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DPR60 – Preliminary Marine Installation Manual

H2020 60kW Test Project

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Note - This report is a deliverable under proposal PR-TMOS-001 which has been awarded to Daretech by DesignPro Ltd. The purpose of the study is to develop a preliminary marine operations plan in order to support the Foreshore application to Clare County Council. All engineering and calculations notes are therefore preliminary, and not for construction at this point.

1. OVERVIEW

PROJECT OVERVIEW

This European Union H2020 funded project has been awarded to DesignPro to design, build, test and validate the 60kW version of the GKinetic Tidal Turbine. The project has a 25-month duration and has begun in XXXX.

A key deliverable is to obtain a site to test the latest 60kW generation of the technology in 2018. The device will be designed and manufactured at the DesignPro facility in Rathkeale Limerick. Following completion of manufacture, the device will be delivered to Foynes, where it will be mobilised into the water. It will be installed at the test site in the Shannon Estuary between Canon Island, and Inistubbrid Island in a water depth of approximately 20m. The device is expected to be tested for a period of at least 9 months where it may be temporarily relocated to shore multiple times for either weather or maintenance reasons.

The purpose of this document is to outline the key operational steps to install the DPR60 device at the test site within 2018.

TECHNOLOGY

The GKinetic tidal turbine is a floating device, that uses 2 x vertical axis rotors to capture kinetic energy from tidal currents or river flows.

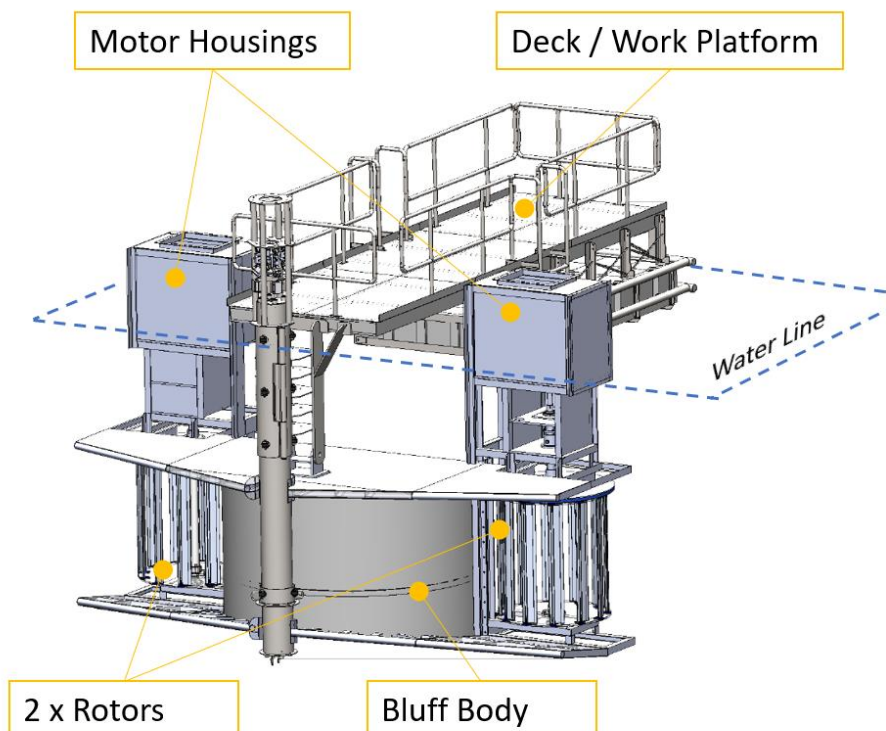


Figure 1 - DPR60 Tidal Turbine in Operating Configuration

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The device is moored at the surface to the moving current with the rotor and bluff body section facing into the current. The bluff body diverts flow into the rotors and thereby increases the inflow current speed to the rotors. The blades, which are self-aligning to the flow, rotate a central drive shaft which are connected to the AC generators contained within the housings. The electricity produced within the generators is conditioned using the onboard switch gear, and transferred to shore via a subsea cable, (not shown). The key characteristics of the Design 60kW, (DPR60), machine is:

Characteristics	Value
Device Dimensions	11m x 9.5m x 6m (l x w x h)
Installed Draught	4m
Dry Weight	20T
Power Capacity	60kW

Table 1 - DPR60 Key Characteristics

STUDY INPUTS

The following has been used as inputs to the preliminary study and calculations.

Criteria	Value Used
Design Current Speed	2.6m/s
Tidal Range	6m
Water Depth	20m
Wave Climate	Sheltered
Co-Efficient of Drag	0.7
Seabed Composition	Unknown
Submerged Service Area (Towing)	17 m ²
Submerged Service Area (Operation)	33.25 m ²
DPR60 Weight	20T
Design Life	5 years
Environmental Loads	See appendix A

Table 2 - Study Inputs and References

2. SITE OVERVIEW



Figure 2 - Overview of Mobilisation, Deployment & Standby Area

MOBILISATION PORT - FOYNES

Due to the proximity, and good road access from the manufacturing site at Rathkeale, the device will be lifted into the water in Foynes port. A site within the port that has sufficient set down areas will be identified and the unit will be offloaded from the delivery truck in the ‘towed configuration’

A crane of sufficient lift capacity will be selected, and the device will be lifted directly into the water. It is likely a small vessel will be required to access the device to release the rigging. Final preparations will then be made before the machine is deemed ready for the installation phase. A detailed mobilisation plan will be developed in due course.

DEPLOYMENT SITE



Figure 3 - Deployment Site

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The test site sits between Canon Island, and Inishtubbrid Island on the Clare side of the Shannon Estuary in Ireland. The following area has been selected for the device installation:

Latitude	52°40'4.97"N
Longitude	9° 3'36.21"W
Installation Target Area	75m radius about nominal

Table 3 - Installation Co-ordinates

The device will be held in place using a mooring system which extends up to 250m from the device. Following installation, the device will operate within an 10m radius from nominal range depending on changing tidal range and flow direction. This will leave sufficient room for passing of other marine users at all times.

3. MARINE EQUIPMENT

INSTALLATION VESSEL

There are several suitable vessels in the area capable of undertaking the installation work, however due to the requirement for a stern winch, and a mooring system it is recommended to utilise the Shannon 1 Multicat which is the 1908 series from Damen. This is a versatile workboat with suitable engine power to undertake the tow from Foynes to the site, and complete the installation works.



Figure 4 - Shannon 1 MultiCat [1908 Series]

Dimension	Value
Length Overall (m)	19.7
Beam (m)	8.1
Bollard Pull (T)	12.3
Max Speed (Knts)	9.2
Power (BPW)	714
Ancillary Equipment	Loader Crane 5.4 ton @ 8.44 m Winch System – 20 ton @ 16m/min

Table 4 - Shannon 1 Key Characteristics

Based on the available information for the Shannon 1 vessel, we can determine the limitations of the installation window. By derating the maximum Bollard Pull linearly over the speed range, and furthermore reducing the max engine power to 80%, it can be shown the max current for maintaining control of the vessel in the flowing current while under tow is approx. 4.2knots. This becomes the T0 time for the installation as shown in high level timing chart in later sections.

Shannon 1 BP Derating

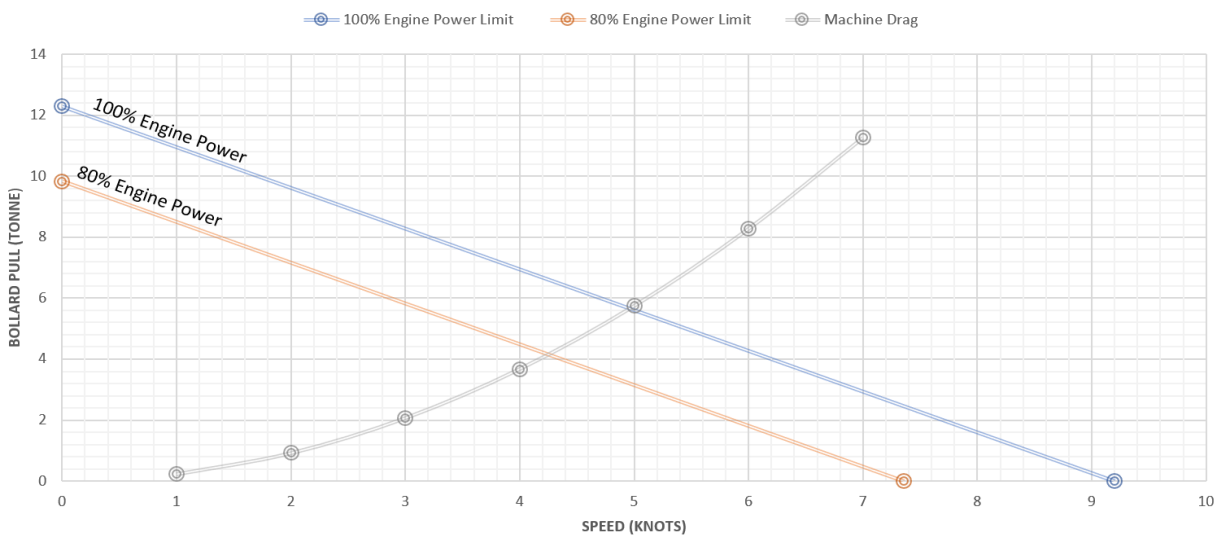


Figure 5 - Shannon 1 Capacity

Vessel	Details	Mooring Install	Device Install	Support
Shannon 1	<ul style="list-style-type: none"> See above 	✓	✓	
Ard Ri	<ul style="list-style-type: none"> Workboat with forward ramp. 15 x 4m LOA with 11 x 4.5m deck 8 Knots top speed Loader Crane 3.4T @ 1.5m, 0.75T @ 9m P2 Certificate 	✓	✓	✓
Capa Lass	<ul style="list-style-type: none"> 12 x 3.6m LOA 1.5m draught 			✓
Cava Lass	<ul style="list-style-type: none"> 3T Bollard Pull P5 Licence 			✓

Table 5 – Available Marine Assets

4. SITE PREPARATION

MOORING INSTALLATION

Following the preliminary analysis, it is deemed a 2-point mooring system is the most suited to the application. The lines comprising of heavy duty marine grade chain, and rope will extend approx. 280m to the northeast of the device location, and approximately 275m to the southeast.

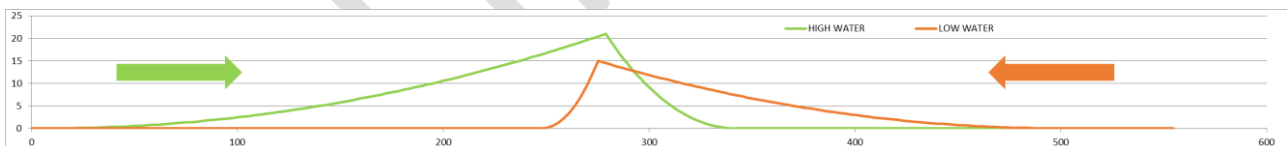


Figure 6 - Mooring Cross Section

At the end of the lines an anchor which has the holding capacity of >180kN will be installed. The details of this anchor will be determined following further site investigation. See Appendix B for mooring system calculations.

The mooring system will be installed in a separate marine operation in advance of the device installation. The abandoned pennant will be left on the seabed with a pick-up line buoyed to the surface ready for recovery on the day of the device installation. The pick-up line will be clearly marked with a large Norwegian buoy to ensure visible to passing marine traffic.

A detailed method statement for installation of fixed moorings will follow more detailed planning stage.

The DPR 60 will contain navigational aids for both the installation, and operational phase of the project to provide hazard identification, channel and waypoint marking to other seafarers.

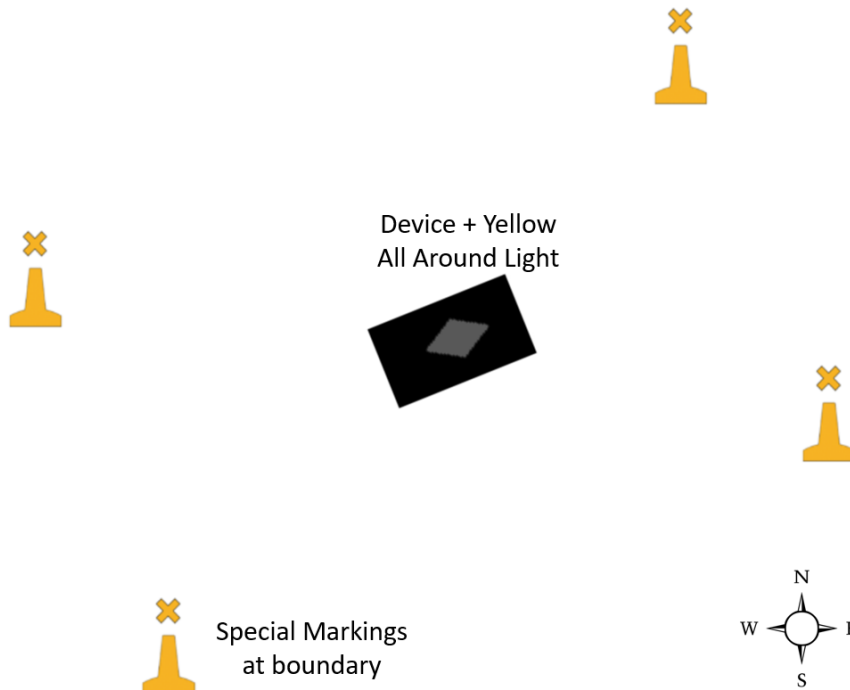


Figure 7 - Navigational Markings for Operation

It is recommended the device is fitted with a masthead containing a white or yellow light and sidelights over the forward centreline. and has a recharging system for the battery. Navigational Aids should be installed to the satisfaction of Shanon Foynes Port Harbour Master.

Situation	Markings
Under Tow	Port / Starboard Lights
Moored	White or Yellow Light on mast
Area Boundary	Special Markings around perimeter

Table 6 - Navigational Aids

The navigational aids will be ready to be operational immediately following the installation of the device at the test site.

5. DEVICE INSTALLATION

ENVIRONMENTAL LIMITS

Marine operations for device installation shall be restricted with the following environmental limits at all times. The final call of what constitutes acceptable will be made by the vessel master on the day of installation, however must not exceed limits set out below.

	Limit
Wind Speed	20 knots (max)
Wave Height	1.0m significant wave.
Peak Current (Day of installation)	4.2 knots ¹
Tidal Condition (For installation)	Neap Ebb Tide

Table 7 - Environmental Limits for Installation

HIGH LEVEL TIMING

The following section gives an hour by hour overview of the installation sequence, from operations in Foynes port, to the completion of the device installation at the test site.

Time	Event
T0 – 24hrs	<ul style="list-style-type: none"> • Mobilisation complete, Device sign off for installation
T0 – 9 hrs	<ul style="list-style-type: none"> • Departure from Foynes. • Transit to standby area due NE of installation target.
T0-6 Hrs	<ul style="list-style-type: none"> • All vessels on station. • Final preparations. • Prepare for temporary mooring hook up.
T0-3 Hrs	<ul style="list-style-type: none"> • Forward vessel prepares mooring hook up • Support vessel tends hook up lines • Standby for T0

¹ *Note – this is specific to installation vessel – see Figure 6 Shannon 1 Capacity*

T0	<ul style="list-style-type: none"> • Load up on moorings and walk back to target position. • Handover messenger line from support vessel. • Messenger line connected. • Hoist in on slack rope
T0 + 30mins	<ul style="list-style-type: none"> • Recover pennant from seabed. • Pennant locked into position on DPR60 • Slip towing bridle
T0 + 40mins	<ul style="list-style-type: none"> • DPR60 now moored. • Installation vessel recovery of temporary moorings. • Tidal operations complete.

Table 8 - High Level Step by Step for Installation

Activities which are tidal dependent have been plotted on a sample tidal curve of current speed v time to show the period of the tidal cycle it is intended they occur at. This graph can be updated with detailed current speed, and time during the detailed planning stage.

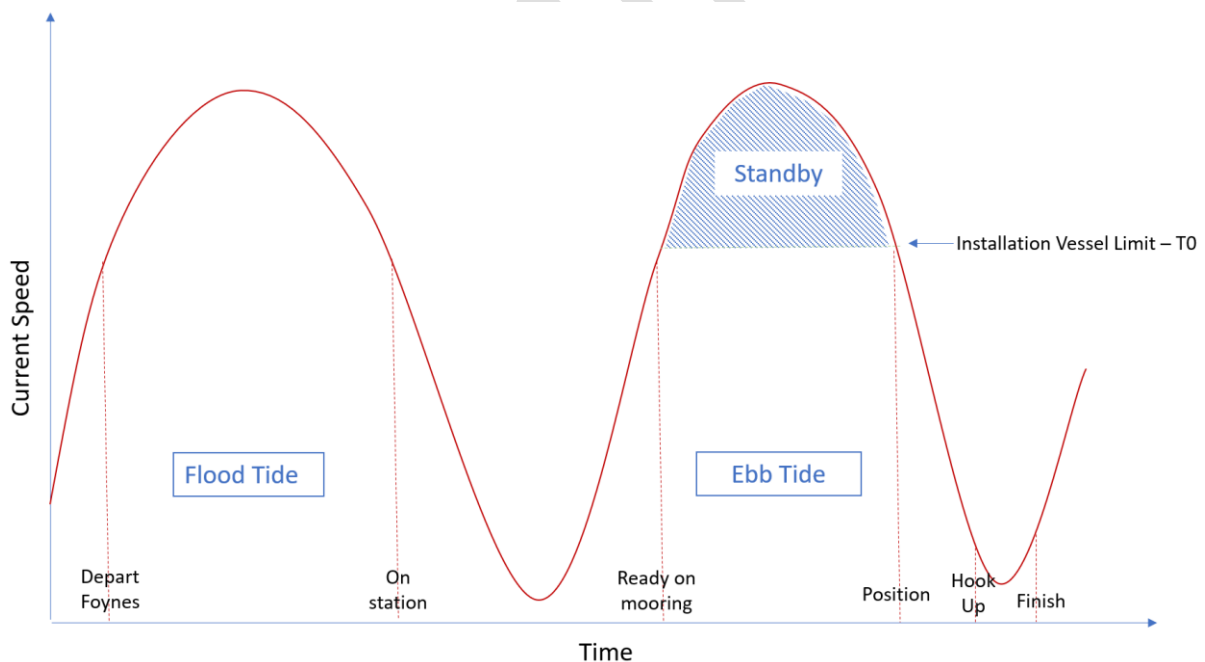


Figure 8 - Sample Operational Timings [Refer to device installation – overview section below]

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 TOWING TO SITE

The device will be towed from Foynes port and will be connected to the forward vessel via a short towing bridle. The length of the tow is to be confirmed but may require the installation of a towing diamond as a marker to other users.

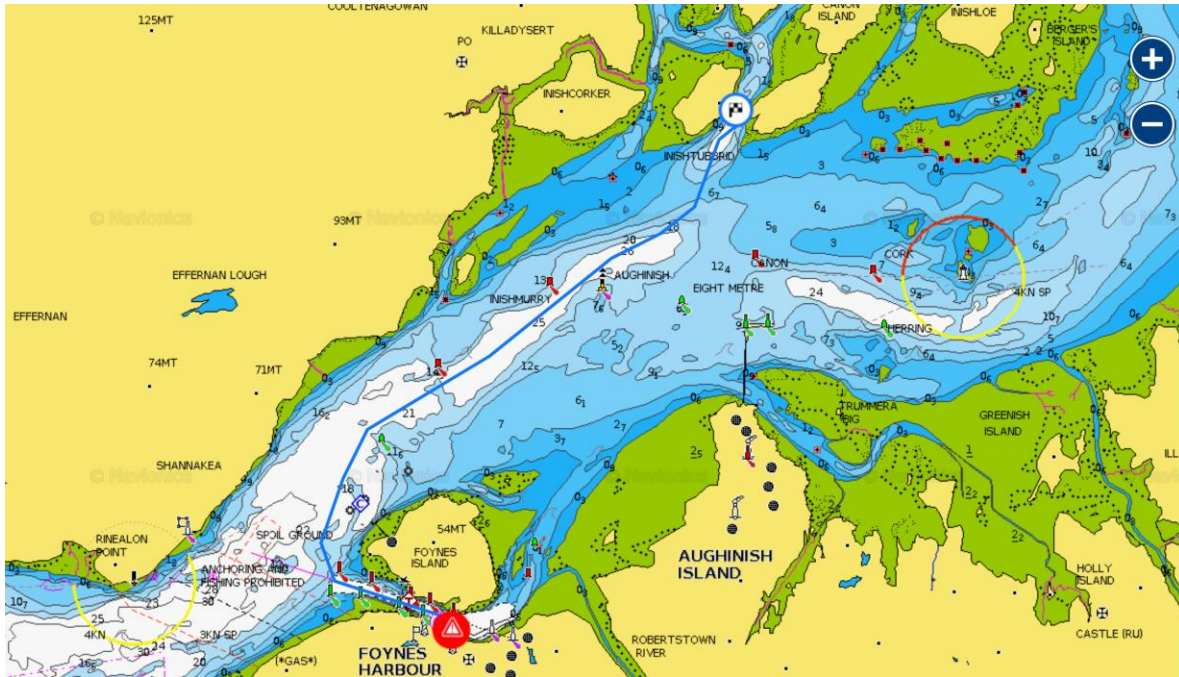


Figure 9 - Indicative Tow Route - [Not for Navigation]

Furthermore, a notice to mariners will be issued to cover the entire installation operation. While under tow the vessels will have the following draughts.

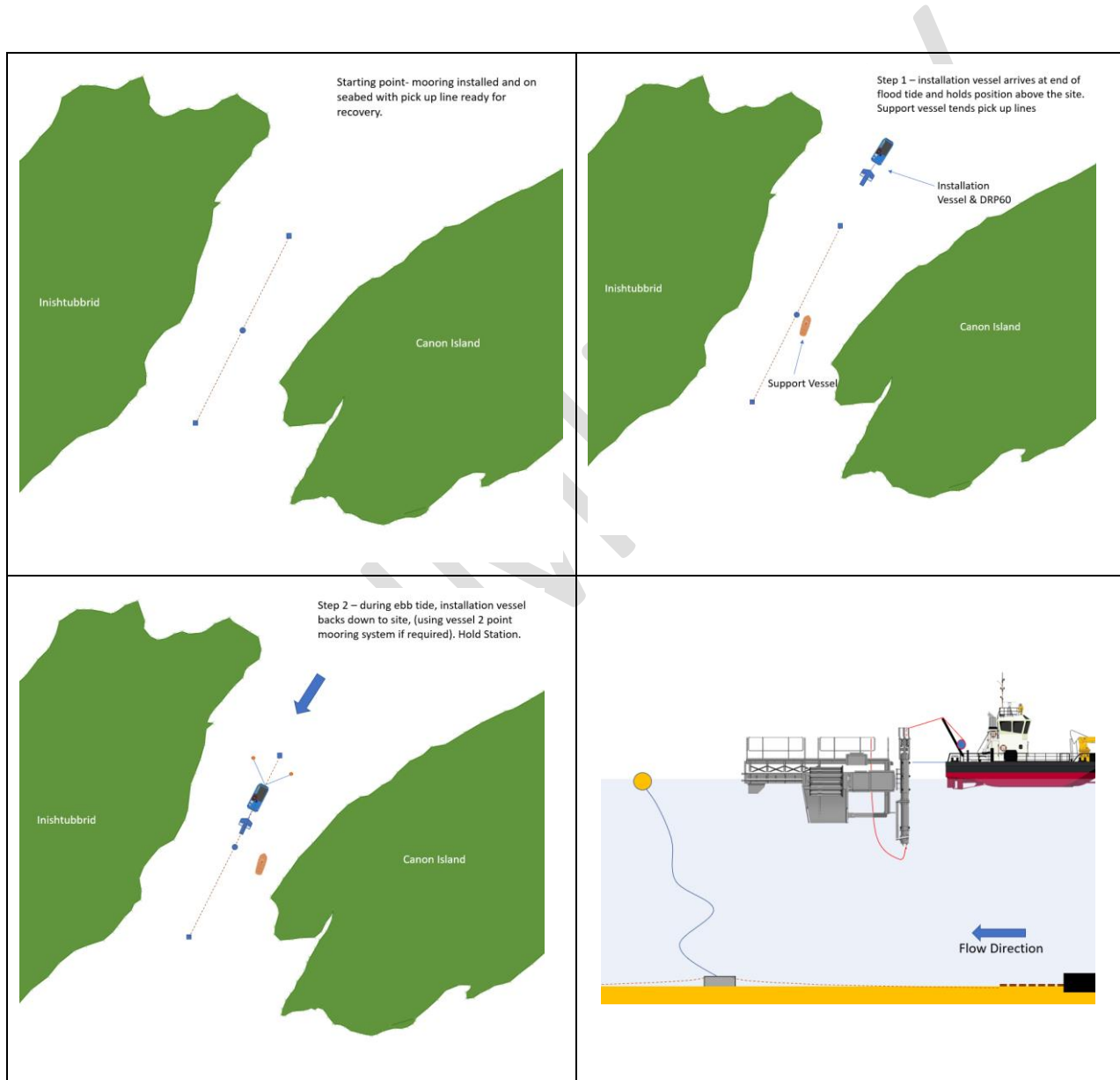
Vessel	Draught
DPR60	3m
Forward Tug	4m Maximum [Final TBC]

Table 9 - Vessel Draughts under Tow

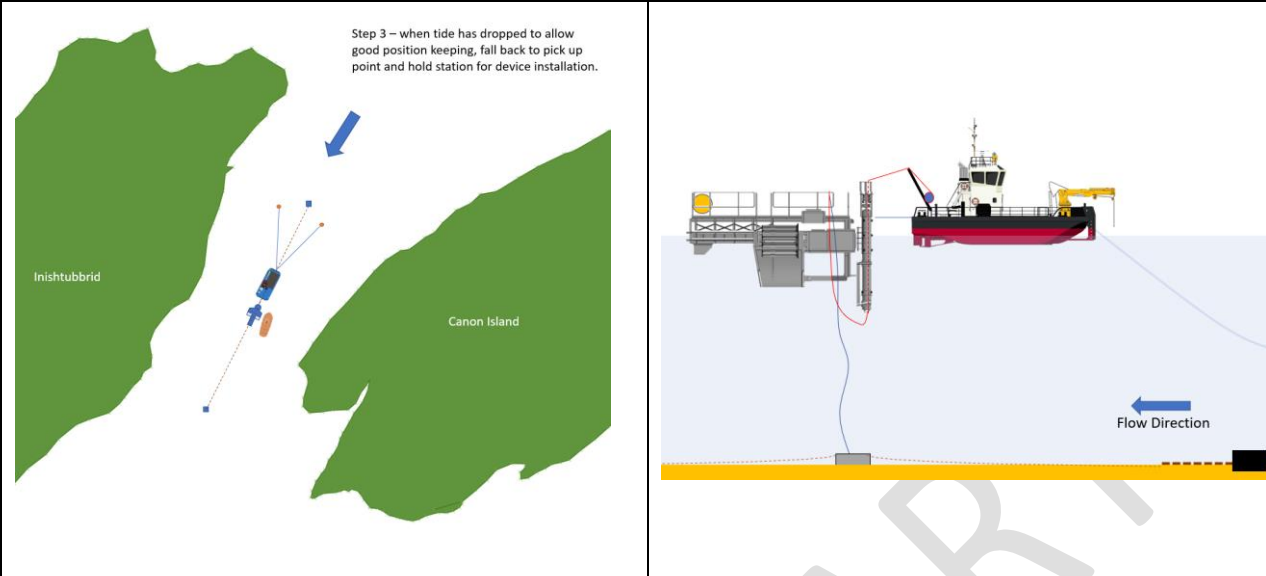
An indicative tow route is given above, the distance to be covered from Foynes to the installation site is just over 5nm and is expected to take approx. 2.5hrs. The towage company will be responsible for producing the passage plan in accordance with IMO Resolution A.893 (21) Guidelines For Voyage Planning. The convoy will leave Foynes approx. 3 hours in advance of high water, and travel to the installation site on the flood tide. It will then standby north of the installation tide and conduct final preparations until the tidal installation window opens. The tow will commence once a valid towing certificate has been issued from the Warranty Surveyor.

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DEVICE INSTALLATION – OVERVIEW

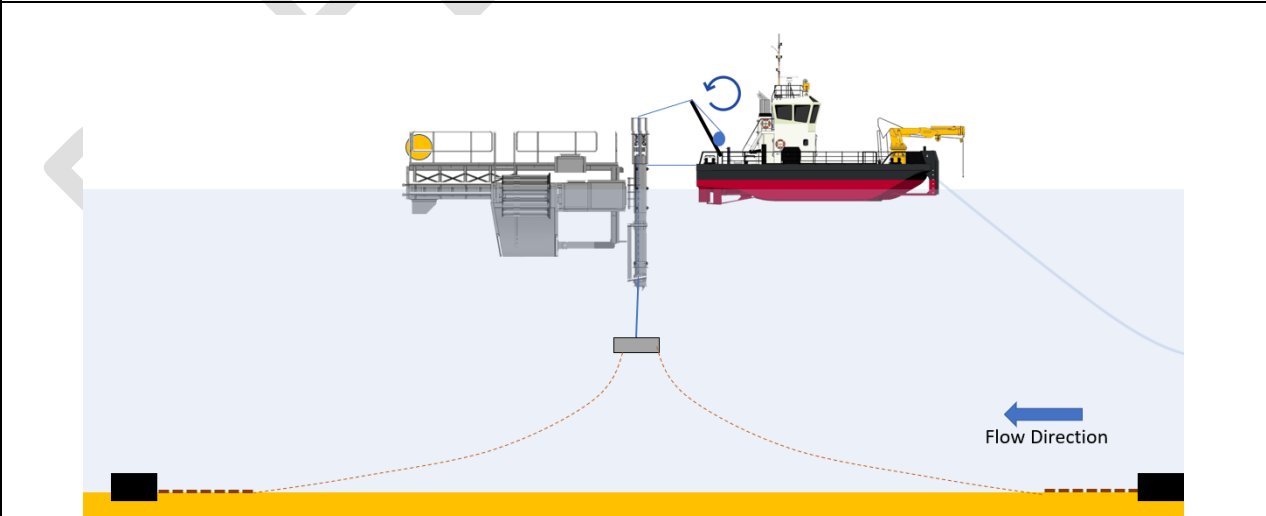
The following gives a high level pictorial overview of the planned operation **which will be undertaken on a single tidal cycle**. At an early point in the project, a detailed marine method statement must be developed, with input from the vessel and device owners, and any other stakeholders through means of a Hazard Identification & Risk Assessment workshop. The outcome of this workshop will be incorporated into the detailed installation procedure.



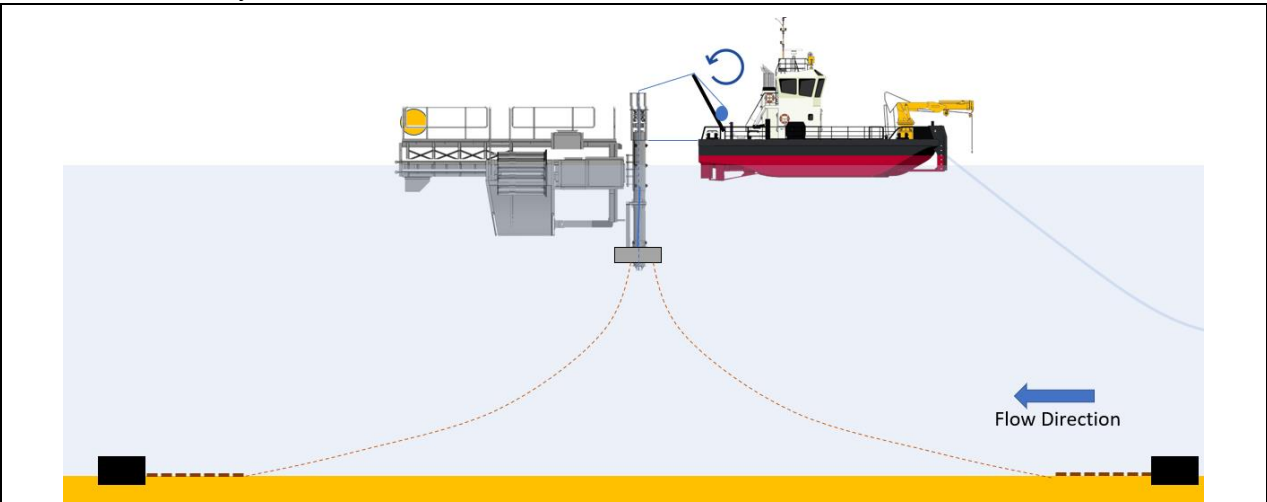
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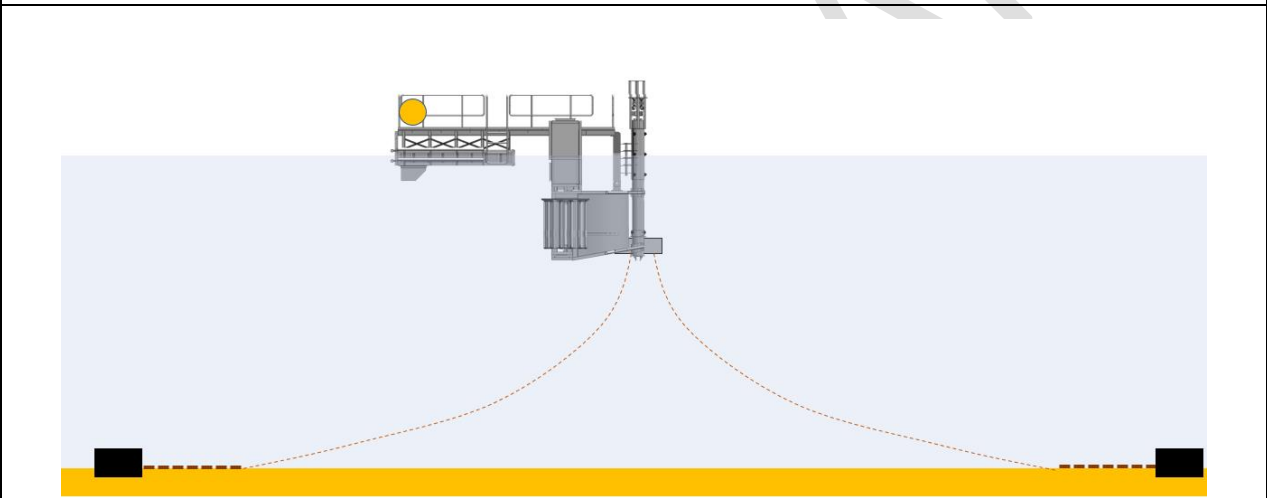
Installation vessel pulls up mooring system on winch, (expected lift force 7T).



As mooring system is lifted device and installation vessel now become anchored. Any position keeping no longer required.



Mooring system to be 'pinned' in place, and lines to installation vessel inch will slack and can be disconnected. **Note** – 'Pinning' method to be determined with input from device design team.



Installation vessel can now completely detach and leave the site. DesignPro team can begin the commissioning at any stage from the moored device.

Figure 10 - Installation Overview [Not to Scale]

6. POST INSTALLATION

CHANNEL RESTRICTIONS

Upon installation an 'As Built' drawing of the final position will be submitted to the harbour master, and Clare County Council, confirming the device is installed in accordance with the permit and licence application.

Due to the reversing currents and change in water surface elevation of the device it's important to note the device will move within a radius of 10m about its installed position. This will leave a suitable channel for other marine users to pass at all times. The extents of this boundary will be marked with 'Special Marking' surface buoys in order to identify and ensure awareness of any associated hazards.

7. PRELIMINARY RISK ASSESSMENT

Ref.	Phase	Hazard	Initial Risk			Control	Final Risk		
			L (1-4)	S (1-4)	R		L (1-4)	S (1-4)	R
1.	Installation Phase	Marine Collision - vessels	3	4	12	<ul style="list-style-type: none"> Notice to mariners issued by harbour master Inter vessel communication systems in place and checked. Clear briefing and understanding by all vessel masters and crew. Navigational markings in place and operating. Emergency bridle on device. 	1	4	4
2.		Loss of installation position keeping	4	3	12	<ul style="list-style-type: none"> Installation vessel capable of holding station on own power. Use of vessel mooring system for fine control over positioning. Support vessel in standby Careful selection of tidal and weather windows. 	2	3	6
3.		Marine incident	3	4	12	<ul style="list-style-type: none"> Stability checks for vessel and device to be undertaken. Hazard Identification & Risk Assessment undertaken with all involved. Detailed planning undertaken of all operational task and risks. 	1	4	4
4.		Abort of operation for operational issue	3	3	9	<ul style="list-style-type: none"> Stage gates of operation, and time to reverse process at any point. 	3	1	3
5.	Operation Phase	Marine Collision – vessels with device	2	4	8	<ul style="list-style-type: none"> 50m Exclusion zone around device marked with ‘special markings’ Notice to mariners issued and As Built submitted to Clare Co.CO & SFPC. 	1	4	4
6.		Mooring Failure	2	3	6	<ul style="list-style-type: none"> Detailed design of anchor within load capacity. Use of certified materials. 	1	2	2
7.		Extreme weather	4	3	12	<ul style="list-style-type: none"> Device can be removed within one tidal cycle. Relocation to more sheltered area north of test site. 	4	1	4