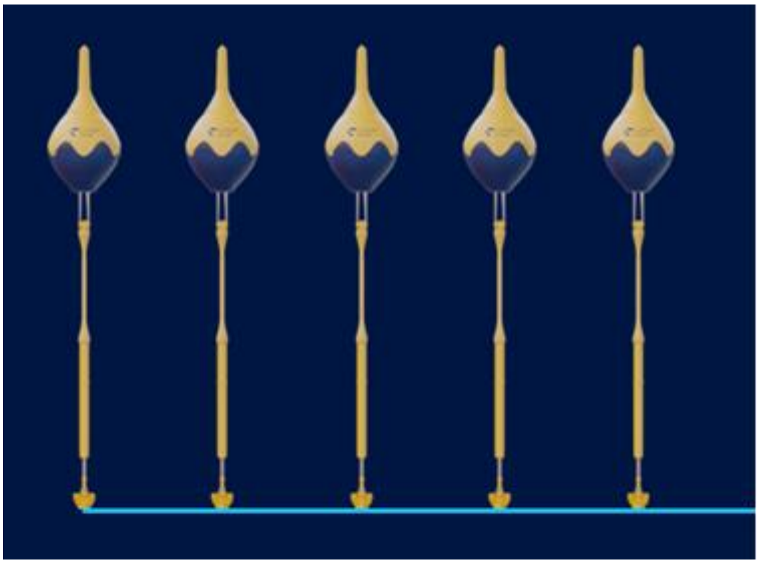
# Endeavor Wave Limited | CorPack wave cluster

## Navigational Risk Assessment Addendum

## EMEC Billia Croo Wave Test Site

**December 2024**



# 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.

Furthermore, in line with regulations, a new site-wide NRA update will be required at least once before the deployment of this array so this document will also be updated in line with any additional updates to the site-wide document.

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

# Document History

| Revision | Date | Description | Originated by | Reviewed by | Approved by |
|---|---|---|---|---|---|
| 1 | 18/12/2024 | Draft | [Re (EMEC) | | [Re (EWLtd) |
| 2 | 20/12/2024 | Final | [Re (EMEC) | | [Re (EWLtd) |
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# Disclaimer

as at the date of writing, we can give no assurances or warranty regarding the accuracy, currency or applicability of any of the content in relation to specific situations or particular circumstances.

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# 1 Introduction

The aim of the 1.8MW (5 individual devices) wave array at EMECs Billia Croo site is to actively demonstrate array scale WEC deployment. CorPower Ocean have worked extensively on deployment of their wave energy converter, HiWave 5 to be deployed at full scale in Acugadoura, Portugal in early 2023. This deployment of CorPowers C4 device, through their subsidiary Endeavour Wave Limited, will provide certified and warrantied wave energy convertors, which will then be deployed in array format at EMEC. Further information is provided in the Project Information Summary.

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 CorPower WEC converts ocean waves into electricity through the rise and fall as well as the back-and-forth motion of moving water. A composite buoy, interacting with this wave motion, drives a Power Take Off (power train located inside the buoy) that converts the mechanical energy into electricity. The WEC consists of a lightweight buoy connected to the seabed through a power conversion module and a mooring system. By means of novel and patented technologies the CPO WEC moves in phase with incoming waves, amplifying the motion and power absorption, making it move in and out of the water surface.

CorPower’s technology addresses the key challenges of efficient wave energy harvesting in a unique way. The device has the ability to tune and detune to the sea conditions, by such introducing a function to wave energy similar to wind turbines pitching the blades to control the driving force of the device.

Inspired by the pumping principle of the human heart, CorPower uses stored pressure to convert energy from waves in both stroke directions. The human heart uses stored hydraulic pressure to provide force for the return stroke, thereby only requiring the muscles of the heart to pump in one direction. In a similar way, CorPower WEC uses pneumatic pressure to push the buoy downwards. It mimics the energy storage aspect of the human heart whereby the upward force of a wave swell pushes the buoy upwards while the stored pneumatic pressure provides the restoring force driving the buoy downwards. This results in an equal energy production in both directions and a light-weight design with high natural frequency.

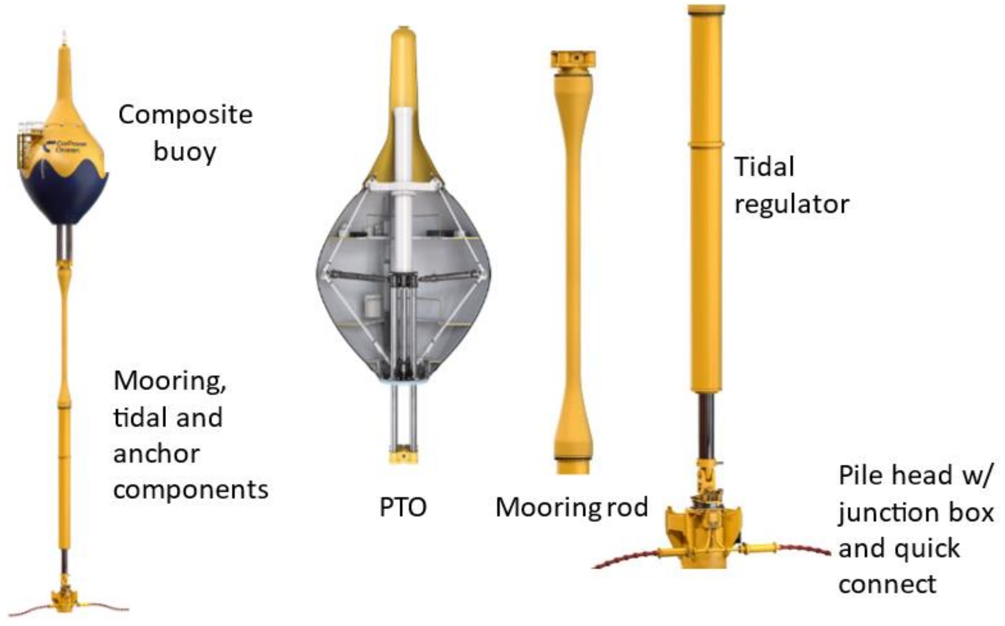


Figure 1. WEC system overview with sub-systems

The CorPower WEC (Figure 1) is a Point Absorber type of WEC rated at 350kW, with a heaving composite buoy on the ocean surface that absorbs the wave energy. The buoy is connected to the seabed using an UMACK anchor & mooring system. The WEC uses a unique phase control technology that allows the WEC to be tuned and detuned, altering the system's response to ocean conditions. In operational tuned mode, phase control makes the device oscillate in phase with incoming waves, strongly amplifying the WEC's motion and thereby the power capture. In storms, the detuned state makes the WEC transparent to incoming waves for enhanced survivability.

This combination allows for a large amount of energy to be harvested using a relatively small and low-cost device. Compact and lightweight devices are efficient to produce in volumes, install, operate, and maintain in modular multi-device arrays using low-cost vessels, which improves uptime, increases availability for a higher annual energy production (AEP), and significantly reduces operational costs (OPEX). Moreover, the WEC composite hulls can be produced in large numbers locally at customers' sites with a unique mobile factory concept developed and operated by CorPower, with low cost and minimum GHG emissions from transport and logistic.

The array ready device will have an industrial design and build quality of a production machine, based on cycles of learning from the previous generation devices. The machine architecture is generally maintained from current technology generation, with innovation on sub-systems designed for reliability and optimised for volume manufacturing. It will have less parts, less complexity and deliver higher performance, reliability, and maintainability.

An overview of the WEC layout is shown in Figure 2, Figure 3 and Figure 4.

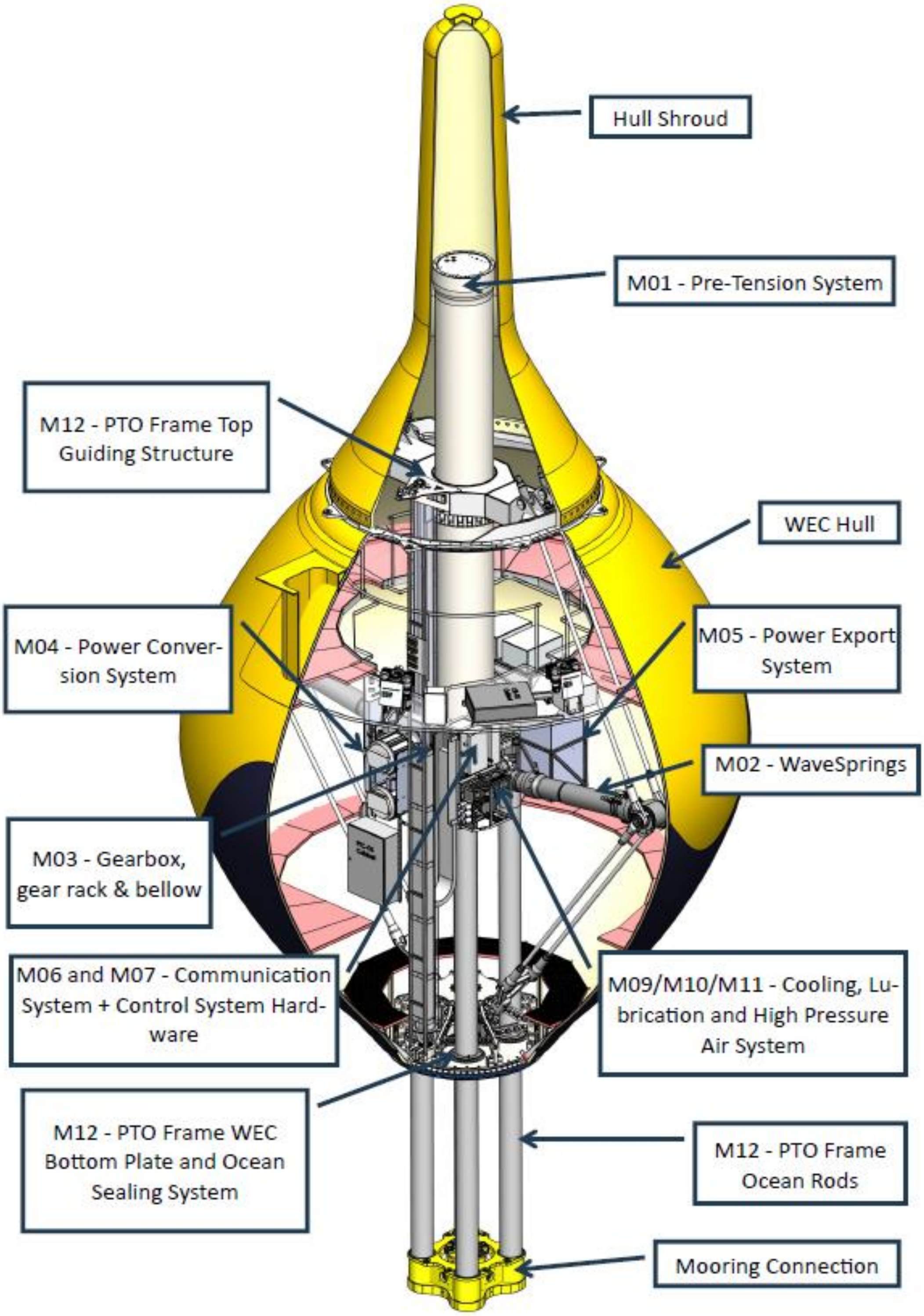


**Figure 2. WEC Overview – PTO modules**


**Figure 3. Corpower WEC with PTO mated in the composite hull, top shroud, and mooring rod in foreground**

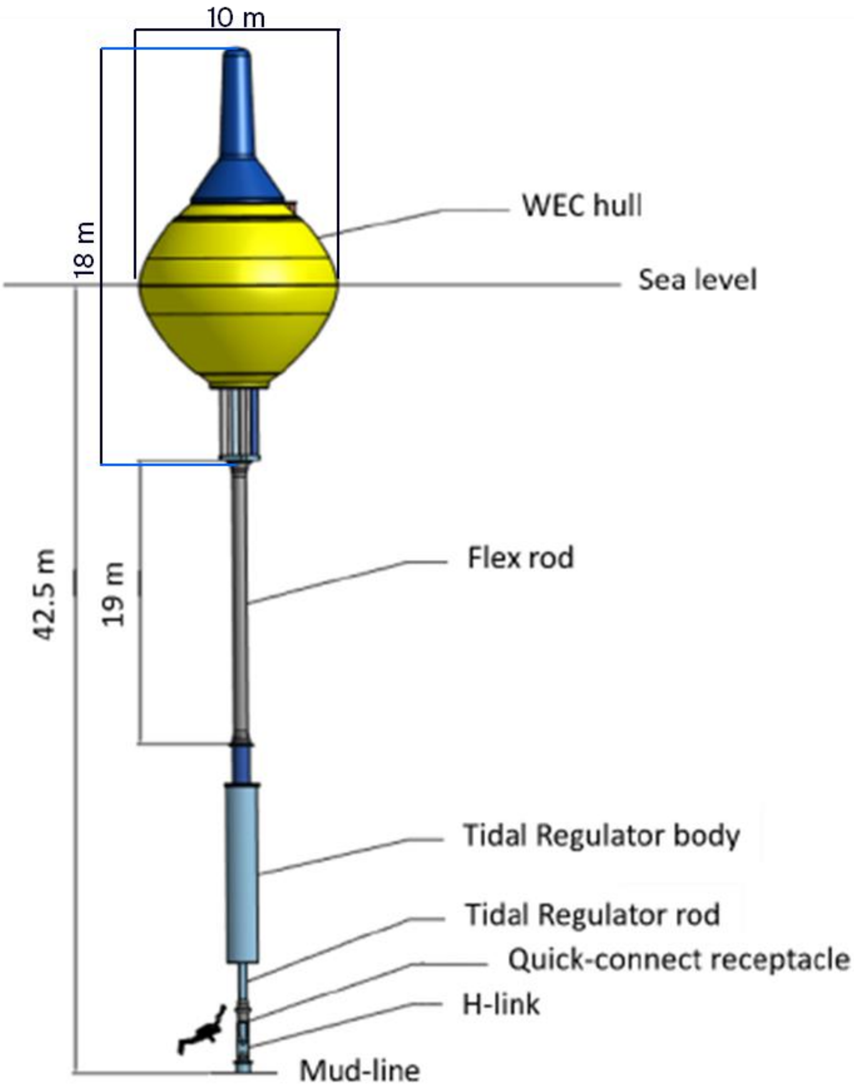


**Figure 4. WEC overview – deployment**

## 2.2 Schedule and test plan

The 5 device CorPack wave cluster can be installed and decommissioned in a short space of time (3 months) which, compared to other array projects, reduces the impacts associated with installation and decommissioning in terms of disturbance to receptors.

**Table 1. Project Schedule**

| Stage | Month | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 3-180 | 181 | 182 | 183 |
| **Installation** | | | | | | | |
| **Operation** | | | | | | | |
| **Decommission** | | | | | | | |

## 2.3 Deployment location

The CorPack wave cluster will be deployed within the area indicated for Billia Croo (Figure 5), with Table 2 indicating the marine license location of the CorPack wave cluster within its perimeters – including its upcoming extension (see related PIS for further information).

**Table 2. Location of CorPack wave cluster**

| Location Description | Latitude and longitude (WGS 84) |
|---|---|
| **Test site outermost boundary points (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 |
| **CorPack site points (bold red line)** | 58° 58.271' N 003° 24.240' W |
| | 58° 58.569' N 003° 23.617' W |
| | 58° 58.242' N 003° 23.029' W |
| | 58° 57.944' N 003° 23.652' W |

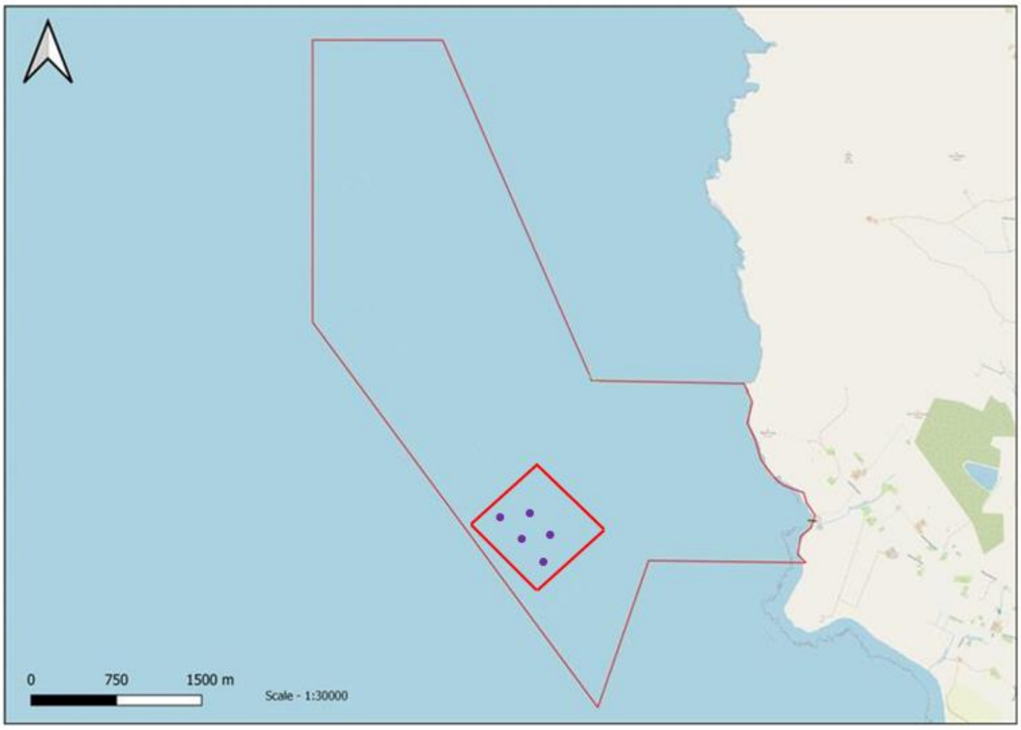


Figure 5. Billia Croo site and proposed CorPack wave cluster array location and configuration

## 2.4 Third party verification

Either Tension Technology International Ltd or Orcades Marine Ltd will perform TPV.

# 3 Key navigational themes

To complete this project-specific assessment, a comprehensive review of the site-wide NRA for EMEC's Billia Croo test site was conducted. This is updated every two years, and this document will be updated as changes are made to the site-wide document (this will occur at least once before deployment of this array). 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

The WEC is connected to the anchor through a quick-connect system consisting of a remote mechanical, electrical and data connection. The mooring system is then made up of a flexible rod, tidal regulation linear actuator, and crossed H-link universal joint, that all combined are the UMACK Anchor (Figure 6). Other anchor types are considered as alternatives, such as rock anchor (drilled) and monopile (vibrated). The UMACK anchor will be vibrated 18m into the seabed, weighs 37 tonnes and has a circumference of 3.7m. The UMACK is an anchoring system that:

- Can resist vertical loads in excess of 15MN
- Can resist over a hundred million load cycles
- Is suitable for sand and sand/clay seabed types
- Mitigates disturbance to marine life with use of Vibratory install methodology
- Can be 100% decommissioned at the end of project, by reversing the vibration installation process
- Eliminates slack-snatch loading events
- Monopile geometry, eliminates the need for a subsea foundation structure
- Reduces deployment and retrieval time to 30-60min. (pull-down + connect)

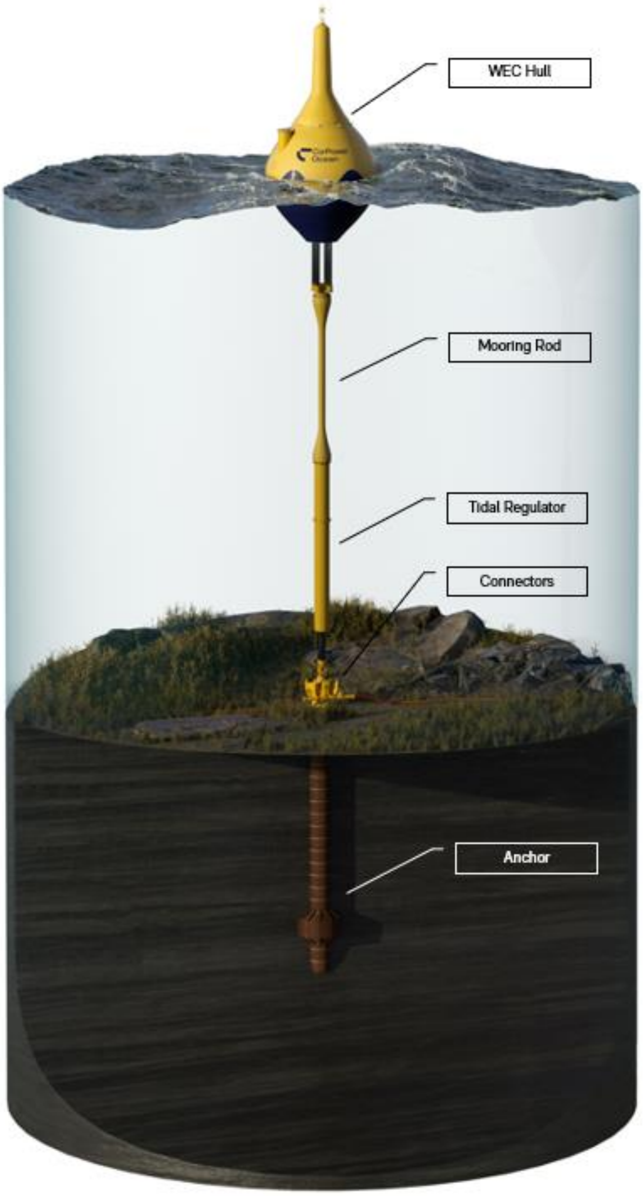


Figure 6. Outline of the Mooring & Anchoring System to the Seabed (UMACK)

## 3.7 Station keeping

The device has AIS and GPS capabilities, therefore if moorings failed and the device became loose the relevant personnel would be notified immediately.

## 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

There are no other developments within the area, thus no anticipated cumulative or in-combination effects are expected.

# 4 Risk controls

## 4.1 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 3, with any project-specific actions including any divergence from the specified control discussed.

**Table 3. 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. | |
| 2. | Training of staff | Staff to be trained to the required standards for their work and have suitable local knowledge of regulations and operations in the Orkney Islands. | |
| 3. | Emergency Response and Cooperation Plan (ERCoP) | ERCoP for site developed and agreed with the MCA and SAR bodies to be consulted. | |
| 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 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. | |

| ID | Embedded risk control | Description | Project-specific actions |
|---|---|---|---|
| 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. | CorPower operates with an electronic incident and accident reporting system, where all incidents including near misses are reported, reviewed, and mitigations to prevent repeat are followed up. |
| 6. | EMEC Procedures | EMEC has a number of SOPs and standards in place to reduce navigation risks, such as:<br>• Task risk assessment.<br>• Control of work (permit to access)<br>• Hazard identification reporting; and<br>• Maritime safety information. | |
| 7. | Hydrography | Contractual responsibility for developer to return the site to the original condition post-decommissioning. | |
| 8. | Charting | New site boundary is not fully marked and buoyage not updated but will be before this deployment in line with NLB and MCA requirements. | Keep stakeholders updated with project timelines as it updates and ensure site is marked correctly and buoyage is in place before deployment. |
| 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. | Radio and/or 4G link, with its respective antenna and mast, could additionally be provided as a backup solution for remote control and monitoring system with onshore SCADA system.<br>Multiple cameras will also be assembled on the WECs of this project: monitoring the inside, and surface/ subsurface components.<br>ROVs will also be used for additional inspection below water of the WEC hull subsurface, the mooring, and the anchoring, especially for the purpose of corrosion and biofouling monitoring. As an example, the ROV currently used is the BlueROV2. |

| ID | Embedded risk control | Description | Project-specific actions |
|---|---|---|---|
| 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. | |
| 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. | |
| 12. | 500m advisory ATBA | A 500m advisory ATBA exists around all test devices located at EMEC test sites. | |

## 4.2 Project-specific risk controls

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

**Table 4. Project-specific risk controls**

| ID | Project-specific risk control | Description |
|---|---|---|
| 1. | Radar reflectors | Use of radar reflectors to improve marking during times of poor visibility. |
| 2. | AIS | Use of AtoN AIS (or virtual AIS 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). |
| 3. | 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. |
| 4. | 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. |
| 5. | Remote shut down including feathering of blades | The devices natural state is survivability mode which it automatically goes into if there is lack of control, communication or in significant weather. |
| 6. | 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. |

| ID | Project-specific risk control | Description |
|---|---|---|
| 7. | Marking and Lighting | Assets to be lit to the requirements of NLB and MCA, and marked in line with IALA guidance, IALA Recommendation O-139 (2013)[1]. The following is typically requested by the NLB:<br>• Yellow day marking/painting;<br>• 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);<br>• Day top mark (if deemed necessary);<br>• Radar reflector; and<br>• AIS AtoN (mandatory for floating devices at EMEC).<br>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 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.<br>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.<br>EMEC also conducts regular stakeholder consultation events to ensure that local marine users are aware of the pipeline of activity. |

[1] All surface piercing structures should be marked as:

- Individual wave and tidal energy devices within a site that extend above the surface are painted yellow above the waterline;
- If marked, the individual devices should have flashing yellow lights. The flash character of such lights must be sufficiently different from those displaying on the boundary lights with a nominal range of not less than 2 nautical miles; and
- A single wave or tidal energy structure standing alone may be marked as either an isolated danger mark or a special mark.

It is also recommended that:

- Radar reflectors, retro-reflecting material, Racons and / or AIS transponders should be considered where the level of traffic and degree of risk requires it;
- The lit Aid to Navigation (AtoN) must be visible to the mariner from all relevant directions in the horizontal plane, by day and night;
- Any floating AtoNs should be located outside the moorings of the floating structures; and
- AtoNs should comply with IALA Recommendations and have an appropriate availability, normally not less than 99% (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 |
|---|---|---|
| 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. |

# 5 Summary and conclusion

This document has been prepared to support a marine licence application for the CorPack wave cluster 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

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