EMEC
THE EUROPEAN MARINE ENERGY CENTRE LTD

Billia Croo Navigation Risk Assessment

February 2019




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Disclaimer

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Abbreviations

Abbreviation	Detail
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
ATBA	Area to be Avoided
AtoN	Aid to Navigation
CGOC	Coastguard Operations Centre
DECC	Department of Energy and Climate Change
EMEC	European Marine Energy Centre
ERCoP	Emergency Response and Cooperation Plan
gt	Gross Tonnage
HAT	Highest Astronomical Tide
HSE	Health and Safety Executive
HW	High Water
IALA	International Association of Lighthouse Authorities
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 Coastguard Agency
MGN	Marine Guidance Note
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
ML	Most Likely
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
NLB	Northern Lighthouse Board
nm	Nautical Mile
NRA	Navigation Risk Assessment
O&M	Operations and Maintenance
OREI	Offshore Renewable Energy Installation
PIANC	Permanent International Association of Navigation Congresses
RNLI	Royal National Lifeboat Institution
RYA	Royal Yachting Association
SAR	Search and Rescue
SHA	Statutory Harbour Authority
SMS	Safety Management System
STCW	Standards of Training Certification and Watchkeeping
UKC	Under Keel Clearance
UKHO	UK Hydrographic Office

Abbreviation	Detail
VHF	Very High Frequency (radio communication)
VMS	Vessel Monitoring System
VTS	Vessel Traffic Service
WC	Worst Credible
WEC	Wave Energy Convertors

Executive Summary

Since 2003, the European Marine Energy Centre (EMEC) Ltd have provided purpose-built, accredited open-sea testing facilities for wave and tidal energy convertors across four test sites in the Orkney Islands. Billia Croo, established in 2003, is the full-scale, grid-connected wave energy test site and is located to the west of the Orkney Mainland.

EMEC are proposing to extend the Billia Croo site and therefore have identified a requirement for a Navigation Risk Assessment (NRA) compliant to the Maritime and Coastguard Agency MGN 543. This NRA both updates the previous NRA and reviews the impact of the proposed extension on navigational safety, identifying any recommendations as required. This NRA is device neutral, not assessing any particular device or type of device, but instead assumes a range of possible devices located within the test site.

Vessel traffic analysis was undertaken on data from the Automatic Identification System, visual observations from a shore-based survey conducted over a number of years and a variety of secondary sources. The analysis identified that the site was clear of the main approach to Stromness, with the majority of the larger vessels approximately two nautical miles to the south. Vessels near the site, mostly fishing and recreational craft, choose to pass either inshore or offshore of the test site. Most vessels active within the site are work vessels conducting installation, maintenance or decommissioning activities on the individual devices. Given the nature of the traffic flow described above, the area of the extension is clear of most traffic routes.

As part of this assessment, consultation was undertaken with a number of local stakeholders and statutory regulators to better understand the baseline conditions and possible impacts to their activities. No consultees raised any significant concerns regarding the EMEC Billia Croo wave test site. In addition, a review of incident data from the Marine Accident Investigation Branch did not identify any significant incidents near to the site, or any involving activities at the site itself.

A number of impacts on navigation were identified and individually assessed, these are as follows:

- No impact on vessel traffic routeing was identified, with the inshore route remaining open to vessel traffic as a result of the extension. Whilst some vessels would need to divert around the extension, the increase in distance travelled was assessed to be negligible.
- Any devices positioned in the site posed a low risk of contact from passing vessels.
- Whilst the prevailing metocean conditions could result in a vessel drifting towards the site, given the proximity of the conditions and the density of traffic, this was assessed to both be low and that the nature of the devices did not alter this.
- An assessment of under keel clearance requirements was undertaken. The results show that the risk of subsurface contact could be reduced significantly if devices were greater than 10m below the surface at Lowest Astronomical Tide.
- No impact on collision risk or visual navigation was identified given the physical size of the devices anticipated to be deployed. Similarly, no impact on communications, radar or positioning systems is anticipated.
- The failure of device moorings was considered at the site, however it was determined that this should be assessed on a device by device basis.

- No significant impacts on recreational or fishing activity were identified as a result of the continued operation of the test site.
- The presence of underwater cables was not assessed to pose a significant hazard to fishing or anchoring operations.
- No impact on Search and Rescue capability was anticipated.
- Whilst there are no other renewable developments in close proximity to Billia Croo, future exploitation of existing and planned lease areas may result in cumulative and in-combination effects.

A navigation risk assessment was conducted that identified 11 hazards relevant to this site. The likelihood and consequence of each were scored based on the results of this assessment and all hazards were deemed to be low risk.

A number of site wide risk controls were identified which are currently in place to manage any risks to navigating vessels. In addition to this, a list of possible risk controls which could be considered for future devices were identified. Given the extension at Billia Croo, the arrangement of cardinal marks will need to be reviewed and a new arrangement of four rather than five cardinal marks is proposed, but this should be agreed with the Northern Lighthouse Board.

Finally, guidance is provided for developers conducting device-specific NRA addendums and the considerations which should be made in each case. This assessment has provided the baseline information for developers to consider during their device-specific assessment but as this assessment is device neutral, any deviations as a result of the specific characteristics of a device should be taken into account.

In summary, the NRA has not identified any significant hazards that relate to the current Billia Croo site or the proposed extension. This document should be reviewed and updated at regular intervals to provide developers with an up-to-date and relevant site-wide assessment of the risks associated with the continued operation of the Billia Croo test site.

1 Introduction

Since 2003, the European Marine Energy Centre Ltd (EMEC) have provided purpose-built, accredited open-sea testing facilities for wave and tidal energy convertors across four test sites in the Orkney Islands. Billia Croo, established in 2003, is the full-scale, grid-connected wave energy test site.

EMEC are proposing to extend the Billia Croo test site and therefore have identified a requirement for a Navigation Risk Assessment (NRA) compliant to the Maritime and Coastguard Agency MGN 543. This NRA both updates the previous NRA and reviews the impact of the proposed extension on navigational safety, identifying any recommendations as required.

This NRA is device neutral, not assessing any particular device or type of device, but instead assumes a range of possible devices located within the test site.

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 1.5.

1.1 Guidance to developers

This document serves as a baseline NRA for the Billia Croo test site. Developers should use this information to develop an NRA Addendum which addresses the specific navigational implications of that project and associated device. Recommendations for developing such addendums is provided in Section 10.2.

1.2 Study area

Figure 1 shows the study area under assessment. The extension is to the north for approximately one nautical mile.

1.3 Previous studies

This addendum builds on the following work conducted for EMEC:

- Billia Croo NRA – Abbott Risk Consulting Ltd (2010, updated in 2011);
- NRA Update – Billia Croo – Anatec Ltd (2014).

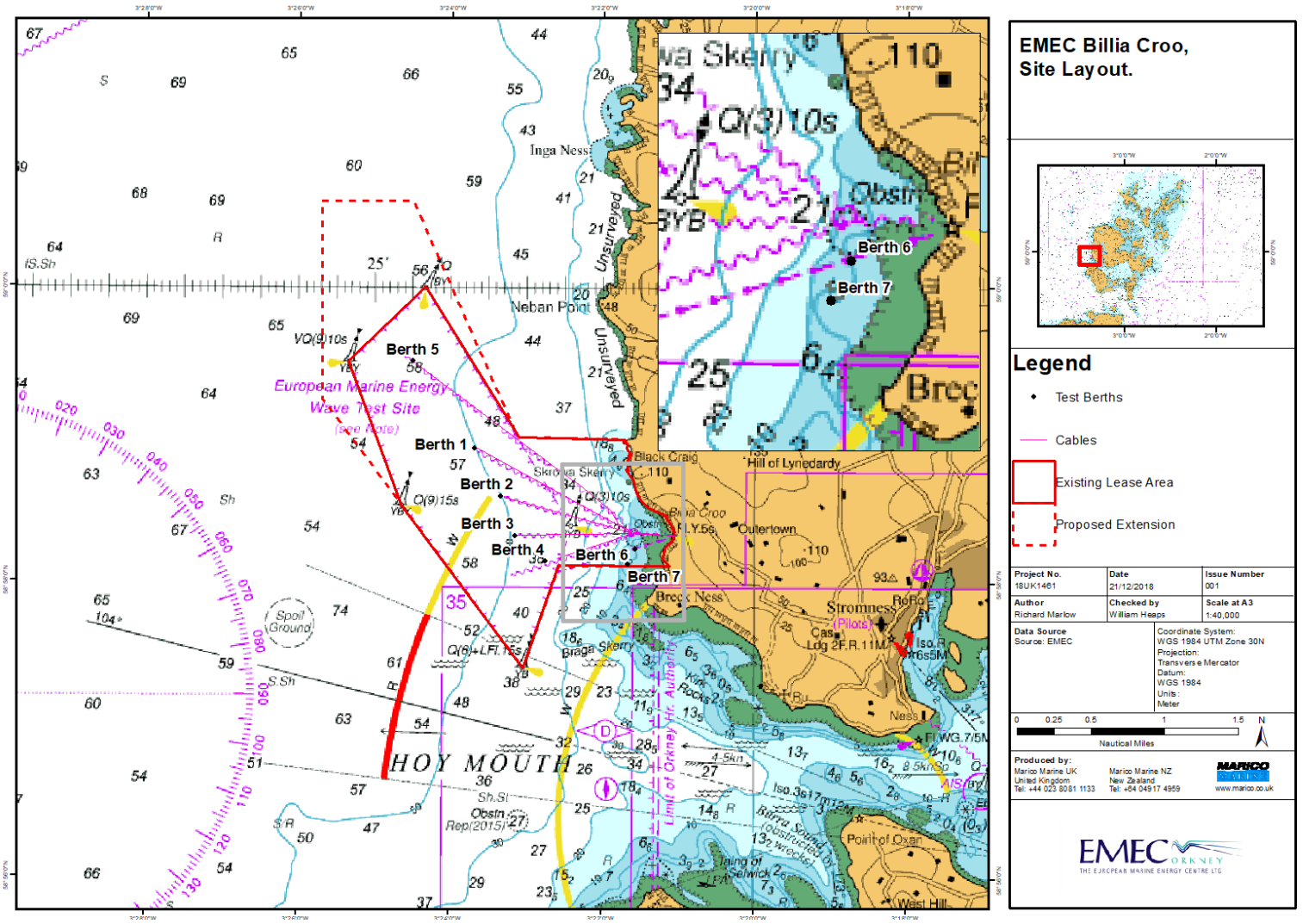


Figure 1: Test site layout at Billia Croo

1.4 Scope and methodology

The scope of this assessment is to:

1) Describe the Billia Croo test site;
2) Provide a description of the existing environment and activities in the study area; including:
    a. Local ports and harbours;
    b. MetOcean conditions;
    c. Existing vessel management plans;
    d. Other users of the area such as aquaculture, anchorages, military and renewable energy installations;
    e. Existing vessel traffic patterns, including frequency and types; and
    f. Existing risk profile for navigational incidents.
3) Determine likely future traffic profile;
4) Identify and assess impacts associated with 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 navigational hazards during the general operation of the test site and the changing phases of developers' testing campaigns at the test site. These hazards are then assessed, and risk controls identified to reduce the risk to As Low as Reasonably Practicable (ALARP); and
6) Make recommendations as to the safety of the test site and identify any additional measures that should be implemented to further improve safety at the site.

1.5 Guidance

Guidance on the assessment requirement was primarily sought from the 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. This report adheres to this standard accordingly. Guidance was also sought from a variety of other publications (outlined in 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, stakeholder consultation, structure layout, collision avoidance, impacts on communications/ radar/ positioning systems and hydrography.

Policy / legislation	Key provisions
Department of Energy and Climate Change (DECC) Methodology for Assessing Marine Navigational Safety Risks of Offshore Wind Farms	The DECC guidance 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 developments 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.
MCA 2014. Under Keel Clearance – Policy Paper.	Guidance on assessment methodology for under keel clearance of OREI devices.

1.5.1 MGN 543 compliance table

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

Table 2: MGN 543 Compliance Table

Annex 1		Report Section
1	An up to date traffic survey of the area	**Section 3 –** Consultation **Section 5** – Vessel Traffic Analysis **Section 8** – Impact on Navigation
2	OREI structures	**Section 8** – Impact on Navigation
3	Assessment of access to and navigation within, or close to, an OREI	**Section 8** – Impact on Navigation **Section 9.3** – Risk Controls
Annex 2		**Report Section**
1	Effects of tides and tidal streams	**Section 4.1** – MetOcean Details **Section 8.3** – Impact of Tides

2	Weather	**Section 4.1** – MetOcean Details **Section 8.3** – Impact of Weather
3	Visual navigation and collision avoidance	**Section 8.3 –** Impact on Collision Avoidance and Visual Navigation **Section 8.11 –** Impact on SAR
4	Communications, radar and positioning systems	**Section 8.6 –** Impact on Equipment
5	Marine navigational marking	**Section 2.3 –** Existing Marking **Section 9.3 –** Marking and Lighting Guidance
Annex 3		**Report Section**
1	MCA Shipping Route Template	**Section 8.1 –** Vessel Routeing
Annex 4		**Report Section**
1	Safety and mitigation measures	**Section 9.3** – Site wide Risk Controls **Section 9.5 –** Device Specific Risk Controls
Annex 5		**Report Section**
1	Emergency response	**Section 8.11 –** Impact on SAR **Section 9.3** – Site wide Risk Controls **Section 9.5 –** Device Specific Risk Controls

2 Billia Croo test site

2.1 Test berths

Billia Croo currently consists of five deep water grid-connected tests berths and two further test berths located in the inshore area of the site. The coordinates of these are provided below in Table 3. The inshore test berths have subsea pipeline infrastructure running from the test berth area to the onshore substation.

Table 3: Test berth locations (WGS84 datum)

Test Berth	Latitude	Longitude
Deep water berth 1	58° 58.906’ N	003° 23.682' W
Deep water berth 2	58° 58.586’ N	003° 23.335’ W
Deep water berth 3	58° 58.319’ N	003° 23.147’ W
Deep water berth 4	58° 58.144' N	003° 22.749' W
Deep water berth 5	58° 59.498' N	003° 24.501' W
Inshore berth 6	58° 58.230' N	003° 21.568' W
Inshore berth 7	58° 58.128' N	003° 21.667' W

The tests berths have been developed to accommodate both single devices and small arrays as well as device components, mooring structures or scientific instrumentation. Devices may be deployed onsite without being connected to a test berth. Please refer to *EMEC Billia Croo Test Site – Project Envelope for Devices and Operations REP646* for further information on the facilities and site infrastructure available at the Billia Croo test site.

2.2 Devices

This assessment is considered device neutral, considering the navigational safety implications of a variety of possible devices stated within the defined Billia Croo Project Envelope within the boundary perimeters of the Billia Croo test site. The following section provides an overview of the possible types of devices which could be deployed within it. Further information on the device characteristics and structures included within the Project Envelope is detailed in *EMEC Billia Croo Test Site – Project Envelope for Devices and Operations REP646.*

Waves have the potential to provide a completely sustainable source of energy, which can be captured and converted into electricity by wave energy converter (WEC) machines. There are a variety of WEC concepts that have been developed to date to extract energy from shoreline out to the deeper waters offshore.

Generic devices which could be deployed can be found on EMEC’s website.[1]

2.3 Moorings

There are a variety of possible methods for fixing WECs to the seabed. MGN 372 lists these five main types:

[1] http://www.emec.org.uk/marine-energy/wave-devices/

1. Seabed mounted / gravity base devices: Physically sit on the seabed by virtue of the weight of the combined device/foundation. In some cases, there may be additional fixing to the seabed.
2. Pile mounted: This principle is analogous to that used to mount most large wind turbines, whereby the device is attached to a pile penetrating the ocean floor. This may be mono, twin or tri-piled.
3. Floating flexible mooring: The device is tethered via a cable/chain to the seabed, allowing considerable freedom of movement. This allows a device to swing as the tidal current directions changes with the tide.
4. Floating rigid mooring: The device is secured into position using a fixed mooring system, allowing minimal movement.
5. Hydrofoil inducing down force: The device uses a number of hydrofoils mounted on a frame to induce a positioning down force from the tidal current flow.

Further information regarding the moorings and foundation characteristics typically installed at the Billia Croo test site are outlined in *EMEC Billia Croo Test Site – Project Envelope for Devices and Operations REP646.*

2.4 Existing marking and lighting

The site is marked by five cardinal marks; one for each cardinal direction and a second westerly cardinal. Each cardinal flashes with yellow lights and is painted using the correct yellow-black colour scheme.

The site is marked on charts and includes a note. Chart 2249 states that *"Mariners should avoid passing within the test area marked by cardinal buoys. Experimental devices usually marked by yellow buoys and lights with daymarks, are temporarily established in the area. Devices marked by buoys may also be deployed between this area the coast."*

The marking of the devices themselves varies, but in general any surface piercing device is marked with one or more yellow lights and is painted yellow above the surface (see IALA requirements in Section 9.3.1).

An advisory 500m "Area to be Avoided" is in place around each device[2] - see Annex A.

[2] https://www.orkneyharbours.com/port-authority/info/notices/marine-excursions-within-the-emec-test-areas

3 Consultation

Consultation was conducted with key stakeholders to gain local knowledge and insight on navigation. A list of stakeholder consultations undertaken to support this update to the Navigation Risk Assessment is given in Table 4. Following each conversation or correspondence, summary notes were drafted and agreed – these are contained in Annex D.

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

Table 4: List of stakeholder consultation

Organisation	Details
Orkney Fisheries Association	29th August 2018 – Meeting at Kirkwall
Orkney Islands Council Marine Services – Statutory Harbour Authority	29th August 2018 – Meeting at Scapa Flow
Orkney Ferries	30th August 2018 – Meeting at Kirkwall
Orkney Marinas	30th August 2018 – Meeting at Kirkwall
Royal Yachting Association	5th September 2018 – Meeting at Hamble
Maritime and Coastguard Agency	19th September 2018 – Meeting at Southampton
Northern Lighthouse Board	21st September 2018 – Teleconference
NorthLink Ferries	No response received

4 Overview of the marine 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. This section provides details of the test site and conditions as relate to navigation.

4.1 MetOcean conditions

4.1.1 Wind

The Admiralty Sailing Directions for the North Coast of Scotland state that there are on average 50 days with gales each year in Kirkwall. This ranges from between one and nine per month, with gales most frequently in the winter months. Figure 2 shows the wind directions and speeds for Billia Croo with a prevailing south westerly wind.

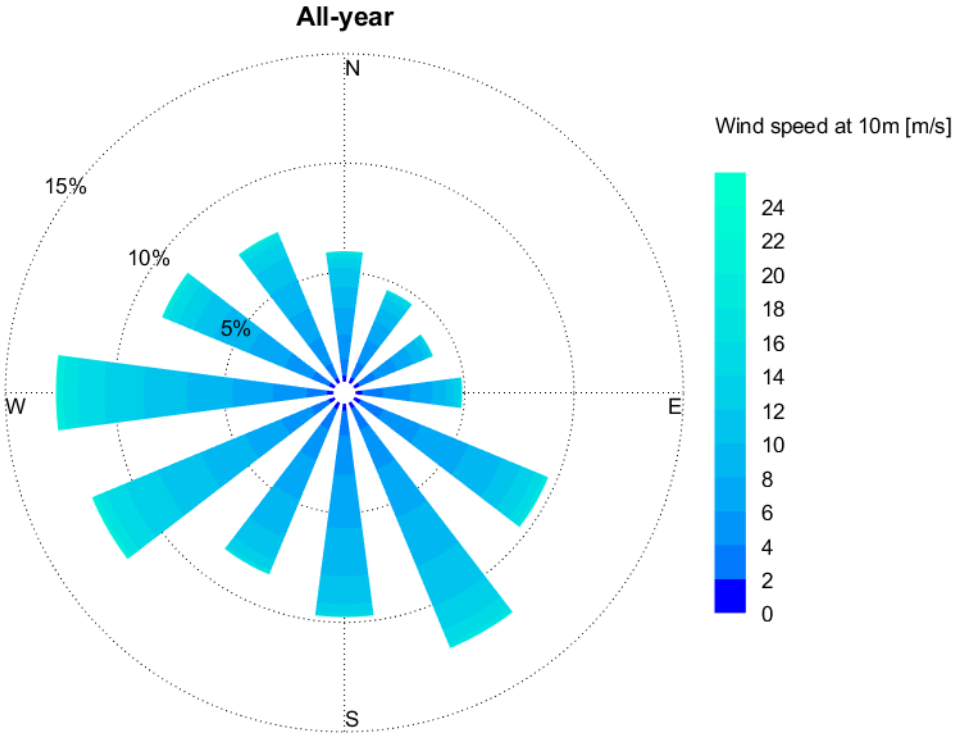


Figure 2: Wind rose for Billia Croo (Source: EMEC)

4.1.2 Wave

Figure 3 shows the wave rose for the Billia Croo test site, the predominant direction is westerly with the average significant wave heights of 1.9 metres from 280 degrees. Modelling also suggests 1 in 100 year significant wave height to be in excess of 15 metres.

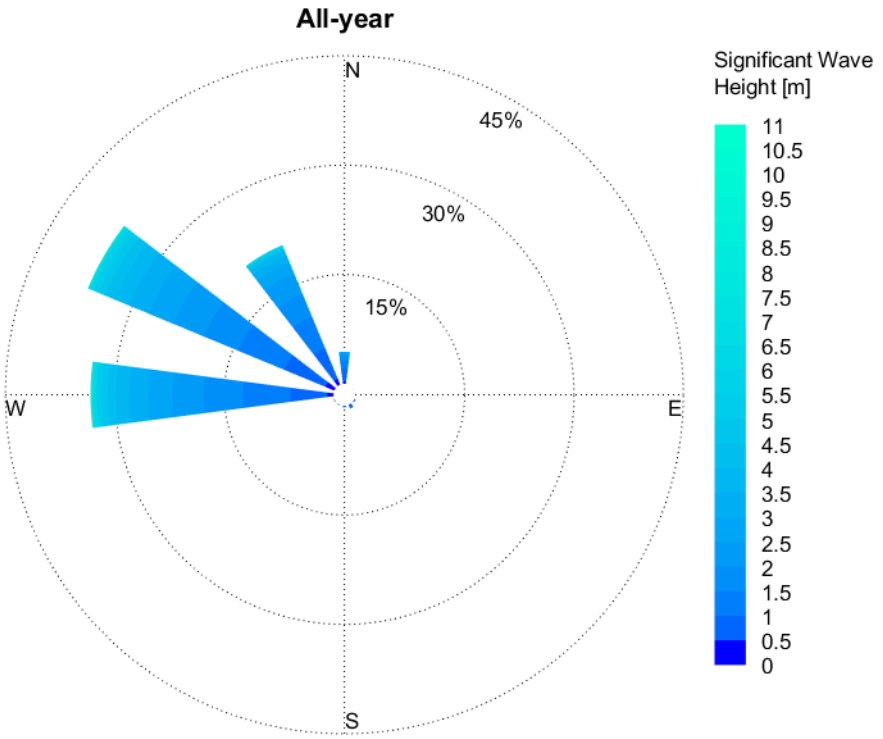


Figure 3: Significant Wave Rose (Source: EMEC)

4.1.3 Tide

Table 5 and Table 6 give the tidal characteristics near to the Billia Croo test site. Within the Hoy Mouth, spring tidal rates can be much more significant, creating an overfalls to the south of Billia Croo test site, near to Berth 4.

Table 5: Tidal Heights (Source: Admiralty Total Tide).

Place	Lat N	Long W	HAT	MHWS	MHWN	MLWN	MLWS	LAT
Stromness	58° 58’	003° 18’	4.2	3.6	2.7	1.4	0.7	0.1

Table 6: Admiralty Total Tide Predictions for study sites (58° 50.97’N 003° 25.08’W)

Tidal Hour	Direction (deg)	Spring (kts)	Neaps (kts)
-6	325	1.0	0.6
-5	317	1.1	0.6
-4	326	1.1	0.6
-3	328	0.2	0.1
-2	138	0.3	0.2
-1	125	0.6	0.3
HW	124	1.6	0.9
+1	128	1.3	0.7
+2	140	0.9	0.5

Tidal Hour	Direction (deg)	Spring (kts)	Neaps (kts)
+3	122	0.6	0.3
+4	030	0.3	0.2
+5	342	0.6	0.4
+6	329	0.9	0.5

4.1.4 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 Orkney Islands are frequently affected by thick fog.

4.2 Existing vessel traffic management

The Billia Croo test site is not within port limits, however is adjacent to the harbour limits of the Orkney Islands Council Marine Services. The limit of Orkney Harbours is between Breck Ness and Braebuster Point for vessels entering Stromness, a pilot boarding station and calling point are located in this area, but clear to the south of the test site. Orkney Islands Council Marine Services have Vessel Traffic Services (VTS) with full radar coverage of the Billia Croo test site, but they do not actively monitor or direct traffic outside the Statutory Harbour Authority (SHA) limits.

The site is within an IMO-adopted Area to be Avoided (ATBA), which was established following the Braer oil spill. All vessels over 5,000 GT carrying oil or other hazardous cargoes should avoid this area.

4.3 Search and rescue

Royal National Lifeboat Institution (RNLI) lifeboats are stationed in the Orkney Islands at Longhope (Hoy), Stromness and Kirkwall (both Orkney Mainland). The Stromness lifeboat is a Severn class all weather lifeboat. She is 17m LOA, has a crew of seven, and is capable of 25 knots having a range of 250 nm.

Her Majesty's Coastguard (HMCG) helicopter assets are based at Sumburgh, Stornoway and Inverness.

Shetland Coastguard Operations Centre (CGOC) are the local coastguard base for the Orkney Islands. The 2015 implementation of the Future Coastguard Programme saw a restructuring of the CGOCs and implementation of a new IT system that enabled areas to be monitored and incidents responded to from any CGOC or from the National Maritime Operations Centre (NMOC) near Southampton. Therefore, whilst Shetland CGOC would likely manage the Orkney Islands, it could be managed from elsewhere.

4.4 Other Offshore Activities

4.4.1 Aquaculture

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 as described in IALA guidance in O-139 (IALA, 2013).

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

There are no charted aquaculture sites near to the Billia Croo test site, nor were any proposed developments mentioned by stakeholders.

4.4.2 Renewables

There are no existing renewable energy sites near to the Billia Croo test site.

A number of existing and proposed lease areas exist on the western coast of the Orkney Islands, these are discussed in Section 7.3.

4.4.3 Subsea Cables

With the exception of the EMEC subsea cables to the test berths, there are no other cables in the study area. A telecom cable passes two nautical miles to the north of the extension boundary.

4.4.4 Anchorages

There are no anchorages near to the test site. The nearest charted anchorages are located inside Stromness Harbour and at Cairston Roads.

4.4.5 Military Exercise Areas

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

4.4.6 Spoil Grounds

A spoil ground exists approximately two nautical miles to the west of the test site however this is marked as disused.

5 Existing vessel traffic at the Billia Croo test site

5.1 Data sources

MCA's MGN 543 requires that *"An up to date, traffic survey of the area concerned 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 variations in traffic patterns and fishing operations. (Note: AIS data alone will not constitute an appropriate traffic survey.)"*

Therefore, the NRA should be based on the best available data that accounts for all marine users, not just those equipped with AIS. Typically, this is achieved through a radar and visual traffic survey from shore or from afloat. Given the availability of alternative data sources, this approach is not considered proportional to the scale of the development, given that:

- The devices are small scale in nature
- The sites have been long established
- The activities at EMEC sites are familiar to all local users and any modifications widely promulgated through Notice to Mariners
- Previous applications for developments at the EMEC test sites have not been considered to have a significant impact upon navigational safety by national and local stakeholders
- Previous NRAs submitted by EMEC or its developers have satisfactorily demonstrated the impact on navigational safety without the use of radar traffic surveys.

To ensure that the NRA includes a full assessment of all vessel types in each study area, particularly those which would not normally carry AIS, use of the following datasets are proposed:

- AIS data between 1st January 2017 and 30th June 2018 (18 months)
- Visual observations between 2009 and December 2015 (see Section 5.9)
- Consultation with local stakeholders, particularly trends in small fishing and recreational craft
- Fishing VMS Data
- RYA recreational cruising datasets
- Secondary sources and previous NRAs, where appropriate.

5.2 Vessel Traffic Routes in Orkney

Figure 4 shows the main routes used by vessel traffic passing the Billia Croo test site. The greatest density of traffic is to the south of the development, vessels inbound to Stromness, particularly the Stromness-Scrabster ferry. An inshore (easterly) and offshore (westerly) route directly adjacent to the development is also discernible. Finally, the activities of vessels engaged in the renewable industry and working on the devices within Billia Croo can be seen. The density of traffic further offshore is not significant.

The site is surrounded by cardinal marks and this has a clear effect on the traffic flows with vessel traffic staying immediately adjacent to the site.

The tracks of all vessels have been categorised by their overall length, as shown in Figure 5. The largest vessels in the study area are the ferries transiting to the south of the site, with occasional transits of vessels between 50m and 100m adjacent to the site (such as the Northern Lighthouse Board vessel, fishing or large construction, maintenance or decommissioning vessels).

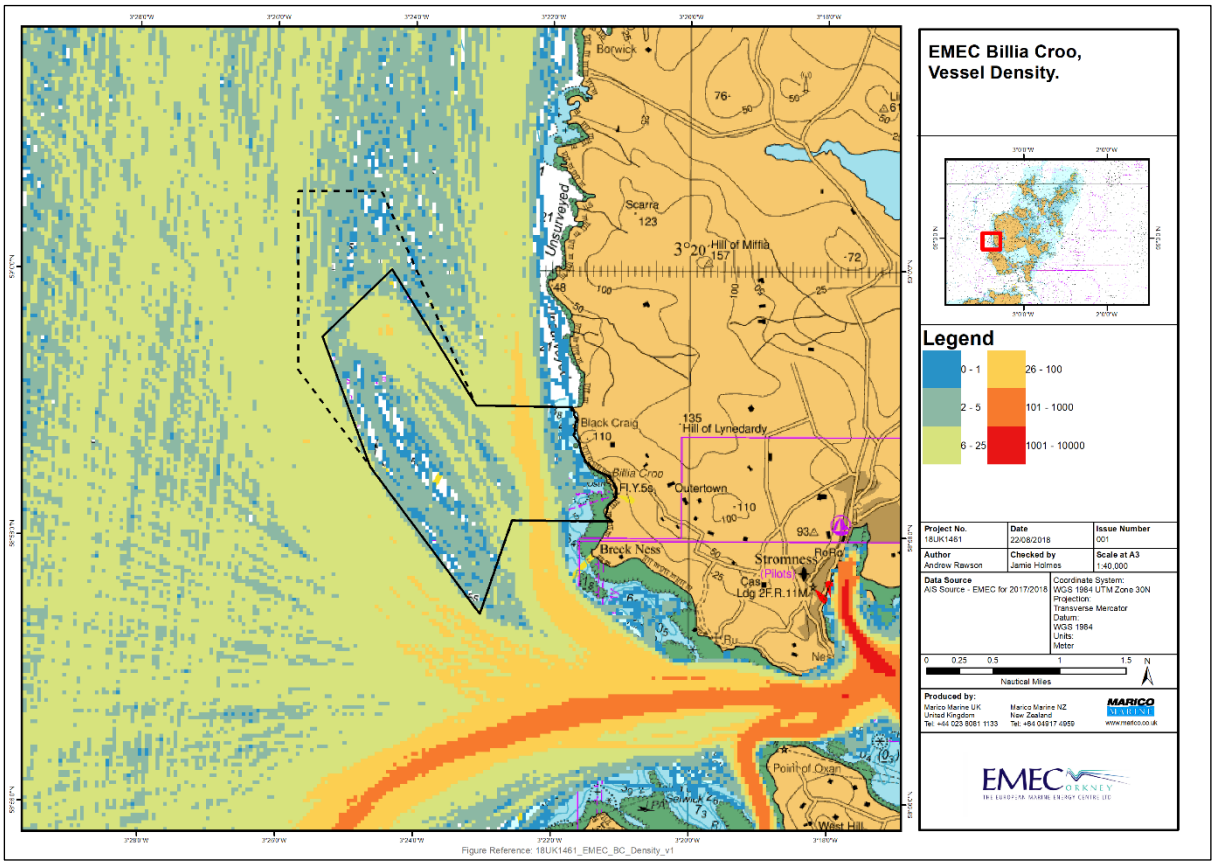


Figure 4: Vessel transit density at the Billia Croo test site

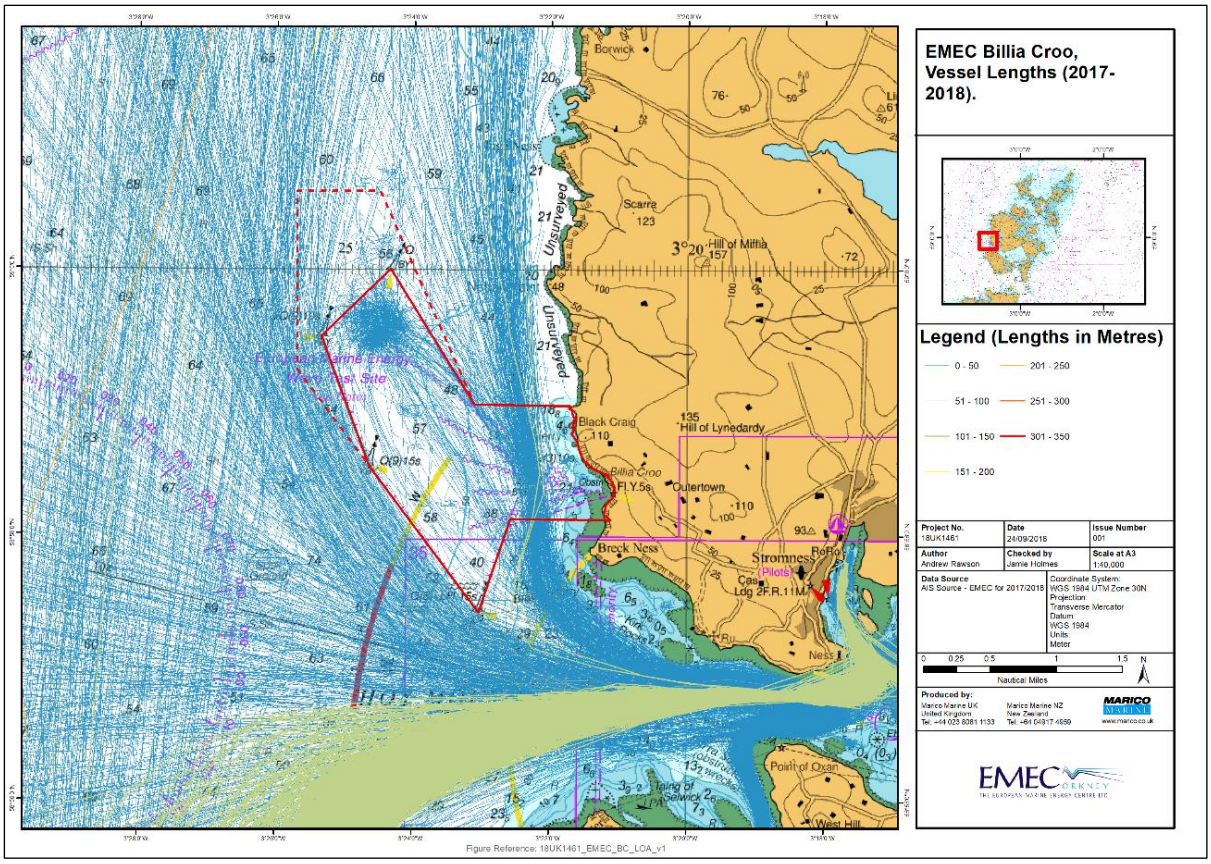


Figure 5: Vessel tracks by length overall

5.3 Commercial shipping

Cargo transits are infrequent, occasionally transiting into Stromness and a single tanker transit was recorded offshore, but both vessel types are well clear of the test site (see Figure 6). The ATBA restriction on vessels in this area prevents many larger commercial vessels from approaching the test site.

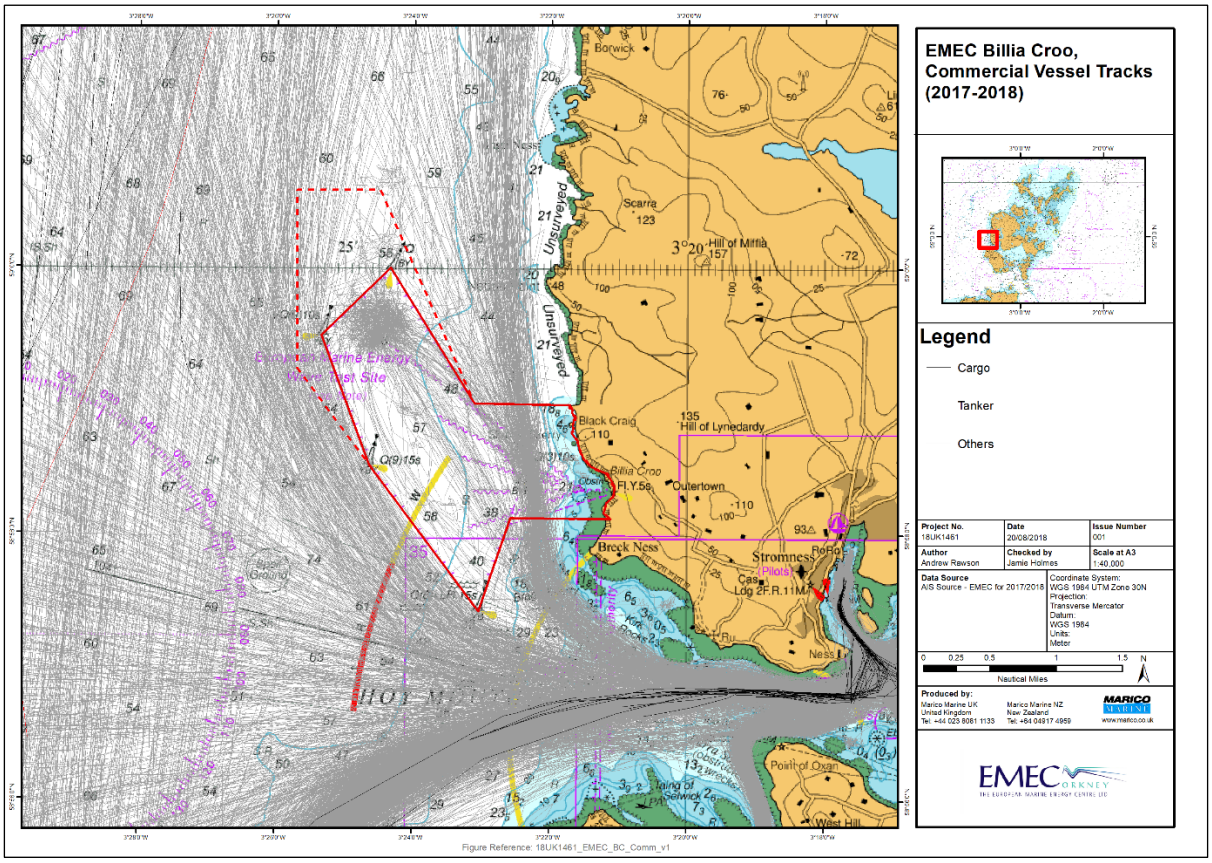


Figure 6: Commercial vessel transits at the Billia Croo site

5.4 Passenger vessels

Stromness is a major ferry port, with the NorthLink Hamnavoe (112m) ferry operating a daily service to and from Scrabster. There is a one nautical mile passing distance of this route to the southern boundary of the Billia Croo test site (see Figure 7).

During the one year of AIS data, only on seven occasions did a passenger vessel pass adjacent to the site. Small passenger boats such as the Golden Marian (15m), Stockholm (40m) and Valkyrie (16m) passed inshore. On one occasion (21st May 2017) the Hamnavoe passed to the east of the site, transiting up the coast before returning two hours later while engaged on an annual wildlife tour that takes place in May every year. The cruise ships Island Sky (91m) and Serenissima (87m) passed within 3nm to the west of the site.

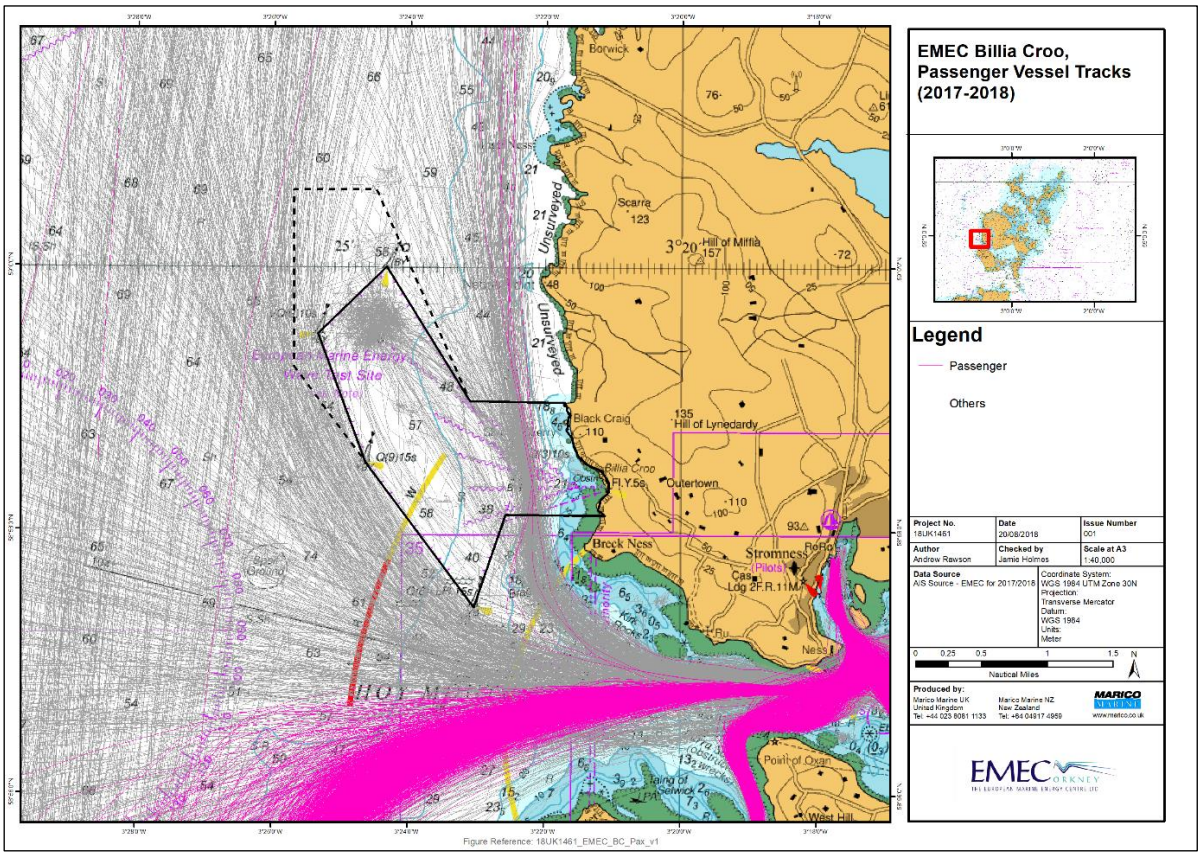


Figure 7: Passenger vessel transits at the Billia Croo site

5.5 Fishing vessels

The transits of fishing vessels are shown in Figure 8. Stromness is an active fishing harbour and a great number of the vessels recorded are passing through Hoy Mouth and then passing to the east or west of the test site. An offshore route of vessels passing to the west of Orkney Mainland also passes clear of the existing Billia Croo test site boundary.

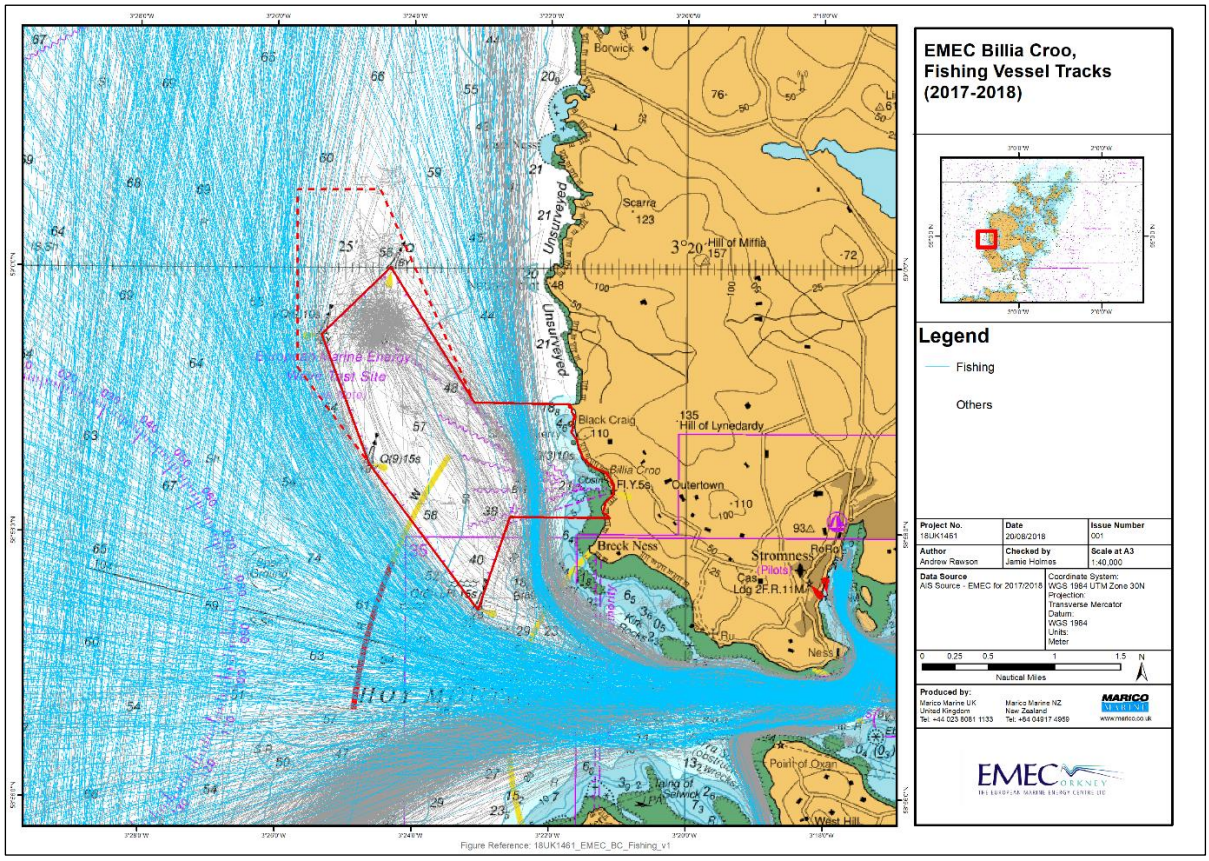


Figure 8: Fishing vessel transits at the Billia Croo site

5.6 Recreational craft

Figure 9 shows the routes of recreational vessels recorded during the data period. Figure 10 supports this data by showing the RYA boating intensity dataset. Both data sources show that the greatest concentration of recreational traffic is in Stromness Harbour and vessels leaving the harbour would do so to the south, towards Scotland, or a lesser number would transit north passed the west coast of the Orkney Islands.

Stromness sailing club is located inside Stromness Harbour however the majority of sailing and racing takes place within the harbour.

AIS is not mandatory on recreational craft and therefore the analysis identifies only a proportion of the total number. An RYA survey in 2014 stated that 37% of vessels transmit AIS, although this is likely to be an overestimate and bias towards larger vessels[3].

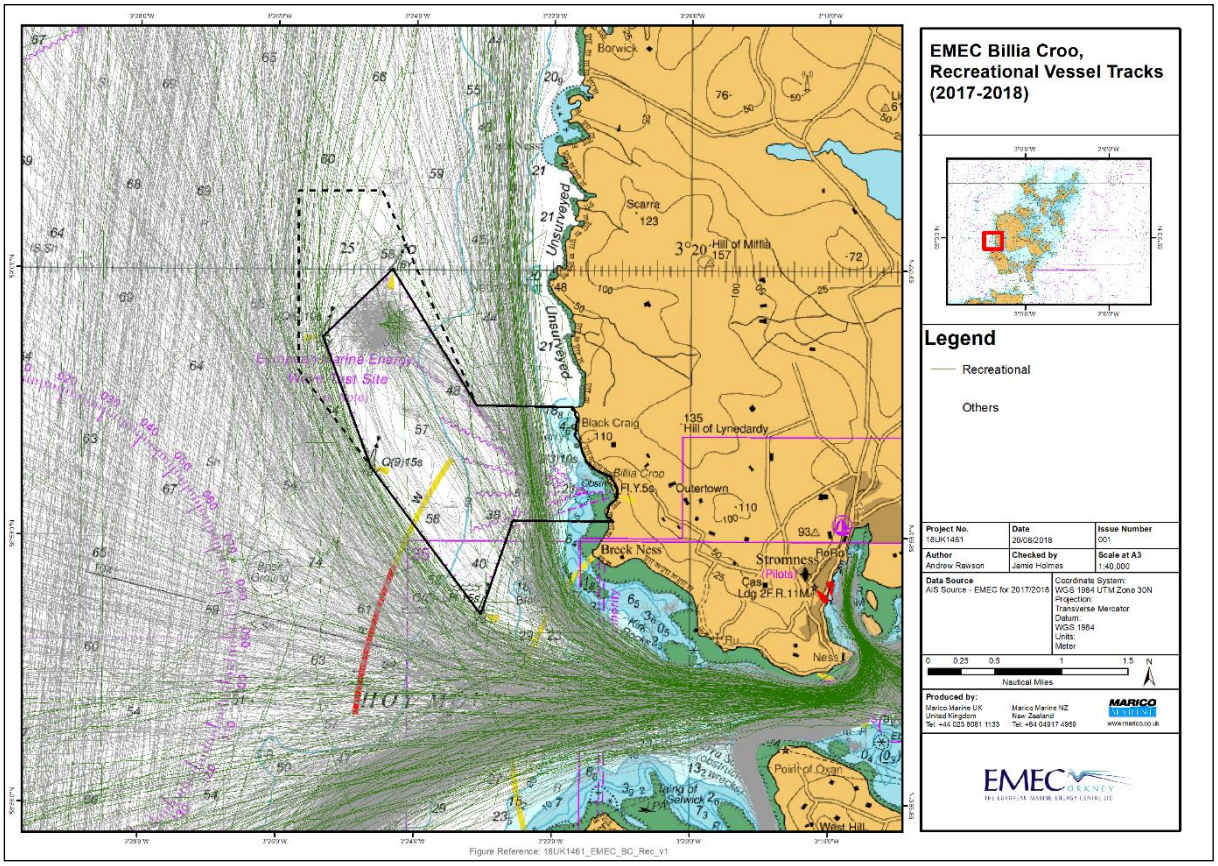


Figure 9: Recreational vessel transits at Billia Croo

[3] https://www.rya.org.uk/newsevents/news/Pages/RYAAISsurveyresults.aspx

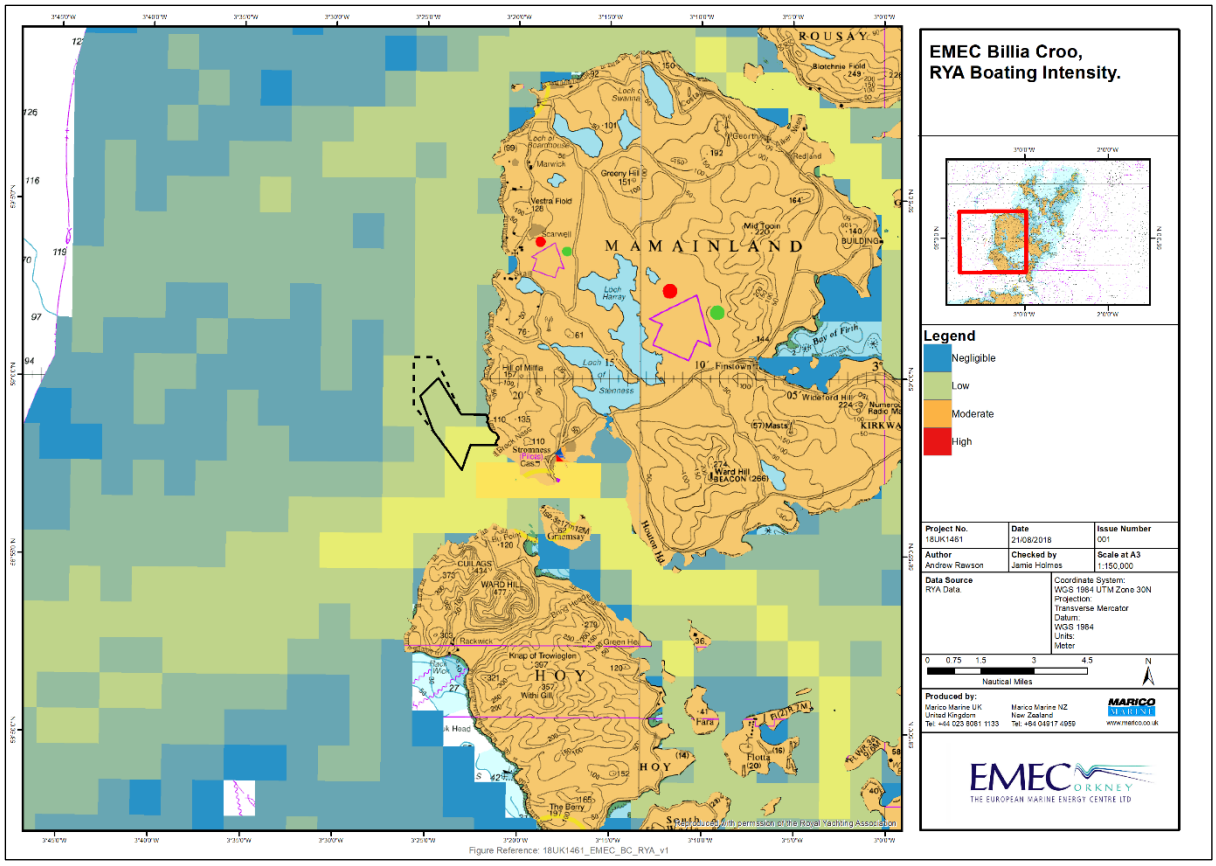


Figure 10: RYA Boating Intensity

Marina tickets were provided by Orkney Marinas during consultation and the seasonality of each site is shown in Figure 11. In 2017, there were 770 visiting yachts to all three marinas in the Orkney Islands, approximately half of which are UK visitors and half are international visitors. 83% of these visitors stay for less than 7 days and there are on average three crew on board.

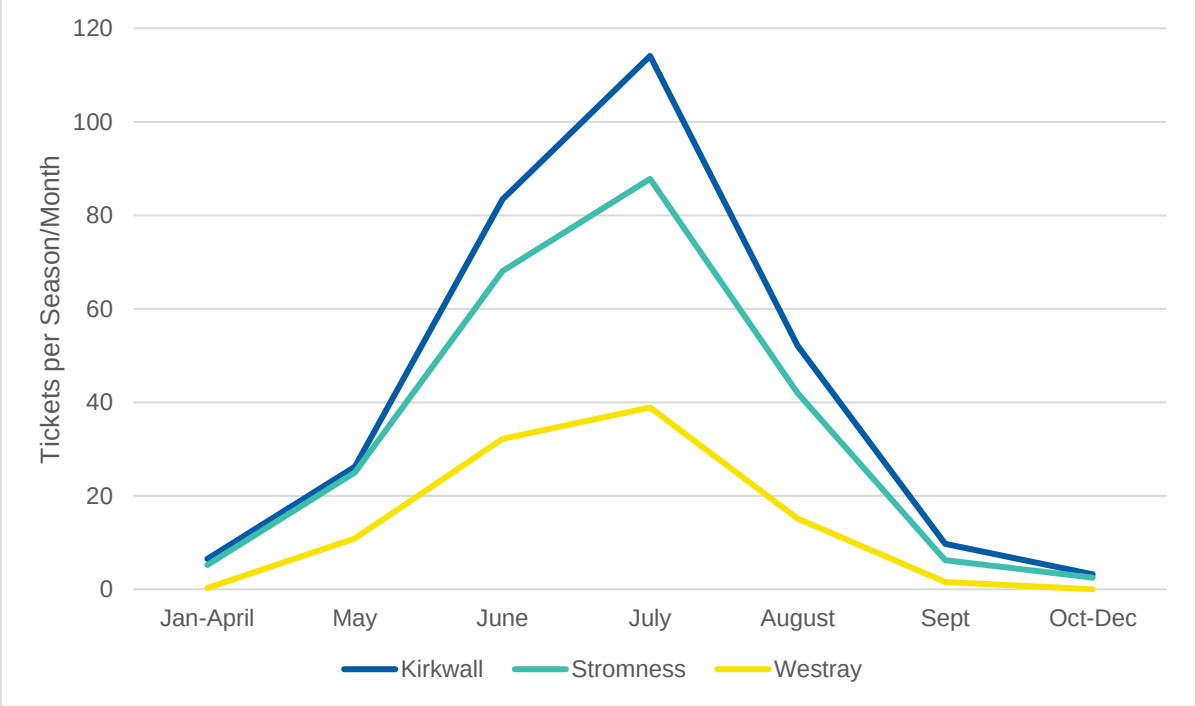


Figure 11: Marina tickets per season

5.7 Tugs and other service vessels

Finally, tugs and service craft, which include pilot boats, tugs, maintenance vessels and other workboats are shown in Figure 12. The key activity within the test site is that of construction, maintenance and decommissioning vessels working at devices positioned within Billia Croo. There is also an inshore route passing the Billia Croo test site which is used by maintenance vessels associated with marine renewable projects on transit between Kirkwall and Stromness.

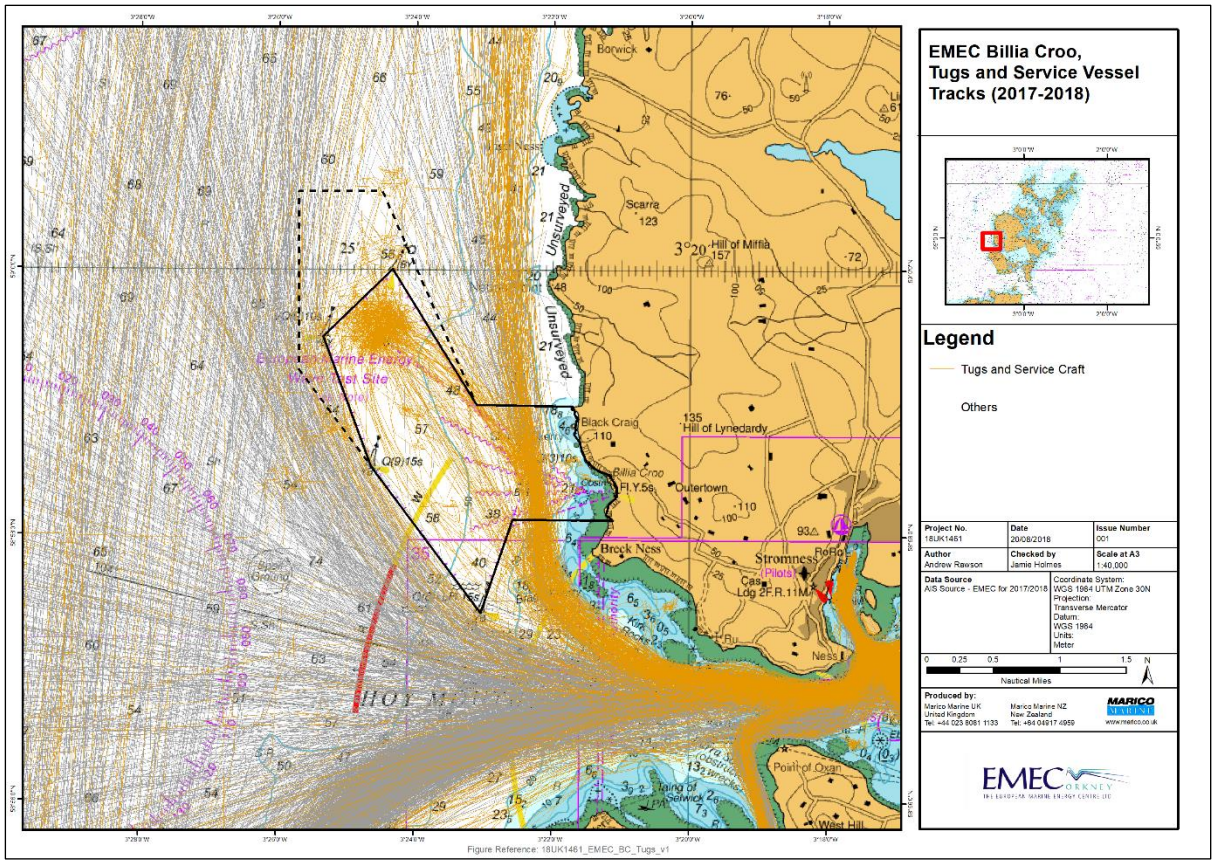


Figure 12: Tug and Service vessel transits at Billia Croo

5.8 Proximity analysis

To better understand the numbers and types of vessels passing near to the Billia Croo test site, proximity analysis was undertaken.

Figure 13 shows the number of transits per year which were recorded within certain distances of the Billia Croo test site. More than 4,000 transits were recorded in total within two nautical miles (including all vessels entering or leaving Stromness), the majority of which are the Hamnavoe passenger ferry, although fishing and service vessels are a significant proportion. Within 500m, the numbers of transits is recorded as substantially less at only 600, which includes a significant number of construction, maintenance and decommissioning vessels. The difference between the number of vessels passing through the existing site and the proposed extension is negligible. This indicates that vessels already transit clear of the footprint of the extension and therefore the impact would be minimal.

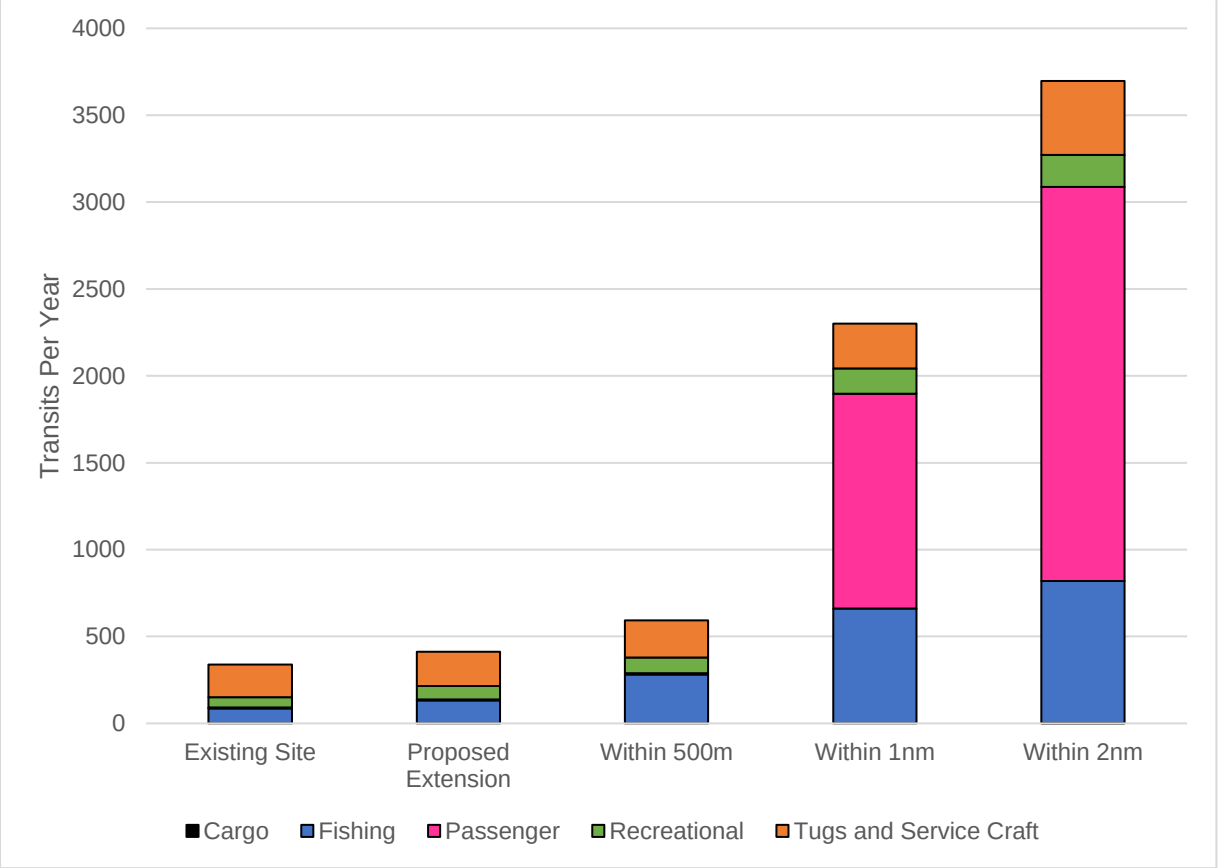


Figure 13: Transits near to the existing site

Figure 14 shows the results by the month of transit. A clear seasonal cycle is apparent with approximately twice as many movements in summer as winter. The Stromness-Scrabster ferry has a summer and winter timetable which accounts for much of this seasonality, however recreational and service vessels are also more active during the summer. December has incomplete data and therefore shows spurious numbers. It is however likely that the figures would be similar to January/November at approximately 120 transits per month.

Finally, Figure 15 examines variation in transit time within 1nm of the site. Recreational and service vessels demonstrate a typical day-night cycle. The ferry operates on a timetable which determines the timing of transits and fishing vessels show a morning-evening departure-return pattern.

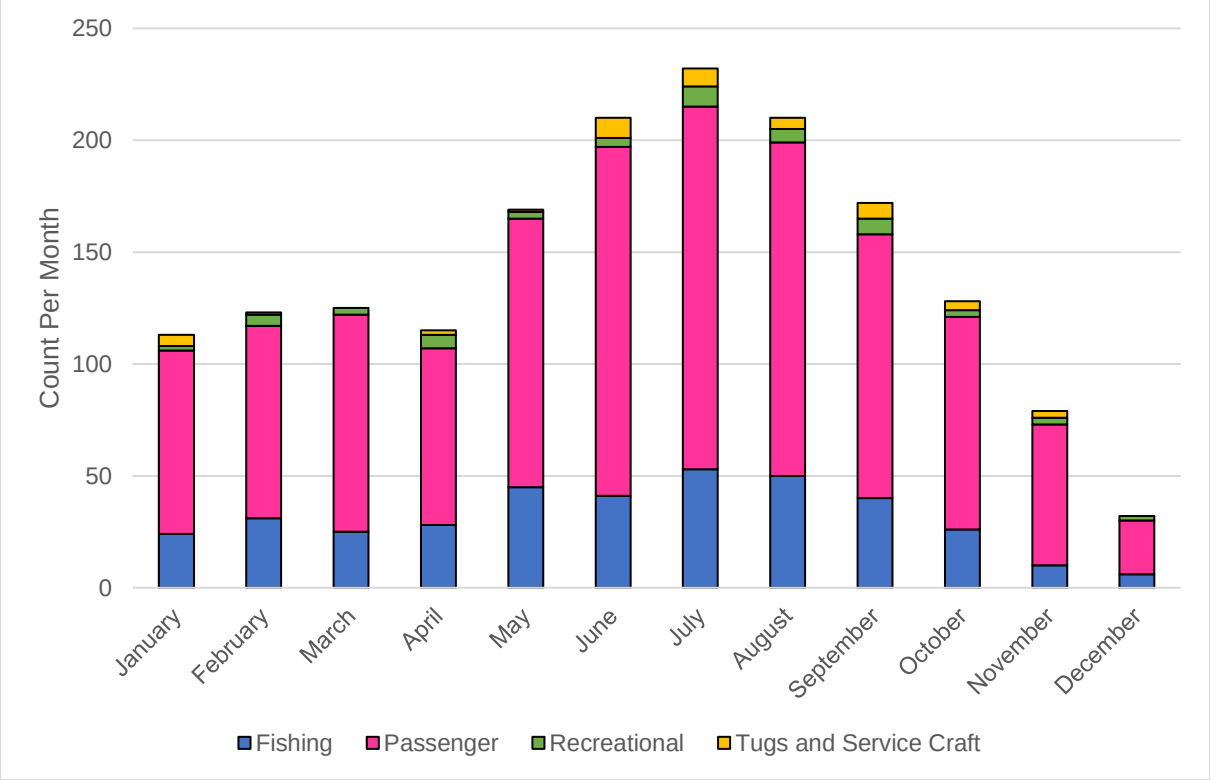


Figure 14: Count per Month within 1nm of site

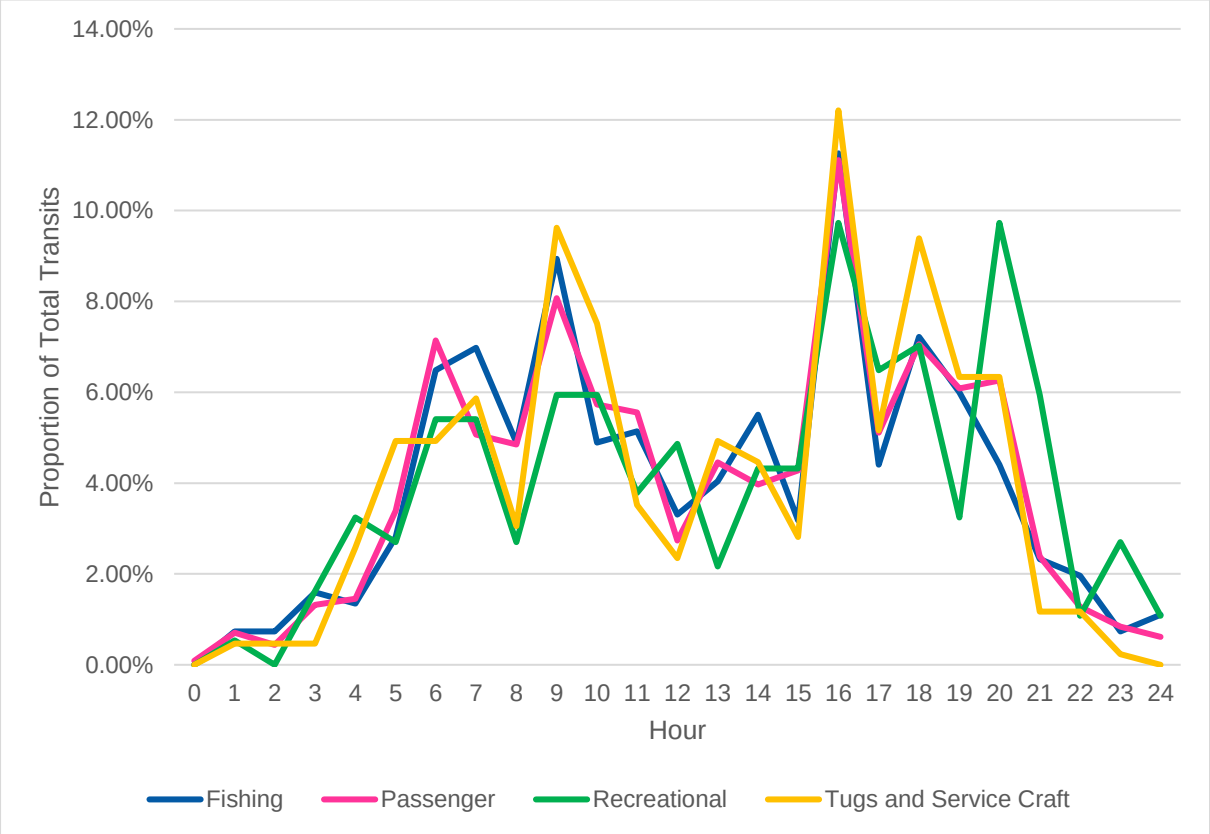


Figure 15: Transit time within 1nm of the site

5.9 Visual observations

In 2009, EMEC commenced a programme of wildlife observations at the Billia Croo test site. The observers were stationed in an ex-coastguard lookout station located on a cliff top, Black Craig, overlooking the test site. Approximately 20 hours of survey were conducted per week, throughout the year, until the end of 2015, averaging 800 hours per year. As part of this survey, vessel traffic was also recorded, and approximate positions plotted.

In total, 4,656 vessel observations were made during this period. All ferry observations (Stromness-Scrabster) and records of the actual wave energy devices under test were discounted, reducing the number of records to 2,515. Figure 16 gives the number of observations recorded at Billia Croo test site per year. An increase in vessels involved in works on devices (barges, powerboats and large commercial vessels) is evident as a result of increased activity on the site during 2011 to 2014 when there were a number of different devices deployed. Numbers of yachts and fishing vessels shows a small decline since 2013, however this may be a result of changes to the survey programme.

Figure 17 shows the seasonality of observations, with a significant summer peak in both maintenance, fishing and recreational traffic.

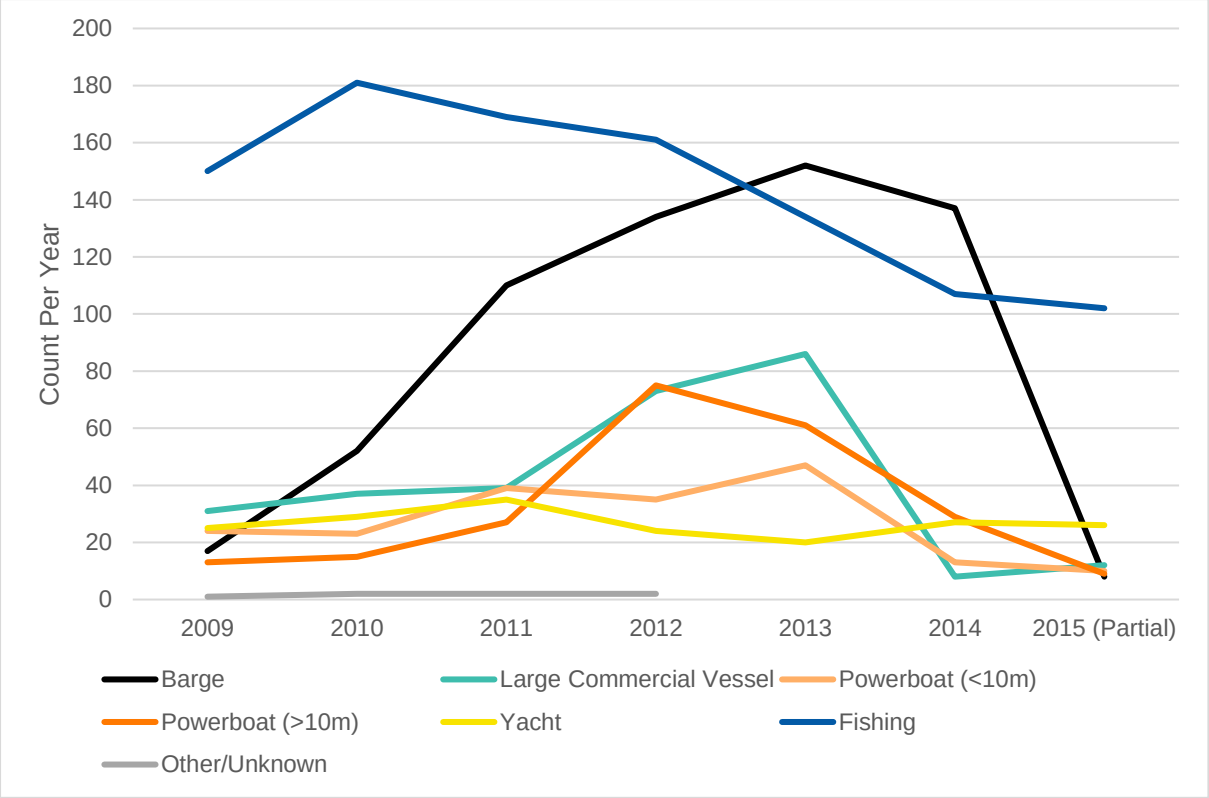


Figure 16: Vessel observations per year at Billia Croo

Figure 18 gives the locations of visual observations during six years of the surveys. Whilst powerboats are spread across the test site, fishing and recreational craft are focused inshore of the site, with a significant number to the south, presumably on transit to/from Stromness.

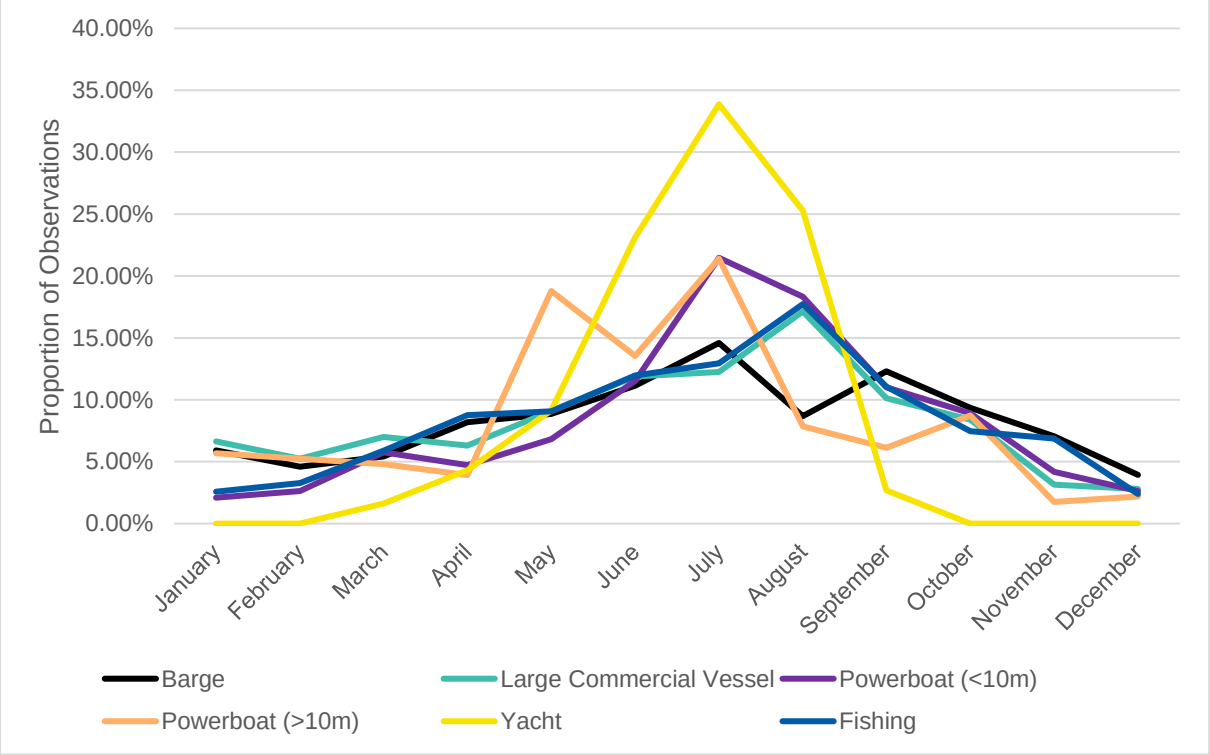


Figure 17: Proportion of observations by month at Billia Croo

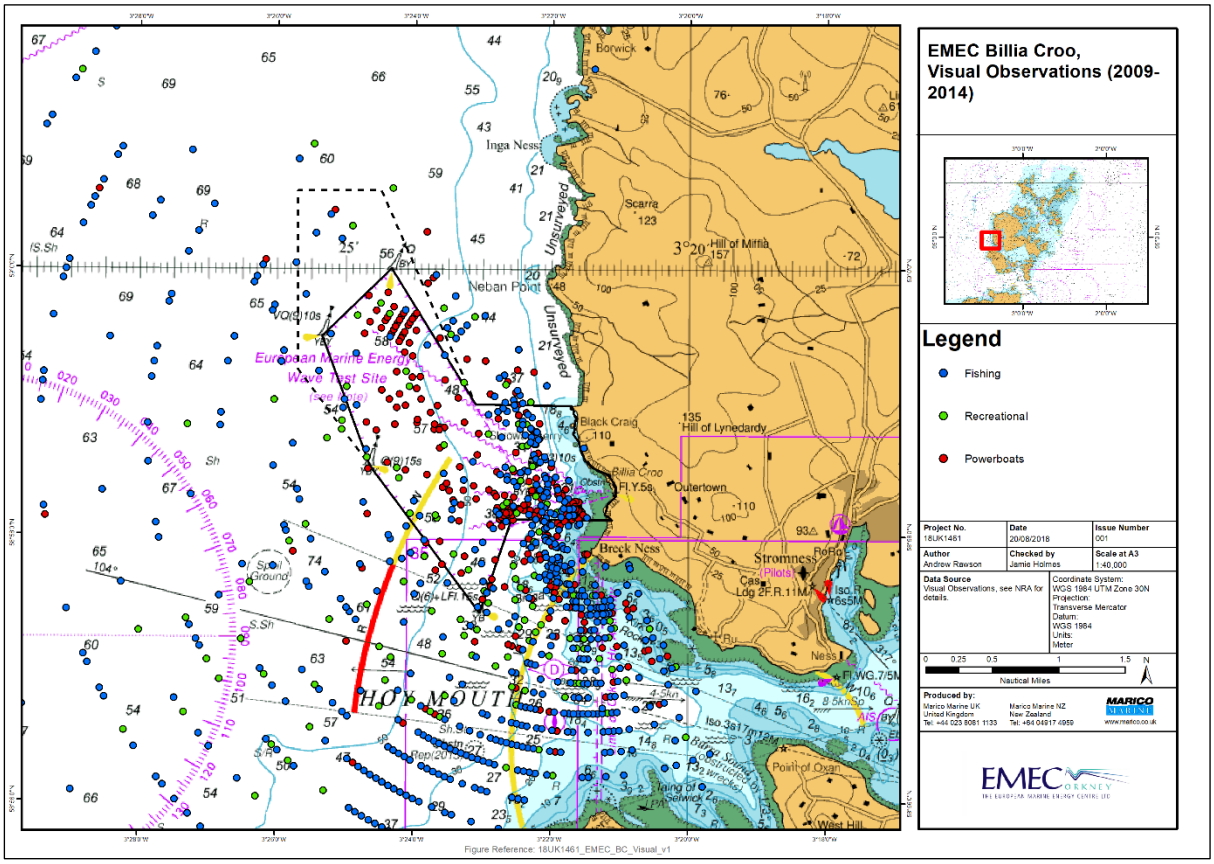


Figure 18: Locations of observations of vessels during visual surveys at Billia Croo

6 Historical incidents

An analysis of MAIB incidents between 1997 and 2015 was conducted. Very few incidents were recorded near to the Billia Croo test site. Four mechanical failures of fishing vessels are shown offshore and a single accident to a person. Many of the incidents are further inshore on the approaches to Stromness.

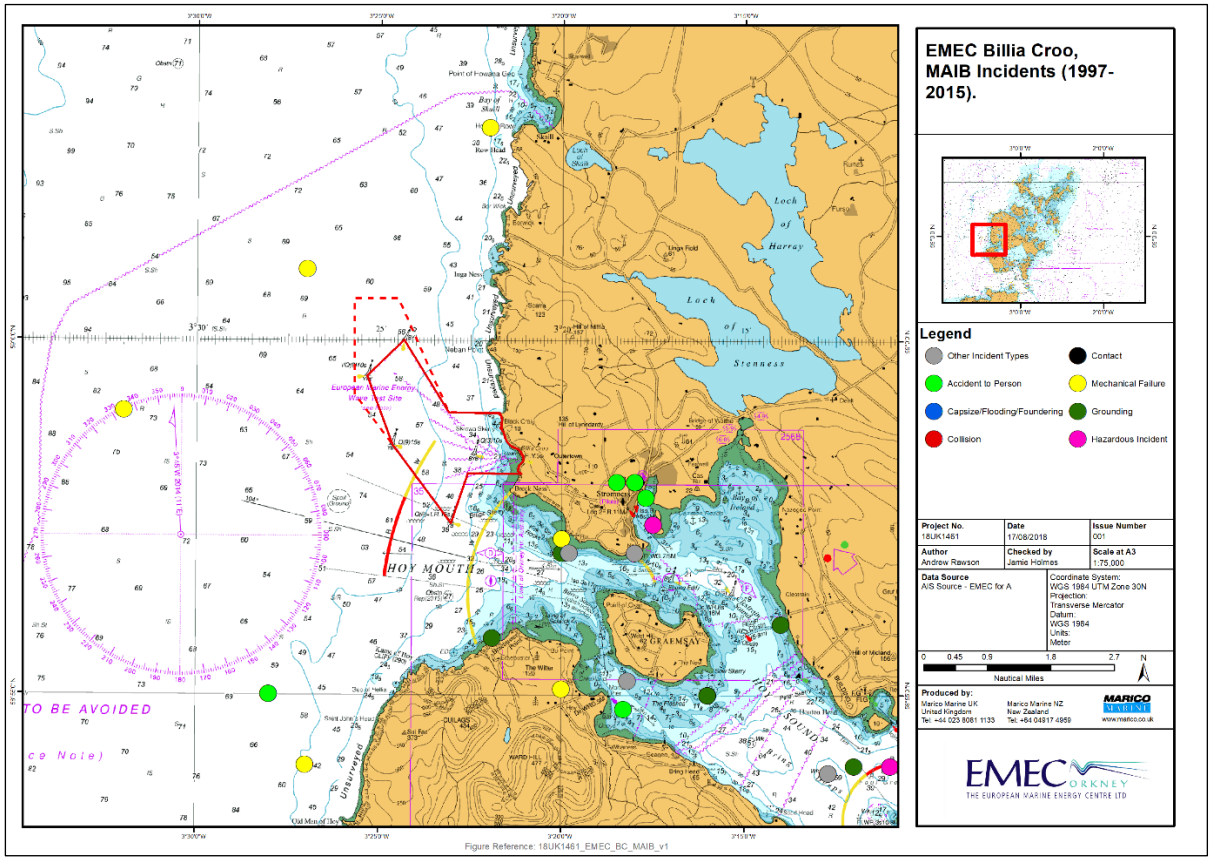


Figure 19: MAIB Incidents between 1997-2015 near Billia Croo

7 Future traffic profile

7.1 Orkney commercial traffic

The following information was captured from the Orkney Islands Council Harbour Authority Annual report 2016-2017[4]:

- 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 Stromness-Scrabster route has increased from 122,241 passengers per year in 2014 to 134,111 passengers per year in 2017, a 10% increase.
- 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.

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

7.2 Fishing and recreational traffic

A review of the Scottish Sea Fisheries Statistics was undertaken from 2008 to 2016[5]. 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 vessels of 10 metres and under were used for creel fishing.

In 2012, there were 354 employed fishermen in the Orkneys (235 regularly and 119 irregularly employed), which has declined to 292 (199 regularly and 93 irregularly).

Figure 20 shows the number of marina tickets per year between 2008 and 2017. There has in general been an increase in the number of recreational vessels visiting the Orkney Islands during the period, with Kirkwall and Stromness being the main marinas.

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

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

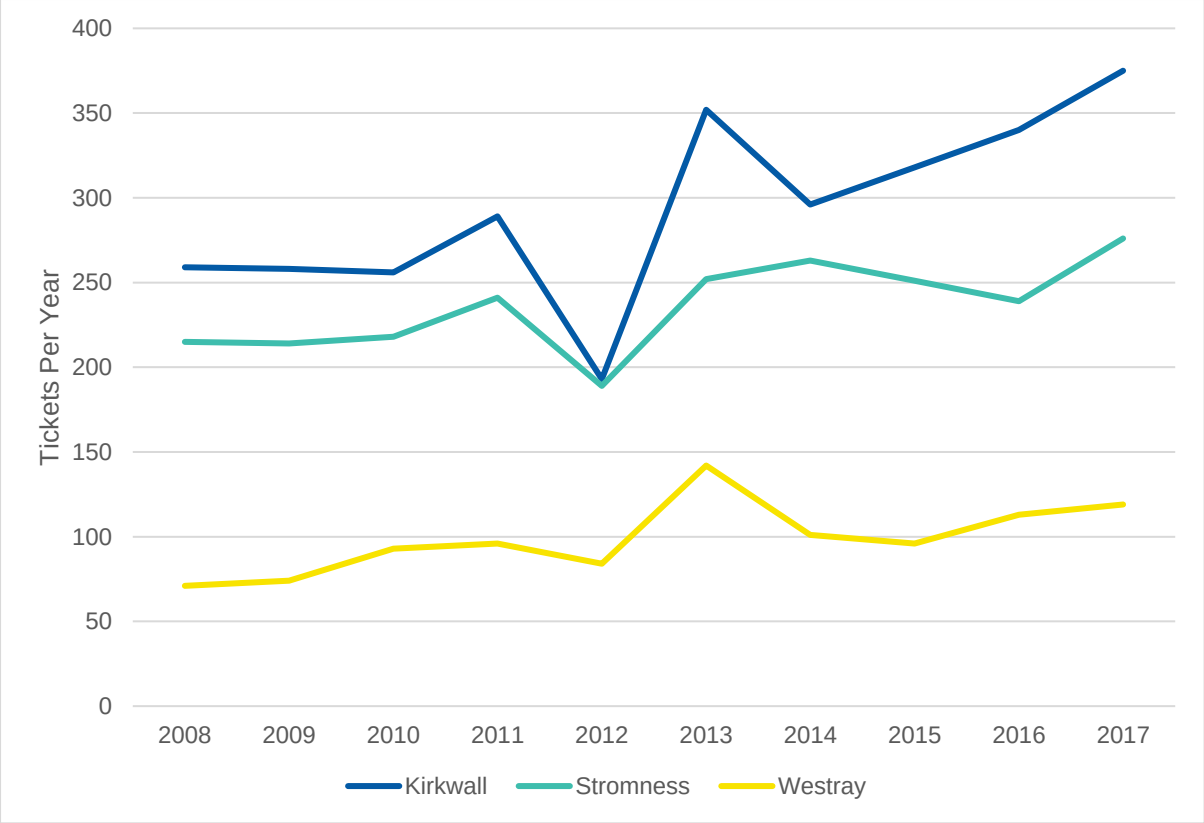


Figure 20: Marina tickets per year

7.3 Renewable energy related traffic

The EMEC test site and the associated test devices are periodically maintained by vessels from Stromness and Kirkwall as shown in Figure 12. The degree to which this traffic varies is dependent upon the number of devices under test within the site.

Any significant changes in renewable vessel traffic, not associated with EMEC, would be the result of further wave or wind leases on the west coast of the Orkney Islands. Figure 21 shows the offshore renewables sites identified in the Scottish National Marine Plan (2015).

A number of Crown Estate lease sites have been identified and are at various stages of consideration:

- Costa Head – scoping report issued in 2011 for initial 10MW's, lease capacity is for 200MW
- Marwick Head – scoping report issued in 2012 for initial 10MW's, lease capacity is for 50MW
- Brough Head - scoping report issued in 2011 for initial 9MW's, lease capacity is for 200MW
- West Orkney Middle South – scoping report issued in 2012 for initial 10MWs, lease capacity for 50MW.

None of these sites have been advanced and no further details have been provided by Marine Scotland.

The plan also identified Options for wind, wave and tidal sites. WN2 and OWN1 are recognised areas for wave and wind energy respectively.

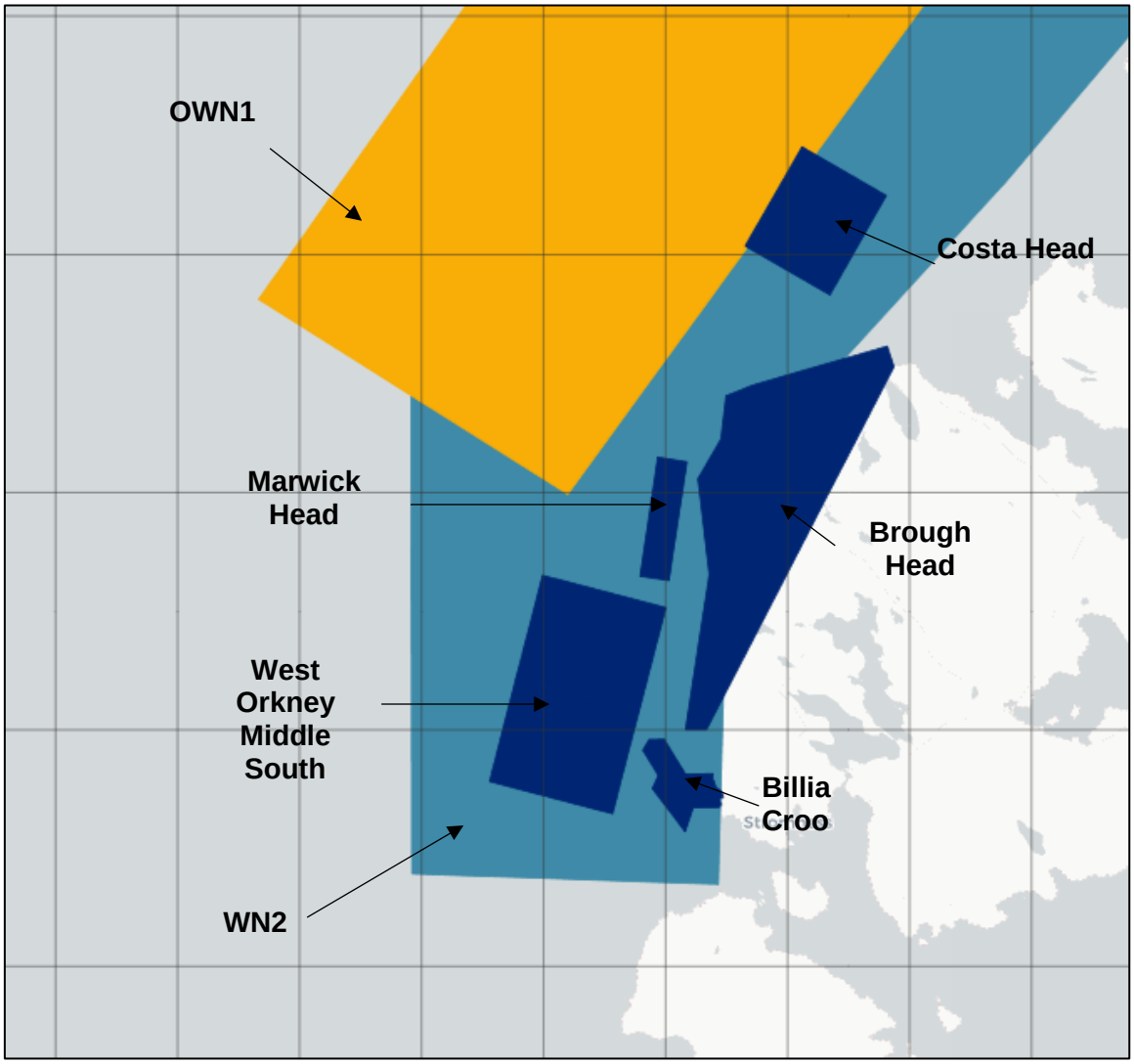


Figure 21: Scottish National Marine Plan Options (Source: Marine Scotland 2015)

In 2018, Marine Scotland published a scoping study for new offshore wind energy sites in Scottish waters. Figure 22 shows the locations of possible areas of future leasing, several of which are located near to the Billia Croo site and are subsequent revisions of those shown in Figure 21.

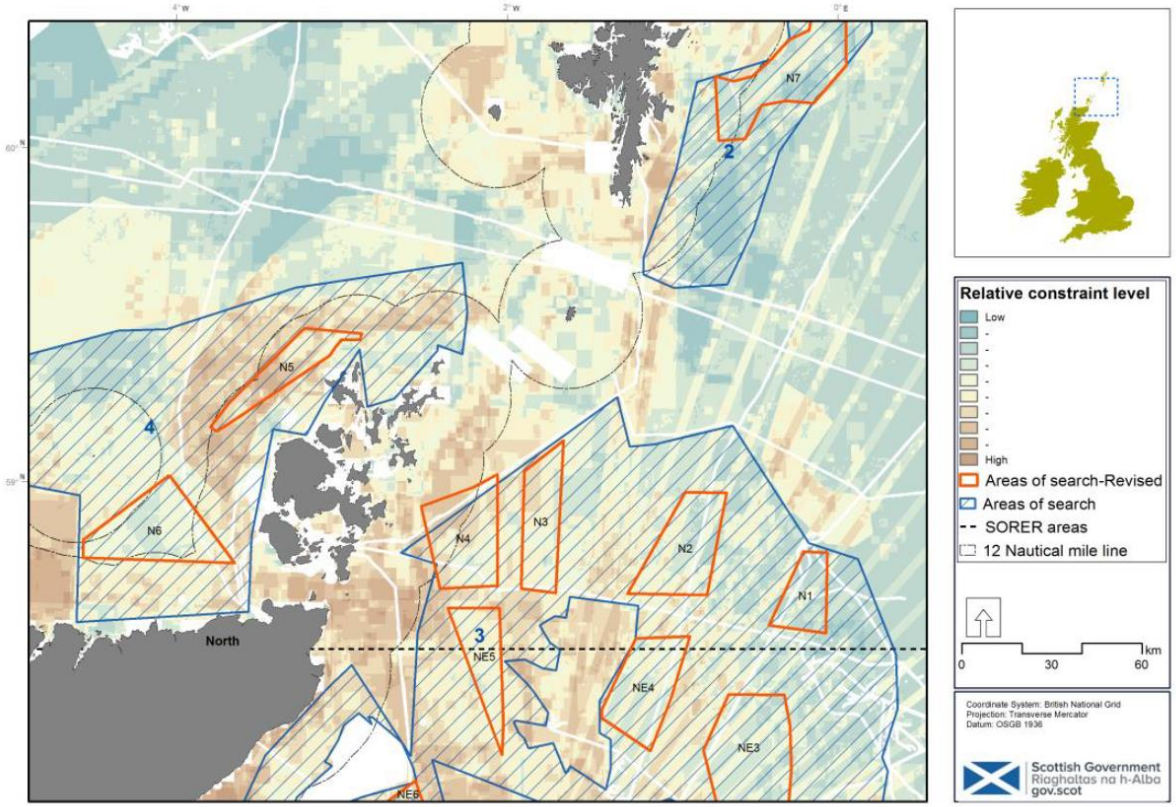


Figure 22: Location of possible wind energy areas (Source: Marine Scotland, 2018)

8 Impacts to navigation

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

ID	Description
1	Impact on Vessel Traffic Routeing
2	Impact on Contact/Allision Risk
3	Impact on Collision Risk, Visual Navigation and Collision Avoidance
4	Effect of the Tides, Tidal Streams and Weather
5	Impact on Under Keel Clearance
6	Impact of Failure of Moorings
7	Impact on Fishing Activity
8	Impact on Recreational Activity
9	Impact on Subsea Cables
10	Impact on Search and Rescue and Emergency Response
11	Impact on Communications, Radar and Positioning Systems
12	Cumulative and In-Combination Effects

8.1 Impact on vessel traffic routeing

8.1.1 Access to the Billia Croo site

MGN 372 provides advice for mariners operating in close proximity to OREIs. There are three options described:

1. Avoid the OREI area completely;
2. Navigate around the edge of the OREI development area, or
3. In the case of a wind farm, navigate, with caution, through the array. (Though this is not applicable to other marine renewable energy sites.)

Chart 2249 states that *"Mariners should avoid passing within the test area marked by cardinal buoys*" and as shown in Section 5, most vessels pass around the site boundary. In addition, advisory 500m Area to be Avoided exists around each device.

Upon reviewing the AIS data contained in Section 5, there are two clear routes used by vessels transiting past the site; an inshore and offshore route. The impacts of each are discussed in turn below and highlighted in Figure 23.

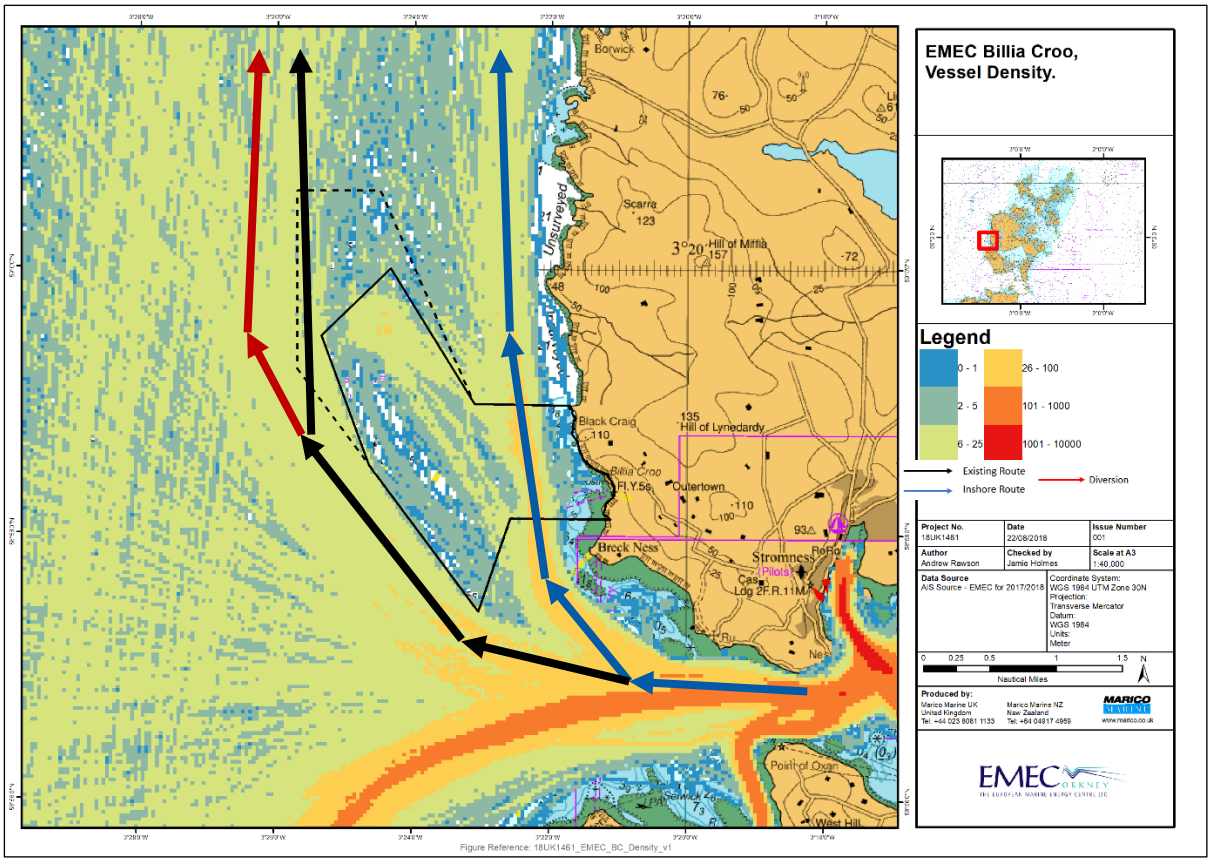


Figure 23: Key vessel routes

8.1.2 Inshore route

The inshore route (marked with a blue arrow in Figure 21) is used more frequently than the offshore route, particularly by smaller vessels such as yachts and fishing vessels. This is due to the reduced transit distance required as opposed to using the offshore route. This route, shown in Figure 24, is less than 750m across between the 5m contour and the eastern cardinal. The proposed extension would not impact the feasibility of this inshore passage.

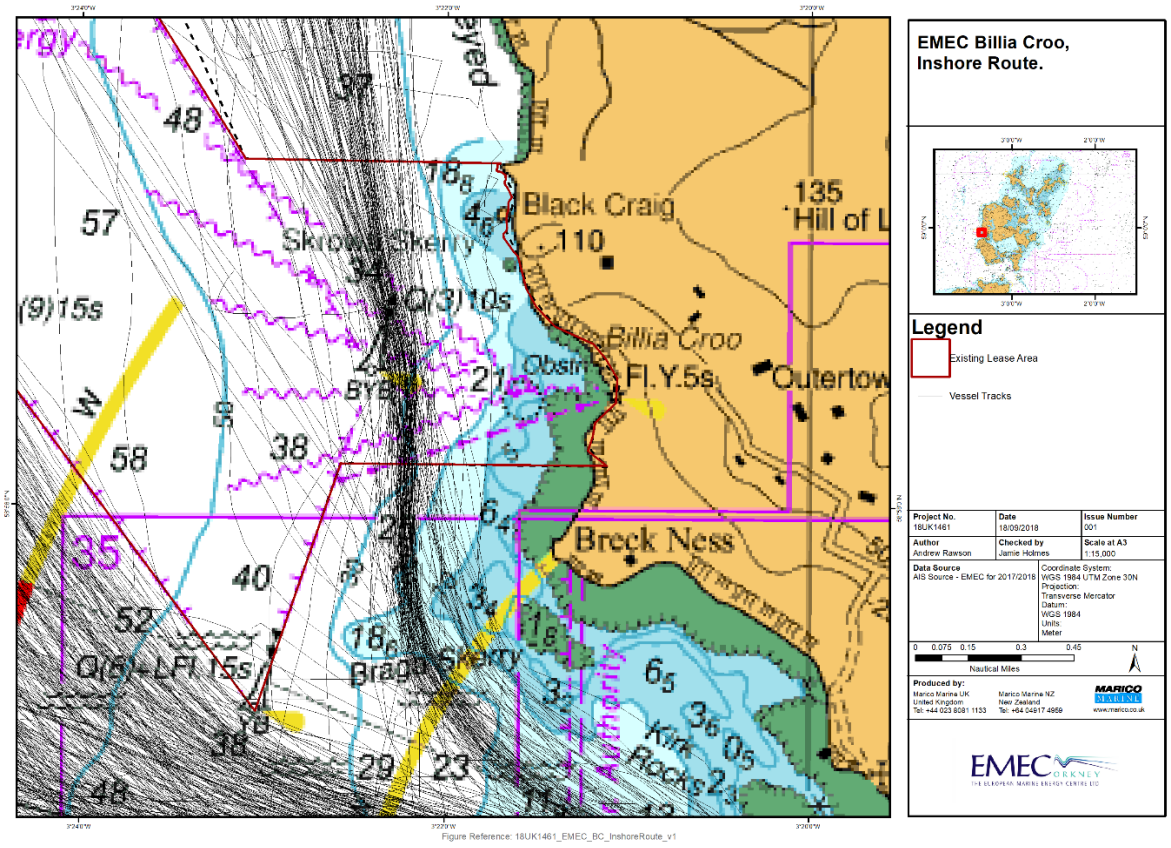


Figure 24: Recreational and fishing vessel tracks inshore of Billia Croo

During consultation, it was identified that in strong westerlies, significant wave refracting occurs off the cliffs and therefore the inshore route can become particularly rough. Vessels would therefore choose to divert further offshore to avoid this.

8.1.3 Offshore route

The offshore route passes to the west of Billia Croo test site (marked with a black arrow in Figure 21). Analysis of vessel traffic data suggests that passing traffic leave less than 500m spacing from the cardinals marking the boundary of the site. With the proposed extension, vessels would necessarily have to divert further offshore to clear the new boundary. This additional distance is minimal and would not require any additional change of course than is currently required. This can be seen in Figure 23 where a significant lull in the traffic density is evident immediately north of the existing site, indicating that vessels are already diverting around the proposed extension to the test site, reducing the impact of the extension.

A vessel on route from the entrance to Stromness Harbour and a point five nautical miles to the north of the existing Billia Croo test site, would travel the following distances:

- Inshore route - 9.7 nm;
- Current offshore route - 11.2 nm;
- Modified offshore route with extension in place - 11.41 nm.

The additional distance travelled (marked by red arrow in Figure 21) is therefore minimal and will not have a significant effect on vessel routeing.

8.2 Impact on contact/allision Risk

8.2.1 Powered contact

A simple geometric model of vessel traffic was used to test how the presence of a device in a test site might pose a hazard of contact to navigating reasons, through for example human error or mechanical failure. The presence of a 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 25 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 x 10^{-4} or 0.016% per transit (Friis-Hansen, 2008).

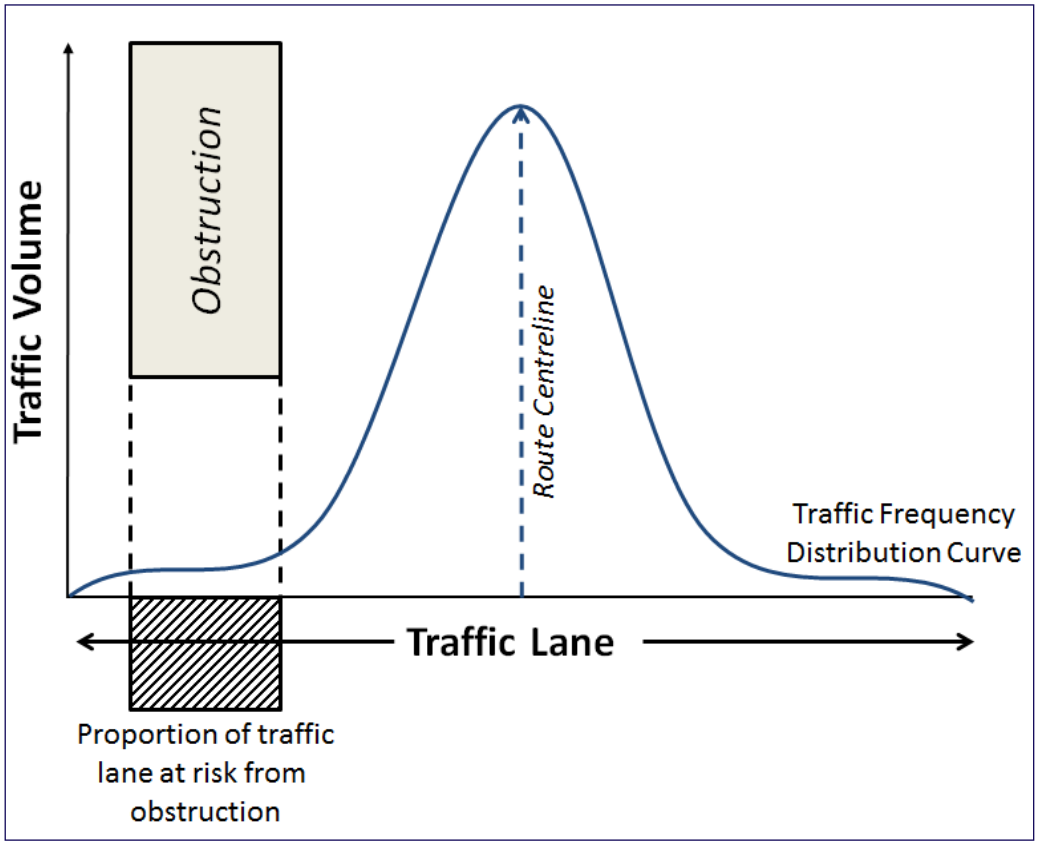


Figure 25: Risk Model

Table 7 shows results for this modelling. As described in Section 5, few vessels not working on the test site pass close to Billia Croo and therefore there are a low number of vessels which could potentially come into contact with the device. This likelihood is further reduced due to the presence of cardinal marks and local knowledge of the site which further reduces the likelihood of contacts.

Contacts by passing vessels with the device are likely to result in minor damage to both the vessel and the device, due to their relatively small scale.

Table 7: Vessel contact risk.

Site	Number of Movements per Year	Modelled Geometric Risk	Failure Rate per Movement	Likelihood of Contact (years)
Billia Croo	500	2.33%	0.01%	857 years

8.2.2 Drift contact

The conditions around Billia Croo can be significant with prevailing westerly waves and wind which could cause a vessel to drift towards the site, potentially contacting a device. The depth of water limits the effectiveness of emergency anchoring as a means of preventing an incident. Such an incident is however unlikely to occur given the relatively sparse traffic density around the site. Furthermore, with the close proximity of the site to the lee-shore, it is unlikely that the consequences of such an event would be greater than would occur if the site was not at this location.

The presence of the RNLI nearby in Stromness would enable a fast response to arrest the drift of a disabled vessel, although their capability would be limited to smaller vessels.

8.2.3 Contact by maintenance vessel

Due to the nature of the operations, a contact between an installation/maintenance vessel and a device is much more likely to occur than with another passing vessel. The maintenance operators are well trained and used to operating in close proximity to these devices which mitigates the likelihood.

8.3 The effects of tides, tidal streams and weather

Navigation around OREIs can be influenced by the tide, tidal streams and weather conditions and this should be considered as part of an NRA.

Section 4 provides data on the metocean conditions around Billia Croo. The tidal stream is north-westerly and south-easterly in orientation, which is parallel to the direction of travel of vessels passing the test site. The tidal stream speeds are not significant in this location to have a significant effect on navigation. Finally, given the size and type of devices in this location there is no expected change to the tidal stream in the area.

The prevailing south-westerly wind has the potential to push vessels transiting offshore towards the devices. Given the low density of traffic and proximity to the lee-shore (for which prudent mariners would leave a wide berth), this would not be a significant hazard.

Poor visibility is relatively common in the Orkney Islands, however as the site is well marked, charted and has existed for several years, mariners would pass around the cardinals and there is a low likelihood of a vessel contacting with a device which they were not aware of.

8.4 Impact on under keel clearance

Whilst many of the devices which have been deployed at the Billia Croo test site are surface piercing, several designs would be bottom mounted or mid-water level (see Section 2.2) which would impact the available depth of water for transiting vessels.

There is no standard clearance definition for safe clearance over underwater devices, instead MGN 543 requires an "*evidence based, case-by-case approach which will include dynamic draught modelling in relation to chartered water depth to ascertain the safe clearance over a*

device". "*To establish a minimum clearance depth over devices, the developer needs to identify from the traffic survey the deepest draught of observed traffic. This will then require modelling to assess impacts of all external dynamic influences giving a calculated figure for dynamic draught. A 30% factor of safety for under keel clearance (UKC) should then be applied to the dynamic draught."* This is detailed further in the MCA policy paper on UKC.

The MCA therefore advocate the following calculation to determine if UKC of a submerged device is acceptable (i.e. if the resulting UKC is greater than 0):

$$UKC\ above\ device = Depth\ at\ CD - Device\ Elevation - (Ship\ Draught * Dynamic\ Factor\ * 1.3)$$

Where:

- Depth at Chart Datum is the depth of water at the site
- Device elevation is the maximum height of device above seabed
- Vessel draught is the deepest vessel draught (which can be assessed from historic and existing vessel traffic records)
- Dynamic factor is a modelled representation of squat, heeling and other dynamic forces on the vessel
- 1.3 is the recommended percentage safety factor for UKC

For the purposes of determining design depths for devices, the device elevation has been removed from the calculation.

The berths at Billia Croo can be identified into three categories:

1. Main test berths (1 to 5) in 35 - 50m of water
2. Extension area to the north in 55m of water
3. Inshore berths in 7 metres of water.

8.4.1 Vessel draughts

Detailed analysis of the vessel draughts transiting near the site was conducted. The actual draughts of vessels at the time of transit was not known for many of the vessels, therefore a review of published specifications and analysis of previously held data was used to make a conservative assumption of the loaded vessel draughts for each vessel.

Figure 26 and Figure 27 show the draughts of vessels transiting within two nautical miles and 500m metres of the extension respectively. By far the most common draught is between two and three metres in both datasets, although the former is driven by the Graemsay ferry and the latter by the fishing vessels in close proximity to the site. The deepest draught vessel which passed through Billia Croo test site, excluding maintenance or installation vessels, were the Northern Lighthouse Board vessels *Pharos* (4.3m) and *Pole Star* (3.4) both of which were servicing the cardinal marks around the site.

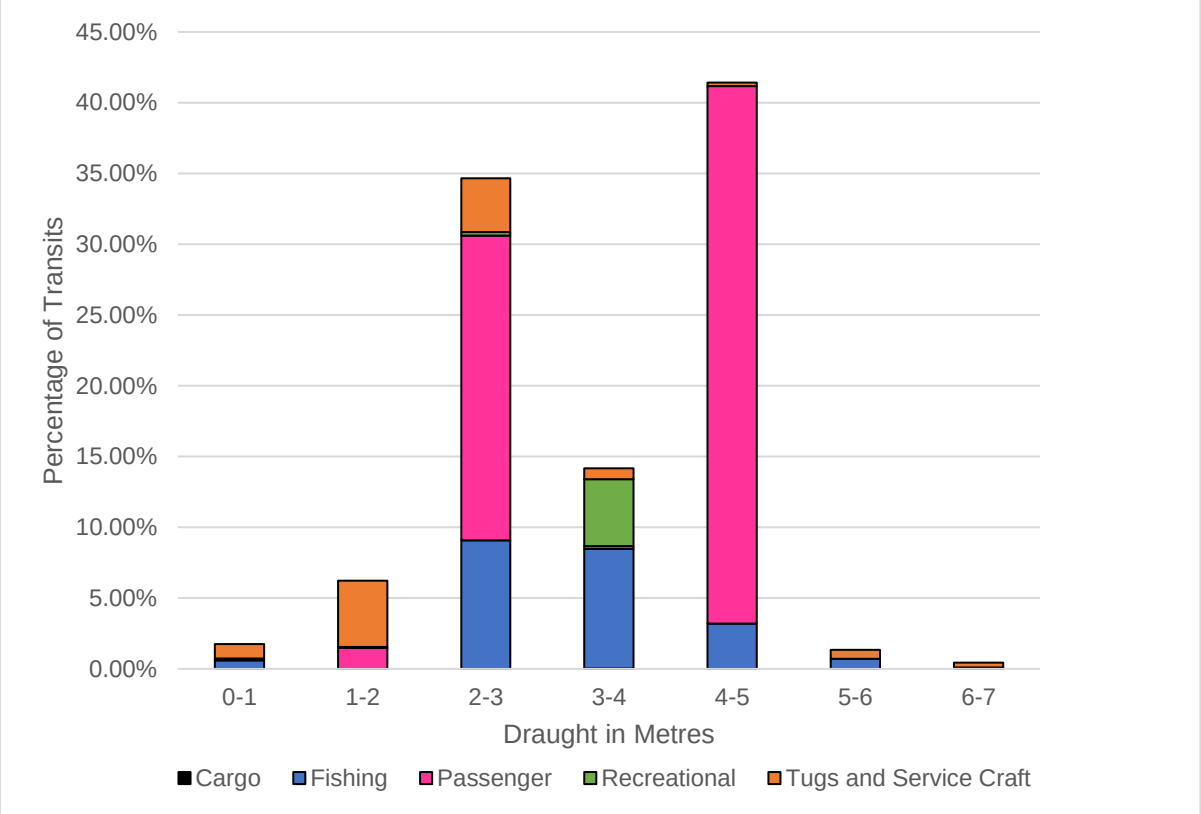


Figure 26: Vessel draught distribution within two nautical miles of site

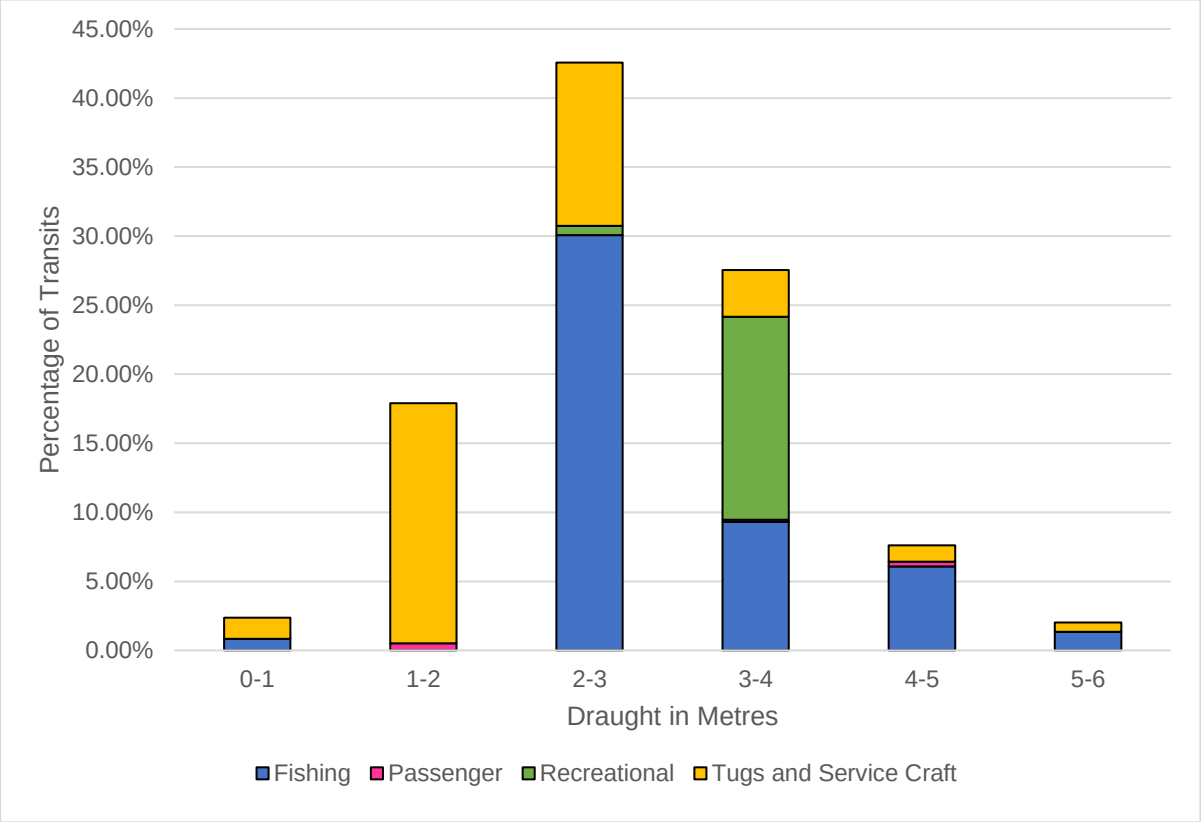


Figure 27: Vessel draught distribution within 500 metres of extension

8.4.2 Dynamic UKC calculations

Calculating the influence of wind and waves on the behaviour of vessels is highly complex and requires a significant understanding of the conditions and characteristics of vessels. To assist with these calculations, the Permanent International Association of Navigation Congresses (PIANC) provide concept design calculations for channel depth (Harbour Approach Channels Design, 2014). The guidance suggests that in an "outer channel" area, the depth of water required should be equal to the draught of the vessel multiplied by between 1.15 and 1.4 depending on the swell conditions. An alternative methodology proposed by the US Army Corp of Engineers (1995) recommends a wave motion value equal to 1.2 times the incident wave height. Both of these calculations give similar results (within 1 metre) using a significant wave height of two metres.

A conservative calculation using the principles of PIANC has been used of vessel draught multiplied by 1.4 to account for dynamic motion multiplied by a 1.3 as an MCA clearance buffer.

8.4.3 Results

Assuming a 50m depth of water (applicable for existing berths 1,2,3 and 5) and that transits occur at the Lowest Astronomical Tide (LAT), the resulting UKC can be calculated. Figure 28 shows the results of the UKC calculations for all vessels within two nautical miles of the site. For vessel transits within two nautical miles, the overriding vessel is the *Hamnavoe* (Stromness-Scabster ferry), which would require a UKC of at least nine metres. 99.4% of transits require less than 10 metres of water to transit. Therefore, in normal conditions, any device which did not extend further than 40 metres above the sea bed (i.e. at least 10 metres below the water level at LAT) would not impede the navigational safety of a vessel.

The analysis was repeated for only those vessels which had previously transited within 500m of the extension area and the results are shown in Figure 29. Less vessels transit within this area, however a similar proportion of 99.5% of transits have a UKC less than 10 metres.

In summary, this analysis suggests that when using average significant wave heights and the types of vessels which transit near the test site, any device with an LAT depth of 40 metres or less (10 metres below LAT) would not pose a navigational risk to passing vessels. Whilst this could be further increased in the area of extension due to the deeper water, a single figure is recommended in the study area to ensure consistency.

An assumption of this UKC assessment has been the use of an average significant wave height, in this case two metres, and it is known that the actual wave heights can be significantly greater (see Section 4.1). During consultation it was discussed that few vessels would navigate near to Billia Croo in these conditions and therefore it would be unrealistic to calculate UKC requirements in these extreme conditions. Furthermore, during discussions it was clear that there was a preference among many navigators to avoid passing over subsurface devices regardless of UKC, which is feasible given the low traffic density and significant room. Given the marking by cardinal marks and that few vessels transit through Billia Croo, this UKC restriction could be relaxed and should be assessed on a case by case basis.

The inshore berths were not calculated using this method as they are in less than 10 metres of water. Therefore, no UKC value would be acceptable and devices which are mid-water column would pose a hazard to navigating vessels if there is no surface marking, or other additional risk controls such as an isolated danger mark.

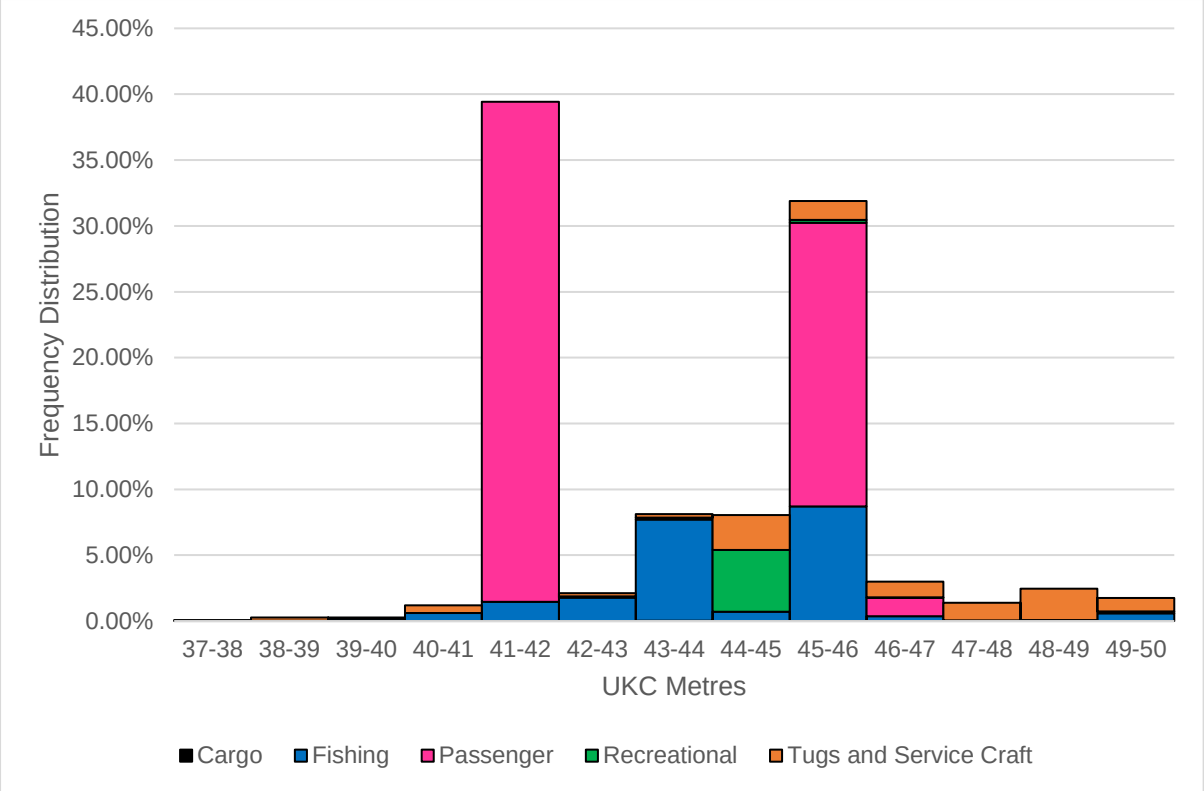


Figure 28: UKC for transits within 2nm of extension

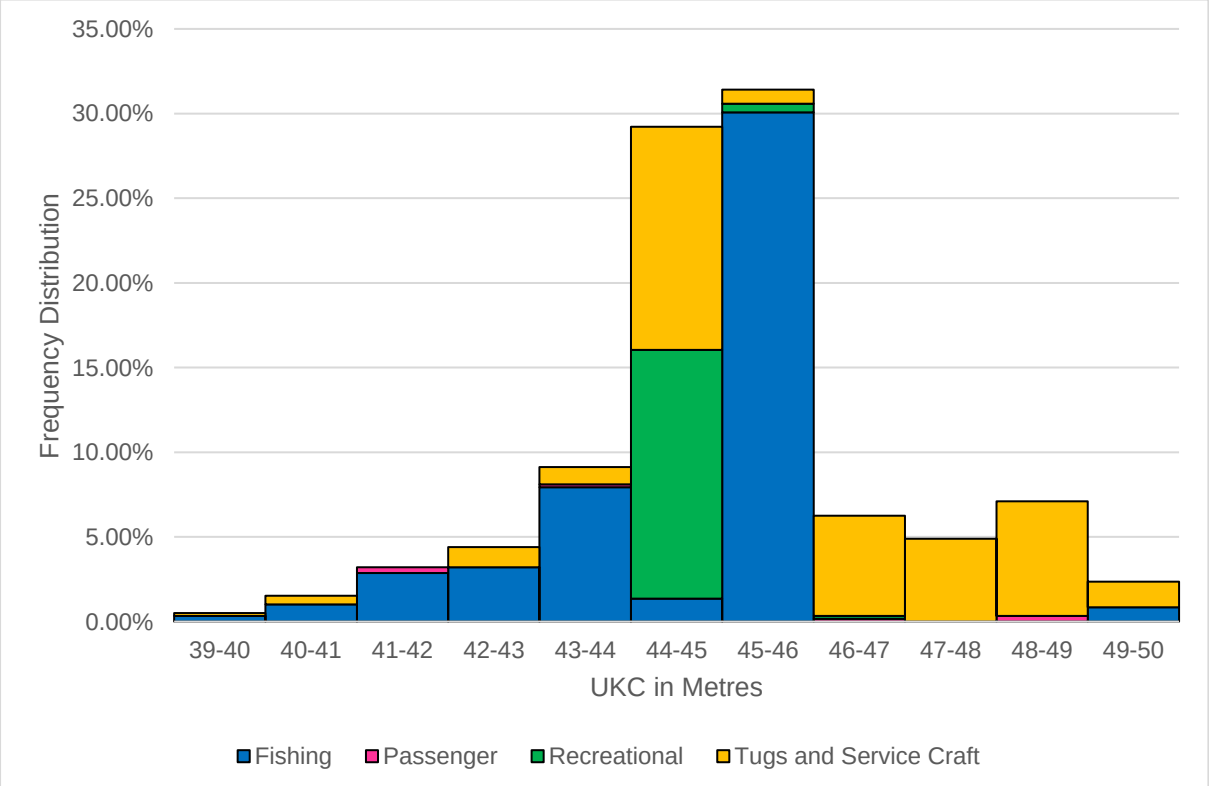


Figure 29: UKC for transits within 500m of extension

8.5 Impact on collision risk, visual navigation and collision avoidance

OREIs have the potential to disrupt traffic flows and obscure other navigating vessels which has the potential to result in a collision. Given the small size of the devices and the low traffic density at Billia Croo, this is not considered to be significant.

The devices could obscure the view of the site boundary cardinal marks, however any approaching vessel would observe a cardinal in the front of the devices and the cardinal's light is a different colour, mitigating this impact.

8.6 Impact on communications, radar and positioning systems

The profile of the devices and the relative size compared to other OREIs does not suggest that there would be any significant impacts upon communications, radar or positioning systems. The export cables are also of such a size and depth of water that it is not likely there would be any discernible electromagnetic impact either.

8.7 Impact of failure of moorings

The test site will contain a number of devices which will be moored to the seabed, the failure of these moorings is a possible hazard which could occur. Mooring failure could occur for a variety of reasons, including incorrect moorings, equipment fatigue and extreme metocean conditions.

The adequacy of mooring arrangements will need to be assessed on a case by case basis, given the specifications of the equipment. Each developer has a requirement to provide a Third-Party Verification on the structural integrity of the device and mooring/foundation system.

If a device were to break free from its moorings, it could be detected through:

- SCADA system
- Position Monitoring (AIS & GPS)
- Harbour Authority radar observations
- Observations from nearby vessels
- Shore based observations from local residents.

A breakout would likely result in a device swept from the test site through the actions of wind and waves. This could pose a navigational hazard to passing traffic, however given the density of traffic recorded during the vessel traffic analysis, this is relatively low. Emergency procedures would need to be in place for alerting HMCG and Orkney Harbours to implement navigational warnings and subsequently recover the device.

8.8 Impact on fishing activity

Analysis of fishing activity near to Billia Croo is given in Section 5.5. Through consultation with Orkney Fisheries it was learnt that fishing around the Orkney Islands is highly variable both in location and magnitude, however fishermen do work around the Billia Croo test site. Whilst fishermen could fish in the test site, generally they would avoid the area due to the potential for surface and bottom hazards which could damage fishing gear through entanglement with devices such as creel strings or directly through trawling.

There have been no reported incidents of fishing gear being damaged on the test devices, and once in location the devices have been well marked and their location well promulgated reducing the chance of an incident. The deployment and maintenance of devices would necessitate the transit of vessels to and from the site which could pass through areas of static gear deployment, potentially damaging them.

A concern was raised that the extension would increase the transit time for fishermen on passage around the site which could exacerbate fatigue and potentially lead to an accident. Analysis in Section 8.1 has shown that the extension is in the same orientation of traffic flow and that there would be minimal additional distance travelled to pass the new obstruction.

8.9 Impact on recreational activity

Section 5.6 shows analysis of recreational activity from AIS data, RYA datasets and marina visitor numbers. Stromness has a marina and therefore a significant number of yachts pass through Hoy Mouth, in addition to local yachtsman. During consultation it was confirmed that most yachts are on passage through this area and that no racing takes place around the devices.

The Orkney Islands have a higher proficiency level of yachtsman as the area is isolated from the UK and yachts must cross either the North Sea or Pentland Firth to reach the area. No issues were identified as a result of the extension to Billia Croo test site, provided that the inshore passage remains open.

8.10 Interaction with subsea cables

As described in Section 4.4.3, there are no subsea cables within two nautical miles of the Billia Croo test site with the exception of the EMEC cables. Subsea cables can pose risks to vessel anchors and fishing gear through snagging, as well as potentially damaging the cables.

The analysis contained in Section 5 has identified no anchoring in the area by third-party vessels, and given the depth of water and metocean conditions, this would not be expected to change. Furthermore, most fishing in the area is using static gear which are less likely to snag on cables.

8.11 Impact on search and rescue and emergency response

Given the scale of the site, the continued operation of the test site is not anticipated to cause any significant impact on SAR operations. The devices will potentially serve as recognised landmarks to vessels in providing their position in an emergency.

Site-wide ERCoP is available which includes details of each device onsite. Each device should have a means of safe access in an emergency, if required.

8.12 Cumulative and in-combination effects with other activities

Whilst Section 4.4 did not identify any existing marine activities in the test site, any new developments could result in a cumulative or in-combination effect on marine traffic.

No significant developments are known to be planned in close proximity to Billia Croo however a number of lease sites exist and are proposed on the west coast of the Orkney Islands (see Section 7.3). If these sites were developed there would be two key cumulative impacts.

Firstly, increased vessel traffic associated with other developments would increase the traffic density in the area and therefore could result in additional collision risks or contact with devices stationed at Billia Croo.

Secondly, the Billia Croo site, in combination with other sites, could result in significant impacts on traffic flow. In particular, the close proximity of West Orkney Middle South, Brough Head and Marwick Head may require significant diversions of vessels around these sites or prevent inshore passage in the area. To mitigate these impacts, navigational corridors between licensed areas may be required, although the determination of these would need to be considered on a case by case basis as the developments are progressed.

9 Navigation Risk Assessment

9.1 Introduction and Methodology

This NRA was commissioned to assess the impact on navigation potentially caused by continued operation of the test site and associated activities, including the installation, testing and decommissioning of device. 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 a Marico risk algorithm 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 C.

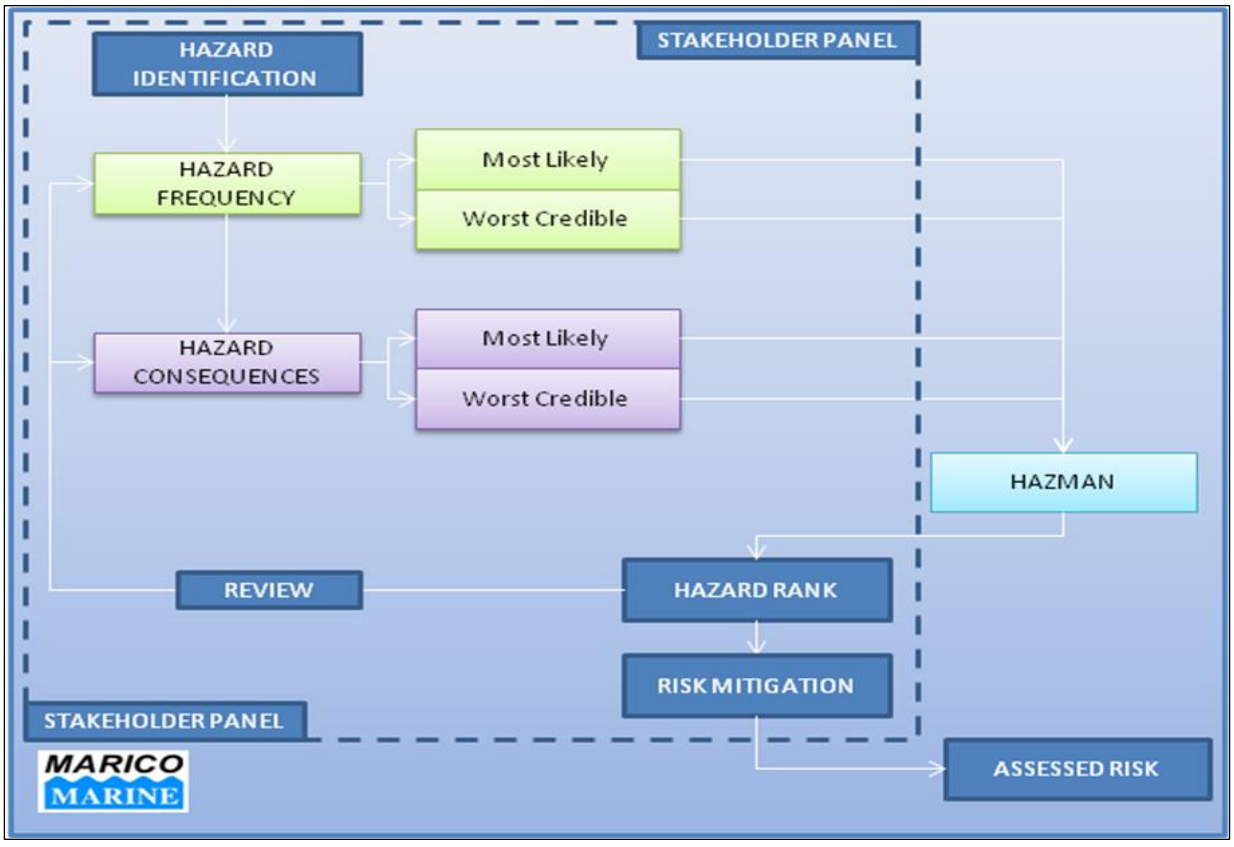


Figure 30: Marico Marine Risk Assessment Methodology

9.2 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 (i.e. a 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; and
- **Breakout –** device breaks its moorings and becomes a hazard to shipping or runs aground.

Vessel categories were defined as follows:

- **Commercial Shipping** – cargo and tankers that carry cargo (including ro-ro, container, bulk or liquid).
- **Passenger Vessels** – passenger ferries and cruise ships;
- **Fishing Vessels** – vessels of all sizes engaged in commercial fishing or trawling;
- **Recreational Vessels** – yachts and pleasure craft;
- **Tugs and Service Craft** – workboats, tugs, pilot vessels and maintenance vessels. Small craft whose primary purpose is commercial.

9.3 Risk control options

9.3.1 Marking and lighting requirements

Marking and lighting requirements for man-made offshore devices are described in IALA Recommendation O-139 (2013). Whilst the requirements for marking and lighting should be based on risk assessment, the document lays out the following recommendations:

- All surface piercing structures should be marked as:
    - Individual wave and tidal energy devices within a site that extend above the surface are painted yellow above the waterline;
    - If marked, the individual devices should have flashing yellow lights. The flash character of such lights must be sufficiently different from those displaying on the boundary lights with a nominal range of not less than 2 nautical miles
    - A single wave or tidal energy structure standing alone may be marked as either an isolated danger mark or a special mark.
- It is also recommended that:
    - Radar reflectors, retro-reflecting material, Racons and / or AIS transponders should be considered where the level of traffic and degree of risk requires

- The lit AtoN must be visible to the mariner from all relevant directions in the horizontal plane, by day and night
- Any floating AtoNs should be located outside the moorings of the floating structures (as outlined in Figure 31)
- AtoNs should comply with IALA Recommendations and have an appropriate availability, normally not less than 99% (IALA Category 2)

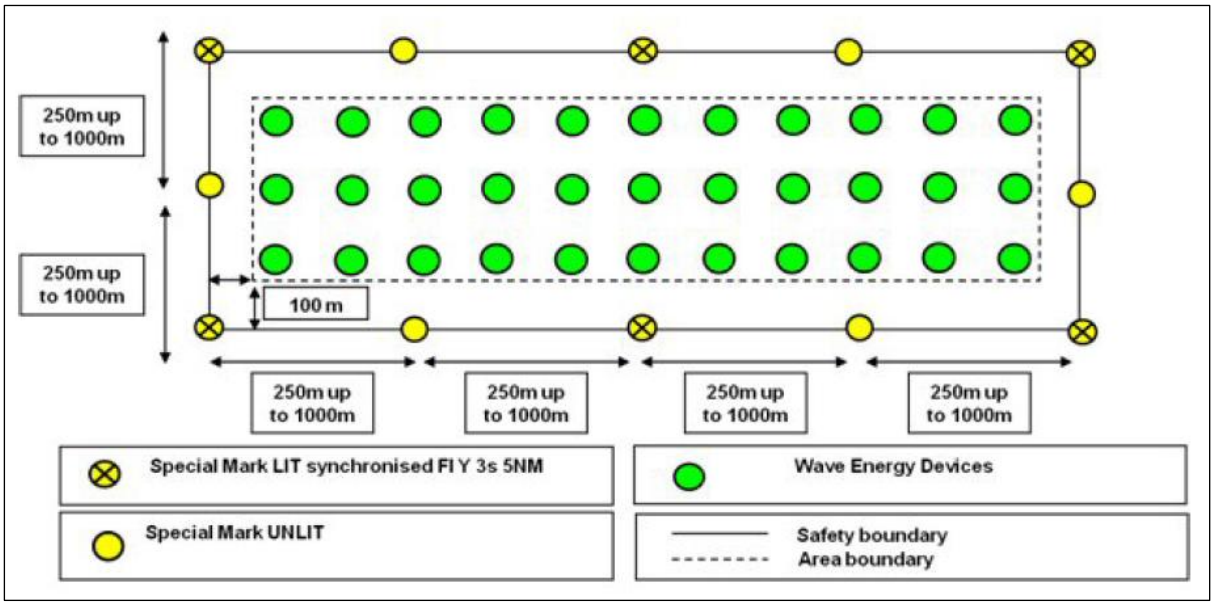


Figure 31: IALA recommendations on marking of wave and tidal devices

During consultation with the Northern Lighthouse Board, they stated that they would typically ask for the following on EMEC surface piercing devices:

- Yellow Day Marking/Painting
- Flashing yellow special mark light (Cat 1)
- Day top mark (if deemed necessary)
- Radar Reflector
- AIS AtoN

Please note, AIS AtoN is mandatory on all floating devices located within EMEC's Billia Croo test site.

Larger devices may require two lights at either end, with synchronised yellow lights. Light ranges are required to be at least three nautical miles. Lighting arrangements are considered on a case by case basis to properly account for the circumstances of each site and the proximity of other devices.

9.3.2 Site embedded risk controls

A number of risk controls are embedded at Billia Croo and have been included in the risk assessment.

Table 8: Embedded Risk Controls

ID	Name	Description
1.	PPE Requirement	Maintenance teams to wear suitable PPE when working on the device, including life jackets.
2.	Training of staff	Staff to be trained to the required standards for their work and have suitable local knowledge of regulations and operations in the Orkney Islands.
3.	ERCoP	Emergency Response and Cooperation Plan for site to be developed and agreed with the MCA and SAR bodies to be consulted.
4.	Layout Plan	Layout plan of the site, drawings, markings and coordinates to be issued to the MCA and Trinity House for comment.
5.	Notice to Mariners and Promulgation	In addition to Notice to Mariners, EMEC's Maritime Safety Information Procedure ensures that all key navigational consultees are informed prior to any works. Distribution could include HM Coastguard, Orkney Marina noticeboards (as necessary), Orkney Fisheries Association, Scottish Fisheries Federation, UKHO and linked to on OIC website. Stakeholders are targeted with information about relevant devices based on their activities and location.
6.	Incident monitoring and reporting	EMEC to encourage incident/near miss reporting and monitor any safety issues at the test site. If necessary, risk control to be reviewed. Risk assessments to be reviewed following any incidents.
7.	EMEC Procedures	EMEC have a number of procedures and standard that are in place to reduce navigation risks: • Task Risk Assessment • Permit to Work • Permit to Access Site • Hazard Identification Reporting • Maritime Safety Information
8.	Hydrography	Responsibility for developer to return the site to the original condition post-decommissioning.
9.	Charting	Site is marked on nautical charts including a chart note.
10.	Site Monitoring	EMEC's SCADA system provides real-time status information, trends, alarms and remote control round-the-clock to facilitate a safe working environment, comprehensive assessment and safe operation of the sites.
11.	CCTV	Billia Croo test site is monitored by CCTV to satisfy operational requirements for control and monitoring of test site activities, visual checks of the test site environment, monitoring of lone worker safety, effective plant operation and substation security.

ID	Name	Description
12.	Site Marking	Billia Croo is marked by five cardinal marks located on the periphery of the site boundary.
13.	Liaison with local stakeholders	EMEC regularly liaises with key local stakeholders to identify and potential issues.
14.	500m advisory Area to be Avoided	A 500m advisory Area to be Avoided exists around all EMEC devices.

9.3.3 Relocation of cardinal marks for extension

Figure 32 shows how the cardinal marks at the test site could be reconfigured following the extension. One of the two western cardinal marks could be placed at the new western extent while the second is removed. A north cardinal mark at the northern limit of the site would box the Billia Croo test site. Under this configuration the site boundary could be simplified, removing one of the cardinal marks. Given the low volume of east-west traffic and the short distance between the top site corners, two cardinal marks may not be required.

A second option would be to locate the northerly cardinal further north, in order to create a safe transit line from the northern cardinal between the eastern and western cardinals. However, this would greatly increase the bounded area and the spacing between the buoys.

Any proposed layout of the site should be discussed and agreed with the Northern Lighthouse Board.

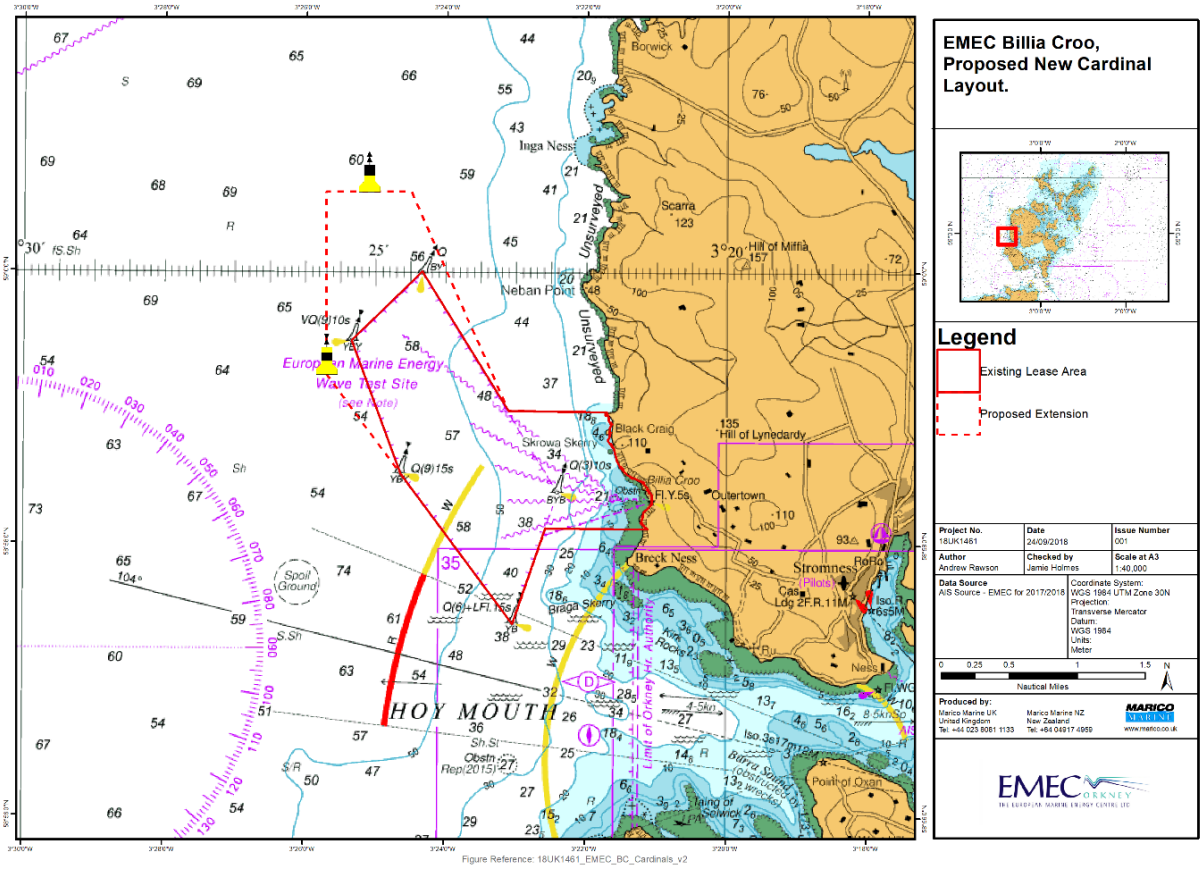


Figure 32: Possible relocation of Billia Croo cardinal marks

9.4 Risk assessment

Full hazard logs are contained in Annex E.

Table 9 shows a summary risk assessment for Billia Croo. All hazards were assessed to be Low Risk with embedded mitigation in place.

Table 9: Billia Croo Summary Risk Assessment

ID	Hazard Title	Hazard Detail	Risk Score
5	Maintenance Vessel Contacts a Device	Maintenance vessel contacts with a device	3.47
9	Third Party Grounding Due to Avoidance of Site	A navigating vessel (all types) grounds due to the presence of the site	3.32
12	Breakout of a Device from Moorings	A device's moorings fail, device becomes a hazard to navigation	3.19
10	Collision with Site Maintenance Vessel	A navigating vessel collides with a tug or maintenance vessel or construction/decommissioning vessel.	3.06
3	Fishing Vessel Contacts a Device	A fishing vessel contacts with a device	2.98
4	Recreational Vessel Contacts a Device	A recreational vessel contacts with a device	2.98
11	Grounding of Maintenance Vessel	A maintenance vessel grounds whilst on passage to/from the site	2.86
2	Passenger Vessel Contacts a Device	A passenger vessel contacts with a device	2.72
8	Third Party Collision Due to Avoidance of Site	Two navigating vessels collide due to the presence of the site.	2.70
1	Commercial Ship Contacts a Device	A commercial vessel such as a cargo vessel or tanker contacts with a device	2.39
7	Fishing Gear Interaction with a Device	A fishing vessel's gear interacts with a device or its moorings or subsea cables.	1.95

9.5 Device specific risk controls

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

Table 10: Possible Device Additional Risk Controls

ID	Name	Description
1.	Radar Reflectors	Use of radar reflectors to improve marking during times of poor visibility.
2.	AIS	Use of AtoN AIS (or virtual AIS) fitted to all surface piercing devices to improve visibility to passing vessels. AIS should be Category 3 with at least 97% up time and use Message 21, or as directed by the NLB.
3.	Heightened monitoring in adverse metocean conditions	During gale force winds, periodic monitoring of the devices is recommended to ensure excessive forces are not acting on the moorings which might cause a breakout.

ID	Name	Description
4.	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.
5.	Remote shut down including feathering of blades	Devices to be fitted with ability to shut down in an emergency, such as feathering any blades or braking to allow access or prevent contact with a vessel.
6.	GPS alert system for turbine moving	Remote monitoring of device to detect any major movements that might indicate a breakout for immediate response. Implement GPS excursion monitoring.
7.	Marking and Lighting	Device to be lit to the requirements of Northern Lighthouse Board and marked in line with IALA guidance. Appropriate statutory Sanctions must be in place to exhibit, alter or discontinue lighting.
8.	Tow risk assessment and passage plan	As required under Orkney Harbours Pilotage Directions 4(3), prior to conducting a towing operation, a risk assessment and passage plan for the move should be conducted. The plan should account for the size of the tow, manoeuvrability restrictions, tow arrangements and metocean conditions.
9.	Guard Vessels	During major construction or maintenance activities, a guard vessel may be considered to assist in protecting the devices from contacts with passing vessel traffic. Due to the low density of traffic, this is not considered necessary unless for extraordinary circumstances. If guard vessels are to be used onsite, it is important that such vessels employed to guard the site follow appropriate guidelines, with clear instructions on when to intervene in a potential incident.
10.	Liaison with local stakeholders	Consultation should be undertaken with Orkney Marine Services, the MCA and NLB prior to installation of device to confirm that adequate risk controls are in place. EMEC also conducts regular stakeholder consultation events to ensure that local marine users are aware of the pipeline of activity.
11.	Installation, Maintenance and Removal	All vessels undertaking activities on site should comply with EMEC procedures (**Section 9.3.2**). Vessels should be mindful of other navigating vessels and avoiding disrupting the activities of others.
12.	ERCoP	Device specific features to be incorporated into site-wide ERCoP.

9.6 Summary

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

10 Conclusions and recommendations

10.1 Conclusions

This site-wide NRA for EMEC's Billia Croo test site has investigated the baseline conditions, possible future changes at the site and conducted a risk assessment for the continued operation of the test site and proposed extension to the site boundary. The following conclusions have been reached:

1. The Billia Croo test site was established in 2003 as a wave energy test site and has successfully operated the site with a variety of devices tested since the site was established.
2. Metocean conditions in the area can be significant, with a prevailing westerly swell and wind. Significant wave heights can exceed 10 metres each year. Poor visibility can occur regularly in the area. Tidal conditions become increasingly significant to the south in the entrance to Scapa Flow, at Hoy Mouth.
3. The area is outside but adjacent to the limits of the Orkney Islands Council Marine Services, although the VTS have full radar coverage of the site but it is not actively monitored. An RNLI lifeboat is based in Stromness, Longhope and Kirkwall.
4. Whilst there are no other renewable developments in close proximity to Billia Croo, future exploitation of existing and planned lease areas may result in cumulative and in-combination effects.
5. Vessel traffic analysis was conducted using AIS, visual observations and secondary sources.
    a. There is very little commercial shipping activity near to the Billia Croo test site, with the largest vessels excluded through the IMO adopted ATBA. Stromness is a ferry port and therefore there are daily ferry services to the south of the site.
    b. Many fishing vessels operate out of Stromness, the majority of which are on transit past the Billia Croo test site, albeit some may fish using static gear in the inshore vicinity.
    c. Recreational craft tend to be on passage past the Billia Croo test site.
    d. The main vessel type using the Billia Croo test site are vessels associated with the renewable industry, transiting to and from the devices and Stromness or Kirkwall.
    e. Whilst 4,000 vessels transited within two nautical miles of the site, only 600 passed within 500m and less than 400 passed within the footprint of the site.
    f. There is a clear seasonality aspect to vessel traffic, with at least twice as many transits in the area during summer compared to winter. Similarly, this is reflected hourly with peaks in activity seen in the morning and evening, with the departure and return of fishing vessels and ferries.
    g. Analysis of seven years of visual observations also supported this analysis, identifying the routes of recreational and fishing vessels inshore and offshore of the test site.
6. Analysis of MAIB incident data between 1997 and 2015 identified no incidents within the test site. Those incidents located within two nautical miles were mostly mechanical failures or accidents to person and were unrelated to EMEC.

7. There is projected to be a steady increase in commercial and recreational traffic passing the Billia Croo test site, however the greatest changes in traffic are related to maintenance vessels at the site, which varies depending on the level of occupancy.
8. The impact to vessel routeing was considered. It was concluded that most vessels currently avoid passing within the test site and the orientation of traffic flow with the extension means that there will be little impact on future vessel traffic. The inshore route will be unaffected by the extension.
9. Analysis of contact risk with the devices showed a very low likelihood of a passing or disabled vessel contacting a device. The most likely contact would involve a vessel operating on devices onsite such as installation, decommissioning and/or maintenance vessels.
10. The risks of the site were not considered to be increased due to the wind, wave and tides. A detailed analysis of under keel clearance requirements was conducted using the draughts of passing vessels. It was concluded that for most operating conditions, a 10m UKC should be maintained for devices to avoid a contact between a submerged device and the types of vessels operating in the area. The inshore berths are not in sufficient depth of water to enable most vessels to safely transit over.
11. Given the low height profile of the devices, the impact was not considered significant to SAR, visual navigation or communications, radar and positioning systems.
12. Mooring failure was identified as a possible hazard, particularly given the significant metocean conditions at the site, however a number of risk controls are already in place to prevent such an event.
13. The impact on fishing and recreational activity was reviewed and it was not considered that the extension would significantly disrupt their activities.
14. An NRA was conducted which identified 11 hazards. By scoring the likelihood and consequence of each, it was determined that all hazards were low risk.
15. A great number of risk controls are already in place at Billia Croo, and a number of additional risk controls were identified to enhance the safety of each additional device. The choice of these controls to employ should be conducted on a case by case basis in consultation with the MCA and NLB.
16. The extension will require the relocation of the five cardinal marks currently in place at Billia Croo test site. A layout was proposed which would reduce this to four cardinal marks and should be discussed with the NLB.

10.2 Key navigational themes for device specific NRAs to consider

This NRA has identified the baseline conditions and key hazards at the Billia Croo test site. Each developer should use this document to conduct a device-specific addendum NRA which references how these hazards may be impacted by the specific characteristics of their device. The following table is provided as a guide to developers.

Table 11: Device Specific NRA Criteria

Item	Title	Description	NRA Comment
Project Description			
1.	Description	Developer to provide a detailed description of the device, its dimension and location.	N/A
2.	Mooring Arrangements	Developer to provide details of the mooring arrangements for the device and confirm that they have been independently verified as adequate to the expected metocean conditions and loadings.	N/A
3.	Construction Methodology	Developer to provide a description of the installation process and methodology.	N/A
4	Maintenance Plans	Developer to provide outline maintenance plans and schedule.	N/A
5	Decommissioning Plan	Developer to provide outline decommissioning methodology.	N/A
Key Navigational Themes			
1	Vessel Routeing	Does the device impact the routeing of vessels in the area?	Billia Croo is well clear of major shipping routes and both an inshore and offshore route remain navigable.
2	Contact/Allision Risk	Does the device pose a risk of contact to navigating vessels?	Few vessels navigate within the site and the use of device and site marking mitigates the risk of contact.
3	Effects of Tide/Tidal Streams and Weather	Does the device influence metocean conditions or is at risk as a result of these conditions?	No impact was identified as relates to the effect of tides and weather.
4	Under Keel Clearance	Does the device compromise a vessel's UKC?	The NRA suggests a 10m LAT UKC threshold, above which additional mitigation would be required.
5	Collision Risk and Visual Navigation	Does the device hinder visual identification of other vessels or key landmarks/aids to navigation?	The scale of the devices does not hinder visual navigation.
6	Communications, Radar and Positioning Systems	Does the device impact the communications, radar and positioning vessels on board vessels or on land?	The scale of the devices is not likely to impact on electronic systems.
7	Moorings	Are the moorings sufficient for the device and the conditions?	Given the significant wave heights at Billia Croo, this should be independently verified for each device.
8	Fishing Activity	Does the device impact upon the activity of fishing vessels?	Relatively little fishing takes place in the study area and fishermen would generally avoid the underwater infrastructure of the site.
9	Recreational Activity	Does the device impact upon the activity of recreational vessels?	There is no racing or small boat sailing at the site, most recreational vessels are yachts on passage.

Item	Title	Description	NRA Comment
10	Subsea Cables	Does the device require cables that may be at risk from snagging, what types of protection will be installed and does this compromise water depth?	There is no evidence of anchoring or gear snagging at Billia Croo historically.
11	SAR	Does the device impact SAR capability and has access been considered in the design of the device?	There is not anticipated to be any impact on SAR access to the site given the small scale of the devices.
12	Cumulative and In Combination	Are there nearby devices which might exacerbate the impacts discussed above?	Cumulative effects depend on layout but the bounding of the site by cardinals mitigates this impact.
Risk Controls			
1	Site Wide Risk Controls	Are the site wide risk controls sufficient for this type of device?	A list of site wide risk controls is given in Section 9.3.2
2	Device Specific Risk Controls	Which additional risk controls are proposed to be in place for this device?	A possible list of device specific risk controls is given in Section 9.5.
3	Marking and Lighting	Have the marking and lighting arrangements been agreed with the MCA and NLB?	Marking and lighting guidance is given in Section 9.3.1.

10.3 Summary

In summary, this NRA has demonstrated that the navigational risks at the Billia Croo test site are managed below ALARP and that the extension will not have any significant impacts on navigational safety. It is recommended that this site NRA is updated periodically to account for any changes in traffic profile or site use.

References

Abbot Risk Consulting Ltd (2010-2011). Billia Croo Navigational Risk Assessment.

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

Anatec (2014). Billia Croo NRA Update.

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 (2015). Billia Croo – Berth 1: MetOcean & Geophysical Description.

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

HSE. Wind and wave frequency distribution for sites around the British Isles, Grid Point 14824.

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

IALA (2004). IALA Recommendation 0-139 on the Marking of Man-Made Offshore Structures.

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

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

Marine Scotland (2015). National Marine Plan.

Marine Scotland Science (2018). Scoping “Areas of Search” Study for Offshore Wind Energy in Scottish Waters.

MCA (2014). Under Keel Clearance – Policy Paper.

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.

MCA (2016). MGN 372: Guidance to Mariners Operating in the Vicinity of UK OREIs.

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

PIANC (2014). Harbour Approach Channels Design Guidelines. PIANC Report No 121.

RYA (2015). The RYA’s Position on Offshore Renewable Energy Developments: Paper–Wave Energy.

US Army Corps of Engineers (1995). Hydraulic Design Guidelines for Deep-Draught Navigation Projects.

Annex A: Area to be Avoided NTM

Orkney Islands Council Harbour Authority – Notice to Mariners

EMEC – 17 September 2010

MARINE EXCURSIONS WITHIN THE EMEC TEST AREAS

1. Purpose

This SOP describes the requirements for excursion trips into any of the EMEC test areas.

2. Scope

This SOP applies to all passenger carrying vessels, whether organised, accompanied or recommended by EMEC, intending to enter EMEC test areas for the purposes of viewing the sites or for photography. In the event that a third party independently charters a vessel in order to enter the EMEC test areas, it is expected that these guidelines are followed.

It does not permit; contact or any form of interaction with any marine energy devices or buoys, surveys, crew transfers, deliveries or collections to/from devices or to/from working vessels – all of these activities are covered by the EMEC Site Access or Work Permit systems.

3. Vessel Requirements

Prior to a site visit; copies of the vessel MCA code certificate, insurance certificate and Master's qualifications shall be sent to EMEC and shall be electronically filed within EMEC systems for reference. Vessel documentation shall be reviewed by EMEC annually.

Vessels accessing the sites are expected to carry at least a working Class B AIS Transponder to permit tracking of vessel movements by EMEC Operations and Orkney VTS.

4. Excursion Guidelines

Passenger boarding shall take place only at harbour steps or a boat slip. Any loading of equipment or baggage shall be loaded under supervision of the vessel crew and shall be lowered by rope or hoist where required. The vessel master is at all times responsible for the safety and welfare of his crew and passengers. Safe weather limits shall be established for the trip by the master, taking into account the vessel capabilities, number of passengers, experience of the passengers and trip purpose. The vessel master shall review current Notices to Mariners. Vessels are requested to remain at least 500m from devices, unless permitted otherwise by the EMEC Duty Manager or developer.

MARINE EXCURSIONS WITHIN THE EMEC TEST AREAS

Wildlife are sensitive to noise and disturbance, particularly marine mammals which use the test sites as a habitat – due care is to be taken.

5. Passenger Briefing

The vessel master shall ensure that all passengers receive a safety briefing which shall include emergency procedures, exits, personal safety equipment, life rafts and an introduction to the nominated first aider.

6. Notifications

The EMEC Operations team (24 hr Duty Manager on 07624 345411 if out of hours) shall be notified prior to all visits in order to establish activity levels on site and to safely co-ordinate traffic. The vessel shall always notify the EMEC Duty Manager, normally by text, on site entry & egress (including total POB).

Annex B: 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	✓	Vessel traffic analysis is contained in Section 5. All vessel types were considered.
At least 28 days duration, within either 12 or 24 months prior to submission of the Environmental Statement	✓	Details of the vessel traffic data are contained in Section 5.1. 18 Months of AIS data was analysed (2017-2018) and in addition visual observations between 2009 and 2015 were used to identify non-AIS vessels.
Multiple data sources	✓	Details of the vessel traffic data are contained in Section 5.1 and include AIS, visual and secondary sources.
Seasonal variations	✓	Details of the vessel traffic data are contained in Section 5.1. Datasets were for several years duration and cover summer and winter periods.
MCA consultation	✓	The MCA were consulted and details are contained in Section 3 and Annex D.
General Lighthouse Authority consultation	✓	The NLB were consulted and details are contained in Section 3 and Annex D.
Chamber of Shipping consultation	**X**	Given the low level of commercial shipping, no consultation was conducted with the CoS.
Recreational and fishing vessel organisations consultation.	✓	The RYA, Orkney Marinas and Orkney Fisheries Association were consulted and details are contained in Section 3 and Annex D.
Port and navigation authorities consultation, as appropriate	✓	The Orkney Islands Council Marine Services Harbour Master was consulted and details are contained in Section 3 and Annex D.
Assessment of the cumulative and individual effects of (as appropriate):		
i. Proposed OREI site relative to areas used by any type of marine craft.	✓	Vessel traffic analysis of all vessel types is contained in Section 5
ii. Numbers, types and sizes of vessels presently using such areas	✓	Vessel traffic analysis of all vessel types is contained in Section 5
iii. Non-transit uses of the areas, e.g. fishing, day cruising of leisure craft, racing, aggregate dredging, etc.	✓	Vessel traffic analysis of all vessel types is contained in Section 5. Fishing and recreational vessels transits passed the site.

Issue: OREI Response	Yes/No	Comments
iv. Whether these areas contain transit routes used by coastal or deep-draught vessels on passage.	✓	Vessel traffic analysis of all vessel types is contained in Section 5. Few deep draught vessels transit passed the site.
v. Alignment and proximity of the site relative to adjacent shipping lanes	✓	Section 8.1 considers the routeing of vessels adjacent to the site.
vi. Whether the nearby area contains prescribed routeing schemes or precautionary areas	✓	Section 4 describes the marine environment in the area. There are no routeing schemes or precautionary areas.
vii. Whether the site lies on or near a prescribed or conventionally accepted separation zone between two opposing routes	✓	Section 4 describes the marine environment in the area and there are no traffic schemes.
viii. Proximity of the site to areas used for anchorage, safe haven, port approaches and pilot boarding or landing areas.	✓	Vessel traffic analysis of all vessel types is contained in Section 5. The route is near to the approach to Stromness (Hoy Sound) and a pilot boarding station is located to the south (Section 4.2).
ix. Whether the site lies within the jurisdiction of a port and/or navigation authority.	✓	The site is outside, but adjacent to, the port limits of Orkney Islands Council Marine Services (Section 4.2)
x. Proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds.	✓	Analysis of fishing vessel activity is contained in Section 5.5. Fishing vessels are active in the area of the site.
xi. Proximity of the site to offshore firing/bombing ranges and areas used for any marine military purposes.	✓	There are no PEXA areas near the site (Section 4.4.5)
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 4.4 identifies other offshore activities near the site, of which there are none.
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 4.4 identifies other offshore activities near the site, of which there are none.
xiv. Proximity of the site relative to any designated areas for the disposal of dredging spoil or other dumping ground	✓	Section 4.4 identifies other offshore activities near the site, a disused spoil ground exists to the south-west.
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.	✓	The site is outside, but adjacent to, the port limits of Orkney Islands Council Marine Services (Section 4.2). However, VTS does have full radar coverage of the site.
xvi. Researched opinion using computer simulation techniques with respect to the displacement of traffic and, in particular, the creation of 'choke points' in areas of high traffic density and nearby or consented OREI sites not yet constructed.	✓	Section 8.1 discusses the impact on vessel routeing. The extension would have minimal displacement of traffic and therefore this impact is not considered significant.
xvii. With reference to xvi. above, the number and type of incidents to	✓	Section 6 analyses historical incidents near the site using MAIB data, of which there are few and

Issue: OREI Response	Yes/No	Comments
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.		none of which are related to EMEC or developers operating on the site.
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.	✓	The impact of the site on vessel contacts is given in Section 8.2. Given the low density of traffic and marking of the site by cardinals, this risk is not considered significant. The risk assessment also did not identify this as a significant hazard (see Section 9.4). Section 8.11 does not identify any significant impact on emergency response capability.
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 8.4 provides a detailed analysis of the impact on UKC. Whilst this should be assessed on a case by case basis for each device, a discussion on the draughts of vessels passing the site can inform the NRA addendums.
d. The burial depth of cabling and changes to charted depths associated with any protection measures.	✓	Section 8.4 provides a detailed analysis of the impact on UKC. Given the depth of water, the cable should not compromise safe navigable depths.
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 8.1 considers the impact on vessel routeing and concludes that most vessels would transit around the buoyed site. For vessels within the site, Sections 8.2 and 8.4 consider the impact on contact risk and UKC requirements and do not identify a significant risk. The risk assessment also did not identify this as a significant hazard (see Section 9.4).
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 8.1 considers the impact on vessel routeing and concludes that most vessels would transit around the buoyed site. Section 9.3.3 discusses the relocation of the existing cardinal marks to account for the extension.

Issue: OREI Response	Yes/No	Comments
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 8.1 considers the impact on vessel routeing and concludes the impact is minimal. Section 8.11 considers that there would be no impact to SAR capability in the site.
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 9.3 discusses risk control options, no safety zones are proposed for the site. However, it is advised that vessels pass around the site.
Annex 2: Navigation, collision avoidance and communications		
1. The Effect of Tides and Tidal Streams : It should be determined whether:		
a. Current maritime traffic flows and operations in the general area are affected by the depth of water in which the proposed installation is situated at various states of the tide i.e. whether the installation could pose problems at high water which do not exist at low water conditions, and vice versa.	✓	Section 4.1 provides current metocean data for the area and the implications of these are considered in Section 8.3 and Section 8.4. The only impact would be for subsurface devices and should be assessed on a case by case impact on UKC.
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 4.1 provides current metocean data for the area and the implications of these are considered in Section 8.3 and Section 8.4. The only impact would be for subsurface devices and should be assessed on a case by case impact on UKC.
c. The maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect.	✓	Section 4.1 provides current metocean data for the area and the implications of these are considered in Section 8.3, which shows the impact is not significant.
d. The set is across the major axis of the layout at any time, and, if so, at what rate.		Section 4.1 provides current metocean data for the area and the implications of these are considered in Section 8.3, which shows the impact is not significant.
e. In general, whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream.	✓	Section 8.2.2 considers the risk of a disabled vessel contact the device. This is not considered to be significant.
f. The structures themselves could cause changes in the set and rate of the tidal stream.	✓	Section 8.3 does not identify that the devices would impact tidal flows, this should be assessed on a case by case basis for each design of device.
g. The structures in the tidal stream could be such as to produce siltation, deposition of sediment or scouring, affecting navigable water	✓	Section 8.3 does not identify that the devices would impact tidal flows, this should be assessed on a case by case basis for each design of device.

Issue: OREI Response	Yes/No	Comments
depths in the OREI or adjacent to the area		
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 4.1 provides current metocean data for the area and the implications of these are considered in Section 8.3, which show no significant impact.
b. The structures could create problems in the area for vessels under sail, such as wind masking, turbulence or sheer.	✓	Section 4.1 provides current metocean data for the area and the implications of these are considered in Section 8.3, which show no significant impact.
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 8.2.2 considers the risk of a disabled vessel contact the device. This is not considered to be significant.
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.	✓	The impact on SAR is considered in Section 8.11. This is not considered to be significant.
b. The MCA's Navigation Safety Branch and Maritime Operations branch will be consulted on the layout design and agreement will be sought.	✓	This is an identified risk control in Section 9.3.
c. The layout design has been or will be determined with due regard to safety of navigation and Search and Rescue.	✓	This is an identified risk control in Section 9.3.
d.i. The structures could block or hinder the view of other vessels under way on any route.	✓	Section 8.5 does not identify any impacts in this regard given the scale of the devices.
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 8.5 does not identify any impacts in this regard given the scale of the devices.
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:	✓	Section 8.6 reviews the possible impacts on ship communications, radar and position systems. Given the scale of the devices this is not considered to be significant.

Issue: OREI Response	Yes/No	Comments
i. Vessels operating at a safe navigational distance 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 8.6 reviews the possible impacts on ship communications, radar and position systems. Given the scale of the devices this is not considered to be significant.
c. The structures and generators might produce sonar interference affecting fishing, industrial or military systems used in the area.	✓	Section 8.6 reviews the possible impacts on ship communications, radar and position systems. Given the scale of the devices this is not considered to be significant.
d. The site might produce acoustic noise which could mask prescribed sound signals.	✓	Section 8.6 reviews the possible impacts on ship communications, radar and position systems. Given the scale of the devices this is not considered to be significant.
e. Generators and the seabed cabling within the site and onshore might produce electro-magnetic fields affecting compasses and other navigation systems.	✓	Section 8.6 reviews the possible impacts on ship communications, radar and position systems. Given the scale of the devices this is not considered to be significant.
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 2.3 gives an overview of current lighting and marking arrangements and Section 9.3 discusses future requirements.
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 2.3 gives an overview of current lighting and marking arrangements and Section 9.3 discusses future requirements. These would need to be assessed on a case by case basis.
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 9.3 discusses the benefit of the use of radar reflectors on the devices. These would need to be assessed on a case by case basis.

Issue: OREI Response	Yes/No	Comments
d. If the site would be marked by additional electronic means e.g. Racons	✓	Section 9.3 discusses the benefit of additional marking on the devices. These would need to be assessed on a case by case basis.
e. If the site would be marked by an AIS transceiver, and if so, the data it would transmit.	✓	Section 9.3 discusses the benefit of additional marking on the devices. These would need to be assessed on a case by case basis.
f. If the site would be fitted with audible hazard warning in accordance with IALA recommendations	✓	Section 9.3 discusses the benefit of additional marking on the devices. These would need to be assessed on a case by case basis.
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 9.3 discusses the benefit of additional marking on the devices. These would need to be assessed on a case by case basis.
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 9.3 discusses the benefit of additional marking on the devices. These would need to be assessed on a case by case basis.
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 9.3 discusses the marking requirements and these would need to be assessed on a case by case basis.
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 9.3 discusses the marking requirements and these would need to be assessed on a case by case basis.
k. The ID marking will conform to a spreadsheet layout, sequential, aligned with SAR lanes and avoid the letters O and I.	✓	Section 9.3 discusses the marking requirements and these would need to be assessed on a case by case basis.
l. Working lights will not interfere with AtoN or create confusion for the Mariner navigating in or near the OREI.	✓	Section 9.3 discusses the marking requirements and these would need to be assessed on a case by case basis.
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).	✓	N/A as the site has already been established.
ii. Post-construction: Cable route(s)	✓	N/A as the site has already been established.

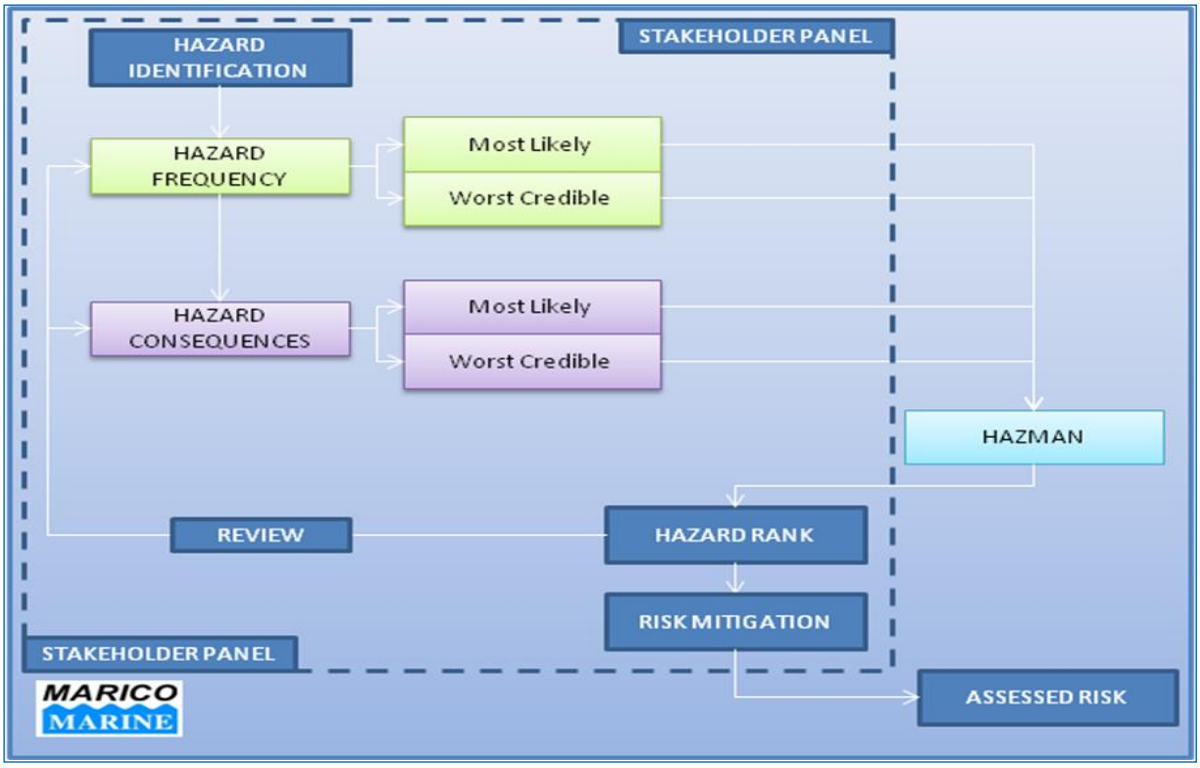
Issue: OREI Response	Yes/No	Comments
iii. Post-decommissioning of all or part of the development: Cable route(s) and the area extending to 500m from the installed generating assets area.	✓	Individual developers commit to a post-decommissioning survey as per their license and berth agreement to demonstrate the seabed is in the condition prior to development.
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 8.1 considers the impact on vessel routeing, however the MCA shipping route template is not considered appropriate for a test site.
b. The width of a corridor between sites or OREIs to allow safe passage of shipping.	✓	Section 8.1 considers the impact on vessel routeing and that there is considerable sea room around the site. Few vessels transit within the site but the proximity of devices should be considered on a case by case basis.
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 9.3 provides an overview of all existing and possible future risk controls for the devices at the site.
i. Promulgation of information and warnings through notices to mariners and other appropriate maritime safety information (MSI) dissemination methods.	✓	Section 9.3 provides an overview of all existing and possible future risk controls for the devices at the site.
ii. Continuous watch by multi-channel VHF, including Digital Selective Calling (DSC).	✓	Section 9.3 provides an overview of all existing and possible future risk controls for the devices at the site.
iii. Safety zones of appropriate configuration, extent and application to specified vessels[6]	✓	Section 9.3 provides an overview of all existing and possible future risk controls for the devices at the site.

Issue: OREI Response	Yes/No	Comments
iv. Designation of the site as an area to be avoided (ATBA).	✓	As per Section 4.2**,** the area is already an ATBA.
v. Provision of AtoN as determined by the GLA	✓	Marking and lighting arrangements are given in Section 9.3 but should be agreed on a case by case basis for each individual device.
vi. Implementation of routeing measures within or near to the development.	✓	Section 9.3 provides an overview of all existing and possible future risk controls for the devices at the site. Traffic routeing is not considered necessary.
vii. Monitoring by radar, AIS, CCTV or other agreed means	✓	Section 9.3 provides an overview of all existing and possible future risk controls for the devices at the site.
viii. Appropriate means for OREI operators to notify, and provide evidence of, the infringement of safety zones.	✓	Section 9.3 provides an overview of all existing and possible future risk controls for the devices at the site.
ix. Creation of an Emergency Response Cooperation Plan with the MCA's Search and Rescue Branch for the construction phase onwards.	✓	Section 9.3 provides an overview of all existing and possible future risk controls for the devices at the site.
x. Use of guard vessels, where appropriate	✓	Section 9.3 provides an overview of all existing and possible future risk controls for the devices at the site.
xi. Any other measures and procedures considered appropriate in consultation with other stakeholders.	✓	Section 9.3 provides an overview of all existing and possible future risk controls for the devices at the site.
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 9.3 provides an overview of all existing and possible future risk controls for the devices at the site.
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.	✓	Checklist has been completed.

Annex C: NRA methodology

Methodology

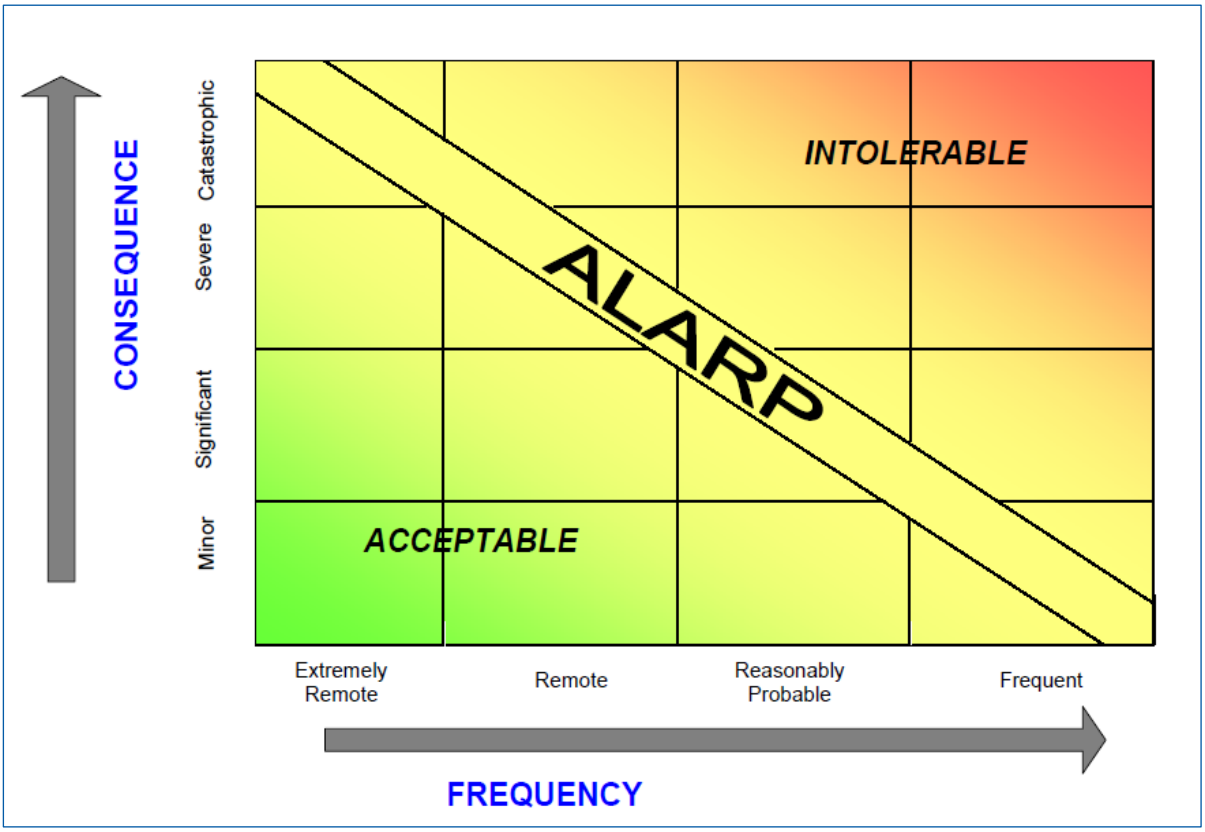
This Navigation Risk Assessment (NRA) was commissioned to assess the impact on navigation potentially caused by the continued operation of the test site and associated activities, including the installation, testing and decommissioning of devices. The NRA is limited to identifying and quantifying any 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;
- **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 were 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 D: Consultation minutes

Minutes – EMEC NRAs – 18UK1461

Client:	EMEC	
Project:	18UK1461	
Attendees:	Helen Croxson (HC)	MCA
	Caitlin Long (CL)	EMEC
	Andrew Rawson (AR)	Marico Marine
	William Heaps (WH)	Marico Marine
Venue:	Spring Place, Southampton	
Date of Meeting:	13:30 to 14:30 19th September 2018	

Item	Action item / Notes for the record	Action
1	**Introduction**	
2	**Overview**	
2.1	AR gave an overview of the NRAs, consultation and work to date.	
3	**Licensing Requirements**	
3.1	HC described her involvement with the EMEC projects, in her previous role in MCA with licensing and more recently as OREI advisor.	
3.2	CL provided an overview of the licensing of the sites. EMEC have a Section 36 consent envelope for Fall of Warness and are applying for the same consent for Billia Croo. For the main sites at Fall of Warness/Billia Croo – generally each developer applies for their own marine licence. For the scale test sites, either the developer can apply for their own marine licence or if it falls within EMEC's envelope they can use the existing marine licence.	
3.3	MCA had requested that EMEC update the NRAs due to the age of the documents. CL/HC were not aware of a specific reference in the licences condition as to how regularly the NRAs should be updated, however HC said she believed the site wide NRAs should be updated every two years. It was agreed that it would be sensible to update at regular intervals, and this should be checked	
4	**NRA Requirements and Structure**	
4.1	AR questioned how the site wide NRAs and device specific NRAs should relate and the difference in their contents. It was agreed that the site wide NRAs should be full MGN 543 compliant NRAs, including traffic analysis, consultation and risk assessment covering all aspects of the sites. The device specific NRA addendums should cover the aspects which cannot be detailed at this stage: • Mooring arrangements • UKC impacts • Marking and Lighting • Account for any key changes in traffic profile beyond that in the full NRAs • Proximity/presence of other devices within the site • How the devices will be installed/decommissioned	

Item	Action item / Notes for the record	Action
	These addendums should also consult with MCA and NLB.	
4.2	The requirements for vessel traffic surveys was discussed. AR explained the datasets gathered, including visual observations, and how this would fill the gaps in an AIS only assessment. HC stated that all assessments should be fully MGN 543 compliant and that any deviation from this is made clear, with the reasons why, and any deviations must be agreed by MCA. HC recommended that the NRAs make clear how this data gap has been addressed	
4.3	AR questioned whether the hydrographic data element of MGN 543 was required in an NRA update. HC and CL will both review their licensing documentation to establish whether there is a requirement or this is covered.	HC/CL
4.4	The process of NRA update submission was discussed. CL agreed that the reports will be issued to NLB/MCA with a Marine Scotland review. The submission of Billia Croo NRA, with the extension, will come through official channels during the Section 36 consent application.	
5	**Under Keel Clearance of Devices**	
5.1	For bottom/non-surface piercing devices, the UKC calculations were discussed, in relation to MCA guidance documents.	
5.2	It was confirmed that there was no specific guidance on how these calculations (e.g. significant wave height return periods) should be conducted but that they should account for local conditions and reflect the feedback from consultees. Information on UKC is available on MCA's website.	
5.3	WH described the feedback from consultees, many would assume doubling their operational draught or avoid the devices entirely, given the significant available sea room and low traffic density.	
6	**Navigational Issues of each site**	
6.1	A general discussion of each site and the feedback of consultees was discussed. AR reported that no issues had been reported by any of the consultees at each site and that specific comments would be fed into the NRAs.	
6.2	The extension to Billia Croo was not suggested to have a significant impact upon navigation given the alignment with traffic, marking arrangements and prior establishment.	

Minutes – EMEC NRAs – 18UK1461

Client:	EMEC	
Project:	18UK1461	
Attendees:	Peter Douglas (PD)	NLB
	Adam Lewis (AL)	NLB
	Caitlin Long (CL)	EMEC
	Andrew Rawson (AR)	Marico Marine
	William Heaps (WH)	Marico Marine
Venue:	Teleconference	
Date of Meeting:	10:00 to 11:00 21st September 2018	

Item	Action item / Notes for the record	Action
1	Introduction	
2	Overview	
2.1	AR gave an overview of the NRAs, consultation and work to date.	
3	General Lighting and Marking Requirements	
3.1	PD explained that NLB would typically ask for the following on surface-piercing EMEC devices: • Yellow Day Marking/Painting • Flashing yellow special mark light • Day top mark (if deemed necessary) • Radar Reflector • AIS AtoN, if practical	
3.2	PD described the lighting requirements for devices. Some of the longer devices may require two lights at either end, both of which are synchronised yellow lights. These allow redundancy in case of failure of one of the lights. Previously a 2nm range was required, this has since been increased to 3nm based on feedback from local stakeholders. There is no requirement for separate devices' lights to be synchronised within a site. E.g. at the Fall of Warness, one device has a 5 second period and one has a 3 second period. This could allow for navigators to differentiate between different devices. The NLB would include in the sanction letter the availability requirements, this is typically Category 1 with a 99.8% uptime for lights, and Category 3 (97%) for AIS AtoN.	
3.3	NLB would usually comment on lighting and marking during the due process of a marine licence. Typically, developers would come to the NLB beforehand to discuss the requirements as this would need to be accounted for in the design of the device. If the device was covered by EMEC's Section 36 consent envelope, EMEC would discuss with NLB the requirements and feed this back to the developers.	
3.4	The test support buoys in the scale sites are marked with special yellow marks and this is considered appropriate.	
4	Billia Croo and Extension	
4.1	The current and past marking at Billia Croo was discussed.	

Item	Action item / Notes for the record	Action
	The NLB maintain the five cardinal marks at Billia Croo, with annual inspections given the adverse conditions at the site to ensure the condition and moorings are not fatigued. There used to be an inshore mark due to the presence of a device in the inshore berths, however this has been removed due to the conditions which often caused this mark to be damaged/breakout.	
4.2	The routes passing the site and the use of the cardinals to divert traffic around the site were discussed. AIS analysis showed little evidence of vessels passing through the extension area given the orientation of traffic flows with the existing site.	
4.3	The requirements of the extension were discussed. Given the orientation of traffic, it may be possible to have a single west cardinal buoy marking the western extent and a single northern cardinal marking the northern extent. This should be reviewed as part of the NRA as to how the positioning could achieve the removal of one of the western cardinals without allowing vessels to navigate over sub-surface devices.	
5	Other Navigational Considerations	
5.1	The promulgation of activities was discussed, and it was noted that it was difficult to work out exactly what was in place at each site at any particular time. AR explained that local consultees had raised the same issue.	

Minutes – EMEC NRAs – 18UK1461

Client:	EMEC	
Project:	18UK1461	
Attendees:	Andrew Blake (AB)	Orkney Ferries
	Glenn Porter (GP)	Orkney Ferries
	John Cowie (JC)	Orkney Ferries
	Caitlin Long (CL)	EMEC
	John Skuse (JS)	EMEC
	Andrew Rawson (AR)	Marico Marine
	William Heaps (WH)	Marico Marine
Venue:	Orkney Ferries, Kirkwall	
Date of Meeting:	09:30 to 10:30 30th August 2018	

Item	Action item / Notes for the record	Action
1	Introduction	
2	Overview	
2.1	AR gave an overview of the NRAs.	
3	Fall of Warness	
3.1	Ferries would enter the Fall of Warness site during strong south easterly winds and flood tides for safety and passenger comfort. Vessels would pass close to the monopile of OpenHydro and then passing inshore, close to the Scotrenewables device.	
3.2	Route would be used all year round, in all conditions and visibilities.	
3.3	In particular rough conditions, ferries would pass to the west and north of Eday. On occasions, crossings would be cancelled due to the weather.	
3.4	Ferries would not be concerned with new devices provided they were clearly marked and appropriate lit. Smaller devices may be hard to see in the rough conditions.	
3.5	Other vessels in the area include offshore supply vessels making passage through the sheltered waters and cruise ships and small passenger vessels. Routes include Iceland and the Faroe Islands. Recently the Dutch Royal Yacht passed through the Fall of Warness.	
3.6	It was noted that the Westray South tidal array, if developed, could squeeze ferry traffic towards the EMEC site or the shores. This combination effect should be included in the NRAs.	
3.7	It was agreed that the current EMEC devices and arrangements do not cause Orkney Ferries any concerns. At present an advisory safety zone of 500m exists around all the devices, although this does not apply to Orkney Ferries with the exception of 300m for the ScotRenewables device.	
3.8	Notice to Mariners are well received and disseminated to all ferries.	
3.9	Exceptional local knowledge of crews, with very little turnover of staff meaning knowledge is retained.	

3.10	Radar returns of devices are generally good except in very poor weather however the bridge teams know where the devices are.	
3.11	Question over UKC, typical draft is 3.25m however UKC should be significant given the effect of the swell.	
3.12	AR to examine PEXA charts to determine if the Orkney Islands is an official military exercise area, however it is known that several naval vessels have transited through the islands.	AR
3.13	Future changes in traffic – no planned changes to vessel routes, however timetables may alter as part of general reviews. Possibility of increased activity associated with hydrogen industry but this is unlikely. Several new fish farm applications had been made.	
3.14	The advisory Area to be Avoided was recognised to be useful and does not impact the ferry routes.	
4	Other sites	
4.1	In general, no concerns about any other sites as ferries pass well clear of them.	

Minutes – EMEC NRAs – 18UK1461

Client:	EMEC	
Project:	18UK1461	
Attendees:	Fiona Matheson (FM)	Orkney Fisheries
	Caitlin Long (CL)	EMEC
	Jonathan Lindsay (JL)	EMEC
	Andrew Rawson (AR)	Marico Marine
	William Heaps (WH)	Marico Marine
Venue:	Orkney Fisheries Association, Kirkwall	
Date of Meeting:	11:00 to 12:30 29th August 2018	

Item	Action item / Notes for the record	Action
1	Introduction	
2	Overview	
2.1	AR gave an overview of the NRAs, FM gave an overview of Orkney Fisheries.	
2.2	Discussion of the importance of the Orkney Fishing Industry, impacts of wider trends in international trade. Annual fluctuations in the demand for certain catches changes the spatial locations and dynamic of fishing in the area.	
2.3	Fishing vessels are based throughout the Orkney Islands, fishing is conducted all year round, for a variety of catches and in a variety of places. Shellfish is a key catch in Orkney.	
2.4	Whilst there is some voluntary resting of sites, management of the fisheries is limited to minimum landing sizes.	
2.5	CL provided an overview of the planned devices likely to be on station at each of the test sites.	
3	Fall of Warness	
3.1	Layout of site to avoid 30m contour to avoid inshore Scallop Diving.	
3.2	Mostly Creel fishing in the area, some diving.	
4	Shapinsay Sound	
4.1	More pressure in winter due to reduced steaming time from Kirkwall and more sheltered site.	
4.2	Mostly Creel	
5	Scapa Flow	
5.1	No issues reported, little fishing in the area, occasional scallop dredging.	
6	Billia Croo	
6.1	Extension would increase steaming time around the site for navigating vessels. Increased transit time would exacerbate fatigue for returning fishermen which may increase the chance of an incident.	

6.2	Inshore route was a lee shore with significant wave reflection off the cliffs which made the passage hazardous during adverse weather. Vessels would therefore keep offshore in these conditions.	
6.3	The proposed extension was discussed, likely opposition from fishing community due to loss of fishing grounds.	
6.4	Fishermen avoid the site due to potential surface hazards and bottom hazards, such as debris left post decommissioning on the seabed.	
6.5	Fishing gear left inshore at Billia Croo for storage and would be moved offshore when strong winds forecast to avoid damage on the rocks.	
7	General Discussion of Impacts	
7.1	It was recognized that fishermen could fish in the EMEC test sites, although many avoided the sites due to potential interactions with devices or cables.	
7.2	Previous instances of loss of gear to contractor's vessels. However, recognized that most regular contractors were aware of the fishermen and their gear and so avoided them. CL asked that any specific instances of gear being cut by contractors is reported to EMEC.	
7.3	No history of contacts between vessels and devices or snagging.	
7.4	Devices are well marked and charted, no issues of poorly visible devices reported by fishermen.	
7.5	Notice to Mariners – well distributed but information overload from multiple notices which makes it hard to understand which are relevant or current. The merits of a centralized store were discussed.	
7.6	Recognised that the sites had existed for many years and all local fishermen were aware of the sites, locations and types of devices installed.	
7.7	Impacts of surveys outwith EMEC's site were highlighted, little notice had been giving for seismic surveys for cable routes that required moving a significant number of static gear (this was not associated with EMEC's activities).	
7.8	General concern on post-decommissioning debris littering the seabed and causing snagging hazard.	
7.9	Discussion on Electromagnetic Field impact on brown crab, but very localized (a few metres) from the cable and unlikely to be significant from the current used by EMEC.	

Minutes – EMEC NRAs – 18UK1461

Client:	EMEC	
Project:	18UK1461	
Attendees:	Brian Kynoch (BK)	Orkney Marinas
	Caitlin Long (CL)	EMEC
	John Skuse (JS)	EMEC
	Andrew Rawson (AR)	Marico Marine
	William Heaps (WH)	Marico Marine
Venue:	Jewsons, Kirkwall	
Date of Meeting:	11:00 to 12:00 30th August 2018	

Item	Action item / Notes for the record	Action
1	Introduction	
2	Overview	
2.1	AR gave an overview of the NRAs,	
2.2	BK gave an overview of Orkney Marinas, with three locations at Stromness, Kirkwall and Westray. Kirkwall marina opened in 2004 and there has been a notable increase in recreational traffic since then.	
2.3	BK would provide visitor numbers and statistics. 770 boats in 2017, 50% from the UK, rest is international (mostly European).	BK
3	Shapinsay Sound	
3.1	Little recreational activity, except on transit to Kirkwall.	
3.2	Annual round Shapinsay Race brought vessels through the Sound, however all other racing is done inside Kirkwall Bay.	
4	Fall of Warness	
4.1	Passage making recreational yachts use this route but no impacts reported by other users.	
4.2	Recognised importance of inshore traffic route to vessels, this route is often used for yachts on passage to Westray.	
4.3	BK questioned the Area to be Avoided. It was noted that 500m advisory area was around each device and not from the test site as a whole.	
4.4	Whilst the site has significant tidal conditions, yachts would plan their passages to avoid the worst conditions.	
5	Scapa Flow	
5.1	Area is little used by yachts.	
5.2	A slipway, jetty and sailing club are located at St Marys but are not particularly active.	
5.3	Fish farms to the north are the key user close to the device.	
6	Billia Croo	

6.1	Yachts on passage would pass near the site.	
6.2	Both inshore and offshore routes are used, the inshore route can be treacherous when conditions are not right, forcing vessels to stay outside the EMEC site.	
6.3	The extension was discussed, no issues were identified as long as the inshore route remained open and the site is well marked.	
6.4	Most small boat activity is limited to inside Stromness Harbour.	
6.5	BK had noticed a trend for larger yachts at the marina, a minimum draft of 2m is maintained.	
7	General Comments	
7.1	Valued the increased awareness that leaflets and charts gave of what was happening at each EMEC test site so that these could be put on websites and disseminated to recreational users.	
7.2	Noticeboards at each marina which provide notice to mariners and info on EMEC. The sites are all marked on charts and are therefore well known to local and visiting yachtsman.	
7.3	Foreign visitors particularly research the Orkney Island using the Orkney Islands Council Marine Services website and the Clyde Cruising Club.	
7.4	A future planned expansion to Stromness marina is being planned.	
7.5	The recent data on recreational activity may be impacted by the works at Westray Pier which has limited recreational access to that marina.	

Minutes – EMEC NRAs – 18UK1461

Client:	EMEC	
Project:	18UK1461	
Attendees:	Brian Archibald (BA)	Orkney Marine Services
	Caitlin Long (CL)	EMEC
	Jonathan Lindsay (JL)	EMEC
	Andrew Rawson (AR)	Marico Marine
	William Heaps (WH)	Marico Marine
Venue:	Orkney Marine Services, Scapa	
Date of Meeting:	13:30 to 14:30 29th August 2018	

Item	Action item / Notes for the record	Action
1	Introduction	
2	Overview	
2.1	AR gave an overview of the NRAs.	
3	Billia Croo	
3.1	Site is not in harbour limits but is covered by CCTV and Radar and VTS operators informally monitor the site.	
3.2	The buoyage was discussed, BA preferred that the buoys are moved to the new extremities and the number is not reduced.	
3.3	The extension is the in line with the existing footprint and clear of the main traffic routes in/out of Stromness, most vessels keep clear.	
3.4	Most small boat traffic would take the inshore route, unless the weather was rough in which case they would stay further offshore or remain in the harbour.	
3.5	Possible that some visiting yachtsman would be unaware of the site however the site is well marked so this is mitigated.	
3.6	Pilotage required into Stromness for vessels greater than 80m, tows and passenger vessels greater than 65m. The ferries and NLB have PEC. Very few other large vessels would pass near to the site as they would typically approach from the south.	
3.7	VTS would broadcast key movements in and out of Stromness but unless the vessels were involved with Billia Croo site, they would not generally inform other traffic about EMEC activities.	
3.8	In general, the increase in the footprint would not impact navigation.	
4	Scapa Flow	
4.1	Within SHA limits and site is actively monitored by VTS.	

4.2	Fish farm located to the north was put in place several years after the test site and has increased traffic to and from the site. These vessels are based out of St Margarets to the south.	
4.3	2 Fish farm applications are being progressed in the eastern section of Scapa Flow. At Flimps Holm and Hunda.	
4.4	St Marys has a small slipway/jetty which is rarely used. Occasional tours used to operate from here but have since stopped	
4.5	Most diving in Scapa is on the German wrecks to the west, diving in this area is typically off the beach.	
4.6	No significant fishing and recreational activity in and around the eastern part of Scapa Flow.	
4.7	Scapa Flow has significant anchorages, including for platforms and STS. The closest anchorages are STS4 and anchorage 5. These are located very close to the limits of the lease area.	
4.8	It was noted that charted limits of the test site and the lease area were not consistent. The chart showed the five gravity base anchors and not the full extent of the test site, future devices may be located further south. BA was concerned with devices further south impacting upon the adjacent anchorages, particularly in combination with future fish farm developments which limits the number of available anchorages.	
4.9	AR would examine the swept paths of the swing of anchored vessels.	AR
4.10	BA noted that there was no chart note on the Scapa Flow site, describing only the Fall of Warness and Billia Croo sites.	
5	Shapinsay Sound	
5.1	BA noted that the charted limits and the lease area were also not consistent. The chart showed the three anchor blocks and not the full extent.	
5.2	The northern limits of the lease area were close to the main approach channel, when larger vessels were approaching other traffic generally transited further south and therefore much closer to the test site.	
5.3	Occasional anchorage to the south in the bay but vessels would be well clear of the test site. This is often used by the ETV.	
5.4	Yachts and fishing boats out of Kirkwall would transit passed the devices.	
6	Fall of Warness	
6.1	Orkney Marine Services now has radar coverage of the site from ERDF funding.	
6.2	BA noted that Orkney Ferries were a key user of the area, particularly in adverse weather. Any loss of navigation due to additional surface devices in this area would result in loss of sailings during adverse weather when this route is required.	
6.3	Larger vessels such as cruise ships and offshore support vessels use this route on transit to Shetlands or Iceland.	
7	General Impacts	

7.1	BA noted that EMEC test sites are well known by locals and being well managed to reduce the impact on navigation.	
7.2	No known contacts with devices in any of the sites.	
7.3	The EMEC test sites should not exclude vessels from navigating through them. Areas can be advised to be avoided but should not be prohibited.	

Minutes – EMEC NRAs – 18UK1461

Client:	EMEC	
Project:	18UK1461	
Attendees:	Stuart Carruthers (SC)	RYA
	Andrew Rawson (AR)	Marico Marine
Venue:	RYA House, Ensign Way, Hamble	
Date of Meeting:	14:00 to 15:00 05th September 2018	

Item	Action item / Notes for the record	Action
1	Introduction	
2	Overview	
2.1	AR gave an overview of the NRAs and the EMEC sites. To date the work has focused on vessel traffic analysis and consultation with local stakeholders, including the Orkney Marinas manager.	
2.2	It was agreed that the sites have not historically caused any incidents and have been well marked and promulgated. The Orkney Islands generally have a higher level of proficiency among yachtsman as they are isolated from the mainland by the Pentland Firth/North Sea and navigation to this area requires a high level of seamanship.	
2.3	AR/SC discussed the RYA Position Papers, contents and history.	
2.4	SC did not believe that there would be any significant impacts on recreation as a result of the extension to Billia Croo.	
3	RYA Position Paper Impacts	
3.1	The assumption on under keel clearance was discussed and a 3m model draft for a large yacht was discussed. This research was linked to the decision for 22m MHWS on wind turbine developments. Any deeper draught vessel would not be able to access most marinas.	
3.2	SC referred to the MCA's UKC policy paper.	
3.3	The charting of the sites were discussed, with the outlines shown on the EMEC website as a guide for visiting yachtsman. SC recommended that a navigational chart is used as a background.	
3.4	The impacts of the cables were discussed on navigation and communication equipment. This policy point refers principally to large offshore cables which pass through inter-tidal areas and where yachts may be in close proximity to them, impacting on cable accuracy. Given the size of the cables this was not thought to be significant.	
3.5	Whilst there were no sailing and racing areas adjacent to the test sites, SC recognised that there was a high degree of diving on wrecks in the area.	
3.6	No significant cumulative or in-combination effects were identified in the study area.	

Annex E: Billia Croo site risk assessment

ID	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency	
1	Commercial Ship Contacts a Device	A commercial vessel such as a cargo vessel or tanker contacts with a device	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Navigational Aid Failure; Adverse Environmental Conditions; Poor Visibility; Avoidance of other vessel;	Moderate damage to device and its moorings; Negligible Damage to Vessel; No Injuries; No Pollution; Minor operational Downtime;	Single fatality or multiple major injuries; Loss of Device; Moderate damage to Vessel; Moderate pollution; Moderate adverse publicity;	1	1	1	2	2	4	3	3	3	1	2.39
2	Passenger Vessel Contacts a Device	A passenger vessel contacts with a device	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Navigational Aid Failure; Adverse Environmental Conditions; Poor Visibility; Avoidance of other vessel;	Moderate damage to device and its moorings; Negligible Damage to Vessel; No Injuries; No Pollution; Minor operational Downtime;	Single fatality or multiple major injuries; Loss of Device; Major damage to Vessel; Moderate pollution; Major adverse publicity;	1	1	1	2	3	4	4	3	4	1	2.72
3	Fishing Vessel Contacts a Device	A fishing vessel contacts with a device	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Navigational Aid Failure; Adverse Environmental Conditions; Poor Visibility; Avoidance of other vessel;	Minor Damage to device and its moorings; Negligible Damage to Vessel; Minor Injuries; No Pollution; Minor operational Downtime;	Single fatality or multiple major injuries; Moderate damage to Device; Loss of Vessel; Minor pollution; Moderate adverse publicity;	2	1	1	2	3	4	3	2	3	2	2.98

ID	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency	
4	Recreational Vessel Contacts a Device	A recreational vessel contacts with a device	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Navigational Aid Failure; Adverse Environmental Conditions; Poor Visibility; Avoidance of other vessel;	Minor Damage to device and its moorings; Negligible Damage to Vessel; Minor Injuries; No Pollution; Minor operational Downtime;	Single fatality or multiple major injuries; Moderate damage to Device; Loss of Vessel; Minor pollution; Moderate adverse publicity;	2	1	1	2	3	4	3	2	3	2	2.98
5	Maintenance Vessel Contacts a Device	Construction, maintenance or decommissioning vessel contacts with a device	Insufficient Lookout; Human Error; Poor operating Procedures; Equipment or Mechanical Failure; Navigational Aid Failure; Adverse Environmental Conditions; Poor Visibility; Avoidance of other vessel;	Minor Damage to device and its moorings; Negligible Damage to Vessel; Minor Injuries; No Pollution; Minor operational Downtime;	Single fatality or multiple major injuries; Major damage to Device; Moderate damage to Vessel; Minor pollution; Moderate adverse publicity;	2	1	1	2	4	4	4	2	3	2	3.47
7	Fishing Gear Interaction with a Device	A fishing vessel's gear interacts with a device or its moorings/cables.	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions;	Minor Damage to moorings; Minor Damage to fishing gear; No Injuries; No Pollution; Minor operational downtime;	Single Major Injury; Loss of gear; No Pollution; Moderate Operational Downtime;	1	2	1	2	2	3	3	1	3	1	1.95
8	Third Party Collision Due to Avoidance of Site	Two navigating vessels collide due to the presence of the site.	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor injuries; Minor damage to vessels; No Pollution; Minor Adverse Publicity;	Single fatality or multiple major injuries; Major damage to Vessels; Moderate pollution; Moderate adverse publicity;	2	2	1	2	2	4	4	3	3	1	2.70

ID	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Stakeholders	Frequency	People	Property	Environment	Stakeholders	Frequency	
9	Third Party Grounding Due to Avoidance of Site	A navigating vessel (all types) grounds due to the presence of the site	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor injuries; Minor damage to vessels; No Pollution; Minor Adverse Publicity;	Single fatality or multiple major injuries; Major damage to Vessel; Minor pollution; Major adverse publicity;	2	2	1	2	3	4	4	3	3	2	3.32
10	Collision with Site Maintenance Vessel	A navigating vessel collides with a tug or maintenance vessel or construction/decommissioning vessel.	Insufficient Lookout; Increased Vessel Activity; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor Injuries; Negligible Damage to Vessel; No Pollution; Minor Adverse publicity;	Single fatality or multiple major injuries; Loss of Vessel; Minor pollution; Moderate adverse publicity;	2	1	1	2	3	4	4	2	3	2	3.06
11	Grounding of Maintenance Vessel	Construction, maintenance or decommissioning vessel grounds whilst on passage to/from the site	Insufficient Lookout; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions; Poor Visibility;	Minor Damage to vessel; Minor Injuries; No Pollution; Minor operational downtime;	Multiple minor or single major injury; Major damage; Minor pollution; Minor adverse publicity;	2	2	1	2	2	4	4	2	2	2	2.86
12	Breakout of a Device from Moorings	A device's moorings fail, device becomes a hazard to navigation	Equipment or Mechanical Failure; Adverse Environmental Conditions; Collision by object; Blade contacts seabed;	Minor damage to device and its moorings; No injuries; No pollution; Minor Adverse Publicity;	No Injuries; Loss of Device; Minor Pollution; Moderate Adverse Publicity;	1	2	1	2	3	1	4	2	3	3	3.19

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