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OCEAN_2G

NRA ADDENDUM FOR OCEAN_2G PROJECT

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MARINE AND RISK CONSULTANTS LTD

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NRA ADDENDUM FOR OCEAN_2G PROJECT

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EXECUTIVE SUMMARY

This NRA has assessed the risk to navigation associated with the Ocean_2G project; the ATIR platform's temporary mooring and assembly in the Shapinsay Sound, the tow to the Fall of Warness and its mooring in that location. The device is 45m LOA with a 6m breadth and has a power rating of 2 MW. There are two subsurface rotating blades with a diameter of 19m. Once deployed it will have a draft of 25m. The device will be fixed to the seabed using chain and gravity anchors.

This assessment has been conducted to the assessment methodology of MGN 543 and MCA guidance on assessing OREIs.

A review of the project sites demonstrates the significant tidal flows in the Fall of Warness site and the interrelationship between the various devices in the EMEC test area. Consultation was conducted with various 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 conducted to understand the traffic profile in the area. The Shapinsay Sound site is well clear of the main shipping routes into Kirkwall and the impact is therefore low. The Fall of Warness site has a lower density of vessel traffic, however some deep draught traffic pass through the area. Vessel traffic in both locations is highly seasonal with cruise ships, recreational and fishing vessels mostly active in the summer months. Incidents were reviewed, and show a relatively low incident rate in the study areas.

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

A risk assessment was conducted to assess the likelihood and consequence of each hazard for each phase of the project. All hazards were scored as Low Risk, though in general the Fall of Warness site had relatively higher hazard risk scores than the Shapinsay Sound site. Risk controls were identified, the majority of which are embedded in the project design, other risk controls were identified and have been recommended.

Recommendations have been identified to implement all embedded risk controls and that the ATIR platform should be fitted with AIS and radar reflectors to improve its visibility.

In summary, the NRA has concluded that the Ocean_2G project is Low Risk with suitable risk controls identified and in place.

CONTENTS

FIGURES

TABLES

ANNEXES

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 Mainteance
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 the European Marine Energy Centre (EMEC) to assess the impact to navigational safety of the Ocean_2G tidal device, ATIR platform, due to be deployed to the Orkney Islands. This study covers three phases of the project:

1. Temporary mooring at Shapinsay Sound for assembly;
2. Tow to the Fall of Warness site;
3. Mooring at Berth 1 in EMEC's Fall of Warness test site.

The study seeks to understand the level of risk to all types of navigating vessels in each of the locations 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 1.4**.

1.1 STUDY AREA

Figure 1 and **Figure 2** show the two key locations of this project and the study areas under assessment.

1.2 PREVIOUS STUDIES

This addendum builds on the following work conducted for the EMEC:

- Fall of Warness Navigational Risk Assessment (Abbot Risk Consulting, 2005);
- Fall of Warness Navigational Risk Assessment Update (Anatec, 2010);
- Shapinsay Sound Navigational Risk Assessment Update (EMEC, 2012);
- Analysis of AIS tracks at the Fall of Warness, Scapa and Shapinsay test sites (Aquatera, 2013).

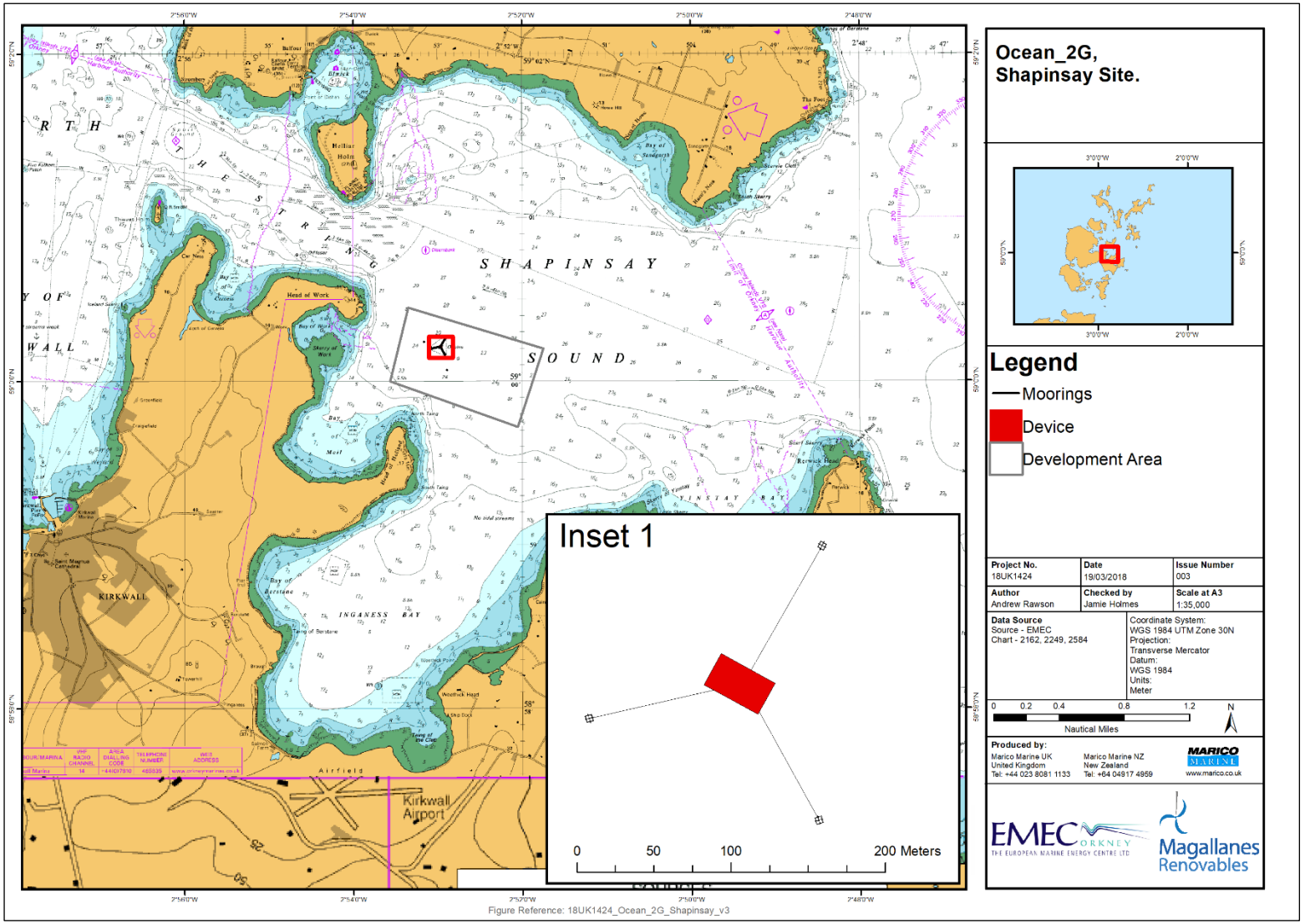


Figure 1: Temporary Mooring Location in Shapinsay Site.

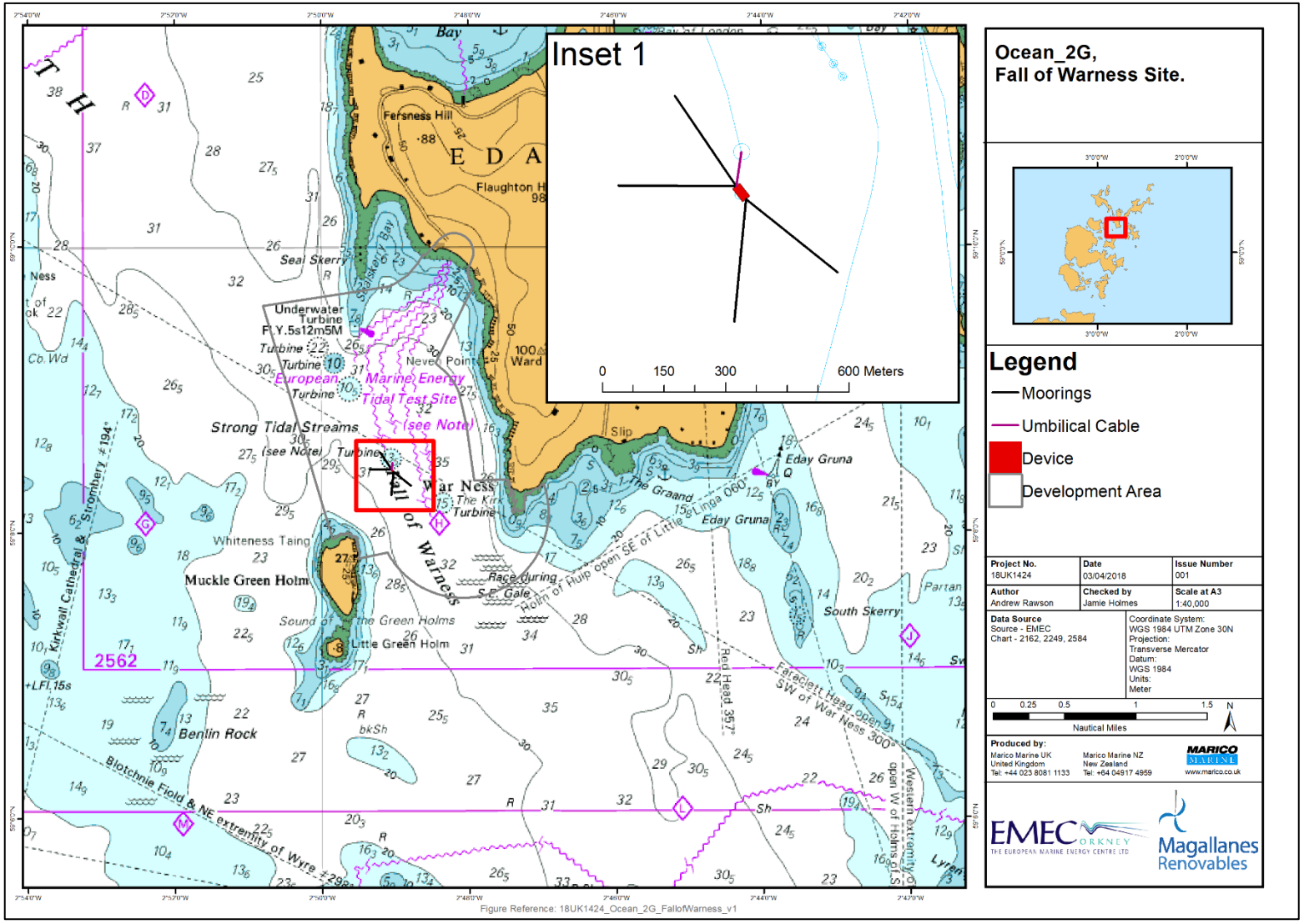


Figure 2: Project site in Fall of Warness.

1.3 SCOPE AND METHODOLOGY

The scope of this project is to:

1) Describe the Ocean_2G device; its layout, marking, construction methodology and decommissioning plan;
2) Provide a description of the existing environment and activities in the study areas; 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) Determine likely future traffic profile during the period when the project would be operational;
4) 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.
5) 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
6) Make recommendations as to the safety of the development and what measures should be implemented to improve it.

1.4 GUIDANCE

Guidance on the assessment requirement was primarily sought from Maritime Coastguard Agency Marine Guidance Note (MGN) 543 (M+F) which replaces MGN 371 and advises the correct methodology to evaluate navigational safety around OREIs through traffic surveys and this report adheres to this standard accordingly. Guidance was also sought from a variety of other publications (see **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.

1.4.1 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 2.1.2 and Section 8.3**
Annex 3		**Report Section**
1	OREI Risk Register and Risk Mitigation Measures for Development	**Section 8, Annex D, Annex E and Annex F**

2 OCEAN 2G PROJECT

2.1 THE DEVICE

The project is for the installation of a floating tidal device of 45m LOA with a 6m breadth, which has a power rating of 2 MW. The device has two subsurface rotating blades each with a diameter of 19m. Once deployed it will have a draught of 25m. The device will be fixed to the seabed using a four point mooring system connected to two mooring points at the bow and stern.

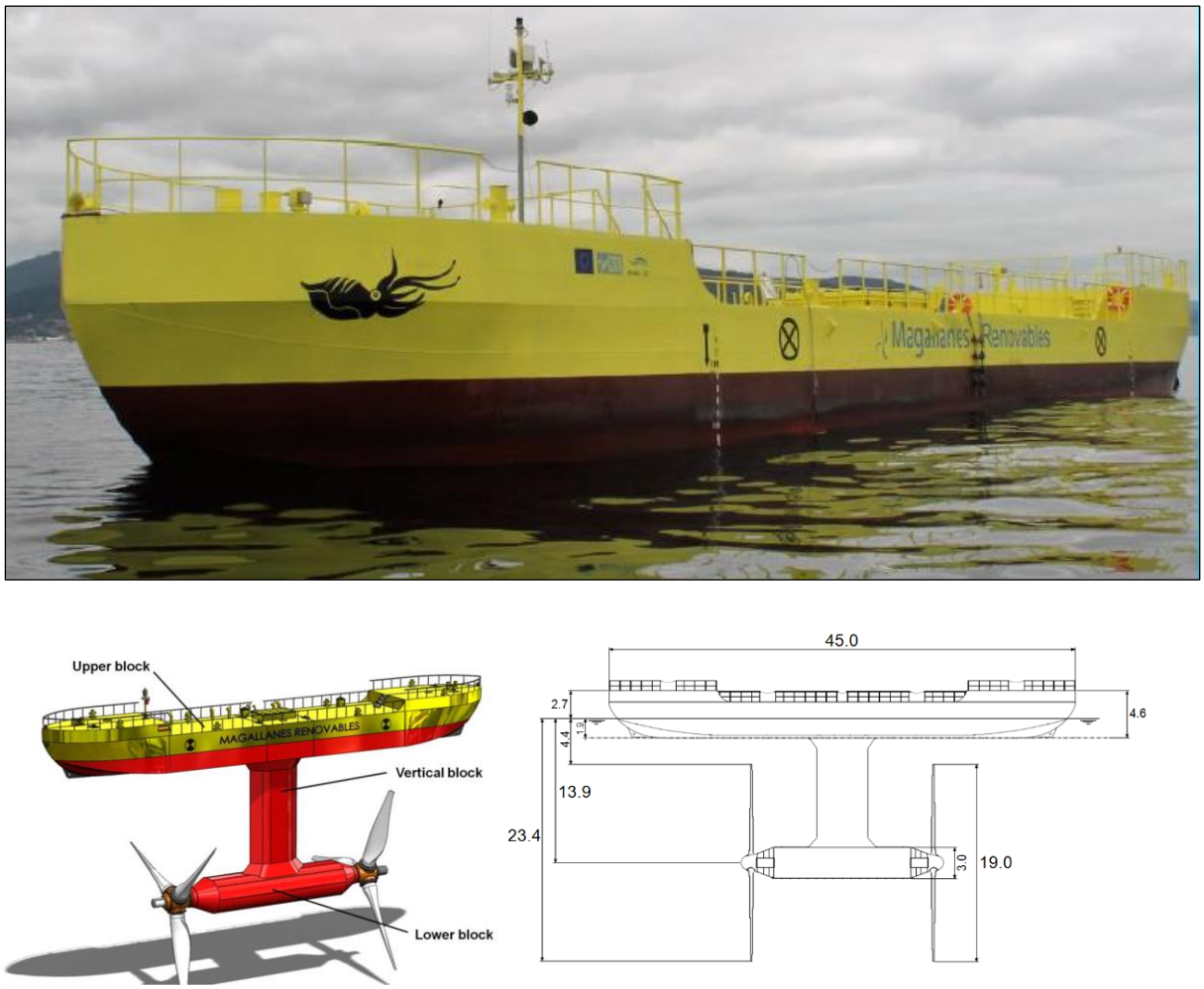


Figure 3: Schematic of Device (metres) – Source: TDK-MAG-MOOR-TR-001.

2.1.1 Moorings

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

To achieve this, it would be necessary to have a safety management system, design specification and installation plan which are independently verified by a competent body. The ATIR platform has been assessed by Tadek for a mooring system against 10-year survival conditions based on but not to the standards of DNV-OS-E301. This assessment (TDK-MAG-MOOR-TR-001) should be reviewed in conjunction with this NRA.

2.1.1.1 Fall of Warness

The Fall of Warness mooring system consists of 4 chain catenary legs, two north and two south, attached to the hull at attachments in the bow and stern. The mooring system holds the platform in line with the current flow. Each mooring leg is identical and consists of a number of parts (see **Figure 4**):

- Hull attachment – a single padeye at the bow and stern, to which the shackle is connected;
- Upper catenary – 50 metres of 76mm chain with MBL >500t;
- Excursion Limiter – 30 metres of 111mm chain or similar arranged in 4 lengths of 30 metres;
- Ground Chain/Lower Catenary – 225m of 76mm chain with MBL >500t; and
- Chain Clump Gravity Anchors – various (75 to 150t with the possibility of in-line clumps of a similar size).

The anchor size has been supported by a statistical assessment of simulated loads using Orcaflex software, namely that the peaks in anchor tensions are momentary spikes of a few seconds in simulated one in 10 year storms.

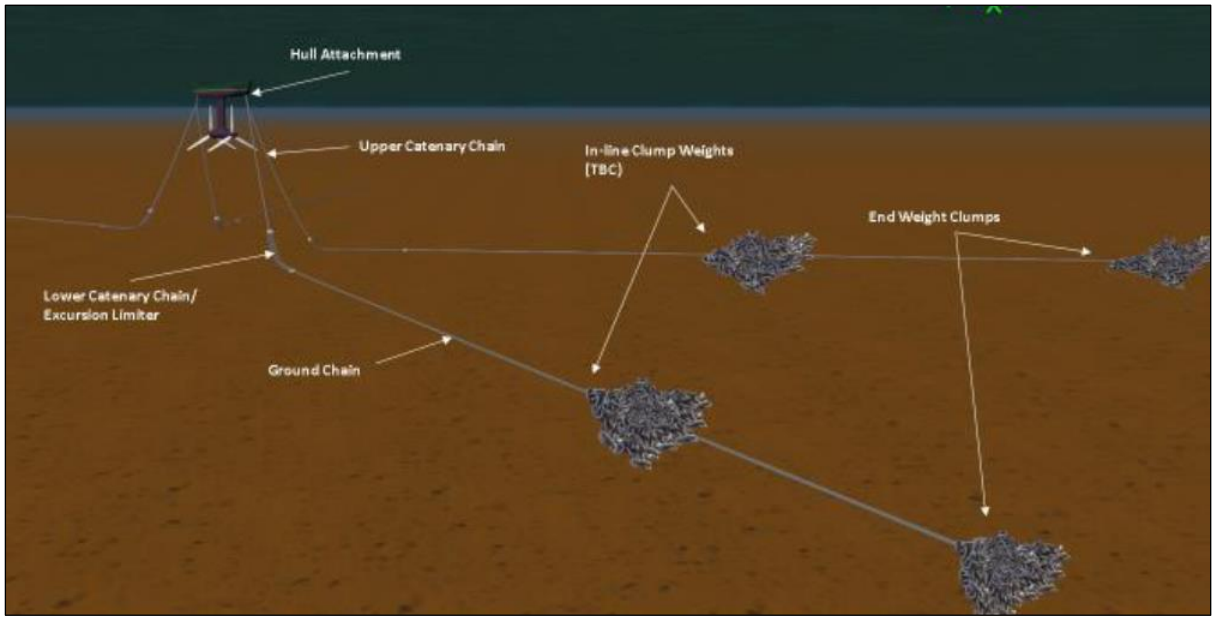


Figure 4: Planned mooring arrangements at Fall of Warness – Source LSK-10159-OP01-TN01.

2.1.1.2 Shapinsay Sound

The Shapinsay Sound site will utilise the existing three 110t gravity base anchors installed at the site (**Figure 5**).

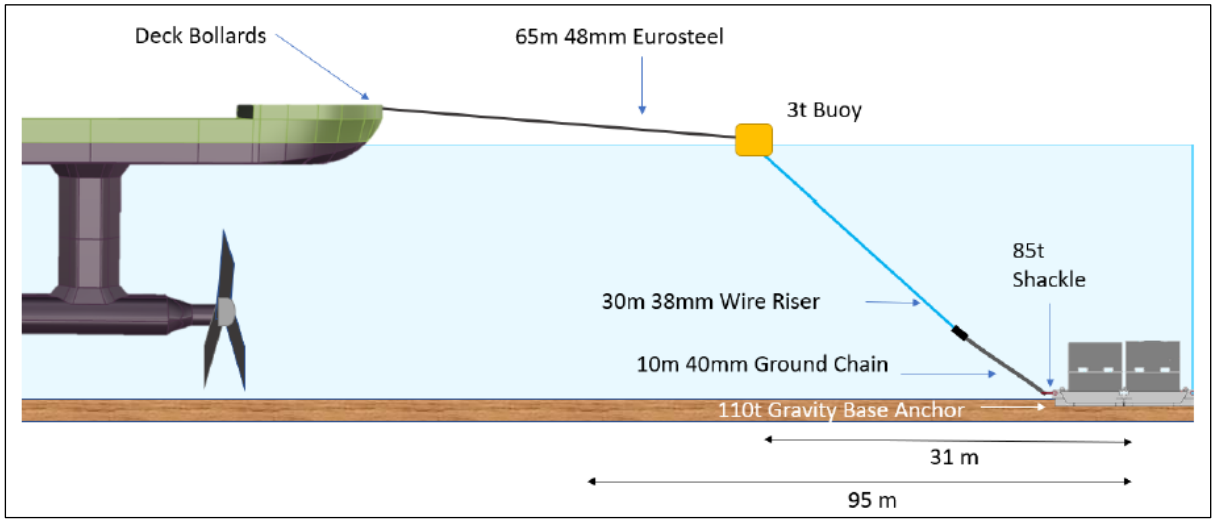


Figure 5: Planned mooring arrangements at Shapinsay Sound- Source LSK-10159-OP01-TN01.

2.1.2 Marking and Lighting

The device is predominately yellow above the waterline and fitted with an all-round white light approximately 5m above the waterline which is visible to at least two nautical miles.

The Northern Lighthouse Board (NLB) have requested that the device be marked in accordance with other renewable devices with two 3 mile yellow lights flashing once every 5 seconds, one at each end of the platform. The lights should be synchronised.[1]

In addition, recommendations were made by stakeholders that it should be fitted with both AIS and radar reflectors.

2.2 EMEC DEVELOPMENT SITE

EMEC was established in 2003 and provides developers with purpose-built, accredited open-sea testing facilitates for wave and tidal energy convertors. The operations are spread across five sites:

- Fall of Warness – grid-connected tidal test site;
- Billia Croo – grid-connected wave test site;
- Shapinsay Sound – scale tidal test site;
- Scapa Flow – scale wave test site; and
- Stronsay Firth – tidal test-site (to be developed).

The Shapinsay Sound site currently has no devices in situ, except three gravity mooring blocks which will be used by the device.

At the Fall of Warness site, there are several projects ongoing at various stages of development and as such the details of projects can only be referenced to the time of writing. Up to date details on active projects at EMEC can be found on the marine licensing page of the Scottish Government website[2] :

- Scotrenewables floating tidal device (SR2000) is located at Berth 5;
- Nautricity bottom mounted turbine at Berth 3 with 20 metres UKC (temporarily removed);
- Openhydro platform at Berth 4.

Three devices are in the process of being decommissioned.

During the lifecycle of the project, a new floating device is proposed at Berth 6 to be installed in 2018/2019. In addition, it is proposed that two new seabed mounted turbines will be installed at Berth 7 by Openhydro; however, it is highly unlikely that this would coincide with the Ocean_2G project.

[1] Correspondence with Peter Douglas, NLB Navigation Manager (Email 21st December 2017).

[2] http://www.gov.scot/Topics/marine/Licensing/marine/scoping

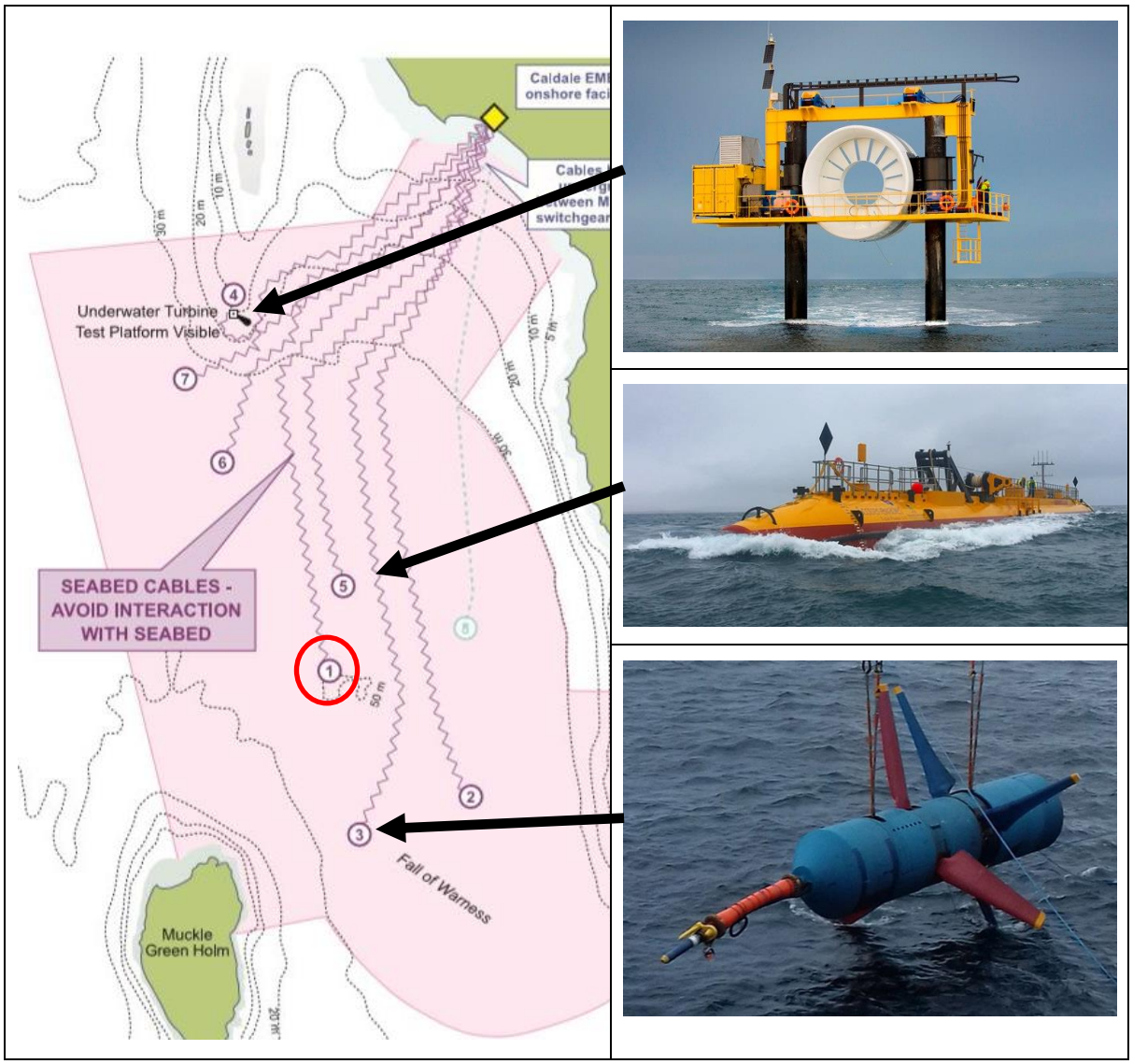


Figure 6: Current location of devices at Fall of Warness – Ocean_2G to be located in Berth 1.

2.3 CONSTRUCTION/DECOMISSIONING PLAN

The device is being validated in Vigo, Spain. It will be towed to Shapinsay Sound, east of Kirkwall, where the blades will be assembled over a period of a few weeks. From there the device will be towed to the Fall of Warness site, for up to two years, before being towed to Shapinsay Sound, and decommissioned.

Prior to deployment, it will be necessary to install moorings at both Shapinsay Sound and Fall of Warness. Leask Marine, likely using the workboat *MV C-Odyssey*, will undertake this task.

Table 3: Planned vessel movements during construction.

Activity	Anticipated Frequency of Vessel Movements
Preparation and installation of moorings at Shapinsay Sound	5-10 day trips
Preparation and installation of moorings at Fall of Warness	5-10 day trips
Assembly of blades at Shapinsay Sound	8-10 day trips
Towing the platform from Shapinsay Sound to Fall of Warness	1 day preparation 1 day towing operation (2x vessels)
Installation of the platform (including attachment to the moorings and subsea cable connection)	8-10 day trips (possibly over 2 x neap periods)

Table 4: Planned vessel movements during decommissioning

Activity	Anticipated Frequency of Vessel Movements
Decommissioning of the platform (including unmooring and subsea cable disconnection)	8-10 day trips (possibly over 2 x neap periods)
Preparation and installation of moorings at Shapinsay Sound	5-10 day trips
Towing the platform from Fall of Warness to Shapinsay Sound	1 day trip
Disassembly of blades	6-8 day trips
Decommissioning of moorings at Fall of Warness	5-10 day trips
Decommissioning of moorings at Shapinsay Sound	5-10 day trips

2.4 TOW BETWEEN SHAPINSAY SOUND AND FALL OF WARNESS

The tow between the two locations will be conducted by Leask Marine using the MV C-Odyssey or the MV C-Fenna, both of which are 26m multicats with between 27t and 35t bollard pulls respectively. The route of the tow is shown in **Figure 7**.

The towing arrangement is shown in **Figure 8**. The tow is planned at four knots and will be an astern tow. During the tow, the device blades will be locked in a downwards bunny-ear position, drawing 18.6 metres and therefore a minimum depth of the tow set at 20 metres, with a 1.4m clearance at LAT. The length of the tow cable is not known but the arrangement will exceed the pilotage requirements for the Orkney pilotage regulations in the Shapinsay Sound.

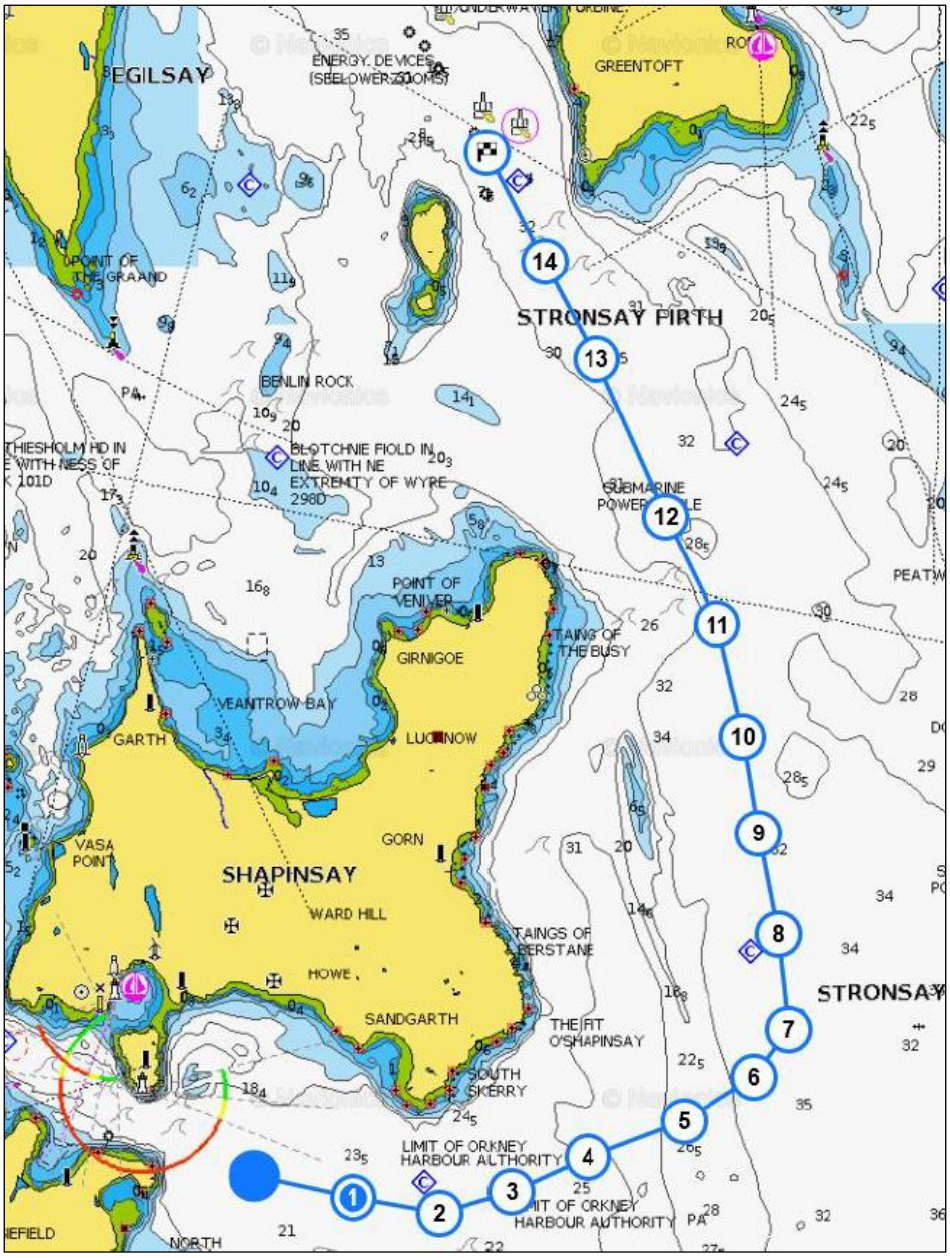


Figure 7: Towage plan (Leask Marine LSK-10159-OP03-TN01-RN02).

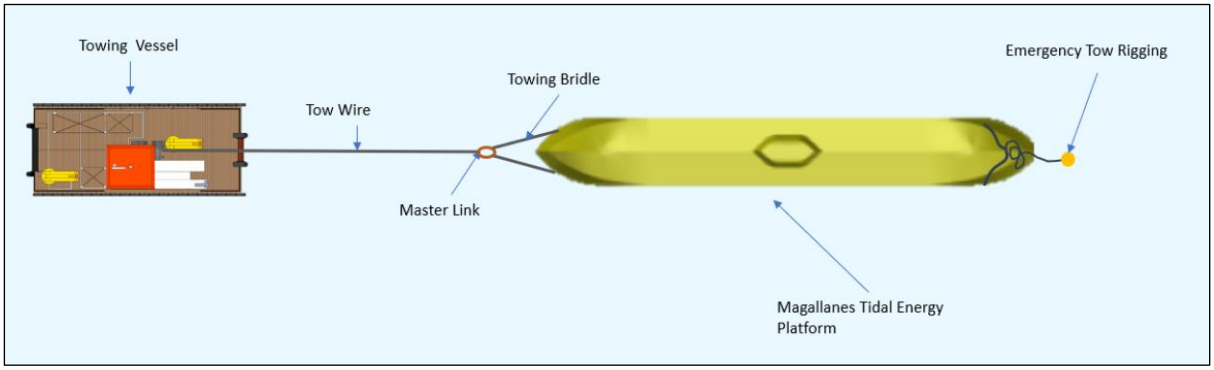


Figure 8: Towage arrangement (Leask Marine LSK-10159-OP03-TN01-RN02).

2.5 OPERATION AND MAINTENANCE

Various maintenance activities will be necessary during the life of the device, these are detailed below in **Table 5**. The O&M base is likely to be the existing facility in Kirkwall, although EMEC's Headquarters are located in Stromness.

Table 5: Planned operational and maintenance vessel movements.

Activity	Anticipated Frequency of Vessel Movements
Surveillance on site	Visits at regular intervals. 2 trips per month (1 day trip). During the first month of platform operation, visits may be more frequent.
Maintenance on site	Visits at regular intervals. 1 trip per month (1 day trip). During the first month of platform operation, visits may be more frequent.
Towing the platform for maintenance	2-3 day trips
Redeployment of platform at Fall of Warness after maintenance	4-6 day trips.

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, from which they are separated by the Pentland Firth. The Fall of Warness is located to the west of Eday and exhibits significant tidal flows. Shapinsay Sound and The String form the principal route into Wide Firth and thus to Kirkwall. This section provides details of the sites and conditions as relate to navigation.

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 9** shows the wind directions and speeds for the Fall of Warness site.

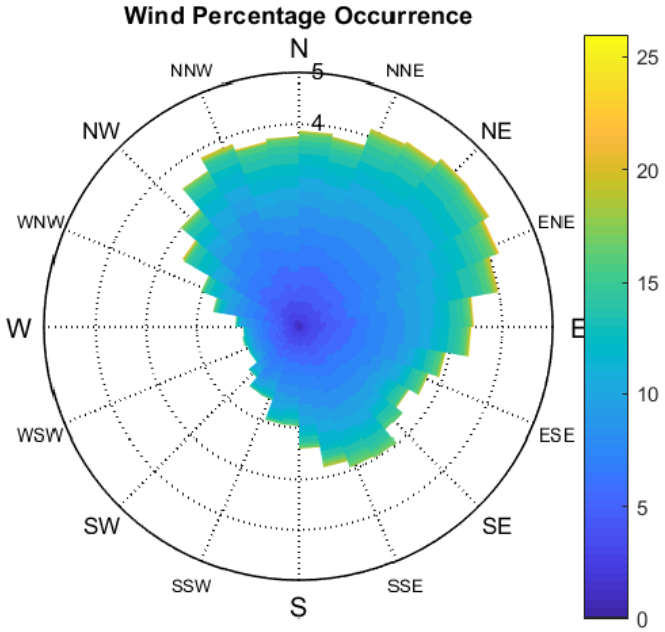


Figure 9: Percentage occurrence of wind directions (m/s) – Source TDK-MAG-MOOR-TR-001.

3.1.2 Wave

Figure 10 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.

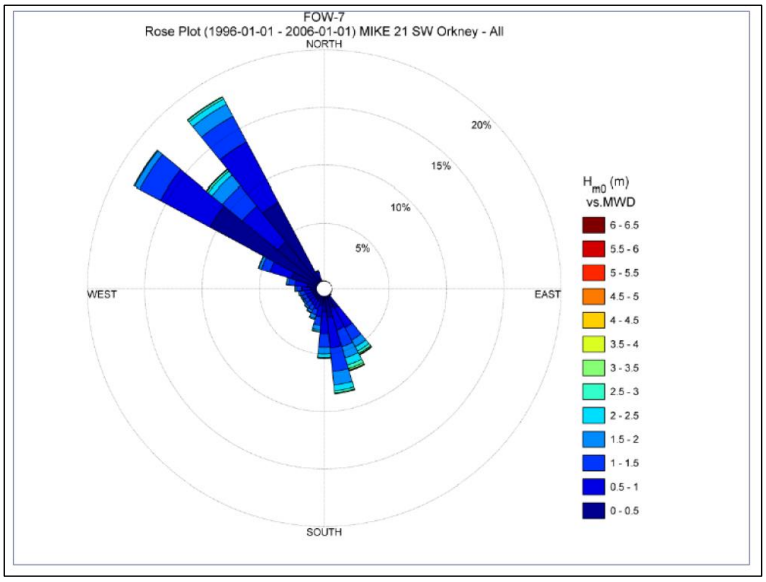


Figure 10: Wave rose plot for percentage occurrence with Hm0 and direction (EMEC Fall of Warness – Berth 1: MecOcean & Physical Description 2015).

3.1.3 Tide

Table 6 and **Table 7** 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 11 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 6: 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 7: Admiralty Total Tide Predictions for study sites.

	Fall of Warness (59° 08.07'N 002° 48.40W			Shapinsay Sound (59° 00.37'N 002° 49.80W		
Tidal Hour	**Direction (deg)**	**Spring**	**Neaps**	**Direction (deg)**	**Spring**	**Neaps**
-6	150	6.2	2.4	099	1.1	0.4
-5	144	7.2	2.8	098	1.8	0.7
-4	141	5.8	2.3	097	2.8	1.1
-3	116	2.8	1.1	096	2.3	0.9
-2	350	0.3	0.1	112	1.4	0.6
-1	308	3.8	1.6	168	0.8	0.3
HW	329	6.4	2.5	245	1.1	0.4
+1	329	6.5	2.5	267	1.3	0.6
+2	320	4.9	1.9	279	1.1	0.4
+3	325	3.8	1.7	283	0.7	0.3
+4	324	1.2	0.5	086	0.3	0.1
+5	160	1.7	0.7	089	0.9	0.4
+6	153	5.7	2.3	101	1.1	0.4

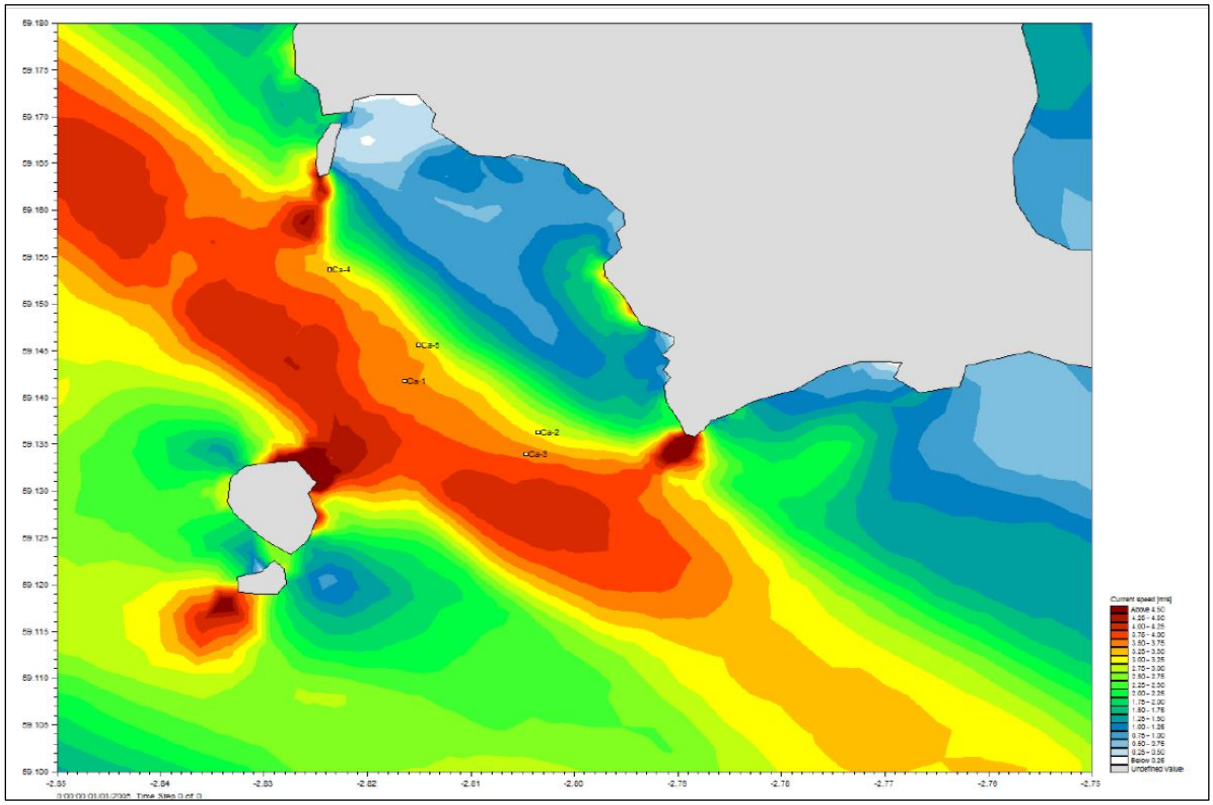


Figure 11:Maximum Tidal Flow for 2005 (EMEC Fall of Warness – Berth 1: MecOcean & Physical Description 2015).

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. Consultees identified that the Fall of Warness site frequently has thick fog.

3.2 EXISTING VESSEL TRAFFIC MANAGEMENT

Shapinsay Sound lies within the port limits of the Orkney Islands Council. Fall of Warness is not within the port limits.

Pilotage is compulsory within the Orkney Harbour Competent Harbour Authority (CHA) Area 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.

Pilots board to the east of Shapinsay Sound.

Orkney Vessel Traffic Services (VTS) is available to all vessels navigating in Wide Firth and Shapinsay Sound. A vessel reporting system and radar surveillance for Shapinsay Sound and Kirkwall Bay is in force.

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. She 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 three charted marine farms near to Shapinsay Sound, in the Bay of Meil, Inganess Bay and Bay of Carness. None are charted in the Fall of Warness.

3.4.2 Renewables

The EMEC development site is located in the Fall of Warness, see **Section 2.2** for further details. No renewable devices are located in Shapinsay Sound. 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

3.4.3 Subsea Cables

The Fall of Warness has multiple subsea cables associated with the EMEC test facilities (see **Section 2.2** for further details). There are disused cables in Shapinsay Sound.

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 both Shapinsay Sound and Fall of Warness.

4 CONSULTATION

Consultation was conducted with key stakeholders to gain local knowledge and insight on navigation. Consultation, due to adverse weather, was undertaken by telephone or by email. A list of stakeholder consultations undertaken is given in Table 8. 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 has been embedded in the assessment of navigation risk for this study.

Table 8: List of stakeholder consultation.

Organisation	Details	Purpose
Maritime and Coastguard Agency	13/03/2018 – Telephone call 22/03/2018 - Email *Helen Croxson – OREI Advisor*	Methodology and Guidance Documentation for Assessment Topics to be covered
Northern Lighthouse Board	21/12/2017 – Email 22/03/2018 - Email *Peter Douglas – Navigation Safety Manager*	Marking and Lighting requirements
Orkney Ferries	19/03/2018 – Teleconference: *Glenn Porter - Superintendent* *Stephen Barnes - Superintendent* *Lewis Garson - Master*	Background on Orkney Ferries Passages through study area Possible impacts of device Risk Control Measures
Orkney Marinas	20/03/2018 – Telephone Call; *Brian Kynock - Chairman*	Background on Recreational Traffic Racing areas and cruising routes Risk Control Measures
Orkney Fisheries	20/03/2018 – Telephone call 23/03/2018 - Email *Fiona Matheson - Secretary*	Background on Fishing in Orkneys Consideration of Impact on Fishing
Orkney Islands Council Marine Services	20/03/2018 – Telephone Call *Alistair Wylie – Deputy Harbour Master Operations*	Activities and management in Shapinsay Sound 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 Ocean_2G device is a single 2MW device and will be located in a licensed test site which has been host to numerous other devices over the last few years and is well charted. This assessment has been conducted based on AIS data and additional information provided by secondary sources and local consultees from the ports, fishing and recreational communities to ensure the activities of small craft not included in the AIS data are integrated into 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 SHAPINSAY SOUND

Figure 12 shows the density of vessel transits through the Shapinsay Sound. The site is well clear of the main shipping route into Kirkwall, which is approximately 0.5nm north of the site. This is shown further in **Figure 13** and **Figure 14** which show the tracks of cargo, tankers and passenger vessels into Kirkwall. These vessels are highly concentrated into the approach to Kirkwall Bay, with the exceptions occurring due to the process of dropping off a marine pilot at the outbound pilot boarding station. The single transit of a commercial vessel into the Bay of Meit is a fish carrier tending to the fish farms in the area.

The largest vessels, shown in **Figure 15** do not anchor in Shapinsay Sound.

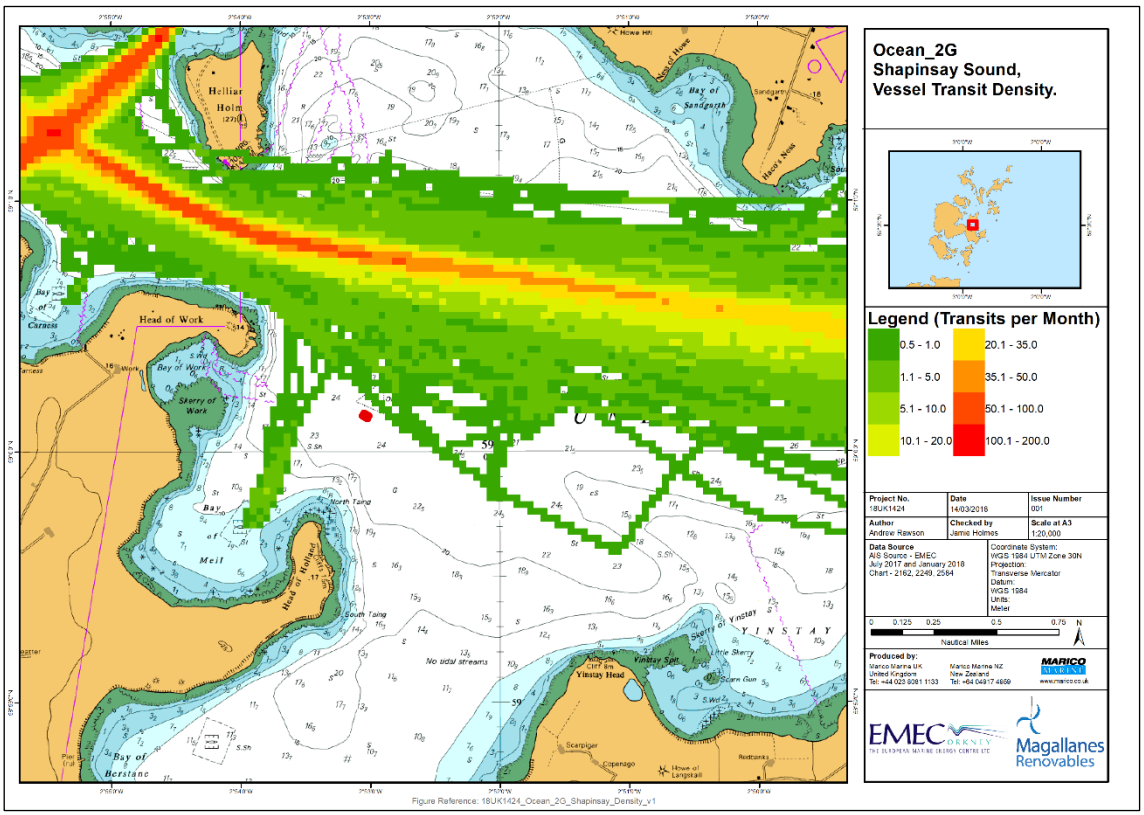


Figure 12: Vessel transit density at the Shapinsay Sound site.

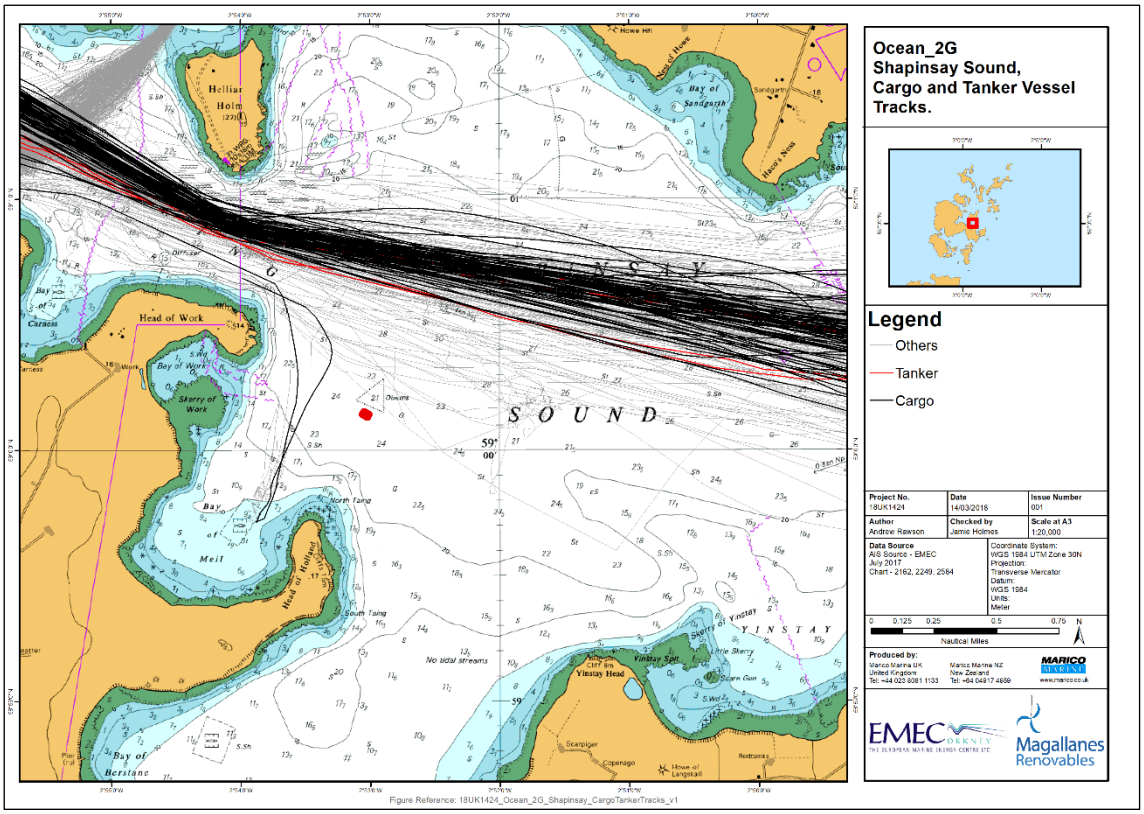


Figure 13: Commercial vessel transits at the Shapinsay Sound site.

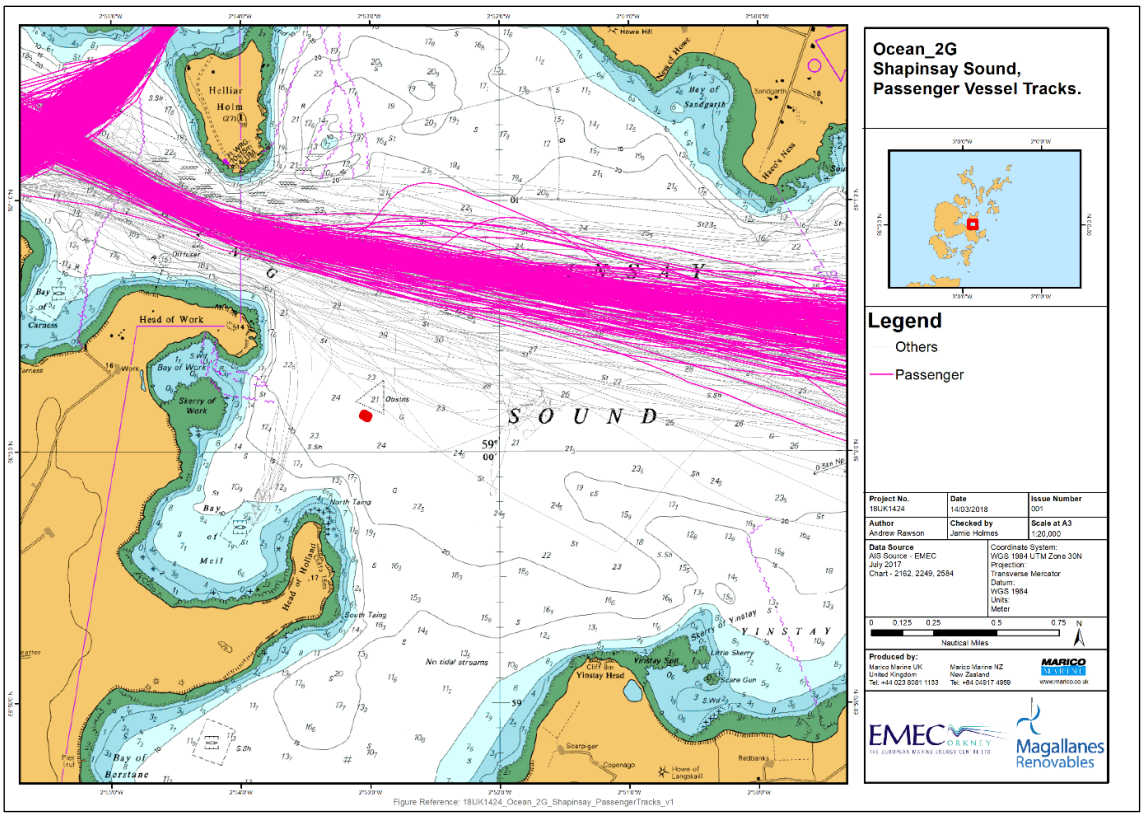


Figure 14: Passenger vessel transits at the Shapinsay Sound site.

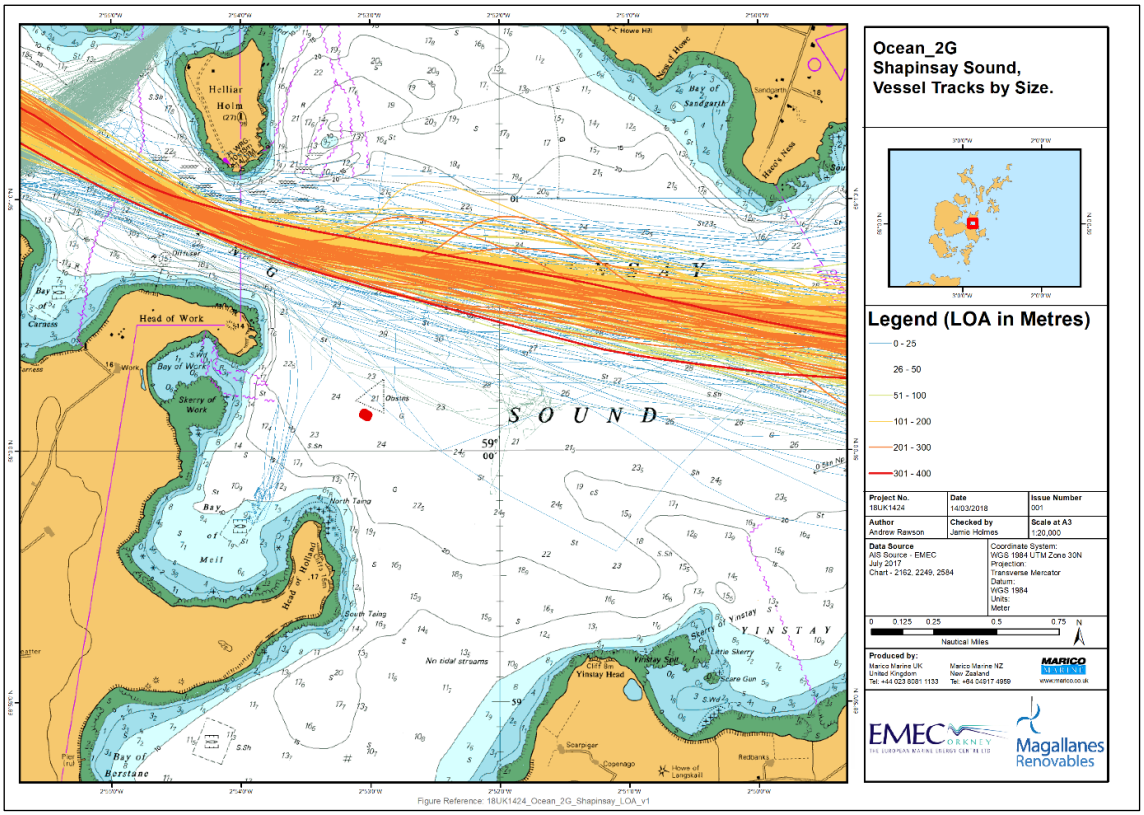


Figure 15: Vessel transits at the Shapinsay Sound site by size.

Figure 16 shows the transits of fishing vessels in the Shapinsay Sound as recorded by AIS. AIS is required on fishing vessels above 15m LOA, and therefore is not fitted to the majority of UK fishing vessels. Consultation with Orkney Fisheries Association revealed that fishing in the Shapinsay Sound is typically static gear (creel) and scallop diving and there are four to five boats operational in this area, based out of Kirkwall. No bottom dredging takes places in this area. Orkney Fisheries foresaw no interference with their activities.

The routes of recreational vessels, who are also not required to carry AIS, are shown in **Figure 17**. Carriage of AIS on yachts is increasing, but would still account for between 10% and 30% of offshore yachts. The tracks of yachts are quite dispersed but the main route is into Kirkwall and its marina, and therefore well clear of the site. Consultation identified that the majority of racing takes place in Kirkwall Bay rather than the Shapinsay Sound, although some longer distance races would pass through this area. The area around the device is not a suitable anchorage for yachts given the lack of shelter and depth of water.

Finally, tugs and service craft, which include pilot boats, tugs, maintenance vessels and other workboats are shown in **Figure 18**. The concentration to the east is a renewable maintenance vessel (C-Odyssey) at the second of EMEC's test berths.

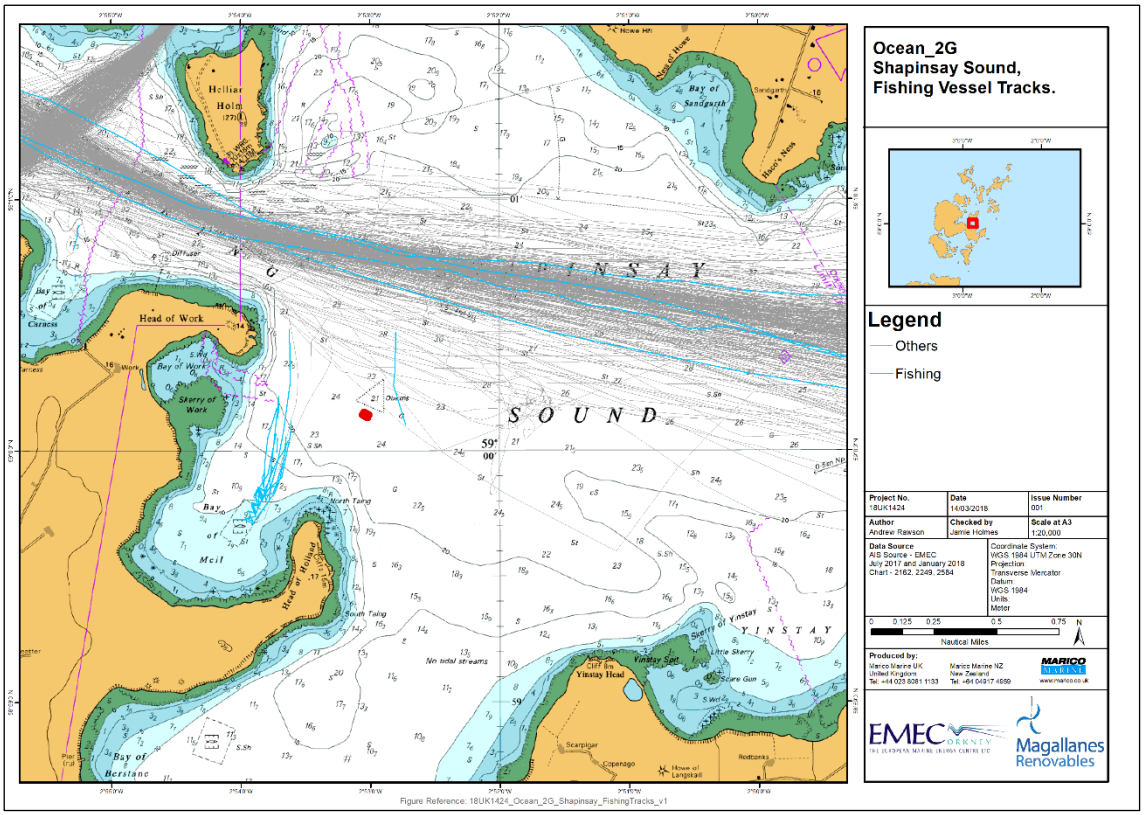


Figure 16: Fishing vessel transits at the Shapinsay Sound site.

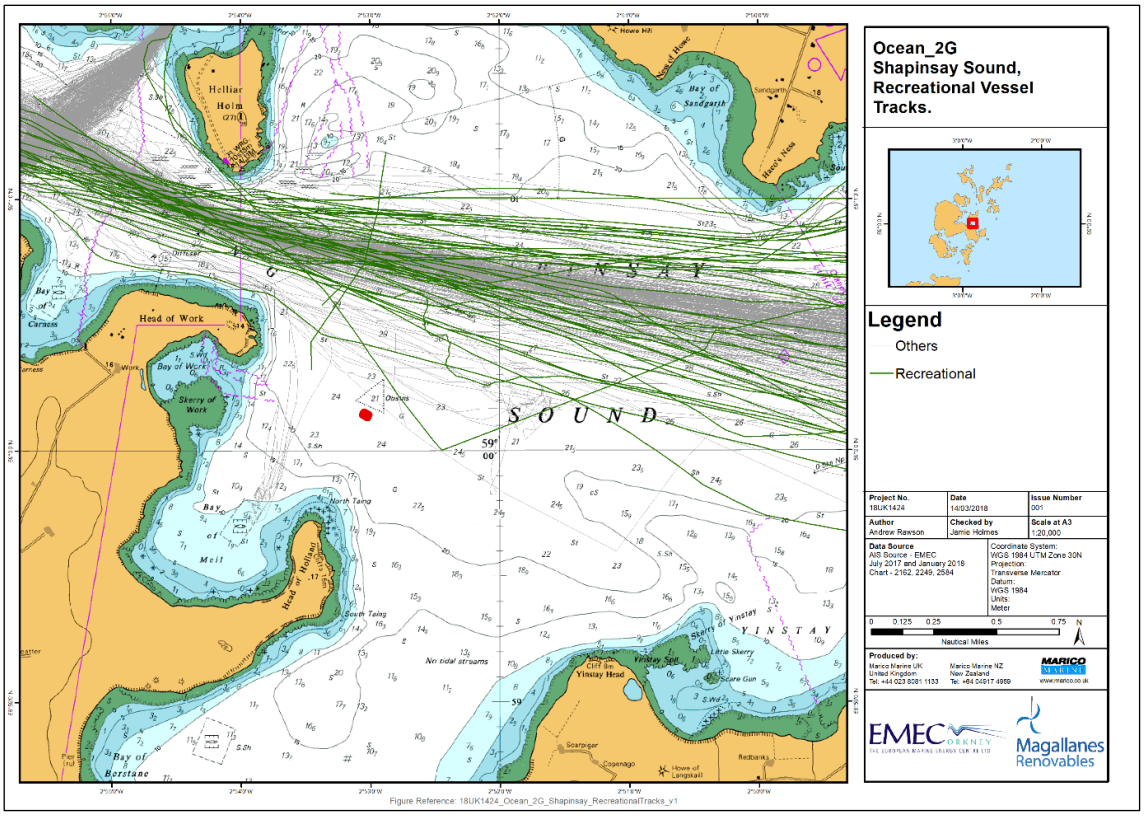


Figure 17: Recreational vessel transits at the Shapinsay Sound site.

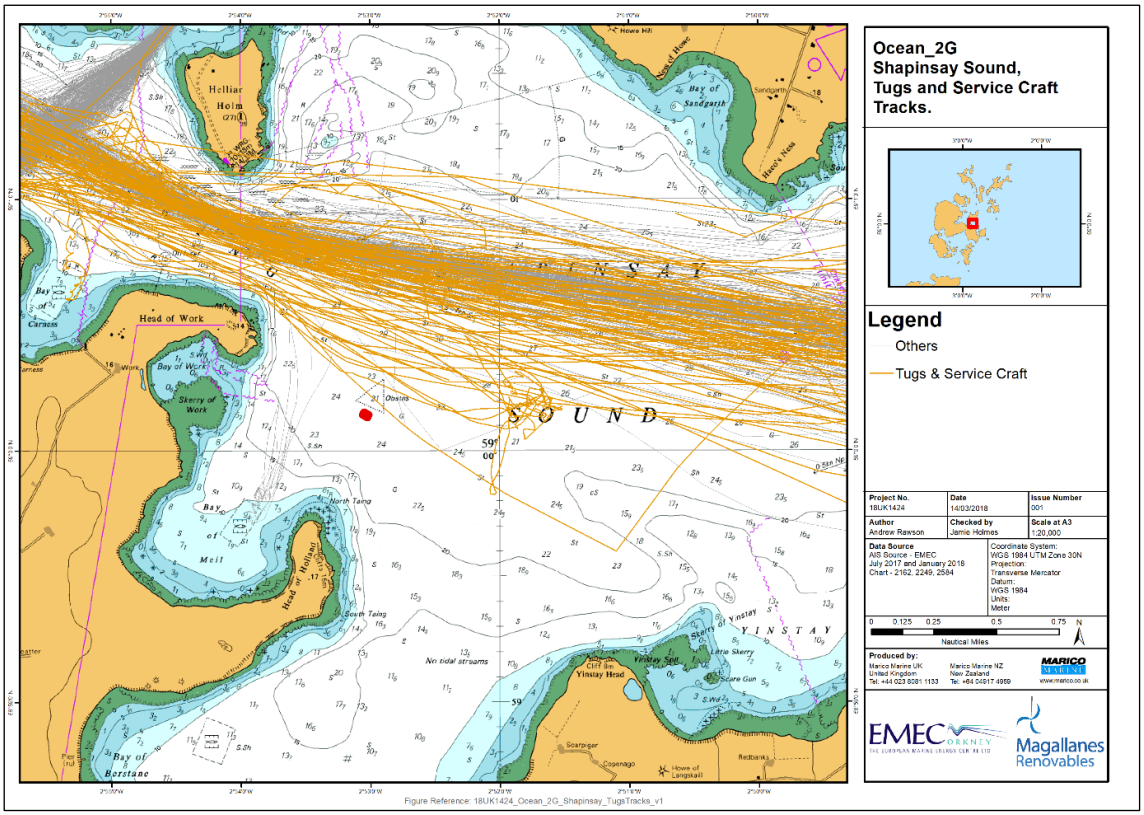


Figure 18: Tugs and Service Craft transits at the Shapinsay Sound site.

5.3 FALL OF WARNESS

The Fall of Warness site is clear of the main routes used by ferries from Kirkwall to Eday (see **Figure 19**). A route through the Fall of Warness is used by some deeper draught vessels when the weather and tidal conditions are suitable (see **Figure 22**), particularly cruise ships. During the July analysis period these were the Boudicca (205m), Magellan (221m), Saga Pearl II (165m), Mein Schiff 4 (294m) and MSC Preziosa (333m).

No tankers operate in this area and cargo transits are infrequent (see **Figure 20**).

Figure 21 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**.

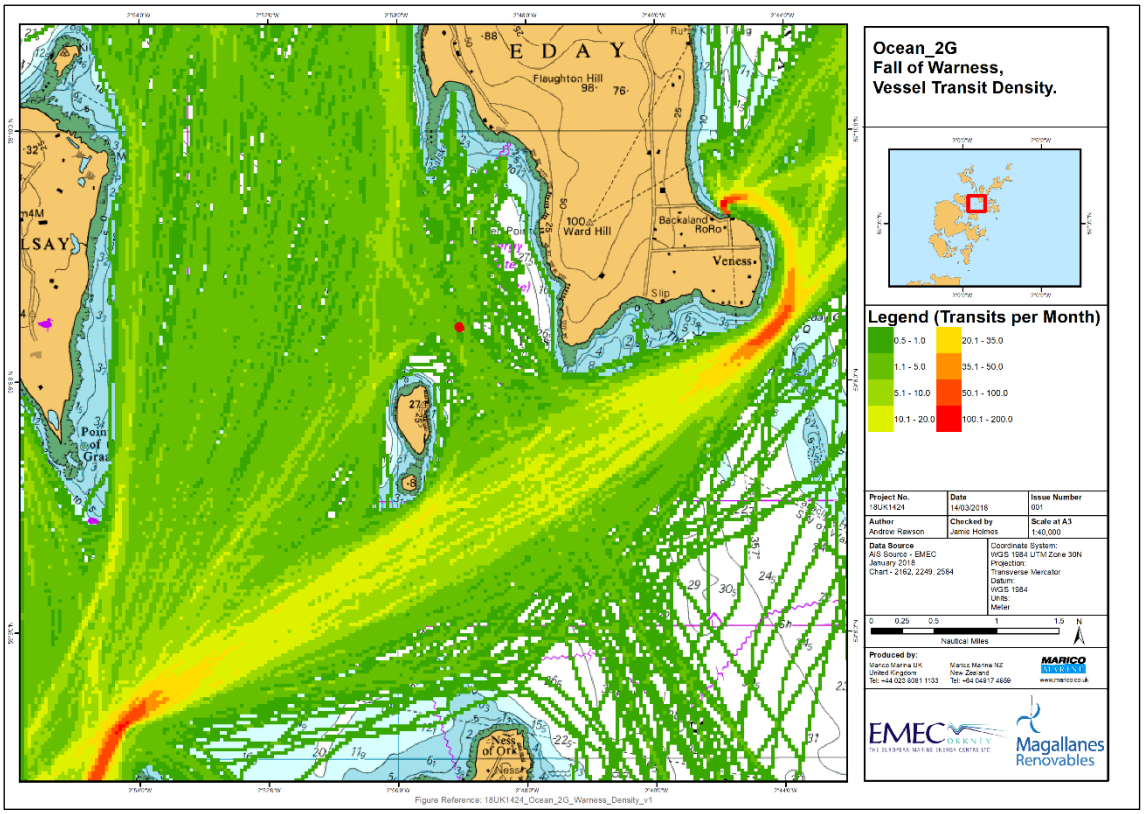


Figure 19: Vessel transit density at the Fall of Warness site.

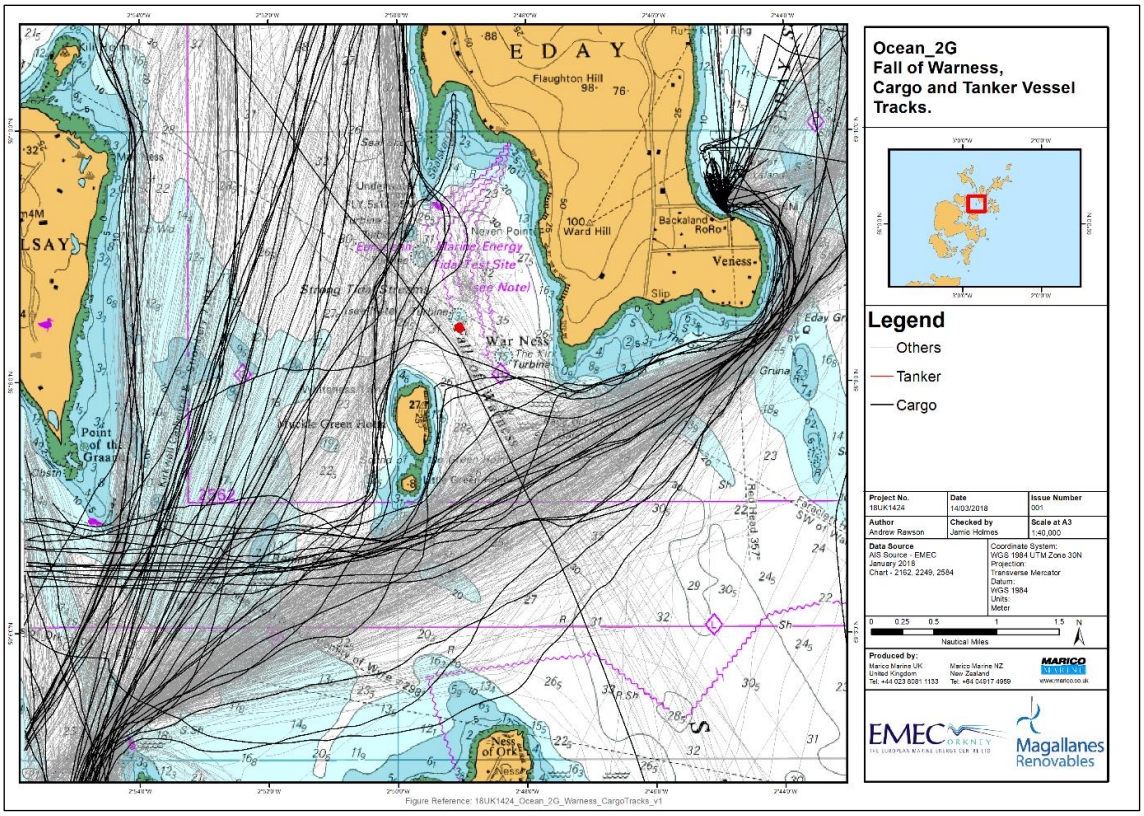


Figure 20: Commercial vessel transits at the Fall of Warness site.

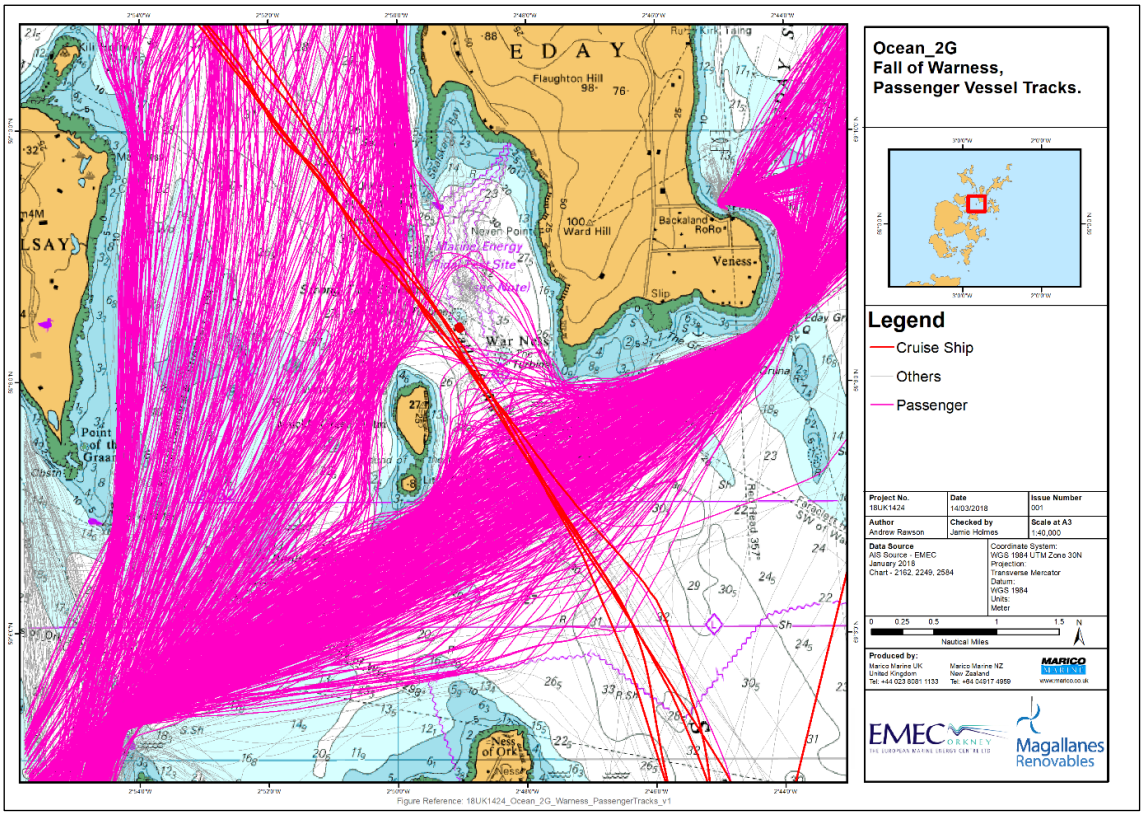


Figure 21: Passenger vessel transits at the Fall of Warness site

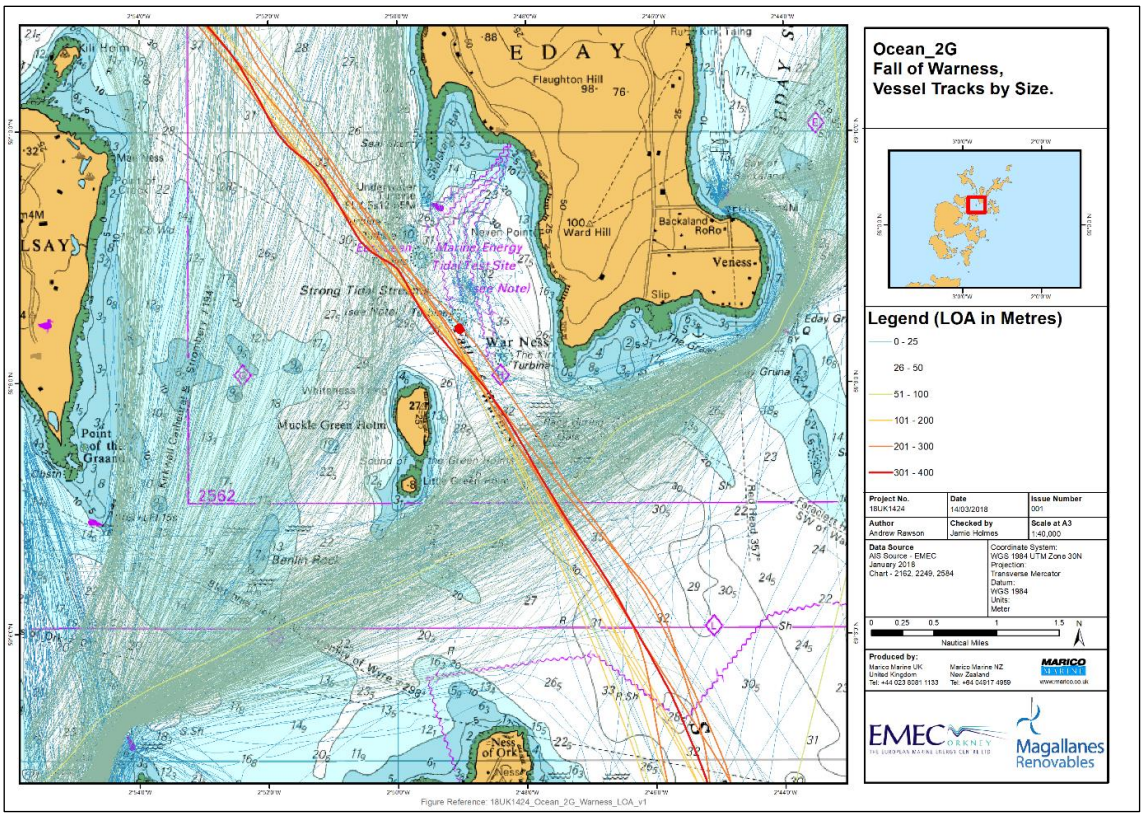


Figure 22: Vessel transits at the Fall of Warness site by size.

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 23**). As such, the impact on fishing of the Ocean_2G device is limited. Occasionally, scallop dredgers are known to operate in this area but would do so clear of the cables and devices. Orkney Fisheries foresaw no interference with their activities.

Similarly, recreational yachts transit through this area (**Figure 24**) but would generally stay close inshore and therefore clear of the device. Consultation recommended that an inshore route remained open to allow yachts to pass close to Eday, this would be achieved with the proposed site location. 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.

Finally, tugs and service craft, which include pilot boats, tugs, maintenance vessels and other workboats are shown in **Figure 25**.

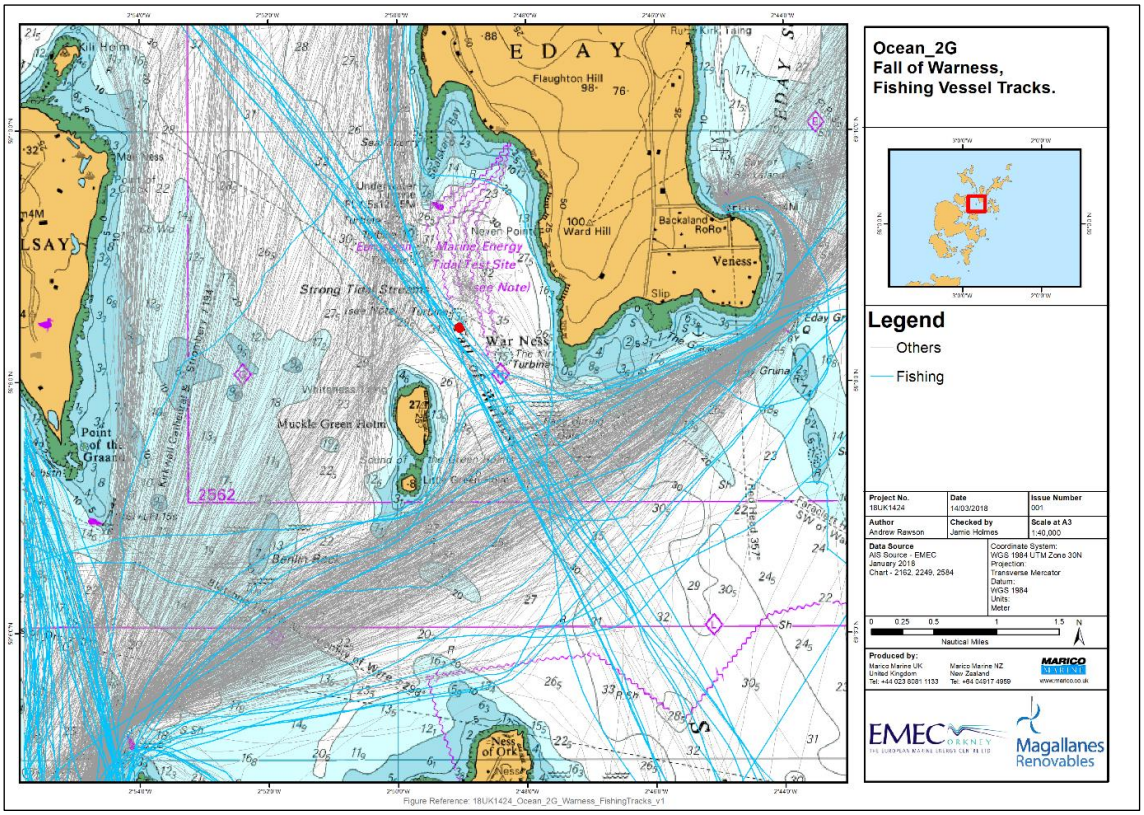


Figure 23: Fishing vessel transits at the Fall of Warness site.

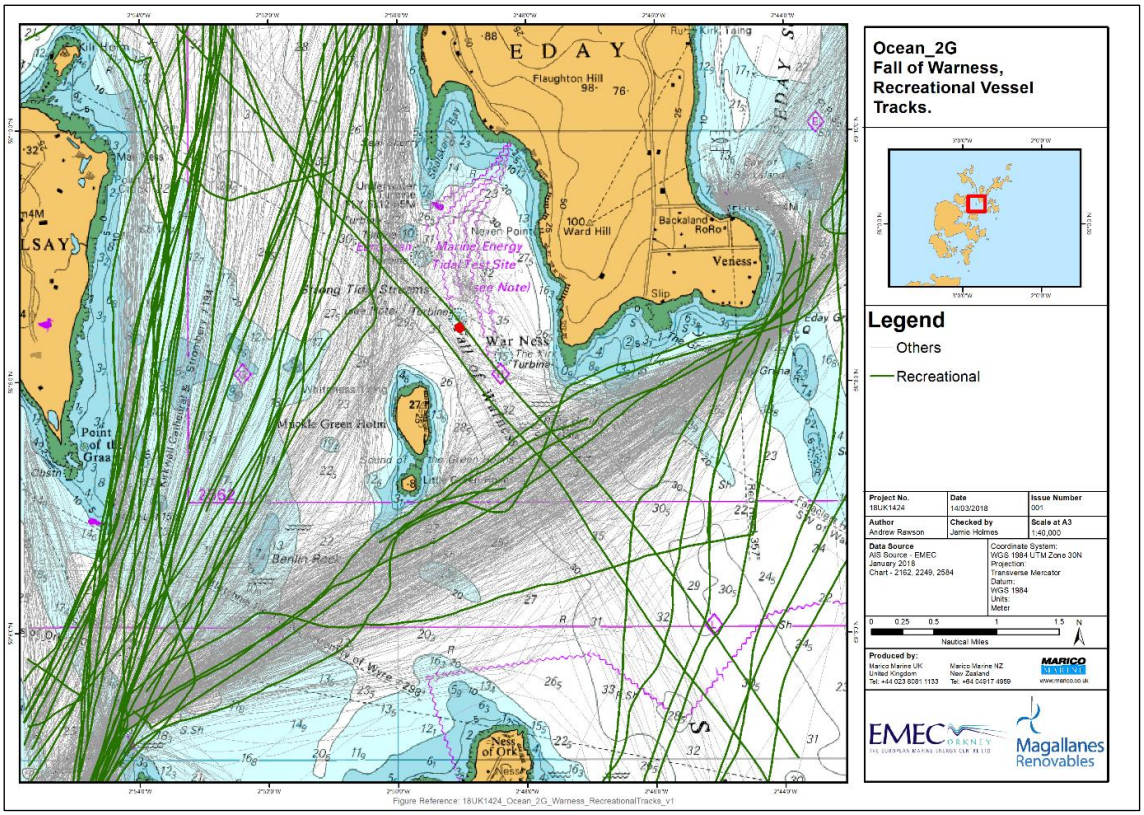


Figure 24: Recreational vessel transits at the Fall of Warness site.

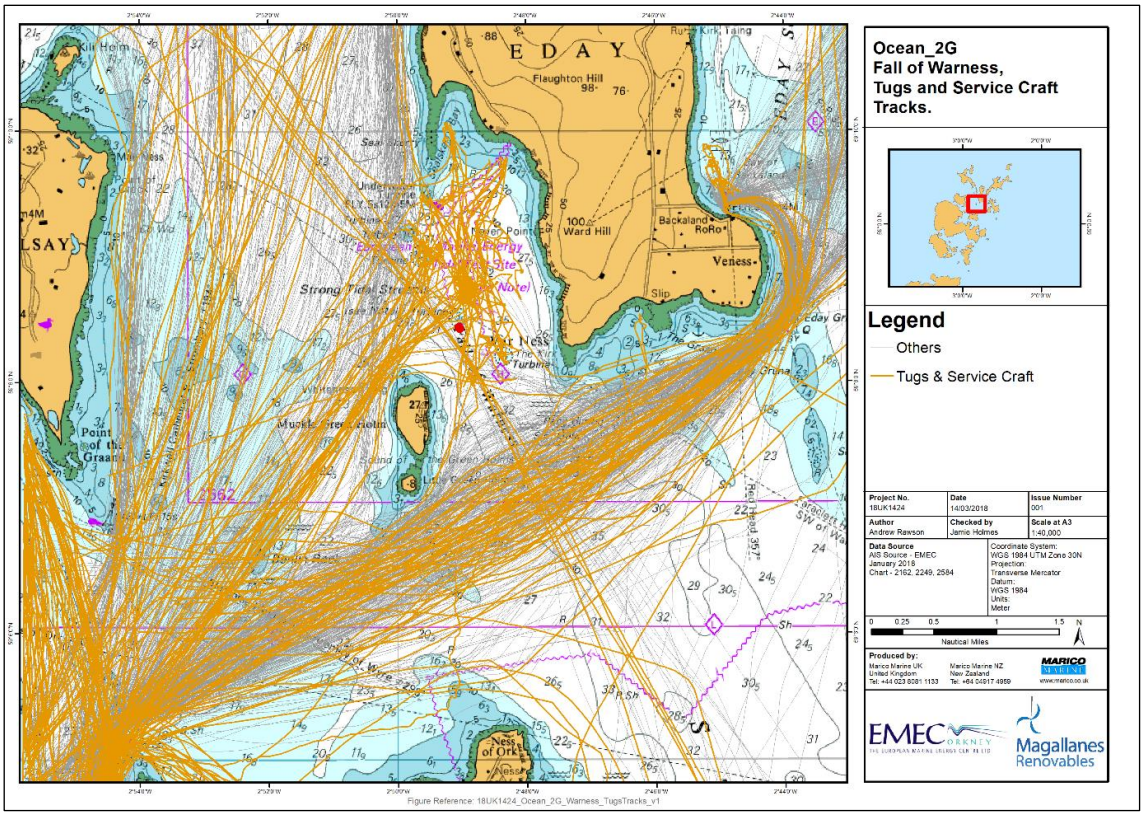


Figure 25: Tug and Service vessel transits at the Fall of Warness site.

5.4 PROXIMITY ANALYSIS

To understand the frequency and distribution of movements passed each site, further analysis was conducted on the vessel traffic data. **Figure 26** shows the frequency and distribution of traffic passing the mooring location in Shapinsay Sound. The majority of transits are well clear to the north, with only the occasional smaller vessel coming further to the south.

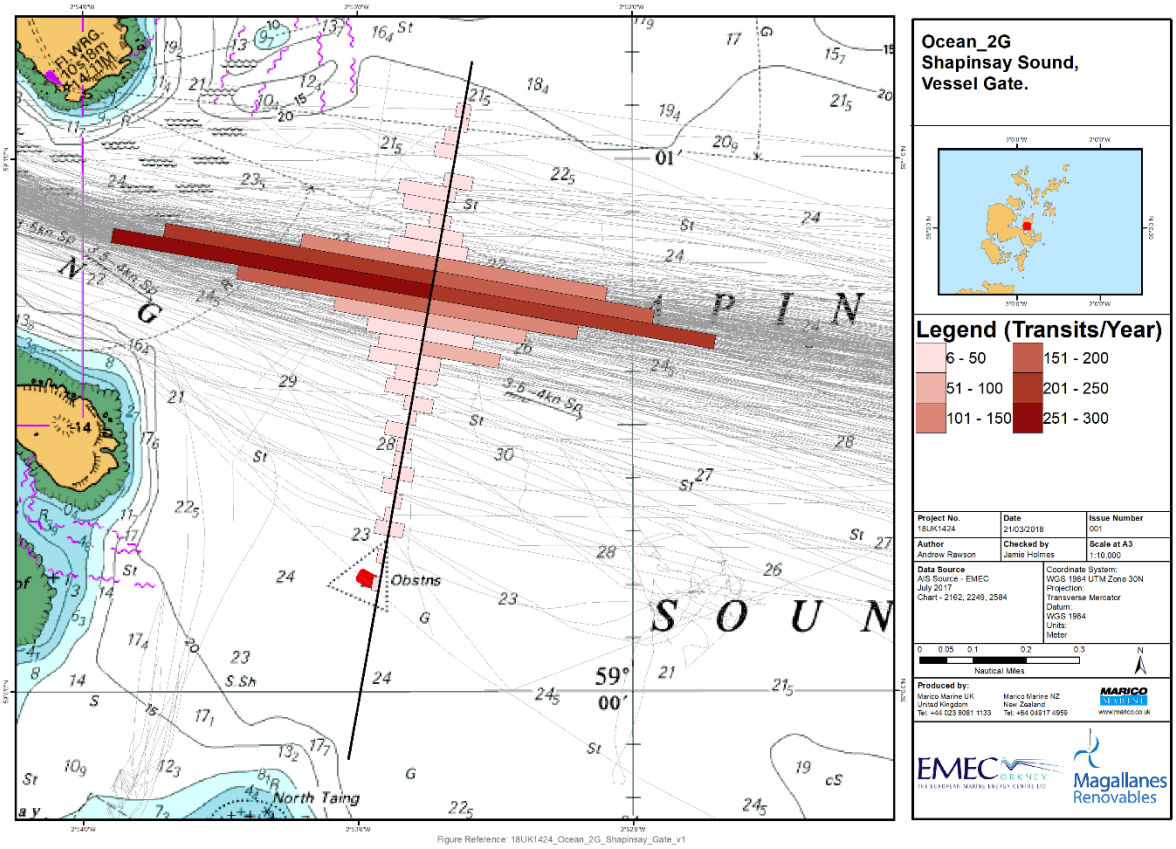


Figure 26: Vessel traffic gate at Shapinsay Sound.

Statistical analysis was conducted of the vessel traffic passing Shapinsay Sound shown in the gate in **Figure 26**. Because the vessel traffic in Fall of Warness is not linear, analysis here considered the number of transits within 0.5nm of the test berth.

Figure 27 and **Figure 28** shows the number of transits per day passed each site across the summer and winter data periods respectively. On average, 9 vessels pass the Shapinsay site per day during summer and 3.5 in winter. At the Fall of Warness site, 1.5 passed within 0.5nm of the device during summer and 1 per day in the winter. Both sites are highly variable, driven by the weather conditions, but there is a clear seasonality aspect to the traffic profile.

Figure 29 considers a temporal difference between the sites and whilst there is an increase during the day, there are key peaks reflecting the ferry timetables.

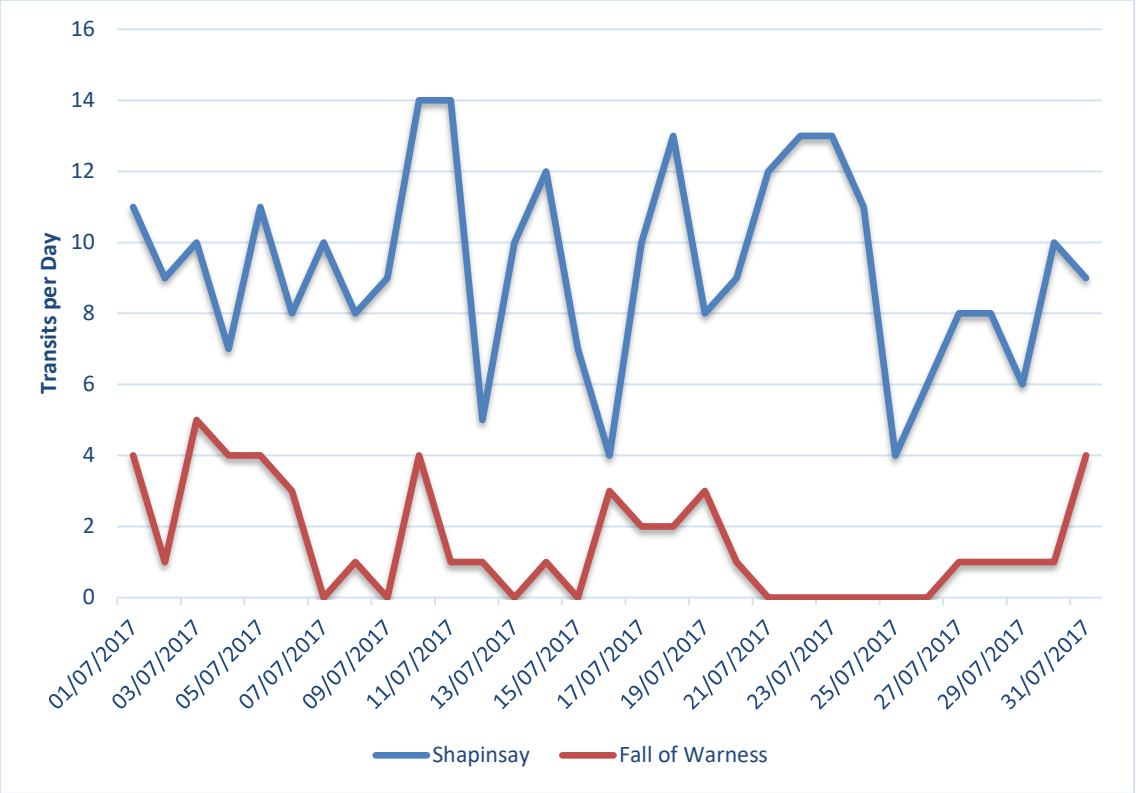


Figure 27: Vessel transits per day (July 2017).

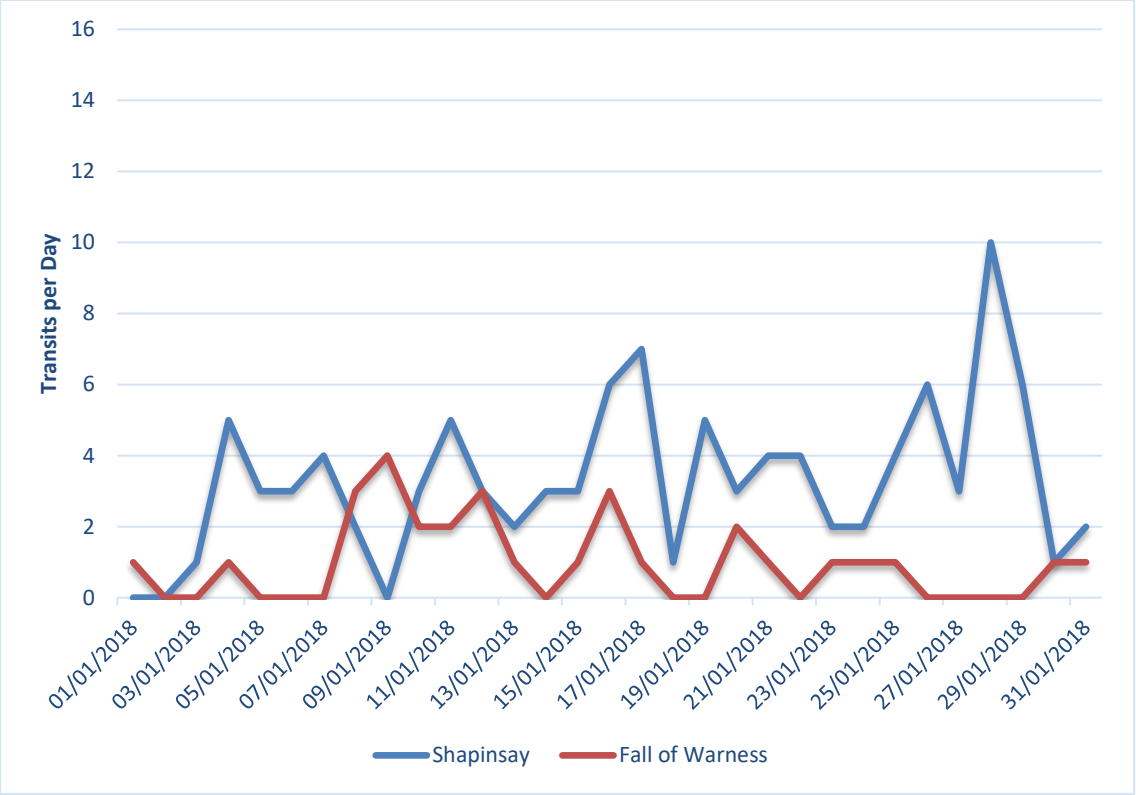


Figure 28: Vessel transits per day (January 2018).

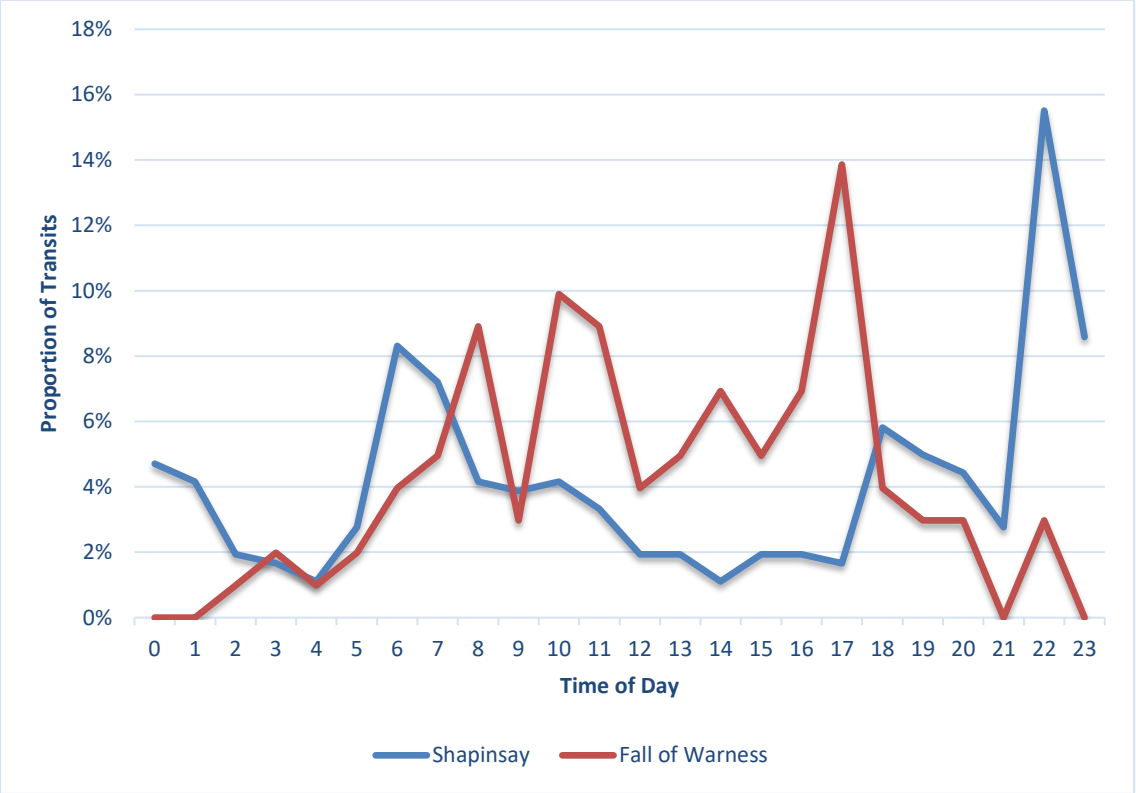


Figure 29: Transits by time of day.

Figure 30 and **Figure 31** show the type and sizes of vessels passing the devices. The Shapinsay site has a number of large vessel types such as cargo vessels, ferries and cruise ships, of which there were 55 transits in July 2017. The Fall of Warness site has a very different profile of vessel types. Fishing boats and workboats, engaged in maintenance at EMEC, make up a much higher proportion of the vessel traffic. Ferries still account for a large proportion of the transits but other deep draught vessels are proportionally much less likely to be in the area.

The size of vessels shown in **Figure 31** further emphasises this, with proportionally more larger vessels in Shapinsay Sound than Fall of Warness.

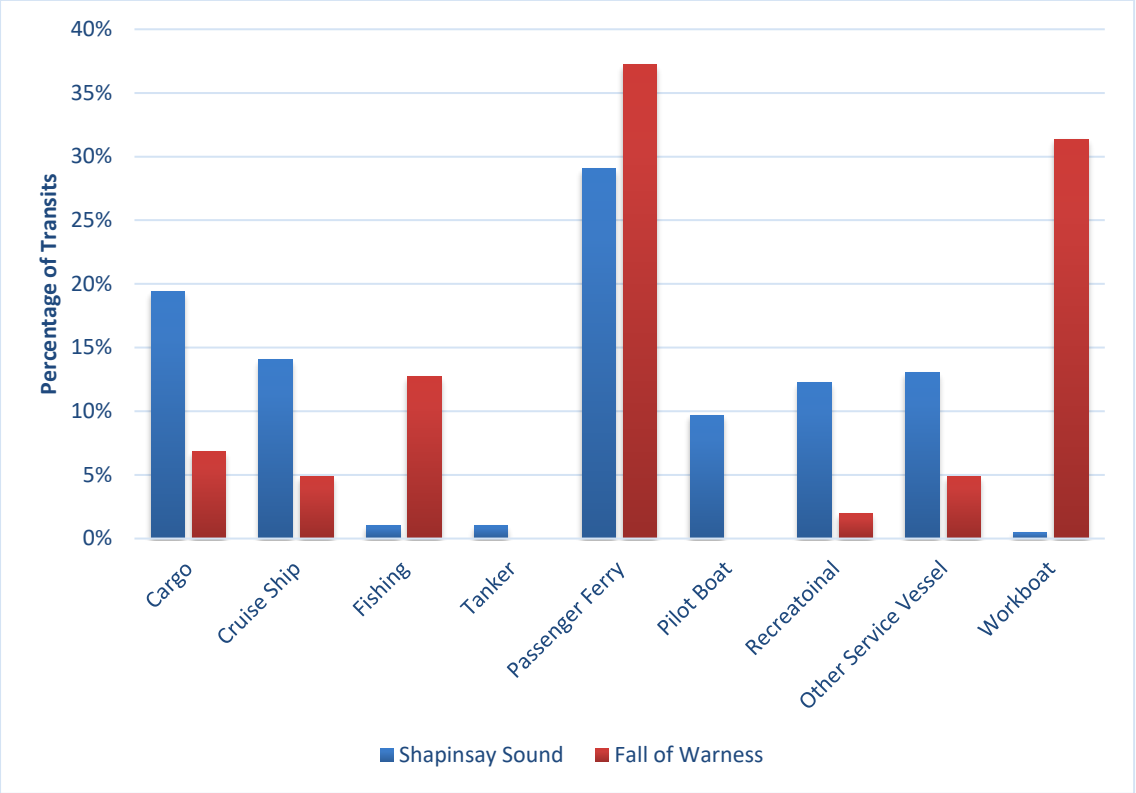


Figure 30: Transits by type.

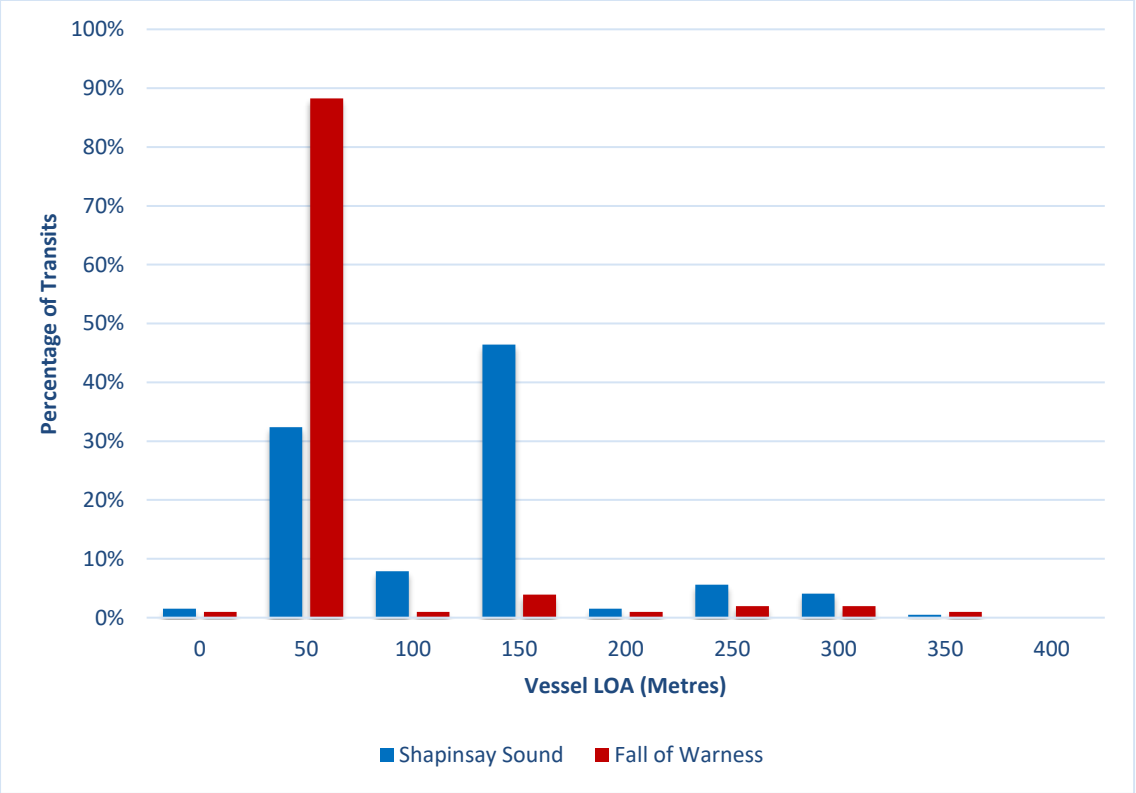


Figure 31: Transits by size.

5.5 HISTORICAL INCIDENTS

Analysis of MAIB incidents between 1997 and 2015 was conducted.

In Shapinsay Sound, a total of 15 incidents were recorded:

- 2 accidents to person (involving a fishing vessel and a passenger vessel);
- 5 groundings (involving 3 fishing vessels, a yacht and a service vessel);
- 1 contact involving a fishing vessel; and
- 7 mechanical failures/loss of control/propulsion.

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 is however a high frequency of groundings, which given the tidal conditions in the area, was to be expected.

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:[3]

- 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 stead 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.[4]

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.

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

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

6.3 RENEWABLE ENERGY RELATED TRAFFIC

The EMEC site and its devices are periodically maintained by vessels from Kirkwall. The construction and maintenance of Ocean_2G, will increase small workboat activity in the area (as shown in **Section 2.3** and **2.5**). As discussed in **Section 2.2**, during the lifecycle of the Ocean_2G 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.

6.4 SUMMARY

It is not considered that the changes in the traffic profile discussed above will materially alter the risk profile around Berth 1 in the two-year lifecycle of the device.

7 IMPACTS TO NAVIGATION

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

7.1 IMPACT ON VESSEL TRAFFIC ROUTEING

The Shapinsay Sound site is well clear of vessel routes (**Section 5**) and therefore would have a negligible impact on vessel routeing. Several points needed investigating as to how Ocean_2G project would impact vessel routeing in the Fall of Warness.

7.1.1 Deep Draught Vessels at Fall of Warness

Analysis of AIS and information gathered during the consultation identified that deep draught vessels occasionally transit through the Fall of Warness, to the east of the Muckle Green Holm. At present, with the Scotrenewables Tidal Power Limited's SR2000 tidal energy device in place, a navigable corridor of 0.75nm exists between the shallows of Muckle Green Holm and the device. With ATIR platform, under the Ocean_2G project, placed to the southwest, this would reduce to 0.45nm. It is estimated that 150 vessels transit through this passage each year (see **Figure 32**) including five cruise vessels per month in the summer. The probability of two vessels meeting is very low and therefore it is reasonable to expect the entire passage to be manageable.

The PIANC Harbour Design Guidelines (2014) give calculations for acceptable widths of channels. A high-level assessment was done against these criteria for a vessel with beam 25 metres. 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.

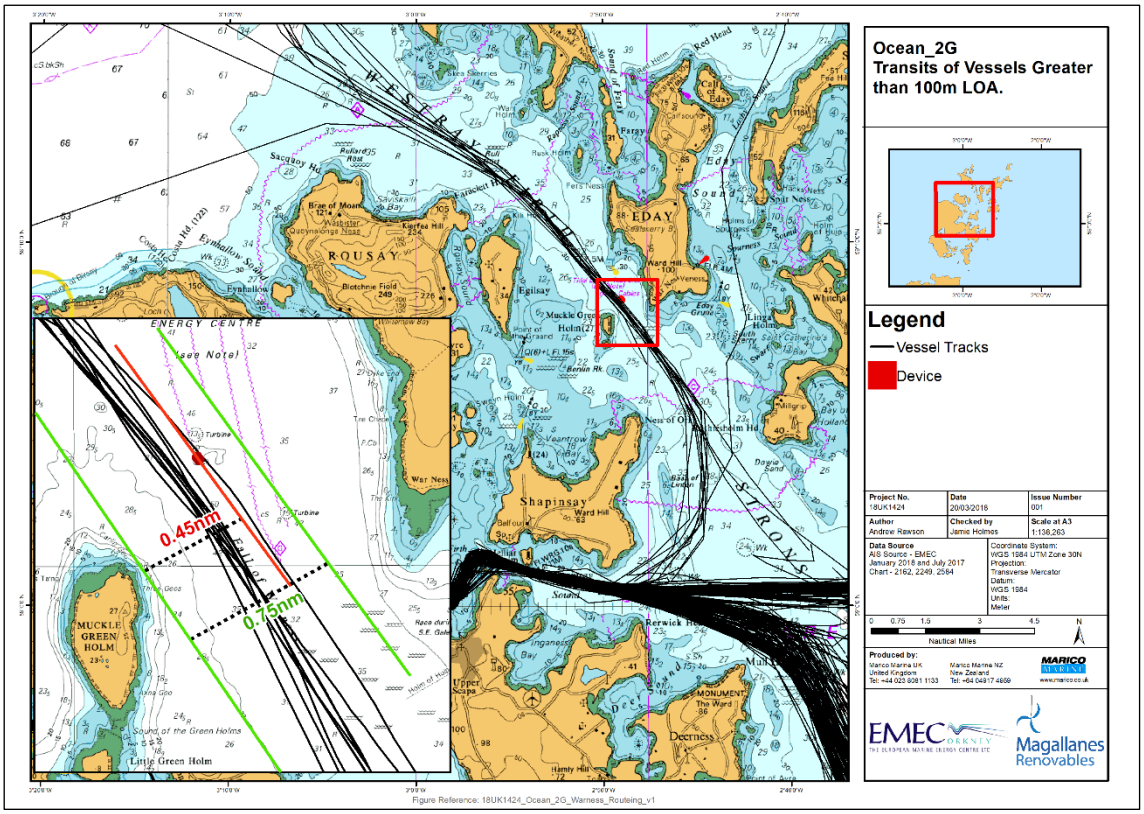


Figure 32: Transits of Vessels greater than 100m LOA.

7.1.2 Impact on Navigation during Significant Tidal Flows

Figure 33 and **Figure 34** 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. The tidal streams therefore do not alter the routes of vessels to the area surrounding ATIR platform.

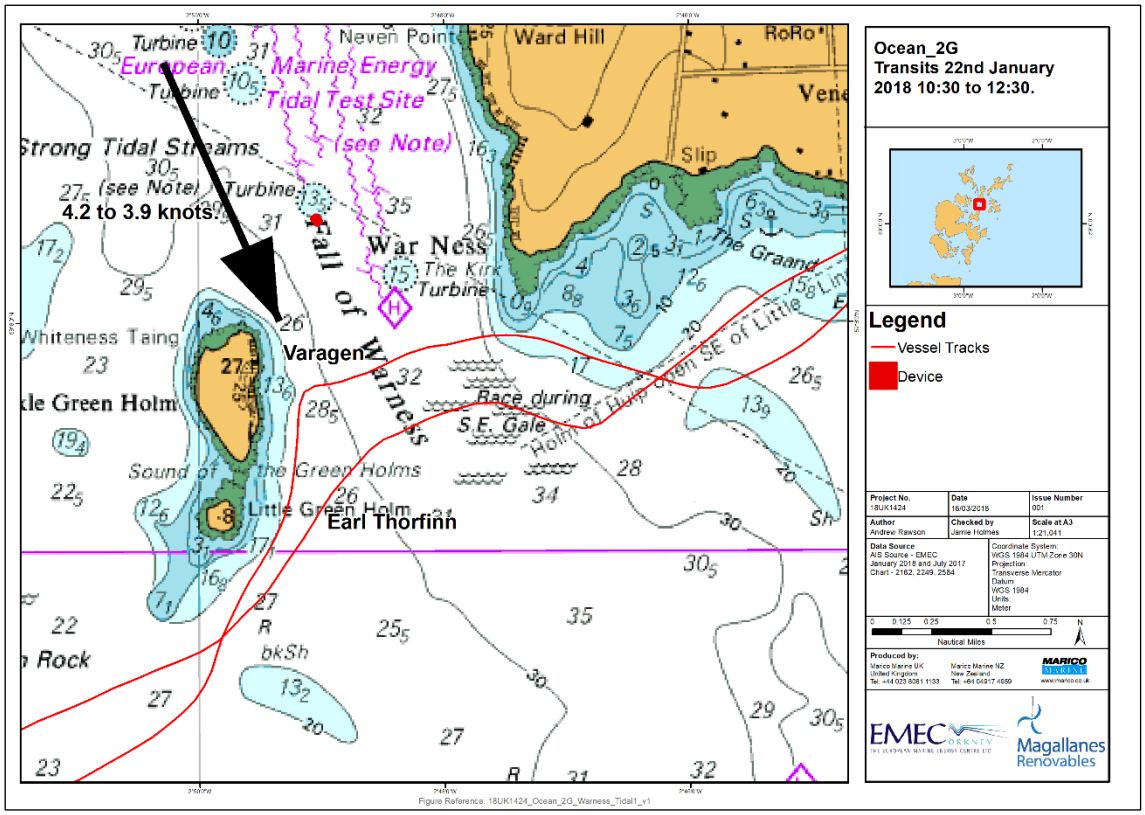


Figure 33: Vessel transits during sample south-easterly flows.

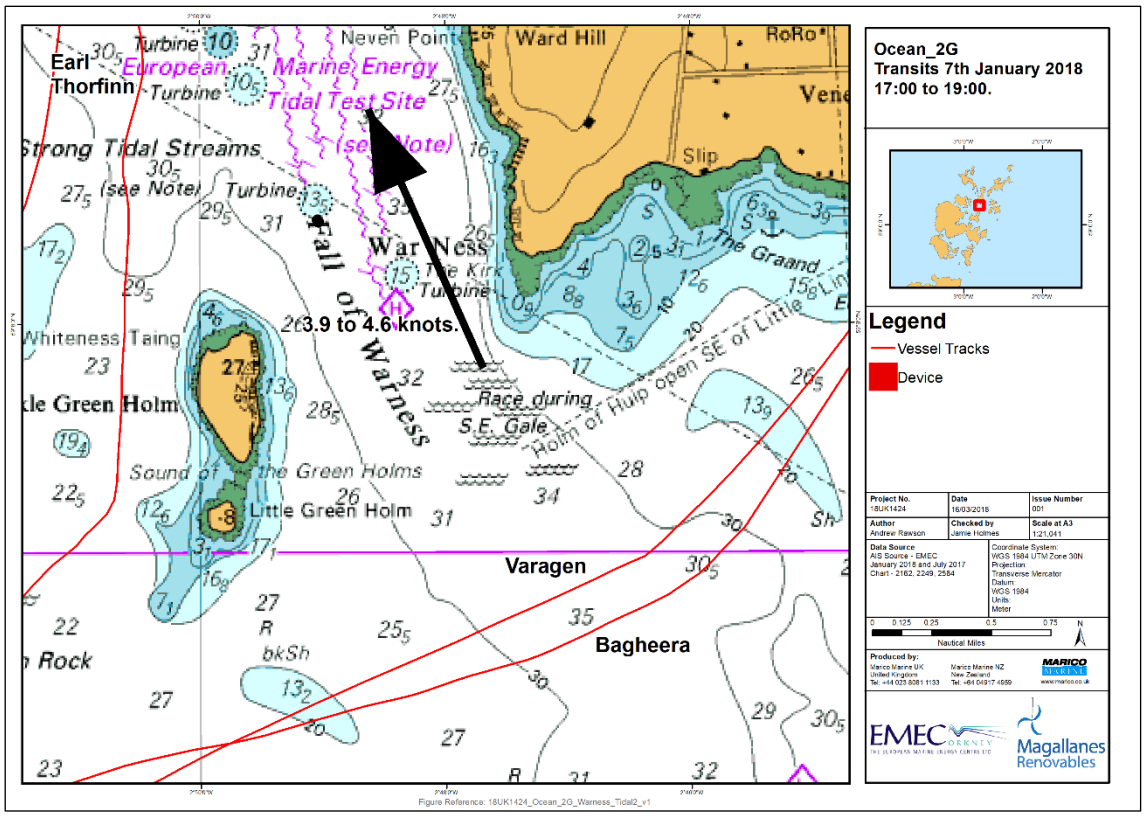


Figure 34: Vessel transits during sample north-westerly flows.

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 SR2000, 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 35** 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 would have to pass clear of the existing devices at present, for which there had not been an issue.

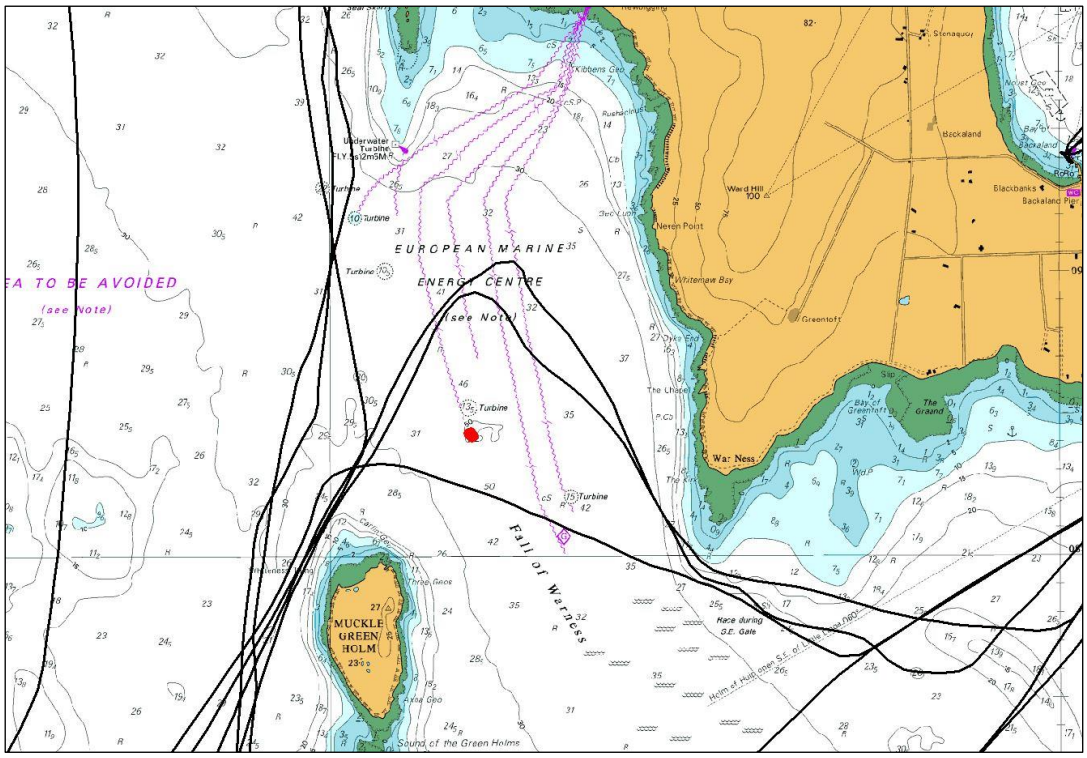


Figure 35: Example passage of ferries during SE gales (09/01/2018) – Wind SE 25 kts.

7.1.4 Recreational Craft Routeing

Finally, 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/ALLISION RISK

A simple geometric model of vessel traffic was used to test how the device would alter traffic flow and the risk of contact. A commercial vessel may collide with the device for many reasons, principally human error or mechanical failure. The presence of the device won't 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.

Figure 36 describes this model, for a vessel traffic flow with a known distribution and frequency passing an obstruction. Using distribution curves, it is possible to estimate the number of vessels which transit at a given distance from the route centreline, and therefore the proportion of transits which intersect the obstacle. However, the bridge team of a vessel take corrective action to prevent this and based on previous research, the proportion of critical navigational decisions which are compromised due to human error or mechanical failure are given as 1.6×10^{-4} or 0.016% per transit (Friis-Hansen, 2008). Given the strong tidal streams in the area and therefore the difficulty a vessel would have in manoeuvring clear of an obstruction, a conservative 10 fold increase of this value has been applied to 0.16%.

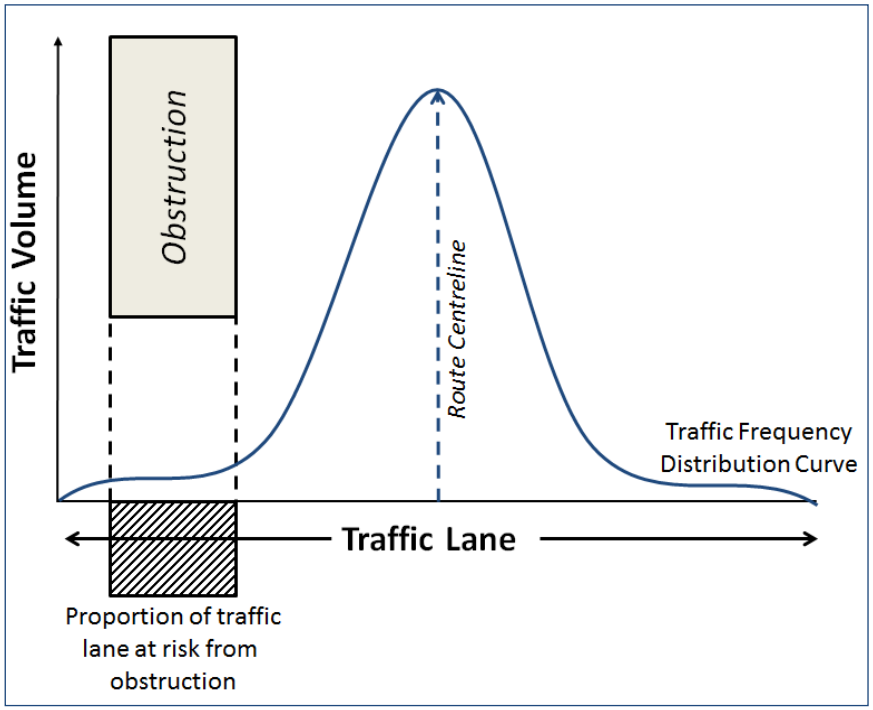


Figure 36: Risk Model.

Table 9 shows the results of the analysis. At the Shapinsay Sound site, whilst the route to the north is busy, the device is located well clear. Furthermore, vessel traffic is concentrated into the entrance of

Kirkwall Bay and therefore has a low distribution from the route centreline. This drives a negligible risk score.

The Fall of Warness site is more constricted and therefore the less numerous vessel transits when compared to Shapinsay Sound must pass relatively closer to the device. The low frequency of movements through this passage, however, results in a low likelihood of a vessel contacting with the device. This analysis includes only transiting vessels, with maintenance vessels not included in this assessment.

There are no contact incidents reported with the existing devices in the Fall of Warness site and stakeholders did not foresee that the ATIR platform would result in one (see **Annex C**). The device should be well marked and fitted with AIS and suitable radar reflecting materials to ensure that is visible in fog and reduced visibility.

Table 9: Vessel contact risk.

Site	Number of Movements per Year	Passing Distance of Route from Device (Metres)	Standard Deviation of Route (Metres)	Modelled Geometric Risk	Failure Rate per Movement	Likelihood of Contact (years)
Shapinsay Sound	2,370	1,050	250	Negligible	0.016%	Negligible
Fall of Warness	156	463	463	2.47%	0.16%	162 years

7.3 IMPACT ON COLLISION RISK

The Shapinsay Sound site is well clear of the main vessel routes in and out of Kirkwall (**Section 5**) and therefore will have a negligible impact on vessel routeing. It is extremely unlikely therefore that it would cause a collision to take place.

The Fall of Warness site is much closer to vessel traffic routes. However, the number of transits through the passage is quite low (at approximately 150 a year (~0.4 per day – see **Section 7.2**). Furthermore, there is more than 0.5nm of navigable sea room to the east and west of the 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 37 shows a schematic of the ATIR platform. The radius of the blades is 9.5 metres and the apex of the swept area is 4.4 metres below the surface. Given the width of the surface platform (6 metres), there are 6.5 metres of swept area either side of the platform.

For a navigating vessel to collide with the blades, the vessel must be within 7 metres of the device and drawing at least 7 metres. It is therefore far more likely that the vessel would collide with the platform than damage the blades, and small vessels would be incapable of contacting the blades.

The mooring arrangements are chain and, given the depth of water, will not compromise Under Keel Clearance (UKC) including when taking into account scouring.

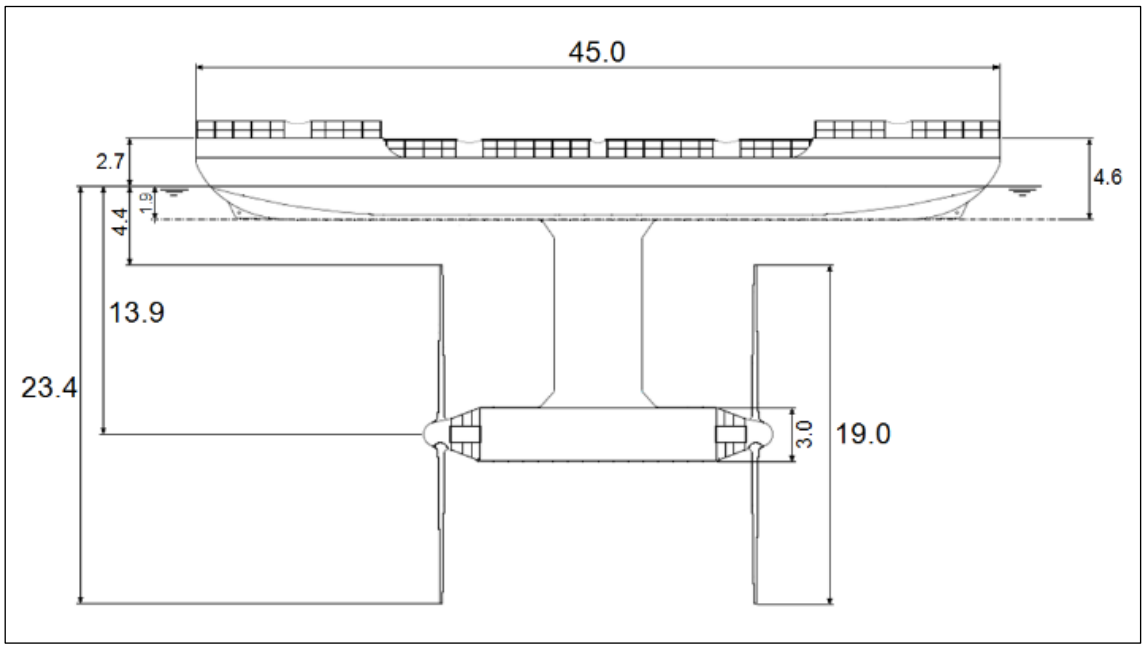


Figure 37: Schematic of Device (metres) – Source: TDK-MAG-MOOR-TR-001.

7.5 IMPACT ON CABLE RISK

An umbilical cable will be required between the platform and the existing cable infrastructure of less than 100 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 neither 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

The device is less than five metres high (**Section 2**) and will therefore ensure that most vessels will be visible over the top when navigating in the area. The exception may be small craft such as open top RIBs or pleasure craft as well as 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 turbines are subsurface, there would be minimal noise generated and so it would not interfere with sound signals used by vessels or aids to navigation.

7.8 IMPACT ON COMMUNICATIONS, RADAR AND POSITIONING SYSTEMS

The ATIR platform is 45m LOA and has a breadth of 6m, with structures extending to 5 metres above sea level. It therefore presents a significant cross section which should be easily identifiable by marine radars. Given that no generating infrastructure exists above the surface, there is no anticipated impact upon communications, radar and positioning systems.

During construction or decommissioning works, it would be likely that there would be large 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

The Shapinsay Sound site is well clear of all other developments and there are no anticipated cumulative or in-combination effects from other devices.

The Fall of Warness site, as a device test centre, is home to numerous other devices (see **Section 2.2** and **Figure 6**). Of these, most are well clear with the exception of the Scotrenewables Tidal Power Limited SR2000 which is located approximately 500 metres to the North-East. 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 ATIR platform and SR2000 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 SR2000. It is likely that the vessels would be offset one to two hundred metres to the west to be equidistant between Muckle Green Holm and the ATIR platform. Given the depth of water and low traffic density, this is not considered a significant impact (see **Section 7.1**).

As discussed in **Section 2.2**, during the lifecycle of the ATIR platform it is possible that further tidal turbines will be installed at the test site.

8 NAVIGATION RISK ASSESSMENT

8.1 INTRODUCTION AND METHODOLOGY

This 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 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**.

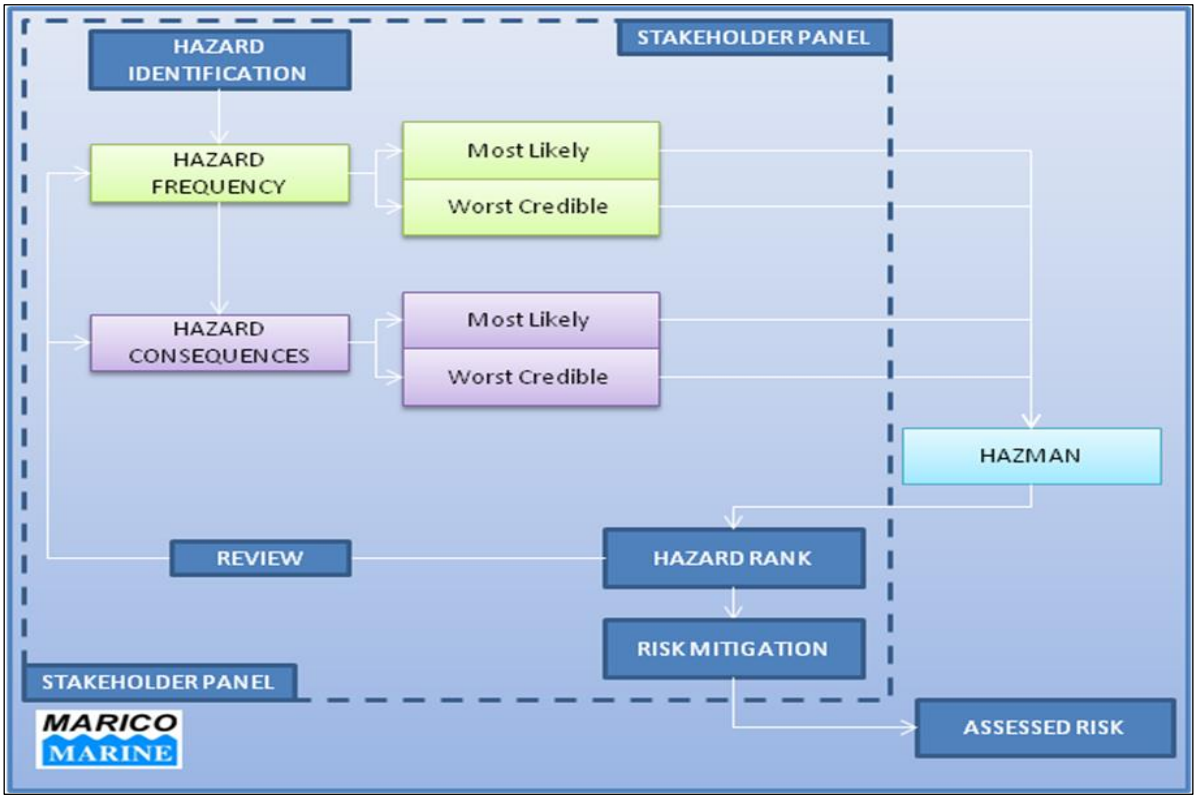


Figure 38: Marico Marine Risk Assessment Methodology

8.2 HAZARD IDENTIFICATION

The 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 ATIR platform);
- **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.

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.

8.3 RISK CONTROL OPTIONS

8.3.1 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 10: 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.

ID	Name	Description
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.
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 to the requirements of Trinity House and marked in line with IALA guidance.
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 metocean conditions.
11.	Agreed weather window for tow	Metocean 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.

8.3.2 Possible Additional Risk Controls

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

Table 11: Possible Additional Risk Controls

ID	Name	Description
1.	Radar Reflectors	ATIR platform will be fitted with radar reflectors. Given the conditions in the Fall of Warness, improving visibility during times of poor visibility is recommended. Whilst the device would have a strong radar return from the beam, most vessels transiting through the area would see a bow/stern profile which would not be as strong.
2.	AIS	ATIR platform should be fitted with AIS to improve visibility to passing vessels. It was also recommended that all other surface protruding devices be fitted with AIS (or virtual AIS ATONs) broadcasting Message 21.
3.	Heightened monitoring in adverse metocean 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.
4.	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.

8.4 RISK ASSESSMENT

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

8.4.1 Shapinsay Sound

Table 12 shows a summary risk assessment of the Shapinsay Sound temporary mooring. All hazards were assessed as Low Risk with embedded mitigation in place. However, all additional risk controls are recommended to be implemented.

A key hazard is contacts between passing vessels and the device, particularly fishing, recreational and maintenance vessels. The larger shipping would be concentrated in the main approach channels to the north (**Section 5**) and therefore the probability of a commercial vessel contacting with the device is low (**Section 7.2**), in such an event, it would cause significant damage. Smaller vessels would spend more time outside of the channel and navigating closer to the moorings, however any contact with the device would cause less damage.

Hazards associated with the device, particularly an injury during maintenance and less significantly the breakout of the device are also scored to be some of the top hazards. Given the relatively benign

conditions in the Shapinsay Sound, a breakout is not considered to be likely, although it could pose a hazard to the main shipping route if it was to occur.

It is unlikely that the device's location would require vessels to avoid it and there is little chance that a vessel's anchor or fishing gear would become tangled in the moorings.

Table 12: Shapinsay Sound Summary Risk Assessment.

ID	Hazard Title	Hazard Detail	Risk Score
3	Fishing Vessel Contacts Device	A fishing vessel contacts with the device	3.55
13	Personal Injury/Man Overboard from Device	Personal Injury or Man Overboard during Construction, Operation or Decommissioning	3.53
4	Recreational Vessel Contacts Device	A recreational vessel contacts with the device	3.47
5	Tug or Service Vessel Contacts Device	A Tug or Service vessel contacts with the device	3.47
12	Breakout of Device or Blade	The device's moorings or part of the device fails, becoming a hazard to navigation	2.85
10	Collision Involving Tug or Service Vessel	A navigating vessel collides with a Tug or Service vessel or construction/decommissioning vessel.	2.79
11	Grounding Involving Tug or Service Vessel	A Tug or Service Vessel grounds whilst on passage to/from the device	2.79
7	Fishing/Recreational Gear Interaction with Device	A fishing vessel's gear or recreational anchor interacts with the device or its moorings.	2.76
8	Third Party Collision Due to Avoidance of Device	Two navigating vessels collide due to the presence of the device	2.61
1	Commercial Ship Contacts Device	A commercial vessel such as a cargo vessel or tanker contacts with the device	2.57
2	Passenger Vessel Contacts Device	A Passenger Vessel contacts with the device	2.57
9	Third Party Grounding Due to Avoidance of Device	A navigating vessel (all types) grounds due to the presence of the device	2.53
6	Commercial Anchor Interaction with Device	A commercial vessel's anchor interacts with the device or its moorings.	1.86

8.4.2 The Tow

Table 13 shows a summary risk assessment of tow between the Shapinsay Sound and Fall of Warness. All hazards were assessed to Low Risk with embedded mitigation in place. However, all 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, which is the highest scored hazard across all three assessments. Most other vessels would leave a wide berth to a towing vessel and the density of traffic on the route is not significant (**Section 5**), 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 in suitable metocean conditions.

Table 13: Tow Summary Risk Assessment.

ID	Hazard Title	Hazard Detail	Risk Score
2	Contact between Device and Tugs	Towing vessel and the device come into contact during the tow operation.	3.68
1	Grounding of Tow	Tug and Tow runs aground	3.22
4	Collision during Tow	Tug and tow collides with another navigating vessel	2.94
5	Contact during Tow	Tug and tow comes into contact with an obstacle. E.g. other EMEC devices.	2.86
3	Loss of Tow	The tow fails resulting in device breakout	1.94

8.4.3 Fall of Warness

Table 14 shows a summary risk assessment for the Fall of Warness. All hazards were assessed to Low Risk with embedded mitigation in place. However, all additional risk controls are recommended to be implemented.

The Fall of Warness site was scored with a generally higher risk profile than the Shapinsay Sound for a number of reasons:

- Significant metocean and tidal conditions in the area which reduces manoeuvrability of transiting vessels;
- Proximity of vessel traffic route to the device, albeit far fewer transits compared to Shapinsay Sound; and
- Less available sea room inshore of Muckle Green Holm.

The top three hazards are all related to the maintenance of the device, or devices in the vicinity. Contacts, groundings and injuries to personnel are possible incidents due to the maintenance of the device. For passing vessels, the risks are generally low. Those scored relatively high are larger vessels passing through the Fall of Warness which may contact the device or in manoeuvring clear run aground. The low density of traffic has resulted in low frequencies for these hazards and therefore low risk scores. The installation of the ATIR platform within the EMEC test area which, has historically had numerous cables and devices, means that most regular runners and fishermen are well aware of the hazards in the area and therefore avoid the area or take seaman like precautions.

Table 14: Fall of Warness Summary Risk Assessment.

ID	Hazard Title	Hazard Detail	Risk Score
5	Tug or Service Vessel Contacts Device	A Tug or Service vessel contacts with the device	3.68
11	Grounding Involving Tug or Service Vessel	A Tug or Service Vessel grounds whilst on passage to/from the device	3.60
13	Personal Injury/Man Overboard from Device	Personal Injury or Man Overboard during Construction, Operation or Decommissioning	3.53
2	Passenger Vessel Contacts Device	A Passenger Vessel contacts with the device	3.15
9	Third Party Grounding Due to Avoidance of Device	A navigating vessel (all types) grounds due to the presence of the device	3.13
10	Collision Involving Tug or Service Vessel	A navigating vessel collides with a Tug or Service vessel or construction/decommissioning vessel.	2.79
1	Commercial Ship Contacts Device	A commercial vessel such as a cargo vessel or tanker contacts with the device	2.79
3	Fishing Vessel Contacts Device	A fishing vessel contacts with the device	2.79
4	Recreational Vessel Contacts Device	A recreational vessel contacts with the device	2.71
12	Breakout of Device or Blade	The device's moorings or part of the device fails, becoming a hazard to navigation	2.53
8	Third Party Collision Due to Avoidance of Device	Two navigating vessels collide due to the presence of the device	2.45
7	Fishing/Recreational Gear Interaction with Device	A fishing vessel's gear or recreational anchor interacts with the device or its moorings.	1.86
6	Commercial Anchor Interaction with Device	A commercial vessel's anchor interacts with the device or its moorings.	1.73

8.5 SUMMARY

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

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 CONCLUSIONS

1. This NRA has assessed the risk to navigation associated with the Ocean_2G project; the ATIR platform's temporary mooring and assembly in the Shapinsay Sound, the tow to the Fall of Warness and its mooring in that location.
2. This assessment has been conducted to the assessment methodology of MGN 543 and MCA guidance on assessing OREIs.
3. A review of the project sites demonstrates the significant tidal flows in the Fall of Warness site and the interrelationship between the various devices in the EMEC test area.
4. Consultation was conducted with various regulators and local stakeholders to understand the activities of vessels in the area and their experiences with the existing EMEC devices.
5. Analysis of vessel traffic was conducted to understand the traffic profile in the area. The Shapinsay Sound site is well clear of the main shipping routes into Kirkwall and the impact is therefore low. The Fall of Warness site has a lower density of vessel traffic, however some deep draught traffic pass through the area. Vessel traffic in both locations is highly seasonal with cruise ships, recreational and fishing vessels mostly active in the summer months.
6. Incidents were reviewed in the area, and show a relatively low incident rate in the study areas.
7. A review of the impacts of the devices was conducted and show little impact on collision risk, contact risk, under keel clearance, search and rescue or communications, radar and position systems.
8. A risk assessment was conducted to assess the likelihood and consequence of each hazard for each phase of the project. All hazards were scored as Low Risk, in general the Fall of Warness site had relatively higher risk scores compared to the Shapinsay Sound site.
9. Risk controls were identified, the majority of which are embedded in the project design, other risk controls were identified and have been recommended.

9.2 RECOMMENDATIONS

The following recommendations have been identified:

1. The project developer under the Ocean_2G project, Magallanes, should implement all embedded risk controls, see **Section 8.3.1**.
2. The ATIR platform should be fitted with AIS and radar reflectors to improve its visibility.

3. EMEC should consider requiring all existing surface protruding devices and future devices to be fitted with AIS.

9.3 SUMMARY

In summary, the NRA has concluded that the Ocean_2G project is Low Risk with suitable risk controls identified and in place.

REFERENCES

Abbot Risk Consulting (2005). Fall of Warness Navigational Risk Assessment.

Admiralty (2008). Admiralty Sailing Directions: North Coast of Scotland Pilot Book NP 52.

Anatec (2010). Fall of Warness Navigational Risk Assessment Update.

Aquatera (2013). Analysis of AIS Tracks at the Fall of Warness, Scapa and Shapinsay test sites.

DECC (2005). Methodology for Assessing the Marine Navigational Safety & Emergency response Risks of Offshore Renewable Energy Installations (OREI)

DfT (2017). UK Maritime Trade Statistics.

EMEC (2012). Shapinsay Sound Navigational Risk Assessment Update.

Friis-Hansen, P. (2008). IWRAP: Basic Modelling Principles for Prediction of Collisions and Groundings Frequencies.

HSE and MCA (2017). Regulatory expectations on moorings for floating wind and marine devices.

IALA (2004). IALA Recommendation 0-117 on the Marking of Offshore Wind Farms.

IMO (2000). Formal Safety Assessment: Decision parameters including risk acceptance criteria. MSC 72/16.

IMO (2002). SOLAS Chapter V: Safety of Navigation.

Leask Marine (2018). Fall of Warness Mooring Configuration and Installation Plan. LSK-10159-OP05-TN01-R02.

Leask Marine (2018). Tow Plan: Shapinsay-Fall of Warness. LSK-10159-OP03-TN01-R02.

Leask Marine (2018). Shapinsay Mooring Configuration and Installation Plan. LSK-10159-OP05-TN01-R02.

MCA (2016). Offshore Renewable Energy Installations: Requirements, Guidance and Operational Considerations for Search and rescue and Emergency Response.

MCA (2016). MGN 543: Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency response.

Orkney Islands Council Marine Services (2018). Annual Report.

RYA (2015). The RYA's Position on Offshore Renewable Energy Developments: Paper 3 (of 4) – Tidal Energy.

Tadek (2018). Technical Overview - Mooring System Design. TDK-MAG-MOOR-TR-001.

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 7.2** and **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 5.5**
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 8.3**

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 8.3**
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 8.3 –** 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 8.3**
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 2.1.2** and **Section 8.3**
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 2.1.2** and **Section 8.3**
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 2.1.2** and **Section 8.3**

d. If the site would be marked by additional electronic means e.g. Racons	✓	**Section 2.1.2** and **Section 8.3**
e. If the site would be marked by an AIS transceiver, and if so, the data it would transmit.	✓	**Section 2.1.2** and **Section 8.3**
f. If the site would be fitted with audible hazard warning in accordance with IALA recommendations	✓	**Section 2.1.2** and **Section 8.3**
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 2.1.2** and **Section 8.3**
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 2.1.2** and **Section 8.3**
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 2.1.2** and **Section 8.3**
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 2.1.2** and **Section 8.3**
k. The ID marking will conform to a spreadsheet layout, sequential, aligned with SAR lanes and avoid the letters O and I.	✓	**Section 2.1.2** and **Section 8.3**
l. Working lights will not interfere with AtoN or create confusion for the Mariner navigating in or near the OREI.	✓	**Section 2.1.2, Section 8.3** 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:		

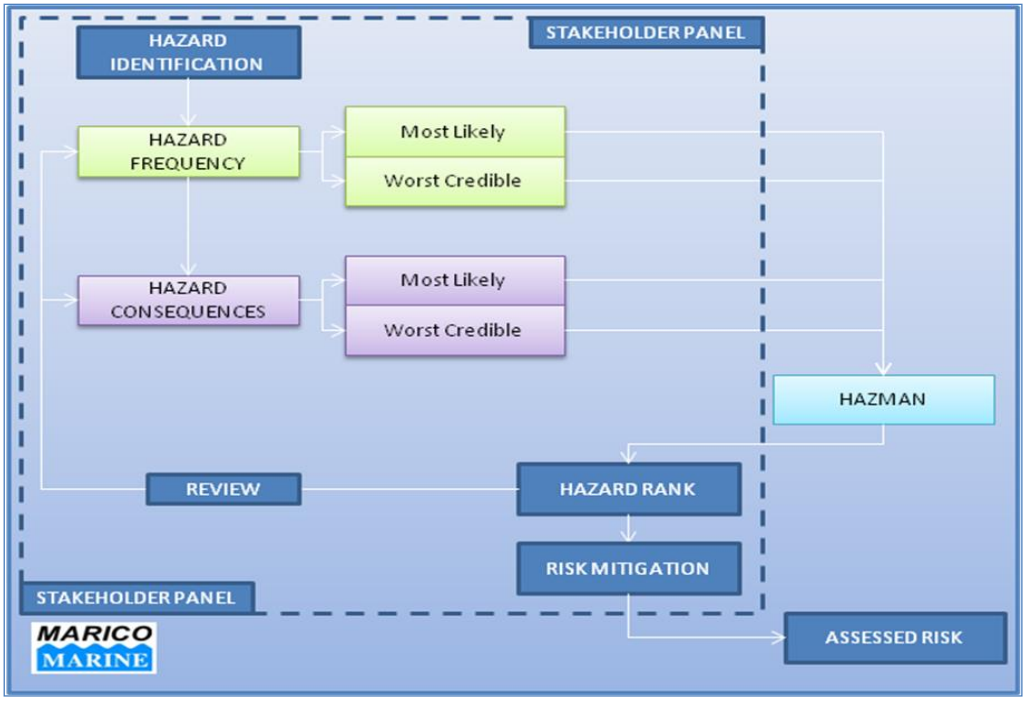
i. Pre-consent: The site and its immediate environs extending to 500m outside of the development area shall be undertaken as part of the licence and/or consent application. The survey shall include all proposed cable route(s).	✓	**Section 8.3.1**
ii. Post-construction: Cable route(s)	✓	**Section 8.3.1**
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.	✓	**Section 8.3.1**
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 8.3**
i. Promulgation of information and warnings through notices to mariners and other appropriate maritime safety information (MSI) dissemination methods.	✓	**Section 8.3**
ii. Continuous watch by multi-channel VHF, including Digital Selective Calling (DSC).		

iii. Safety zones of appropriate configuration, extent and application to specified vessels[5]		
iv. Designation of the site as an area to be avoided (ATBA).	✓	**Section 8.3**
v. Provision of AtoN as determined by the GLA	✓	**Section 8.3**
vi. Implementation of routeing measures within or near to the development.	✓	**Section 8.3**
vii. Monitoring by radar, AIS, CCTV or other agreed means	✓	**Section 8.3**
viii. Appropriate means for OREI operators to notify, and provide evidence of, the infringement of safety zones.	✓	**Section 8.3**
ix. Creation of an Emergency Response Cooperation Plan with the MCA's Search and Rescue Branch for the construction phase onwards.	✓	**Section 8.3**
x. Use of guard vessels, where appropriate	✓	**Section 8.3**
xi. Any other measures and procedures considered appropriate in consultation with other stakeholders.	✓	**Section 8.3**
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 8.3**
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 8.3**

Annex B NRA Methodology

Methodology

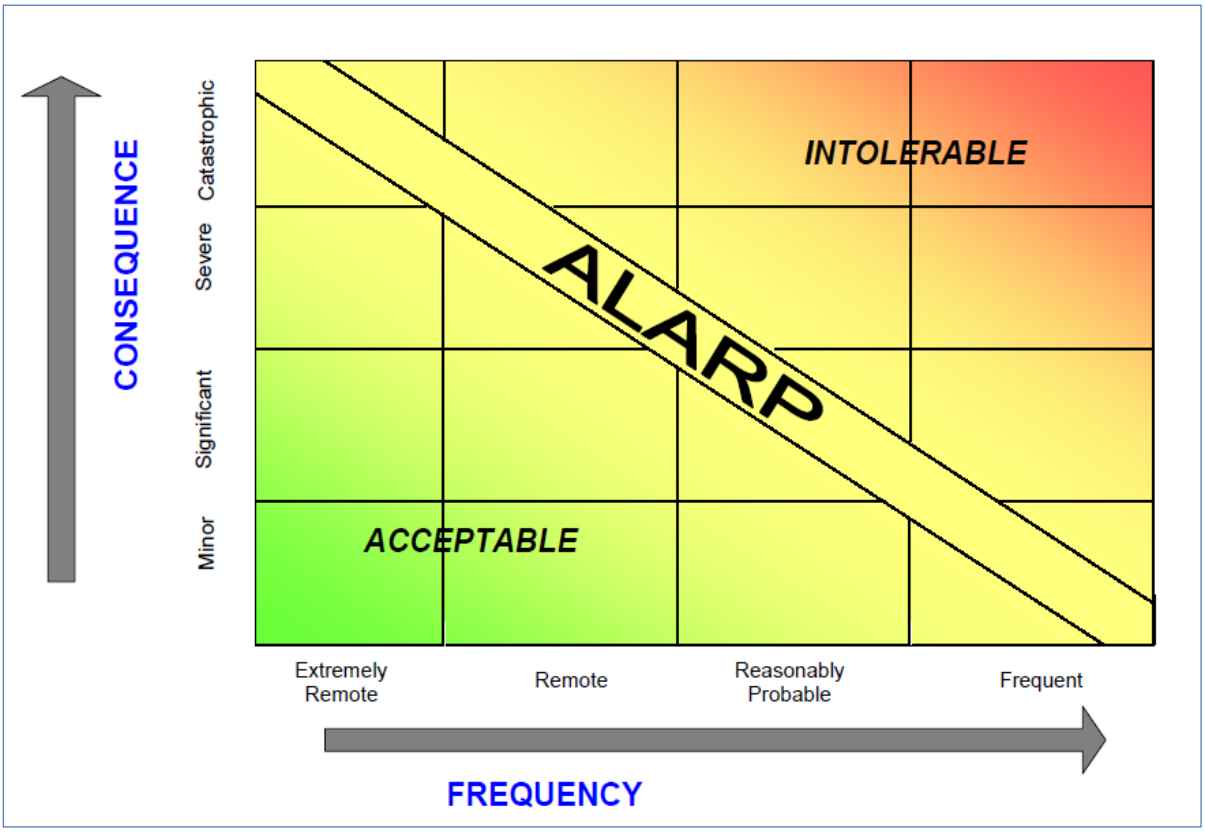
This Navigation Risk Assessment (NRA) was commissioned to assess the impact on navigation potentially caused by each of the three phases of the project. The NRA is limited to identifying and quantifying any additional or increased navigational risk resulting from the project. It subsequently identifies 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

Correspondence – EMEC Ocean 2G – 18UK1424 Navigation Risk Assessment

From: Helen Croxson
Sent: 21 March 2018 20:38
To: Andrew Rawson
Cc: Peter Lowson
Subject: RE: EMEC Ocean_2G Project NRA Addendum

Andrew,

Thank you very much for early sight of the proposed new EMEC Ocean 2G Project.

I have considered your email and attachments, and have the following initial comments to make at this stage:

Firstly, confirmed that as this has no engine (i.e. not under its own propulsion) it's not considered a ship as per Merchant Shipping Legislation. Marine Scotland Licensable activity. *HC to query re: towage aspect/loadline (exemptions) with MCA Marine Technology.*

Impact on navigation for both commercial and recreational craft should be established specifically:

Collision Risk
Navigational Safety
Visual intrusion and noise
Risk Management and Emergency response
Marking and lighting of site and information to mariners
Effect on small craft navigational and communication equipment
The risk to drifting recreational craft in adverse weather or tidal conditions
The likely squeeze of small craft into the routes of larger commercial vessels.

The Navigational Risk Assessment (NRA) will need to be submitted in accordance with MGN 543 (and MGN 372) and the MCA Methodology for Assessing the Marine Navigation Safety & Emergency Response Risks of Offshore Renewable Energy Installations (OREI).

This NRA should be accompanied by a detailed MGN 543 Checklist.

How old is the existing traffic survey data? The shipping and navigation study should include radar and manual observations in addition to AIS data to ensure vessels of less than 300gt are captured, and should be completed within 24 months prior submission.

The marking of offshore wave and tidal energy installations will be based on recommendations of the IALA, and the offshore structures marking can be found on the IALA website. NLB to be consulted.

Consideration will need to be given to the implications of the site size and location on SAR resources and Emergency Response Co-operation Plans (ERCOP) for both construction and operation phases. Any additional Search and Rescue requirements, as per MGN 543 Annex 5, will be discussed and agreed at the approval stage and recorded in a SAR checklist.

Particular attention should be paid to any cabling routes and where appropriate burial depth for which a Burial Protection Index study should be completed and, subject to the traffic volumes, an anchor penetration study may be necessary. If cable protection are required e.g. rock bags, concrete mattresses, the MCA would be willing to accept a 5% reduction in surrounding depths referenced to Chart Datum. This will be particularly relevant where depths are decreasing towards shore and potential impacts on navigable water increase.

The cumulative and in combination effects require consideration and the proximity of sites close to the development area will require a detailed assessment.

Regulatory expectations on moorings for floating wind and marine devices to be followed which includes Third Party
Verification. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/640962/Regulatory_expectations_on_mooring_devices_from_HSE_and_MCA.PDF

Full consultation with local users/stakeholders should be undertaken, NLB regarding lighting and marking, and relevant Harbour Authorities.

I hope you find this useful at this stage.

Kind regards

Helen

Maritime & Coastguard Agency

Helen Croxson, Offshore Renewables Advisor
Navigation Safety Branch, Bay 2/25
Maritime & Coastguard Agency
Spring Place, 105 Commercial Road, Southampton, SO15 1EG
Tel:
Mobile:
Email:

Please note I currently work Tuesdays, Wednesdays and Thursdays.

Correspondence – EMEC Ocean 2G – 18UK1424 Navigation Risk Assessment

From: Peter Douglas
Sent: 22 March 2018 16:00
To: Andrew Rawson
Cc: Ed Rogers; Gillian Burns
Subject: RE: Navigation Risk Assessment for EMEC Tidal Project

Hi Andrew,

Yesterday was productive, thank you.

The Ocean-2G looks to be an interesting project. Our lighting recommendation remains as below. Whilst we don't consider a radar reflector to be necessary, it wouldn't do any harm to fit such to satisfy other local stakeholders. We would now require AtoN AIS to be installed.

Am in the office tomorrow if you wish to discuss.

Best wishes,

Peter

Peter Douglas
Navigation Manager
Northern Lighthouse Board

From: Peter Douglas
Sent: 21 December 2017 12:44
To: Caitlin Long
Cc: Steven Driver; Gillian Burns
Subject: RE: EMEC - Fall of Warness - Magallanes

Hi Caitlin,

Steve isn't at work at present -apologies for the delay in picking this up.

We've looked at the Magellanes design, which is quite a sizeable 'vessel'.

The marking requirements will depend to some extent on which berth it is going into, but in general:

- We wouldn't accept the same lighting as the Spanish – we would prefer to see it marked as a renewable device with two 3 mile yellow lights flashing once every 5 seconds, one at each end of the platform. The lights should be synchronised.
- We wouldn't require a radar reflector as it looks to be a sizeable radar target.
- AtoN AIS would be advisable.

Hope this is helpful in the planning stage.

Best wishes,

Peter

Correspondence – EMEC Ocean 2G – 18UK1424 Navigation Risk Assessment

From: orkneyfisheries
Sent: 23 March 2018 12:28
To: Andrew Rawson
Subject: Re: Navigation Risk Assessment for EMEC Tidal Project

Hello Andrew

I have clarified with the relevant fishermen that this device should not interfere with their activities,

Rgds

Fiona

Minutes – EMEC Ocean 2G – 18UK1424 Navigation Risk Assessment

Client:	EMEC	
Project:	18UK1424	
Attendees:	Glenn Porter (GP)	Marine Superintendent – Orkney Ferries
	Stephen Barnes (SB)	Marine Superintendent – Orkney Ferries
	Lewis Garson (LG)	Master – Orkney Ferries
	Andrew Rawson (AR)	Marico Marine – Senior Consultant
Venue:	Teleconference	
Date of Meeting:	15:00 to 15:30 19th March 2018	

Item	Action item / Notes for the record	Action
1	**Introduction**	
2	**Overview**	
2.1	AR provided an overview of the project, the device and the scope of the Navigation Risk Assessment. The NRA would assess three phases of the Ocean_2G tidal device: • Temporary mooring in Shapinsay Sound; • Tow to Fall of Warness; and • Mooring in Fall of Warness.	
2.2	Plots were provided of the device location to Orkney Ferries and minutes were provided in return of previous consultation Orkney Ferries had undertaken with tidal projects in Westray South.	
3	**Shapinsay Sound**	
3.1	The location of the device in Shapinsay Sound was reviewed. It was concluded that the location was well clear of the main ferry routes into Kirkwall.	
3.2	The pilotage arrangements were discussed, with a disembark point approximately 0.5nm to the north and therefore clear of the development site.	
3.3	A significant number of cruise vessels come into Kirkwall, up to 150 a year, however most would transit straight through this area.	
3.4	There were no major anchorages near to the mooring site, however on occasion some smaller vessels may anchor in Inganess Bay.	
3.5	The impacts to fishing and recreational may be more significant but this would need to be discussed with the relevant stakeholders.	
4	**Fall of Warness**	
4.1	The key ferry routes were considered to be well clear of Berth 1, with the Kirkwall-Eday route passing to the south of the area and the Kirkwall-Westray routes well to the west. The routes of other vessels (e.g. cruise ships) go through the development site. Fishing vessels in the area would generally only be on transit rather than engaged in fishing.	

4.2	During bad weather, particularly strong S.E. winds with a big swell, ferries may choose to pass to the west of Muckle Green Holm, coming into the Fall of Warness development site before passing close inshore at War Ness. This allows the vessel to maintain some shelter and head into the swell rather than beam on, allowing for a smoother passage. Navigation in the area can be challenging under these conditions.	
4.3	In general it was felt that the existing devices in the Fall of Warness had a minimal impact on navigation. It was not anticipated that the Ocean_2G device would alter this.	
5	**Risk Controls / Arrangements**	
5.1	Risk controls were discussed. The following were recommended: • AIS was strongly recommended to be fitted to the device; • Radar reflectors were recommended, the vessel would likely have a good return when viewed side on but may be poor from the end; • AR explained the recommendation for 2 x yellow flashing lights as marking. LG recommended that these could be differentiated from the other devices (e.g. phasing/intervals); • Notice to Mariners are provided by the developers to Orkney Harbour, generally with Orkney Ferries copied in, and therefore they felt they were well provided with information; • AR explained that it was not anticipated that any formal safety zones would be applied for as part of this project; •	
5.2	It was noted that the area regularly had very thick fog and therefore enhanced marking in the form of radar reflectors and AIS was strongly recommended. The existing devices are generally well visible in most conditions with the rougher seas further to the south.	
5.3	Maintenance vessels are based in Stromness and Kirkwall. Orkney Ferries have had no problems with interactions with these vessels.	

Minutes – EMEC Ocean 2G – 18UK1424 Navigation Risk Assessment

Client:	EMEC	
Project:	18UK1424	
Attendees:	Brian Kynock (BK)	Orkney Marinas
	Andrew Rawson (AR)	Marico Marine – Senior Consultant
Venue:	Teleconference	
Date of Meeting:	09:30 to 10:00 20th March 2018	

Item	Action item / Notes for the record	Action
1	**Introduction**	
2	**Overview**	
2.1	AR provided an overview of the project, the device and the scope of the Navigation Risk Assessment. The NRA would assess three phases of the Ocean_2G tidal device: • Temporary mooring in Shapinsay Sound; • Tow to Fall of Warness; and • Mooring in Fall of Warness.	

2.2	BK provided an overview of Orkney Marinas and recreational activities in the Orkneys:
	• There are 3 marinas:
	  ○ Kirkwall – 90 berths;
	  ○ Stromness – 60 berths;
	  ○ Westray – 12 berths.
	• Approximately a third are visitor berths.
	• 780 visitors last year, typically between April and September;
	• Off-season, the marinas are infrequently staffed by volunteers, during peak season there are employed staff;
	• The marinas have a 20m LOA and 4m draught restriction. Larger vessels will need to anchor or go alongside the quay.
	• There is a yacht club in Kirkwall, with racing generally in Kirkwall Bay. Some racing is further, e.g. round Shapinsay Race or Norway-Orkneys race.	

2.3	Plots were provided of the device location to BK.	
3	**Shapinsay Sound**	
3.1	BK could not see a problem with the location of the device here, it was well clear of routes and unlikely to pose a hazard.	
3.2	Given the depth of water and suitability, no recreational vessels would choose to anchor near the device berth.	
4	**Fall of Warness**	
4.1	Most yachts in the Fall of Warness would be transiting through, to Westray or further north (Fair Isle etc.). Common to see yachts sticking to the shore of Eday.	

4.2	BK described how quiet the area is and how there have been no reported issues between yachts and the existing devices.	
4.3	Provided the device is well marked and inshore route to the east is available then BK could not forsee a problem with this device berth.	
5	**Risk Controls / Arrangements**	
5.1	AR described the marking and lighting arrangements. BK recommended that AIS be fitted to the device, more yachts use AIS than radar nowadays, especially with the rise of tablet chart plotting apps.	
5.2	There had been no issues with near misses between the maintenance vessels and recreational traffic.	
5.3	Notice to Mariners are downloaded from the Orkney Harbours website and posted on the noticeboards at each of the marinas.	

Minutes – EMEC Ocean 2G – 18UK1424 Navigation Risk Assessment

Client:	EMEC	
Project:	18UK1424	
Attendees:	Alistair Wylie (AW)	Orkney Islands Council Marine Services – DHM Operations
	Andrew Rawson (AR)	Marico Marine – Senior Consultant
Venue:	Teleconference	
Date of Meeting:	14:00 to 15:00 20th March 2018	

Item	Action item / Notes for the record	Action
1	**Introduction**	
2	**Overview**	
2.1	AR provided an overview of the project, the device and the scope of the Navigation Risk Assessment. The NRA would assess three phases of the Ocean_2G tidal device: • Temporary mooring in Shapinsay Sound; • Tow to Fall of Warness; and • Mooring in Fall of Warness. Plots were provided of the device location to AW.	
3	**Shapinsay Sound**	
3.1	AW describes the types of traffic passing through Shapinsay Sound, including 140 cruise ships. Noted that the device was tucked away to the south, but that it should not be placed any further north, particularly with the pilot disembarking point to the north.	
3.2	Vessels very occasionally anchor in the bays to the south of Shapinsay	
3.3	Bay of Meil has some fish farm traffic but there would be minimal impact on recreational of fishing activities.	
3.4	Maintenance vessels based on Kirkwall have not had any impact on navigational safety of other vessels, no near misses or congestion issues reported.	
4	**The Tow to Fall of Warness**	
4.1	The proximity of the moorings to the main shipping channel means that encountering fishing gear is unlikely as the shipping route needs to be kept clear of pots.	
4.2	Pilotage is required under the regulations, but would be reviewed at the time given the position of the site (see below).	
5	**Fall of Warness**	
5.1	A minority of cruise ships go through the Fall of Warness, on passage to Iceland or the west coast of Scotland.	
5.2	Passenger ferries will take this route when a strong south-easterly wind creates swells up to 10m off the headland, for which vessels should not be beam on to. These ferries at	

	the moment and would continue to pass to the north of the ScotRenewables device and therefore would be clear of the Ocean_2G device.	
5.3	Vessels would be unlikely to pass between the two devices.	
5.4	Majority of any fishing and recreational activity in this area would be passing through. Large purse seiners on passage between Petershead and the North Atlantic can come through this area.	
5.5	It was noted that some of the Fall of Warness devices used to be marked by AIS but are no longer.	
5.6	Harbour team now have radar coverage of the Fall of Warness but they are not required to monitor the area.	
6	**Risk Controls / Arrangements**	
6.1	Orkney Harbour team would expect to see the device marked with AIS, radar reflectors and notice to mariners to be issued for its activities. Increasing visibility is important, given the large swells that can occur in the area and the propensity for fog.	
6.2	The device would require pilotage, given its size, particularly the inbound tow into the Orkneys. The outbound tow would need to be reviewed as to whether pilotage is required given it is positioned further east than the Disembark point. A pre-towage survey and a towage plan will be required as per Pilotage Directions 4(3).	

Annex D Shapinsay Sound Risk Assessment

ID	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Embedded Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score	Possible Additional Risk Controls
							People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency		
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; Major damage to Vessel; Minor pollution; Major adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting;	1	2	1	2	2	4	4	2	4	1	2.57	Radar Reflectors; AIS;
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; Minor pollution; Major adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting;	1	2	1	2	2	4	4	2	4	1	2.57	Radar Reflectors; AIS;
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; Major damage to Device; Loss of Vessel; Minor pollution; Major adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting;	2	1	1	2	4	4	4	2	4	2	3.55	Radar Reflectors; AIS;
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; Major damage to Device; Loss of Vessel; Minor pollution; Major adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting;	2	1	1	2	4	4	3	2	4	2	3.47	Radar Reflectors; AIS;
5	Tug or Service Vessel Contacts Device	A Tug or Service 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; Loss of Vessel; Minor pollution; Major adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting; Site Access Application;	2	1	1	2	4	4	3	2	4	2	3.47	Radar Reflectors; AIS;

ID	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Embedded Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score	Possible Additional Risk Controls
							People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency		
6	Commercial Anchor Interaction with Device	A commercial vessel's anchor interacts with the device or its moorings.	Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Holding Ground;	Damage to moorings; No Injuries; No Pollution; Minor operational downtime;	Single Major Injury; Loss of Anchor; No Pollution; Moderate Operational Downtime;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting;	1	2	1	2	2	3	2	1	3	1	1.86	Radar Reflectors; AIS;
7	Fishing/Recreational Gear Interaction with Device	A fishing vessel's gear or recreational anchor interacts with the device or its moorings.	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions;	Damage to moorings; Damage to fishing gear; No Injuries; No Pollution; Minor operational downtime;	Single Major Injury; Loss of Anchor; No Pollution; Moderate Operational Downtime;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting;	1	2	1	2	3	4	2	1	3	2	2.76	Radar Reflectors; AIS;
8	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; Minor pollution; Moderate adverse publicity;	Notice to Mariners;	2	2	1	2	2	4	3	2	4	1	2.61	
9	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; Moderate adverse publicity;	Notice to Mariners;	2	2	1	2	2	4	3	2	3	1	2.53	
10	Collision Involving Tug or Service Vessel	A navigating vessel collides with a Tug or Service vessel or construction/decommissioning vessel.	Insufficient Lookout; Increased Vessel Activity; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor Damage to device and its moorings; Negligible Damage to Vessel; Minor Injuries; No Pollution;	Single fatality or multiple major injuries; Loss of Vessel; Minor pollution; Moderate adverse publicity;	PPE; Training; ERCOP; Site Access Application;	2	2	1	2	3	4	3	2	3	1	2.79	
11	Grounding Involving Tug or Service Vessel	A Tug or Service 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;	Single fatality or multiple major injuries; Loss of Vessel; Minor pollution; Moderate adverse publicity;	PPE; Training; ERCOP; Site Access Application;	2	2	1	2	3	4	3	2	3	1	2.79	
12	Breakout of Device or Blade	The device's moorings or part of the device fails, becoming 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; Adverse Publicity;	No Injuries; Loss of Device; Minor Pollution; Moderate Adverse Publicity;	Inspection and Maintenance; Remote Shutdown; GPS Monitoring; ERCOP; Incident Monitoring and Reporting;	1	2	1	2	3	1	4	2	4	2	2.85	Heightened monitoring in adverse metocean conditions;

ID	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Embedded Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score	Possible Additional Risk Controls
							People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency		
13	Personal Injury/Man Overboard from Device	Personal Injury or Man Overboard during Construction, Operation or Decommissioning	Human Error; Poor Operating Procedures; Equipment or Mechanical Failure; Adverse Weather Conditions;	No damage; Minor injuries; No pollution; Minor Adverse Publicity;	Single Fatality; No Damage; No Pollution; Moderate Adverse Publicity;	PPE; Training; ERCOP; Incident Monitoring and Reporting; Site Access Application;	2	1	1	2	4	4	1	1	4	3	3.53	

Annex E Project Tow Risk Assessment

ID	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Embedded Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score	Possible Additional Risk Controls
							People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency		
1	Grounding of Tow	Tug and Tow runs aground	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 to device and tug; Multiple moderate injuries; Minor pollution; Major operational downtime;	Training; ERCOP; Tow Risk Assessment and Passage Plan; Tow Weather Window;	2	2	1	2	3	3	4	2	4	2	3.22	
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 tow; Minor injuries; No Pollution; Minor operational downtime;	Major damage to device and tug; Multiple moderate injuries; Minor pollution; Major operational downtime;	Training; ERCOP; Tow Risk Assessment and Passage Plan; PPE; Tow Weather Window;	2	2	1	2	4	3	4	2	4	2	3.68	
3	Loss of 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	1	1	1	3	1	4	2	4	2	1.94	
4	Collision during Tow	Tug and tow collides with another navigating vessel	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 to device and tug; Multiple moderate injuries; Minor pollution; Major operational downtime;	ERCOP; Notice to Mariners; Training; Tow Risk Assessment and Passage Plan; Site Access Application; Tow Weather Window;	2	2	1	2	3	4	4	2	4	1	2.94	AIS; Radar Reflectors; Pre-planning with Orkneys Harbour;
5	Contact during Tow	Tug and tow comes 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 to device and tug; Multiple moderate injuries; Minor pollution; Major operational downtime;	ERCOP; Training; Tow Risk Assessment and Passage Plan; Tow Weather Window;	2	2	1	2	3	3	4	2	4	1	2.86	

Annex F Fall of Warness Risk Assessment

ID	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Embedded Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score	Possible Additional Risk Controls
							People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency		
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; Major damage to Vessel; Minor pollution; Major adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting;	1	2	1	2	3	4	4	2	4	1	2.79	Radar Reflectors; AIS;
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; Minor pollution; Major adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting;	1	2	1	2	3	4	4	2	4	2	3.15	Radar Reflectors; AIS;
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; Major damage to Device; Loss of Vessel; Minor pollution; Major adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting;	2	1	1	2	3	4	4	2	4	1	2.79	Radar Reflectors; AIS;
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; Major damage to Device; Loss of Vessel; Minor pollution; Major adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting;	2	1	1	2	3	4	3	2	4	1	2.71	Radar Reflectors; AIS;
5	Tug or Service Vessel Contacts Device	A Tug or Service 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; Loss of Vessel; Minor pollution; Major adverse publicity;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting; Site Access Application;	2	2	1	2	4	4	3	2	4	2	3.68	Radar Reflectors; AIS;
6	Commercial Anchor Interaction with Device	A commercial vessel's anchor interacts with the device or its moorings.	Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Holding Ground;	Damage to moorings; No Injuries; No Pollution; Minor operational downtime;	Single Major Injury; Loss of Anchor; No Pollution; Moderate Operational Downtime;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting;	1	2	1	2	1	3	2	1	3	1	1.73	Radar Reflectors; AIS;

ID	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Embedded Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score	Possible Additional Risk Controls
							People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency		
7	Fishing/Recreational Gear Interaction with Device	A fishing vessel's gear or recreational anchor interacts with the device or its moorings.	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions;	Damage to moorings; Damage to fishing gear; No Injuries; No Pollution; Minor operational downtime;	Single Major Injury; Loss of Anchor; No Pollution; Moderate Operational Downtime;	Remote Shutdown; ERCOP; Marking and Lighting; Notice to Mariners; Incident Monitoring and Reporting;	1	2	1	2	2	3	2	1	3	1	1.86	Radar Reflectors; AIS;
8	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; Minor pollution; Moderate adverse publicity;	Notice to Mariners;	2	2	1	2	1	4	3	2	4	1	2.45	
9	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; Moderate adverse publicity;	Notice to Mariners;	2	2	1	2	3	4	3	2	3	2	3.13	
10	Collision Involving Tug or Service Vessel	A navigating vessel collides with a Tug or Service vessel or construction/decommissioning vessel.	Insufficient Lookout; Increased Vessel Activity; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor Damage to device and its moorings; Negligible Damage to Vessel; Minor Injuries; No Pollution;	Single fatality or multiple major injuries; Loss of Vessel; Minor pollution; Moderate adverse publicity;	PPE; Training; ERCOP; Site Access Application;	2	2	1	2	3	4	3	2	3	1	2.79	
11	Grounding Involving Tug or Service Vessel	A Tug or Service 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;	Single fatality or multiple major injuries; Loss of Vessel; Minor pollution; Moderate adverse publicity;	PPE; Training; ERCOP; Site Access Application;	2	2	1	2	4	4	3	2	3	2	3.60	
12	Breakout of Device or Blade	The device's moorings or part of the device fails, becoming 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; Adverse Publicity;	No Injuries; Loss of Device; Minor Pollution; Moderate Adverse Publicity;	Inspection and Maintenance; Remote Shutdown; GPS Monitoring; ERCOP; Incident Monitoring and Reporting;	1	2	1	2	3	1	4	2	4	1	2.53	Heightened monitoring in adverse metocean conditions;
13	Personal Injury/Man Overboard from Device	Personal Injury or Man Overboard during Construction, Operation or Decommissioning	Human Error; Poor Operating Procedures; Equipment or Mechanical Failure; Adverse Weather Conditions;	No damage; Minor injuries; No pollution; Minor Adverse Publicity;	Single Fatality; No Damage; No Pollution; Moderate Adverse Publicity;	PPE; Training; ERCOP; Incident Monitoring and Reporting; Site Access Application;	2	1	1	2	4	4	1	1	4	3	3.53	