Navigational Safety Risk Assessment for the Wave Test Site at the European Marine Energy Centre

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Glossary

AIS	Automatic Identification System. A (usually) vessel mounted transponder system whereby identification information is transmitted to other vessels or shore-based interrogation systems. Can be fitted to fixed objects e.g. platforms or devices to provide information of use to the mariner
ATBA	Area To Be Avoided. An area so designated is marked on charts along with details of the area and vessels to which it applies
AtN	Aids to Navigation. Those aids, including visual marks, lights, buoyage, electronic devices etc provided for the mariner to assist in the safe navigation of the vessel
Cable (as a measurement of distance)	1/10th of a nautical mile (approx 185 metres) and a standard measure of distance at sea
CHA	Competent Harbour Authority. A statutory authority responsible for a defined area of water in and around a port or harbour
Chart Datum	By international agreement, Chart Datum is a level so low that the tide will not frequently fall below it. In the UK, this is normally approximately the level of LAT
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea, 1972
DP	Dynamic Positioning
DTI	Department of Trade and Industry
EMEC	European Marine Energy Centre
EMI	Electromagnetic Interference
EPR	Ethylene Propylene Rubber
GLA	General Lighthouse Authority. The general name given to those authorities with responsibilities for Aids to Navigation in specific geographical areas. In the waters around the UK and Republic of Ireland, these authorities are: Trinity House, Northern Lighthouse Board and the Commissioners for Irish Lights
GT	Gross Tonnage. The total volume of a vessel, expressed in units of 100 cubic feet (gross ton), with certain open structures, deckhouses, tanks, etc., exempted. Also called Gross Registered Tonnage
HAT	Highest Astronomical Tide. HAT is the highest level which can be predicted to occur in average meteorological conditions and under any combination of astronomical conditions. This level will not occur every year. HAT is not the extreme level as storm surges may cause higher levels to occur. Determined by inspection over a period of years
HIE	Highlands and Islands Enterprise
HIRA	Hazard Identification and Risk Assessment
HSE	Health and Safety Executive
IMM	International Maritime Mobile (Radio Channels)
IMO	International Maritime Organisation
kV	Kilovolt
LAT	Lowest Astronomical Tide. LAT is the lowest level which can be predicted to occur in average meteorological conditions and under any combination of astronomical conditions. This level will not occur every year. LAT is not the extreme level as storm surges may cause lower levels to occur. Determined by inspection over a period of years
LOA	Length Overall.(of a vessel)
m	Metre
MCA	Maritime and Coastguard Agency
MGN	Marine General Notice
MHWN	Mean High Water Neaps. The height on MHWN is the average, throughout a year, of two successive high waters during those periods of 24hrs (approx. once

	per fortnight) when the range is the least
MHWS	Mean High Water Springs. The height on MHWS is the average, throughout a year, of two successive high waters during those periods of 24hrs (approx. once per fortnight) when the range is the greatest.
MLWN	Mean Low Water Neaps. The height on MLWN is the average, throughout a year, of two successive low waters during those periods of 24hrs (approx. once per fortnight) when the range is the least
MLWS	Mean Low Water Springs. The height on MLWS is the average, throughout a year, of two successive low waters during those periods of 24hrs (approx. once per fortnight) when the range is the greatest
MSL	Mean Sea Level. The average level of the sea surface over a period (normally 18.6 years)
MV	Motor Vessel
MW	Megawatt
NavWarns	Navigation Warnings
NLB	Northern Lighthouse Board
NM	Notice to Mariners. A NM is an update or alteration to a chart. Issued to allow the mariner to update their charts to the latest safety-critical information. NMs are issued in paper format on a weekly basis (also available online at www.ukho.gov.uk), or via the online searchable NMs database at www.nmwebsearch.com. They are also reproduced in the magazines 'Practical Boat Owner' and 'Motor Boats Monthly'
nm	(International) Nautical Mile. (1,852 metres)
OIC	Orkney Island Council
OREI	Offshore Renewable Energy Installation
RACON	RAdar beaCON. A transponder system which shows up on a vessel's radar as a coded mark adjacent to the contact
RNLI	Royal National Lifeboat Institution
RYA	Royal Yachting Association
SCADA	Supervisory, Control And Data Acquisition
ShipRoutes	ShipRoutes is a UK shipping route database administered by Anatec Ltd which brings together data from a variety of sources to provide a representation of shipping routes and traffic densities by vessel type in UK waters. It is used to assist in identifying shipping passing in proximity to proposed offshore developments
SPFA	Scottish Pelagic Fishermen's Association
SWFPA	Scottish White Fish Producers Association
SFF	Scottish Fishermens' Federation
TEU/teu	Twenty foot Equivalent Unit. A twenty-foot equivalent unit is a measure of containerized cargo equal to one standard 20 ft (length) × 8 ft (width) × 8.5 ft (height) container (approximately 39 m^3).
Tidal Stream	A distinction is drawn between tidal streams, which are astronomical in origin, and currents, which are independent of astronomical conditions and which, in the waters around the British Isles, are mainly of meteorological origin
UKHO	UK Hydrographic Office
VHF	Very High Frequency (Radio)
VTS	Vessel Traffic Services
WEC	Wave Energy Conversion (device)

1.0 Background

The European Marine Energy Centre (EMEC) was established in the Orkney Islands in 2002 to provide a facility for the testing of marine renewable energy devices. This comprised a Wave Energy Conversion (WEC) device test facility (the "Wave Test Site") at Billia Croo and, in 2006, a tidal energy device test site in the Fall of Warness, (the "tidal test site").

The Wave Test Site area is situated on the west coast of Mainland (the principal island of the Orkney Islands) and was chosen after an option study which compared a number of factors including its impact on navigation. Consultation with stakeholders was undertaken at the time in order to gauge the potential impact and the comments made were taken into account in the controls that were subsequently put in place. A Hazard Identification and Risk Assessment (HIRA) process was undertaken in order to identify the potential risks from the devices and buoys that could be sited at the Wave Test Site and appropriate monitoring and procedural controls introduced as part of a Safety Management System for the Centre as a whole. These controls included Standard Operational and Emergency Response Procedures for control of work and responses to identified accident scenarios e.g. partial loss of device mooring or vessel collision.

In 2006, a requirement was raised for a shallow water test berth. As such devices generally required to be sited in depths less than 20m it was not possible to use the established test site where the charted depths are around 50m. Hence, a site closer inshore was required.

As the shallow water test area was to be outwith the current test site, an assessment of the navigational safety issues arising from the establishment of an Offshore Renewable Energy Installations (OREI) was conducted in 2008 in accordance with the Maritime and Coastguard Agency's (MCA) guidance at the time - Marine General Notice MGN 275(M) - Proposed Offshore Renewable Energy Installations (OREI) – Guidance on Navigational Safety Issues. (Reference [1]). Since then, that guidance has been superseded by MGN 371 (M+F) Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response Issues (Reference[2]). The issues that require to be addressed remain unchanged.

The methodology for this assessment followed that for assessing the Marine Navigational Safety Risks of Offshore Wind Farms contained in the Dti/BERR publication - Guidance on the Assessment of the Impact of Offshore Wind Farms (Reference [3]). The assessment also reviewed the navigational safety impact of the Wave Test Site as a whole.

1.1 Purpose

The aim of this document is to document the methodology, arguments and evidence used in the generic Navigational Safety Risk Assessment (NSRA) so that developers intending to use the site can develop device specific navigational safety risk assessments taking into account the generic hazards identified and the mitigations put in place for the site as a whole such that the risks could be considered tolerable. Such device specific navigational risk assessment shall be produced by developers and included as appendices to this document.

1.2 Scope

The scope of the NRA covers the risks to navigation presented by the Wave Test Site for both the deep and shallow water test areas and reviews the effectiveness of the established controls to ensure that the risks remain tolerable.

2.0 Risk Claim

2.1 Navigational Safety Claim

The risk from the deep water Wave Test Site is considered to be "tolerable with monitoring"[1] given the controls already implemented during the construction and operational phases of that element of the Wave Test Site area. Whilst the test berth occupancy (i.e. device days deployed at the test berths) has only been a fraction of the test site's capacity, there has been no incident in the five years that the site has been in existence that has given cause to review any of the controls put in place at the start of operations. The risks, however, will be monitored and reviewed during further device installation and operational activities.

The risk from the addition to the present test site of the shallow water test area is considered as being "tolerable with monitoring" given the implementation of such measures as were detailed in the risk assessment report. The impacts of siting devices in the Wave Test Area will be monitored throughout deployment and continued contact maintained with users of the area before and during installation, operations and decommissioning.

2.2 Supporting Reasoned Argument & Evidence

The supporting arguments for the above assessments are contained in this report. They are derived from qualitative analysis based on a number of sources of data including expert opinion (both written and oral) of the marine users of the area and quantative data regarding vessel movements.

2.3 Tools/Techniques

Organisations and individuals who could be affected by the establishment of such a facility were identified at the outset. Such stakeholders were either involved in the HIRA workshop or their views were sought individually. A list of stakeholders is at Annex A.

In order to identify the hazards presented by the development of the Wave Test Site and make an assessment of the level of risk and, from there, propose appropriate controls to reduce such risks to tolerable level, a HIRA workshop was held in July 2003. This used a structured examination of the various elements of the EMEC Wave Test Site in order to identify potential hazards to personnel and the environment. In particular, it examined the marine safety aspects of the Wave Test Site and determined whether the proposed controls were appropriate and what operational and emergency procedures were appropriate in the case of an event occurring. This resulted in a hazard log being constructed and actions taken to ensure that all identified risks were reduced to a tolerable level. Early stakeholder

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[1] Risk Tolerability definitions are taken from are from Dti/BERR publication - Guidance on the Assessment of the Impact of Offshore Wind Farms (Reference 2) Table C.4.4. These are also contained at Annex D.

involvement in the consultation process was an integral part of the data gathering exercise and provided much of the data for the HIRA.

This HIRA has, subsequently, been reviewed in the light of the proposal to establish a shallow water test area and the additional information and operational experienced gained since the commissioning of the Wave Test Site.

The assessment of the proposal to establish a shallow water test area built, therefore, on the original assessment work and, where appropriate, reviewed and updated the results of earlier consultations by means of direct contact and discussion with the key stakeholders. This was particularly the case where the particular hazards associated with the shallow water test area outside the original defined Wave Test Area had changed the original assumptions.

3.0 Description of the Marine Environment

3.1 Current Marine Environment

The Wave Test Site has been established off the west coast of the Orkney Islands at Billia Croo since 2002. It lies within the International Maritime Organisation (IMO) adopted "Area To Be Avoided" which encompasses the waters of the Orkney Isles and which requires all vessels over 5000 GT carrying oil or other hazardous cargo to avoid the area designated.

The Wave Test Site is within an area designated by The Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989 (Reference [4]) as prohibited to fishing using trawls, nets or other "mobile gear" between May 1st and 30th September each year.

The site lays outwith the statutory harbour area administered by Orkney Island Council through the Orkney Harbours Department as the Competent Harbour Authority (CHA).The general layout is illustrated at Figure 1.

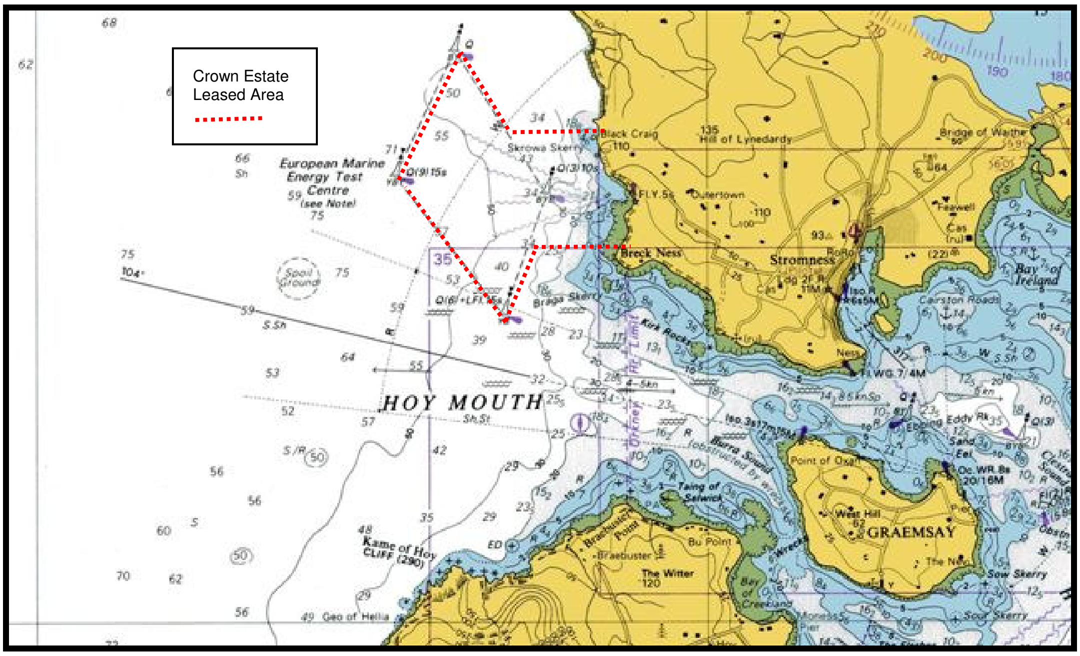

Figure 1 EMEC Billia Croo Wave Test Site

Not to be Used for Navigation. Reproduced from Admiralty Chart 2562 by permission of Her Majesty's Stationery Office and the UK Hydrographic Office (www.ukho.gov.uk)

The deep water test area is defined on the chart by a pecked line between the four cardinal buoys which mark the test site. It does not include the shallow water area. The charted area does not indicate, by either its symbology or by any notation, that any marine activities (e.g. fishing) are restricted or prohibited within the area so defined. The note on the chart states that *"Experimental Devices, normally marked by yellow buoys and lights, may be established in the area indicated. Mariners should avoid passing inside the Cardinal buoys marking the test site."*

The Wave Test Site comprises the shore facility element and an offshore element. The shore facility consists of a combined substation and control building sited on the foreshore at Billia Croo. The offshore element comprises 4 separate sites (test berths) within the overall facility test area, each fed by a separate 11kV subsea cable. The cables are Ethylene Propylene Rubber (EPR) double wire armoured, 120mm^2 subsea cables and are buried to a point 5 metres below Mean Low Water Springs. (MLWS) (i.e. approximate to the 5 metre contour). From there to a point some 250 metres beyond MLWS, the cable is protected by cast iron cable protectors. Thereafter, the cable is laid on the seabed taking care to avoid "bridging", i.e. leaving lengths of cable unsupported between high points wherever possible. Regular surveys of the cable show that, since being laid in 2002 and despite its surface lay, there has been no significant movement of the cable.

The shallow water test area is provided with 3 horizontally drilled boreholes which contain one low pressure and two high pressure rated pipes. These can be used in a variety of ways as a means of connecting devices to the shore side power generation facilities.

The test berths have not, at this time of this report, all been in use. This reflects the immature state of the industry over this period where the development of devices has not yet reached the point where developers are able to undertake prototype testing at EMEC.

3.1.1 Tidal Stream

The tidal stream rates and direction for spring and neap conditions are shown at Table 1. This data was derived from survey work undertaken by Fugro Ltd using a vessel mounted Acoustic Data Current Profiler (ADCP) in 2001 prior to site construction. The data covers from 4hrs before, to 5hrs after, high water Stromness and was undertaken on a Spring tide. As can be seen, the tidal rates are weak and variable in direction.

Tidal Stream – 58 58.35N 003 21.89W		
Hours +/- HW Stromness	Direction of Stream (Degrees)	Rate at Spring Tides (kts)
-6	-	-
-5	-	-
-4	350	0.16
-3	004	0.03
-2	148	0.15
-1	158	0.09
HW	336	0.10
+1	325	0.14
+2	002	0.15
+3	276	0.07
+4	093	0.14
+5	-	-
+6	-	-

Table 1 Tidal Stream – Billia Croo Wave Test Centre

3.1.2 Tidal Height

There is tidal height data available specifically for the Wave Test Site area. However, the data for Stromness in Table 2 would be indicative of the tidal height data for the area.

	LAT	MLWS	MLWN	MSL	MHWN	MHWS	HAT
Standard Port – (WICK)	0.0	0.7	1.4	2.0	2.8	3.5	4.0
Secondary Port Differences (STROMNESS)		0.0	0.0	+0.05	-0.1	+0.1	
Heights relative to Chart Datum		0.7	1.4	2.05	2.7	3.6	
			Mean Range (Neaps) 1.3 metres				
		Mean Range (Springs) 2.9 metres					

Table 2 Tidal Height Data - Stromness

3.1.3 Hydrographic Survey

A detailed hydrographic survey has been undertaken of Billia Croo as part of the pre-construction activities for the main test site. Additional surveys have been conducted for shallow water area.

3.1.4 Weather Data

Prevailing wind data was obtained for the general area from HSE Offshore Technology Report 2001/030 – Wind and Wave Frequency Distributions for Sites around the British Isles (Reference[5]). This data has been produced using hindcast data from North European Storm Study (NESS) extension model (NEXT) for the periods between January 1977 to December 1979 and January 1989 to December 1994. The Grid Point used (14824) is some 45 nm to the north west of Billia Croo and shown at Figure 2. This data is considered to be more relevant for the site than, for example, Kirkwall airport where the modification by the land mass is considerably greater. The wind rose data is at Figure 2.

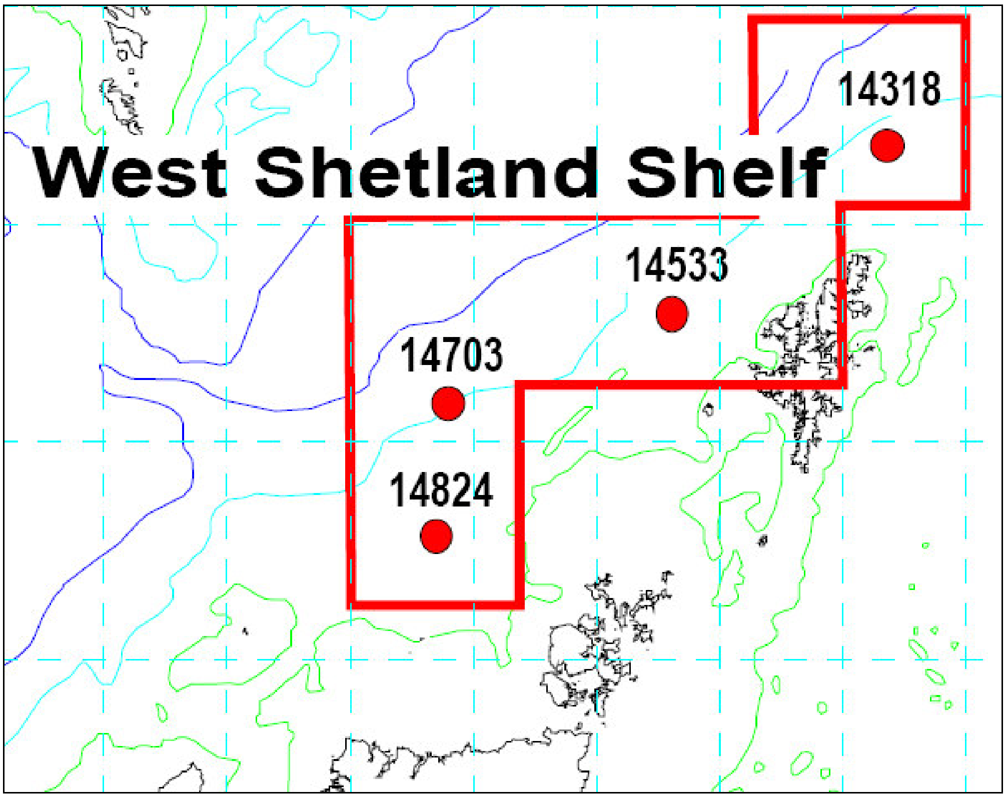

Figure 2 Wind Data Grid Point - 14824

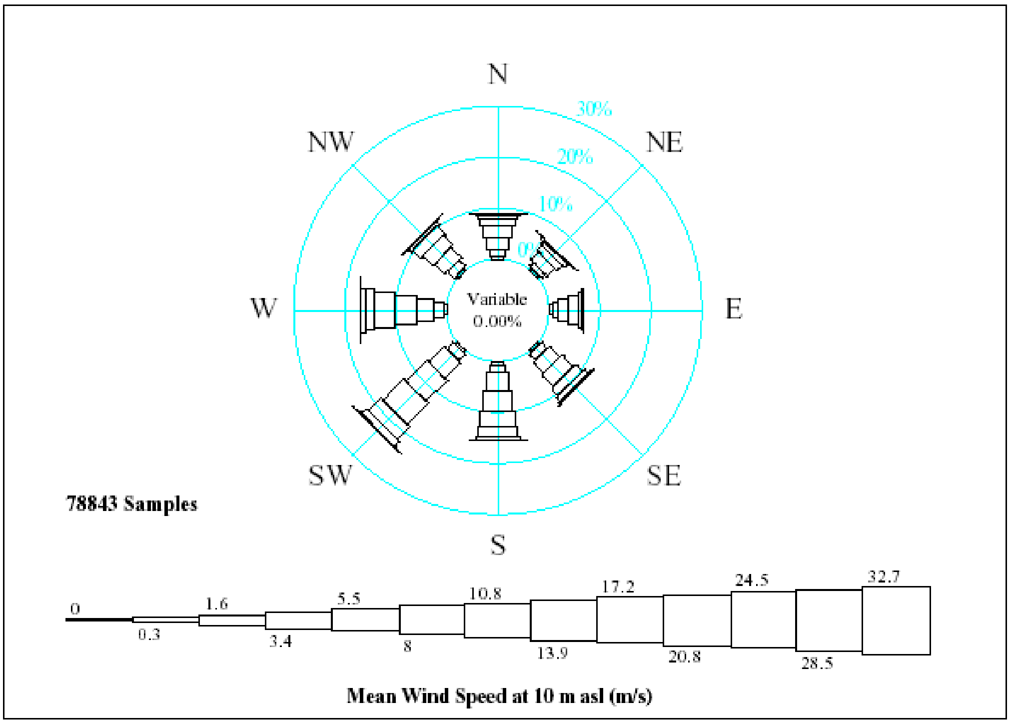

Figure 3 Mean Wind Speed

4.0 Description of the Development and the Impact on the Marine Environment

4.1 The Wave Test Site

The Wave Test Site has been established since 2003. The test berth occupancy and site activity (e.g. device installation, infrastructure maintenance and repair) has, up to now, been relatively low. There has, however, been the opportunity to monitor the impact of the site on marine activities within the area and, during that period, there have been no incidents of note with regard to the hazarding of vessels using the general area. The evidence obtained from local users has been that the site is adequately marked and charted and that, with those controls in place, its presence does not create an intolerable level of risk significantly beyond the base level risks associated with that area of coast.

4.2 Options

4.2.1 Wave Test Site Selection

The original option studies for the establishment of a European Marine Energy Centre (EMEC) had reviewed a number of sites before settling on Billia Croo bay. One of the factors in the choice (besides the appropriate wave climate) had been the relatively low level of traffic in the general area and, specifically, the displacement of the proposed site from the known traffic routes into and out of Scapa Flow through Hoy Mouth. The site required access to a suitable grid connection and to be within reasonable distance of the proposed Data Centre at Stromness. The site which best met the necessary criteria on the west coast of Orkney was Billia Croo.

4.2.2 Shallow Water Test Area

The establishment of a shallow water test area was limited by the requirement to be installed within reach of the EMEC test site infrastructure in order that the monitoring and certifying of the device could be conducted under the remit of the Centre. The requirements for siting such devices in a water depth of less than 20m meant that it is not possible to site it in the original Wave Test Site where the charted depths are in the order of 50m. Hence, it was necessary to identify an area where there were suitable depths and where it was possible to link the device to the EMEC infrastructure through the substation and control room at Billia Croo bay. Such areas are only to be found closer inshore of the current Wave Test Site area and, consequently, outside of the charted test site area. Hence, the area leased from the Crown Estate was extended to include the inshore area as shown at Figure 1

.

4.3 Test Berth Wave Energy Conversion Devices

4.3.1 Deep Water Test Area

In order to assess the risks from the installation, operation and decommissioning of a device in the deep water area, a number of assumptions were made as to the device characteristics and methodologies required to be employed to install such a device. It is assumed that a device (or array of devices) would have multi-leg moorings which take up much of the 500m test berth area allocated to each device. It would have moving parts that will interact with the waves and would be awash or protrude above the sea surface at certain states of the tide.

Power and control cables would connect the device to the shore based infrastructure at Billia Croo Bay.

4.3.1.1. Installation and Commissioning

Installation is assumed to be conducted in two phases. Firstly, the mooring would be installed by specialist vessel and then the device towed into position and attached to the mooring. The mobilisation port or berth is assumed to be from within Scapa Flow e.g. Lyness.

4.3.2 Shallow Water Test Area

In order to assess the risks from the installation, operation and decommissioning of a device at the shallow water berth, a number of assumptions were made as to the device characteristics and methodologies required to be employed to install such a device in the shallow water test area. It was assumed that the device would have a seabed footprint of approximately 20m by 20m, and would be sited on a piled foundation. It would have moving parts that will interact with the waves at the sea surface and which were assumed to protrude above the sea surface at certain states of the tide.

4.3.2.1. Installation and Commissioning

The foundation installation is assumed to be undertaken by a jack-up barge with an accompanying construction vessel. The jack up barge would be equipped with a drilling rig in order to drill sockets for the piles. It was further assumed that the jack-up barge would be mobilised at a suitable facility (such as Stromness or Lyness as agreed with OIC Harbours) and that the jack-up barge would be towed or transported to the site vicinity using a tug and the accompanying construction vessel.

Once the foundation piles have been installed the device will be transported out to the foundation under tow on or on a vessel.

All works will be controlled under the EMEC Permit to Work system, with full method statements and risk assessments submitted in advance to EMEC. All notifications, as required by the EMEC Safety Management System Marine Safety Information Notifications procedure, will be undertaken prior to installation.

4.3.2.2. Connection Cable to Shore

The shore cable /energy export lines and control/data umbilical connecting the device to the shore based support unit and control systems will be run from the unit to the shoreline within the LP pipeline.

4.3.3 Operation

It is assumed that monitoring of the technical performance and function of the devices will take place over a period of at least one year on the test site. During that period any necessary monitoring of the local environmental impacts of the devices will be undertaken in collaboration with EMEC's ongoing monitoring programme, where appropriate.

4.3.4 Decommissioning

Device manufacturers will be responsible for the removal of their devices and associated infrastructure components. It is assumed that the devices will be decommissioned using the following sequence:

a. Mobilisation of decommissioning vessels and support boats to the test location.

b. Recover the device(s) and return to shore facility either on board the transport vessel or towed beside it.

c. Recover the mooring and umbilical and return to shore facility.

d. Demobilisation of the construction vessel and/or dive boat.

e. Removal all debris and proportionate reinstatement of the seabed in line with regulators' recommendations.

4.4 The Future Environment

The future environment at the Wave Test Site is dictated by the development status of various devices which have booked the facilities. Occupancy is planned to increase from mid-2008. At present, the occupancy is shown in Table 3.

Berth	2008	2009	2010
North	Installation of moorings	Array of 2 devices	Array of 2 devices

North Middle	Installation of moorings	Array of 2 devices	Array of 2 devices
South Middle	Installation of single device	Single device	Single device
South	Single device (6 months)	Single device	Single device
Shallow Water Test Area	Nil	Single device	Single Device

Table 3 EMEC Wave Test Site – Berth Occupancy

As can be seen, the presence of devices under test on the main test site is expected go from somewhere in the region of relatively low usage of one berth to the almost continued presence of seven devices (dependent on developers removing their devices from site for maintenance/inspection etc).

5.0 Analysis of Marine Traffic

5.1 Current Traffic Densities and Types/

The siting of devices at the shallow water berth can, potentially, have a major impact on shipping. Hence it is necessary to have adequate information to enable the effects of the proposed site on vessel navigation to be fully assessed. Potential sources of information are discussed below.

5.1.1 Maritime Traffic Database

The Department for Business, Enterprise and Regulatory Reform (BERR) has compiled a multi-source Marine Traffic Database which is available on-line[2]. Input for this database has been obtained from, amongst others:

- Maritime and Coastguard Agency;
- Department for Transport;
- Department for Environment Food and Rural Affairs;
- The Crown Estate;
- Royal Yachting Association;
- Ministry of Defence;
- British Marine Aggregate Producers Association;
- Anatec UK Ltd.

The database makes use of data obtained from radar, Automatic Identification Systems (AIS), International Marine Organisation (IMO) recognised routes and data obtained from other studies. The database also uses shipping density data from the ShipRoutes database administered by Anatech (UK) Limited. This is based on

[2] Maritime Traffic Database at www.maritimedata.co.uk

information from port returns, satellite and other sensors to establish vessel routing information around the UK.

Unfortunately, the limitations of the database are such that it was not able to provide data that could be of use in this study.

The availability and use of data from the ShipRoutes database for the Orkney area was discussed in 2005 with Anatec UK Ltd [3] who administer the database. It was stated by Anatech that the Shiproutes database;

- Contains no data on fishing vessels or leisure craft and;
- The data on near shore activities is low

It was further discussed with Angela Wratten of the Department for Business and Regulatory Reform in 2008 who agreed that the usefulness of the database was limited. Hence, information available through ShipRoutes has not been used in the assessment of risk in the area under consideration.

5.1.2 Automatic Information Systems (AIS) Data.

The MCA has access to AIS data collected by its AIS sub-stations around the UK and is able to monitor and record data from vessels so fitted to the west of the Orkney Islands. At present such vessels include all vessels with a Gross Tonnage in excess of 300tons and passenger carrying vessels. AIS was not available either from the MCA or any commercial source when the assessment was undertaken in December 2007/ January 2008.

AIS data is now available from commercial sources which cover this area.

5.1.3 Other Data Sources

The types of vessels identified in studies as using Hoy Mouth as an entry/exit point to Scapa Flow/ Stromness consisted of:

- Ferries plying the route between Stromness and Scrabster;
- Vessels engaged in fishing off the west coast of Mainland;
- RNLI Lifeboats engaged in Search and Rescue (SAR) activities;
- Dive boats on passage to dive sites;
- Yachts on passage along the west coast of Mainland Orkney.

Information was sought directly from these sources in order to identify all vessel types which use the area and, in particular, those not fitted with AIS, which would not be included in AIS data gathering were such data were not available.

[3] Mr Alistair MacDonald, Anatech, March 2005

5.1.4 Ferries

The only passenger carrying vessels currently using Hoy Sound are NorthLink Ferries undertaking the route between Stromness and Scrabster. As a result of discussions with the ferry operators, a questionnaire was sent to the Company requesting information on routes, vessel characteristics, and for their professional opinion on the impact of the present test area and the proposed additional shallow water test berth. The completed response is at Annex C.

These ferries run a minimum of three times per day, 5 days per week and twice per day on Saturdays and Sundays for 52 weeks of the year. During summer peak season an additional round trip is operated on the Saturday for a period of 10 weeks. Hence there are 1996 transits of Hoy Mouth per year. The ferry company which previously managed this route also ran a service from Stromness to Lerwick using Hoy Mouth before making passage up the west coast of Mainland, Orkney but that service is no longer in use.

The passage plan that is in use by the Masters of the NorthLink ferries for the Stromness/Scrabster route is shown at Figure 4.

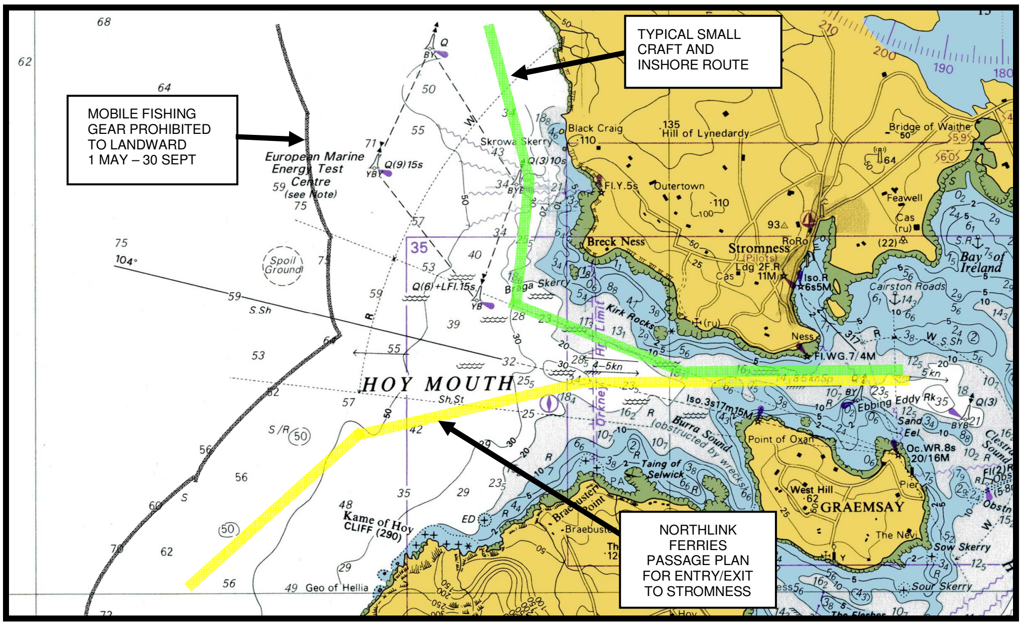

Figure 4 NorthLink Ferry Passage Plan and Inshore Passage

5.1.5 Fishing vessels.

The Wave Test Site is are within the zone designated as prohibited to mobile fishing gear between 1st May to 30th September each year. Fishing in the inshore area containing the test site consists of creeling conducted by small, locally based, day-fishing vessels. The maximum number of creelers which could, potentially, operate in this area is between 6 - 10 with 3 fishermen in particular using the area on a regular basis. Larger vessels are known to operate further offshore out to 70 -

100nm using fixed gear in deeper water but there is no evidence of such vessels attempting to operate in the area within 2 miles of the coast at this point.

Creeling involves the placing of long lines of creels (pots) on the seabed with a buoyed clump weight at each end. These lines may consist of between 30 or 40 creels on a line of up to 800 metres in length overall. It is normally laid parallel to the land. The creels are normally recovered, checked and re-laid daily. The vessels undertaking this are small craft of less than 10 metres in length.

Discussions with representatives of the Orkney Creel Fishermen's Association Orkney Fishermen's Society (OFS), Orkney Fishermen's Association (OFA) and the fishermen themselves who work the area (See Annex B) indicated that creeling usually took place close inshore and usually within the 15 metre contour. It was stated that, occasionally, creels may be deployed out to 30 metres. This limits the creel fishing areas to an area to landward of the main Wave Test Site area but in the area shallow water test area. Therefore, the presence of seabed obstructions in the main Wave Test Site area, where the charted depths are greater than 30 metres, does not impact with their activities whereas devices and cables in the shallow water test area have the potential to present a hazard to the creelers.

5.1.6 RNLI

The Stromness Lifeboat is a Severn Class vessel berthed in Stromness Harbour. It would be expected to respond to emergencies off the west coast of Mainland.

YEAR	CALL-OUTS
2005	11
2006	14
2007	9
2008	14
2009	2

Figure 5 Stromness Lifeboat Call-outs 2005 - 2009

Whilst not all of these involved the lifeboat taking passage to the west of Mainland, approximately 50% of the call outs involve incidents in either the Sound of Hoy or to the west of Mainland.

5.1.7 Dive boats

Dive boats transiting between Stromness and the coastal "scenic" diving areas on the west coast use the area as a route to reach the diving areas. Such passages are occasionally conducted in the hours of darkness. Generally, such vessels (mainly converted fishing vessels drawing 3-4m) remain outside the 10m contour on exiting Hoy Sound before turning onto a northerly heading to pass east of the EMEC Wave Test Site East Cardinal Buoy. Their preferred routes are shown at Figure 6.

5.1.8 Sailing and Motor Yachts.

The route between Scapa Flow/Stromness and the north of Mainland is identified in Royal Yachting Association sailing directions as a route to and from Eynhallow Sound (See Figure 7). Discussion with the RYA (Scotland) Coastwatcher[4] indicated that, whilst not in regular use, a number of yachts (probably no more than 20), use this route each year. Due to the requirements and constraints on the passage plan given the tidal conditions at both Hoy Mouth and Eynhallow Sound, it is probable that yachts would be under power for the inshore part of passage to the North of Hoy Mouth between the Wave Test Site and the shore. Sailing yachts would not attempt this passage in adverse weather but may undertake it in the hours of darkness.

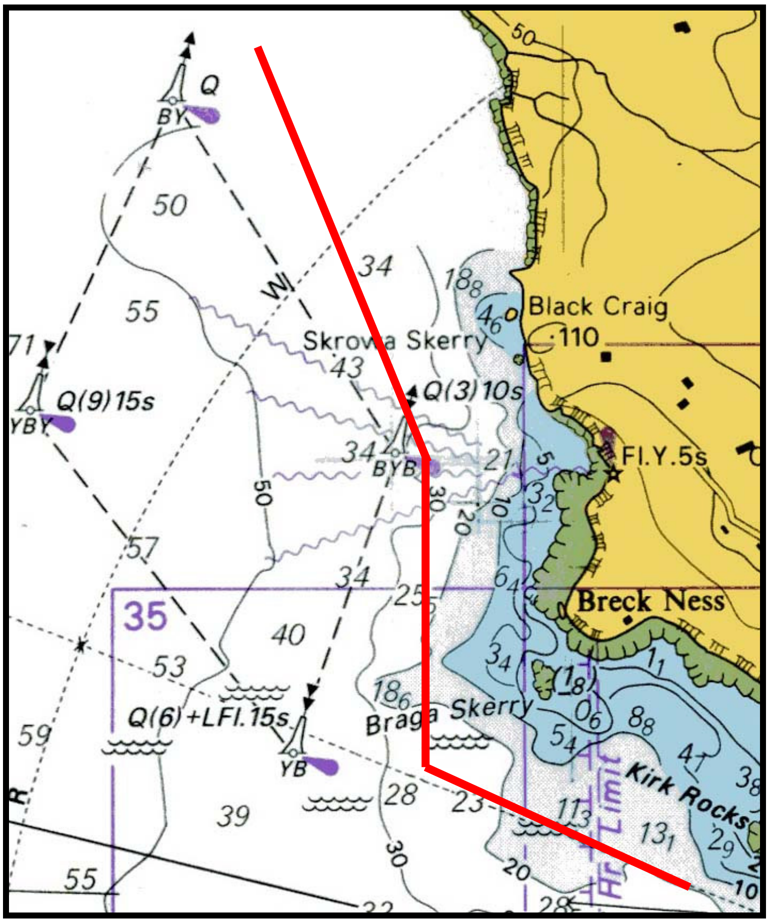

Figure 6 Typical Small Craft/Vessel Inshore route

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[4] Mr Mike Grainger – RYA Coastwatcher

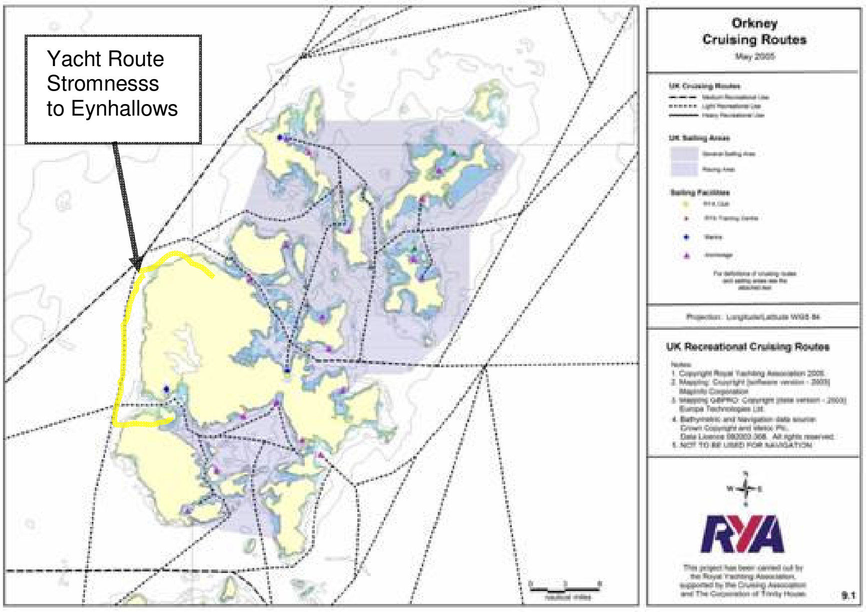

Figure 7 RYA Cruising Routes in the Orkney Islands

5.1.9 Diving

Diving is not reported as taking place in the area due to the exposed nature of the area and the lack of worthwhile sites of potential interest.

5.1.10 Military Usage

There are no military exercise areas immediately adjacent to the proposed area and there are no indications of the area as being a transit route for other than surface vessels.

5.1.11 Cruise Ships

A significant number of cruise ships visit the Orkney Isles particularly between April and September each year. Annual totals are in the order of 90 visits per annum. None of these visits are known to involve passage through Hoy Mouth or along the west coast of Mainland.

5.2 Future Traffic Patterns, Densities and Types

5.2.1 Orkney Transhipment Terminal

Orkney Island Council (OIC) has plans for the creation of a container Transhipment Hub in Scapa Flow at Lyness on Hoy. This would be able to accept Post-Panamax vessels of 5,000 – 7,500teu[5] and larger[6]. If this hub were to be built, it is likely to increase traffic movements approaching and departing the Orkney

[5] teu. Twenty foot equivalent unit (See Glossary)

[6] 10,000teu vessels are currently on the drawing board

Islands. It is probable that the larger, transatlantic vessels would most probably be routed through the Pentland Firth approaches to Scapa Flow (i.e. from the south) However, it is not clear from the studies conducted so far what the anticipated levels of vessel traffic would be and the precise routes that would be taken by feeder vessels. It is possible that Scapa Flow could see an increase in traffic from vessels between 2000 and 3000teu. However, it should be noted that access through Hoy Mouth is limited by a man-made obstruction lying between Graemsay and Mainland in Clestrain Sound which has a least charted depth of 5.8m thus limiting the size of vessels able to that entry/exit route and there is no indication in the proposal documentation that Hoy Mouth would be used by any vessels associated with transhipment operations.

5.2.2 Oil & Gas Support

There is also the possibility that, with the increase in oil and gas exploration to the west of the Orkney Islands, traffic levels involving support vessels could increase. However, whilst there is no indication that this would involve use of Hoy Mouth, if vessels were to do so, then there could be a significant increase in vessels such as Anchor Handling Tugs (AHTs), platform supply vessels and Emergency Response Vessels using similar routes as the current NorthLink ferries passing some 0.9nm to the south of the wave test area.

5.2.3 Fishing

Given the present levels of catch and the very traditional use of the inshore waters for creel fishing, it is not considered that there will be significant changes to the numbers of fishermen using this particular area[7].

5.2.4 Ferries

NorthLink Ferries does not, at present, intend to re-initiate the Stromness to Lerwick ferry route. If it were to do so, the increase in traffic levels would be minimal as the number of scheduled sailings would not be expected to more than three per week based on previous schedules and the current service run from Kirkwall. The route undertaken would, according to information provided by NorthLink Ferries at Annex C, be to seaward of the test site area in areas of lesser swell.

5.3 Effect on Current Traffic Densities and Types

Given the figures expressed by the relevant stakeholders, estimates of the traffic levels by vessel types using the inshore passage to the east of the Wave Test Site east cardinal buoy are shown in Table 4.

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[7] Meeting with OFS/OFA members Aug 2007 (See Annex B).

Vessel Type	Average Transits per year	Comment
Fishing Vessel	200	Conservative estimate. The creel fishermen were unable to provide figures for time spent in this area
Dive Boats	30	Assuming all transits occur Apr – Sep
Yachts	20	Assuming all transits occur Apr -Sep
Lifeboat	5	Assuming 50% of average annual call outs to west of Mainland
TOTAL	255	

Table 4 Estimated Traffic Levels using the Inshore Passage

This is an average of less than one per day over the year. Even in what could be considered as periods of “high” activity, it is considered unlikely that traffic density would exceed three vessels per day.

5.3.1 Ferries and Other Large Vessels

The responses from the NorthLink ferry company (See Annex C) indicate that their vessels’ passage plan has not been influenced by the siting of the Wave Test Site. Its siting has not introduced any “pinch points” for the entry or departure to Hoy Mouth. Whilst there might be potential risks arising from vessels attempting to enter and exit Hoy Mouth simultaneously, resulting in manoeuvres to avoid collision putting the outbound vessel at risk from devices in the southern part of the test area as a result of a requirement to alter to starboard, this is considered as remote because, firstly, the present level of traffic does not give rise to simultaneous entry/exit situations between vessels likely to be hampered by such a situation and, secondly, Hoy Mouth is within the harbour limits and, hence, under the control of the Orkney Harbours harbour control room at Scapa Bay which further mitigates against such occurrences. There is a mandatory reporting point for vessels prior to entry through Hoy Mouth. Hence, it is considered that the siting of the Wave Test Site has had little or no effect on the largest vessels (i.e. NorthLink Ferries) using Hoy Mouth in terms of concentrating traffic routes such that there was a corresponding increase in traffic density in at one area.

5.3.2 RNLI

The RNLI Stromness Lifeboat Coxswain indicated that, whilst in normal circumstances, he would take the inshore passage between the test area and the shore with the Severn Class lifeboat, if the weather was severe he would go further offshore, beyond the test site area, in order to get into an area of more consistent, regular, seas rather than risk the more chaotic nature of seas further inshore and, in those circumstances, would not consider the inshore passage where the hazards of breaking waves and the lee shore are all too obvious in severe weather.

5.3.3 Orkney Dive Boats

The dive boats' use of the area to the west of Mainland, Orkney is limited as most of their activity is concentrated within Scapa Flow on the dive sites in that locality. However, there are dive sites on the west coast, to the north of the Wave Test Site, that are reached by a route through Hoy Mouth and up the west coast. Their passage is, to an extent, modified by the existence of the site in that it imposes a slight "dogleg" as can be seen in Figure 6. According to the representative of the Orkney Dive Boats Association [8], the Wave Test Site is adequately marked and charted. The importance of maintaining the inshore route for such vessels was strongly expressed.

If the weather is such that the inshore route presents any hazard (not necessarily associated with the site but from the general condition), then it is unlikely that the conditions would be suitable for diving in the areas to which the route leads and so the route would not be used.

5.3.4 Other Vessel Types

The installation of the Wave Test Site has generated a requirement for vessels of different types required for installation, deployment and maintenance of devices and associated infrastructure on the Wave Test Site. These vessels range from North Sea anchor handling tugs (AHTs) to small work boats for recovery of wave data buoys, maintenance of navigation buoys, diving support and ROV surveys. The levels of activity associated with the Wave Test Site have, over the last few years, been relatively low, amounting to some estimated:

- 12 visits per year to the buoys.
- 20 days per year involved in subsea cable surveys using divers or ROVs operated from a work boat.
- <50 days per year mooring installation/inspection work.

Lyness provides a suitable berth for the conduct of device preparation, maintenance, and inspection before and after deployment to the Wave Test Site. Towing of devices to and from Lyness to the Wave Test Area may be an infrequent event but future device deployment levels (all four berths are expected to be occupied from summer 2008 onwards) will undoubtedly increase the number of deployments and associated activities (e.g. laying moorings) significantly. AHTs / large work vessels may become regular users of Lyness Pier and Hoy Mouth.

The establishment of the Wave Test Site has, to an extent, constrained vessels running parallel to the coast as they have to remain to the east of the East Cardinal buoy. The distance between the charted position of the buoy and the 10m contour is, approximately 4 cables. (see Figure 6). Despite that, the levels of traffic are such that the constraints on the inshore passage have not significantly affected density levels by concentrating traffic or of increasing the incidence of vessels requiring to take actions in accordance with the COLREGs due to meeting other vessels.

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[8] Mr Andy Cuthbertson

Hence, it is considered that there has been no significant effect on traffic density caused by the siting of the Wave Test Site either involving small craft using the inshore route or of larger vessels which remain to seaward.

5.4 Effect of Wave Test Site on Future Traffic Densities

As the deep water test area has been in operation for five years at the time of this report, there has been no examination of the "effect on future traffic densities" as that, in effect, been covered in Section 5.3. However, as the shallow water test area had yet to be established and used for devices at the time of this report, it was necessary to examine its potential impact. The use of the shallow water test area between the present Wave Test Site and the foreshore will to an extent constrain the traffic currently using the inshore passage.

The extent to which each device and its construction, operation, maintenance and decommissioning, will impact on traffic density is examined below.

5.4.1 Construction and Installation

The assumed construction activities for the notional shallow water device foundations and device will, to an extent reduce the width of the inshore passage. A jack up barge and/or construction vessels involved in the foundation installation operations could be in place, it is assumed, for 2 – 3 weeks on or around the 10m contour and even out to the 20m contour. Depending on the exact potion of the device, such operations may reduce the available width between the East Cardinal Buoy and the 10m contour (presently 4 cables (365m)). That said, if the position of the device is within the bay, the effective reduction is unlikely to be greater than that resulting from natural features either side of the bay. In the case of the device installation, it is not expected that it would reduce the passage to less than 2.5 cables (457m). Such installation operations would, in general, be planned to be conducted in fair weather and so conditions will be favourable for safe navigation.

5.4.2 Operation

The proposed siting of shallow water devices close to the shore in the shallow water test area would not impact significantly on the inshore passage used by small craft. Its proximity to the shore and position ensures that it does not lie on the track of vessels using the inshore passage. The lateral distance between the proposed position and the East Cardinal mark indicating the main Wave Test Site area is, approximately, 4.5 cables (822metres).

It has been proposed by the Northern Lighthouse Board (NLB) that it would be appropriate for a single device to be marked using either a West Cardinal Buoy or a Starboard hand lateral buoy. The use of a buoy to mark shallow water devices could reduce the inshore passage and create a potential pinch point for traffic.

5.4.3 Maintenance

It is estimated that a shallow water device will require a maintenance visit and, hence, removal from the test berth every 3 months. Unscheduled removals for repair are also possible. This would involve the same activities as for the device installation and require a suitable vessel to be moored over the platform for, approximately, 8-10 hours at a time for each recovery and re-installation activity.

5.4.4 Decommissioning

It is expected that the impact of decommissioning activities will be similar to those arising from the construction and installation phases.

6.0 Navigation Risk Assessment

6.1 Hazard Identification, Risk Assessment and Controls

In order to identify the impacts of the potential hazards that the Wave Test Site, discussions were held with the key local stakeholders who used the waters to the west of Mainland. These discussions aimed to identify the perceived hazards presented by shallow water device and to examine the impact of the siting of the Wave Test Site. Those included in the discussions included representatives from:-

- NorthLink Ferries
- Orkney Harbours Department of Orkney Island Council as the Competent Harbour Authority for adjacent waters
- Local fishing organisations
- Local sailing organisations
- Local Dive Boat Association
- Inter-Island Ferry company (Orkney Ferries)

6.2 Hazard Identification Methodology

The hazard identification process was conducted against the key issues identified in MGN 275 (Reference[1]) (which has now been superseded by MGN 371 (Reference[2]), although the issues are unchanged) and using the guidance contained in Dti/BERR publication - Guidance on the Assessment of the Impact of Offshore Wind Farms (Reference [3]). These issues were used to generate keywords for assessing each activity phase (construction, operation and de-commissioning) associated with the test site or device. The hazards associated with the facility or device type were then assessed for the risk that they presented to other mariners. The outcome of the assessment is tabulated in Annex D.

The following sections summarise the findings.

6.3 Shallow Water Test Area Hazards

6.3.1 Construction/Installation

The hazards and consequent risks arising from the construction/installation phase are considered below.

6.3.1.1. Navigational Hazard

Tow to Installation Site

The construction barge is assumed to be towed to the installation site from the mobilisation berth (expected to be either Stromness or Lyness). A review of any planned passage will be conducted and, depending on the draught of the chosen barge and the adequacy of the bathymetric source data, the requirement for a route survey will be considered. If the route is conducted within Orkneys Harbours' waters, the timing of the move will be co-ordinated by Harbour Control such that conflicts with other movements are avoided e.g. NorthLink Ferries Stromness to Scrabster ferry movements. The Orkney Harbourmaster will be consulted on all aspects of barge movements including the requirement for route survey. The method statement for this phase would be scrutinised by EMEC as part of the pre-installation process checks and the navigational safety aspects subject to appropriate review.

Foundation and Device Installation

Vessels undertaking foundation installation, maintenance or decommissioning work will present a hazard to other vessels which transit the area. They will, to an extent, restrict the passage and present a risk of collision to those vessels. The navigable part of the inshore passage is, at its narrowest point to the east of the Wave Test Site East Cardinal buoy. Any proposed installation within the shallow water area, together with associated jack up barge and construction vessel activity whilst engaged in the piling foundations work, could further restrict clear water on the seaward side by a significant distance. As previously stated, such piling operations are assumed to take between 10 – 20 days and be conducted continuously during that time.

The device installation process is assumed to take approximately 8 hours and would be conducted in fair weather and in daylight hours. The vessel would remain moored in position over the platform whilst lowering the device to be connected to the platform. The same issues apply for this activity as for the platform pile installation. The vessel would display the appropriate lights and marks for vessels engaged in such activities and the activity would be promulgated appropriately.

The vessel types likely to be using the inshore passage would, as demonstrated in Section 6, consist of fishing vessels, recreational vessels such as yachts and dive boats and the lifeboat.

The recreational vessels would, given the time of year in which the activities will be conducted, most likely be conducting their passages in daylight hours and, by the nature of their activity, be doing so in fair weather. Whilst the fishing vessels are less constrained by weather, they are equipped with appropriate navigation systems which can assist with the identification and avoidance of vessels engaged in such construction activities. The lifeboat will not be constrained by the weather in the conduct of its activities - indeed, that is when it is most likely to be at sea. However, experience, local knowledge and the high standard of navigation equipment onboard would provide appropriate mitigation for potential errors of navigation in all weathers and states of visibility.

The key issues with regard to safety of navigation are, firstly, knowing that the installation spread is there and, secondly to be able to see and identify it in all states of visibility.

Hence, notice of the works would be promulgated through the UKHO Maritime Safety Information system (i.e. Notices to Mariners (NMs) and Navigational Warnings (NavWarns)) and the jack up barge and the construction vessel would comply with the International Regulations for Preventing Collisions at Sea (COLREGS) (Reference [6]) in that they would display the appropriate lights and marks for vessels engaged in such activities.

Vessels may be at risk of collision if they either violate or incorrectly apply the COLREGs. In the circumstances where there is little likelihood, given the traffic density, of this applying in a situation between two vessels transiting the passage, this is more likely to occur in a situation involving a vessel in transit and the construction vessels. However, the conspicuous nature of the (stationary) vessels involved and their proximity to the shore at the westerly extreme of the inshore passage is considered as being unlikely to lead to any ambiguity about the construction vessels activities. The presence of other standby vessels during the construction also allows monitoring of passing traffic and could be used to alert vessels to the presence of the construction activities if the erring vessel appears to be taking insufficient or incompetent action.

Vessels could also be put at risk if they were to suffer propulsion failure such that they were set down onto the construction spread. However, the dwell time of vessels passing the spread in the "window" whereby failure of propulsion would cause them to be set down (by wind or tide) onto the spread is small due to the limited extent of the spread. The traffic density is such that the likelihood of such an occurrence can be considered as extremely remote and is, in any case much less than the background risk of the vessel grounding.

The risk from the constructions and installation phases is, therefore, considered to be "broadly acceptable[9]".

Risk Control Measures:

- Movement of installation vessels through Hoy Mouth is regulated by Orkney Harbour Control.
- Consideration of requirement for route survey.
- Method statements subject to review by EMEC.
- Submission of MSI to enable promulgation of local and national NMs/NavWarns.
- Vessel marking and lighting in accordance with COLREGS.
- Standby vessel present to monitor and advise traffic.

6.3.1.2. Effects of Tide and Tidal Stream

There would be little effect from the tidal stream on a jack up barge and any construction vessels in the proposed area given the low observed rates.

6.3.1.3. Effects of Weather

Adverse weather, e.g. heavy precipitation or fog, would reduce visibility and increase the risk to other vessels transiting the inshore passage. Given that the likelihood of recreational vessels conducting a transit of the inshore passage in fog is unlikely due to the nature of their activities, it is considered that any risk of collision is very low. For other vessels such as the fishing vessels and lifeboat, appropriate, updated and corrected navigation systems and the experience of the personnel should ensure that the risk remains tolerable and certainly no more than the background risk for navigating in fog, in such close proximity to the shore and in such shallow waters as is necessitated by the choice of passage.

Construction vessels are expected to operate to specific vessel operating procedures which specify limiting environmental operating parameters. Responses to adverse weather situations would be undertaken in accordance with vessel operating procedures such that, in the case of forecast bad weather, the vessels would either move to a place of refuge or take such measures necessary to remain safely in position e.g. by raising a jack-up platform to a safe height or adjusting the mooring.

Risk Control Measure: ❑ Monitoring of meteorological forecasts. ❑ Construction vessel procedures for adverse weather avoidance. ❑ Ensure that a risk assessment is carried out for the vessel to ensure that the vessel is fully able to operate in any reasonably foreseeable environmental

6.3.1.4. Effects on Communications, Radar and Positioning Systems

There would be no adverse or unusual effects on communications, radar and positioning systems caused by the vessels or equipment used during the construction phase with the exception of the issue of the use of inappropriate International Maritime Mobile (IMM) VHF channels. The use of IMM VHF during construction for communication between ship and shore or between vessels could interfere with other marine activities. The Principal Contractor will liaise with Orkney Harbours Department to ensure that suitable working channels are selected to avoid compromising authorised communications.

Risk Control Measure:

- ❑ Liaise with Orkney Harbours Department to establish suitable working channels for construction related activities.

6.3.2 Shallow Water Device Operational Phase

The operational phase presents several potential hazards to other marine users.

6.3.2.1. Collision with Shallow Water Device

Vessels using the inshore passage would, as previously described, consist of fishing vessels, yachts and dive boats on passage and the RNLI lifeboat. There is clearly a potential risk of any collision between these vessels using the inshore passage and a shallow water device when in operation. The device may be either awash or submerged at most states of the tide and may be unlit if it is considered impractical to do so. Whilst the body of a device would be painted a highly visible colour (yellow), it is considered that marine growth could soon reduce any beneficial effect with regard to visibility.

The lateral distance between a shallow water device position and the East Cardinal mark indicating the main Wave Test Site area will vary). Vessels using the inshore passage tend to make for the Wave Test Site easterly Cardinal Buoy either visually or by way point and pass close to the east of it before altering to the North West to pass a suitable distance off the next headland (Neban Point). It is considered that, given the low density of traffic and the potential average numbers which may be undertaking such a passage i.e. one per day (See Table 4)), there is little likelihood of vessels having to take collision avoidance actions such that they would be potentially standing into danger. Hence, there is considered to be little or no risk induced by this factor.

Navigation error by vessels undertaking the passage could induce a risk of collision with a shallow water device. However, the extent of the cross track error required to cause a collision with a device could be, approximately, 4 cables (731m) – assuming that the vessel would intend passing close (within 0.5 cable (<100m)) to the east of the East Cardinal buoy. Such an error would, given the proximity of the shore and other hazards in this area adjacent to the inshore channel, in all probability lead to a vessel going aground at some other point on the passage. Hence, it is considered that the increase in risk resulting from a device in the shallow water area is negligible when compared to the background risk.

The routes taken by the Lifeboat are, naturally, dependent on the position of the reported incident/casualty but it was stated by the Coxswain [10] that the presence of the Wave Test Site does not inhibit or constrain their routes to potential incident

[10] Mr Fred Breck - discussions 20 Aug 2007

areas. The inshore route would be the normal route for proceeding to incidents to the north but, in adverse weather, a route further to seaward of the test area would be favoured as being in less steep seas and further from the lee shore. The marking and lighting of the Wave Test Site are considered by the Coxswain as appropriate and adequate for the conditions.

The marking and lighting of a device within the shallow water area is discussed in detail in Section 7. However, the general requirements would be for any device to be appropriately charted and marked by a buoy. Where possible, devices should be appropriately lit in accordance with the guidance.

Risk Control Measures:

- ❑ Appropriate charting of device.
- ❑ The introduction of a starboard hand lateral buoy to seaward of the device.
- ❑ Device to be lit where possible.

6.3.2.2. Fishing Gear Entanglement

The fishing activities conducted in the close inshore area where the shallow water device is to be sited consist only of creeling. As previously described, this is undertaken by vessels under 10m in length using strings of creels up to 800 metres in length. The creel fishermen's main concern[11] is that subsea cables provide a potential snagging hazard for their fishing gear and that entanglement with them could cause their vessels to capsize when hauling in. If the cable were not in full contact with the seabed the potential for snagging is greater. There was also concern that cable movement (caused by the force of the tidal stream) would endanger their fishing gear when laid.

It is known from ROV inspections of the Wave Test Site undertaken by EMEC that parts of such fishing gear have become entangled with the subsea cables running from the main test site to the shore in the vicinity of the inshore passage. With regard to the presence of the device itself, in discussions with the fishermen engaged in creeling in this area, they stated that, as long as they are aware of the location of the device and the cables, they do not consider that it represents a hazard to them or their gear[11]. The seabed in the vicinity is extremely rough and it is unlikely that gear would be swept into the area of the device by storms or tides. Therefore the risk from entanglement leading to vessels capsizing during recovery of entangled creel lines is considered to be very low.

6.3.3 Failure

Mechanical failure of a shallow water device could, potentially, lead to a hazard being presented to shipping. The most likely failures identified is associated with

[11] Meeting EMEC/OFS/OFA 21 Aug 2007

such a device is structural failure of the device leading to the whole, or parts of it breaking free of the platform. The most likely scenario is that a major component will fail and break free in high, wind generated, sea-states and, given the strength and direction of the prevailing seas and the weak tidal stream, the component(s) will be driven ashore within Billia Croo. However, the most hazardous scenario is for a large component part or the entire device to be driven south into Hoy Mouth thus presenting a hazard to vessels entering or leaving Stromness/Scapa Flow.

The failure of the device, either whole or in part, should be indicated by the Supervisory Control And Data Acquisition (SCADA) system. However, the exact nature of the failure would be difficult to determine from the received data and it would, probably, require visual observation to verify the extent of any failure. The fitting of a positional information beacon or locator in the device body which would be activated by its failure would be a useful indicator and risk mitigator.

Risk Control Measures:

- Manufacturer should conduct design stage assessment of risks to navigation from failures.
- Manufacturer to have appropriate maintenance procedures for safety critical components e.g. mooring components.
- Procedures should be put in place by the operator to ensure appropriate promulgation of device loss/out of position information and to integrate these with EMEC's Emergency Response Procedures.
- Consideration should be given to the inclusion of a radio locator beacon to be fitted to the energy conversion unit and activated on break-away of the flap from the platform.

6.3.3.1. Anchoring

There is no hazard presented by the subsea shore connections associated with the device. There are no designated anchoring areas near the device location and, due to the proximity of the shore and the nature of the seabed, vessels do not normally use Billia Croo as an anchorage. The risk to vessels anchoring is, therefore, considered as extremely remote.

6.3.3.2. Electro-Magnetic Interference (EMI) from a Shallow Water Device

Given that the position close inshore of the device and the fact that most devices will use alternating current for transmitting power, it is considered that there is very low probability for EMI effects from a shallow water device to affect navigational systems. Some potential devices intend to use hydraulic systems for power transfer and, in which case, there is no potential for such interference

6.3.3.3. Acoustic Interference

There are no known adverse effects on navigation systems from acoustic interference arising from the shallow water devices particularly in view of the background noise that close to the shore.

6.3.3.4. Effects on Communications, Radar and Positioning Systems

A shallow water device is not considered to present any hazard to communication, radar and positioning systems during operations.

6.3.4 Shallow Water Device Decommissioning Phase

It is assumed that the when a shallow water device is decommissioned at the end of its operational trials phase, the piles will be left in-situ and remain as part of the EMEC Wave Test Site infrastructure. The decommissioning phase is, therefore, a reversal of the device installation process involving a vessel, operating divers, to disconnect the device from the seabed platform and lift the device onto a barge vessel or tow the device into Stromness or Lyness. The procedure may be expected to take less than 8 hours and would be conducted in fine weather during daylight hours. The risk from this activity is considered to be the same as for the device installation process.

6.4 Deep Water Test Area Hazards

The main Wave Test Site covers some 1.4nm^2 of sea area and the devices within it, though only presenting relatively small areas of navigational hazard have the potential to pose a substantial risk to shipping during their installation, operation and de-commissioning. The hazards and risks presented by these various phases are considered below.

6.4.1 Installation and Decommissioning of Devices

Device installation usually requires vessels to lay moorings, tow devices out to the test berths and to connect devices to the mooring and the subsea export cables. Such activities have been conducted on a number of occasions in the past 3 years. Vessels used for these activities have included Anchor Handling Tugs (AHTs) with sophisticated Dynamic Positioning (DP) systems as well as smaller, conventional tugs and workboats. The activities have occasionally involved multiple vessels. Installation and decommissioning activities are conducted within the designated wave test area and are subject to control and approval of EMEC management using their control of work procedures.

As the area lies 0.9nm to the north of the ferries routes there is no conflict with their passage plans. Vessels such as dive boats and yachts pass to the east of the site utilising the inshore passage. Passing east of the East Cardinal Buoy means that such vessels pass some 4 cables (731 metres) clear of the nearest test berth within the test area.

Risk Control Measure:

- ❑ Charting of area.
- ❑ Marking of area by Cardinal Buoys.
- ❑ Vessels engaged in construction/installation conform to COLREGs.

6.4.2 Operational Phase

6.4.3 Collision with Devices within the Wave Test Area

The types of vessel most likely to undertake a passage plan that could involve them in deliberately or unintentionally entering the test site area are those using the inshore passage. (The NorthLink ferries pass some 9 cables (1,640 metres) to the south of the test area and do not pass to westward of the site.) Hence, it is the small craft that, either through ignorance of the existence of the test area or in the belief that devices are not present in the area, are more likely to enter the area and collide with a device. Given the relatively low number of transits this would assume a high incidence of rule breaking.

A further hazard is posed to vessels suffering a propulsion failure when passing the test area such that they were set down onto devices within it. Due to the size of the test area, the prevailing winds and tide, it could present a particular risk to vessels using the inshore passage at certain stages of their passage. The absence of traffic routes to the west of the area means that the likelihood of a vessel being set down from that direction is regarded as extremely remote. The risk to a vessel, if that were to occur, is considerably less than the background risk from the certainty of it grounding on the foreshore. Vessels approaching from the north are, possibly, the most at risk from such a scenario. The tidal stream sets north/south along the coast and any failure could conceivably set the vessel into the test area such that it collides with a device. However, the actual density of devices within the area, their size, the density of traffic and total numbers of vessels which may be subject to such a failure is so low that such a risk can be considered as extremely remote.

If such an incident does occur, the SAR services may be required to enter the Wave Test Area. To do so could put the lifeboat itself at risk from the devices and their moorings. Whilst the devices themselves would be marked and lit, the conditions could render such navigational aids difficult to see. It is considered that it will be of help to the lifeboat service if they are to have an up to date status of the location and type of devices in the test berths. This should be accomplished by regular communication between EMEC and the lifeboat station.

Risk Control Measure:

- ❑ Charting of area.
- ❑ Cardinal buoys marking extremities of site.
- ❑ Device marked and lit as “special Mark” (Topsides painted yellow, yellow cross and fitted with yellow flashing light.
- ❑ Provision of test berth occupancy, device location and general characteristics to the SAR service.
- ❑ EMEC Emergency Response Procedures

6.4.3.1. Anchoring

There are no designated anchoring areas near the wave test area (which is in 50m of water) and, due to the proximity of the shore and the nature of the seabed, vessels do not normally use any part of the west coast of Mainland, including Billia Croo, as an anchorage. Further inshore, in the vicinity of the subsea export cables, the area is not considered as an anchorage or a place of refuge. The risk to vessels anchoring from device moorings or subsea export cables is, therefore, considered as extremely remote.

6.4.3.2. Effects of Tide and Tidal Stream

The tidal stream is generally weak in the inshore area and sets mainly in a north/south direction in the wave test area. The effects of tidal stream on vessels have been considered above. Due to the nature of the seabed there is not believed to be any significant effect, with regard to tidal stream and height, that impacts on navigational safety, from the siting of devices in the wave test area.

6.4.3.3. Failure

Device failures could potentially lead to a hazard being presented to vessels. The most probable failures identified as arising from the types of device that have been, and are likely to be, installed, are mooring failures. The result of mooring failures could lead to entire devices becoming a hazard to shipping if, as a result of the effects of wind and tide, they get swept out of the test area.

The device moorings are required, as with the rest of the device to be subject to design substantiation and, where appropriate, be compliant with relevant codes. The moorings and safety critical components should be subject to maintenance routines such that wear does not exceed design tolerances.

Indication of abnormal device movement or mooring/umbilical failure should be indicated to the device operators through the SCADA system installed in the devices. This would be monitored on a 24/7 basis and should alert the operators to a failure. Measures would then be taken in accordance with the joint Emergency Response Procedures for loss (or partial loss) of mooring/umbilical or for the device being out of position.

Risk Control Measures:

- Device developers should conduct design stage assessment of risks to navigation from failures.
- Device developers to have appropriate maintenance procedures for safety critical components e.g. mooring components.
- Joint Emergency Response Procedures should be developed with EMEC to ensure appropriate action in case of fault conditions.

6.4.4 Other Navigational Issues

6.4.4.1. Electromagnetic Interference (EMI) from Devices

There are no known adverse effects on navigation systems from EMI arising from the infrastructure or devices likely to be employed at the Wave Test Site.

6.4.4.2. Acoustic Interference

There are no known adverse effects on navigation systems from acoustic interference arising from the infrastructure or devices likely to be employed at the Wave Test Site.

6.4.4.3. Effects on Communications, Radar and Positioning Systems

The devices and the associated test site infrastructure are not considered to present any hazard to communication, radar and positioning systems during operations.

7.0 Wave Test Site Marking and Lighting

7.1.1 Deep Water Wave Test Area

The Wave Test Site has been charted and annotated as shown in Figure 1. The comments from other marine users i.e. NorthLink Ferries, RNLI, fishermen and leisure users are that the current arrangements are adequate and appropriate with regard to navigational safety.

The individual devices within the area shall be lit and marked as required by the Northern Lighthouse Board (NLB). This shall generally require the visual parts to be painted yellow and for the device to be lit with a flashing yellow light of appropriate characteristics. It is not intended to mark each device with a "special mark" buoy. as, firstly, IALA O-139 "The Marking of Man-Made Offshore Structures" (Reference[7]) does not require this when devices are installed in area for which the boundary is marked by navigation buoys and, secondly, such buoys would have to be sited some considerable distance from each device in order to avoid interference between the mooring gear associated with the devices and, hence, would not provide any useful indication to the mariner with regard to the precise location of the device.

7.1.2 Shallow Water Test Area

The shallow water test area is not, itself, marked by buoys. It has been proposed by the NLB that it would be appropriate for a shallow water device to be marked using either a West Cardinal Buoy or a Starboard hand lateral buoy. Due to restrictions in placing such a buoy caused by the proximity of the subsea cables from the main Wave Test Site, the nature of the seabed and depth of the area, this would mean that a buoy could be approximately 1.5 cables (274 metres) from a device and could, therefore, reduce the inshore passage to, approximately, 3 cables (approximately 548 metres). This is considered to be adequate for navigation purposes given the types of vessel using the passage even allowing for the unlikely event of vessels meeting at this choke point.

The type of buoy is a matter for discussion. It is contended that a West Cardinal buoy in such a position would cause confusion given the proximity of the East Cardinal Buoy some 3 cables (548 metres) to the north west, marking the easterly edge of the Wave Test Site. The presence of 2 Cardinal Buoys so close together may be assumed by some to be marking a common object but, of course, the buoys would be on the "wrong" side of the assumed object and, hence, could cause confusion. A lateral mark would, perhaps, be more appropriate and would help delineate the eastern side of the inshore passage more clearly.

Errors by vessels in ignoring or wrongly applying the rules regarding the cardinal and lateral buoyage system could occur such that they pass closer inshore and collide with the device. The choice of buoy as discussed above would help avoid that possibility but the obvious danger of closing the shore should, in most cases, help in the mariner's decision-making process.

In view of the perceived risks presented by a shallow water WEC device, it is recommended that such devices should be appropriately charted and marked. Given that a device is likely to be in-situ for, at least, one year, and that it would be outside the main wave test area, it is appropriate that the charts be amended to show any device in the shallow water area. It is recommended that such devices be marked as an "Obstruction" in accordance with Admiralty Chart 5011 Section K (Reference [8]) and annotated accordingly e.g. "Wave Energy Conversion Device". The installation of a buoy, as recommended by the NLB, should be investigated with regard to the practicalities of mooring in the proposed area and, if practicable, it is recommended that a lateral, starboard hand buoy is used for the reasons given above. The upper parts of any device which may be visible at a certain states of the tide shall be painted yellow.

8.0 Search & Rescue (SAR) Overview and Assessment

The Wave Test Site area, when occupied with devices, presents a number of issues with regard to SAR activities. In the event of a vessel entering the deep water Wave

Test Site area and requiring assistance from the emergency services, any SAR vessel attempting to enter the area will be at risk from the devices present.

It is considered that a shallow water WEC device does not present any particular issues with regard to SAR activities. With regard to the potential impact on subsequent SAR activities or for activities not related to the device, it remains a hazard to the same extent as a buoy or, indeed, an isolated rock. It is considered that there is no significant increase in risk to SAR activities above the background risks of operating in the close inshore area at Billia Croo.

There are no issues which are considered as affecting the use of helicopters within the wave test area.

It is considered that it would be appropriate for the RNLI to be informed of the status of the test berths such that, they are aware at all times of the presence of devices and their associated hazards. This can be achieved by suitable liaison between EMEC and the local RNLI station.

9.0 Status of Risk Control Log

The risk control log for the Wave Test Site (including the shallow water test berth) has been developed and is an integral part of EMEC's safety management system. The risk controls are shown as part of the Hazard Log at Annex D.

10.0 Major Hazards Summary

The major hazards are contained within the Hazard Log at Annex D.

11.0 Through Life Safety Management

EMEC has a commitment to manage the risks associated with the activities undertaken at the Centre. It has established an integrated management system which ensures that the safety and environmental impacts of those activities are tolerable.

11.1 Updating Risk Assessments

There is a policy to review and update the original risk assessments undertaken by EMEC for the wave and tidal test sites in the light of experience and new data. This report represents a review of the original work undertaken for the Wave Test Site. EMEC is also commissioning a review and update of the navigational risk assessment conducted for the tidal test site at Eday prior to its installation. This demonstrates a commitment to continuous review and improvement required of a Safety Management System.

11.2 Safety Policy and Safety Management System

EMEC has an established and operating Safety Policy embedded in its Integrated Management System which covers the operations of the Centre and, in particular, the marine activities involved at the Wave Test Site area.

The EMEC Wave Test Site is managed by EMEC personnel and subject to the EMEC Integrated Management System established to manage safety, health, environmental and quality issues involved in the Centre's operations. The Management System encompasses operational and emergency procedures for the control of marine work and other activities. It details responses to emergency situations including collision between vessels and other vessels/devices within the test site area, loss of moorings/devices and injury to personnel involved in construction of maintenance activities. It also provides guidance on the responses to vessels which may enter the test site area. The system is considered robust and subject to management review.

12.0 References

[1] Maritime and Coastguard Agency's (MCA) Marine General Notice MGN 275(M) - Proposed Offshore Renewable Energy Installations (OREI) – Guidance on Navigational Safety Issues.

[2] Maritime and Coastguard Agency's (MCA) Marine General Notice MGN 371 (M+F) Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response Issues

[3] Guidance on the Assessment of the Impact of Offshore Wind Farms – Methodology for Assessing Marine Navigational Safety Risks of Offshore Wind Farms. DTI/pub 8145/0.5k/12/05/NP November 2005.

[4] Statutory Instrument 1989 No. 2307 (S.150) The Inshore Fishing (Prohibition of Fishing and Fishing Methods) (Scotland) Order 1989.

[5] HSE Offshore Technology Report 2001/030 – Wind and Wave Frequency Distributions for Sites around the British Isles.

[6] Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS) (as amended)

[7] IALA Recommendation O-139 "The Marking of Man-Made Offshore Structures, Edition 1, December 2008.

[8] Admiralty Chart 5011 – Symbols and Abbreviations used on Admiralty Charts.

Annex A - Stakeholders

Organisation	Contact	Contact Details
MCA	Captain Paul Townsend	MCA Bay2/30, Spring Place 105 Commercial Road Southampton SO15 1EG
RNLI	Fred Breck	RNLI, Coxswain of Stromness Severn Class Lifeboat
NLB	Guy Platten	Director of Marine Operations, Northern Lighthouse Board 84 George Street Edinburgh EH2 3DA
RYA	Ms Agnes Barclay	RYA Scotland\ Caledonia House South Gyle Edinburgh EH12 9DQ
MoD, Defence Estates	Julian Chafer	Head Of Safeguarding Safeguarding Section Defence Estates Kingston Road Sutton Coldfield West Midlands B75 7RL
Orkney Island Council, Orkney Harbours Department	Capt Nigel Mills	Orkney Harbours Harbour Operations Manager Harbour Authority Building Scapa Orkney KW15 1SD
Orkney Ferry Company	James King	Orkney Ferries Shore Street, Kirkwall, Orkney, KW15 1LG
Orkney Fishermen's Association	Alan Coghill	Orkney Fishermen's Association 5 Ferry Terminal Building Kirkwall Pier Kirkwall Orkney KW15 1HU
Orkney Fishermen's Society	Stewart Crichton	Orkney Fishermen's Society Ltd, Garson Industrial Estate, Stromness, Orkney KW16 3JU
Orkney Creel Fishermen's Association	Robert Smith	Orkney Creel Fishermen's Association
Sail Orkney	Mike Cooper	
Orkney Marina	John Hinckley	
Orkney Sailing Club	Chris Irvine	Orkney Sailing Club

Annex B - Orkney Fishermen's Organisations Meeting - Attendees

Contact	Organisation
W M G Sinclair	Owner/Skipper
W Laughton	Owner/Skipper
W Seatter	Owner/Skipper
J M Flett	Owner/Skipper
Michael Lyall	Owner/Skipper
G W Sinclair	Owner/Skipper
E H Sinclair	Owner/Skipper
N Matheson	Owner/Skipper
I James	Owner/Skipper
J Harwick	Owner/Skipper
Invited But Did Not Attend	
Alan Coghill	Orkney Fishermen's Association
S Crichton	Orkney Fishermen's Society

Annex C - NorthLink Ferries Consultation Response

EMEC Wave Energy Conversion Device Test Site Facility

Navigational Risk Assessment Questionnaire for NorthLink Ferries

Note: This questionnaire is part of the process of consultation in accordance with the MCA's requirements as expressed in MGN 275(M) regarding the siting of Offshore Renewable Energy Installations (OREI). The responses will be taken into account in the Navigational Risk Assessment submitted to the Scottish Executive as part of the consents process for the proposed addition to the EMEC Wave Energy Device Test of a shallow water, inshore test berth. The Navigation Risk Assessment is being undertaken by Abbott Risk Consulting. Please Contact David Cantello on 07734 877185 if there are any questions regarding the questionnaire. Thank you for taking the time to complete it.

No.	Question	Response	Name/Position
VESSEL CHARACTERISTICS / ROUTES			
1	What are the number and type of NorthLink vessels using the Sound of Hoy? (numbers can be expressed as transits through, or presence in the area, by day/month year)	6 transits daily Monday to Friday and also Saturday during the 10 week peak season. 4 transits daily Saturday & Sunday outside the peak season.	Gordon Cameron Master
2.	What are the characteristics of the vessels? (i.e. LOA, beam and draught, GRT)	LOA: 112.0 m Beam 18.6 m Draft 4.40 m Gross tonnage 8780	Gordon Cameron Master
3.	What route/passage plan is followed on entering/departing Hoy Sound? (please provided key waypoints if possible)	Kame of Hoy bgn 148 x 1.0 58 56.3N 003 24.7W course 073 x 1.7 to 58 56.8N 003 21.5W course 090 x 2.56 to 58 56.8N 003 16.56W. This is for inbound. Outbound is reciprocal.	Gordon Cameron Master
4.	Are your vessels fitted with E-navigation systems which display an integrated ECDIS/radar/AIS picture? If not, how is AIS information displayed?	Yes	Gordon Cameron Master

NEW DEVICE/TEST BERTH			
5.	Will the siting of the additional test berth in position 588 58.289N 0038 21.569W provide any additional hazards to your vessel(s)?	No	Gordon Cameron Master
6.	Given that the device to be sited in this position is a non-buoyant structure anchored into the seabed (i.e. not moored) would structural failure of the device be likely to present any hazard to your vessel(s)?	If structural failure was to occur this would most likely happen in severe SW'ly to NW'ly conditions. It is possible that debris could be carried in to the narrow passage between Skerry of Ness and point of Oxan which is also relatively shallow.	Gordon Cameron Master
7.	Would the addition of an additional buoy in position 588 58.249N 003 21.99W (either a lateral or cardinal mark) cause any confusion with other Aids to Navigation (AtN) sited in the area?	No	Gordon Cameron Master
WAVE ENERGY TEST SITE (I.E. THE PRESENT TEST BERTHS ENCOMPASSED BY THE CARDINAL BUOYS			
8.	If a floating device were to break its moorings at any of the test berths within the test site, would the effects of tide and wind make it likely that the device would present a hazard to navigation of your vessels(s) given their normal routes?	If structural failure was to occur this would most likely happen in severe SW'ly to NW'ly conditions. It is possible that debris could be carried in to the narrow passage between Skerry of Ness and point of Oxan which is also relatively shallow.	Gordon Cameron Master
9.	Has the presence of the test site caused any alteration in routing of the NorthLink vessels using Hoy Sound?	No	Gordon Cameron Master
10.	Would the presence of the test site limit manoeuvring when acting in accordance with the COLREGs on passing in or out of Hoy Sound?	No	Gordon Cameron Master
11.	If the ferry route from Stromness to Lerwick were to be re-instated, would the position of	No. The previous operator did ply this route but the area where the site is located would have been avoided due to depth of water and swell	Gordon Cameron

	the Wave Energy Device test site present an additional hazard to, or cause changes to routing , of vessels taking that route?	conditions.	Master
12.	Are the present AtN (i.e. 4 x cardinal buoys) adequate and visible (to both eye and radar) in all environmental states?	4 x cardinal buoys are adequate. In certain conditions the buoys could be lost on the radar due to sea scatter.	Gordon Cameron Master
13.	If not, would additional AtN (e.g. RACON, AIS AtN) help?	Yes	Gordon Cameron Master
14.	Is the site adequately charted and annotated to describe the potential hazards that may be present?	Yes	Gordon Cameron Master
15.	ANY ADDITIONAL COMMENTS		

Annex D – Hazard Log

Risk Criticality and Risk Tolerability Matrices used in Risk Log

Risk Criticality	Condition	Explanation
Broadly Acceptable	None	Technical review is required to confirm the risk assessment is reasonable. No further action is required
Broadly Acceptable	None	Technical review is required to confirm the risk assessment is reasonable. No further action is required
Tolerable with monitoring	With a commitment to risk monitoring and reduction during operation	Risk must be mitigated with engineering and/or administrative controls. Must verify that procedures and controls cited are in place and periodically checked
Tolerable with Additional Controls	With a commitment to further risk reduction before operation	Risk should be mitigated with design modification, engineering and/or administrative control to a Risk Class of 4 or below before construction
Tolerable with Modifications	With a commitment to further risk reduction before construction	Risk must be mitigated with design modification and/or engineering control to a Risk Class of 5 or lower before consent
Unacceptable	None	Risk must be mitigated with design modification and/or engineering control to a Risk Class of 5 or lower before consent
Unacceptable	None	Risk must be mitigated with design modification and/or engineering control to a Risk Class of 5 or lower before consent

Hazard Identification Risk Assessment (HIRA)					
HIRA Risk Matrix					
	Consequence	Insignificant	Minor	Major	Catastrophic
Frequency	Definition	No significant harm to people	Injury to vessel crew Injury to OREI installation crew Injury on the shore	Loss of vessel crew members (1-3) Loss of OREI installation or maintenance crew members (1-3) Fatalities on shore (1-3)	Total loss of vessel crew Total loss of OREI installation or maintenance crew Multiple fatalities onshore
Frequent	Likely to happen annually or more frequently	Tolerable with Additional Controls	Tolerable with Modifications	Unacceptable	Unacceptable
Reasonably Probable	Likely to happen duting the license period of an OREI (nominally 20 years)	Tolerable with monitoring	Tolerable with Additional Controls	Tolerable with Modifications	Unacceptable
Remote	Unlikely (but not exceptional) to happen during the licence period	Broadly Acceptable	Tolerable with monitoring	Tolerable with Additional Controls	Tolerable with Modifications
Extremely Remote	Only likely to happen in exceptional circumstances	Broadly Acceptable	Broadly Acceptable	Tolerable with monitoring	Tolerable with Additional Controls

Wave Test Site Hazard Log

Element	Phase	Guide word	Hazard	Consequence	Initial Risk			Controls / Mitigation	Residual Risk		
					Frequency	Consequence	Risk		Frequency	Consequence	Risk
Subsea Cables	**Construction & Commissioning**	Main Test Site Cable Construction and Installation Phase is Complete.									
Wave Test Site and Devices	**Installation and Commissioning**	Vessel NUC	Vessel not under command	Collision between NUC vessel and installation vessel(s) leading to damage to vessel damage/injury /loss of life	Remote	Major	**Tolerable with additional controls**	Notice to Mariners (NTM)/ Navigation Warning(NavWarns) Vessel Lighting and marking	Extremely remote	Major	**Tolerable with monitoring**
		Violation/ Mistakes/Slips/ Lapses	Vessel enters designated test area and collides with installation vessel	Collision between vessels leading to damage to vessel/injury /loss of life	Reasonably probable	Major	**Tolerable with modifications**	Area appropriately charted Cardinal buoys Vessel marked and lit appropriately. Monitoring of traffic by installation vessel	Extremely remote	Major	**Tolerable with monitoring**
		Radio Interference	Use of incorrect IMM VHF channels	Interference with IMM VHF ship/shore and ship/ship communications	Frequent	Minor	**Medium**	Installation vessel(s) to agree working channels with Orkney Harbours	Unlikely	Minor	**Low**
	Operation	Vessel NUC	Vessel not under command	Collision between NUC vessel and device(s) leading to damage to vessel damage/injury /loss of life	Extremely Remote	Major	**Tolerable with monitoring**		Extremely remote	Major	**Tolerable with monitoring**
		Violation/ Mistakes/Slips/ Lapses	Vessel enters designated test area and collides with installation vessel	Collision between vessel and device(s) leading to damage to vessel/injury /loss of life	Remote	Major	**Tolerable with additional controls**	Area appropriately charted Cardinal buoys Device marked and lit	Extremely remote	Major	**Tolerable with monitoring**
		EMI	EMI Interference with navigational equipment	Potential for navigational error due to effects on navigation equipment e.g.magnetic compass	Extremely remote	Insignificant	**Broadly acceptable**	No evidence of EMI effects seen from other similar sub-sea cables in area e.g. Billia Croo. Test site cables are lower voltage than other inter-island power cables in Orkney area	Extremely remote	Insignificant	**Broadly acceptable**
		Maintenance	Cable inspection is in inshore channel	Collision between transiting vessels and vessel undertaking inspection.	Remote	Major	**Tolerable with additional controls**	Inspection vessel marking and lighting. Compliance with COLREGs	Extremely remote	Major	**Tolerable with monitoring**
		Acoustic noise	Interference with military/civil SONAR	Potential for navigational error due to inaccurate depth readings due to the effects on SONAR	Extremely remote	Insignificant	**Broadly acceptable**	Acoustic output likely to be mainly low frequency broadband and unlikely to interfere with HF, narrowband navigational/depthfinder sonars.	Extremely remote	Insignificant	**Broadly acceptable**
		Device Failure	Loss of device or significant components	Surface vessel collision with floating objects	Reasonably Probable	Major	**Tolerable with Modifications**	Device provides indication of failure through SCADA system. EMEC Emergency Response Procedures	Extremely Remote	Major	**Tolerable with monitoring**
		Anchorage	Device moorings/subsea cables	Vessels anchors snagging on device moorings	Reasonably Probable	Minor	**Tolerable with Additional Controls**	Area is too deep for normal anchorage. No anchorages adjacent.	Extremely remote	Insignificant	**Broadly acceptable**

Wave Test Site Hazard Log

Element	Phase	Guide word	Hazard	Consequence	Initial Risk			Controls / Mitigation	Residual Risk		
					Frequency	Consequence	Risk		Frequency	Consequence	Risk
Shallow water test berth	**Construction & Commissioning**	Vessel NUC	Vessel not under command	Collision between NUC vessel and installation vessel(s) leading to damage to vessel damage/injury /loss of life	Remote	Major	**Tolerable with additional controls**	Notice to Mariners (NTM)/ Navigation Warning(NavWarns) Vessel Lighting and marking	Extremely remote	Major	**Tolerable with monitoring**
		Violation/ Mistakes/Slips/ Lapses	Vessel collides with installation vessel	Collision between vessel and installation vessels leading to damage to vessel/injury /loss of life	Remote	Major	**Tolerable with Additional Controls**	Vessel marked and lit appropriately. Monitoring of traffic by installation vessels	Extremely remote	Major	**Tolerable with monitoring**
	Operation	Vessel NUC	Vessel not under command	Collision between NUC vessel and device leading to damage to vessel damage/injury /loss of life	Extremely Remote	Major	**Tolerable with monitoring**	Installation of Lateral Buoy Charting of device	Extremely remote	Major	**Tolerable with monitoring**
		Violation/ Mistakes/Slips/ Lapses	Vessel collides with installation vessel	Collision between vessel and installation vessels leading to damage to vessel/injury /loss of life	Remote	Major	**Tolerable with Additional Controls**	Installation of Lateral Buoy Charting of device	Extremely remote	Major	**Tolerable with monitoring**
		EMI	EMI Interference with navigational equipment	Potential for navigational error due to effects on navigation equipment e.g. magnetic compass	Extremely Remote	Insignificant	**Broadly acceptable**	Device power take-off is hydraulic	Extremely Remote	Insignificant	**Broadly acceptable**
		Acoustic noise	Interference with military/civil SONAR	Potential for navigational error due to inaccurate depth readings due to the effects on SONAR	Extremely Remote	Insignificant	**Broadly acceptable**	Acoustic output likely to be mainly low frequency broadband and unlikely to interfere with HF, narrowband navigational sonars.	Extremely Remote	Insignificant	**Broadly acceptable**
		Device Failure	Loss of device or major components	Surface vessel collision with floating objects	Reasonably Probable	Major	**Tolerable with modifications**	Design substantiated by independent contractor. SCADA Indication of abnormal device movement or mooring umbilical failure. *Consideration to fitting of positional locator beacon.*	Remote	Major	**Medium**
		Maintenance	Vessel collides with maintenance vessel	Collision between vessel and maintenance vessel leading to damage to vessel/injury /loss of life	Remote	Major	**Tolerable with Additional Controls**	Vessel marked and lit appropriately. Monitoring of traffic by maintenance vessels	Extremely remote	Major	**Tolerable with monitoring**
	De-commissioning	Vessel NUC	Vessel not under command	Collision between NUC vessel and de-commissioning vessel(s) leading to damage to vessel damage/injury /loss of life	Remote	Major	**Tolerable with additional controls**	Notice to Mariners (NTM)/ Navigation Warning(NavWarns) Vessel Lighting and marking	Extremely remote	Major	**Tolerable with monitoring**
		Violation/ Mistakes/Slips/ Lapses	Vessel collides with installation vessel	Collision between vessel and de-commissioning vessel(s) leading to damage to vessel damage/injury /loss of life	Remote	Major	**Tolerable with Additional Controls**	Vessel marked and lit appropriately. Monitoring of traffic by de-commissioning vessels	Extremely remote	Major	**Tolerable with monitoring**