WEDUSEA | OE Buoy

Navigational Risk Assessment Addendum

EMEC Billia Croo Wave Test Site

March 2026




Purpose

This document is provided as an addendum to and should be read in conjunction with the document 'Billia Croo Navigation Risk Assessment (NRA) – REP522'. It describes the key project-specific navigational risks to be addressed in relation to the proposed activities at the European Marine Energy Centre test site at Billia Croo, Orkney Islands, together with proposed mitigation for reduction/elimination of these risks. Site location navigational risks are covered in the site-wide Billia Croo NRA produced by EMEC.

This document has been prepared to support a marine licence application for the OE35 device. For further information regarding the project, please refer to the Project Information Summary.

Document History

Revision	Date	Description	Originated by	Reviewed by	Approved by
001	06/02/2023	Draft	AS (EMEC)	DL (EMEC)	SB (Ocean Energy)
002	22/05/2025	Revised Draft	AM (EMEC)	DL (EMEC)	SB (Ocean Energy)
003	10/07/2025	Final Draft	AM (EMEC)	DL (EMEC)	SB (Ocean Energy)
003 v2	10/09/2025	Final Draft with requested revisions	AM(EMEC)	DL(EMEC)	
003 v3	10/03/2026	Final draft post gap analysis	AM (EMEC)	DL (EMEC)	

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1 Introduction

WEDUSEA will demonstrate a grid connected 1MW OE Buoy floating wave energy converter. This rigorous technical and environmental demonstration will happen over an extended 2-year period in Atlantic wave conditions with outcomes directly impacting policy, technical standards, public perception and investor confidence. The project will demonstrate that the technology is on a cost reduction trajectory in line with EU SET Plan targets and will be a stepping-stone to larger commercial array scale up and further industrialisation. The action will also integrate subcomponents such as moorings and PTOs which will improve the efficiency, reliability, scalability, sustainability and circularity of the technology.

The WEDUSEA OE Buoy device will be situated at Berth 5 in the north-west region of the EMEC site. It will be grid connected via umbilical and export cable rated to 1MW at 11kV. The water depth at the site is approximately 60m. The device is a floating oscillating water column, with a maximum draft of 9.8 m. The device remains on station with a traditional 3-point catenary style mooring system comprising anchors, catenary chain to a buoy, and a rope hawser from the buoy to the device.

The deployment phase of this project is to begin in April 2026 with the installation of the mooring components, followed with the device hook-up in June. The device will remain on station for 24 months, with frequent site visits and extensive environmental monitoring which will inform future projects and lends itself to the de-risking sentiment of this project. An extensive environmental monitoring program will be carried out during this period.

This assessment has been produced as an addendum to the site-wide Navigational Risk Assessment for the Billia Croo test site (REP522). This document identifies and assesses any project-specific navigational risks and discusses the proposed risk control measures to be implemented in order to reduce the risk associated with the project.

2 Project overview

Further information regarding the project is available in the Project Information Summary.

2.1 Asset information

The OE Buoy is a full-scale floating oscillating water column (OWC) device that uses an air turbine, mounted on the deck to generate electricity for export to the grid.

The OE Buoy device is 32m long and 16m wide with a draft of 9.8 m and constructed using around 650 tonnes of steel. The design schematic of the device is shown in Figure 1 and Figure 2 where the black portion of the device is below the waterline and the yellow part is above. The Buoyancy chamber, with a volume of 1,874 cu.m., houses the machinery space in a watertight environment with usable space of 1,500 cu.m to house electrical and ancillary equipment. The construction using steel results in a highly reusable material enabling the future Circular Economy after industrial roll-out.

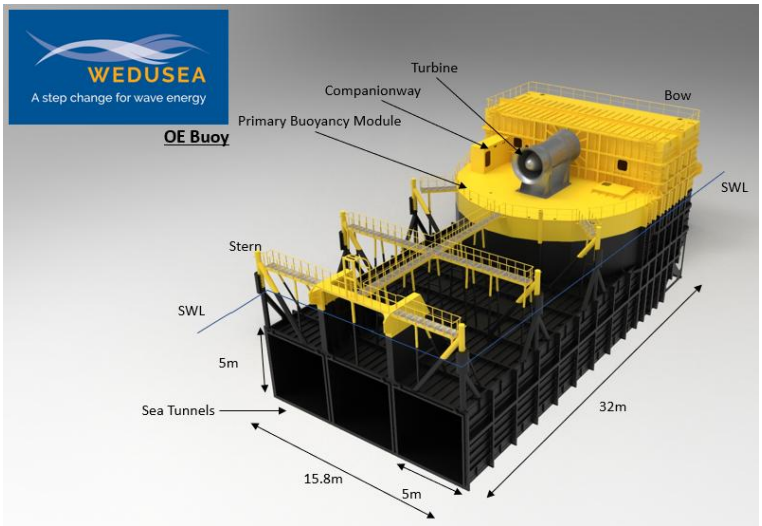

Figure 1. Design schematic of OE Buoy 1MW OWC

Figure 2. WETS OE Buoy being towed from Portland Oregon

2.2 Schedule and test plan

Table 1. Project schedule

Site Surveying/ Commissioning	Q2 2026
Installation/ Deployment	Q2/ Q3 2026
Operation Duration	2026 - 2028
Decommissioning	Q4 2028

The project schedule will be updated and refined as Ocean Energy progress towards deployment.

2.3 Deployment location

The OE Buoy device may be positioned in close proximity to the cable connection at Berth 5. Below shows the associated marine license boundary on a generic background for clear

viewing and on Admiralty Chart 2249 for navigational purposes. The coordinates of this boundary alongside the outermost boundary points of the Billia Croo test site are shown in Table 2. The device will be docked at Lyness Pier before installation, and OIC will be notified of planned activities well in advance.

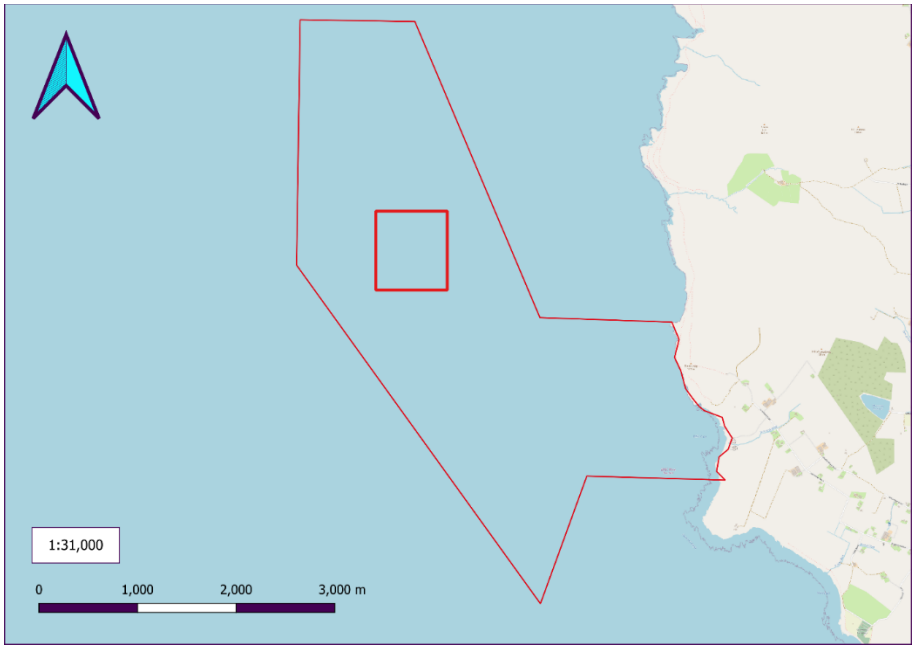

Figure 3. WEDUSEA marine license boundary within Billia Croo test site

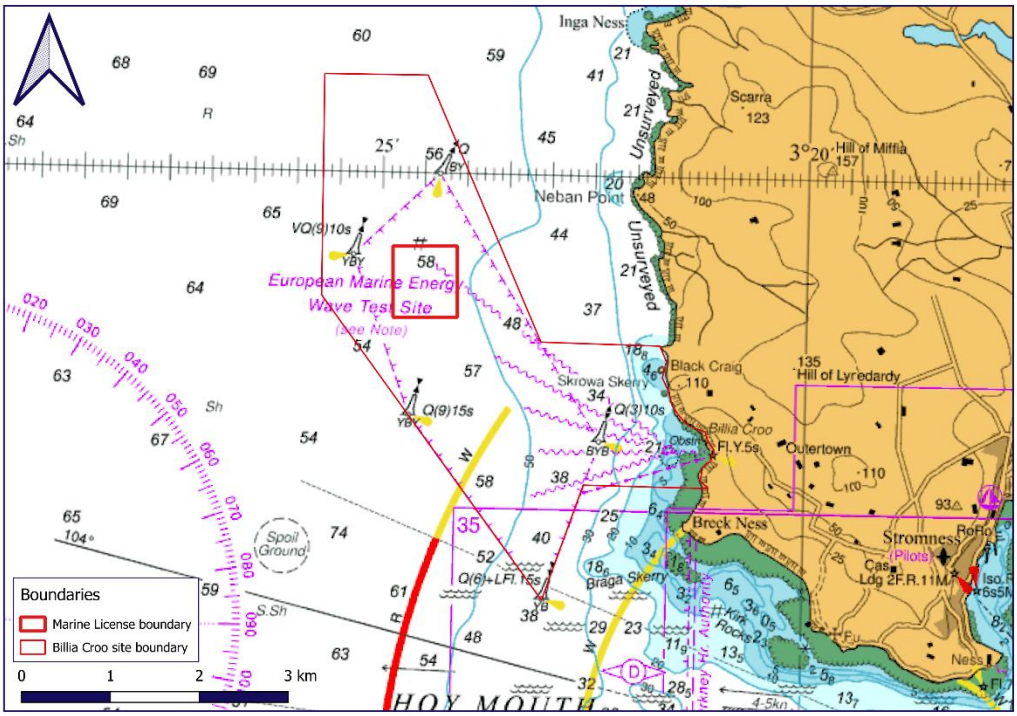

Figure 4. WEDUSEA marine license boundary within Billia Croo test site on Admiralty Chart 2249 (Orkney Islands, Western Sheet)

Table 2. Coordinates of device centre and ML boundary

Location Description	Latitude and longitude (WGS 84)
Test site outermost boundary points (on thin red line)	58°59.240' N 003°25.694' W
	59°00.587' N 003°25.711' W
	59°00.587' N 003°24.491' W
	58°58.393' N 003°22.391' W
	58°57.418' N 003°23.038' W
WEDUSEA site points (bold red line)	58°59.552′ N 003°24.110′ W
	58°59.122′ N 003°24.093′ W
	58°59.114′ N 003°24.849′ W
	58°59.544′ N 003°24.867′ W

2.4 Third party verification

A full TPV, which will reflect the device as a whole within the context of the Billia Croo test site, will be submitted at least three months prior to deployment. Internally within the project, Wood PLC will be conducting oversight of the hull fabrication, system integration and commissioning. A member of DNV sits on the Strategic Advisor Board. Wood PLC reviewed the mooring design produced by Exeter during the Go/ No Go Process, and the EU funding authority (CINEA) appointed three external experts to review the design.

3 Key navigational themes

In order to complete this project-specific assessment, a comprehensive review of the site-wide NRA for EMEC's Billia Croo test site was conducted. The following navigational themes have been considered during the assessment.

3.1 Vessel routing

Any vessels that do transit the site or in waters adjacent to the site will be aware of the test site presence as it is marked on United Kingdom Hydrographic Charts. Also, a notice to mariners will be issued by Orkney Harbours Authority before any works relating to this project are undertaken.

3.2 Contact / allision risk

A notice to mariners and uses of appropriate marking and lighting to alert other mariners to the device should mitigate the risk of contact. The test site is charted on the United Kingdom Hydrographic Office Charts.

3.3 Effects of tide / tidal streams and weather

The location of the Billia Croo site was initially selected due to the strong wave conditions. A device-specific TPV will be conducted which includes assessment on the moorings and takes into account the conditions found at the Billia Croo test site.

3.4 Collision risk and visual navigation

The scale of the assets to be installed during this project are not expected to hinder visual navigation.

3.5 Communication, radar and positioning system

The scale of the assets to be installed during this project are not likely to impact on electronic communication or positioning systems.

3.6 Moorings

A 3-point system, catenary chain from anchor to floating buoy, and a hawser rope from the surface buoy to the device will be utilised in this project (Figure 5).

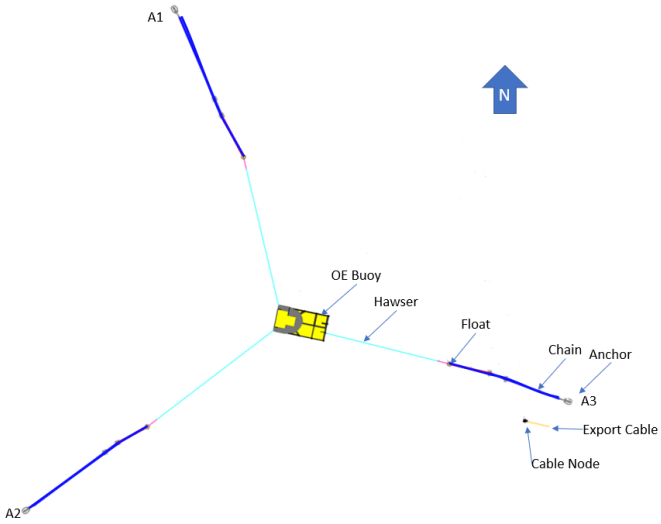

Figure 5. Berth 5 OE Buoy mooring layout

A wire rope safety line is in place between the device and hawser rope. A Mooring load shackle will be in connection between the device and hawser line to measure the load in the mooring line. This will be continuously monitored with alarms for a no-load case and extreme load case to inform the monitoring and alarm system.

The mooring load is continuously monitored by the SCADA system onboard. Each of the lines has a mooring load shackle which records the mooring force, and a warning and critical alarm limit is programmed into the system. If exceeded, a text message and email to pre-specified users (such as personnel with the contractor and EMEC). Remote access to the onboard system is possible to check CCTV and verify alarm notifications.

The anchor system connects the mooring line to the seabed, and the use of drag embedment anchors (DEA) has been recommended. A DEA, also known as drag or plate anchors, is a type of anchoring system used to secure objects or structures to the seabed or the ground. It works by burying the anchor in the soil or sediment through drag resistance. A conservative estimation of anchor size requirement has been given as three 5T DEAs minimum.

- The drag embedment anchor has been designed to penetrate the seabed. The holding capacity of the drag embedment anchor is generated by the resistance of the soil or sediment in front of the anchor. The drag embedment anchor is very well suited for resisting large horizontal loads, but not for large vertical loads although there are some

drag embedment anchors available on the market today that can resist significant vertical loads. Initial data from the deployment site indicates a good depth of sand available for drag embedment anchors. An example of a potential anchor is the Stevpris MK6 drag embedment anchor, as shown in Figure 5 may be used. Final details of the chosen anchor can be provided once contracted. An anchor such as the 5T specified for this project would be 4.6m wide, 4.17m long and 2.9m tall.

Figure 6. Drag embedment anchor

3.7 Station keeping

Collision loads with other large vessels has not been considered in this structural analysis as it has been confirmed in the trim and stability booklet that in the unlikely event of a collision, the OE Buoy would remain stable and afloat with the loss of one buoyancy compartment. As the collision with another vessel has been classed as low risk - 'Billia Croo Risk Assessment', explicitly analysing the structure against a collision would have little value as ultimately designing the structure to be able to resist a collision without damage would result in the OE Buoy being significantly overdesigned.

3.8 Fishing activity

Relatively little fishing takes place in the study area and fishermen would generally be expected to take precautions in order to avoid any underwater assets that may be present across the test site.

3.9 Recreational activity

There is minimal racing or small boat sailing at the test site, and few recreational vessels are recorded in the vicinity.

3.10 Subsea cables

There is no evidence of anchoring or gear snagging at Billia Croo historically.

3.11 Search and rescue

The device will not alter the capability of search and rescue operations in the area or interfere with neither RNLI nor helicopter operations.

3.12 Cumulative and in-combination

The current applications being considered within the Billia Croo test site at this time is outlined in Table 3. Any simultaneous operations within the test site will be managed by following procedures outlined within EMEC's SimOps SOP (SOP093/ SOP095).

All devices are located within the Test Site marked by cardinal buoys and therefore passing traffic would keep clear of all the projects reducing the cumulative risk of interactions between passing vessels and the devices. Moreover, vessels undertaking activities within the Test Site should comply with EMEC standard operating procedures. This would include being mindful of other navigating vessels and avoid disrupting the activities of others, further reducing the likelihood of allision or collision in the cumulative scenario. Moreover, the minimum spacing between any of these proposed projects is at least 0.3 nm, which is considered sufficient separation for small maintenance vessels to navigate between the various devices. Furthermore, though the OE Buoy will be placed near Berth 5's cable – the same Berth where removal of the WEC Penguin 1 is taking place: the cable end will be moved within an approximate 550 m area South, and the new device will be greatly distanced from any removal activities associated with the Penguin device. The figures below show where the cable is likely to be positioned at the Billia Croo test site after movement alongside specific measurements that compare the movement area (554 m), the distance between the Northern mooring line of the OE Buoy and the sunken Penguin device (213 m), and the length of the OE Buoy's umbilical cable which will attach to the end of the Berth 5 cable (207 m). These images will also be provided to MD-LOT in PDF format for clearer inspection. Additionally, this move will be covered by a separate marine license which is currently pending consultation after agreement with MD-LOT.

Due to this project's negligible navigational risk at the Billia Croo site and it being a single device deployment, EMEC considers this license to not need a full NRA additionally completed.

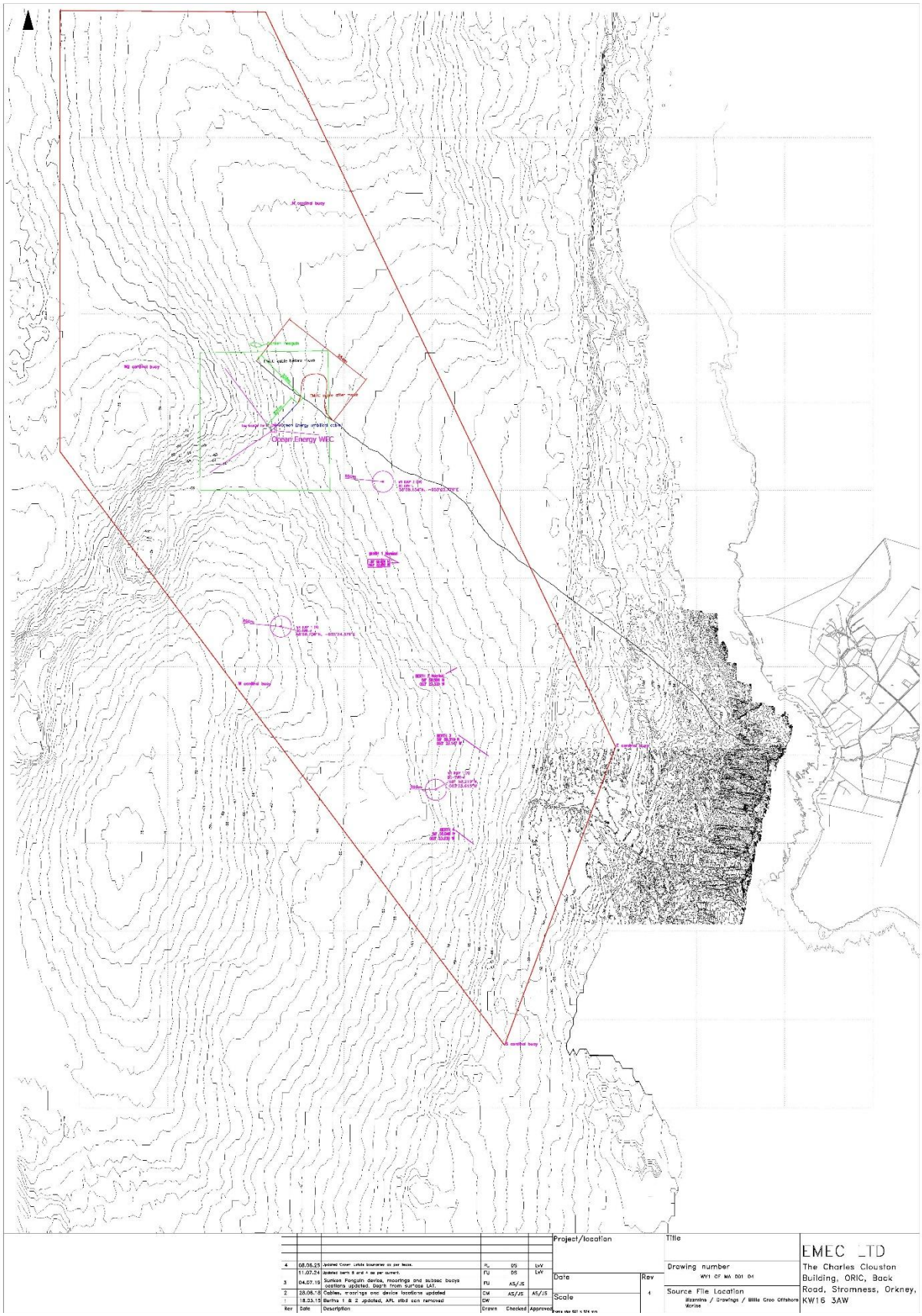

Figure 7. Indication of Berth 5 cable, sunken Penguin device, and OE Buoy within the Billia Croo test site

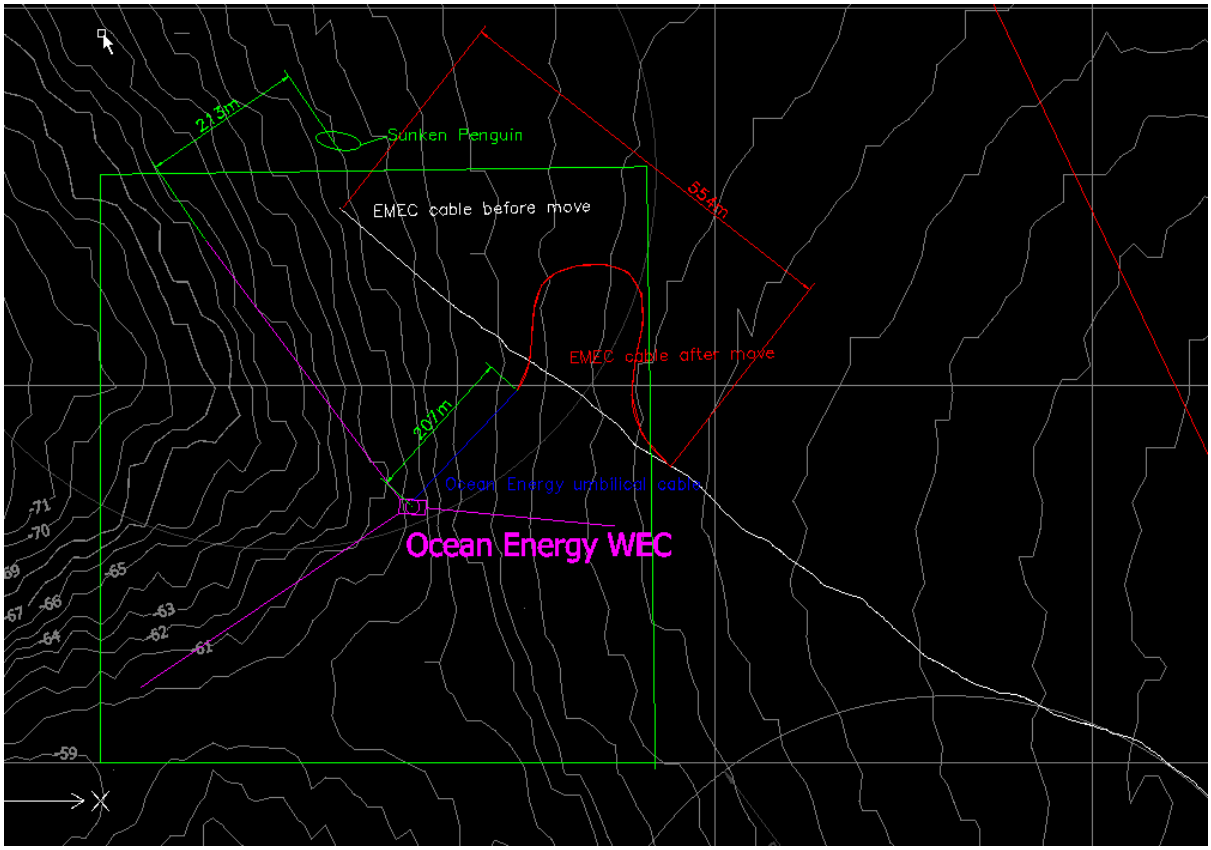

Figure 8. Close up of measurements and likely positioning of cable without shortening applied prior to termination

Table 3. Current applications at the Billia Croo Test Site

Application Reference Number	Applicant Name	Date of Application	Application Stage	Device
00011048	Endeavour Wave Ltd	N/A	Licence	Wave energy convertor array - 5x CorPowers
00010221	Simply Blue Energy (Orkney) Ltd	17/01/2023	Licence	Wave energy convertor array - 14x CorPowers C4 devices
00010515 / 00009607	Fortum Energy UK Ltd	04/08/2023 / 12/12/2023	Licence	Removal of the WEC Penguin 1, and its mooring components and ancillary equipment, from the seabed at Berth 5
N/A	WEDUSEA	N/A	Application Submitted	Installation, operation and decommissioning of a single OE35 device at Berth 5.

4 Hazard Identification

The following key hazards for Billia Croo (and similarly to this project specifically) in Table 4, alongside their rankings in Table 5, are taken from the site-wide NRA. This site-wide NRA has been sent to MD-LOT in March 2026 following minor revisions requested. Nevertheless, the hazards and controls identified have remained the same as previous. The risk matrix used for the assessment of these hazards is included within Appendix A, and the related Hazard Log is detailed within Appendix B.

Table 4. Hazard list

#	Title	Rationale
1	**Large Commercial Vessel Contacts a Device**	Analysis identifies that large vessels up to 250 m in length are known to navigate near to the site, which could result in a contact with the device.
2	**Passenger Ferry/Cruise Ship Contacts a Device**	Analysis and consultation identified that ferries make frequent transits past the site. Furthermore, cruise ships up to 250 m in length and are known to navigate near the site. These could result in contact following mechanical failure.
3	**Fishing/Fish Farm Vessel Contacts a Device**	Analysis and consultation identified that fishing boats transit past Billia Croo. Given the proximity of operations, a contact with the device is feasible.
4	**Recreational Vessel Contacts a Device**	Analysis and consultation identified that recreational vessels transit past Billia Croo. Given the proximity of operations, a contact with the device whilst on passage is feasible.
5	**Tug & Service/Maintenance Vessel Contacts a Device**	O&M support vessels necessarily navigate within the site and in close proximity to the proposed device. A contact with the device is a realistic scenario during operations.
6	**Fishing Gear Interaction with Device/Cables**	Analysis and consultation identified that fishing boats transit past Billia Croo. Given that some of the device and its associated moorings are subsurface, fishing gear may become snagged with device infrastructure.
7	**Collision Due to Avoidance of Site**	The presence of the site and device (alongside others) may influence vessel traffic flows, increasing interactions between non-project vessels that might result in a collision.
8	**Grounding Due to Avoidance of Site**	The presence of the site and device (alongside others) may influence vessel traffic flows, increasing the proximity to shallow water which could result in a grounding.
9	**Collision with Site Maintenance Vessel**	The movements of site maintenance vessels poses an additional risk of collision to other transiting vessels.
10	**Grounding of Maintenance Vessel**	O&M support vessels necessarily navigate within the site and near to shallow water which could result in a grounding.
11	**Breakout of a Device from Moorings**	The devices moorings could be damaged and a breakout occur which poses a risk to other navigating vessels.

Table 5. Ranked hazard list

Hazard ID	Hazard rank	Hazard title	Overall risk score
5	1	Tug & Service/Maintenance Vessel Contacts a Device	8.9
8	2	Grounding Due to Avoidance of Site	7.6
9	3	Collision with Site Maintenance Vessel	6.6
3	4	Fishing/Fish Farm Vessel Contacts a Device	6.3
4	4	Recreational Vessel Contacts a Device	6.3
10	4	Grounding of Maintenance Vessel	6.3
2	7	Passenger Ferry/Cruise Ship Contacts a Device	4.9
1	8	Large Commercial Vessel Contacts a Device	4.3
11	9	Breakout of a Device from Moorings	4.1
7	10	Collision Due to Avoidance of Site	3.8
6	11	Fishing Gear Interaction with Device/Cables	3.7

5 Risk controls

5.1 Site-wide risk controls

A number of risk controls are embedded by the processes EMEC has implemented in order to operate the site and the layout of the Billia Croo test site. The embedded risk control measures are detailed in Table 6, with any project-specific actions including any divergence from the specified control discussed. Embedded site-wide risk controls are also provided in Appendix C.

Table 6. EMEC embedded risk controls for Billia Croo test site

ID	Embedded risk control	Description	Project-specific actions
1.	PPE Requirement	Maintenance teams to wear suitable PPE when working on the assets, including life jackets.	The contractor, a highly experienced offshore operator, will be leading the offshore tasks and will enforce their own health and safety regulations before going on site.
2.	Training of staff	Staff to be trained to the required standards for their work and have suitable local knowledge of regulations and operations in the Orkney Islands.	The contracted offshore operator are local to EMEC and are very experienced in working on the EMEC Berths and with Wave Energy converters.
3.	Emergency Response and Cooperation Plan (ERCoP)	ERCoP for site developed and agreed with the MCA and SAR bodies to be consulted.	Offshore Operations Project Planning, led by the contractor and EMEC will ensure practices in place will reduce risks to as low as possible.
4.	NtM and Promulgation	In addition to NtM, EMEC's Maritime Safety Information Standard Operating Procedures (SOP) ensures that all key navigational consultees are informed	

ID	Embedded risk control	Description	Project-specific actions
		prior to any works. Distribution could include HMCG, Orkney Harbours (available via Orkney Islands Council Marine Services website), Orkney Marina noticeboards (as necessary), Orkney Fisheries Association, Scottish Fisheries Federation and UKHO. Stakeholders are targeted with information about relevant assets based on their activities and location.	
5.	Incident monitoring and reporting	EMEC to encourage incident/near miss reporting and monitor any safety issues at the test site. If necessary, risk control to be reviewed. Risk assessments to be reviewed following any incidents.	The contractor to encourage incident/near miss reporting and monitor any safety issues at the test site. If necessary, risk control to be reviewed. Risk assessments to be reviewed following any incidents.
6.	EMEC Procedures	EMEC has a number of SOPs and standards in place to reduce navigation risks, such as: • Task risk assessment; • Control of work (permit to access) • Hazard identification reporting; and • Maritime safety information.	
7.	Hydrography	Contractual responsibility for developer to return the site to the original condition post-decommissioning.	The contractor will ensure that the site is returned to a suitable condition post-deployment.
8.	Charting	Site is marked on nautical charts including a chart note.	
9.	Site Monitoring	EMEC's SCADA system provides real-time status information, trends, alarms and remote-control access to facilitate a safe working environment, comprehensive assessment and safe operation of the sites.	Onboard SCADA and safety monitoring system issues warnings and alarms to specified contacts (device owner, EMEC, Green Marine), along with onboard CCTV, will be used to ensure safe operation onsite. There are a number of alarms in the station keeping system. If exceeded, a text message and email to pre-specified

ID	Embedded risk control	Description	Project-specific actions
			users (such as personnel with the contractor and EMEC). Remote access to the onboard system is possible to check CCTV and verify alarm notifications. Data will be monitored and backed up 24/7.
10.	CCTV	Billia Croo test site is monitored by CCTV at EMEC's onshore substation, to satisfy operational requirements for control and monitoring of test site activities, visual checks of the test site environment, monitoring of lone worker safety, effective plant operation and substation security.	CCTV onboard OE Buoy for monitoring. 7 cameras onboard, 2 external and 5 internal.
11.	Liaison with local stakeholders	EMEC regularly liaises with key local stakeholders to identify any potential issues as soon as possible. Regular updates include information regarding upcoming deployments and significant operations at the site.	The WEDUSEA project will also undertake a stakeholder engagement process before and installation and during deployment.
12.	500m advisory exclusion zone	A 500m advisory exclusion zone exists around all test devices located at EMEC test sites.	

5.2 Project-specific risk controls

The following table provides a description of the risk controls that will be implemented during the project.

Table 7. Project-specific risk controls

ID	Project-specific risk control	Description
1.	AIS	Use of AtoN AIS (or virtual AIS if permitted) fitted to all surface piercing assets to improve visibility to passing vessels. AIS should be Category 3 with at least 97% up time and use Message 21, or as directed by the Northern Lighthouse Board (NLB).
2.	Heightened monitoring in adverse metocean conditions	During gale force winds, periodic monitoring of the assets is recommended to ensure excessive forces are not acting on the moorings which might cause a breakout. Mooring loads will be constantly monitored, and warnings and alarms will be set at sensible force levels
3.	Inspection and maintenance programme	Regular maintenance regime by developer to check the asset, its fittings and any signs of wear and tear. This should identify any failings which might result in a mooring failure and breakout. Refer to the findings of your third party verification mitigation against device breakage.

ID	Project-specific risk control	Description
4.	Remote shut down	Devices to be fitted with ability to shut down in an emergency, such as closing of shutoff valve, spin down of generator/turbine and electrical disconnect
5.	GPS alert system for asset moving	Remote monitoring of device to detect any major movements that might indicate a breakout for immediate response. Implement GPS excursion monitoring.
6.	Marking and Lighting	Assets to be lit to the requirements of NLB and marked in line with IALA guidance, IALA G1162 (2021)[1]. The following is typically requested by the NLB: • Yellow day marking/painting; • Flashing yellow special mark light (Category 1) (larger devices may require 2 lights at each end which are synchronised; light ranges should be at least 3 nautical miles); • Day top mark (if deemed necessary); • AIS AtoN (mandatory for floating devices at EMEC). Appropriate statutory sanctions must be in place to exhibit, alter or discontinue lighting.
8.	Tow risk assessment and passage plan	As required under Orkney Harbours Pilotage Directions 4(3)[2], prior to conducting a towing operation, a risk assessment and passage plan for the move should be conducted. The plan should account for the size of

[1] When identifying the marking requirements, it must be taken into consideration that some tidal devices:
- Have fast-moving sub-surface elements such as whirling blades; and
- Do not allow for safe under keel clearance (UKC).

The level of marking should be decided after a risk assessment has been conducted.
It is recommended that:
a) Subject to the proper risk assessment, areas containing on surface or sub-surface wave or tidal devices are marked by appropriate AtoN. In addition, radar reflectors, retro-reflecting material, racons and / or AIS transponders should be considered where the level of traffic and degree of risk requires.
b) The AtoN must be visible to the mariner from all relevant directions in the horizontal plane, by day and lighted at night.
c) Taking the results of a risk assessment into account, lights must have an appropriate nominal range and vertical divergence and may be synchronized.
d) Individual wave and tidal energy devices within a site that extends above the surface are painted predominantly yellow above the waterline and have yellow retro-reflective tape as required by the competent authority. If navigation is permitted within site, marking of individual devices may be required.
e) If marked, the individual devices should have flashing yellow lights. The flash character of such lights must be sufficiently different from those displayed on the boundary lights with a nominal range of not less than two Nautical miles.
f) Floating AtoN could be located outside the moorings of the floating structures.

Based on risk assessment, a single wave or tidal energy extraction structure, standing alone, may be marked as follows:
- isolated Danger mark; or
- special mark.

The AtoN described herein should comply with IALA recommendations and guidelines, and have an appropriate availability normally not less than 99.0% (IALA Category 2).

[2] Orkney Islands Council Competent Harbour Authority (2016) The Orkney Pilotage Direction 1988 (as amended 2007, 2010 and 2016).

ID	Project-specific risk control	Description
		the tow, maneuverability restrictions, tow arrangements and metocean conditions.
9.	Guard vessels	During major construction or maintenance activities, a guard vessel may be considered to assist in protecting the devices from contacts with passing vessel traffic. Due to the low density of traffic, this is not considered necessary except for extraordinary circumstances. If guard vessels are to be used onsite, it is important that such vessels employed to guard the site follow appropriate guidelines, with clear instructions on when to intervene in a potential incident.
10.	Liaison with local stakeholders	Consultation should be undertaken with Orkney Marine Services, the MCA and NLB prior to installation of device to confirm that adequate risk controls are in place. EMEC also conducts regular stakeholder consultation events to ensure that local marine users are aware of the pipeline of activity.
11.	Installation, maintenance and removal	All vessels undertaking activities on site should comply with EMEC standard operating procedures. Vessels should be mindful of other navigating vessels and avoid disrupting the activities of others.
12.	ERCoP	Project-specific annex to be incorporated into site-wide ERCoP. UKHO will be consulted with regarding this ERCoP.

6 Summary and conclusion

This document has been prepared to support a marine licence application for the OE Buoy deployment and should be read in conjunction with the document 'Billia Croo Navigational Risk Assessment (NRA) – REP522'.

In summary, the NRA has concluded that the deployment of the devices is low risk with suitable risk controls in place.

Appendix A: Risk Assessment Scoring Matrix

Consequence					Likelihood				
					1	2	3	4	5
Score	People	Property	Environment	Business	Negligible	Extremely Unlikely	Remote	Reasonably Probable	Frequent
1	None	Less than £10,0000	No Impact	No Impact	1	2	3	4	5
2	Slight injury(s)	£10,000-£100,000	Tier 1 Local assistance required	Local negative publicity Minor damage to device	2	4	6	8	10
3	Multiple minor or single serious injury	£100,000-£1million	Tier 2 Limited external assistance required	Widespread negative publicity Moderate damage to device	3	6	9	12	15
4	Multiple serious injury or single fatality	£1million-£10million	as Tier 2 Regional assistance required	National negative publicity Major damage to device	4	8	12	16	20
5	More than one fatality	>£10million	Tier 3 National assistance required	International negative publicity Major damage to device	5	10	15	20	25

Risk Definitions	
1-3.99: Negligible 4-8.99: Low Risk	Broadly Acceptable - Current controls to be monitored
9-14.99: Medium Risk	Tolerable (if ALARP) - further controls to be considered and existing controls monitored.
15-19.99: Significant 20-25: High Risk	Unacceptable - Activity not to proceed and controls to be immediately implemented to reduce risk

Appendix B: Hazard Log

Hazard ID	Hazard Rank	Hazard title	Hazard type	Designed in Mitigation (Refer to Mitigation Table)	Possible causes	Realistic Most Likely Consequences	Realistic Most Likely Scores					Realistic Worst Credible Consequences	Realistic Worst Credible Scores					Overall Risk Score	Overall Risk Rating
							People	Property	Environment	Business	Frequency		People	Property	Environment	Business	Frequency		
1	8	Large Commercial Vessel Contacts a Device	Contact / Allision	EMER (1-5) OPS (2/6/7/9/10/11) PROM (1-4) DES (1-4)	Insufficient Lookout Inadequate Passage Planning Human Error/Fatigue Equipment or Mechanical Failure on Vessel Poor Visibility in Area Reduced Seakeeping due to Tidal or Weather Constraints Failure of Navigational Aids on Device Charts not up to date Confusion on Site Layout	Minor injury; Minor damage: No pollution; Moderate adverse publicity / short term interruption to EMEC/Operators.	1	2	1	3	2	Single fatality; Major damage; Moderate pollution incident (Tier 2); Moderate adverse publicity / long term interruption to EMEC/Operators.	4	4	3	4	1	4.3	Low Risk - Broadly Acceptable
2	7	Passenger Ferry/Cruise Ship Contacts a Device	Contact / Allision	EMER (1-5) OPS (2/6/7/9/10/11) PROM (1-4) DES (1-4)	Insufficient Lookout Inadequate Passage Planning Human Error/Fatigue Equipment or Mechanical Failure on Vessel Poor Visibility in Area Reduced Seakeeping due to Tidal or Weather Constraints Failure of Navigational Aids on Device Charts not up to date Confusion on Site Layout	Multiple major injuries; Minor damage: No pollution; Moderate adverse publicity / short term interruption to EMEC/Operators.	3	2	1	3	2	Multiple fatalities; Major damage; Moderate pollution incident (Tier 2); Moderate adverse publicity / long term interruption to EMEC/Operators.	5	4	3	4	1	4.9	Low Risk - Broadly Acceptable
3	4	Fishing/Fish Farm Vessel Contacts a Device	Contact / Allision	EMER (1-5) OPS (2/6/7/9/10/11) PROM (1-4) DES (1-4)	Insufficient Lookout Inadequate Passage Planning Human Error/Fatigue Equipment or Mechanical Failure on Vessel Poor Visibility in Area Reduced Seakeeping due to Tidal or Weather Constraints Failure of Navigational Aids on Device Charts not up to date Confusion on Site Layout	Multiple minor injuries; Negligible damage: No pollution; Minor adverse publicity / short term interruption to EMEC/Operators.	2	1	1	2	3	Single fatality; Moderate damage; Minor pollution (Tier 1); Moderate adverse publicity / long term interruption to EMEC/Operators.	4	3	2	4	2	6.3	Low Risk - Broadly Acceptable
4	4	Recreational Vessel Contacts a Device	Contact / Allision	EMER (1-5) OPS (2/6/7/9/10/11) PROM (1-4) DES (1-4)	Insufficient Lookout Inadequate Passage Planning Human Error/Fatigue Equipment or Mechanical Failure on Vessel Poor Visibility in Area Reduced Seakeeping due to Tidal or Weather Constraints Failure of Navigational Aids on Device Charts not up to date Confusion on Site Layout	Multiple minor injuries; Negligible damage: No pollution; Minor adverse publicity / short term interruption to EMEC/Operators.	2	1	1	2	3	Single fatality; Moderate damage; Minor pollution (Tier 1); Moderate adverse publicity / long term interruption to EMEC/Operators.	4	3	2	4	2	6.3	Low Risk - Broadly Acceptable

Hazard ID	Hazard Rank	Hazard title	Hazard type	Designed in Mitigation (Refer to Mitigation Table)	Possible causes	Realistic Most Likely Consequences	Realistic Most Likely Scores					Realistic Worst Credible Consequences	Realistic Worst Credible Scores					Overall Risk Score	Overall Risk Rating
							People	Property	Environment	Business	Frequency		People	Property	Environment	Business	Frequency		
5	1	Tug & Service/Maintenance Vessel Contacts a Device	Contact / Allision	EMER (1-5) OPS (1-11) DES (1-4)	Insufficient Lookout Human Error/Fatigue Equipment or Mechanical Failure on Vessel Poor Visibility in Area Reduced Seakeeping due to Tidal or Weather Constraints Failure of Navigational Aids on Device	Multiple minor injuries; Negligible damage: No pollution; Minor adverse publicity / short term interruption to EMEC/Operators.	2	1	1	2	4	Single fatality; Moderate damage; Minor pollution (Tier 1); Moderate adverse publicity / long term interruption to EMEC/Operators.	4	3	2	4	3	8.9	Low Risk - Broadly Acceptable
6	11	Fishing Gear Interaction with Device/Cables	Obstruction	EMER (1-5) OPS (2/6/7/9/11) PROM (1-4) DES (1-6)	Insufficient Lookout Unawareness of device layout Human Error/Fatigue Equipment or Mechanical Failure on Vessel Poor Visibility in Area Reduced Seakeeping due to Tidal or Weather Constraints Failure of Navigational Aids on Device Charts not up to date Confusion on Site Layout	Multiple minor injuries; Minor damage: No pollution; Minor adverse publicity / short term interruption to EMEC/Operators.	2	2	1	2	2	Single fatality; Moderate damage; Minor pollution (Tier 1); Moderate adverse publicity / long term interruption to EMEC/Operators.	4	3	2	4	1	3.7	Negligible Risk - Broadly Acceptable
7	10	Collision Due to Avoidance of Site	Collision	EMER (1/2/4/5) OPS (2/9) PROM (1-4) DES (1-4)	Reduced searoom with device Increased maintenance traffic Human Error/Fatigue Equipment or Mechanical Failure on Vessel Reduced Seakeeping due to Tidal or Weather Constraints Poor Visibility	Multiple minor injuries; Minor damage: No pollution; Minor adverse publicity / short term interruption to EMEC/Operators.	2	2	1	2	2	Single fatality; Major damage; Moderate pollution incident (Tier 2); Moderate adverse publicity / long term interruption to EMEC/Operators.	4	4	3	4	1	3.8	Negligible Risk - Broadly Acceptable
8	2	Grounding Due to Avoidance of Site	Grounding	EMER (1/2/4/5) OPS (2/9) PROM (1-4) DES (1-4)	Reduced searoom with device Human Error/Fatigue Equipment or Mechanical Failure on Vessel Reduced Seakeeping due to Tidal or Weather Constraints Poor Visibility	Multiple minor injuries; Minor damage: No pollution; Minor adverse publicity / short term interruption to EMEC/Operators.	2	2	1	2	4	Single fatality; Major damage; Moderate pollution incident (Tier 2); Moderate adverse publicity / long term interruption to EMEC/Operators.	4	4	3	4	2	7.6	Low Risk - Broadly Acceptable
9	3	Collision with Site Maintenance Vessel	Collision	EMER (1/2/4/5) OPS (1-11) PROM (1-4) DES (1-4)	Insufficient Lookout Human Error/Fatigue Equipment or Mechanical Failure on Vessel Poor Visibility in Area Reduced Seakeeping due to Tidal or Weather Constraints	Multiple minor injuries; Minor damage: No pollution; Minor adverse publicity / short term interruption to EMEC/Operators.	2	2	1	2	3	Single fatality; Major damage; Minor pollution (Tier 1); Moderate adverse publicity / long term interruption to EMEC/Operators.	4	4	2	4	2	6.6	Low Risk - Broadly Acceptable
10	4	Grounding of Maintenance Vessel	Grounding	EMER (1/2/4/5) OPS (1-11) PROM (1-4)	Insufficient Lookout Inadequate Passage Planning Human Error/Fatigue Equipment or Mechanical Failure on Vessel Reduced Seakeeping due to Tidal or Weather Constraints Poor Visibility	Multiple minor injuries; Negligible damage: No pollution; Minor adverse publicity / short term interruption to EMEC/Operators.	2	1	1	2	3	Single fatality; Moderate damage; Minor pollution (Tier 1); Moderate adverse publicity / long term interruption to EMEC/Operators.	4	3	2	4	2	6.3	Low Risk - Broadly Acceptable

Hazard ID	Hazard Rank	Hazard title	Hazard type	Designed in Mitigation (Refer to Mitigation Table)	Possible causes	Realistic Most Likely Consequences	Realistic Most Likely Scores					Realistic Worst Credible Consequences	Realistic Worst Credible Scores					Overall Risk Score	Overall Risk Rating
							People	Property	Environment	Business	Frequency		People	Property	Environment	Business	Frequency		
11	9	Breakout of a Device from Moorings	Breakout	EMER (1-5) OPS (2/7/8/9/10) DES (1-4/7) MON (1-3)	Severe metocean conditions Insufficient mooring arrangements Installation failure	Minor injury; Minor damage: No pollution; Minor adverse publicity / short term interruption to EMEC/Operators.	1	2	1	2	3	Multiple major injuries; Moderate damage; Minor pollution (Tier 1); Moderate adverse publicity / short term interruption to EMEC/Operators.	3	3	2	3	1	4.1	Low Risk - Broadly Acceptable

Appendix C: Embedded Risk Controls (as per Site-Wide NRA)

Number	Title	Description	Responsible	EMEC Reference
Emergency Response and Incident Investigation (EMER)				
EMER1	Site Wide ERCOP	Emergency Response and Cooperation Plan, to ensure that arrangements are in place for the protection of all employees and other persons that may be present in the area or premises and/or reputation in the event of an emergency occurring. Includes: -Liaison arrangements between EMEC and HMCG -Details of the Sites and Activities (including layouts) -Roles and Responsibilities -Procedures and Communications Channels -SAR Assets Details and Capabilities	EMEC	ERP014 v7 01/09/2023 ERP015 v13 23/04/2024
EMER2	Developer ERCOP	Provision of details, pictures and arrangements of specific devices/vessels by developers to update the site-wide ERCOP.	Developer	FORM264 v3 04/02/2022
EMER3	Emergency Shutdown	If there is an indication of an incident with a device onsite (e.g. mooring failure, device loss) the	EMEC / Developer	ERP014 v7 01/09/2023

Number	Title	Description	Responsible	EMEC Reference
		EMEC duty manager has the ability to initiate a shutdown and/or disconnection of a device remotely.		
EMER4	Periodic Exercises	Periodic emergency management and response exercises will be run at EMEC, ran in conjunction with MRCC/SAR.	EMEC / HMCG	ERP014 v7 01/09/2023
EMER5	Incident Reporting and Investigation	There are statutory incident reporting requirements and expectations: -MAIB (Merchant Shipping Act) -HSE (RIDDOR) -Orkney VTS if in Harbour Authority Area -EMEC Duty Manager Site-Wide/Device Specific risk assessments to be reviewed following incidents, and additional risk controls identified if appropriate.	Various	FORM024 v7 03/05/2019 SOP008 v9 27/07/2023
Operational Management (OPS)				
OPS1	Control of Work	The EMEC Permit to Work and Permit to Access Site systems are intended to allow EMEC and contractors to control/coordinate safe activities within the site. Method Statements and Task Risk Assessments are required to be approved prior to access to or any works on site.	EMEC	SOP003 v18 02/08/2023

Number	Title	Description	Responsible	EMEC Reference
OPS2	Marine Operating Guidelines	Detailed guidance for marine operations to promote high standards in the areas of health, safety and the environment during the planning and execution of all work on EMEC sites. Includes -Health and Safety -Management of Operations -Emergency Response -Equipment and Vessels -Environmental Management -Stakeholders	EMEC	GUIDE010 v5 17/02/2022
OPS3	Control of SimOps	Full assessment of the risks arising from simultaneous operations prior to authorising site access.	EMEC	SOP093 v3 28/11/2019 SOP095 v2 31/10/2019
OPS4	Vessel Standards	All work vessels accessing an EMEC site require: -MCA Vessel Coding (e.g. SCV) -Appropriate Insurance -Crewed by suitably trained/qualified personnel -AIS (Class A/B) on any vessel operating/installing in EMEC sites. -VHF (Ch16 and EMEC's private channel P1) -Mooring Arrangements (e.g. Minimum spacing or moorings to cables)	Developer	ERP014 v7 01/09/2023 GUIDE010 v5 17/02/2022

Number	Title	Description	Responsible	EMEC Reference
OPS5	PPE	Personnel operating on site are to wear appropriate Personal Protective Equipment (e.g. hard hats, work boats, protective glasses, lifejackets, thermally insulated floatation suits). PLBs are rarely used at EMEC sites, but some of EMECS lifejackets are equipped with GPS PLBs that activate on inflation.	EMEC / Developer	GUIDE010 v5 17/02/2022 ERP014 v7 01/09/2023
OPS6	Guard Vessels	During major construction or maintenance activities, a guard vessel may be considered to assist in protecting the devices from contacts with passing vessel traffic. Due to the low density of traffic, this is not considered necessary unless for extraordinary circumstances and has been rarely used. If guard vessels are to be used onsite, it is important that such vessels employed to guard the site follow appropriate guidelines, with clear instructions on when to intervene in a potential incident. Required if unlighted, unmarked navigational hazards are present	Developer	GUIDE010 v5 17/02/2022

Number	Title	Description	Responsible	EMEC Reference
		on site as a result of developer activities. Guard Vessels are required to comply with EMEC Vessel requirements.		
OPS7	Inspection and Maintenance Programme	Regular maintenance regime by developer to check the device, its fittings and any signs of wear and tear. This should identify any failings which might result in a mooring failure and therefore prevent breakout.	Developer	
OPS8	Task Risk Assessments	To ensure that all activities and operations within the control of EMEC are assessed for the risks they present to staff, suppliers and the public and that those risks are reduced to a level as low as reasonably practicable. Required as part of Control of Work procedures.	Developer	FORM025 v7 17/01/2022 SOP004 v6 10/01/2023
OPS9	Device Specific NRAs	Each developer is required to create a device specific addendum to the site-wide EMEC NRA to support applications to deploy, operate and remove assets at EMEC Test Sites.	Developer	FORM292-295
OPS10	Tow risk assessment and passage plan	As required under Orkney Harbours Pilotage Directions 4(3), prior to	Developer	

Number	Title	Description	Responsible	EMEC Reference
		conducting a towing operation, a risk assessment and passage plan for the move should be conducted. The plan should account for the size of the tow, manoeuvrability restrictions, tow arrangements and MetOcean conditions		
OPS11	Training	Developers are responsible for ensuring that all staff engaged on operations are competent to carry out the allocated work.	Developer	GUIDE010 v5 17/02/2022
Promulgation and Awareness (PROM)				
PROM1	Notice to Mariners	To ensure that the appropriate authorities are informed of works being carried out in waters within EMEC's Test Site areas and of the installation of any permanent/semi-permanent structure such that the information is promulgated through appropriate channels to mariners. To include: -UKHO -Orkney Harbour Authority -Orkney Ferries -HMCG Shetland -NLB -Orkney Fisheries Association -Orkney Fisheries Society -Scottish	EMEC / Developer	FORM068A v7 19/12/2018 FORM068B v7 03/05/2018 SOP063 v18 27/07/2021

Number	Title	Description	Responsible	EMEC Reference
		Fishermen's Federation -Marine Scotland -RYA Scotland -The Orcadian (if appropriate)		
PROM2	Consultation	Consultation with key stakeholders prior to site installations to ensure effective micrositing.	Developer	
PROM3	Site Marking and charting	Site is marked on nautical charts including an appropriate chart note.	EMEC / Developer	GOV017/018
PROM4	500 m Advisory Exclusion Zones	A 500 m advisory exclusion zone exists around all test devices located at EMEC. Nautical charts indicate that mariners should exercise caution whilst navigating in this area and obtain local knowledge (FoW). Nautical charts indicate that mariners should avoid passing within the test area marked by cardinal buoys (BC).	EMEC	SOP094 v6 07/08/2023
Site and Device Design (DES)				
DES1	Device Marking	Device to be lit to the requirements of NLB and marked in line with IALA guidance. Appropriate statutory sanctions must be in place to exhibit, alter or discontinue lighting.	Developer	
DES2	AIS	AIS transmitting an Aid to Navigation Type 21 message should be installed	Developer	

Number	Title	Description	Responsible	EMEC Reference
		on all surface piercing devices.		
DES3	Radar Reflectors	Use of radar reflectors to improve marking during times of poor visibility.	Developer	
DES4	Marking and Lighting	Device to be lit to the requirements of Northern Lighthouse Board and marked in line with IALA guidance. Appropriate statutory Sanctions must be in place to exhibit, alter or discontinue lighting.	Developer	
DES5	Hydrography	Contractual responsibility to return the site to the original condition post-decommissioning.	Developer	
DES6	Cable protection	From 15 m depth to shore, cast iron cable protectors are used (Billia Croo/FoW). Buried to 12 m from MLWS (Billia Croo) and "buried" (FoW).	EMEC	
DES7	Third Party Verification	All moorings will have Third Party Verification as set out in MGN654 and in line with marine licence conditions.	Developer	
Site Monitoring (MON)				
MON1	Site Monitoring: CCTV, Radar and AIS Monitoring	To satisfy operational requirements for control and monitoring of Test Site activities, visual checks of the Test Site environment, monitoring of lone worker safety, effective plant operation and	EMEC	ERP014 v7 01/09/2023

Number	Title	Description	Responsible	EMEC Reference
		substation security. EMEC's SCADA system provides real-time status information, trends, alarms and remote-control access to facilitate a safe working environment, comprehensive assessment and safe operation of the sites. EMEC's procedures set out the equipment and management of the SCADA system. Billia Croo monitored from Black Craig/substation FoW monitored from Caldale substation (Eday).		
MON2	Heightened monitoring in adverse met-ocean conditions	During gale-force winds, periodic monitoring of the devices is recommended to ensure excessive forces are not acting on the moorings which might cause a breakout	EMEC / Developer	
MON3	GPS alert system for turbine moving	Remote monitoring of device to detect any major movements that might indicate a breakout for immediate response. Implement GPS excursion monitoring.	EMEC / Developer	

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