Device-specific Navigational Risk Assessment: C-GEN Floating Tidal Energy Convertor at Warrior Way

Version	Date	Description	Originated by	Reviewed by	Approved by
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Introduction

META has undertaken a META Sitewide Navigational Risk Assessment which covers the META Phase 2 (Open Water) test areas (Warrior Way; Dale Roads; and East Pickard Bay) and considers the full range of device types and activities consented in the META Phase 2 project design envelope.

In addition to this the META Phase 2 Marine Licence ORML1957v2 consent conditions require that:

"The Licence Holder must submit a device-specific Navigational Risk Assessment (NRA) for written approval at least 8 weeks prior to any deployment operation. This NRA must propose appropriate device-specific risk controls. No deployment may be undertaken prior to written agreement from the Licensing Authority.

The Licence Holder must ensure that any actions outlined in the Navigational Risk Assessment are implemented as approved in writing by the Licensing Authority. Any proposed changes to the actions outlined in the documents must be submitted to, and agreed in writing by the Licensing Authority prior to any changes being enacted."

The purpose of this document is to identify navigational risk associated with the C-GEN floating tidal energy convertor deployment at the META Warrior site and outline appropriate measures that will be implemented to manage risk.

Device and project description

1. Overview

META would like to deploy the device described below at the **META Warrior Way site from 1st June 2025 to the 31st August 2025.**

The device comprises of an electrical generator designed by C-GEN Engineering, that is integrated with a micro horizontal axis tidal turbine (3m diameter) designed by Swansea University and mounted on a test barge (Figure 1) provided by Rudders Boatyard. This turbine mounted on this barge was extensively tested at Warrior Way in 2023 and 2024. The novel addition to this proposed deployment is the C-GEN electrical generator. This 800mm diameter generator is fully sealed and will be mounted directly on the end of the turbine shaft. A cable dragchain will carry the power and sensor cables from the generator to the power conversion panel on board the barge. Power will be stored in the 48Vdc battery loadbank and any excess will be dumped to a resistive load. The blade will be fully submerged at all times with a minimum clearance of 2m from the sea surface.

Figure 1 Test barge (10m x 6m).

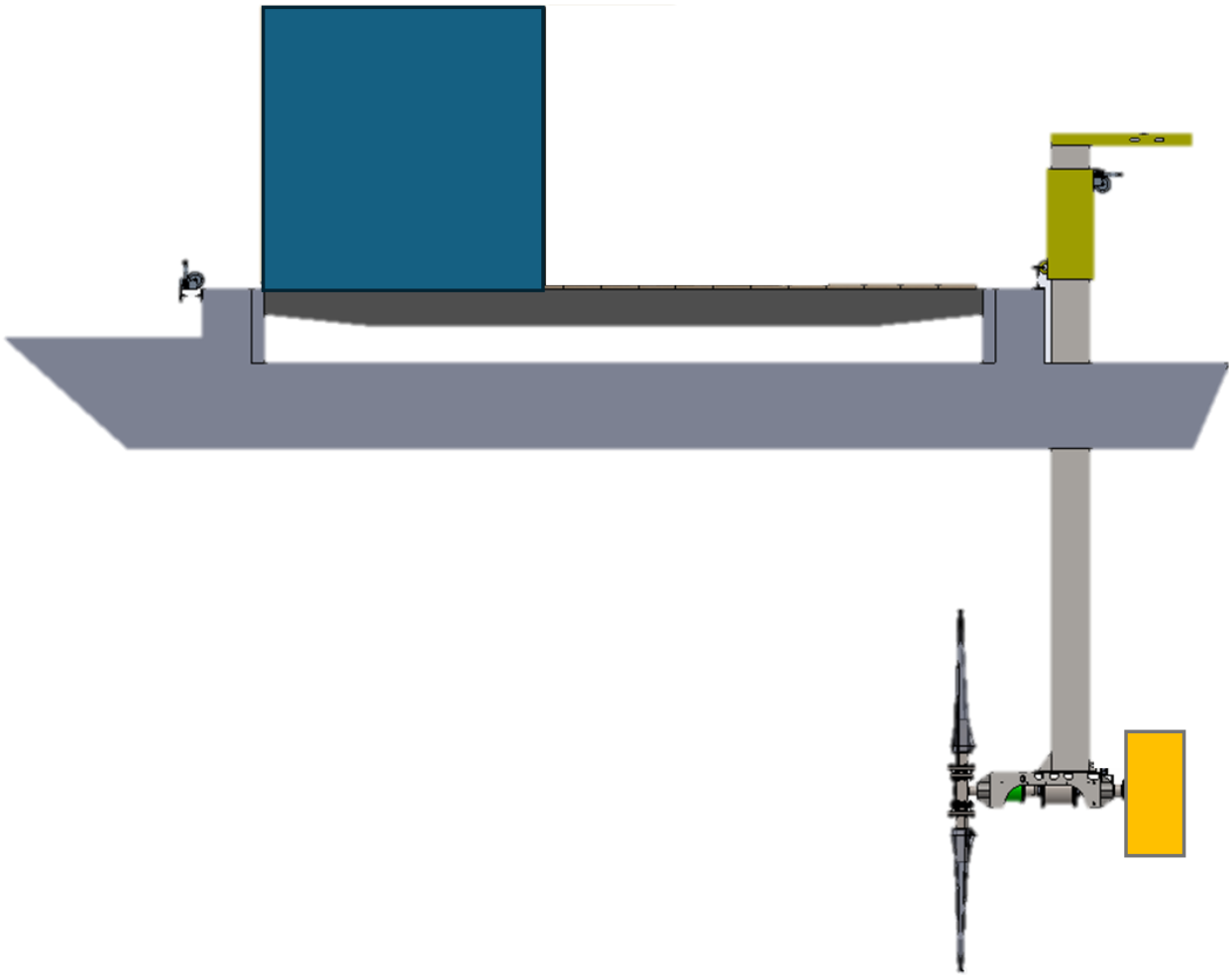

Figure 2 Device in operational position

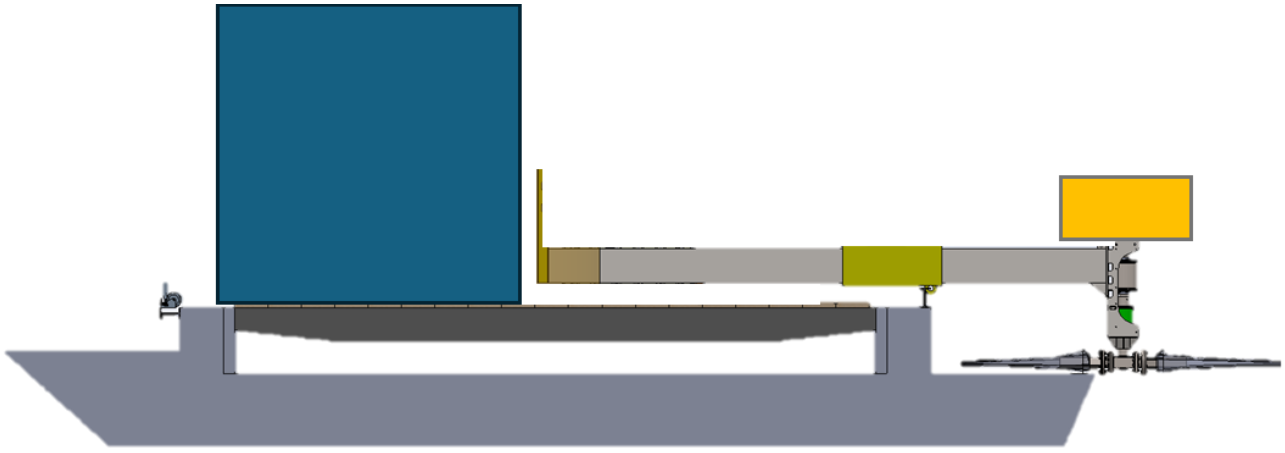

Figure 3 Device in towing position

2. Mooring arrangement

The floating platform is moored in position with a swinging mooring using two 2.5tn gravity anchors 10m apart perpendicular to the flow, each with ground chain and octoplait rope risers, attached to a large swivel and hard-shell buoy, to which the floating platform is then tethered to using a bridle. This mooring arrangement will allow the floating platform to align with the flow on both the flood and ebb tide. The drawing below illustrates the full system (Figure 4). This mooring system proved successful to moor the same test barge in this location at Warrior Way in February 2025 to support the Porpoise Power test programme.

1. Gravity anchor
2. Chain
3. Mooring Line
4. Swivel connector – swinging mooring
5. Test barge with turbine attached
6. Tidal turbine and generator (enclosed yellow box)

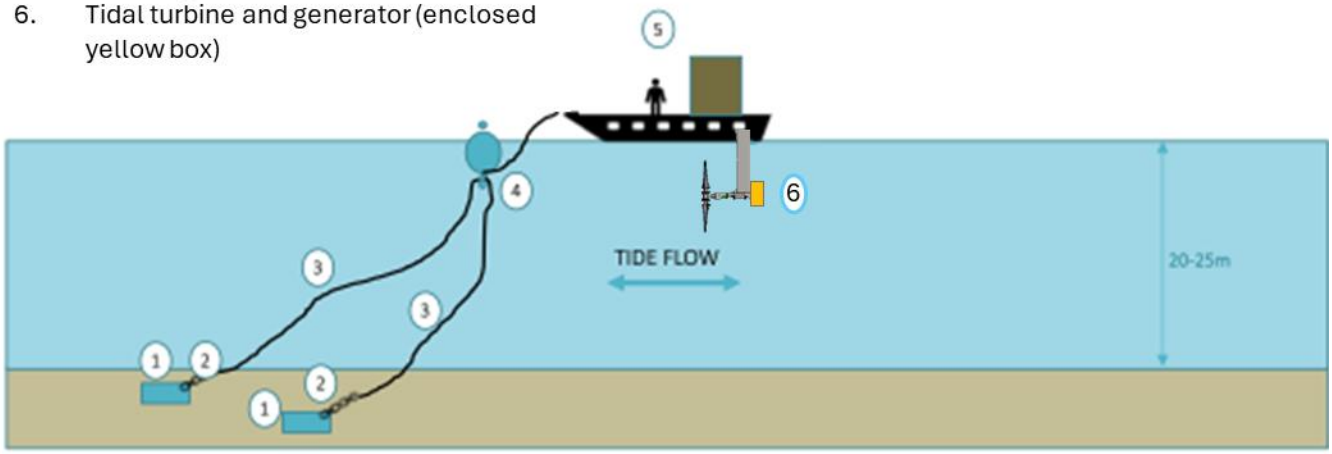

Figure 4 Illustration of full system not to scale.

3. Key locations

The device moorings are to be located at the following co-ordinates:

Table 1 Device and mooring positions

	Latitude:	Longitude:
Device mooring position	**51° 42.222' N**	**4° 55.61' W**

The device will be deployed on a swinging mooring therefore the device will move upstream and downstream of the mooring depending on whether the tide is coming in or out. This mooring design has been chosen so the device always aligns with the current direction and so it can operate during both an incoming and outgoing tide.

For the proposed swinging mooring arrangement, the maximum swing radius from the central mooring position (51° 42.222' N 4° 55.61' W) to the end of the device will be 43m (Figure 4). This is the worst-case scenario for a LWS (Low Water Spring) when there is the most slack in the mooring lines. The

device will only be swinging during slack water as the tide turns. Once the tide turns the device will find a settled position either upstream or downstream of the mooring depending which way the tide is flowing. The two mooring blocks will be positioned around 10m apart perpendicular to the tide to minimise lateral movement in relation to the tidal flow direction so the swing radius across the channel will actually be less than the worst-case scenario.

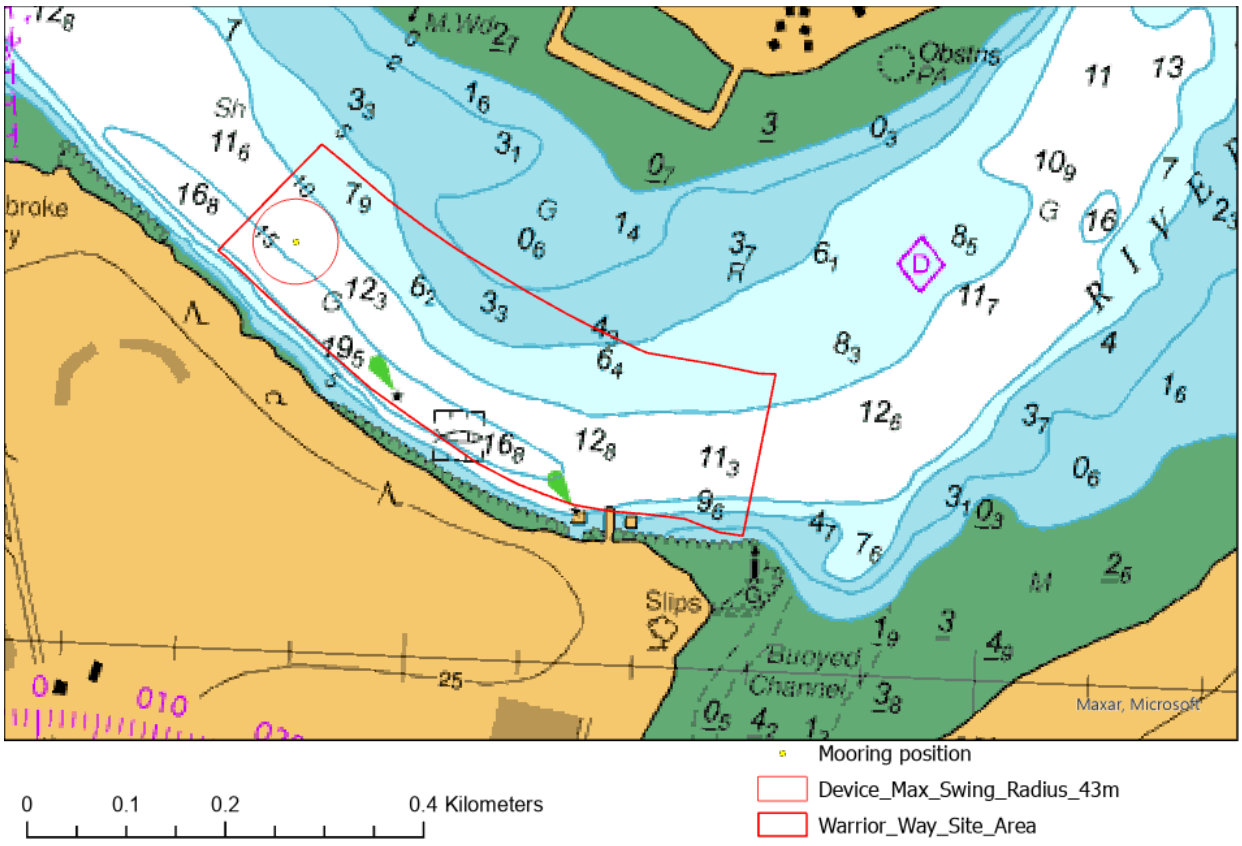

Figure 4 Device position and worst-case scenario (LWS) swing radius of the swinging mooring.

Rudders Boatyard will be the vessel contractor. The chart below shows the tow route that will be taken from where the device is launched at Rudders Boatyard to the mooring location (Figure 5).

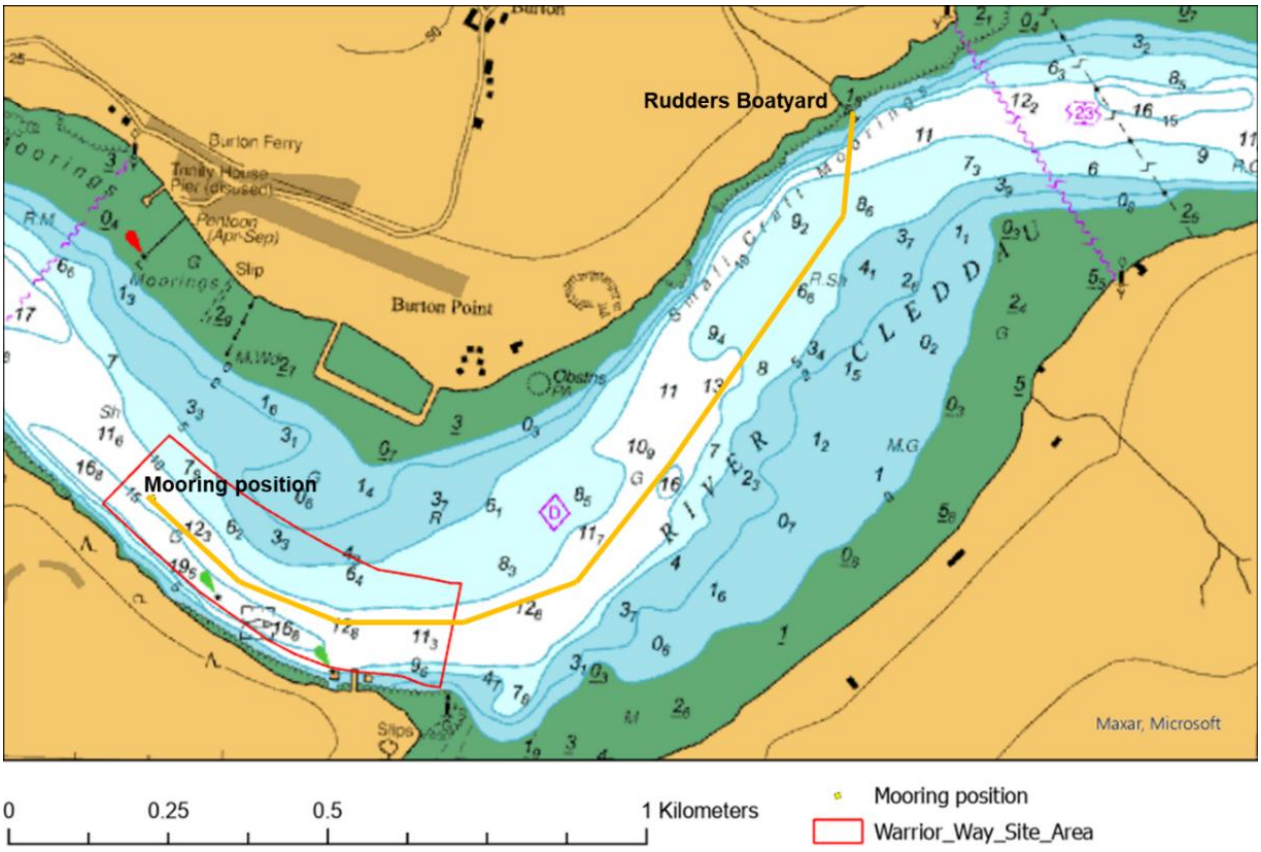

Figure 5 Tow route between the mooring location and the vessel contractor Rudders Boatyard.

4. Summary of activities

Summary of Installation, Maintenance and Decommissioning activities presented below (Table 2). Detailed RAMS, specific lift plans and specific tow plans will be drafted and provided to MHPA in a timely manner prior to commencement of work.

Table 2 Summary of Installation, Maintenance and Decommissioning activities

Task	**Installation**
1	Vessel contractor to make up and install mooring. Mooring will be micro-sited at locations away from any sensitive habitats / species identified during the Warrior Way Benthic Habitat Mapping by Ocean Ecology (See Device-specific EMP and pre-deployment monitoring report for more details).
2	Assembly of floating platform and CGEN and Swansea University tidal energy convertor hardware at Rudders Boatyard.
3	Vessel contractor to tow the assembled device to the test site and connect it up to the pre-laid mooring.
Task	**Operation and Maintenance**
1	Personnel to be transported to the device and, onboard the platform, run a series of performance tests on the device.

2	The device will be able to operate remotely and there will be failsafe processes for monitoring the device and remote shutdown. Any loss of power will also shutdown the system and bring the blades to a halt.
3	During the test programme the vessel contractor may detach the device from the moorings and tow it back to the contractor's dock to conduct maintenance and optimisation tasks that cannot be conducted at sea. Following the completion of the necessary works at the dock the vessel contractor will tow the device back to site and reconnect it to its moorings.
Task	**Decommissioning**
1	Once testing is complete, the vessel contractor is to detach the device from the moorings and tow it back to the contractor's dock.
2	All hardware and equipment are to be removed from the floating platform. Heavy objects are to be crane lifted from the floating platform.
3	The floating platform is then to be disassembled, and crane lifted from the water by the vessel contractor
4	The vessel contractor is to lift and remove the moorings from the test site, leaving no equipment on the seabed.

Floating Tidal Energy Convertor Navigational Risk Controls

Risk Controls		
1.	**Devices Specific Risk Controls**	1. All Mooring equipment to be clearly marked with yellow marker buoys **"WARNING MARINE ENERGY DEVICE, NO MOORING"** 2. Floating platform to be Marked with clear signs on both sides **"WARNING MARINE ENERGY DEVICE, NO MOORING, NO CLIMBING OR BOARDING"** 3. An all-round white light for a vessel at anchor. 4. Yellow cross day mark fitted at height above top platform 5. 4g GPS tracker 6. TPV of mooring system 7. Continuous remote monitoring of device (including CCTV) and remote shutdown capabilities will be implemented. 8. Secure during remote operation i.e. everything is locked away in the shipping container except the Emergency Stop Button. Anyone boarding the barge without a key will only be able to shutdown the turbine. 9. Coordinating project activities (e.g. Installation, maintenance and Decommissioning activities) with local activities providers (e.g. Pembrokeshire Performance Sailing Academy) and MHPA advice.
1.	**Site Wide Risk Controls**	Site-wide risk controls adopted as part of the META project are found in the META Sitewide NRA, Section 10.3. Controls applicable to this deployment are:

		1. Notice to Mariners to inform stakeholders of the floating turbine presence issued by MHPA and shared directly with META Warrior Way stakeholder list 2. META will engage with MHPA to ensure device is marked and lit appropriately for navigational safety 3. Detailed Risk Assessment Method Statements (RAMS), specific Tow Plans and Emergency Response Plan will be in place before commencement of works 4. Compliance with IMO conventions including COLREGs and SOLAS 5. Signage on device access points 6. Signage and information on deployment made available at recreational access points e.g. Llanion Cove Slipway and Rudders Boatyard

Appendix 1: Sitewide Navigational Risk Assessment

The following table taken from the META Sitewide Navigational Risk Assessment shows the top ten risks assessed for Warrior Way. All hazards were assessed to be low (green) risk if appropriate risk controls are in place.

10.4.1 Warrior Way

Rank	Hazard Ref.	Affected Areas	Accident Category	Hazard Title	Consequence Descriptions		Risk Overall
					Most Likely (ML)	Worst Credible (WC)	
1	18	META Site: Warrior Way	Grounding	Grounding: Tugs/Service Craft	Not Stranded	Grounding leading to loss of structural integrity, and pollution.	3.88
2	17	META Site: Warrior Way	Grounding	Grounding: Commercial Vessel	Not Stranded	Grounding leading to loss of structural integrity, and pollution.	3.83
3	16	META Site: Warrior Way	Grounding	Grounding Recreational Vessel	e.g. moving out of channel for other traffic, and "touching bottom" (Not stranded).	Grounding leading to sinking or loss of stability	3.82
4	12	META Site: Warrior Way	Contact	Contact with Floating Object: Recreational Vessel	e.g. striking NavAid, possible crew injury.	Striking larger object (e.g. large flotsam) possible multiple injuries, and significant damage leading to sinking	3.65
5	1	META Site: Warrior Way	Collison	Collision: Tugs/Service Craft - Recreational Vessel	Glancing blow, both vessels continue on voyage	Leisure vessel sinks with loss of life	3.48
6	4	META Site: Warrior Way	Collison	Collision: Recreational Vessel - Passenger Vessel / Ferry	Glancing blow, minor damage to both vessels, multiple injuries on leisure vessel	Leisure vessel sinks with multiple loss of life	3.45
7	5	META Site: Warrior Way	Collison	Collision: Recreational Vessel - Commercial Vessel	Glancing blow, minor damage to both vessels, multiple injuries on leisure vessel	Leisure vessel sinks with multiple loss of life	3.45
8	6	META Site: Warrior Way	Collison	Collision: Commercial Vessel - Passenger Vessel / Ferry	Glancing blow, minor damage to both vessels	Multiple injuries on both vessels, major damage to one or both	3.31
9	15	META Site: Warrior Way	Grounding	Grounding: Passenger Vessel / Ferry	P: Moderate - multiple minor injuries	Large ferry grounds: multiple injuries during event, major business disruption	3.22
10	10	META Site: Warrior Way	Contact	Contact with Fixed structure: Tugs/Service Craft	e.g. minor collision with device structure	Serious collision, or anchor fouling leads to capsize. P: Major	2.96

Appendix 2: Device Specific Navigational Risk Assessment

Device Specific Navigational Risk Assessment			
Site:	Warrior Way	**Installation Date:**	1st June 2025
Developer:	C-GEN Engineering	**Decommissioning Date:**	31st August 2025
Key Navigational Themes (Section 9 of META Sitewide Navigational Risk Assessment)			
Item	**Title**	**META Sitewide Navigational Risk Assessment comment**	**Any additional device-specific comment**
1.	**Vessel Routing**	The Warrior Way site boundaries encompass the deep-water channel to the east of the Cleddau Bridge. Several stakeholders expressed concern that vessels would be pushed to shallower water to the north. However, in practice, only a small part of the test area will be used at any one time, and it was accepted that this would have minimal impact on vessel routing. (META Sitewide NRA, section 9.1)	Proposed swinging mooring, however even with this mooring arrangement there should be sufficient space and depth for vessels that use this area to pass safely. Only swinging on slack water as the as tide turns. Once incoming or outgoing tidal flow established mooring and device orientation will be aligned with the flow parallel with the channel.
2.	**Impact Collision/Allision Risk**	This assessment has identified three hazards in this category: Collision, contact with floating object, and contact with fixed structure.	Device will have appropriate marking and lighting agreed with MHPA.

		Existing MHPA port control measures will remain effective, including clear channel marking, traffic management and zoning of the Waterway. (META Sitewide NRA, section 9.2)	Notice to Mariners will be issued and promulgated with relevant information regarding the device.
3.	**The effects of Tides/Tidal Streams and Weather**	No impact is expected on local tidal streams. Devices will be designed for the deployment conditions, and will be well maintained, therefore breakaway is considered unlikely to occur. (META Sitewide NRA, section 9.3)	The mooring arrangements designed for the site conditions will undergo Third Party Verification (TPV) by a suitably qualified and experienced naval architect.
4.	**Under Keel Clearance**	Will need to be assessed on device specific basis and managed with appropriate controls (temporary AtoNs such as navigational marker buoys, Notices to Mariners, proactive traffic management) to mitigate against impact due to insufficient Under Keel Clearance. (META Sitewide NRA, section 9.4)	Not applicable for the floating device. Anchors in ~15m water depth will not compromise Under Keel clearance.
5.	**Impact on Fishing Activity**	There is no large-scale commercial fishing activity at Warrior Way. Fishers will be made aware of deployment through Notice to Mariners issued and sent via direct email to those who have registered specific interest in META Warrior Way activities. (META Sitewide NRA, section 9.5)	n/a
6.	**Impact on Recreational Activity**	This Warrior Way site is intensively used for recreational purposes, both individuals in private vessels, and organised groups. In particular the area is regularly used for youth sail training and other activities, and therefore the vessels involved may be under the control of very inexperienced helmsmen. Regular exercises such as planned and controlled capsize drills are also regularly undertaken. There was concern raised at the stakeholder workshop that the extent of the Warrior Way test site boundary would significantly impact on these activities.	Single floating device deployment creating a point obstruction. See all Risk Controls that will be implemented to reduce impact.

		However, it is noted that in practice only one device will be deployed at any one time, which will in effect be a “point” obstruction at one location within the wider test site boundary. Risk, and inconvenience to other users can be significantly reduced through the designed in measures such as clear promulgation of the device location (Notices to Mariners etc.), marking with AtoNs (buoys) and in the case of short period deployments of certain devices provision of guard boats. (META Sitewide NRA, section 9.6)	
7.	**Interaction with Subsea Cables**	No existing subsea cables are relevant to any of the sites. (META Sitewide NRA, section 9.7)	n/a
8.	**Impact on Search and Rescue and Emergency Response**	Due to the small-scale nature of the devices to be deployed, there is not expected to be any impact on SAR and emergency response. (META Sitewide NRA, section 9.8)	n/a
9.	**Impact on Communications, Radar and Positioning Systems**	No impacts are anticipated. (META Sitewide NRA, section 9.9)	n/a
10.	**Cumulative and In-Combination Effect**	Increased activity expected in the Milford Haven Waterway due to other projects, however it is not considered to have a significant impact in combination with the META test areas. (META Sitewide NRA, section 9.10)	n/a