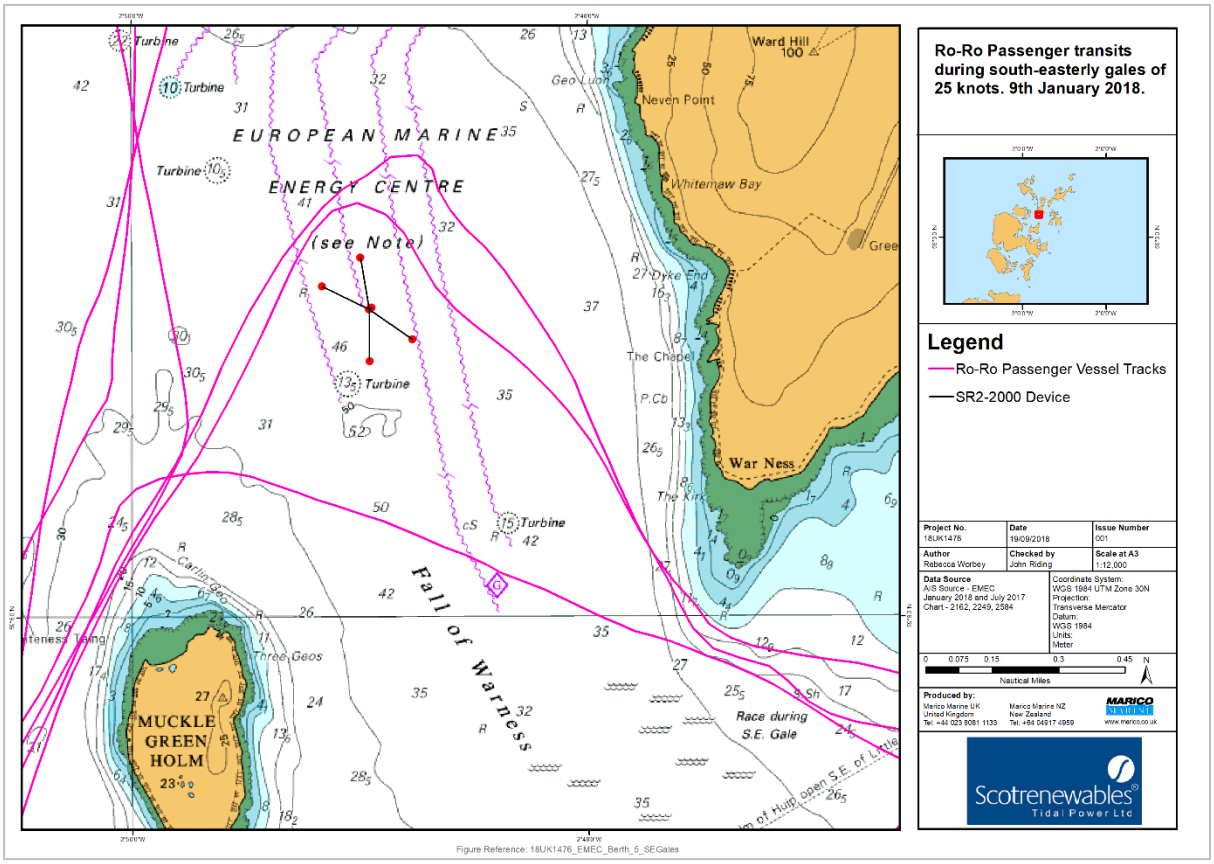

Figure 7-4: Passenger Vessels during SE gales of 25 knots - 09/01/2018

7.1.4 Recreational Craft Routeing

Recreational craft may pass through the Fall of Warness on passage in the Orkneys. The presence of the device would not restrict access to the area and a significant inshore route would remain open to

pass to the east. It is not anticipated that the device would alter recreational craft routeing in any way or offset them into commercial shipping routes.

7.2 IMPACT ON CONTACT RISK

A commercial vessel may collide with the device for many reasons, principally human error or mechanical failure. The presence of the device will not increase the relative likelihood that these two causes occur, however the relative risk is increased if vessel traffic must necessarily transit closer, providing less room to correct an error should it occur. The low frequency of movements past the device through the Fall of Warnes results in a low likelihood of a vessel contacting with the device.

There are no historical contact incidents reported with the existing devices in the Fall of Warness., however, the device should be well marked and fitted with AIS and suitable radar reflecting materials to increase its visibility and lessen contact risk.

7.3 IMPACT ON COLLISION RISK

Although near to vessel traffic routes, the number of transits through the route is low. There is more than 0.5nm of navigable sea room to the east and west of the Fall of Warness devices. Therefore, the probability of two vessels meeting in this passage and not being able to manoeuvre as a result of the presence of the device is low.

There are no reported instances of collisions as a result of the presence of the devices.

7.4 IMPACT ON UNDER KEEL CLEARANCE

Figure 7-5 shows a schematic of the device and the dimensions are given in **Table 7**. The diameter of the blades is 20 metres and the depth of the rotor tips when extended is 3.2m and retracted, 2.3m below the surface. The EMEC Section 36 consent envelope specifies a minimum clearance of 2.5 m from the rotor tips to the water surface. When the legs are up (for transport or in order to access nacelles for maintenance), the device falls 0.2m short of this requirement. However, it was noted that on these occasions (see **Section 2.5**) there would be a maintenance vessel present increasing visibility of the device, and able to provide warnings to other traffic. Such operations would be widely promulgated by Notices to Mariners, radio broadcasts and other available communication channels. Additionally, when the legs are raised, visibility of the device will increase as the majority of the legs will be resting at the water surface.

For a navigating vessel to collide with the blades while the blades are lowered, the vessel must be drawing at least 3.2 metres (**Figure 7-5**). A collision would, therefore, only be possible within 23m of the device. Small vessels would be unlikely to draw enough and larger vessels would have to be navigating well within the voluntary navigation exclusion zone of 500m (300m for ferries) to be capable of contacting the blades.

Table 7: Device Characteristics

Device Characteristic	Dimension (m)
Hull length Over-All	74
Beam of Hull Tube	3.8
Depth to uppermost rotor tip when rotors extended	3.2
Depth to bottom rotor tip (deepest point)	23.2
Depth of rotors below surface when rotors retracted	2.3
Depth of platform below waterline	2.3
Height of hull tube exposed above the water surface	1.5

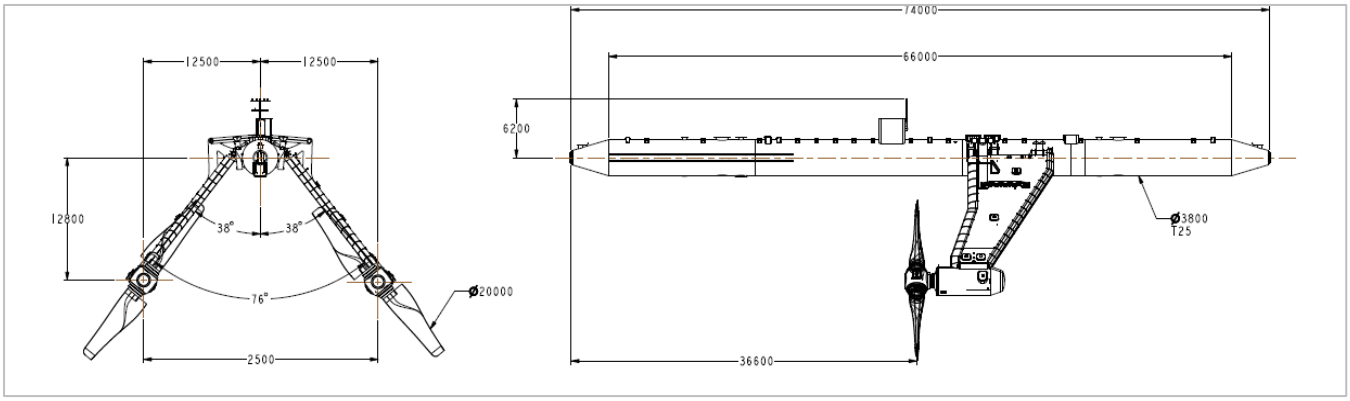

Figure 7-5: Schematic of Device – legs down (metres)

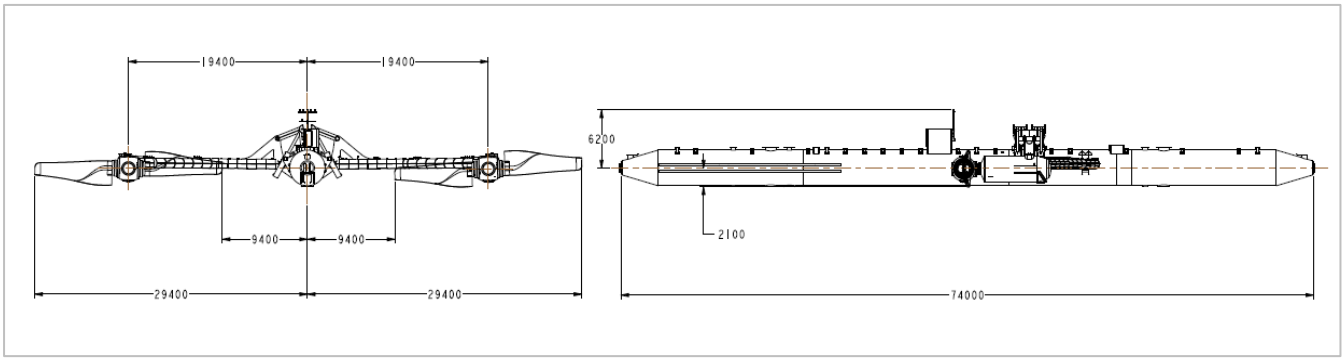

Figure 6: Schematic of Device – legs up (metres)

7.5 IMPACT ON CABLE RISK

An umbilical cable will be required between the device and the existing cable infrastructure of less than 600 metres. Given the proximity to the device and other existing cables, this should have a negligible impact upon navigation.

The export cables for this device are pre-installed and, therefore, the risks will not change from the baseline environment.

7.6 IMPACT ON SEARCH AND RESCUE

The device will not alter the capability of search and rescue operations in the area or interfere with RNLI or helicopter operations.

An ERCOP plan for the site should be prepared and submitted to the MCA.

7.7 IMPACT ON VISUAL NAVIGATION AND COLLISION AVOIDANCE

Given that the device is less than 2m high above the waterline, most vessels will be visible over the top when navigating in the area. The exception may be small pleasure craft and maintenance vessels working on the device. Prudent mariners will provide sufficient clearance from the device when navigating and this will further reduce the chance of a hidden vessel emerging in a collision scenario.

The location is not on the leading line of any navigational aids nor will significantly alter the visibility of other lights or buoyage. It should be marked in accordance with the requirements of the Northern Lighthouse Board and could serve as an additional aid to navigation for navigating vessels. As the rotors are subsurface, there will be minimal noise generated.

When the Orbital O2 is not on site, the moorings and cables will be marked as follows; two 1m diameter pickup buoys at the mooring ends, in addition to an A4 polyform buoy with a trailing pick up

foam buoy at the cable end. Such occasions are expected to be brief and will be promulgated by Notices to Mariners in advance.

7.8 IMPACT ON COMMUNICATIONS, RADAR AND POSITIONING SYSTEMS

The hull length is 74m LOA and has an exposed hull tube height of 1.5m. Given that the generating infrastructure exists below the surface, there is no anticipated impact upon communications, radar and positioning systems.

During construction and decommissioning works, it will be likely that there will be works vessels on station in close proximity to the devices. This could cause shadowing of the device from other navigating vessels. However it is likely that the works vessels would be in close proximity and, therefore, this would not pose a hazard to navigation.

7.9 CUMULATIVE AND IN-COMBINATION EFFECTS

Several other devices are located in close proximity to the Berth 5 site. Of these, most are well clear with the exception of the Ocean 2G site which is located approximately 500 metres to the South-West. As discussed in **Section 7.1.1**, for those deep draught vessels whose passage is through the Fall of Warness, it is likely that they would pass to the west of the Ocean 2G and Orbital O2 rather than in between the two devices due to the limited sea room. To the west of the ATIR platform, there would be approximately 0.5nm of navigable waters, and it can be seen from **Section 7.1.1** that the vessels have a specific track which takes them equidistant between Muckle Green Holm and the devices. The maximum offset in order to achieve this offset is one to two hundred metres to the west. Given the depth of water and low traffic density, this is not considered a significant impact (see **Section 7.1**).

8 NAVIGATION RISK ASSESSMENT

8.1 INTRODUCTION AND METHODOLOGY

This NRA was commissioned to assess the impact on navigation potentially caused by the project. The NRA is limited to identifying and quantifying any additional or increased navigational risk resulting from the project. It subsequently identifies possible mitigation measures where appropriate and makes recommendations.

The process starts with the identification of all potential hazards. It then assesses the likelihood (frequency) of a hazard causing an incident and considers the possible consequences of that incident. It does so in respect of two scenarios, namely the "most likely" and the "worst credible". The quantified values of frequency and consequence are then combined using the Marico HAZMAN ll software to produce a risk score for each hazard. These are collated into a "Ranked Hazard List" from which the need for possible additional mitigation may be reviewed.

The hazards were scored using the collective experience of the project team and consultees, with traffic analysis, incident analysis and other available information to support the assessment. For a description of the risk assessment methodology see **Annex B**.

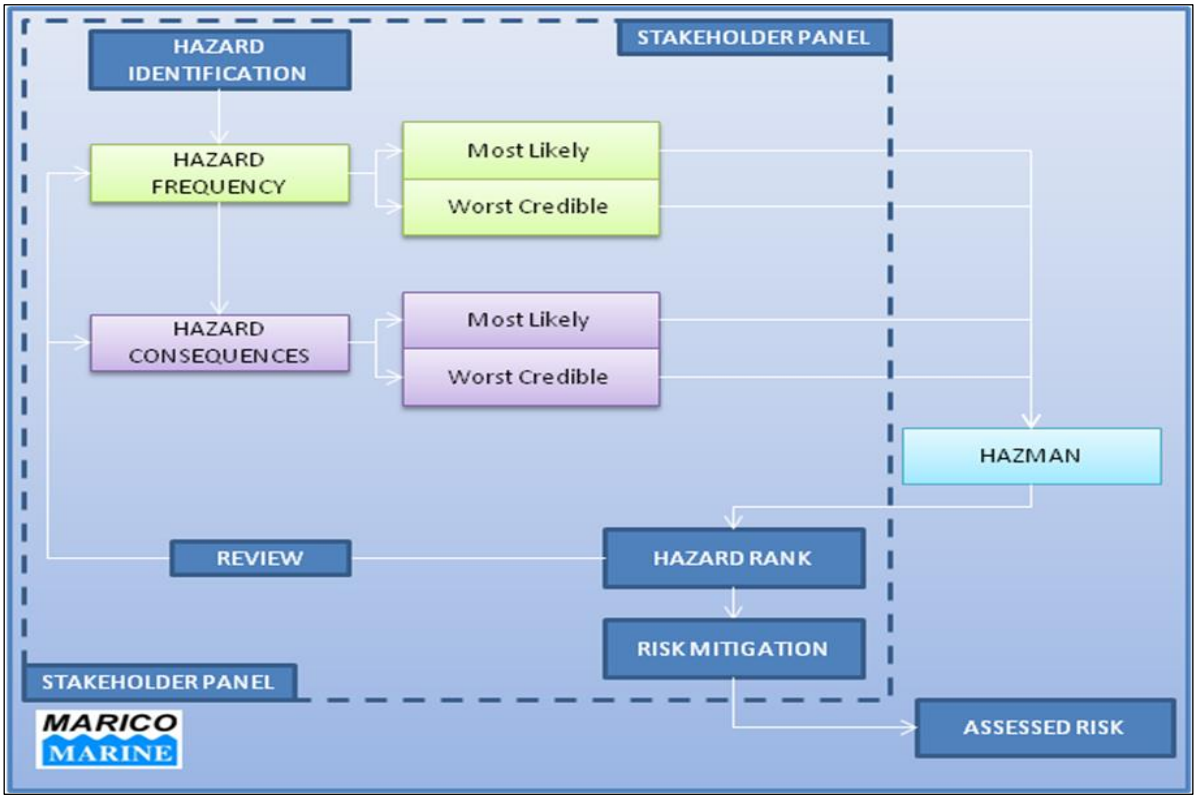

Figure 8-1: Marico Marine Risk Assessment Methodology

Hazard IdentificationThe following hazard types were identified.

Collision – two navigating vessels come into contact;

Contact/Allision – a navigating vessel comes into contact with a fixed or stationary object (including the Orbital O2 device);

Grounding – a navigating vessel makes contact with the seabed;

Obstruction – A vessel or its equipment becomes entangled with subsurface infrastructure, including moorings or cables;

Breakout – Device breaks its moorings and becomes a hazard to shipping or runs aground;

Vessel categories were defined as follows:

Commercial Shipping – cargo and tankers that carry cargo (including ro-ro, container, bulk or liquid).

Passenger Vessels – Passenger ferries and cruise ships;

Fishing Vessels – vessels of all sizes engaged in commercial fishing or trawling;

Recreational Vessels – yachts and pleasure craft;

Tugs and Service Craft – workboats, tugs, pilot vessels and maintenance vessels. Small craft whose primary purpose is commercial.

8.2 RISK CONTROL OPTIONS

8.2.1 Embedded Risk Controls

A number of risk controls are embedded in the design of the project and have been included in the risk assessment.

Table 8: Embedded Risk Controls

ID	Name	Description
1.	Inspection and Maintenance Programme	Regular maintenance regime by developer to check the device, its fittings and any signs of wear and tear. This should identify any failings which might result in a mooring failure and therefore prevent breakout.
2.	Remote shut down including feathering of blades	Device to be fitted with ability to shut down in an emergency and feather the blades.
3.	PPE	Maintenance teams to wear suitable PPE when working on the device, including life jackets.
4.	Training of staff	Staff to be trained to required standards for their work and have suitable local knowledge of regulations and operations in the Orkneys.
5.	GPS Alerting for turbine moving	Remote monitoring of device to detect any major movements that might indicate a breakout for immediate response.
6.	ERCOP	Emergency Response and Cooperation Plan for site to be developed and issued to the MCA for comment.

ID	Name	Description
7.	Layout Plan	Layout plan of the site, drawings, markings and coordinates to be issued to the MCA and Trinity House for comment.
8.	Marking and Lighting	Device to be lit by 2x yellow lights with synchronised flashing evert three seconds with a nominal range of 3 nautical miles mounted a minimum of 3m above the waterline.
9.	Notice to Mariners	Notice to Mariners to be issued prior to any works or deployment to Orkney Marine Services team. Distribution should also include Marina noticeboards, Fisheries Association, UKHO, Orkney Ferries and linked to on the EMEC website.
10.	Tow risk assessment and passage plan	As required under Orkney Harbours Pilotage Directions 4(3), prior to the conduct of the tow, a risk assessment and passage plan for the move to be conducted. Plan should account for the size of the tow, arrangements and met-ocean conditions.
11.	Agreed weather window for tow	Met-ocean limits to be defined prior to the tow to ensure an adequate weather window and tidal conditions are suitable.
12.	Incident monitoring and reporting	EMEC to encourage incident/near miss reporting and monitor any safety issues at the project sites. If necessary, risk control to be reviewed. Risk assessments to be reviewed following any incidents.
13.	Site Access Application for Maintenance Vessels	All maintenance vessels should be approved before accessing the EMEC sites. EMEC to be aware of any maintenance operations before they are conducted.
14	Hydrography	Pre-installation and post-decommissioning surveys of project site.
15	Radar Reflectors	Orbital O2 is to be fitted with radar reflectors at a minimum of 3m above the water line improving visibility during bad weather.

8.2.2 Possible Additional Risk Controls

Further additional risk controls identified during the assessment are as below.

Table 9: Possible Additional Risk Controls

ID	Name	Description
1	AIS	It was requested during consultation with the Northern Lighthouse Board that the device be fitted with AIS to improve visibility to passing vessels.
2	Heightened monitoring in adverse met-ocean conditions	During gale force winds, periodic monitoring of the device is recommended to ensure excessive forces are not acting on the moorings which might cause a breakout.
3	Pre-planning with Orkneys Harbour prior to deployment and tow	Prior to the project tow, Orkney Marine Services Harbourmaster to be informed of the programme and towage plan. If considered necessary, safety information will be broadcast to other vessels on Channel 16.

8.3 RISK ASSESSMENT

The risk assessment was divided into the following categories:

- Device on Site (operation, maintenance, construction, decommissioning)
- Device under Tow (to and from site for installation, maintenance and decommissioning)

The device on site risk assessment was scored assuming the worst credible footprint and as such the increased footprint resulting from support vessels and raised legs during maintenance, construction and decommissioning was considered.

The summary risk assessment is given in **Table 10**. All hazards were scored as Low Risk with embedded mitigation in place, as most regular runners and fishermen are already aware of the hazards in the area. However, additional risk controls (**Table 9**) are recommended. The highest scoring hazard is 'Maintenance Vessel Contacts Device', due to the proximity of the maintenance vessels (including vessels associated with installation and decommissioning).to the device, in comparison to the general in-transit vessel traffic.

Table 10: Summary Risk Assessment -Device on Site

ID	Hazard Title	Hazard Detail	Risk Score
1	Commercial Ship Contacts Device	A commercial vessel such as a cargo vessel or tanker contacts with the device	2.93
2	Passenger Vessel Contacts Device	A Passenger Vessel contacts with the device	3.10

ID	Hazard Title	Hazard Detail	Risk Score
3	Fishing Vessel Contacts Device	A fishing vessel contacts with the device	2.98
4	Recreational Vessel Contacts Device	A recreational vessel contacts with the device	3.06
5	Maintenance Vessel Contacts Device	Maintenance Vessel contacts with the device	3.96
6	Fishing Gear Interaction with Device	A fishing vessel's gear interacts with the device or its moorings.	1.95
7	Third Party Collision Due to Avoidance of Device	Two navigating vessels collide due to the presence of the device	2.54
8	Third Party Grounding Due to Avoidance of Device	A navigating vessel (all types) grounds due to the presence of the device	2.54
9	Collision Maintenance Vessel	A navigating vessel collides with a Tug or Maintenance Vessel or construction/decommissioning vessel.	2.71
10	Grounding Maintenance Vessel	A Maintenance Vessel grounds whilst on passage to/from the device	2.86
11	Breakout of Device from Moorings	The device's moorings fail, device becomes a hazard to navigation	2.54

8.3.1 The Tow

The risk assessment for the tow of the device to Berth 5 is given in **Table 11.** All hazards were assessed to Low Risk with embedded mitigation in place. However, additional risk controls are recommended to be implemented. The most significant hazard is a contact between the device and the towing vessels, as a result of human error or mechanical failure. Vessels usually give a wide berth to a towing vessel, so the probability of a collision is low, but the proximity of the tug and the tow makes this incident more likely. Other hazards during the passage are not considered likely, provided the tow is thoroughly planned and undertaken during suitable met-ocean conditions.

Table 11: Tow Summary Risk Assessment.

ID	Hazard Title	Hazard Detail	Risk Score
1	Grounding of Device	Tug and/or device run aground	2.61
2	Contact between Device and Tugs	Towing vessel and the device come into contact during the tow operation.	2.71
3	Loss of Device while under tow	The tow fails resulting in device breakout	1.62
4	Collision during Tow	Tug and/or device collides with another navigating vessel	2.61
5	Contact during Tow	Tug and/or device come into contact with an obstacle. E.g. other EMEC devices.	2.61

ID	Hazard Title	Hazard Detail	Risk Score
6	Third Party Collision	Third Party Collision due to avoidance of device during tow	2.57
7	Third Party Grounding	Third Party Grounding due to avoidance of device during tow	2.49

8.4 SUMMARY

In summary, all hazards assessed in this NRA have been scored as Low Risk.

Full hazard logs are contained in **Annex D** and **Annex E**.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 CONCLUSIONS

- The Incident rate is low with only 8 incidents recorded between 1997 and 2015. Of these, one near-miss involving a renewables support vessel was navigationally significant.
- Few vessels transit past the Fall of Warness site, with 48 transits recorded within 0.5nm of the device within winter and 51 in summer.
- Passenger vessels are the most common vessel type within the study area accounting for 54% of vessel traffic.
- The contact and collision risk is low with 0.5nm of navigable room to the west of the Fall of Warness site.
- All hazards were scored as low risk.
- The highest scoring hazards were associated with project vessels (maintenance and towing), due to the proximity of the vessels to the device. The risk however, was scored as low, due to the experience and awareness of the project vessel team.
- Consultation confirmed that the majority of local marine users are used to navigating around the existing berths /devices within the area and as such, were not concerned with the presence of the new device.
- A review of the impacts of the devices shows little impact on collision and contact risk, search and rescue or communications, radar and position systems.
- Three additional risk control measures have been identified, implementation of which is recommended.
- The risk assessment considered the increase in risk when the legs are raised in order to access nacelles for maintenance and while in transport. The risk was scored as low due to, the infrequent occurrence of such scenario, the increased visibility of the device and the presence of a maintenance vessel with the ability to provide warnings to other traffic. Such operations would be widely promulgated by Notices to Mariners, radio broadcasts and other available communication channels.

9.2 RECOMMENDATIONS

- During consultation, the Northern Lighthouse Board recommended that the device be fitted with AIS to improve visibility to passing vessels.
- Heightened monitoring during adverse weather conditions is recommended to ensure excessive forces are not acting on the moorings which might cause a breakout.
- Prior to the project tow, Orkney Marine Services Harbourmaster to be informed of the programme and towage plan. If considered necessary, safety information should be broadcast to other vessels.

9.3 SUMMARY

In summary, the increase in risk to navigating vessels as a result of the installation, operation (including maintenance) and decommissioning of the Orbital O2 device is Low.

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Annex A MGN 543 Checklist

MGN 543 (M+F) Safety of Navigation: Offshore Renewable Energy Installations –

Guidance on UK Navigational Practice, Safety and Emergency Response

Issue: OREI Response	Yes/No	Comments
Annex 1 : Considerations on Site Position, Structures and Safety Zones		
1. Site and Installation Co-ordinates: Developers are responsible for ensuring that formally agreed co-ordinates and subsequent variations of site perimeters and individual OREI structures are made available, on request, to interested parties at relevant project stages, including application for consent, development, array variation, operation and decommissioning. This should be supplied as authoritative Geographical Information System (GIS) data, preferably in Environmental Systems Research Institute (ESRI) format. Metadata should facilitate the identification of the data creator, its date and purpose, and the geodetic datum used. For mariners' use, appropriate data should also be provided with latitude and longitude coordinates in WGS84 (ETRS89) datum.		
Traffic Survey – includes:		
All vessel types	✓	**Section 5**
At least 28 days duration, within either 12 or 24 months prior to submission of the Environmental Statement	✓	**Section 5 –** AIS Only
Multiple data sources	✓	**Section 5 –** AIS Only
Seasonal variations	✓	**Section 5 –** January and July
MCA consultation	✓	**Section 4 and Annex C**
General Lighthouse Authority consultation	✓	**Section 4 and Annex C** - NLB
Chamber of Shipping consultation	**X**	
Recreational and fishing vessel organisations consultation.	✓	**Section 4 and Annex C –** Orkney Marinas and Orkney Fisheries Association
Port and navigation authorities consultation, as appropriate	✓	**Section 4 and Annex C -** Orkney Islands Council Marine Services
Assessment of the cumulative and individual effects of (as appropriate):		
i. Proposed OREI site relative to areas used by any type of marine craft.	✓	**Section 5 and Section 7.1**
ii. Numbers, types and sizes of vessels presently using such areas	✓	**Section 5**

iii. Non-transit uses of the areas, e.g. fishing, day cruising of leisure craft, racing, aggregate dredging, etc.	✓	**Section 5**
iv. Whether these areas contain transit routes used by coastal or deep-draught vessels on passage.	✓	**Section 5**
v. Alignment and proximity of the site relative to adjacent shipping lanes	✓	**Section 5 and Section 7.1**
vi. Whether the nearby area contains prescribed routeing schemes or precautionary areas	✓	**Section 3.2**
vii. Whether the site lies on or near a prescribed or conventionally accepted separation zone between two opposing routes	✓	**Section 3.2**
viii. Proximity of the site to areas used for anchorage, safe haven, port approaches and pilot boarding or landing areas.	✓	**Section 3.2**
ix. Whether the site lies within the jurisdiction of a port and/or navigation authority.	✓	**Section 3.2**
x. Proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds.	✓	**Section 5**
xi. Proximity of the site to offshore firing/bombing ranges and areas used for any marine military purposes.	✓	**Section 3.4**
xii. Proximity of the site to existing or proposed offshore oil / gas platform, marine aggregate dredging, marine archaeological sites or wrecks, Marine Protected Area or other exploration/exploitation sites.	✓	**Section 3.4**
xiii. Proximity of the site to existing or proposed OREI developments, in co-operation with other relevant developers, within each round of lease awards.	✓	**Section 3.4**
xiv. Proximity of the site relative to any designated areas for the disposal of dredging spoil or other dumping ground	✓	**Section 3.4**
xv. Proximity of the site to aids to navigation and/or Vessel Traffic Services (VTS) in or adjacent to the area and any impact thereon.	✓	**Section 3.2**
xvi. Researched opinion using computer simulation techniques with respect to the displacement of traffic and, in particular, the	✓	**Section 7.3**

creation of 'choke points' in areas of high traffic density and nearby or consented OREI sites not yet constructed.		
xvii. With reference to xvi. above, the number and type of incidents to vessels which have taken place in or near to the proposed site of the OREI to assess the likelihood of such events in the future and the potential impact of such a situation.	✓	**Section 5.4**
3. OREI Structures – the following should be determined:		
a. Whether any feature of the OREI, including auxiliary platforms outside the main generator site, mooring and anchoring systems, inter-device and export cabling could pose any type of difficulty or danger to vessels underway, performing normal operations, including fishing, anchoring and emergency response.	✓	**Section 7**
b. Clearances of wind turbine blades above the sea surface are *not less than 22 metres* above MHWS.		**N/A**
c. Underwater devices i. changes to charted depth ii. maximum height above seabed iii. Under Keel Clearance	✓	**Section 7.4**
d. The burial depth of cabling and changes to charted depths associated with any protection measures.	✓	**Section 7.5**
4. Assessment of Access to and Navigation Within, or Close to, an OREI to determine the extent to which navigation would be feasible within the OREI site itself by assessing whether:		
a. Navigation within or close to the site would be safe:		
i. by all vessels, or ii. by specified vessel types, operations and/or sizes. iii. in all directions or areas, or iv. in specified directions or areas. **v.** in specified tidal, weather or other conditions	✓	**Section 7**
b. Navigation in and/or near the site should be:		
i. prohibited by specified vessels types, operations and/or sizes. ii. prohibited in respect of specific activities, iii. prohibited in all areas or directions, or iv. prohibited in specified areas or directions, or v. prohibited in specified tidal or weather conditions, or simply	✓ ✓ ✓ ✓	**Section 7** and **Section 8.2**

vi. recommended to be avoided.	✓	
c. Exclusion from the site could cause navigational, safety or routeing problems for vessels operating in the area e.g. by preventing vessels from responding to calls for assistance from persons in distress.	✓	**Section 8.2**
Relevant information concerning a decision to seek a safety zone for a particular site during any point in its construction, extension, operation or decommissioning should be specified in the Environmental Statement accompanying the development application	✓	**Section 8.2 –** No Safety Zone
Annex 2 : Navigation, collision avoidance and communications		
The Effect of Tides and Tidal Streams : It should be determined whether:		
a. Current maritime traffic flows and operations in the general area are affected by the depth of water in which the proposed installation is situated at various states of the tide i.e. whether the installation could pose problems at high water which do not exist at low water conditions, and vice versa.	✓	**Section 3.1** and **Section 7.1**
b. The set and rate of the tidal stream, at any state of the tide, has a significant effect on vessels in the area of the OREI site.	✓	**Section 3.1** and **Section 7.1**
c. The maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect.	✓	**Section 3.1** and **Section 7.1**
d. The set is across the major axis of the layout at any time, and, if so, at what rate.		**Section 3.1** and **Section 7.1**
e. In general, whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream.	✓	**Section 3.1**
f. The structures themselves could cause changes in the set and rate of the tidal stream.	✓	**Section 2.1** and **Section 3.1**
g. The structures in the tidal stream could be such as to produce siltation, deposition of sediment or scouring, affecting navigable water depths in the OREI or adjacent to the area	✓	**Section 7.4**
2. Weather: It should be determined whether:		

a. The site, in normal, bad weather, or restricted visibility conditions, could present difficulties or dangers to craft, including sailing vessels, which might pass in close proximity to it.	✓	**Section 2.1** and **Section 3.1**
b. The structures could create problems in the area for vessels under sail, such as wind masking, turbulence or sheer.	✓	**Section 2.1** and **Section 3.1**
c. In general, taking into account the prevailing winds for the area, whether engine failure or other circumstances could cause vessels to drift into danger, particularly if in conjunction with a tidal set such as referred to above.	✓	**Section 2.1, Section 3.1** and **Section 8**
3. Collision Avoidance and Visual Navigation: It should be determined whether:		
a. The layout design will allow safe transit through the OREI by SAR helicopters and vessels.	✓	**Section 7.6**
b. The MCA's Navigation Safety Branch and Maritime Operations branch will be consulted on the layout design and agreement will be sought.	✓	**Section 8.2**
c. The layout design has been or will be determined with due regard to safety of navigation and Search and Rescue.	✓	**Section 7.6**
d.i. The structures could block or hinder the view of other vessels under way on any route.	✓	**Section 7.7**
d.ii. The structures could block or hinder the view of the coastline or of any other navigational feature such as aids to navigation, landmarks, promontories, etc.	✓	**Section 7.7**
4. Communications, Radar and Positioning Systems - To provide researched opinion of a generic and, where appropriate, site specific nature concerning whether:		
a. The structures could produce radio interference such as shadowing, reflections or phase changes, and emissions with respect to any frequencies used for marine positioning, navigation and timing (PNT) or communications, including GMDSS and AIS, whether ship borne, ashore or fitted to any of the proposed structures, to: i. Vessels operating at a safe navigational distance	✓ ✓	**Section 7.8**

ii. Vessels by the nature of their work necessarily operating at less than the safe navigational distance to the OREI, e.g. support vessels, survey vessels, SAR assets. iii. Vessels by the nature of their work necessarily operating within the OREI.	✓ ✓	
b. The structures could produce radar reflections, blind spots, shadow areas or other adverse effects: i. Vessel to vessel; ii. Vessel to shore; iii. VTS radar to vessel; iv. Racon to/from vessel.	✓ ✓ ✓ ✓ ✓	**Section 7.8**
c. The structures and generators might produce sonar interference affecting fishing, industrial or military systems used in the area.	✓	**Section 7.8**
d. The site might produce acoustic noise which could mask prescribed sound signals.	✓	**Section 7.7** and **Section 7.8**
e. Generators and the seabed cabling within the site and onshore might produce electro-magnetic fields affecting compasses and other navigation systems.	✓	**Section 7.8**
5. Marine Navigational Marking: It should be determined:		
a. How the overall site would be marked by day and by night throughout construction, operation and decommissioning phases, taking into account that there may be an ongoing requirement for marking on completion of decommissioning, depending on individual circumstances.	✓	**Section 2.2.2** and **Section 8.2**
b. How individual structures on the perimeter of and within the site, both above and below the sea surface, would be marked by day and by night.	✓	**Section 2.2.2** and **Section 8.2**
c. If the specific OREI structure would be inherently radar conspicuous from all seaward directions (and for SAR and maritime surveillance aviation purposes) or would require passive enhancers.	✓	**Section 2.2.2** and **Section 8.2**

d. If the site would be marked by additional electronic means e.g. Racons	✓	**Section 2.2.2** and **Section 8.2**
e. If the site would be marked by an AIS transceiver, and if so, the data it would transmit.	✓	**Section 2.2.2** and **Section 8.2**
f. If the site would be fitted with audible hazard warning in accordance with IALA recommendations	✓	**Section 2.2.2** and **Section 8.2**
g. If the structure(s) would be fitted with aviation lighting, and if so, how these would be screened from mariners or guarded against potential confusion with other navigational marks and lights.	✓	**Section 2.2.2** and **Section 8.2**
h. Whether the proposed site and/or its individual generators complies in general with markings for such structures, as required by the relevant GLA in consideration of IALA guidelines and recommendations.	✓	**Section 2.2.2** and **Section 8.2**
i. The aids to navigation specified by the GLAs are being maintained such that the 'availability criteria', as laid down and applied by the GLAs, is met at all times.	✓	**Section 2.2.2** and **Section 8.2**
j. The procedures that need to be put in place to respond to casualties to the aids to navigation specified by the GLA, within the timescales laid down and specified by the GLA.	✓	**Section 2.2.2** and **Section 8.2**
k. The ID marking will conform to a spreadsheet layout, sequential, aligned with SAR lanes and avoid the letters O and I.	✓	**Section 2.2.2** and **Section 8.2**
l. Working lights will not interfere with AtoN or create confusion for the Mariner navigating in or near the OREI.	✓	**Section 2.2.2, Section 8.2** and **Section 7.7**
6. Hydrography - In order to establish a baseline, confirm the safe navigable depth, monitor seabed mobility and to identify underwater hazards, detailed and accurate hydrographic surveys are included or acknowledged for the following stages and to MCA specifications:		
i. Pre-consent: The site and its immediate environs extending to 500m outside of the development area shall be undertaken as part of the licence and/or consent application. The survey shall include all proposed cable route(s).	✓	**Section 8.2.1**
ii. Post-construction: Cable route(s)	✓	**Section8.2.1**

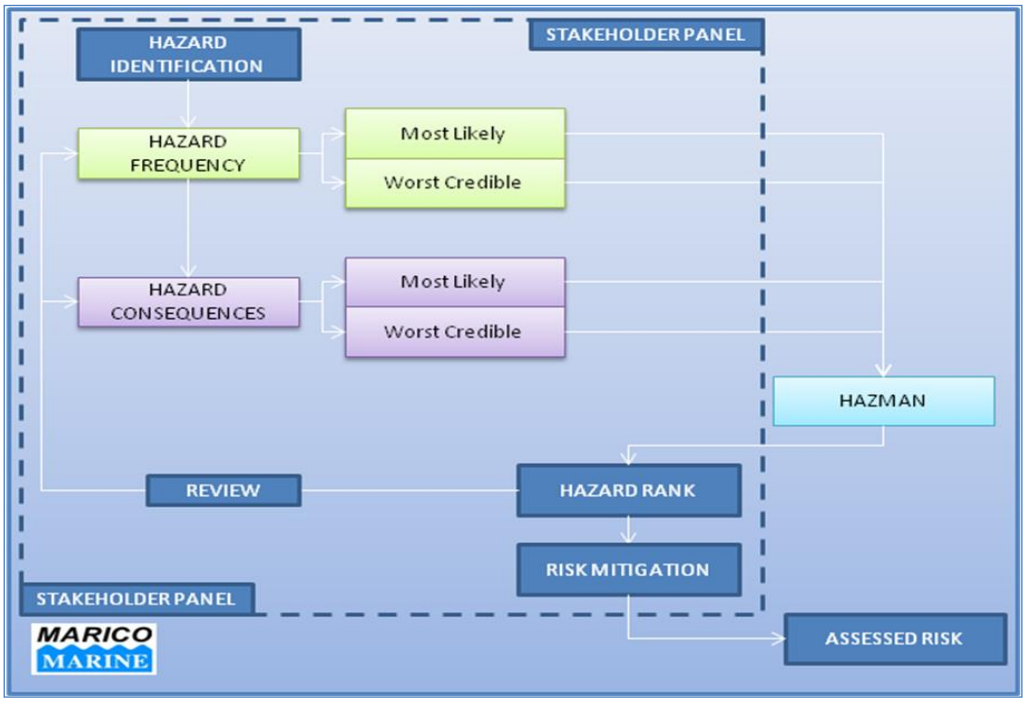
iii. Post-decommissioning of all or part of the development: Cable route(s) and the area extending to 500m from the installed generating assets area.	✓	**Section8.2.1**
Annex 3: MCA template for assessing distances between OREI boundaries and shipping routes		
"Shipping Route" template and Interactive Boundaries – where appropriate, the following should be determined:		
a. The safe distance between a shipping route and turbine boundaries.	✓	**Section 7**
b. The width of a corridor between sites or OREIs to allow safe passage of shipping.	✓	**Section 7**
Annex 4: Safety and mitigation measures recommended for OREI during construction, operation and decommissioning.		
Mitigation and safety measures will be applied to the OREI development appropriate to the level and type of risk determined during the EIA. The specific measures to be employed will be selected in consultation with the Maritime and Coastguard Agency and will be listed in the developer's Environmental Statement (ES). These will be consistent with international standards contained in, for example, the SOLAS Convention - Chapter V, IMO Resolution A.572 (14)3 and Resolution A.671(16)4 and **could include any or all** of the following:	✓	**Section 8.2**
i. Promulgation of information and warnings through notices to mariners and other appropriate maritime safety information (MSI) dissemination methods.	✓	**Section 8.2**
ii. Continuous watch by multi-channel VHF, including Digital Selective Calling (DSC).		
iii. Safety zones of appropriate configuration, extent and application to specified vessels[4]		

iv. Designation of the site as an area to be avoided (ATBA).	✓	**Section 8.2**
v. Provision of AtoN as determined by the GLA	✓	**Section 8.2**
vi. Implementation of routeing measures within or near to the development.	✓	**Section8.2**
vii. Monitoring by radar, AIS, CCTV or other agreed means	✓	**Section 8.2**
viii. Appropriate means for OREI operators to notify, and provide evidence of, the infringement of safety zones.	✓	**Section 8.2**
ix. Creation of an Emergency Response Cooperation Plan with the MCA's Search and Rescue Branch for the construction phase onwards.	✓	**Section 8.2**
x. Use of guard vessels, where appropriate	✓	**Section 8.2**
xi. Any other measures and procedures considered appropriate in consultation with other stakeholders.	✓	**Section 8.2**
Annex 5: Standards, procedures and operational requirements in the event of search and rescue, maritime assistance service counter pollution or salvage incident in or around an OREI, including generator/installation control and shutdown.		
The MCA, through HM Coastguard, is required to provide SAR and emergency response within the sea area occupied by all offshore renewable energy installations in UK waters. To ensure that such operations can be safely and effectively conducted, certain requirements must be met by developers and operators.		
a. An ERCoP will be developed for the construction, operation and decommissioning phases of the OREI.	✓	**Section 8.2**
b. The MCA's guidance document *Offshore Renewable Energy Installation: Requirements, Advice and Guidance for Search and Rescue and Emergency Response* for the design, equipment and operation requirements will be followed.	✓	**Section 8.2**

Annex B NRA Methodology

Methodology

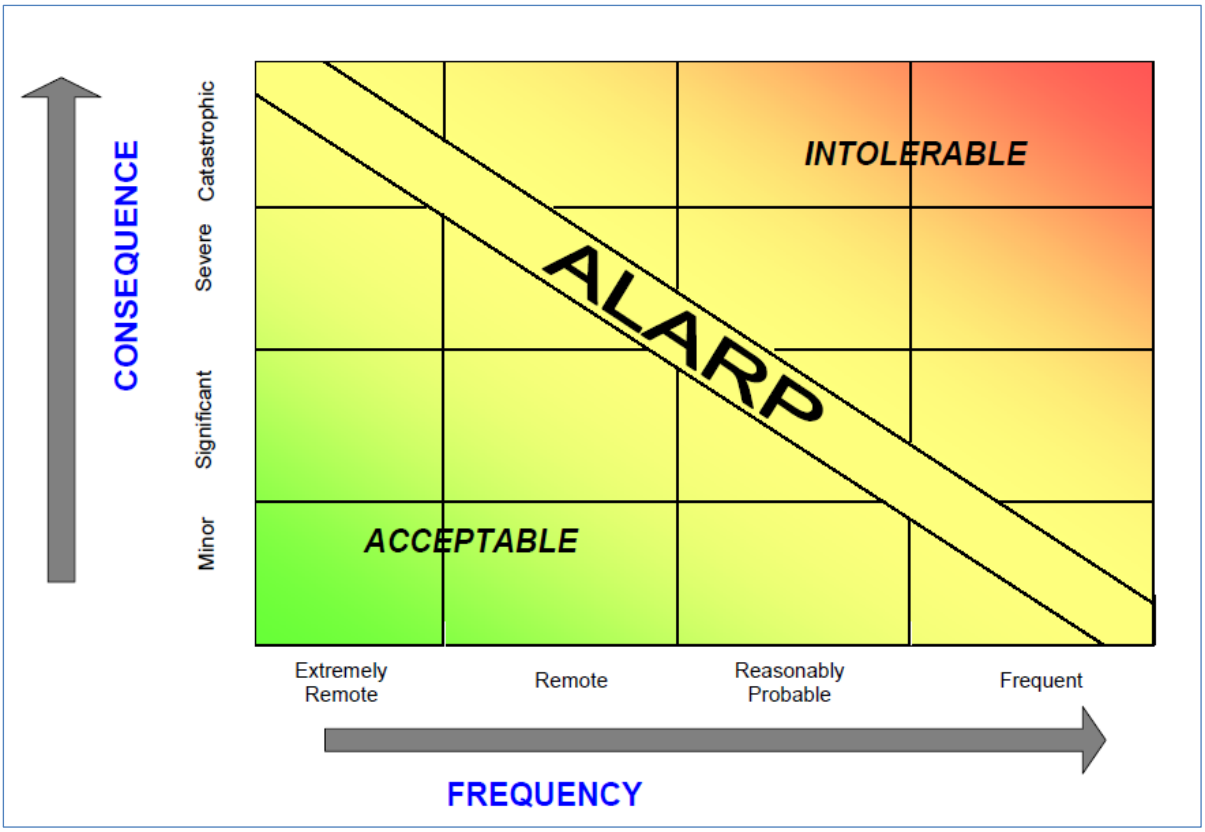
This Navigation Risk Assessment (NRA) was commissioned to assess the impact on navigation potentially caused by each of the three phases of the project. The NRA is limited to identifying and quantifying any additional or increased navigational risk resulting from the project. It subsequently identifies possible mitigation measures where appropriate and makes recommendations. The process starts with the identification of all potential hazards. It then assesses the likelihood (frequency) of a hazard causing an incident and considers the possible consequences of that incident. It does so in respect of two scenarios, namely the "most likely" and the "worst credible". The quantified values of frequency and consequence are then combined using the Marico HAZMAN software to produce a Risk Score for each hazard. These are collated into a "Ranked Hazard List" from which the need for possible additional mitigation may be reviewed.



Marico Marine Risk Assessment Methodology.

Criteria for Navigational Risk Assessment

Risk is the product of a combination of consequence of an event and the frequency with which it might be expected to occur. In order to determine navigational risk a Formal Safety Assessment (FSA) approach to risk management is used. International Maritime Organisation (IMO) Guidelines define a hazard as "something with the potential to cause harm, loss or injury", the realisation of which results in an accident. The potential for a hazard to be realised can be combined with an estimated or known consequence of outcome. This combination is termed "risk". Risk is therefore a measure of the frequency and consequence of a particular hazard.



General risk matrix.

The combination of consequence and frequency of occurrence of a hazard is combined using a risk matrix which enables hazards to be ranked and a risk score assigned. The resulting scale can be divided into three general categories:

Acceptable;

As Low as Reasonable Practicable (ALARP); and

Intolerable.

At the low end of the scale, frequency is extremely remote and consequence minor, and as such the risk can be said to be “acceptable”, whilst at the high end of the matrix, where hazards are defined as frequent and the consequence catastrophic, then risk is termed “intolerable”. Every effort should be made to mitigate all risks such that they lie in the “acceptable” range. Where this is not possible, they should be reduced to the level where further reduction is not practicable. This region, at the centre of the matrix is described as the ALARP region. It is possible that some risks will lie in the “intolerable” region, but can be mitigated by measures, which reduce their risk score and move them into the ALARP region, where they can be tolerated, albeit efforts should continue to be made when opportunity presents itself to further reduce their risk score.

The FSA methodology used in this NRA, determines where to prioritise risk control options for the navigational aspects of a project site. The outcome of this risk assessment process should then act as the basis for a Navigation Safety Management System, which can be used to manage navigational risk.

Hazard Identification

Hazard identification is the first and fundamental step in the risk assessment process. It was undertaken for this project by three Marico Marine specialists using the results of the analysis and feedback from local stakeholders. In order to ensure that the process was both structured and comprehensive, potential hazards were reviewed under the following headings;

Project phase;

Incident category;

Geographical area; and

Vessel type.

The three project phases have been assessed individually due to their different navigational risk exposure and magnitude, i.e. the different nature of the operations, the vessels involved, and the potential cost of any consequences. The five incident categories identified as being relevant to this study are:

Collision – two navigating vessels come into contact;

Contact/Allision – a navigating vessel comes into contact with a fixed or stationary object (including the Ocean_2G device);

Grounding – a navigating vessel makes contact with the seabed;

Obstruction – A vessel or its equipment becomes entangled with subsurface infrastructure, including moorings or cables;

Breakout – Device breaks its moorings and becomes a hazard to shipping or runs aground;

Personal Injury – Maintenance activities result in a person injured or overboard.

The vessel types considered were:

Commercial Shipping – cargo and tankers that carry cargo (including ro-ro, container, bulk or liquid).

Passenger Vessels – Passenger ferries and cruise ships;

Fishing Vessels – vessels of all sizes engaged in commercial fishing or trawling;

Recreational Vessels – yachts and pleasure craft;

Tugs and Service Craft – workboats, tugs, pilot vessels and maintenance vessels. Small craft whose primary purpose is commercial.

Risk Matrix Criteria

As indicated earlier, frequency of occurrence and likely consequence were both assessed for the "most likely" and "worst credible" scenario. Frequencies were assessed according to the levels set out below.

Frequency criteria.

Scale	Description	Definition	Operational Interpretation
F5	Frequent	An event occurring in the range once a week to once an operating year.	One or more times in 1 year
F4	Likely	An event occurring in the range once a year to once every 10 operating years.	One or more times in 10 years 1 - 9 years
F3	Possible	An event occurring in the range once every 10 operating years to once in 100 operating years.	One or more times in 100 years 10 – 99 years
F2	Unlikely	An event occurring in the range less than once in 100 operating years.	One or more times in 1,000 years 100 – 999 years
F1	Remote	Considered to occur less than once in 1,000 operating years (e.g. it may have occurred at a similar site, elsewhere in the world).	Less than once in 1,000 years >1,000 years

Using the assessed notional frequency for the "most likely" and "worst credible" scenarios for each hazard, the probable consequences associated with each were assessed in terms of damage to:

People - Personal injury, fatality etc.;

Property – Project and third party;

Environment - Oil pollution etc.; and

Business - Reputation, financial loss, public relations etc.

The magnitude of each was then assessed using the consequence categories given below. These have been set such that the consequences in respect of property, environment and business have similar monetary outcomes.

Consequence categories and criteria.

Cat.	People	Property	Environment	Business
C1	**Negligible** Possible very minor injury (e.g. bruising)	**Negligible** Costs <£10k	**Negligible** No effect of note. Tier1 may be declared but criteria not necessarily met. Costs <£10k	**Negligible** Costs <£10k
C2	**Minor** (single minor injury)	**Minor** Minor damage Costs £10k – £100k	**Minor** Tier 1 – Tier 2 criteria reached. Small operational (oil) spill with little effect on environmental amenity Costs £10K–£100k	**Minor** Bad local publicity and/or short-term loss of revenue Costs £10k – £100k
C3	**Moderate** Multiple minor or single major injury	**Moderate** Moderate damage Costs £100k - £1M	**Moderate** Tier 2 spill criteria reached but capable of being limited to immediate area within site Costs £100k -£1M	**Moderate** Bad widespread publicity Temporary suspension of operations or prolonged restrictions to project Costs £100k - £1M
C4	**Major** Multiple major injuries or single fatality	**Major** Major damage Costs £1M -£10M	**Major** Tier 3 criteria reached with pollution requiring national support. Chemical spillage or small gas release Costs £1M - £10M	**Major** National publicity, Temporary closure or prolonged restrictions on project operations Costs £1M -£10M
C5	**Catastrophic** Multiple fatalities	**Catastrophic** Catastrophic damage Costs >£10M	**Catastrophic** Tier 3 oil spill criteria reached. International support required. Widespread shoreline contamination. Serious chemical or gas release. Significant threat to environmental amenity. Costs >£10M	**Catastrophic** International media publicity. Project site closes. Operations and revenue seriously disrupted for more than two days. Ensuing loss of revenue. Costs >£10M

Hazard Data Review Process

Frequency and consequence data was assessed for each hazard drawing initially on the knowledge and expertise of the Marico Marine specialists. This was subsequently influenced by the views and experience of the many stakeholders, whose contribution was greatly appreciated, as well as historic incident where available. It should be noted that the hazards were scored on the basis of the "status quo" i.e. with all existing mitigation measures taken into consideration. The outcome of this process was then checked for consistency against the assessments made in previous and similar risk assessments.

Having decided in respect of each hazard which frequency and consequence criteria are appropriate for the four consequence categories in both the "most likely" and "worst credible" scenarios, eight risk scores were obtained using the following matrix.

Risk factor matrix used for hazard assessment.

Consequences	Cat 5	5	6	7	8	10
	Cat 4	4	5	6	7	9
	Cat 3	3	3	4	6	8
	Cat 2	1	2	2	3	6
	Cat 1	0	0	0	0	0
	Frequency	**>1,000 years**	**100-1,000 years**	**10-100 years**	**1 to 10 years**	**Yearly**

Where:

Risk Number	*Risk*
0 to 1.9	*Negligible*
2 to 3.9	*Low Risk*
4 to 6.9	*As Low as Reasonably Practical*
7 to 8.9	*Significant Risk*
9 to 10.0	*High Risk*

It should be noted that occasionally, a "most likely" scenario will generate a higher risk score than the equivalent "worst credible" scenario; this is due to the increased frequency often associated with a "most likely" event. For example, in the case of a large number of small contact events, the total damage might be of greater significance than a single heavy contact at a much lesser frequency.

Hazard Ranking

The risk scores obtained from the above process were then analysed further to obtain four indices for each hazard as follows:

The average risk score of the four categories in the "most likely" set;
The average risk score of the four categories in the "worst credible" set;
The maximum risk score of the four categories in the "most likely" set; and
The maximum risk score of the four categories in the "worst credible" set.
These scores were then combined in Marico Marine's hazard management software "HAZMAN" to produce a single numeric value representing each of the four indices. The hazard list was then sorted in order of the aggregate of the four indices to produce a "Ranked Hazard List" with the highest risk hazards prioritised at the top.

Mitigation

Mitigation measures that could be employed to reduce the likelihood or consequence of the hazards occurring are then identified.

Annex C Consultation Minutes

Minutes –Orbital O2 Berth 5 EMEC – Orkney Marinas

Client:	Orbital Marine	
Project:	18UK1476	
Attendees:	[redacted] (BK)	Orkney Marinas
	[redacted] (AR)	Marico Marine
	[redacted] (WH)	Marico Marine
Venue:	Jewsons, Kirkwall	
Date of Meeting:	11:00 to 12:00 30th August 2018	

Item	Action item / Notes for the record	Action
1	**Introductions**	
2	**Overview**	
2.1	AR gave an overview of the NRA and device.	
2.2	BK gave an overview of Orkney Marinas, with three locations at Stromness, Kirkwall and Westray. Kirkwall marina opened in 2004 and there has been a notable increase in recreational traffic since then.	
2.3	BK would provide visitor numbers and statistics. 770 boats in 2017, 50% from the UK, rest is international (mostly European).	BK
3	**Activity around Fall of Warness / Berth 5**	
3.1	Passage making recreational yachts use this route, but no impacts reported by other users.	
3.2	Recognised importance of inshore traffic route to vessels, this route is often used for yachts on passage to Westray.	
3.3	A future planned expansion to Stromness marina is being planned.	
3.4	Whilst the site has significant tidal conditions, yachts would plan their passages to avoid the worst conditions.	
4	**Impact Assessment**	
4.1	No general concerns as a result of installation of new device in comparison to existing device.	
5	**General Comments**	
5.1	Valued the increased awareness that leaflets and charts gave of what was happening at each EMEC test site so that these could be put on websites and disseminated to recreational users.	
5.2	Noticeboards at each marina which provide notice to mariners and info on EMEC. The sites are all marked on charts and are therefore well known to local and visiting yachtsman.	
5.3	Foreign visitors particularly research the Orkneys using the Orkney Marine Services website and the Clyde Cruising Club.	

5.4	The recent data on recreational activity may be impacted by the works at Westray Pier which has limited recreational access to that marina.	
5.5	BK questioned why exclusion area is a 500m advisory area around each device and not around the test site as a whole.	

Minutes –Orbital O2 Berth 5 EMEC – Orkney Fisheries

Client:	Orbital Marine	
Project:	18UK1461	
Attendees:	[redacted] (FM)	Orkney Fisheries
	[redacted] (AR)	Marico Marine
	[redacted] (WH)	Marico Marine
Venue:	Orkney Fisheries, Kirkwall	
Date of Meeting:	11:00 to 12:30 29th August 2018	

Item	Action item / Notes for the record	Action
1	**Introduction**	
2	**Overview**	
2.1	AR gave an overview of the NRA and FM gave an overview of Orkney Fisheries activities.	
2.2	The importance of the Orkney Fishing Industry was discussed in addition to the impacts of wider trends in international trade. FM explained that the spatial locations and dynamics of fishing in the area is primarily driven by annual fluctuations in the demand for certain catch types.	
2.3	Fishing vessels are based throughout the Orkneys, fishing is conducted year-round, for a variety of catches however, shellfish is a key catch in the Orkneys.	
2.4	Whilst there is some voluntary resting of sites, management of the fisheries is limited to minimum landing sizes.	
3	**EMEC Berth 5**	
3.1	Overview of device to be on station at EMEC Berth 5.	
3.2	Layout of site to avoid 30m contour to avoid inshore Scallop Diving. Scallop diving occurs at 30m contour. Fall of Warness Site, including Berth 5 already avoids the 30m contour.	
3.3	Mostly Creel fishing in the area, some diving.	
4	**General Discussion of Impacts**	
4.1	It was recognized that fishermen could fish in the EMEC test sites, although it was noted that many avoided the sites due to potential interactions with the devices or cables.	
4.2	FM noted that there have been instances of loss of gear to contractor's vessels. However, recognized that most regular contractors were aware of the fishermen and their gear and so avoided them.	
4.3	No prior history of contacts or snagging between vessels and any devices at the Fall of Warness site.	
4.4	FM happy that devices are well marked and charted and state that no issues with device visibility had been reported by fishermen. This would need to be similar for new devices.	
4.6	It was recognised that the sites have existed for many years and subsequently all local fishermen are well aware of the sites, locations and types of devices installed.	

4.7	The Impacts of seismic cable route surveys were highlighted as a potential impact, with little notice being given for seismic surveys that required moving a significant amount of static gear. (General observation, not specific to Berth 5)	
4.8	FM raised that there is a general concern on post-decommissioning debris littering the seabed causing snagging hazard.	
5	**Other Comments**	
5.1	It was noted that, while well distributed, Notice To Mariners are numerous which often makes it hard to understand which are relevant or current and leads to information overload. The merits of a centralised notice system was raised.	
5.2	Electromagnetic Field impact on brown crab was discussed. Very localized (a few metres) from the cable and unlikely to be significant/ change resulting from the installation of the new device.	

Minutes –Orbital O2 Berth 5 EMEC – Orkney Ferries

Client:	Orbital Marine	
Project:	18UK1476	
Attendees:	[redacted] (AB)	Orkney Ferries
	[redacted] (GP)	Orkney Ferries
	[redacted]	Orkney Ferries
	[redacted] (AR)	Marico Marine
	[redacted] (WH)	Marico Marine
Venue:	Orkney Ferries, Kirkwall	
Date of Meeting:	09:30 to 10:30 30th August 2018	

Item	Action item / Notes for the record	Action
1	**Introductions**	
2	**Overview**	
2.1	AR gave an overview of the device and NRA.	
2.2	It was noted that the new device mainly differed from previous devices when in maintenance mode (or under tow) when the raised turbine blades made the vessel much wider than the hull unit. However, this was not considered an issue as another vessel would have to come very close to make contact.	
2.3	Similarly, when in operation, the turbines would protrude beyond the limits of the hull and could provide an underwater contact hazard for deep drafted vessels coming very close to the device. However, this would mean such vessels being well within the device's voluntary exclusion zone. It was considered most likely to be a risk for device maintenance vessels, which would have their own controls to prevent such contact.	
3	**Ferry activity within the Fall of Warness**	
3.1	Ferries would enter the Fall of Warness site during strong south easterly winds and flood tides for safety and passenger comfort. Vessels would therefore, pass close to the O2 device.	
3.2	Route would be used all year round, in all conditions and visibilities.	
3.3	In particularly rough conditions, ferries would pass to the west and north of Eday. On occasions, crossings would be cancelled due to the weather.	
3.4	Exceptional local knowledge of crews, with very little turnover of staff meaning knowledge is retained.	
3.5	Radar returns of devices are generally good except in very poor weather however the bridge teams know where the devices are.	
3.6	Other vessels in the area include offshore supply vessels making passage through the sheltered waters and cruise ships and small passenger vessels. Routes include Iceland and the Faroe Islands. Recently the Dutch Royal Yacht passed through the Fall of Warness.	

3.7	Future changes in traffic – no planned changes to vessel routes, however timetables may alter as part of general reviews. Possibility of increased activity associated with hydrogen industry but this is unlikely. Several new fish farm applications had been made.	
3.8	The advisory exclusion zone was recognized to be useful and does not impact the ferry routes.	
4	**Review of Impacts**	
4.1	No concern over new device provided it is clearly marked and appropriately lit. It was noted that smaller devices are harder to see in rough conditions.	
4.2	It was agreed that the current devices and arrangements do not cause Orkney Ferries any concerns. At present an advisory safety zone of 500m exists around all the devices with the exception of 300m for Orkney Ferries. The devices and the EMEC area are generally well known to local stakeholders, and especially ferry crew.	
5	**Other Comments**	
5.1	EMEC / Orkney Harbours Notices to Mariners are well received and formally disseminated to all ferries.	

Minutes – Orbital O2 Berth 5 EMEC – MCA

Client:	Orbital Marine	
Project:	18UK1476	
Attendees:	[redacted] (HC)	MCA
	[redacted] (AR)	Marico Marine
	[redacted] (WH)	Marico Marine
Venue:	MCA HQ Spring Place Southampton	
Date of Meeting:	14:15 to 14:30 - 19th September 2018	

Item	Action item / Notes for the record	Action
1	**Introduction**	
1.1	WH and AR had previously attended a meeting with HC to consult upon the Site wide NRA's which are currently been updated for all of the Orkney test sites on behalf of EMEC. At the closure of that meeting, WH asked HC if she could briefly comment upon the device-specific NRA required for the new device to be located at Berth 5, Fall of Warness. HC agreed that this would be appropriate and make efficient use of time for all concerned. These notes therefore record the formal consultation with the MCA for this NRA	
2	**Overview**	
2.1	HC had already benefitted from a site wide overview of the Fall of Warness site, and WH clarified that the additional NRA only covered one device at a single berth within that site (Berth 5). WH explained that the new device was similar to, though slightly larger than, a previous floating tidal device, the main difference being the ability to lift the underwater blades above water for maintenance and transits to and from site, in which configuration the device had considerably increased beam.	
3	**MCA NRA requirements**	
3.1	HC had already agreed that device specific NRAs need only to address those aspects of the device which could not have been known when the site-wide NRA was produced / last reviewed. For example: • Mooring arrangements • UKC impacts • Marking and Lighting • Account for any key changes in traffic profile beyond that in the full NRAs • Proximity/presence of other devices within the site • How the devices will be installed/decommissioned HC noted that additional consultation would be required with all stakeholders who may be affected.	

	There was no requirement to gather new data (e.g. vessel traffic) if no evidence this had changed since the site-wide NRA.	
4	**Other Comments**	
4.1	HC suggested that the NRA should consider device operation and maintenance while on site, and device transit to and from site as separate activities HC requested that SAR / ERCOP be specifically considered within the NRA HC re-iterated that in principle, the NRA should be MGN 543 compliant, but could refer to the site-wide NRA to avoid duplication of effort.	

Minutes –Orbital O2 Berth 5 EMEC – Northern Lighthouse Board

Client:	Orbital Marine	
Project:	18UK1476	
Attendees:	[redacted] (PD)	Northern lighthouse Board (NLB)
	[redacted] (RW)	Marico Marine (MM)
Venue:	Email	
Date of Meeting:	13th and 16th September 2018	

Item	Action item / Notes for the record	Action
1	**Request for Feedback**	

	Hi[redacted],
	
	Marico Marine is currently undertaking a Navigation Risk Assessment for the installation of a new tidal device at the Fall of Warness EMEC Berth 5 tidal test site. As part of the NRA we are conducting consultation with key stakeholders.
	
	Please find information pertaining to the device and project below and attached [*location map]*.
	
	Orbital O2 Device Summary
	• The Orbital O2 will replace the SR1-2000 device currently situated at Berth 5.
	• Orbital O2 will remain on site for 17 years as a commercial project.
	• Orbital O2 will be 74m in length and have a 10m blade length.
	• Orbital O2's blades will not tuck underneath for transportation and as such its footprint will be 60m during transport.
	• The footprint of the Orbital O2 will be largely the same as the SR1-2000 when moored (10m increase in length).
	• Anchoring will be in an 'X' shaped configuration (See attached)
	• When the device is off-site, pick-up buoys will be on site marking the end of the cable and the locations of the chains
	  ○ Mooring End: 2x 1 m diameter pick-up buoy
	  ○ Cable End: A4 polyform buoy with a trailing pick up foam buoy
	• The Orbital O2 will be lit by 2 yellow lights synchronised flashing once every three seconds with a nominal range of 3 nautical miles and mounted a minimum of 3m above the waterline.
	• The device will be fitted with a radar reflector at a similar elevation.
	
	If you have any comments on the information provided, I would be grateful if you could provide by return email.
	
	Additionally, if you have any questions, please do not hesitate to get in touch.	

	Many thanks, [redacted]	
2	**Response**	
2.1	Hi [redacted], Good to hear from you. In addition to the lights and radar reflector as below, we would also require the device to be fitted with AtoN AIS. Happy to discuss further. [redacted]	

Minutes –Orbital Marine - EMEC Berth5 – Orbital O2

Client:	EMEC	
Project:	18UK1476	
Attendees:	[redacted] (SC)	RYA
	[redacted] (AR)	Marico Marine
Venue:	RYA House, Ensign Way, Hamble	
Date of Meeting:	14:00 to 15:00 05th September 2018	

Item	Action item / Notes for the record	Action
1	**Introduction**	
2	**Overview**	
2.1	AR gave an overview of the NRA AND the EMEC site. To date the work has focused on vessel traffic analysis and consultation with local stakeholders, including the Orkney Marinas manager.	
2.2	It was agreed that the Fall of Warness sites have not historically caused any incidents and have been well marked and promulgated. The Orkneys generally have a higher level of proficiency among yachtsman as they are isolated from the mainland by the Pentland Firth/North Sea and it was noted that navigation to this area requires a high level of seamanship.	
2.3	AR/SC discussed the RYA Position Papers, contents and history.	
3	**RYA Position Paper Impacts**	
3.1	The assumption on under keel clearance was discussed and a 3m model draft for a large yacht was discussed. Any deeper draught vessel would not be able to access most marinas.	
3.2	SC referred to the MCA's UKC policy paper.	
3.3	The charting of the sites was discussed, with the outlines shown on the EMEC website as a guide for visiting yachtsman. SC recommended that a navigational chart is used as a background.	
3.4	The impacts of the cable on navigation and communication equipment were discussed. This policy point refers principally to large offshore cables which pass through inter-tidal areas and where yachts may be in close proximity to them, impacting on cable accuracy. Given the size of the cables this was not thought to be significant.	
3.5	No significant cumulative or in-combination effects were identified in the study area.	

Annex D Device On-Site Risk Assessment

Risk Assessment – Device on Site

ID	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Embedded Risk Controls	Risk Score
1	Commercial Ship Contacts Device	A commercial vessel such as a cargo vessel or tanker contacts with the device	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Navigational Aid Failure; Adverse Environmental Conditions; Poor Visibility; Avoidance of other vessel;	Moderate damage to device and its moorings; Negligible Damage to Vessel; No Injuries; No Pollution; Minor operational Downtime;	Single fatality or multiple major injuries; Loss of Device; Moderate damage to Vessel; Moderate pollution; Moderate adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting; Radar Reflector;	2.93
2	Passenger Vessel Contacts Device	A Passenger Vessel contacts with the device	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Navigational Aid Failure; Adverse Environmental Conditions; Poor Visibility; Avoidance of other vessel;	Moderate damage to device and its moorings; Negligible Damage to Vessel; No Injuries; No Pollution; Minor operational Downtime;	Single fatality or multiple major injuries; Loss of Device; Major damage to Vessel; Moderate pollution; Major adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting; Radar Reflector;	3.10
3	Fishing Vessel Contacts Device	A fishing vessel contacts with the device	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Navigational Aid Failure; Adverse Environmental Conditions; Poor Visibility; Avoidance of other vessel;	Minor Damage to device and its moorings; Negligible Damage to Vessel; Minor Injuries; No Pollution; Minor operational Downtime;	Single fatality or multiple major injuries; Moderate damage to Device; Loss of Vessel; Minor pollution; Moderate adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting; Radar Reflector;	2.98
4	Recreational Vessel Contacts Device	A recreational vessel contacts with the device	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Navigational Aid Failure; Adverse Environmental Conditions; Poor Visibility; Avoidance of other vessel;	Minor Damage to device and its moorings; Negligible Damage to Vessel; Minor Injuries; No Pollution; Minor operational Downtime;	Single fatality or multiple major injuries; Moderate damage to Device; Loss of Vessel; Minor pollution; Moderate adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting; Radar Reflector;	3.06
5	Maintenance Vessel Contacts Device	Maintenance Vessel contacts with the device	Insufficient Lookout; Human Error; Poor operating Procedures; Equipment or Mechanical Failure; Navigational Aid Failure; Adverse Environmental Conditions; Poor Visibility; Avoidance of other vessel;	Minor Damage to device and its moorings; Negligible Damage to Vessel; Minor Injuries; No Pollution; Minor operational Downtime;	Single fatality or multiple major injuries; Major damage to Device; Moderate damage to Vessel; Minor pollution; Moderate adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting; Radar Reflector;	3.96
6	Fishing Gear Interaction with Device	A fishing vessel's gear interacts with the device or its moorings.	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions;	Minor Damage to moorings; Minor Damage to fishing gear; No Injuries; No Pollution; Minor operational downtime;	Single Major Injury; Loss of gear; No Pollution; Moderate Operational Downtime;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting;	1.95

ID	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Embedded Risk Controls	Risk Score
7	Third Party Collision Due to Avoidance of Device	Two navigating vessels collide due to the presence of the device	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor injuries; Minor damage to vessels; No Pollution; Minor Adverse Publicity;	Single fatality or multiple major injuries; Major damage to Vessels; Moderate pollution; Moderate adverse publicity;	Notice to Mariners; Marking and lighting; Radar reflector	2.54
8	Third Party Grounding Due to Avoidance of Device	A navigating vessel (all types) grounds due to the presence of the device	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor injuries; Minor damage to vessels; No Pollution; Minor Adverse Publicity;	Single fatality or multiple major injuries; Major damage to Vessel; Minor pollution; Major adverse publicity;	Notice to Mariners; Marking and lighting; Radar reflector	2.54
9	Collision Maintenance Vessel	A navigating vessel collides with a Tug or Maintenance Vessel or construction/decommissioning vessel.	Insufficient Lookout; Increased Vessel Activity; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor Injuries; Negligible Damage to Vessel; No Pollution; Minor Adverse publicity;	Single fatality or multiple major injuries; Loss of Vessel; Minor pollution; Moderate adverse publicity;	PPE; Training; ERCOP; Site Access Application;	2.71
10	Grounding Maintenance Vessel	A Maintenance Vessel grounds whilst on passage to/from the device	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor Damage to vessel; Minor Injuries; No Pollution; Minor operational downtime;	Multiple minor or single major injury; Major damage; Minor pollution; Minor adverse publicity;	PPE; Training; ERCOP; Site Access Application;	2.86
11	Breakout of Device from Moorings	The device's moorings fail, device becomes a hazard to navigation	Equipment or Mechanical Failure; Adverse Environmental Conditions; Collision by object; Blade contacts seabed;	Minor damage to device and its moorings; No injuries; No pollution; Minor Adverse Publicity;	No Injuries; Loss of Device; Minor Pollution; Moderate Adverse Publicity;	Inspection and Maintenance; Remote Shutdown; GPS Monitoring; ERCOP; Incident Monitoring and Reporting;	2.54

Annex E Project Tow Risk Assessment

Risk Assessment – Tow To Site

ID	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Embedded Risk Controls	Risk Score
1	Grounding of Device	Tug and/or device run aground	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor damage to tug and device; Minor injuries; No Pollution; Minor operational downtime;	Major damage to device and tug; Multiple minor or single major injury; Minor pollution; Major operational downtime;	Training; ERCOP; Tow Risk Assessment and Passage Plan; Tow Weather Window;	2.61
2	Contact between Device and Tugs	Towing vessel and the device come into contact during the tow operation.	Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions;	Minor damage to tug and device; Minor injuries; No Pollution; Minor operational downtime;	Moderate damage to device and/or tug; Multiple minor or single major injury; Minor pollution; Moderate operational downtime;	Training; ERCOP; Tow Risk Assessment and Passage Plan; PPE; Tow Weather Window;	2.71
3	Loss of Device while under tow	The tow fails resulting in device breakout	Equipment or Mechanical Failure; Adverse Environmental Conditions;	No damage; No Injuries; No pollution; No downtime;	Loss of device; No Injuries; Minor pollution; Major operational downtime;	Inspection and Maintenance; Training; ERCOP; Tow Risk Assessment and Passage Plan; Tow Weather Window;	1.62
4	Collision during Tow	Tug and/or device collides with another navigating vessel	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor damage; Minor injuries; No Pollution; Minor operational downtime;	Major damage; Multiple minor or single major injury; Minor pollution; Major operational downtime;	ERCOP; Notice to Mariners; Training; Tow Risk Assessment and Passage Plan; Site Access Application; Tow Weather Window;	2.61
5	Contact during Tow	Tug and/or device come into contact with an obstacle. E.g. other EMEC devices.	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor damage to tug and tow; Minor injuries; No Pollution; Minor operational downtime;	Major damage; Multiple minor or single major injury;; Minor pollution; Major operational downtime;	ERCOP; Training; Tow Risk Assessment and Passage Plan; Tow Weather Window;	2.61
6	Third Party Collision	Third Party Collision due to avoidance of device during tow	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor damage to third party vessels; Minor injuries; No Pollution; No downtime;	Major damage to third party vessels; Multiple major injuries or single fatality; Minor pollution; Major operational downtime;	ERCOP; Notices to Mariners; Lighting and marking of tow	2.57
7	Third Party Grounding	Third Party Grounding due to avoidance of device during tow	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor damage to third party vessels; Minor injuries; No Pollution; No downtime;	Major damage to third party vessels; Multiple minor or single major injury; Minor pollution; Major operational downtime;	ERCOP; Notices to Mariners; Lighting and marking of tow	2.49