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Mocean Energy Orkney M100P Test 2020

Project-specific Environmental Management Plan (PEMP)

Final

Report to Mocean Energy

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1 INTRODUCTION

1.1 BACKGROUND

Mocean Energy, based in Edinburgh, is developing wave energy converters (WECs) for various applications from small-scale off-grid use to large, utility-scale projects. Its core technology is its hinged raft WEC, which consists of two hulls with novel shapes connected by a single hinge. Wave forcing, and the hulls' dynamics cause a rotation about the hinge, which is converted to electricity via a power take-off system.

Mocean Energy is undertaking a project funded by Wave Energy Scotland (WES) through its Novel WEC Programme to build and test at sea a 1/2-scale prototype of its M100 (i.e. 100 kW) WEC. The 1/2-scale prototype, which is to be tested is referred to as the **M100P**.

Testing is planned to be undertaken in an area to the East and offshore of Deerness, Orkney in 2020. The primary purpose of testing is to gather performance data and learnings from deployment of the device in order to inform further development of Mocean's Wave Energy Converter designs.

This Project Environmental Management Plan (PEMP) has been produced to support a Marine Licence application under Part 4, Section 54 of the Marine (Scotland) Act 2010 for this deployment.

Table 4 presents the results from the environmental assessment of the Project; a process which draws together, in a systematic way, an assessment of a project's likely significant environmental effects. This helps to ensure that the importance of the predicted effects, and the scope for reducing any adverse effects through mitigation, are fully understood by the public and the competent authority.

1.2 CONTENTS OF THE PEMP

The PEMP details the proposed mitigation, monitoring and management measures for all stages of the project including installation/construction, operation and maintenance (O&M) and decommissioning of the device.

Mocean Energy are committed to updating and improving this PEMP through consultation and as more data, information and experience is gathered. In addition, they are committed to working closely with stakeholders and other developers to ensure that all mitigation and monitoring activities are conducted in line with best practice and best available knowledge at all times. Mocean Energy will also strive to actively engage with other developers and stakeholders to address the key issues and uncertainties associated with wave energy development through targeted research initiatives.

2 CONSTRUCTION METHOD STATEMENT

2.1 PROJECT OVERVIEW

The following activities are proposed:

- Construction and installation;
- Operation and maintenance; and
- Decommissioning/final removal of all equipment.

2.2 PROJECT LOCATION

The M100P will be installed at a location to the east of Deerness, Orkney (see

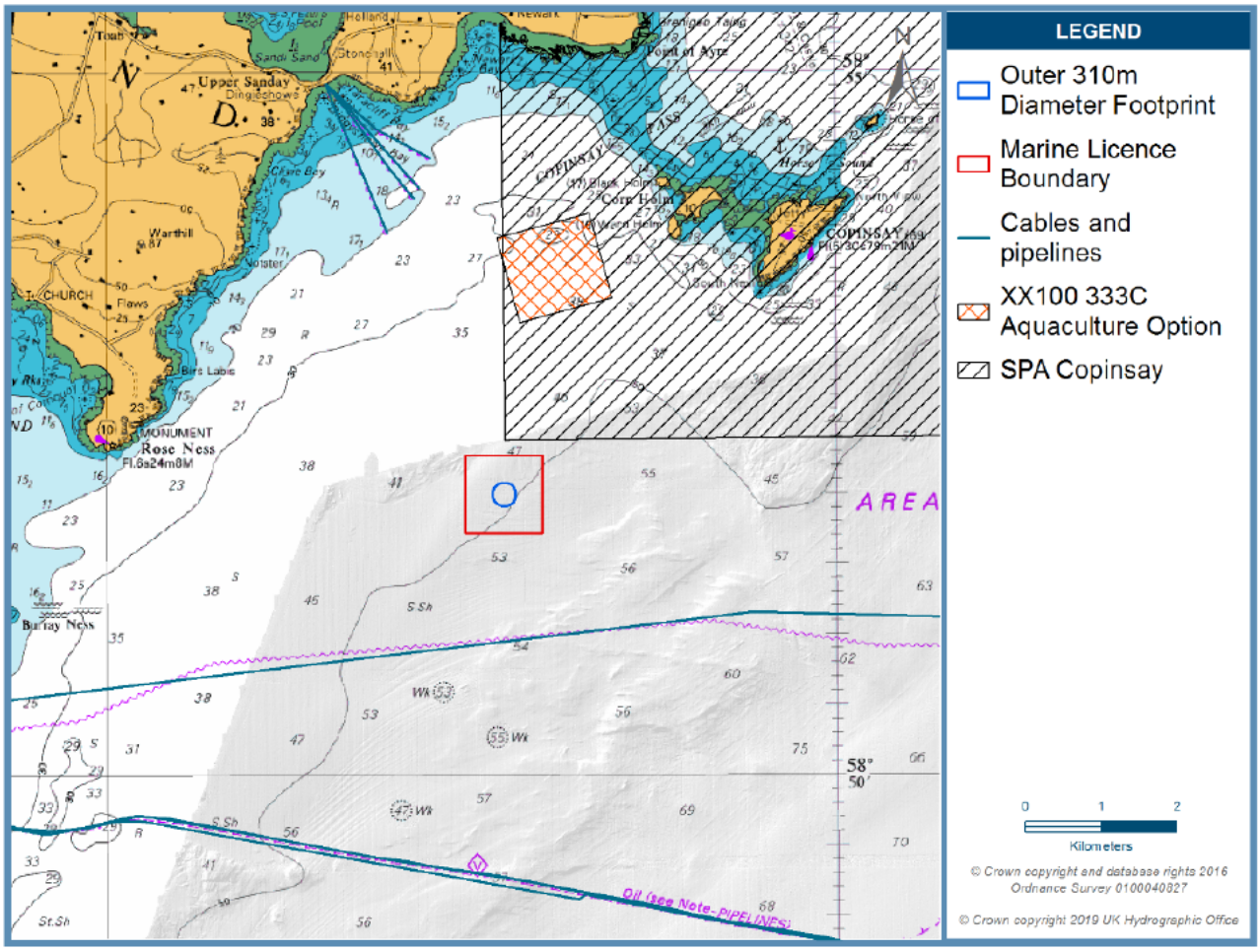

Figure 2-1). The licence boundary required for installation of the device is specified in Table 1. The precise location of the device and anchors (within the licence boundary provided) will be determined prior to anchor installation and will be confirmed (post-installation) with Marine Scotland Licensing Operations Team (MS-LOT) upon submission of the formal Table of Deposits (Form FEP5). This flexibility in the installation location is required to ensure that no obstructions exist in proximity of the anchoring locations on the seabed.

Table 1 Coordinates of licence boundary

Latitude	Longitude

Degrees	Decimal Min	Degrees	Decimal Min
58	52.266'N	2	45.085'W
58	51.716'N	2	45.089'W
58	51.714'N	2	44.028'W
58	52.264'N	2	44.024'W

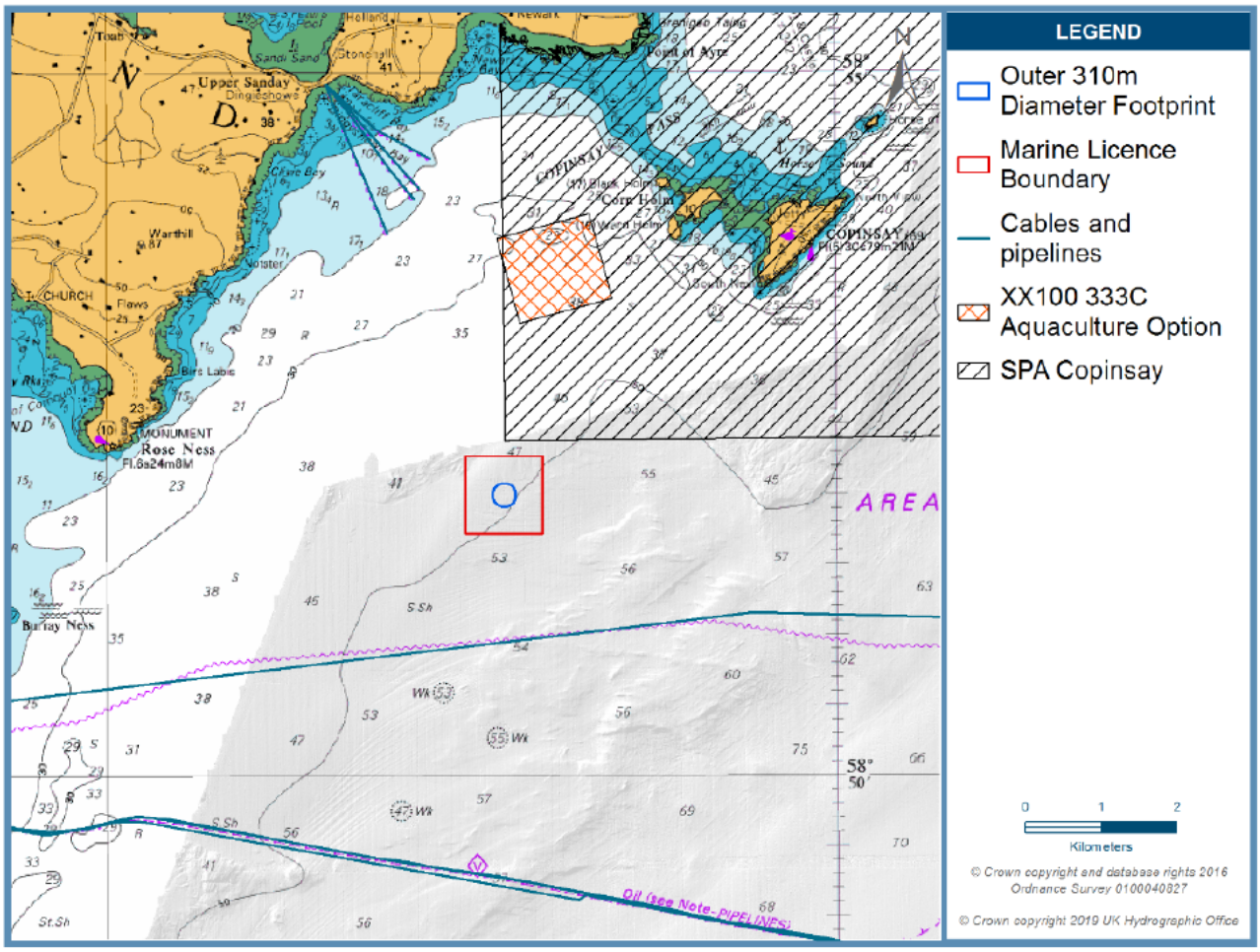

Figure 2-1 Proposed licence and deployment area at Test Site

2.3 PROJECT SCHEDULE, TIMINGS AND COMMENCEMENT DATES

The proposed installation, operations, maintenance and decommissioning schedule (indicative) for the Project is shown in Appendix A. The anticipated date of installation of the M100P and its associated mooring system is the beginning of April 2020. The operational period of the test is anticipated to last up to the end of September 2020. To allow some contingency in the programme, the marine licence application will cover the period until December 2020. Thereafter, all equipment will be completely removed from site.

At all times, onsite works will be subject to Mocean Energy's HSE Plan (NWEC3 R20) and Mocean Energy's Operations Plan (NWEC3 R21), which are managed by Mocean Energy to minimise any potential conflicts and maximise any opportunities that may arise.

2.4 TECHNICAL DESCRIPTION OF COMPONENTS

Hull Structure

The M100P consists of two yellow painted steel hulls connected at a hinge through a pair of steel hinge pins. The key dimensions of the machine are given in Table 2. Figure 2-2 shows a visualisation of the machine on the pier. Figure 2-3 shows a visualisation of the machine deployed at sea; however, the mooring lines are not shown here. Note that in both figures, the machine will be painted yellow. Figure 2-4 gives the general arrangement of the machine.

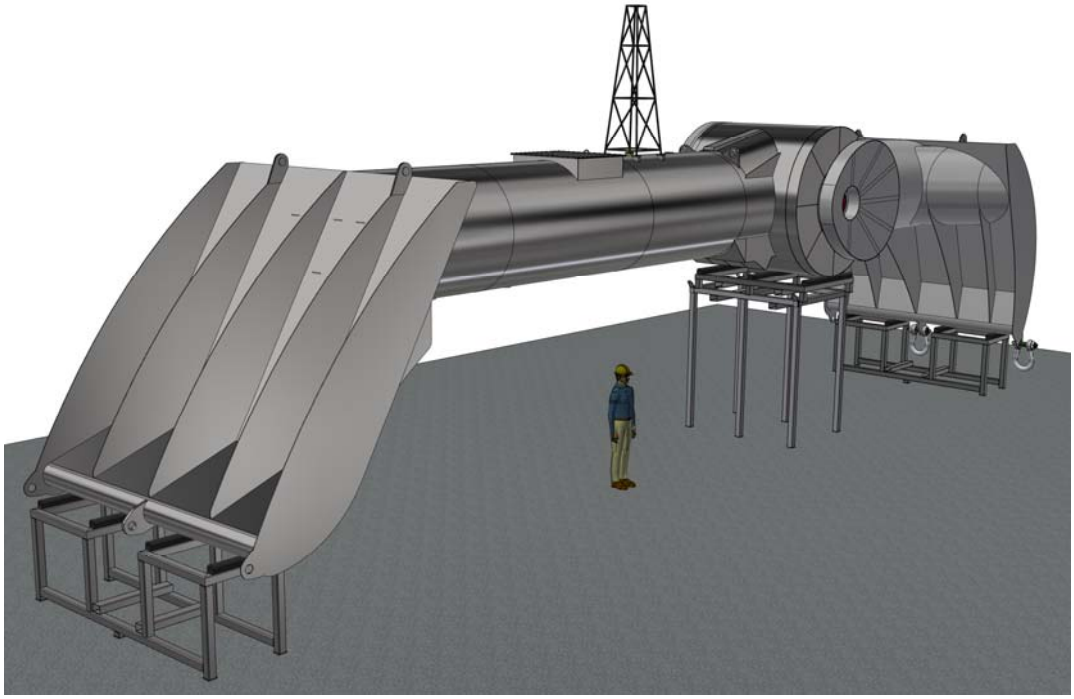

Figure 2-2 M100P visualisation on pier.

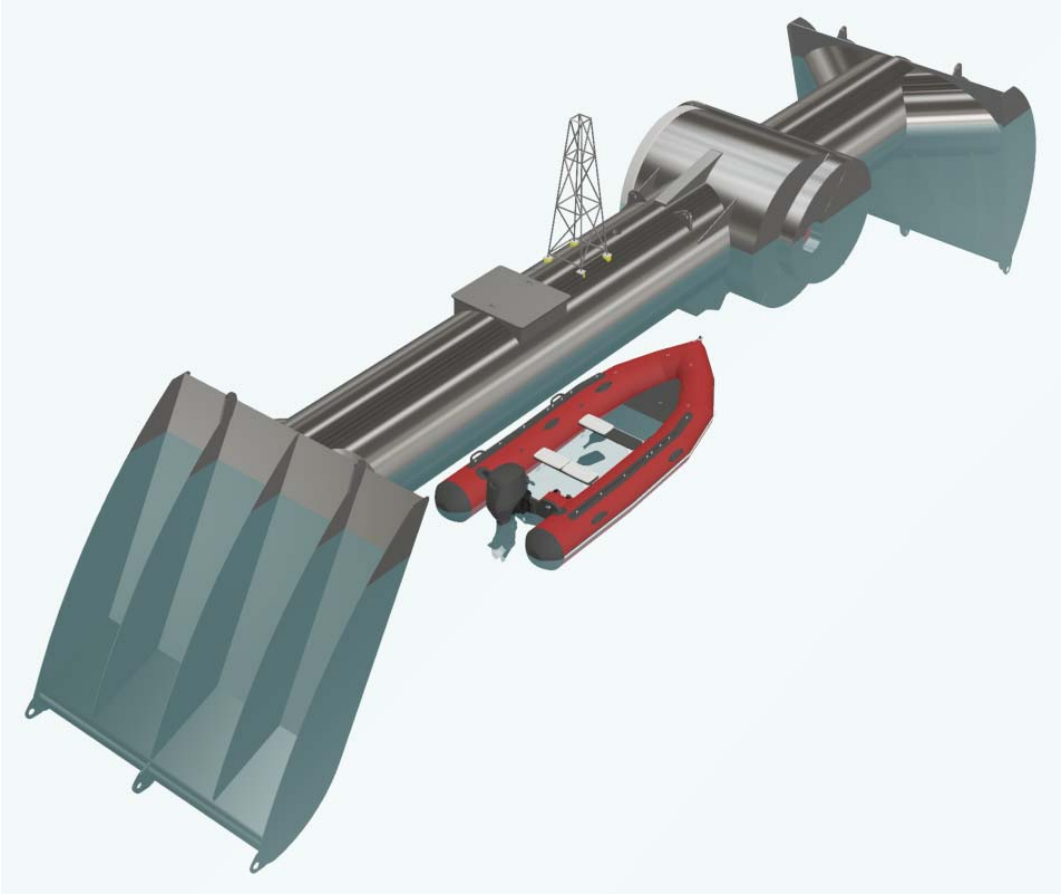

Figure 2-3 M100P visualisation as deployed at sea.

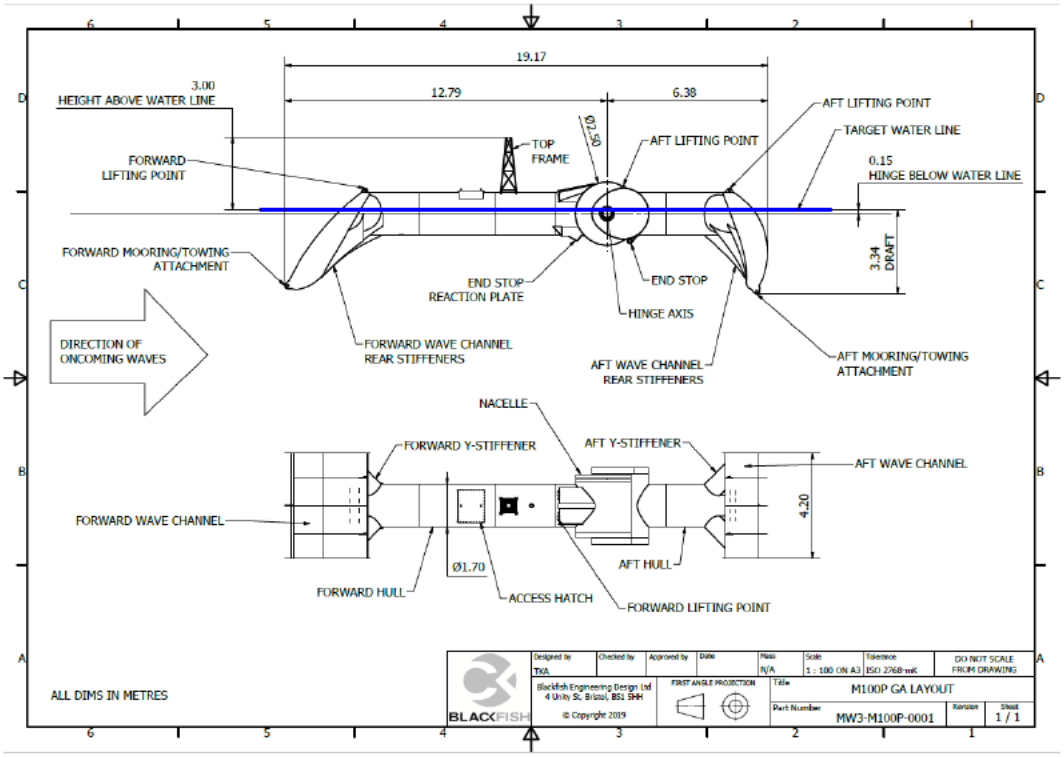

Figure 2-4 M100P Drawing with dimensions

Table 2 Key dimensions of the M100P

Dimension	Units	Value
Length overall	m	19.2
Beam	m	4.2
Draft	m	3.4
Mass	tonnes	31.5

Internal Systems

The rotation of the aft hull with respect to the forward hull drives a gearbox and then a generator. Power from the generator is then conditioned and used onboard the WEC to power local system. Power beyond that needed to power on-board systems is stored in 30 kWh of batteries. Once the batteries are fully charged, excess power is dissipated through an onboard dump resistor. Key onboard systems that use power include: the control, communications, cooling, instrumentation, and navigation lighting.

Moorings System Overview

Figure 2-5 shows the construction of the mooring system. The system is made of 2 mooring lines, the mooring attachment points on the 2 legs are attached to a 4m bridle at the forward mooring point on the WEC.

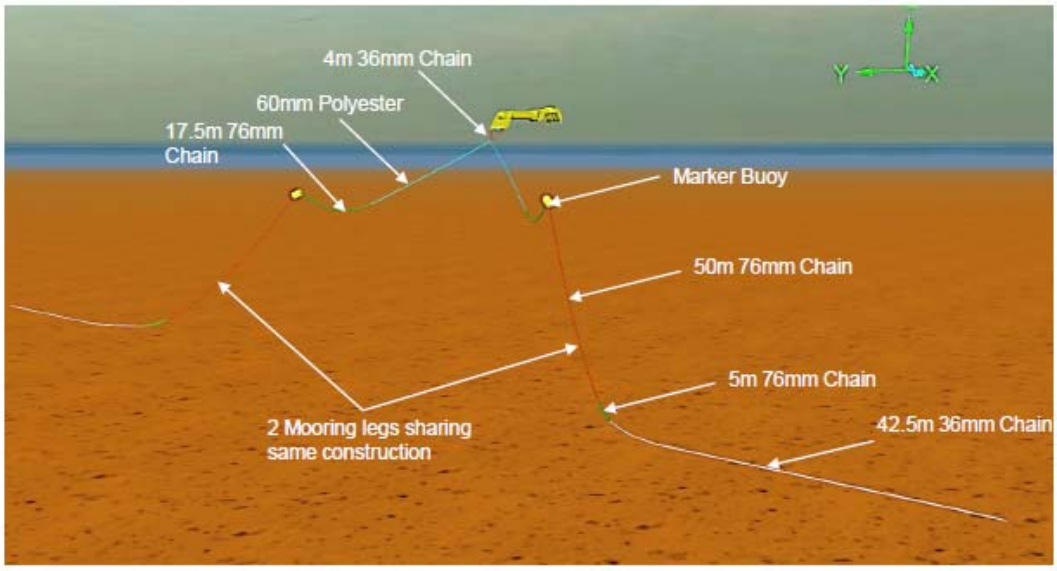

Figure 2-5 Mooring leg structure

The distance between the end points of the mooring legs is shown in Figure 2-6.

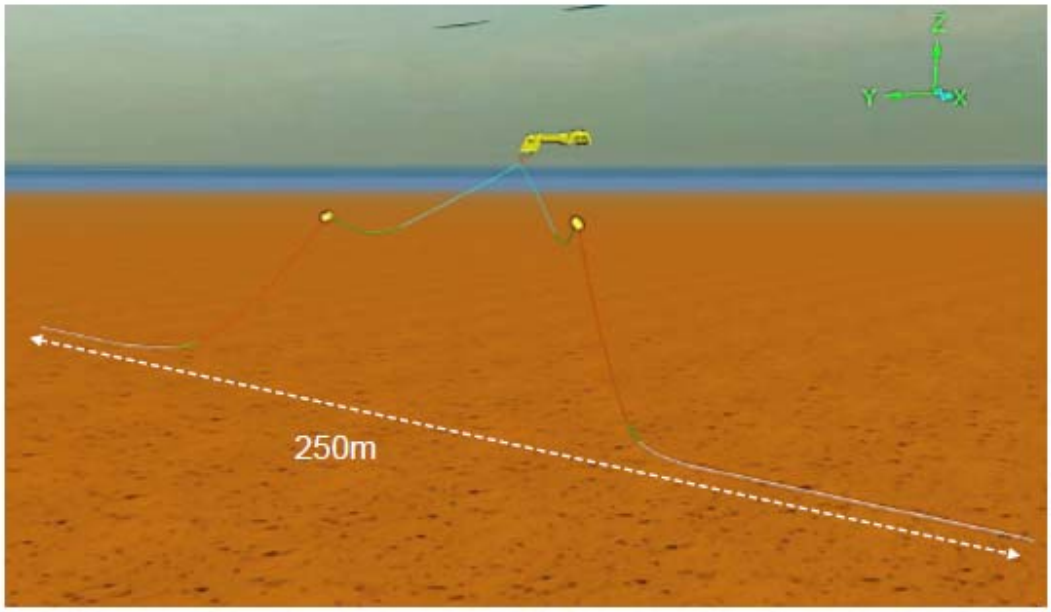

Figure 2-6 The WEC with Mooring Spread

The mooring footprint is represented in the schematic in Figure 2-7.

- The radius of the current mooring design, without contingency for design optimisation is 125m.
- The static position of the moorings is shown by the dashed blue line.
- The static point of the forward mooring point on the WEC is marked by the red cross.
- The dynamic excursion as a result of 6m Hs conditions is measured to be 75m from the static position of the device.
- The maximum 75m excursion is likely to be from East to West, with less excursion from West to East.
- The marker buoys are 45m along the mooring line from the forward mooring attachment point on the WEC.

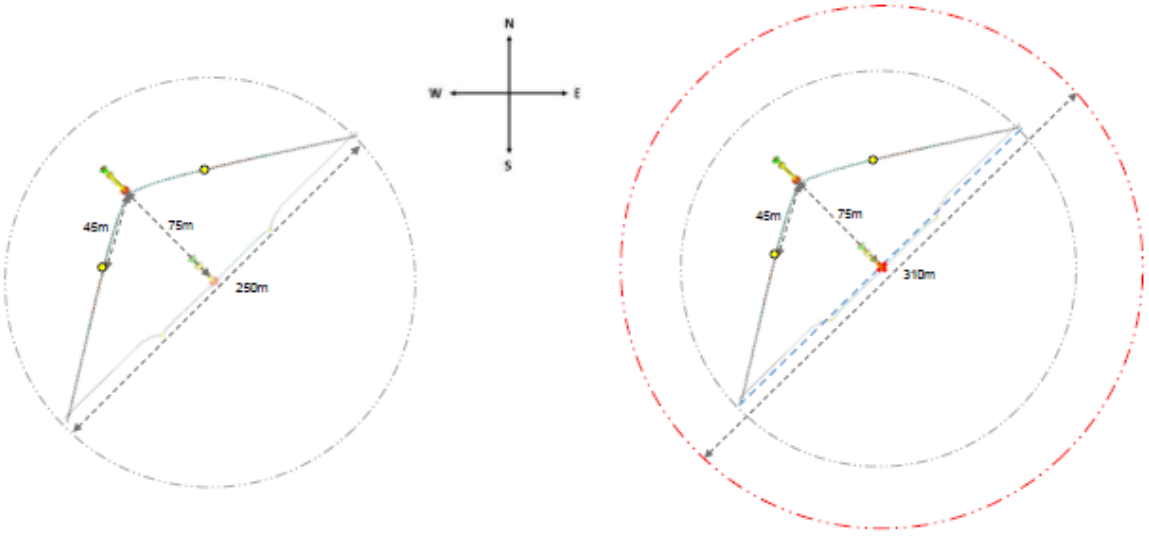

Figure 2-7 Mooring footprint (left), with allowance (right)

The design may be subject to further optimisation in advance of deployment. Therefore, an allowance of 30 m on each mooring leg is presented as this allows for minor changes that may occur during detailed design. This results in an increased radius of the mooring spread to 155 m (310 m diameter).

Depending on the seabed conditions, the anchors will be either drag embedment anchors or gravity-based foundations. No drilling will be required for their installation.

When the M100P is not connected to the mooring system (i.e. prior to installation or during maintenance), the mooring system will be held in place by a surface buoy.

Umbilical

Depending upon further funding which has not yet been confirmed, there is potential to add an umbilical to the WEC part way through the testing programme in 2020, in order to demonstrate the potential to power a temporary piece of equipment placed on the seabed (e.g. a remotely operated vehicle docking station and/or a battery) as proof of concept. This would not provide power to shore and hence would not be grid connected. The umbilical would be integrated with the mooring and would not involve excursion of any equipment outside of the consented area.

Ancillary Scientific Equipment

In addition to the WEC, a Wave Rider (or similar) measurement buoy, including its own mooring and anchor, will be anchored in the vicinity of the WEC within the licence boundary to measure metocean conditions.

2.5 OPERATIONAL PLANS AND METHODOLOGIES

2.5.1 Construction and installation

The vessel spread required for installation is shown in Table 3. Further details of the vessels likely to be used for the deployment are provided in the Vessel Management Plan in Appendix B.

Table 3 Vessels utilised for installation

Vessel Type	Task
Multi Cat (x1)	Anchor and Mooring installation/removal. Device installation and removal. At-sea battery charging and power demonstration.
Rigid Hulled Inflatable Boat (RHIB) (x1)	At-sea visual inspection. Wave Rider installation and removal.

Figure 2-8 Example vessel of Multi Cat

Figure 2-9 Example vessel of RHIB

Mooring installation

The proposed mooring installation phases are described below:

- preliminary phase: anchor and ground chain installation
- deployment phase: The device is towed to site and final mooring arrangements and hook-up are made.

It is good practice to decouple where possible the installation of anchors from loadout, and this normally helps de-risk the project in terms of weather exposure.

Depending on the seabed conditions, the anchors will be either drag embedment anchors or gravity-based foundations. The preferred anchor solution is conventional drag embedment anchors, which have very high holding to weight ratio when deployed in suitable stable sediments.

It is proposed that the anchors and ground chain will be installed before the device and buoyed off for easy pick up. The synthetic mooring lines will either be installed the day before the platform load-out or on the day. Mooring design guidance states that synthetic lines should only be left on the seabed for temporary phases due to the perceived risk of sediment ingress which can cause internal abrasion. In reality modern ropes are well protected.

Prior to device installation and while the device is at quayside for maintenance, the mooring system will remain deployed and buoyed off to a surface buoy.

Device installation

It is anticipated that the installation of the anchors will be completed in 1 day and connecting the M100P will be completed within 1 day. It is expected that the he M100P device can be installed in conditions of Hs < 1.5m.

Assuming the Nylon ropes are pre- installed with anchors and left onsite while waiting for the WEC installation, the following installation process is proposed. This will be confirmed with the nominated marine installation contractor.

a. The WEC is towed onsite with pennants[1] on
b. The mooring ropes are retrieved from surface buoys
c. The mooring ropes are connected to preinstalled pennants on WEC
d. The WEC is pulled towards the last anchor to connect the last mooring line and provide pretension to the system

2.5.2 Device testing

The device testing will consist of running the machine under normal operating conditions at the deployment site, collecting data with onboard instrumentation, logging that data, and sending some of it back to a control centre on shore via wireless signals. Onboard instrumentation will measure parameters needed to assess power absorption, engineering quantities like loads, and to monitor the health of the machine.

[1] The mooring pennant is a short length of line that forms part of the mooring system near the WEC.

2.5.3 Maintenance

The device has been designed so that regular maintenance is not required. However, because it is a prototype, it is anticipated that during performance testing, maintenance and inspection will be performed approximately every 2 weeks. Additional unplanned maintenance may also be necessary.

Maintenance activities will take place across three different locations, depending upon nature and duration of the activity:

- **On Station:** As much routine and responsive maintenance as possible will take place at the proposed mooring location.
- **Sheltered Mooring:** There is a designated sheltered mooring location nearby in Holm Sound where the device will be moored temporarily where a sheltered sea state is required for specific maintenance activities.
- **Hatston Quay:** For maintenance activity requiring the device to be lifted out of the water, Hatston Quay in Kirkwall will be used.

We estimate that maintenance activity will be required every two weeks.

2.5.4 Monitoring

During deployment, the device will be monitored 24/7 by the Mocean Team using the Graphic User Interface ("GUI") and its related alarms. In addition to the GUI, the device will also include an AIS transponder which can be monitored in case of communications failure with the device. An emergency response plan will be in place which will identify contacts, contractors, process and procedures for responding to any unplanned excursion of the device.

2.5.5 Decommissioning

Decommissioning will involve the removal of the M100P and all associated equipment. This will be a reverse of the installation procedures outlined in Section 2.5.1. The device is planned to be removed from site by a Multi Cat vessel in 1 day, and its mooring lines and anchors, and the Wave Rider buoy are planned to be removed from site by a Multi Cat vessel in a further 1 day.

3 ENVIRONMENTAL ASSESSMENT & MONITORING

3.1 MITIGATION, MONITORING AND MANAGEMENT MEASURES IN RELATION TO POTENTIAL ENVIRONMENTAL EFFECTS

The environmental assessment involves the evaluation and prediction of the magnitude of impact of the Project on the existing environment. Spatial extent, scale (size, amount, volume and intensity), duration, frequency and timing, reversibility and sensitivity of receptors, are all factors for consideration of the magnitude of impact. Professional expert judgement is used to determine the likely significance of effects. The approach taken isin line with industry guidelines or other established approaches.

The assessment of potential residual impacts and proposed mitigation/monitoring measures are outlined and described within the context of the proposals in Table 4.

Table 4 Residual impacts and mitigation/monitoring measures

Potential residual impact	Receptor	Assessment	Proposed mitigation and monitoring measure(s) and reporting
All phases including construction and installation, operation and maintenance and decommissioning			
Disturbance from support vessel activity – vessel noise and presence	Cetaceans Seals Basking sharks Marine birds (seaducks, divers)	The M100P and its moorings and anchors will be installed using one standard multi-cat work vessel, assisted by a RHIB. Installation activities will be completed over two days. Maintenance and inspection will be performed approximately every two weeks throughout testing. It is possible that unplanned onsite maintenance will occur. There is one designated seal haul-out in the wider vicinity of the Test Site at the island of Copinsay (see Appendix figure B.3). The Vessel Management Plan will include measures to ensure a minimum approach distance is adhered to when passing designated seal haul-outs. No significant effects on any sensitive species are expected from this low level of vessel activity.	**Adherence to SMWWC** Relevant measures from the Scottish Marine Wildlife Watching Code (SMWWC) (SNH, 2017) will be implemented by Mocean Energy and all marine contractors. These will include: • Speed will be reduced to 6 knots when any marine mammals or birds are sighted within or near to transit routes, where consistent with crew and navigational safety and the completion of constrained operations. • A steady speed and course will be maintained where possible if a marine mammal approaches a project vessel. • Care will be taken to avoid splitting up groups and mothers and young. • Minimum approach distances (as stated in the SMWWC) for vessels on approach to marine mammals and birds will be adhered to, although this may be varied according to species and circumstance. Specifics will be agreed with SNH and listed in the CEMD and implemented. • Sudden unpredictable changes in speed, direction and engine noise will be avoided to avoid disturbance to any marine mammals in the vicinity. • Rafts of birds will not be intentionally broken up or flushed. • During the seabird breeding season (April to August inclusive) vessel transit corridors will be at least 50 m from shore in the vicinity of cliff-nesting seabirds to avoid disturbance. **Vessel Management Plan** A Vessel Management Plan has been developed which will be implemented to help ensure a minimum approach distance is adhered to when passing designated seal haul-outs (refer to draft VMP in Appendix B). **Reporting** The Vessel Management Plan will be maintained throughout the project. Any changes will be agreed in advance with Marine Scotland.

Potential residual impact	Receptor	Assessment	Proposed mitigation and monitoring measure(s) and reporting
Introduction of marine non-native species (MNNS) (via vessels, devices or other equipment)		The WEC will be assembled in Cowdenbeath in Fife, prior to transportation to Kirkwall via road. The WEC will be towed from Hatston Pier to the site for final deployment using a local operator in Orkney. Therefore, there is no potential for the introduction of MNNS via vessels used to tow the devices and from the device itself.	No specific mitigation is proposed in relation to this impact during the deployment and operation of the M100P WEC.
Habitat creation and Fish Aggregation Device (FAD) effects due to introduction of new structures	Benthic species and habitats Fish and shellfish (gadoids and crustaceans)	It is likely that fish will aggregate around the M100P WEC device. No significant effects are anticipated from the deployment of a single hinged raft WEC device of this type.	No specific mitigation is proposed in relation to this impact during the deployment and operation of the M100P WEC.
Construction and installation			
Seabed disturbance from installation of the mooring system.	Benthic species and habitats Demersal fish and shellfish	During installation of the mooring system there is potential for minimal disturbance to seabed habitat and to benthic species including demersal fish and shellfish. No drilling is proposed with respect to the mooring system installation therefore potential disturbance is considered to be highly localised and temporary. A benthic survey carried out in September 2019 confirmed that the deployment area is consistent with a previous survey conducted by SNH, which reported the presence of SS.SSa.CFiSa to the east of Holm Sound, where there were few signs of infaunal life and a sparse epifaunal	No specific mitigation is proposed in relation to this impact during the deployment and operation of the M100P WEC.

Potential residual impact	Receptor	Assessment	Proposed mitigation and monitoring measure(s) and reporting
		community mainly composed of widely scattered echinoderms. Where there was hard rock substrates observed in the study, a low-diversity encrusting community of serpulid worms, bryozoans, coralline algae and E. esculentus were found and therefore the rocky habitat was assigned to the CR.MCR.EcCr.FaAlCr biotope.	
Underwater noise from mooring system installation leading to disturbance	Cetaceans Seals Basking sharks	The preferred mooring solution is drag embedment anchors or gravity-based foundations therefore no drilling is required.	No specific mitigation is proposed in relation to this impact during the deployment and operation of the M100P WEC.
Operation and maintenance			
Displacement of marine mammals, basking sharks and seabirds due to the presence of the array	Marine mammals, basking shark and seabirds	The introduction of new structures into the environment has the potential to displace marine mammals, basking sharks and seabirds from the immediate surrounding area. The presence and operation of a single M100P WEC and its associated anchors and moorings with an overall footprint of 0.05 Km^2 is highly unlikely to adversely affect marine through mammals, basking shark and seabirds which will still be able to inhabit and pass the area.	No specific mitigation is proposed in relation to this impact during the deployment and operation of the M100P WEC.
Underwater noise from WEC operation leading to disturbance	Cetaceans Seals Basking sharks	There is no risk of injury or death from underwater noise generated by a single operating WEC.	No specific mitigation or monitoring is proposed in relation to this impact during the deployment and operation of the M100P WEC.

		No anticipated significant impacts are expected from the M100P WEC.	
Entanglement in mooring lines or cables leading to injury or death	Cetaceans Basking shark	A study commissioned by Scottish Natural Heritage (SNH) concluded that moorings associated with marine renewable energy devices are unlikely to pose a major threat in terms of entanglement risk to cetaceans and basking sharks due to the size and mass of the moorings. However, there is a greater risk for large baleen whales[2] due to their large size and foraging habits (Benjamins *et al*. 2014). There is a very low likelihood of occurrence of large baleen whale species at the site with humpback whale a very occasional visitor to Orkney waters (Evans eta l, 2010) The presence of a single WEC and associated 2 taut nylon mooring lines, covering a small footprint (0.05 Km²) is not anticipated to result in any significant entanglement risk for large baleen whale species.	No specific mitigation or monitoring is proposed in relation to this impact during the deployment and operation of the M100P WEC. **Reporting** Any notable events will be recorded and reported to Marine Scotland no later than 24 hours after observation.
Presence of WEC and associated infrastructure leading to barrier effects	Cetaceans Seals Basking sharks	The presence of a single M100P WEC and associated infrastructure is not expected to result in any significant barrier effects for marine mammals or basking sharks.	No specific mitigation or monitoring is proposed in relation to this impact.
Changes to hydrodynamics and sediment regime	Hydrodynamic and physical processes	The presence of a single M100P WEC and associated infrastructure is not expected to result in any significant changes to hydrodynamics and sediment regime.	No specific mitigation or monitoring is proposed in relation to this impact.

[2] Such as the fin whale *Balaenoptera physalus*, or humpback whale *Megaptera novaeangliae.*

Electromagnetic Field (EMF) effects	Diadromous fish, gadoids and elasmobranchs	EMF effects are not expected to be a significant issue for the M100P WEC as there is no umbilical connection from the device to shore and therefore there are no significant length of electrical cables associated with the device.	No specific mitigation or monitoring is proposed in relation to this impact.

4 REFERENCES

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5 APPENDICES

APPENDIX A APPENDIX A: PROJECT PROGRAMME

Activity	Project Week																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Mooring Installation	X																																
Device Installation		X																															
Testing		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								
Maintenance – On Station				X				X				X				X				X				X									
Maintenance – Sheltered Mooring						X								X								X											
Maintenance – Hatston Quay										X								X															
Device & Mooring Removal																										X							
Contingency																										X	X	X	X	X	X	X	X

APPENDIX B VESSEL MANAGEMENT PLAN (VMP)

B.1 INTRODUCTION

This VMP details the anticipated type and number of vessels that will be used during the construction and installation, maintenance and decommissioning of the M100P at the Test Site. It also highlights the likely ports and transit routes that will be used during all phases of the deployment.

B.2 VESSEL DETAILS

The selection and contracting of vessels is primarily driven by market conditions, vessel availability and ultimately, cost. Therefore, the actual vessels will be selected near to the time of works. The developer will confirm the project vessel spread at the earliest possible opportunity prior to works commencing as required (as per normal maintenance activities). The vessels presented in the following figures and Appendix Table B.1 are indicative of the vessels likely to be used.

Appendix Figure B.1 Example Multi Cat vessel

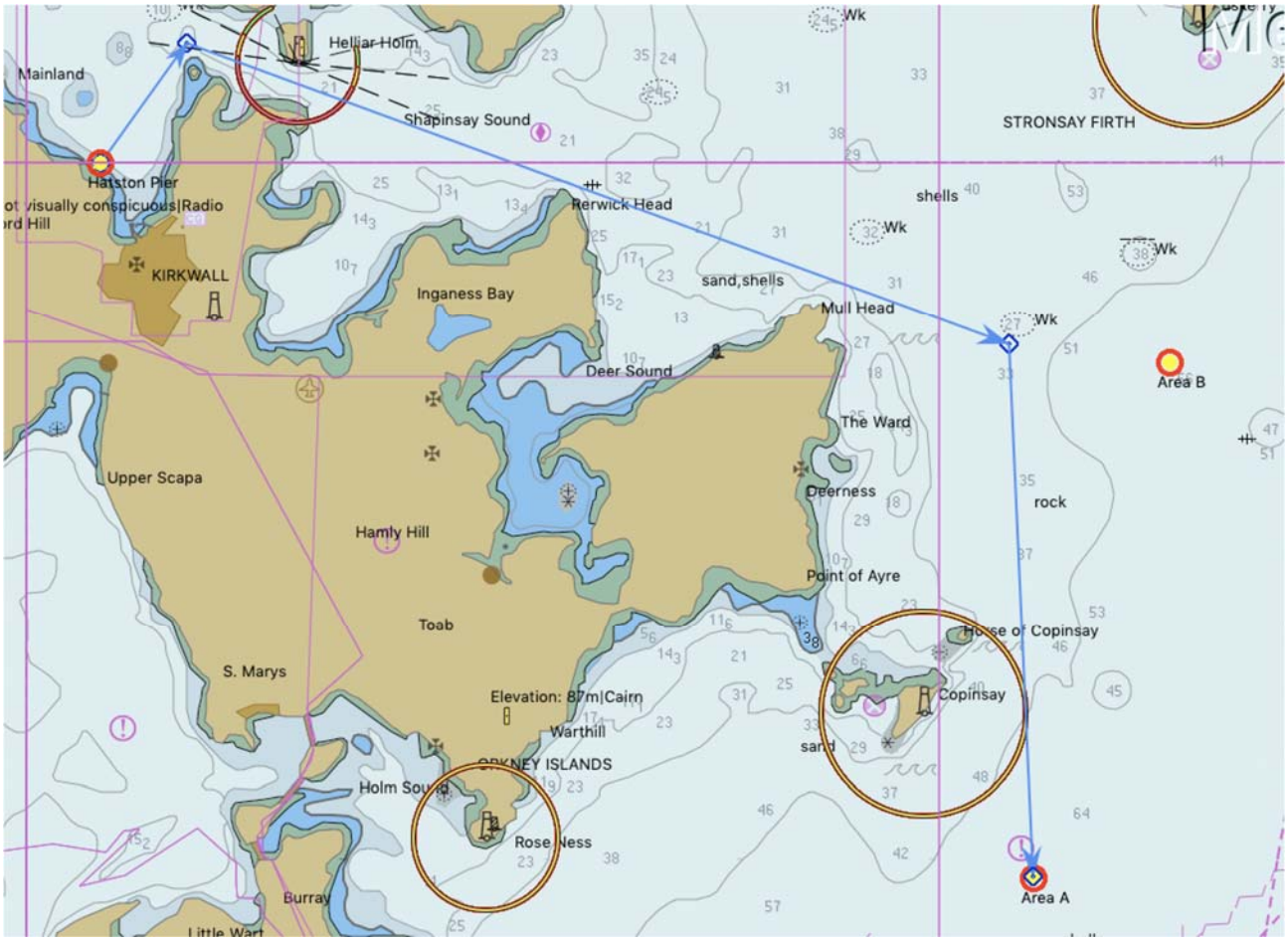
Appendix Figure B.2 Example Rib vessel

Appendix Table B.1 Vessel information (FOR MAIN VESSELS ONLY)

	MV C-FENNA	MV C-ODYSSEY	GREEN ISLE
Flag state	UK	UK	UK
Port	Kirkwall	Kirkwall	Stromness
Year of build	2013	2011	2015
Type	Neptune Eurocarrier 2611	Multiworker Twenty6	Damen
Length	26.5 m	26 m	27.7 m
Beam O.A.	11 m	10.5 m	12.5 m
Draught	2.6 m	2.5 m	2.9 m

B.3 VESSEL ROUTES

Indicative vessel transit routes between Hatston Pier and the test site are presented in Appendix figure B.3. The same route will be used for all phases of the deployment. Vessels will as far as possible avoid passing within 500m of any identified seal haul-out site when in transit. Seal haul-outs with a 500m buffer and suggested vessel routes in close proximity to the test site are provided in Appendix figure B.3.



Appendix figure B.3 Transit Routes

A designated Marine Operations Manager/Marine Superintendent is responsible for the discharge of relevant licence conditions whilst at sea. This will be Mocean Energy's Operations Manager, Yan Gunawardena.

APPENDIX C NAVIGATION AND LIGHTING PLAN

The proposed navigation and lighting arrangements are as follows:

1. Main WEC structure above waterline painted yellow
2. A mast or similar structure to be fixed to the WEC. At the top of the mast at a minimum height above waterline of 3.0 metres, a yellow flashing light with a characteristic of: Flash 1 every 5 seconds with a visibility of 3 miles
3. A passive radar reflector to be fixed on the mast
4. Close to the top of the mast below the light to be fitted with a yellow “St Andrews” cross special mark. The bars of the cross should be at least 75 cm long x 15 cm wide
5. An AIS transmitter appropriate for an AtoN (Aid to Navigation)

Note that there may be a requirement from the regulator for additional buoyage in the form of Cardinal marks and/or Special marks to mark the surrounding area.

Navigation warnings and communications plan

Navigation warnings will be communicated through Notices to Mariners (NtoM) to inform mariners of circumstances which affect the safety of navigation. It is the responsibility of the developer (Mocean Energy) to ensure that Notices to Mariners are issued. NtoM’s will be disseminated as widely as possible and should include at least the following recipients:

- UK Hydrographic Office
- Maritime and Coastguard Agency (MCA) through the local MRCC (Shetland)
- Northern Lighthouse Board (NLB)
- Kingfisher Fortnightly
- Orkney Islands Council Harbour Authority
- RYA
- Orkney Fisheries Association
- Orkney Fishermen’s Society
- Scottish Fisheries Federation

Notice to Mariners must be issued well in advance of any operations being undertaken to allow promulgation through the appropriate channels, and for the marine installation phase the NtoM may be required to be published in the local newspaper for at least two weeks prior to installation.

The NtoM should contain the following information:

- Details of works program including period & purpose
- Duration and start and stop dates
- Positions of maximum extent of projected works
- Details of lights, buoys and other navigational aids
- Proposed routes of vessels involved in installation (from port to site)
- Changes to existing routing measures/vessel movement
- Details of any areas to be avoided
- Vessels not involved in works with the device should avoid the area.
- Proposed positions of devices and other associated features on completion of works
- Instructions to vessels

- That vessels involved in the works will keep a listening watch on VHF Channel 16

The NtoM will be specific and kept concise bearing in mind that the information will be broadcast on radio by the local Harbour Authority.

NtoM's will be issued 14 days prior to the commencement of marine works. Once the installation is completed then the NtoM will be cancelled and an amended NtoM will be issued simultaneously to cover the operating period. Any further significant changes which may affect navigation will be dealt with by cancelling and re-issuing a NtoM such as the decommissioning phase. On completion of decommissioning and the site is cleared the NtoM will be cancelled.

APPENDIX D COMMITMENTS TABLE/REGISTER

Appendix Table B.2 Commitments Register

Ref	Issue	Commitment or action	Responsibility	Timescales	Status

APPENDIX E RELEVANT MARINE LICENCE CONDITIONS

TO BE COMPLETED FOLLOWING ISSUE OF LICENCE