NOVA SCOTIA

MARINE RENEWABLE-ELECTRICITY LICENCE

Province of Nova Scotia

Marine Renewable-energy Act

LICENCE HOLDER:	Cape Sharp Tidal Venture Ltd.
LICENCE NUMBER:	2018-001
EFFECTIVE DATE:	May 23, 2018
EXPIRY DATE:	May 23, 2028

Pursuant to Section 30 of the *Marine Renewable-energy Act*, as amended from time to time, a Licence granted to the Licence Holder is subject to the Terms and Conditions attached to and forming part of this Licence, for the following activity:

Construction, installation, operation and decommissioning of two (2) in-stream tidal energy generators with an aggregate nameplate capacity of four (4) megawatts at Berth D within the FORCE Marine Renewable-electricity Area.

For greater certainty, the activity authorized under this Licence and its terms and conditions is subject to the *Marine Renewable-energy Act* and its regulations.

Geoff MacLellan
Minister

May 23/18
Date Signed

NOVA SCOTIA

MARINE RENEWABLE-ELECTRICITY LICENCE

TERMS AND CONDITIONS

Province of Nova Scotia

Marine Renewable-energy Act

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Licence

The following schedules are attached to and form part of this Licence:

- Schedule "A" CSTV Technical Description;
- Schedule "B" Survey of Berth D;
- Schedule "C" Project Plan; and
- Schedule "D" Insurance Requirements.

Definitions:

Terms which are defined in either the *Marine Renewable-energy Act* or its regulations have the same meaning in these licence terms and conditions, unless otherwise provided.

In this Licence:

"Commercial Operation" means the completion of the design, construction and commissioning of the Generation Facility;

"Deployment" means the placement of a device or associated equipment in position ready for use;

"Effective Date" means the date that this Licence is effective, as noted at the head of this document;

"Generation Facility" means one or more device(s) described in the Project Plan and Schedule A, together with all protective and other associated equipment and improvements as may be modified from time to time pursuant to the terms of this Licence;

"MRE-Act" means the *Marine Renewable-energy Act*;

"NSPI" means Nova Scotia Power Incorporated;

"Licence Area" means the area of submerged land for which the specific location has been determined by survey and defined as Berth D and as contained in Schedule B of this Licence;

"Licence Holder" means Cape Sharp Tidal Venture Ltd.;

"Program Administrator" means a representative of the Nova Scotia Department of Energy who has been assigned to receive information on the Department's behalf with respect to this Licence;

"Project Plan" means the project plan attached as Schedule "C";

"Regulations" means the *Marine Renewable-energy General Regulations*;

"Technical Description" means the description of the technology contained in Schedule A of this Licence;

1.0 Scope of Approval

1.1 *Project Details.* This Licence is limited to the project as described in the schedules attached to and forming part of this Licence.

1.2 *Project Technology.* The Licence for the project is limited to the technology as described in the schedules attached to and forming part of this Licence and limited to the aggregate nameplate capacity first stated above.

1.3 *Licence Area.* The Licence Area is Berth D (12.56 hectares) as set out in the Schedule B. Generator(s) authorized under this Licence shall be constructed, installed and operated within the Licence Area.

1.4 *Development and Operation.* The Licence Holder shall develop and operate the project as described in the Project Plan attached to and forming part of this Licence.

1.5 In the event of a conflict between the MRE-Act and its regulations and the terms and conditions of this Licence, the MRE-Act and its regulations shall prevail.

2.0 General Terms and Conditions

2.1 *Renewal eligibility.* To be eligible to renew the term, the Licence Holder must have fulfilled its obligations under this Licence, MRE-Act and its regulations and shall submit and receive written approval of a new project plan for the coming renewed term.

2.2 *Other Approvals, Permits and Authorizations.* This Licence is subject to the terms and conditions herein, and the Licence Holder obtaining and maintaining all other necessary approvals, permits or authorizations under municipal, provincial and federal acts, regulations and by-laws.

2.3 Feed-in Tariff Approvals. Without limiting the generality of 2.2, the Licence Holder must be in good standing with Feed-in Tariff Approvals FIT-D-001 and FIT-D-002.

3.0 Commercial Operation Deadline/Term of Licence

3.1 The Licence Holder shall reach Commercial Operation on the project on or before December 17, 2020.

3.2 This Licence is valid for a term of ten (10) years from the Effective Date.

4.0 Rent Payments

4.1 In accordance with Section 26 of the Regulations, the Licence Holder is exempt from any rent or fee prescribed in Section 23 of the Regulations in relation to this license.

5.0 Environmental Monitoring Plan

5.1 The environmental monitoring plan (EMP) must be developed using relevant baseline data and identify appropriate environmental effects indicators. The plan shall consider project effects on, but not limited to, the following:

- fish and lobster;
- marine birds;
- marine mammals;
- acoustics;
- physical oceanography;
- currents and waves; and
- benthic environment.

The EMP shall include contingencies to be implemented as alternative courses of action in the event mitigation and/or monitoring activities cannot be implemented, are not functioning as designed or do not provide expected results.

5.2 The Licence Holder shall update and revise the EMP to reflect best available and economic practices, methods, and technologies respecting environmental monitoring; changes in the Project Plan and circumstances of the project; and changes in the, or knowledge of the, physical, ecological, and environmental circumstances and impacts of the project.

5.3 EMP reports shall be submitted in writing to the Minister at a schedule to be determined by the Nova Scotia Department of Energy.

5.4 Upon knowledge of serious harm to marine mammals, fish, marine invertebrates, and marine birds, the Licence Holder shall, without unreasonable delay, notify the Program Administrator and the Department of Fisheries and Oceans Canada.

6.0 Engagement Requirements

6.1 *Mi'kmaq Engagement Plan.* The Licence Holder shall not construct or install a generator, cable or other equipment or structure in the Licence Area until the Licence Holder has submitted and the Minister has approved an engagement plan for the Mi'Kmaq. The plan shall outline ongoing and proposed engagement activities with the Mi'kmaq of Nova Scotia and shall include, as a minimum, a description and general schedule of activities under the authority of the Licence. The Licence Holder shall implement the plan following approval. The plan shall be updated and resubmitted annually to the Minister for approval on or before January 31st throughout the term of this Licence.

6.2 *Stakeholder Communication and Engagement Plan.* The Licence Holder shall not install any generator, including any cable or any other equipment or structure owned by the Licence Holder and used or intended to be used with the generator, before submitting a stakeholder communication and engagement plan to the Minister for approval. The plan shall outline ongoing and proposed engagement activities with stakeholders and shall include, as a minimum, a description and general schedule of activities under the authority of the Licence. The Licence Holder shall implement the plan following approval. The plan shall be updated and resubmitted annually to the Minister for approval on or before January 31st, throughout the term of this Licence.

7.0 Reporting Requirements

7.1 *Deployment Notice.* The Licence Holder shall notify the Program Administrator at a minimum, thirty (30) days prior to the Deployment or testing of generator(s) or equipment under the authority of the Licence.

7.2 *Deadlines for reports.* In accordance with Section 13 of the Regulations, the Licence Holder shall submit written reports ("Activity Reports") to the Minister detailing the activities carried on under the authority of the Licence:

a. no later than July 31 of each year that the Licence is valid, for activities carried on between January 1 and June 30; and

b. no later than January 31 of each year that the Licence is valid, for activities carried on between July 1 and December 31.

7.3 *Content of Reports.* At a minimum, the Activity Reports shall include:

a. Detailed and up-to-date project schedule;
b. Status update on operational aspects of the project;
c. Operational capacity factor for each generator and calculation methodology;
d. Progress updates on the activities outlined in the project schedule;
e. Detailed and up-to-date procurement schedule;
f. Amended procurement deadlines;
g. Summary of any entities procured for goods/services;
h. Actual financial statements related to procurement, construction, operations, and monitoring activities;
i. Data relating to socio-economic matters;
j. Lessons learned deemed beneficial to the sector; and
k. Changes in the corporate governance structure of the Licence Holder.

7.4 *Event notification.* The Licence Holder shall notify the Program Administrator within ten (10) business days upon reaching the following milestone(s):

a. Receipt of any federal, provincial, or municipal regulatory approvals;
b. Approval of additional funding or grants;
c. Completion of any NSPI grid interconnection activities;
d. Connection to the transmission or distribution grid;
e. Issuance of any manufacturing or fabrication contracts;
f. Installation of a generator and any cable or other equipment or structure used or intended to be used with a generator;
g. Reaching Commercial Operation;
h. Reaching commercial operation under the power purchase agreement;
i. Achieving 9% capacity factor;
j. Achieving 35% capacity factor;
k. Commencement of decommissioning activities; and
l. Completion of decommissioning and rehabilitation activities.

7.5 *Press release notification.* The Licence Holder shall notify the Program Administrator at least one (1) day prior to any press release related to the activities authorized under the Licence.

8.0 Incident Reporting

8.1 The Licence Holder shall, without unreasonable delay, provide the Program Administrator a report of any significant adverse environmental effects, reportable spill, accident or near miss, generator malfunction or impact to human health or safety together with a description of the response.

8.2 The Licence Holder shall notify the Program Administrator at least one (1) day in advance of any press release or press-conference related to an incident or near-miss.

8.3 The Licence Holder shall ensure that:

a. Any incident or near-miss is investigated, its root cause and causal factors identified where possible and applicable corrective action taken; and

b. Any incident or near-miss is investigated, its root cause, causal factors and corrective action taken must be submitted in writing to the Program Administrator no later than thirty (30) days after the day on which the incident or near-miss occurred.

9.0 Risk Management Plan

9.1 The Licence Holder shall not install any generator, including any cable or any other equipment or structure in the Licence Area until the Licence holder has submitted and the Minister has approved a Risk Management Plan. The Licence Holder shall implement and adhere to the Risk Management Plan following approval.

9.2 The Risk Management Plan must be developed using relevant project information and shall contain all the information listed in Section 18 of the Regulations.

10.0 Decommissioning, Abandonment and Rehabilitation Plan

10.1 In accordance with Section 19 of the Regulations, the Licence Holder shall not construct or install a generator, cable or other equipment or structure in the Licence Area until the Licence Holder has submitted and the Minister has approved a Decommissioning, Abandonment and Rehabilitation Plan.

10.2 The Decommissioning, Abandonment and Rehabilitation Plan shall be developed using relevant project information and shall contain all the information listed in Section 20 of the Regulations.

10.3 The Licence Holder shall update the Decommissioning, Abandonment and Rehabilitation Plan to reflect best available and economic practices, methods, and technology of decommissioning, abandonment and rehabilitation; changes in the Project Plan and circumstances of the project; and changes in the, or knowledge of the, physical, ecological, and environmental circumstances and impacts of the project.

11.0 Financial Security and Insurance

11.1 *Insurance.* The Licence Holder shall provide proof of liability insurance to the satisfaction of the Minister prior to the commencement of any activities authorized under the Licence.

11.2 *Coverage*. The Licence Holder shall maintain its insurance coverage in full force and effect for the term of the Licence as set out in Schedule "D".

11.3 The Licence Holder shall provide financial security prior to the commencement of any activities authorized under the Licence on terms and conditions acceptable to the Minister. Financial security shall be in an amount to ensure decommissioning of the project based on the estimated cost of all decommissioning activities described in the approved Decommissioning, Abandonment and Rehabilitation Plan.

11.4 The Licence Holder shall ensure that any security provided prior to the commencement of any construction, installation, operation and decommissioning activities authorized under the Licence is kept in effect throughout the term of the Licence. The Licence Holder shall provide proof of financial security annually on or before January 31, through the term of the Licence.

11.5 Financial security described in this section shall be in one of the following forms:

a. Cheques made payable to the Minister of Finance;
b. Government guaranteed bonds, debentures, term deposits, certificates of deposit, trust certificates or investment certificates assigned to the Minister of Finance; or

c. Irrevocable letters of credit, irrevocable letters of guarantee, performance bonds or surety bonds in a form acceptable to the Minister.

12.0 Project Milestones

12.1 The Project Plan will be used to track material progress relating to project development. The Licence Holder shall adhere to and implement the following:

Table 1. Project milestones to complete construction, installation and commissioning of two (2) in-stream tidal energy generators.

Activity	Generator 1 FIT-D-001	Generator 2 FIT-D-002
Resource Characterization	Complete	Complete
Site Characterization	Complete	Complete
Design Validation Complete	Complete	[redacted]
Generator Build Commences	Complete	
Generator Build Complete	[redacted]	
Marine Operations - Mobilization		
Deployment		
Grid Connection		
Commissioning		
Commercial Operation Date		

12.2 The Licence Holder shall notify the Program Administrator within ten (10) business days following completion of project milestones listed in Table 1 (above).

13.0 Performance Requirements

13.1 The Licence Holder shall provide final as-constructed drawings of the Generation Facility and all associated infrastructure to the Program Administrator no later than ninety (90) days upon reaching Commercial Operation.

13.2 The Licence Holder is subject to the following performance targets:

a. Capability of deployed generators(s) to be operated and controlled with consistency following installation; and
b. Maintenance of an annual average capacity factor of at least 9% for each generator under the authority of the Licence.

13.3 The Licence Holder shall provide performance reports to the Program Administrator no later than January 31 of each year through the term of this Licence. At a minimum, the report must include the following for each generator installed:

a. Amount of energy generated;
b. Date(s) energy was generated;
c. Peak generation;
d. Capacity factor achieved and calculation methodology;
e. Number and date(s) of days deployed;
f. Number and date(s) of operating days;
g. Number and date(s) of maintenance days (planned and unscheduled);
h. The type of maintenance required; and,
i. A summary of operational issues impacting energy production or safe operation of the Generation Facility.

13.4 In the event any generator fails to meet the annual performance standard detailed in 13(2)(b) for a period of one (1) year, the Licence Holder must submit a report to the Minister outlining a reasonable time-line and plan for restoration of the generator(s) to either render it fully functional or provide details for removing the generator(s) from the Licence Area within one (1) year from when the report was received. The Licence Holder must implement the restoration as submitted; any change is subject to prior approval of the Minister. The Licence Holder cannot invoke this provision within three years of it being previously invoked, and not more than twice overall.

14.0 Notice to Minister and Program Administrator

14.1 Notice, documents and other information required to be sent to the Minister of the Nova Scotia Department of Energy, shall be in writing and may be served by personal service or electronically, addressed as follows:

Attention: Minister of Energy

Nova Scotia Department of Energy
Joseph Howe Building
1690 Hollis Street
PO Box 2664
Halifax, NS B3J 3J9

Phone: (902) 424-4575
Fax: (902) 424-0528

Email: energyminister@novascotia.ca

14.2 Notice and/or information required to be sent to the Program Administrator shall be in writing and sent via email to: marinerenewables@novascotia.ca

15.0 Notice to NSPI

15.1 In the event the Licence expires, is suspended or revoked, the Minister will notify NSPI.

16.0 Standards

16.1 The Licence Holder must comply with industry standards for marine renewable energy conversion systems as they exist at the time of the issuance of this Permit and as amended, including but not limited to the International Electrotechnical Commission (IEC) Technical Committee (TC) 114.

CSTV TECHNOLOGY DESCRIPTION

1 Technology to be deployed

1.1 OpenHydro Open-Centre Turbine

The OpenHydro Open-Centre Turbine will be the technology used for deployment at Berth D, the key design features of the Open-Centre Turbine include:

1. ***Simple construction:*** manufactured from a small number of components – only a single moving part (rotor).

2. ***Permanent magnet generator:*** the advanced permanent magnet generator removes the requirement for a gearbox – a common cause of failure in large scale wind turbines.

3. ***Bi-directional:*** the turbine operates in both the ebb and flood direction without the need to yaw to orientate itself into the tide.

4. ***Scalable:*** OpenHydro has demonstrated that the technology is scalable by increasing the diameter from 3m to 6m and again from 6m to 16m. The latest 16m diameter design has been installed, tested, commissioned, recovered and upgraded at FORCE, Nova Scotia. The turbine will be reinstalled during the summer of 2018.

Figure 1: Open Centre Turbine on the deployment barge.

The turbines will be connected to shore via a subsea power conversion unit (known as the Turbine Control Centre – TCC). A general schematic of the turbine and converter is outlined in Figure 14.

Figure 2: Turbine and Converter Schematic

1.2 Proof of Ownership/licence for proposed technology

OpenHydro holds 100% control of the world rights to its technology including a broad portfolio of intellectual property (IP). Upon acquisition of the technology, OpenHydro secured assignment of all pending and granted patent applications and began its own intensive programme of patent filing. As a business, OpenHydro places high importance on its IP strategy. A number of staff are assigned to the development of OpenHydro's IP portfolio and this process is supported and executed by external consultants.

OpenHydro has a clear, three-stage approach for the progression of each patent application.

1. European Patent Office: stage one involves the initial registration of the patent with the EPO (European Patent Office).
2. PCT application: within one year, OpenHydro files a PCT (Patent Cooperation Treaty) application which provides the company with the right to file on a global basis.
3. National filings (key markets): within three years, a full suite of national filings are made within Europe and all other key markets around the world.

1.3 Main collector elements

The OpenHydro Open Centre Turbine is a shrouded, horizontal axis turbine, with four key components: a horizontal axis rotor, a direct-drive permanent magnet generator, a hydrodynamic duct and a subsea gravity base type support structure. Simplicity is a key advantage of this device, with no lubricant, seals, or gearbox, meaning reduced maintenance requirements. Seawater is used for both generator cooling and lubrication. This general arrangement provides smooth reaction torque and is relatively easy to seal from the surrounding seawater, as well as being flexible in that it may be configured to produce different voltage outputs.

The turbines and TCCs, supported by subsea base structures, are placed directly onto the seabed, deep enough so as not to pose a hazard to shipping. Each Open Centre Turbine can be rated at up to 2MW, depending on precise site conditions and detailed economic assessment.

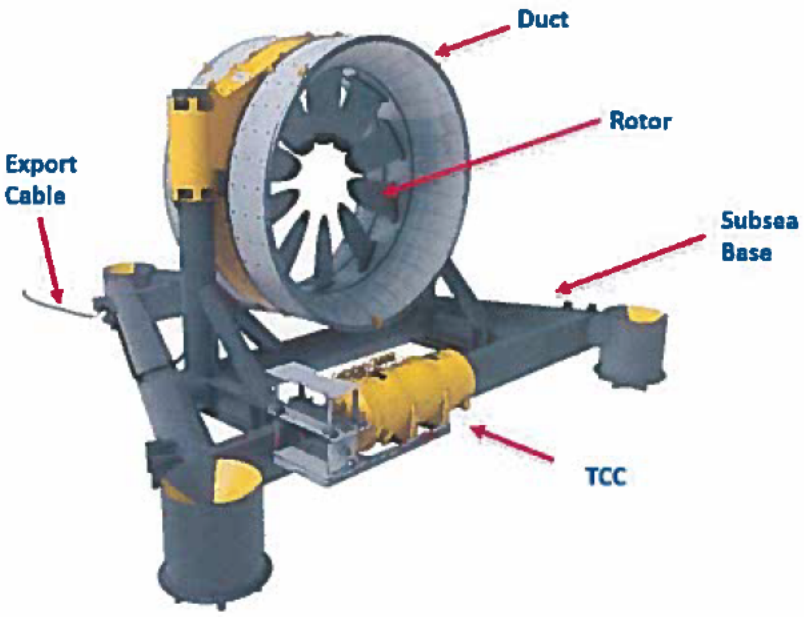


Figure 3: Open Centre Turbine System Key Components

The support structure for the OpenHydro Open Centre Turbine is an unpinned gravity base structure, which is installed along with the turbine as one assembly. OpenHydro has developed a specialized methodology for installing its Open-Centre Turbines, allowing all preparatory works to be performed in the safe and controlled working environment of a harbour.

The duct is designed to straighten and intensify the flow of water. This serves to make the turbine suitable for use in tidal streams that are not completely bi-directional. It is OpenHydro's experience from testing on their research structure at the European Marine Energy Centre (EMEC) in the Orkney Islands, Scotland, where ebb flow sets in at approximately 60° to the main direction, that off-axis flow of a few 10s of degrees causes a negligible effect in generation due to the duct.

The generator is a permanent-magnet, synchronous machine with an AC output. The generator rotor is integrated into the outer ring of the turbine rotor and the generator stator is integrated into the stator ring. The principal components of the Open-Centre Turbine generator are shown in Figure 18 below.

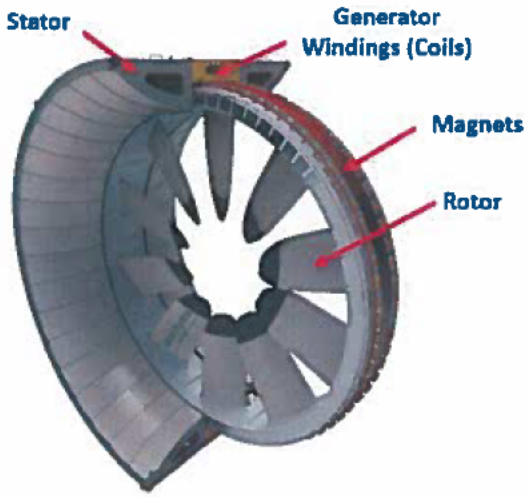


Figure 4 - Electrical Generator Components: section view

The turbine is designed to be bi-directional with fixed pitch blades, thus eliminating the need for complex blade pitching and yawing mechanisms. The blades are supported at the tips, which are retained within the outer housing, thereby reducing collision risk potential for marine life.

1.4 Device Reaction Force

The turbine is supported within the flow by a Subsea Base (SSB) structure which has been proven at increasing device scales by the successful deployment and recovery of full scale systems in France and Canada. All forces imparted on the turbine and SSB are ultimately reacted across the three feet by a combination of friction and restraint by embedment in the seabed. The moments imparted about the three axes of overturning and the rotor torque are counteracted by the self-weight of the system. As such, the total self-weight of the system, up to 1,000 tons weight in water, is designed to ensure adequate factors of safety against both sliding and overturning.

1.5 Power take-off

Turbine(s) that are grid connected require the addition of subsea connectors, cabling and power conversion equipment. During normal operations, the turbine load is controlled automatically to ensure optimum output. The turbine control system is able to cap turbine torque and power. Both are achieved by reducing the electrical load on the turbine generator and thus allowing the turbine rotational speed to increase. The turbine output follows a particular characteristic and the control system uses this to accurately regulate the power. Once the output power reaches the cap level it will continue to deliver that power level as the tidal flow increases by reducing the torque on the generator and allowing the rotational speed to increase. When the flow drops and the turbine power drops below the cap limit, the turbine will then deliver power at its optimum efficiency. The power and torque cap maximum limits are set by the electrical infrastructure of the turbine, power conversion equipment and array architecture.

Please refer to Section 3 '*Predicted Performance*' for the predicted energy capture efficiency of the Open Centre Turbine.

1.6 Directionality

The Open-Centre Turbine is bi-directional, with symmetrical blades and venturi sections resulting in equal performance from the front and rear. In addition, extensive Computational Fluid Dynamics (CFD) analysis has shown that the turbine can operate with no decrease in efficiency at incoming flows of up to 30° off axis. This provides a significant advantage when considering the variation of around 10° in ebb tide directions observed from harmonic predictions carried out by OpenHydro at Berth D. The ability to operate in off-axis conditions has also been verified experimentally at the test facility in EMEC.

OpenHydro's certified design loading derivation considers the separate contributions of tide, waves, storm and turbulence to the currents imparted on the turbine. This analysis also takes into account the changing magnitude of these contributions across all angles in the horizontal plane. Together with an understanding of deployment tolerances and how coefficients of thrust and torque vary with inflow angle, a clear factor of safety is obtained on the global stability of the device and SubSea Base.

1.7 Fixing system details

OpenHydro's Subsea Base (SSB) support structure is a gravity foundation concept which has been successfully proven on a number of operations. A general concept view of the OpenHydro subsea base arrangement is provided in Figure 5 below. Composed of a combination of structural steel and ballast fill material (normally concrete), the system is designed to be both deployed and recovered using the OpenHydro designed barge system.

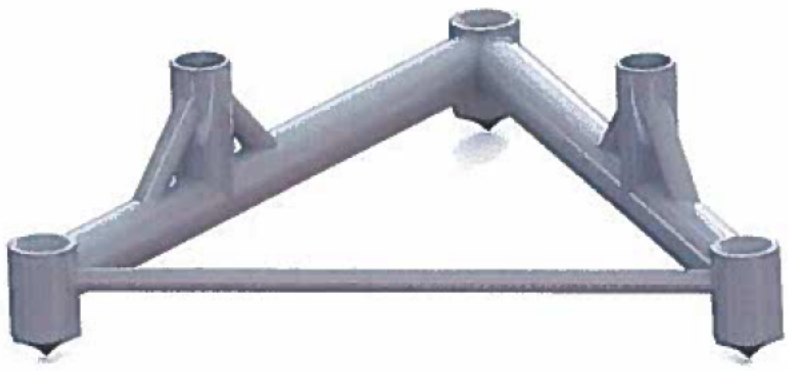


Figure 5 - Subsea Base Concept Design

This allows the turbine and SSB to be placed at a pre-determined location without any preparation of the landing surface. An algorithm is used to analyse the bathymetry across the entire development site and screen out any deployment positions which would result in problematic levels of tilt [redacted] or seabed protrusion within the Subsea Base foot-print [redacted]. Together with the proven accuracy of the deployment methodology, this method allows problematic areas of the seabed to be safely avoided.

Footprint of demonstration device

The SubSea Base which will support the turbine will have a length and width of no more than 40 m, as shown in Figure 23. Final dimensions will be chosen by consideration of the footprint and ballast required to prevent overturning.

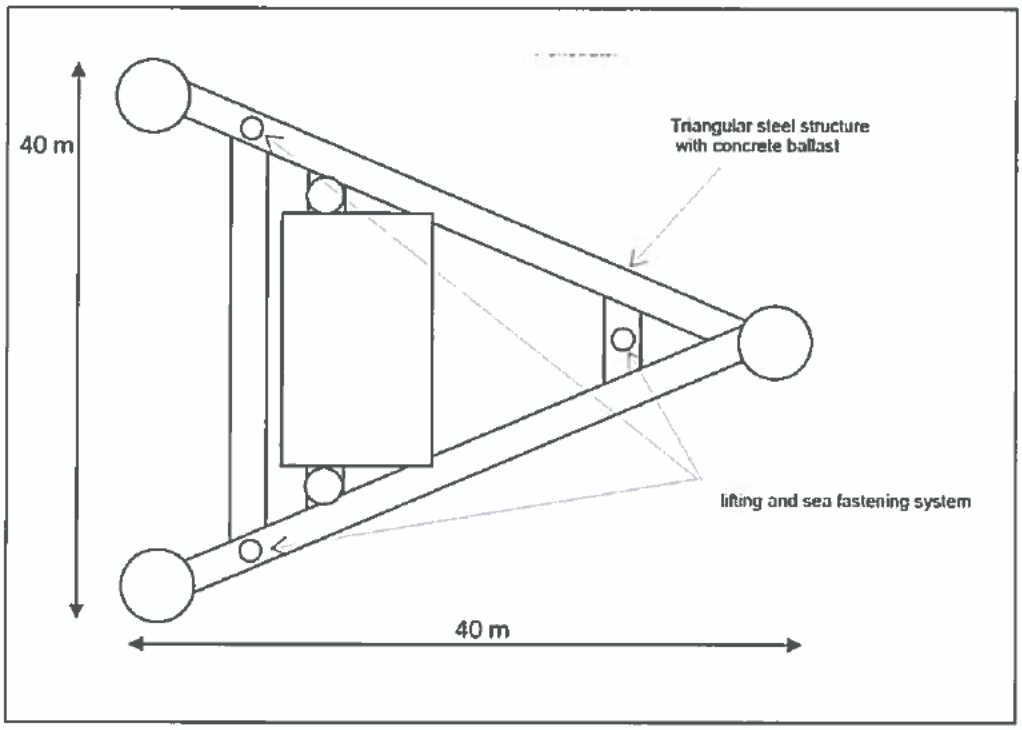


Figure 6: SubSea Base footprint dimensions (Not to scale)

1.8 Redundancy

Generator Components

The generator consists of a large number of parallel groups of coils in series of 24 groups of 3 coils. [redacted]

PLC

The Programmable Logic Controller (PLC) provides the means to manage all turbine control systems and system protection mechanisms. The PLC also manages all data capture and management functions. Dual redundant PLC's are provided with each turbine control centre which allows redundancy in the event of a hardware shutdown. One of the PLC's will be onshore and connected to the turbine system via an optical fibre link.

2 Tidal Array

2.1 Modelling used to develop the array

CFD modelling has been undertaken to determine proper device spacing guidelines to reduce wake effect interaction between devices to an acceptable level. The results of various simulations suggest that devices should be spaced at least 80 meters (5 rotor diameters) apart in the direction normal to the predominant flows and 200 meters (approximately 12 rotor diameters) apart in the direction parallel to the predominant flows.

Since the proposed array will only consist of two turbines, OpenHydro will not to deploy one device downstream of the other.

Considerations and Assumptions

Seabed Location Characterisation

OpenHydro has developed an automated process for identifying areas of seabed that would prove unsuitable for device deployment. The process places a device at every point on the bathymetry map and determines if the resulting tilt of the device would be acceptable or if there are any objects that would protrude far enough within the SubSea Base to obstruct operation of the device.

The tilt of the device is defined as the angle between the plane comprising the three feet of the device's subsea base and the horizontal plane. Figure 19 illustrates this definition. The tripod configuration of the feet on the OpenHydro SubSea Base provides some tolerance for deployment on uneven terrain.

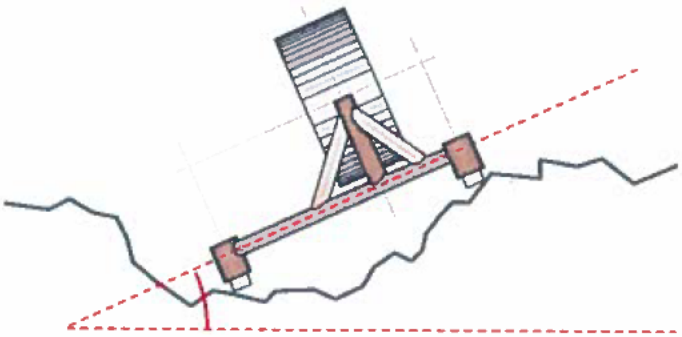


Figure 7: Illustration depicting the definition of turbine tilt

Protrusion occurs when a seabed feature or boulder penetrates the plane created by the three feet of the device's SubSea Base. Figure 25 illustrates this concept. The triangular SubSea Base of the Open Centre Turbine allows for protrusions to penetrate its frame; however, any protrusion with a height near that of the turbine or outer venturi is considered unacceptable as it may come in contact with one of the crossbeams of the subsea base or the outer venturi of the turbine.

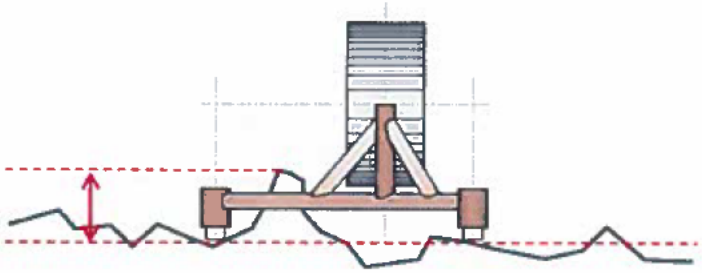


Figure 8: Illustration depicting the definition of protrusion.

This bathymetry analysis tool takes into account the desired orientation of the turbine with respect to the predominant flow directions, with an allowance for the turbine deployment accuracy of ±10°. The maximum protrusion allowed is [redacted] and the maximum tilt is [redacted] in any direction. The process also assumes that all potential obstacles have been properly characterised within the bathymetric data.

Results of the modelling

Applying this process to the area surrounding Berth D produces three different layers that each indicate locations considered unsuitable for turbine deployment based on their respective characteristic (*i.e.* turbine tilt, protrusion height, and deployment depth).

The results indicate that deployment of two turbines at Berth D in an array is possible, with the preferred configuration being referred to as the proposed layout (see next section).

2.2 Proposed Array Layout including cable connections

Proposed layout

The configuration shown in Figure 9 is the preferred location and places the two turbines near to the Berth D centroid and the location where the flow (ADCP- Acoustic Doppler Current Profile) data was collected. There is a lateral turbine spacing of approximately 100 meters normal to the predominant flow directions. Energy predictions at this site have a higher degree of certainty than the other configurations due to the close proximity to ADCP data.

Array connections

The two turbines in the array will be connected to a common, offshore hub connecting the two turbines to the sub-sea export cable. The two turbines will function independently of each other so, should one turbine fail, the functionality of the other turbine is not affected.

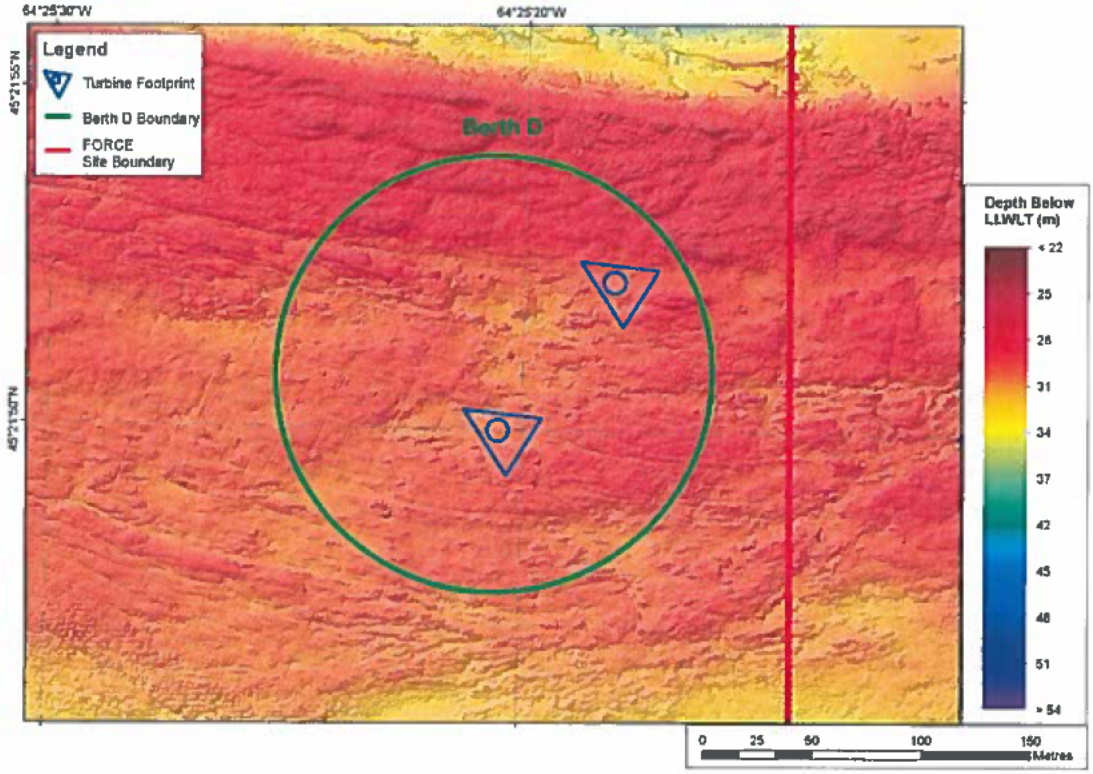


Figure 9: Tidal Array Proposed Layout

3 Predicted Performance

3.1 Predicted Energy Capture Efficiency

The energy capture efficiency of the Open Centre Turbine is an area of continuous research and improvement. The power curve for the proposed system is shown in Figure 10. This curve shows the power delivered to shore, after hydrodynamic, mechanical, electrical and transmission losses within the system are accounted for. There are three zones within the power curve as shown in Figure 1 below:

- Zone 1: Up to the cut-in speed of the system, no power is generated. The turbine system uses an electrical kick start function to commence generation at approximately 1 m/s.
- Zone 2: Once kick started the turbine operates with an optimised efficiency controlled by a Maximum Power Point Tracking (MPPT) algorithm developed by OpenHydro.
- Zone 3: Once the system reaches the power cap level (2MW), the control system automatically adjusts the running parameters to maintain constant power – [redacted]

Figure 10: Predicted power generation of a 16m Turbine System.

3.2 Predicted Availability

The average annual availability for the OpenHydro device is predicted to be approximately [redacted]%. This will be confirmed through the demonstration phase.

3.3 Basis for Prediction

The performance and reliability predictions are based on the knowledge acquired from:

- Turbine testing: Four 16m Open-Centre Turbines have been deployed and recovered for inspections at sites in France (Paimpol-Bréhat) and Canada (Minas Passage).
- Scale turbine testing: Seven generations of 6m scale Open-Centre Turbines have been successfully tested at EMEC in the Orkney Islands, Scotland.
- Computation simulation: CFD is used to model turbine performance and loading.
- Laboratory scale testing: Tank testing of scale models is carried out to validate the computational modelling tools.

3.4 Device Maintenance

The main driver for the maintenance interval for the Open-Centre Turbine is the replacement of the wear pads within the bearing system. OpenHydro has tested the bearing system in real conditions at scales from 6m to 16m turbines and in laboratory conditions. On the basis of the findings to date, a 5-year maintenance interval is planned. Continuous monitoring of the bearing wear is carried out, allowing early intervention to be planned if required.

Scheduled Maintenance Procedure

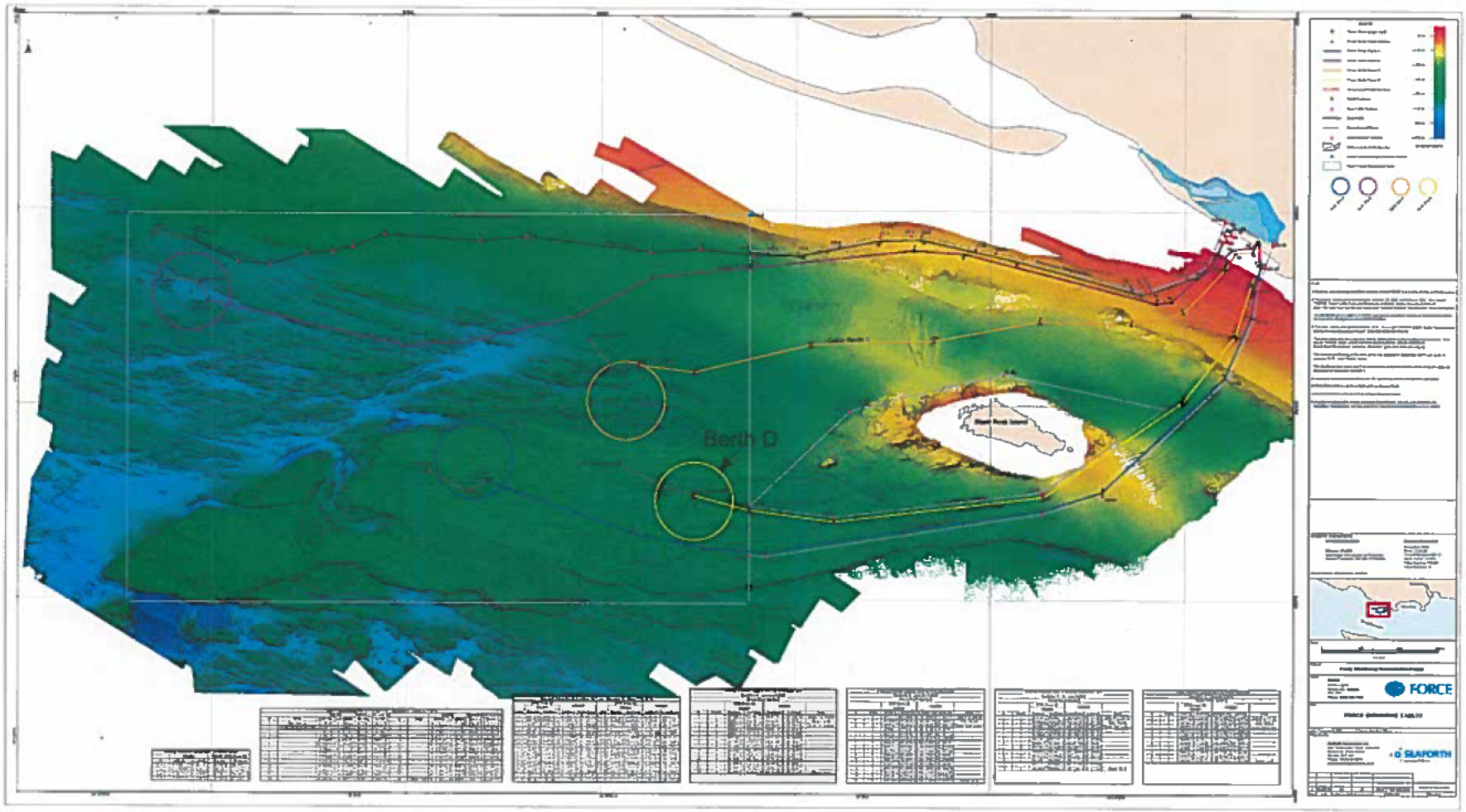
The maintenance procedure for the devices will consist of recovering the device, performing the maintenance onshore, and then re-deploying the device. Table 11 highlights the standard maintenance activities that are planned to be carried out on every maintenance cycle.

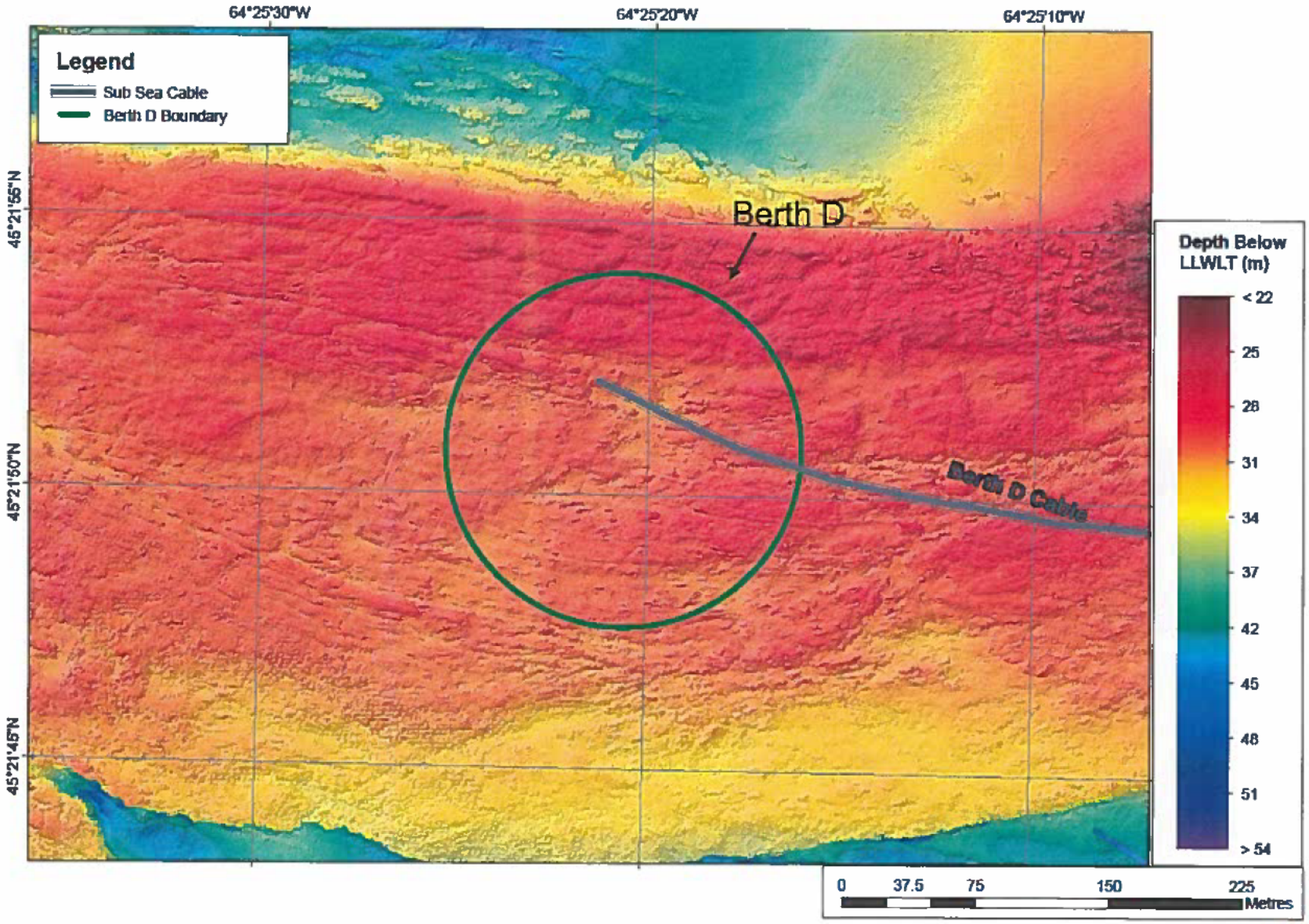
Table 1: Standard Device Maintenance Activities

Activity	Description
Turbine Inspection	The turbine is designed to allow access to the static components of the generator. A full inspection will identify any adjustments or component replacements required.
Bearings	It is planned to replace the wear pads in the bearing system at each maintenance cycle
Anodes	All anodes in the cathodic protection system will be inspected and those with less than 5 years life remaining will be replaced.
Surface Repairs	Coating system touch up will be carried out.
Electrical system	Full systems check and maintenance prior to redeployment.

Schedule B – Survey of Berth D

Beginning at a centre point having a northing of 5024384.64 metres and an easting of 388607.56 metres and extending radially 200 metres.





The above described Cape Sharp Tidal Venture Licence Area (Berth D) contains an area of 12.56 hectares.

CAPE SHARP TIDAL

Cape Sharp Tidal Project Plan

Date	27th February 2018
Author	Kieran O'Malley/Anne-Marie Belliveau
Reviewed	Alisdair McLean

Cape Sharp Tidal Venture Ltd.

Version history

Revision	Date	Author	Description
0.1	22.01.2018	Kieran O'Malley	Issue for review
0.2	26.01.2018	Kieran O'Malley	Issue for review
0.3	27.02.2018	Kieran O'Malley	Final issue
0.4			
0.5			
0.6			

Table of Contents

Introduction

This project plan for Cape Sharp Tidal project sets out the following in accordance with correspondence from the Nova Scotia Department of Energy to Cape Sharp Tidal dated 19th December 2017:

- any changes to the project, including a rationale for these changes;
- project milestones that set out how the project will meet the Commercial Operation Date set out in the FiT Approval and beyond; and
- a description of activities required to meet these project milestones.

1) Project Changes

The only significant project change from the previous project documents submitted is that the milestone dates (including Commercial Operation Date) need to be updated to reflect the current project status. This is discussed in more detail in the following section.

2) Project Milestones

The project plan which forms part of the project agreement between Cape Sharp Tidal Ventures Ltd. (CST) and the Province of Nova Scotia as represented by the Minister of Energy (Department of Energy – DoE) was dated 27th March 2014.

CST has made significant progress in the design, procurement, construction and installation of two turbines at Berth D at Fundy Ocean Research Centre for Energy (FORCE) culminating in the deployment and connection to the grid of the first in-stream tidal turbine in North America in November 2017. The installation date was later than originally planned due to several unforeseen events. The turbine was disconnected from the grid in April 2017 and recovered in June 2017 to complete upgrades and repairs to the turbine control centre (TCC) that is attached to the turbine.

Table 1 below sets out the proposed milestones to complete the installation and commissioning of the two turbines.

Table 1 – Revised Milestones to Project Completion

Activity	First Turbine Redeployment	Second Turbine Deployment
Design validation complete	Complete	[redacted]
Build commences	Complete	
Build complete	[redacted]	
Mobilisation complete		
Deployment and grid connection		
Commercial Operation Date		

3) Project Milestone Activities

This section provides an overview of the activities required to meet the project milestones.

Design Validation Complete

This activity is not required for the first turbine redeployment as design of this turbine has been completed. The second turbine is an updated version of the first turbine with many design improvements. The design improvements will result in more efficient and reliable operation of the turbine and is the next evolution in the Open-Centre Turbine design. The design validation is a final check on the design and loading calculations for the turbine improvements.

Build Commences

This is not required for the first turbine redeployment as repair works are well under way. For the second turbine, once the design validation has been completed, procurement of the newly designed elements can commence. This will involve a tender process and negotiation with suppliers and signing of contracts. Once this has been completed and relevant parts have been delivered, the turbine build commences.

Build Complete

This marks the date that construction of all the main elements of the turbine system - the subsea base, the generator, the turbine control centre and electrical cable tails – is complete. For the first turbine redeployment, the final element to be completed is the TCC which is due to be finished by end of March.

Mobilisation Complete

Once the turbine build is completed, the turbine elements need to be transported to the site from where they will be deployed and all the elements assembled, connected up and tested. Mobilisation is complete when the full turbine system is assembled on the barge at the quayside ready for deployment.

Deployment and Grid Connection

Following from the mobilisation, the turbine and associated systems are tested in tow trials (under tow on the barge). Once these have concluded satisfactorily, the turbine is delivered to Berth D at FORCE and lowered into position. Once the turbine is in position, cable connection works are completed. Following some final on-site tests, the turbine is connected to the national grid and power generated from the turbine is exported to the grid through the FORCE substation.

Commercial Operation Date

When the turbine is connected to the grid, a number of further tests are carried out to confirm that the turbine operates as expected and in compliance with the grid code. Once this is confirmed, full commercial operation can commence.

Schedule D – Insurance Requirements

Commercial General Liability Insurance

Comprehensive General Liability Insurance for liabilities arising out of property damage, personal injury and bodily injury including death resulting from any activity connected with the existence, management, maintenance and operation of Cape Sharp Tidal Venture Ltd.'s tidal energy project at FORCE. All such policies shall name as Additional Insureds Nova Scotia, their successors and assigns, and their respective directors, officers and employees. This insurance will include the following provisions:

- policy limit of liability of $5 million per occurrence (can be structured as primary plus supplementary layers or primary plus Umbrella and/or Excess);
- annual aggregate limits permitted for Products Hazard & Completed Operations, Pollution coverage and Employee Benefits liability coverage; no other policy aggregates permitted;
- Products Hazard and Completed Operations, Pollution coverage subject to separate annual aggregate limits equal to the policy limit of liability;
- Sudden & Accidental Pollution coverage for all insured perils;
- nil deductible for Bodily Injury;
- maximum deductible all other occurrences of $100,000 per occurrence, except Sudden & Accidental Pollution ($1.0 million each claim);
- no hazardous operations exclusion permitted (i.e. excavation, pile driving, shoring, blasting, under-pinning or demolition);
- owners' and contractors' protective liability;
- blanket written and oral contractual liability;
- contingent employers liability;
- personal injury liability;
- broad form occurrence property damage; and
- fire fighting expense liability.

Environmental Impairment Liability Insurance

Environmental Insurance insuring Cape Sharp Tidal Venture Ltd., all contractors, subcontractors, suppliers, and tradesmen while working on site, engineers, architects, consultants and subcontractors, Nova Scotia, their successors and assigns and their respective directors, officers, employees, agents and servants.

The insurance shall include the following provisions:

- policy limit of $5 million per occurrence (can be structured as Primary plus Supplementary, Layered or Primary plus Umbrella and/or Excess);
- Claims made form permitted;

- Extended reporting period of 24 months, as required;
- Minimum of 24 months completed operations coverage;
- Cross liability and separation of interest with respect to each Insured;
- Nova Scotia and their respective directors, officers and employees included as Additional Insureds;
- Breach of any of the terms or conditions of the policy, or any negligence or willful act or omission or false representation by an Insured or any other person, shall not invalidate the insurance with respect to Nova Scotia; and
- Primary insurance without right of contribution of any other insurance carried by Nova Scotia.

Marine - Hull & Machinery And P&I (Protection & Indemnity)

Insuring the machinery equipment vessels and other marine property of contractors and subcontractors not insured under any other water craft provisions found in the course of construction policies.

The insurance shall include the following provisions:

- policy limit of liability Hull & Machinery of $5 million per occurrence; and
- Protection & Indemnity (P&I) limit of liability as defined by Canadian Marine Underwriting Standards.

Documentation Required

The general insurance documentation to be produced by Cape Sharp Tidal Venture Ltd. shall meet the following requirements. No other documentation is required. For general insurance purposes, Cape Sharp Tidal Venture Ltd., may elect to have separate letters produced for the construction period and the operating phase, or may combine these into one letter from one broker covering both the construction period and the operating phase.

General Insurance – Construction Period

For the general insurance program covering the construction period, Cape Sharp Tidal Venture must produce by at the latest four months prior to deployment a letter from its insurance broker appointed for the project, on the broker's letterhead, dated and signed by an authorized representative of the insurance broker, stating:

- that the broker has been appointed by Cape Sharp Tidal Venture Ltd. as its insurance broker for the construction period of the Cape Sharp Tidal Venture Ltd. tidal energy project;
- that the broker has examined the general insurance requirements included in this document, identified as the Insurance Requirements;

- the estimated total amount of the insurance premiums for the full construction period, including any coverage extension periods beyond completion of Cape Sharp Tidal Venture Ltd. tidal energy project and confirming that all of the general insurance requirements set out in the Insurance Requirements have been included in this estimated cost;
- that in the opinion of the broker, the estimated total insurance premium cost is its best estimate as of the date of its letter;
- that in the opinion of the broker, that there is no known impediment as of the date of its letter to producing general insurance policies meeting all of the Insurance Requirements with coverage to take effect from the date of the signing of the Agreement.

If more than one insurance broker has been appointed by Cape Sharp Tidal Venture Ltd. with each broker responsible for a portion of the construction period insurance program, each of the brokers shall produce a letter meeting the above requirements. Each of these letters shall clearly identify the elements of the construction period general insurance program that have been assigned to the respective brokers. Each broker's letter will deal solely with the elements of the construction period insurances that have been assigned to it.

General Insurance – Operating Phase

For the general insurance program covering the operating phase, Cape Sharp Tidal Venture Ltd. must produce a letter from its insurance broker appointed for the project, on the broker's letterhead, dated and signed by an authorized representative of the insurance broker, stating:

- that the broker has been appointed by Cape Sharp Tidal Venture Ltd. as its insurance broker for the operating phase of the Cape Sharp Tidal Venture Ltd. tidal energy project;
- that the broker has examined the general insurance requirements included in this document, identified as the Insurance Requirements;
- the estimated total amount of the insurance premiums for the first full year of the operating phase after completion of Cape Sharp Tidal Venture Ltd. tidal energy project, and confirming that all of the general insurance requirements set out in the Insurance Requirements have been included in this estimated cost;
- that in the opinion of the broker, the estimated total insurance premium cost is its best estimate as of the date of its letter;
- in the opinion of the broker, that there is no known impediment as of the date of its letter to producing general insurance policies meeting all of the Insurance Requirements with coverage to take effect from the date of the signing of the Agreement.

If more than one insurance broker has been appointed by Cape Sharp Tidal Venture Ltd., with each broker responsible for a part of the operating phase insurance program, each of the brokers shall clearly identify the elements of the operating phase insurance program that have been assigned to the respective brokers. Each broker's letter will deal solely with the elements of the operating phase insurances that have been assigned to it.