Alternative Energy

HS1000 1 MW Tidal Turbine at EMEC
Supporting Documentation
ScottishPower Renewables (UK) Limited for Hammerfest Strøm UK Ltd.

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AURORA

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NON-TECHNICAL SUMMARY

Hammerfest Strøm UK Limited (HSUK) propose to install a tidal turbine known as the HS1000 at a test berth at the European Marine Energy Centre (EMEC) tidal test facility in the Fall of Warness off the island of Eday in the Orkney archipelago. This supporting document provides information on the technical details of the project, with specific relation to environmental impacts and mitigation measures.

Based on a 300 kW prototype which has undergone field trials in Norway, the design of the HS1000 has gone through a detailed conceptual phase with adaption for UK tidal conditions. The device has a rated power output of 1 MW and power will not exceed this output.

The installation is to be carried out in May and June 2011. The device will operate for five years with little or no interference. Visual inspections of the device will take place throughout the five years although more inspections are likely to occur in the first year. It is anticipated that the nacelle will be brought onshore once for routine maintenance.

Previous to this document, a scoping consultation was carried out where relevant stakeholders were consulted and invited to express comments on the project. The main issues of wildlife impacts (such as collision risk and underwater noise) and navigational safety and risk were common themes raised by stakeholders and these have been addressed within this supporting document.

HSUK is developing an Environmental Monitoring Plan (EMP) and is keen to work with stakeholders to address any future concerns and monitoring programmes. HSUK has already been in consultation with EMEC and SNH, to ensure issues are adequately addressed and lie within SNH monitoring recommendations and any requirements raised during the consent application process.

A Navigation Safety Risk Assessment (NSRA) has been commissioned from an established risk consultancy, to assess the risk to navigation posed by the installation, operation and maintenance and eventual decommissioning of the device. This alongside ongoing communication with EMEC and consultation with navigation stakeholders has established the necessary actions for mitigating and monitoring any impacts on navigation likely to arise due to the device. The device will be charted as an underwater object of known size and depth and will lie within the already charted EMEC leased area for testing of tidal energy devices. Notice of all operations at the test berth will be issued in line with the EMEC notification procedure.

In addition to navigation risk the other potential issue raised relates to the impact on wildlife in the area, particularly in relation to potential collision and avoidance associated with seals, cetaceans and diving birds. Tidal technology is a novel industry and little impact investigation has thus far been carried out, so impacts associated with devices are largely unknown. Mitigation and monitoring will be applied with this in mind. HSUK have, where possible, developed technology and methodologies to mitigate potential impacts.

Based on the assessment undertaken and the appropriate mitigation and monitoring proposed by HSUK it is concluded that the deployment of the HS1000 will not lead to any significant negative environmental impacts. Due to the novel nature of the technology associated with tidal technology, there remains uncertainty regarding the potential impacts. This is particularly true with regard to impacts on marine wildlife including collision risk, avoidance/attraction and disturbance from underwater noise. HSUK will put into practice an Environmental Monitoring Programme (EMP) which strives to clarify some of the presently unclear issues.

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1 INTRODUCTION

1.1 Background to the project

Hammerfest Strøm UK Limited (hereafter "HSUK") is proposing the installation of a tidal energy device at the European Marine Energy Centre (EMEC) testing facilities at the Fall of Warness off the coast of Eday in the Orkney Islands. Installation is proposed to take place in May/June 2011. The device will have a rated capacity of 1 MW of renewable energy available for export to the grid.

The device, which is known as the HS1000 is based on a 300 kW prototype which has undergone field trials in Norway. The design of the HS1000 has gone through a detailed conceptual phase with adaption for UK tidal conditions. ScottishPower Renewables UK Limited (hereafter "SPR") are working with HSUK on the development of the device, with SPR taking responsibility for consents and licensing and acting as agent on HSUK's behalf.

EMEC is a leading organisation in testing commercial scale wave and tidal technologies. As the first centre of its kind in the world, EMEC has established high standards for environmental performance and has already prepared an Environmental Statement (ES) for the construction of the tidal test site at the Fall of Warness. This document represents supporting environmental information for the deployment and testing of the HS1000 device.

1.2 Purpose and scope of this document

This supporting documentation for the device deployment consent applications has been produced by Xodus AURORA. During its preparation discussions with stakeholders and statutory consultees have been undertaken to support the applications to deploy a tidal test device.

It should be noted that initial consultation discussed the requirement for an application under the Electricity Act 1989, in which electricity generation proposals over 1 MW offshore must be authorised under Section 36 of the Act. This in turn stipulates the requirement to undertake a statutory Environmental Impact Assessment (EIA)/Environmental Statement (ES). HSUK and SPR have made the decision that they will limit the electricity generation of the HS1000 to a maximum of 1 MW and as such neither S36 consent nor a statutory EIA/ES is required.

This study has included consideration of the installation, operation and decommissioning of the HS1000 device at the EMEC Fall of Warness tidal test site, Orkney (see Figure 1.1). The HS1000 device is to be installed at the test berth 1 within the tidal test site. This document considers the tidal device together with any seabed infrastructure required to connect it to the offshore end of the EMEC cable.

1.2.1 Document structure

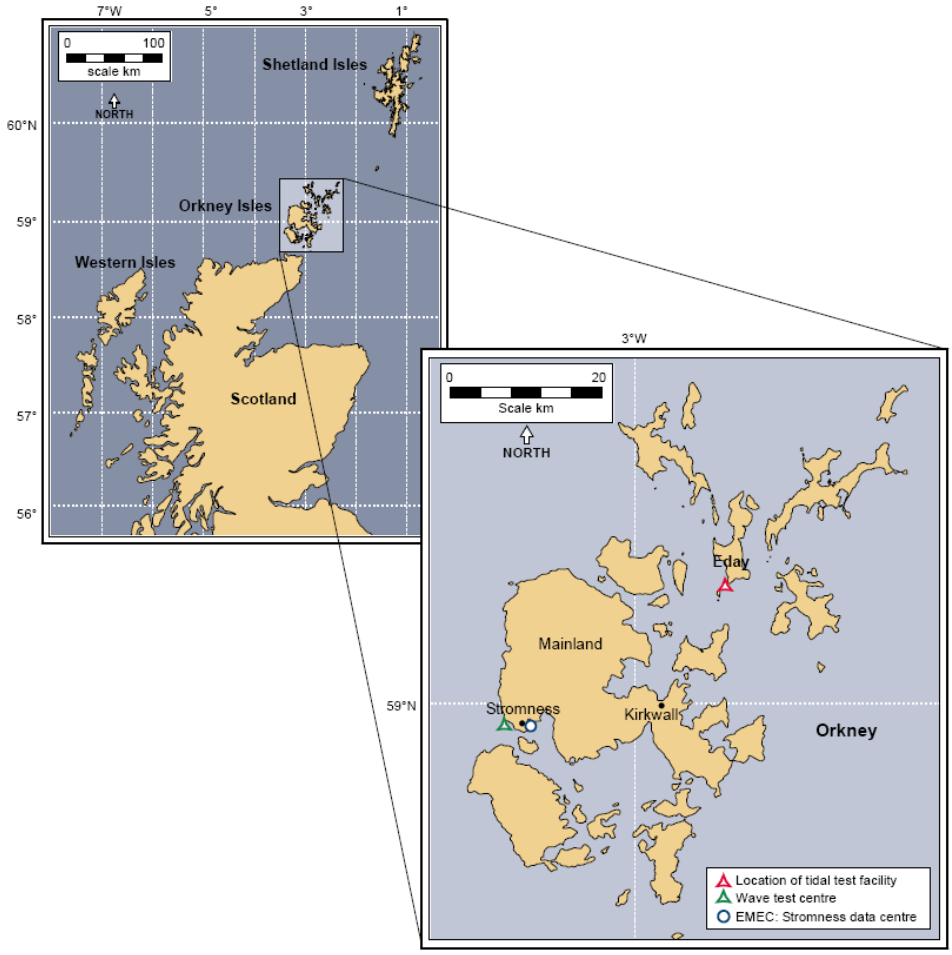
The document is split into a number of sections following the process through which potential environmental impacts of the device have been considered. The key premise of the document is to identify all possible impacts and to look at those identified as significant in greater detail to inform Marine Scotland and its advisors. It also provides a framework for developing an Environmental Monitoring Programme (EMP).

Table 1.1 Explanation of document sections

Section	Title	Explanation
1.4	Legislative framework	Consideration of relevant policy, legislation and guidance relating to the testing of a tidal energy device
1.5	Consultation	A summary of stakeholder responses to Scoping and an indication of where each issue has been addressed within this document
2	Project Description	A detailed description of the proposed project including timescales, methods, device structure and possible accidental events

Section	Title	Explanation
3	Key Environmental Sensitivities	EMEC Monitoring Advisory Group (MAG) Environmental Sensitivities table, incorporating site specific context and discussion of nearby conservation areas
4	Environmental Assessment	Identification and discussion of all potential environmental impacts associated with each phase of development, presented in tabular format with proposed mitigation measures and residual risk ratings
5	Assessment of Potential Key Impacts	Detailed discussion of those impacts identified in Section 4 with a residual impact of moderate or higher, and those potential impacts of unknown significance
6	Mitigation and Monitoring Strategy	A framework strategy for the EMP and a register of commitments made throughout the document

Figure 1.1 Location of tidal test berth, Fall of Warness, Orkney



1.3 Legislative framework

The following consents are likely to be required prior to installation of the turbine at the EMEC facility:

- FEPA Licence – Section 5 Food and Environment Protection Act (FEPA) 1985 Part II;
- Section 34 – Coast Protection Act (CPA) 1949; and
- European Protected Species (EPS) Licence.

Consideration has also been given throughout the project to the EU Birds Directive and the EU Habitats Directive, including the need for Habitats Regulations Assessment (HRA) and associated Appropriate Assessment (AA).

Developers wishing to deploy devices for testing at EMEC are required to submit supporting environmental information which considers the possible range of impacts their device may have on the receiving environment. This process is important as it will help identify sensitive environmental receptors and possible navigational risks at the test site and therefore put in place mitigation measures to minimise any anticipated negative impacts. This supporting document will be supplemented by the subsequent production of a detailed EMP.

EMEC has in place a seabed lease under the Crown Estate Act 1961 for the Fall of Warness tidal test site.

EMEC manages and assists with the licence application process. In addition the EMEC developer guidance advises developers to demonstrate the consideration of environmental issues in the planning, design and decommissioning of its test devices (EMEC 2005a).

1.4 Consultation

As part of the CPA and FEPA consent applications consultation was undertaken in late 2009 and early 2010 with the following organisations: Marine Scotland, Maritime and Coastguard Agency (MCA), Northern Lighthouse Board (NLB), Orkney Fisherman's Association (OFA), Orkney Islands Council (OIC, Marine Services), Royal Society for the Protection of Birds (RSPB), Scottish Environment Protection Agency (SEPA), Scottish Government (Coast Protection Act, CPA) and Scottish Natural Heritage (SNH). Some issues and areas of concern were raised during these consultations, which are summarised in Table 1.2. All issues have been considered by HSUK and are, where appropriate, addressed within this document.

Initial consultation discussed the requirement for an application under the Electricity Act 1989, in which electricity generation proposals over 1 MW offshore must be authorised under Section 36 of the Act. A decision was made to limit the electricity production of the HS1000 to 1 MW meaning neither an S36 consent or statutory EIA/ES is needed. Appropriate consideration has been given to reflect this when addressing the concerns raised during consultation.

Table 1.2 Summary of consultee responses

Organisation	Issue Raised	Response	Section
Scottish Natural Heritage (SNH)	Seal collisions with operational turbines (in particular in relation to protected species - harbour seals at Sanday SAC and grey seals at Faray and Holm of Faray SAC)	This has been considered. Methodologies to monitor the collision risk of the turbine are being considered alongside design and practicality	Section 3 Section 6
	The HS1000 tidal device could result in actions listed as offences under the Habitats Regulations in respect of cetaceans, such as noise and collision risk	Information to inform the Habitats Regulations Assessment has been provided as well as consideration of appropriate and practical mitigation and monitoring Underwater noise studies carried out on the 300kW device in Norway provide initial indications of the acoustic signature of the turbine. Further underwater noise monitoring specific to this site are under consideration Methodologies to monitor the collision risk of the turbine are being considered alongside design and practicality	Section 6 Appendix C
	Land based works may have the potential to affect otters	Any onshore works will be within EMEC's compound on Eday which was consented through the original EIA for the test site and therefore outside the scope of this report	N/A
	Consideration of environmental sensitivities and key conservation designations in the area	These have been considered throughout this document	Section 3 Section 4 Section 5
	CITES Appendix III species basking shark are likely to use the area for passage and feeding	Collision risk and disturbance to basking sharks has been considered	Section 3 Section 4 Section 5 Section 6
	Noise issues during installation and operation	Underwater noise studies carried out on the 300kW device in Norway provide initial indications of the acoustic signature of the turbine. Further underwater noise monitoring specific to this site are under consideration	Section 6 Appendix C

Organisation	Issue Raised	Response	Section
Scottish Natural Heritage (SNH)	A detailed monitoring strategy should be submitted including interaction of the device wildlife and the downstream effects of the device	This has been considered. Methodologies to monitor the collision risk of the turbine are being considered alongside design and practicality Potential effects of the device on the hydrographic environment were covered in the original tidal site EIA which indicated that operations of individual test devices would not result in any significant modification An EMP will be developed in consultation with SNH prior to commencement of installation activities	Section 6
	Antifoulants, lubricants and anti-corrosives. Advocate the use of ultra smooth surfaces and out of sea maintenance over anti fouling paints	All potential discharges to sea and accidental events have been considered, including contingency plans	Section 2
	Site preparation for installation	Prior to the installation there will be no seabed preparation required	Section 2
	Plan and possible impacts of decommissioning	Proposed decommissioning strategy included in this document. In addition a decommissioning programme will be produced	Section 2 Section 4 Section 5
Marine Scotland	Preparation of the seabed prior to construction may be required on a separate FEPA license	Prior to the installation there will be no seabed preparation required	Section 2
	Provision of a Gantt chart for each installation stage	A Gantt chart has been developed for each stage of the installation	Appendix A
	Hydrodynamics of the substructure	Potential effects of the device on the hydrographic environment were covered in the original tidal site EIA which indicated that operations of individual test devices would not result in any significant modification	Section 2
	What type of vessels will be involved in positioning the substructure	Information is provided on the types of vessels to be used	Section 2
	Details on foundations and weights for FEPA application	Information is provided regarding foundations and weight	Section 2
	Timescales and contingency plan for maintenance	Timescales and contingency plan for maintenance have been considered	Section 2
	Have the cables coming onshore been trialled in Scottish waters	All cable work to shore in the tidal test site is the responsibility of EMEC and is therefore out with the scope of this document. Depending on micro-siting, HSUK will need to install 50-150 m of cable between the device and the EMEC cable	Section 1 Section 2

Organisation	Issue Raised	Response	Section
	Seal and otter collision	This has been considered. Methodologies to monitor the collision risk of the turbine are being considered alongside design and practicality Any onshore works will be within EMEC's compound on Eday which was consented through the original EIA for the test site. Marine works will not be within the normal otter range (out to 10 m water depth)	Section 3 Section 6
	Underwater noise relating to cetaceans and migratory fish	Underwater noise studies carried out on the 300kW device in Norway provide initial indications of the acoustic signature created by the turbine. Further underwater noise monitoring specific to this site is under consideration	
SFPA	Have not listed any specific concerns associated with the development	-	
Orkney Islands Council (OIC) Marine Services	Position of device not the same in map and script	Location coordinates (prior to micro-siting) and figures have been provided and are now consistent	Section 1 Section 2
	Depth of water at site stated as 52 m is this correct? OIC think it is less	Water depth was recorded as 52 m below chart datum by IX Survey in 2009	Section 2
	Provision for detached parts and identification of buoyant parts	Accidental events such as components becoming detached (including consideration of their potential buoyancy) have been considered	Section 2 Section 5
	Potential navigational risk to Orkney Ferries	Navigation Risks have been considered and an NSRA has been undertaken	Section 5 Appendix D
Northern Lighthouse Board	Notification to Mariner prior to positioning of well marked and lit vessels	This has been considered in the NSRA	Section 5 Appendix D
	NSRA should include procedures relating to detached parts	This has been considered in the NSRA	Section 5 Appendix D
	Notification of device location to Hydrographic Office	This has been considered in the NSRA	Section 5 Appendix D
	Planning of moorings during installation	Dynamic Positioning Vessels will be used and therefore no mooring requirements. Will be a potential requirement to temporarily buoy the ballast packages during installation. This has been considered in the NSRA	Section 2
	Decommissioning method and timescale	Proposed decommissioning strategy included in this document. In addition a decommissioning programme will be produced	Section 2

Organisation	Issue Raised	Response	Section
Royal Society for the Protection of Birds (RSPB)	Monitoring to gauge effects on biodiversity	Methodologies to monitor the collision risk of the turbine are being considered alongside design and practicality.	Section 6
Maritime and Coastguard Agency (MCA)	The device should be marked to UKHO requirements	This has been considered in the NSRA	Section 2
	New cables should be subject to a site specific NSRA	The HS1000 device will be deployed at an existing EMEC test berth and connect to an existing EMEC cable. Depending on micro-siting, HSUK will need to install 50-150 m of cable between the device and the EMEC cable	N/a

2 PROJECT DESCRIPTION

2.1 Introduction

HSUK are proposing to install a tidal device known as the HS1000 at the EMEC tidal test site. The HS1000 will have a rated capacity of 1 MW and is based on an existing 300 kW prototype device which has undergone extensive testing in the fjords of northern Norway. Testing on the 300 kW device has highlighted the effectiveness of the patented operation methods including a successful installation and reinstallation operation for the device (one of few examples worldwide). The testing period also provided information on the reliability and performance of individual components. Information gathered from the testing period has been used to inform and optimise the design and development of HS1000.

The design of the HS1000 has undergone a detailed conceptual phase with adaption for UK tidal conditions and an increased output from 300 kW in the prototype to 1MW in the HS1000 device.

2.2 Technology

The technology is an evolution of a horizontal axis wind turbine (see Figure 2.1), and there are many similarities in the design of the structure and drive train. However the density of water as compared to air means that the rotor diameter is considerably less than would be required for an equivalent rated wind turbine. The turbine characteristics also incorporate a much slower rotation and tip speed. The nacelle does not yaw like traditional wind turbines. The blades of the device pitch to maximise the energy extracted from the tidal currents and are able to extract energy in both ebb and flood tide. The rotating blades turn a low speed shaft to the gearbox. The gearbox increases the speed of rotation to allow generation at network frequency.

Figure 2.1 Pictorial representation of prototype Hammerfest tidal device

2.3 Location of device

The proposed location of the HS1000 device lies directly south of Seal Skerry, within the EMEC tidal test site, off the west coast of Eday. Figure 2.2 shows detailed information regarding the location and bathymetry at the proposed site.

The device will be located at 59° 08.5231 N, 2°49.0530 W. The feet of the device will have an area of contact with the seabed of 32.97 $m^{2,}$ the overall footprint at this location will be approximately 200 m^2, In addition there will 50 - 150 m of cable connecting the device to the EMEC cable.

2.4 Schedule of operations

The first operation on site will be the installation of the substructure and ballast to the seabed. This will take place in May to June 2011. Cable connection will occur next and finally the nacelle will be lowered onto the support structure and the turbine commissioned. Nacelle installation will also take place in May to June 2011. The commissioning phase will then commence and is expected to last one month.

The schedule is designed so that the support structure and nacelle will be installed on a neap tide, ensuring the most favourable conditions for the operation. The operation is dependent on the correct tidal and weather window coinciding; a slip in the programme due to adverse environmental conditions would mean installing during the next most suitable neap tide.

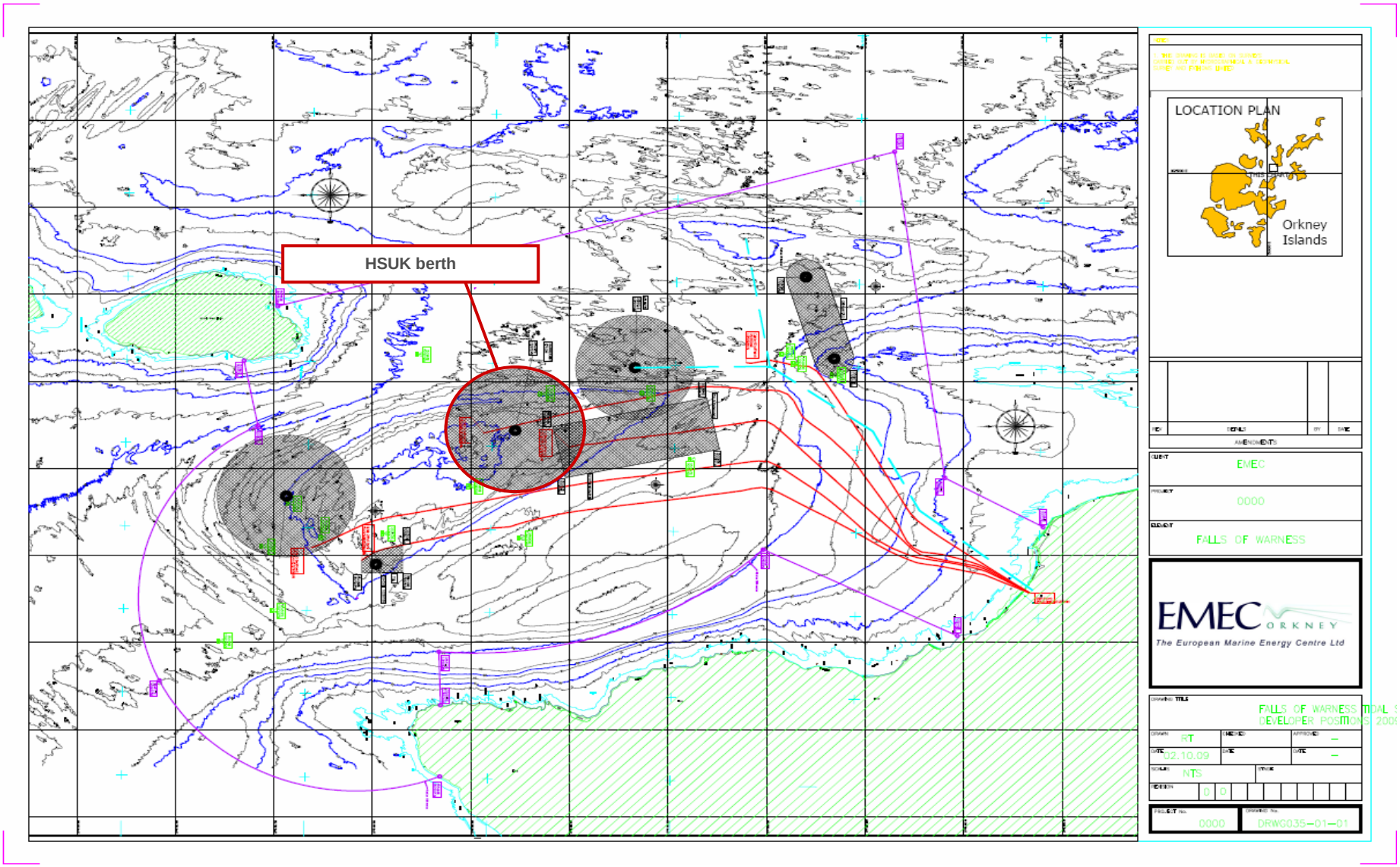
Once fully commissioned, the HS1000 turbine will operate autonomously for approximately five years with the option to extend to an additional five years.

For the detailed proposed schedule of the key tasks of the proposed installation at EMEC, please refer to Appendix A.

2.5 Onshore facility requirements

Any onshore works will be within EMEC's compound on Eday which was consented through the original EIA for the tidal test site and therefore outside the scope of this report.

Figure 2.2 Device location within the EMEC tidal test site



2.6 Device structure and operation

The design of the device has been considered to ensure it can meet the conditions of the environment within which it is intended to operate. The 300kW device operated successfully in Norway for over 4 years. The device will undergo independent third party certification prior to deployment at EMEC.

The device incorporates a substructure (see Figure 2.3), which will include a self-levelling device at the top to allow the turbine rotor to face squarely into the current. The substructure will be seabed mounted and incorporate gravity based foundations using three ballast packages with a combined weight of approximately 800 tonnes in air.

Gravity based foundations enable ease of removal at decommissioning. The nacelle can be removed from the substructure for maintenance purposes. Other than the gravity base the device has no other requirements for mooring or anchoring to the seabed.

Supported on the substructure is a nacelle, comprising a 21 m diameter rotor with a blade length of 8.98 m. The nacelle will not rotate, but the turbine blades will pitch according to the direction and speed of the tidal flow. Table 2.1 outlines indicative overall dimensions of the device.

The device will be connected to the existing EMEC cable via a short umbilical cable. The end point of the EMEC cable is located at 59°08.479'N, 02°49.080'W (353296E 1028567N) and is expected to be approximately 50 – 150 m from the device.

In the event of a cable failure or unsuitability of the EMEC cable it is important that tests can continue. A loadbank may be mounted on the rear leg of the device which will be used to dissipate the electricity generated from the device. This loadbank would not be attached separately to the seabed and will not increase the footprint of the device.

No subsea transformers are required.

Table 2.1 Dimensions of the HS1000 tidal turbine

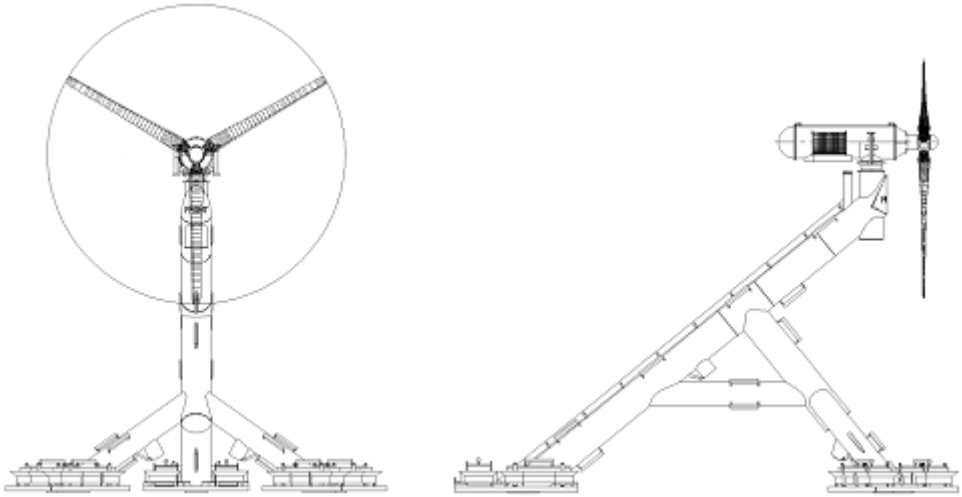
Item	Specification (m)
Support structure height	22
Nacelle centreline height above seabed	22
Blade length	8.98
Rotor diameter	21
Height to blade tip above seabed	32.5

The weight of the substructure will be approximately 160 tonnes in air, increasing to 320 tonnes when the weight of the nacelle is included. This estimated mass excludes the three gravity base securing masses, known as ballast packages, which will together comprise approximately a further 450 tonnes in air.

The tidal flow will rotate the turbine rotor blades and power a generator in the nacelle. The dimensions of the rotor diameter have been designed to accommodate site specific requirements in regard to technical, navigational and environmental conditions such as water depth and tidal resource. The maximum power output of the turbine, rated at a water speed of 2.7 m/s, is 1 MW.

The HS1000 device uses a pitch control mechanism to control power output. This mechanism works by monitoring output and using a hydraulic system to feather each of the three blades, thereby controlling hydrodynamic lift and the torque produced. This ensures that power output is capped at 1 MW. In addition the device is fitted with one mechanical brake. This control method has been extensively proven by the prototype device in Norway which was operated successfully for four years before being removed for research and then re-installed in August 2009.

Figure 2.3 Illustration/drawing of the HS1000 tidal turbine



2.7 Installation

The installation of the device will comprise of two main operations, both occurring in May to June 2011:

- Substructure and cable installation
- Nacelle installation

Operations will be scheduled to take place during daylight hours; however, as mitigation to delays, operations may need to take place during the hours of darkness if a period of slack water occurs at this time. At the proposed installation date hours of day light will be in the region of 20 hours.

2.7.1 Site establishment and vessel requirements

Prior to installation of the device no seabed preparation will be required. It is intended that a Dynamic Positioning (DP) vessel will be used for installation. The vessel will remain in position by operation of its dynamic positioning thruster system. Table 2.2 provides details of the vessels involved with the different activities and the number of days that the vessels will be on site. Detailed vessel specification for the vessels likely to be used is included in Appendix A.

Table 2.2 Vessel activities

Activity	Type of vessel	No. of days on site over a 5 year period
Installation of substructure	DP heavy lift	1
Cable connection	DP	3
Nacelle installation	DP heavy lift	1
Maintenance – ROV surveys	DP	9 (over 5 years)
Maintenance – nacelle removal	DP heavy lift	1
Decommissioning	DP heavy lift	2

2.7.2 Substructure (including ballast) installation and cable connection

The three ballast packages will be lifted to the seabed and buoyed off for later pick up and placement. This ensures that once the substructure is positioned, the time it remains with no ballast in situ is kept to a minimum.

At an acceptable tidal velocity towards slack water the substructure will then be lowered to the seabed from the vessel using a crane. The orientation and attitude of the structure will then be checked via acoustic positioning and verified by ROV. The lifting slings and tag lines will then be released by the ROV. The ballast packages will then

be lifted into the ballast receptacles on the support structure. This will be monitored by ROV before the ballast lifting wire is released.

Following installation of the substructure and ballast packages the umbilical cable will be installed to connect the substructure to the EMEC cable. The EMEC cable termination is lifted and the umbilical cable is connected. Cable tests will then be carried out prior to the umbilical cable being laid towards the substructure. An ROV will remove the wet mate receptacle protection caps and connect the Medium Voltage (MV) cable from the substructure to the corresponding receptacle at the end of the umbilical. Instrumentation packages will connect the umbilical to the substructure.

In the event that the EMEC cable is not suitable a loadbank will be used, this is discussed in section 2.9.4.

An as-installed survey is then carried out using ROV, followed by demobilisation of the vessel and equipment.

2.7.3 Nacelle installation

In advance of a slack tide the nacelle will be lifted from a heavy lift DP vessel ready for immediate deployment. At maximum allowable tidal velocity the nacelle will be lowered using guide lines. Once the nacelle is landed it will be locked using ROV. The MV cable is then mated to the nacelle.

An as-built survey is then conducted using ROV, followed by demobilisation of vessel and equipment. The DP vessel is expected to be on site for one day during the installation of the nacelle.

2.8 Materials

Table 2.3 lists the main material types which comprise each part of the tidal device (including reference to material safety data sheets (MSDS) where appropriate).

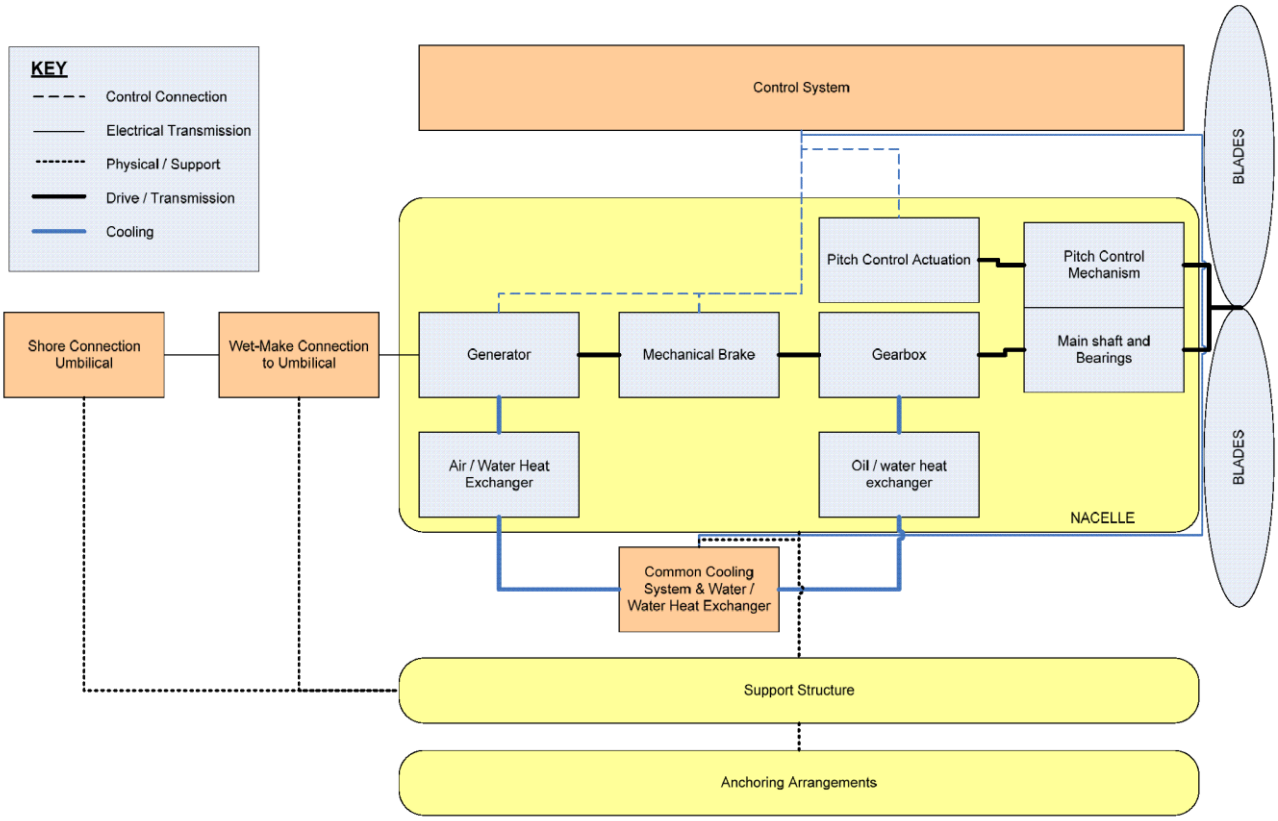
Table 2.3 Table of deposits on the seabed

Material	Grade/Spec	Quantity	Comment
Carbon Steel (nacelle, ballast, substructure)		1120 tonnes	
Duplex stainless steel (cable connectors)		< 100 kg	
Aluminium (anodes)		350kg	
Bronze (seals)		<100kg	
Glass reinforced polymer (nose cone)		4 tonnes	
Glass/carbon/epoxy composite		12 tonnes	Initial estimate
Battery		TBC	Inside sealed nacelle
Paint	NORSOK M-501	300 litres	Initial estimate
Antifoulants	Intersleek 900	100 litres	
Lubricant (Hub)	Oils	<1500 litres	
Lubricant (Gearbox)	Oils	<750 litres	
Lubricant (Hydraulics)	Oils	<600 litres	
Lubricant (Main bearing)	Oils	<300 litres	
Lubricant (Generator)	Oils	<100 litres	

2.9 Subsystems

Figure 2.3 shows the principal subsystems contained within the nacelle. These are described under the section headings which follow.

Figure 2.3 Diagram to show principal subsystems of the tidal device



2.9.1 Power conversion system

The nacelle of the device will have a power rated capacity of 1 MW, although the device will not be continuously generating at this power level.

The rotational speed of the turbine blades at the rated power output of 1 MW will be 10.2rpm with a blade tip speed of 11.2 m/s. The blades pitch in order to maximise the energy extracted from the tidal currents during normal operation. During normal stop and emergency stop of the turbine, the pitch mechanism will assist in slowing down the turbine.

The gearbox will step up the rotational speed to the generator. This is a similar arrangement to that found in many wind turbine designs. The low speed shaft connects the gearbox to the turbine rotor. The gearbox increases the rotational speed to allow the generator to produce electrical output at the required frequency for network connection. Electrical power is then transferred to shore via the connecting power and control cable.

The blades and nacelle are designed to be negatively buoyant.

2.9.2 Mechanical brake

A mechanical brake will be located on the high speed shaft between the gearbox and generator. This, in conjunction with the pitch control system will allow rotation of the device to be stopped in an emergency and for maintenance and inspection purposes.

2.9.3 Cooling system

A number of components within the nacelle produce heat during their operation. This is removed by a common cooling system which is cooled, via a heat exchanger, by water from the external environment. The main heat producing components in the nacelle are:

- Main bearings

- Gearbox
- Generator

The cooling system will result in slightly elevated temperatures around the device. During operation the heat exchanger will discharge heat into the tidal stream. Due to the continuous flow of water past the device and subsequent mixing and dispersion within a large body of open water, the device will not result in a build-up of heat within the local environment. The temperature increase resulting from the cooling system is expected to be negligible.

2.9.4 Loadbank system

If required, a loadbank will be mounted on the rear leg of the substructure. Its dimensions will be approximately 2 x 3 x 4 m and weigh 4 tonnes. The loadbank will help dissipate any electricity generated should the EMEC cable to shore not be functioning correctly. It is expected that under full capacity there will be a temperature increase within one metre of the device of about 0.02 °C. The loadbank will be coated in the same material as the substructure.

2.9.5 Lubrication and hydraulic systems

The main bearings, gearbox and pitch mechanism require lubrication and this is provided for by up to four sealed oil lubrication systems. To enable the three to five year service interval of the device to be achieved, the lubrication systems contain multiple high quality filtration systems.

Lubrication of the generator is provided through a small inventory of grease contained within the bearings.

A hydraulic system will exist to provide actuation as part of the pitch control mechanism. In addition the hydraulic system may be used to operate the mechanical brake. The hydraulic system will be sealed and contain an inventory of oil.

2.9.6 Nacelle Sealing

The nacelle will be a fully sealed unit. The seal will be a water lubricated seal designed to retain a dry internal environment to protect the sensitive systems contained within it. Should any water ingress occur, it will be monitored via a bilge and level alarm. Water collected will be retained within the nacelle until it is removed to land during a servicing operation. Water will then be drained, and disposed of in an appropriate manner.

2.9.7 Control system

The device can be controlled remotely via the SCADA connections and control system. These are used to start and stop the turbine, pitch the blades and operate the onshore electrical equipment to allow grid connection. They also communicate with the various operating systems and condition monitoring systems to provide status reports and alarms on a wide variety of performance indicators such as generator temperature, voltage, and water ingress amongst others. Under normal operating conditions the device can be operated automatically and does not require constant supervision to optimise output and carry out start up and shut down operations. However, it is possible to manually intervene with the device using the control systems.

2.10 Corrosion protection

In compliance with North Sea standards, cathodic protection will be provided in the form of an aluminium sacrificial anode.

2.11 Antifouling system

Methods for preventing marine growth (prevention and removal) will be investigated during the testing period at EMEC. Currently a combination of copper and thermoplastic based proprietary paints is proposed.

A method for cleaning marine growth from the blades is also currently in development and will be tested on the prototype installed at EMEC.

2.12 Atmospheric emissions

No atmospheric emissions will be produced by the device during operation; however emissions will be produced by the vessels used to install, maintain and decommission the device at the test site location. Estimated emissions for each stage of the device's life are given in Table 2.4.

Calculation factors are based on UK Oil and Gas emissions factors and the Institute of Petroleum (2000) provide guideline fuel consumption figures, which estimate a fuel consumption of between 18 and 20 tonnes per 24 hour day. This fuel consumption factor is an estimate for a working DP vessel and working heavy lift DP vessel.

It is assumed for these calculations that only one vessel will be required on site at any given time. Cable connection and general maintenance will be carried out from the smaller DP vessel but should nacelle recovery be required for maintenance, a heavy lift DP vessel will be used.

The atmospheric emissions produced in Table 2.4 are given as the total emissions for the five year testing period. Based on DEFRA (2007) figures for UK emissions in 2006, the emissions for the whole project are equivalent to 0.004% of the UK's yearly emissions. However, it should be considered that when the 1 MW device is commissioned this will give a CO_2 saving for the energy production sector.

2.13 Device marking

Device marking is discussed in detail in the NSRA.

2.14 Maintenance and servicing requirements

The nacelle of the device is designed to be removable from the substructure for maintenance. Upon removal of the nacelle for maintenance purposes it will be transported to shore and not maintained in situ. It will then be transported back to the site and reinstalled after maintenance activities have been completed. This will be carried out using a heavy lift DP vessel which is expected to be on site for one day.

The device can also be visually inspected with the use of an ROV.

The device is designed for a maintenance interval of three - five years. During this period it is intended that no significant intervention activities will be required. Between two and six ROV inspections will be made of the device during the first year of testing. For these inspections a ROV will be deployed from a DP vessel. The vessel will be on site for a period of one day. Observations recorded during the first year will be used to determine the inspection interval used beyond this time, and it is expected that the inspection interval will be lengthened. Presently it is estimated there will be a requirement for three further inspections after the first year.

During the operating history of the 300 kW prototype the device operated reliably in-situ for four years and did not have to be removed for maintenance as a result of faults. On removal of the device for forensic examination to assess component wear it was found all components to be in a good state of repair and the device was redeployed in the same location in August 2009.

Table 2.4 Atmospheric emissions (Institute of petroleum, 2000)

Phase	Vessel	Fuel consumption (tonnes/day)	Days	Atmospheric emissions (tonnes) (2 d.p.)						
				CO_2	CO	NO_X	N_2O	SO_2	CH_4	VOC
Installation of substructure	Heavy lift	20	1	64.00	0.17	0.73	0.00	0.00	0.00	0.02
Cable connection	Small DP	18	3	172.80	0.45	1.97	0.01	0.00	0.01	0.06
Nacelle installation	Heavy lift	20	1	64.00	0.17	0.73	0.00	0.00	0.00	0.02
Maintenance – ROV	Small DP	18	9	518.40	1.34	5.90	0.04	0.00	0.02	0.19
Maintenance – nacelle	Heavy lift	20	1	64.00	0.17	0.73	0.00	0.00	0.00	0.02
Decommissioning	Heavy lift	20	2	128.00	0.33	1.46	0.01	0.00	0.00	0.05
TOTAL			**17**	**1011.20**	**2.62**	**11.50**	**0.07**	**0.00**	**0.03**	**0.38**

2.15 Decommissioning

Prior to decommissioning a Decommissioning Plan will be submitted to DECC in line with the Energy Act 2004. The decommissioning procedure is virtually a reversal of installation. A heavy lift DP vessel will be used for decommissioning and is expected to be on site for two days. The five phases of decommissioning will be:

- Lift and removal of the nacelle;
- Subsea cutting of umbilical cable;
- Removal of ballast packages;
- Lifting of substructure; and
- Recovery of umbilical cable.

2.16 Accidental events

The device will contain oils for lubrication and hydraulic fluids. These will be recognised marine standard substances appropriate for the device and the environment.

The device is equipped to allow remote access and control, and this will allow it to be controlled via a suitable connection. A control computer will be located at the Eday substation and a further control location may be established at EMEC's Stromness data centre and through the remote access, the system will be accessible from anywhere.

In the event of a mechanical failure the device control system will shut the system down. This is achieved by pitching the blades to shed power, and by activating the mechanical brake to halt turbine rotation.

The following contingency arrangements will be in place to minimise the impact of any accidental events:

- An Emergency Response Plan which will be the responsibility of HSUK will be developed in conjunction with EMEC and will dovetail with Emenrgency Response Plans already put in place by EMEC;
- All vessels used will be audited in line with the developers procedures; and
- Vessels will be required to carry oil and chemical spill mop-up kits and have a Shipboard Oil Pollution Emergency Plan (if appropriate) in place.

A hazard identification and risk assessment (HIRA) will be carried out under the EMEC permit to work system to ensure that risks arising during the installation and operational phases are effectively managed. Table 2.5 summarises the key accidental events likely to be associated with deployment of the HS1000 device at the EMEC tidal test site.

Table 2.5 Accidental events

Event	Detection mechanism	Potential Impact	Mitigation
Loss of equipment (support structure, ballast packages, nacelle) during transit	Visual	Damage to equipment, damage to vessel, injury to crew (possibly fatal)	Sea fastening of all temporary items to deck will be undertaken in accordance with the conditions of the vessel class and will be approved prior to acceptance of sail away by independent third party warranty surveyor
Loss of equipment (support structure, ballast packages, nacelle) during installation	Visual Crane will register sudden loss of weight	Ballast packages or equipment will sink to the seabed resulting in damage to equipment being installed or equipment previously set down.	Lifting operations will be conducted using appropriately rated lifting equipment and lifting gear maintained and examined in accordance with a suitable scheme meeting regulatory requirements. The marine contractor selected will be assessed for competency and use suitably qualified and experienced personnel (SQEP) Installation methodologies and procedures will be subject to an appropriate risk assessment EMEC has a series of Emergency Response Plans (ERPs) and Standard Operating Procedures (SOPs) and all plans drawn up by HSUK will be fully integrated with these
Nacelle detaches from support structure during operation	Visual Loss in power production	Negatively buoyant and sink to seabed	Engineered to very high safety factors and tested for fatigue
Blades brake off from nacelle during operation	Decrease/loss in power production	Negatively buoyant and sink to seabed	Blades have been engineered to very high safety factors and tested for fatigue
Situation develops that requires shutdown of the device for safety reasons e.g. a grid fault or marine operational emergency	Warning from external parties	Turbine can be remotely shutdown. No further impact to turbine expected	An Uninterruptible Power Supply (UPS) at the EMEC compound on Eday will ensure power for up to 24 hours to the turbine in the event of loss of grid connection
Oil spillage from vessels	Visual	Pollution of water and nearby coast	Vessels will have emergency procedures and where relevant Shipboard Marine Pollution Emergency Plans (SOPEPS) in place that will be implemented in the event of a spill/wider emergency
Oil leak from nacelle	Level and pressure sensors will detect changes in the oil levels	Pollution of water	Only small inventories of oils within the nacelle Nacelle is sealed and at atmospheric pressure. Leakage only possible from high to low pressure and therefore only seawater leakage into nacelle or hub possible. Such leakage will be detected by the controls system and HSUK notified by alarm

3 SUMMARY OF KEY ENVIRONMENTAL SENSITIVITIES

The environmental characteristics of the Fall of Warness tidal test site have been investigated as part of the site development EIA (EMEC, 2005) and subsequent environmental monitoring undertaken by EMEC (SMRU, 2007, 2008). Since 2005 marine wildlife monitoring has been carried out on the tidal test site to establish a baseline of marine wildlife (seals, cetaceans and birds) activities in the waters of the tidal test site. In addition SPR has undertaken a seabed survey to characterise the seabed at the deployment site.

EMEC, together with SNH has compiled an environmental sensitivities chart for the Fall of Warness tidal test site [(EMEC, 2005a) and amended according to data from EMEC Tidal Site Wildlife Observations (2005 –present)]. This is presented in Table 3.1 below. Additional notes to put the SPR test berth location into context have been added in bold italics. The bold line around specific months indicates the months during which installation (substructure and nacelle) and decommissioning operations are likely to take place.

Table 3.2 summarises the conservation interests in and around the EMEC tidal test site of relevance to the offshore deployment of the HS1000 tidal device. The locations of these sites are illustrated in Figure 3.1.

Table 3.1 Seasonal variation of key offshore environmental sensitivities (from EMEC, 2010)

Harbour Seals	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Harbour seals pup in early June and July, and this is followed by a moulting period in late July and early August. The closest haulout sites are at Seal Skerry, The Graand (on the south coast of Eday) and on Muckle and Little Green Holms, with a European protected population on the near by island of Sanday. The key issues to consider are collision risk and construction/operation/decommissioning disturbance. ***HSUK Site Context – Harbour seals from Sanday SAC, approximately 30 km from the proposed test berth, may potentially use the Fall of Warness to travel between haulout sites. The Seal Skerry harbour seal haulout is located 3 km to the north of the proposed test berth.***												
Grey Seals	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The grey seal breeding season is from early October to late November. The moulting period follows in January to March (females), and March to May (males). Grey seal breeding colonies are located adjacent to the site on Muckle and Little Green Holms, with a European Protected SAC to the north on the islands of Faray and Holm of Faray. The key issues to consider are collision risk and construction/operation/decommissioning disturbance. ***HSUK Site Context – Grey seals from Faray SAC, approximately 10 km from the proposed test berth, may potentially use the Fall of Warness to travel between haulout sites. Muckle Green Holm grey seal colony is located 3 km to the south west of the proposed test berth. EMEC observations of marine mammal surface activity indicate grey seal concentrations may be greatest closer to the coast.***												
Harbour Porpoise	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
There are no resident populations of Harbour Porpoise, however from observations a moderate number of sightings have been made in the months from July to September. This species has a large ranging nature and it has been suggested that they move offshore during the winter. They are also a European Protected Species. The key issues to consider are collision risk and construction/operation/decommissioning disturbance. ***HSUK Site Context – Harbour porpoise are likely to be present at the proposed test berth.***												

Cetaceans	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minke whale, Risso, Orca and White-beaked dolphins have been recorded in the Fall of Warness during the summer months. They carry a high European Protective Species status, but are present in extremely low numbers with a sporadic occurrence. The key issues to consider are collision risk and construction/operation/decommissioning disturbance. ***HSUK Site Context – Cetaceans are likely to be present at the proposed test berth.***												
Birds	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bird species are present all year round and of note there is a cormorant breeding colony on Little Green Holm (April-June) adjacent to the test site. The key issue to consider is collision risk. ***HSUK Site Context – All bird species are protected under the Wildlife and Countryside Act, 1981, which prohibits the killing, injuring, taking or selling of any wild bird or their nest or eggs, in the case of the tidal test site particular attention is given to diving birds. Little Green Holm cormorant breeding colony is located approximately 3.5 km to the south of the proposed test berth.***												
Finfish and Shellfish	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The site (and Orkney as a whole) is located within spawning and nursery areas of a number of fish species. ***HSUK Site Context – Proposed test berth is a very small location relative to the much larger spawning and nursery areas which cover wider areas than Orkney as a whole.***												
Basking Sharks	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
From the wildlife observations, low numbers of basking sharks have been sighted in late summer and are regularly spotted in Orkney waters during the summer. They are usually seen along the tidal fronts where mixing water increases the zooplankton population on which they feed and are a UK BAP priority species. The key issues to consider are collision risk and construction/operation/decommissioning disturbance. ***HSUK Site Context – Basking sharks likely to be present at the proposed test berth.***												
Otters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
A few sporadic otter sightings have been recorded over the past few years in the shallow site waters. Otters normally cub in the winter months in Orkney, although they can breed at any time of the year. They are a European Protected Species (EPS) and the key issue to consider is and disruption caused by shore based works. ***HSUK Site Context – No onshore works outwith those already consented in the original tidal test site EIA proposed.***												

Key: Sensitiviy level	High	Moderate	Low	Minor interaction	Unclear due to lack of data

Information regarding the seabed in the vicinity of the proposed deployment may be taken from the Coastal and Seabed Processes Review undertaken by HR Wallingford (2005), a seabed survey carried out by Aquatera (2005) and a seabed survey carried out by iXSurvey (2009). Results found that the site at Eday is underlain with a stratigraphic rock sequence with superficial sediments formed from eroded sandstones, flagstones and mud stones of the Mid Devonian period. Where surficial sediments exist they are discontinuous and have little internal structure and have, on average, an overlying depth of 1.5 metres from the seabed. Coarse dense sediments interpreted as

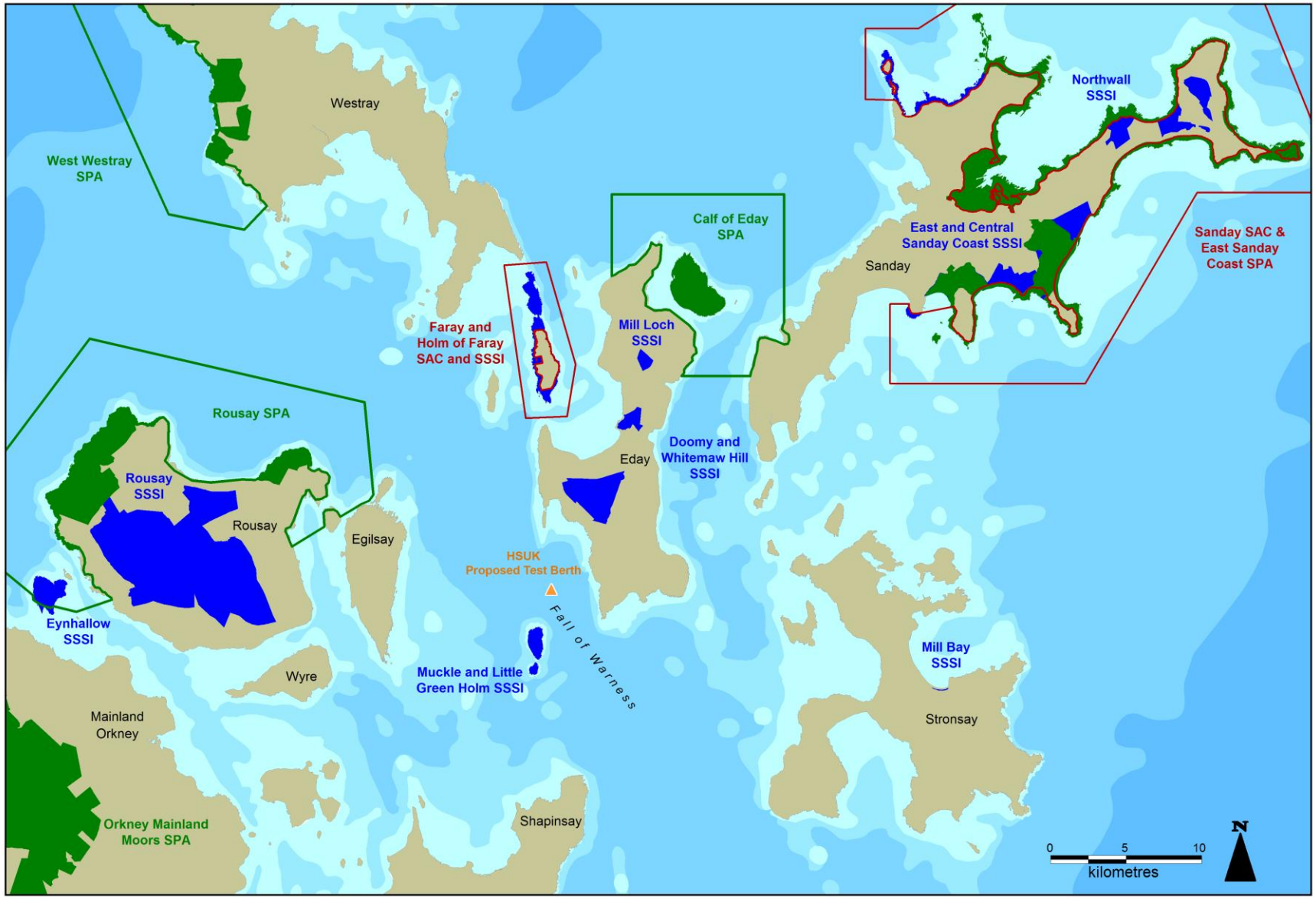
gravel occur frequently throughout the surficial layer. The sub-littoral zone is sparsely populated with species including *Laminaria spp.*, velvet crab (*Necora puber*) and other species typical of the wider area. No species or habitats of conservation importance were found in these surveys.

Table 3.2 Conservation designations in and around the Fall of Warness

Designation	Site	Qualifying Interest
SAC SSSI	**Faray and Holm of Faray** Geographical extent covers whole of Faray and Holm of Faray to the north of the proposed development site	Annex II species, grey seal (*Halichoerus grypus*). Well established breeding colony – the second largest breeding colony in the UK. The islands are largely covered by semi-improved grassland, with many tussocks of tufted hair-grass, however Iris beds are also found, along with small areas carpeted with sedge
SSSI	**Muckle and Little Green Holm** Geographical extent covers the two small islands of Muckle Green Holm and Little Green Holm to the south west of the proposed test berth	Nationally important grey seal breeding colony making up 3% of the British breeding population. A cormorant colony on Little Green Holm is a priority species on the local Biodiversity Action Plan (BAP). Vegetation consists of rough pasture with coarse tussocks of tufted hair-grass. In addition, a small area of marsh around the valley drains into a lagoon behind the shingle beach at the north-west of the island. Little Green Holm supports the grass, Yorkshire fog
SPA SSSI	**Rousay** Geographical extent on the island of Rousay encompasses the north-west coastal section of Quendal-Brings and the north-east coast sector at Faraclett Head. The recent extension stretches approximately 2 km into the Westray Firth to the north of the Fall of Warness	Rousay supports nationally and internationally important numbers of breeding Arctic terns, other important birds and some Annex I habitats (although not designated as an SAC) and geological features. This area is of national importance for its wide range of plants associated with cliff top maritime grassland, maritime heath and inland heath. The moorland rises to 250 m and plants on its exposed hilltops are normally found at much higher altitudes elsewhere in Scotland. These include alpine bearberry, alpine saw-wort and dwarf willow. Five nationally scarce plants are found on the moorland. In Orkney three of those – serrated wintergreen, shady horsetail and a hybrid pondweed – can only be found here. The pondweed is found in Muckle Water. Because of its unique nutrient levels this loch is rich in plant life, including some scarce species. It is the only loch of its kind in Orkney.
SPA SSSI	**Calf of Eday** Geographical extent covers the entire Calf of Eday and its recent extension which stretches approximately 2 km in all directions seaward	The Calf of Eday SPA and its extension supports, each year, an internationally important assemblage of birds; approximately 30,000 during the breeding season including the northern fulmar, great black-backed gull, European shag, kittiwake, common guillemot and 200 – 300 pairs of cormorant. The land is covered by heather, with smaller areas of wet heath, semi-improved grassland and coastal grassland.

Designation	Site	Qualifying Interest
SAC SPA	**Sanday** Geographical extent covers much of the east coast of Sanday (East Sanday Coast SPA for internationally important breeding land birds) and extends seaward to the east by approximately 2 km	The Sanday SAC supports the largest group of harbour seals (*Phoca vitulina*) at any discrete site in Scotland. The breeding groups represent over 4 % of the UK population of harbour seals. The Annex I habitat, 'Reefs' are the primary reason for selection of this site as an SAC, other qualifying habitats are 'Sandbanks which are slightly covered by sea water all the time' and 'Mudflats and sand flats not covered by seawater at low tide'. The site is an SPA for over-wintering bar-tailed godwit (*Limosa lapponica*) and the migratory species purple sandpiper (*Calidris maritima*) and turnstone (*Arenaria interpres*)

Figure 3.1 Conservation sites in and around the Fall of Warness



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4 ENVIRONMENTAL ASSESSMENT

4.1 Introduction

A systematic approach is used to provide a simple method of identifying all the potential sources of hazard as a result of the device and their risk to the environment. This method of impact assessment uses the design information of the development and therefore provides a good overview of the project's environmental influence. Having the ability to forecast environmental complications during design and prototype testing enables developers to be fully aware and take a responsible approach towards the sustainable implementation of their development.

To ensure a consistent approach to impact assessment by different developers the assessment has followed the methodology set out in the EMEC EIA guidance (EMEC, 2005a). The assessment uses a simple criterion (Table 4.1) to grade each impact individually and then mitigation is implemented if required and the residual impact rated to prove whether the mitigation will be adequate in reducing the impact.

As a responsible tidal developer, SPR has undertaken such an impact assessment of the HS1000 device deployment and testing phase.

Table 4.1 Impact assessment criteria

Impact	Ecological effects	Socio-economic effects	Stakeholder concern
Major	Degradation to the quality or availability of habitats and/or wildlife with recovery taking more than 2 years	Change to commercial activity leading to a loss of income or opportunity beyond normal business variability/risk. Potential short term effect upon public health/well-being, real risk of injury.	Concern leading to active campaigning locally or wider afield.
Moderate	Change in habitats or species beyond natural variability with recovery potentially within 2 years	Change to commercial activity leading to a loss of income or opportunity within normal business variability/risk. Possible but unlikely effect upon public health/well-being. Remote risk of injury	Widespread concern, some press coverage, no campaigning
Minor	Change in habitats or species which can be seen and measured but is at same scale as natural variability	Possible nuisance to other activities and some minor influence on income or opportunity. Nuisance but no harm to public.	Specific concern with limited group
Negligible	Change in habitats or species within scope of existing variability and difficult to measure or observe	Noticed by, but not a nuisance to other commercial activities. Noticed by but no effects upon the health and well-being of the public	An awareness but no concerns
No impact	None	None	None
Beneficial	An enhancement of ecosystem or popular parameter	Benefits to local community	Benefits to stakeholder issues and interests

4.2 Impact identification

Using the above criteria all potential impacts of the device were judged against all potential sensitive receptors (as required by the EMEC EIA guidance). The issues identified during this process are presented in Table 4.2 below. Potential impacts have been identified for all phases; installation, operation and decommissioning.

Any potential residual impacts, ranked as minor (or higher) or where potential impacts are unknown have been discussed in more detail in Section 5. Where a potentially significant impact is being discussed the aim was to outline a case explaining, and as far as possible justifying, why the proposed activity is required. This description highlights why the impact is potentially significant, the scale of impacts that could arise under different circumstances if appropriate, possible mitigation principles and the level of residual impacts that could be expected. The assessment considers positive as well as negative aspects arising from activities.

Table 4.2 Environmental impacts associated with testing of the HS1000 tidal device at EMEC

Identified Activity	Prediction of Potential Impact	Routine or Non Routine Event	Continuous, Temporary or Intermittent	Potential Impact Significance	Proposed Management and Mitigation Measures or Comments	Residual Impact Significance
Vessel operations: Installation, maintenance and decommissioning						
Vessel activity	Noise and vibration (engines) resulting in disturbance to wildlife – presence of internationally, nationally and locally important populations of seals, cetaceans and birds	NR	Temporary		The activities will occur over a short period of time to reduce the potential for noise disturbance. Installation activities will be undertaken by a Dynamic Positioning (DP) system equipped vessel. This will involve regular use of thrusters to maintain position throughout installation and decommissioning. Duration of substructure installation is one day. Duration of cable installation is three days. Duration of nacelle installation is one day. Decommissioning is expected to last two days Maintenance vessel present between two and six times for one day at a time in the first year after the first year it is anticipated that the maintenance vessel will be present three times for one day at a time Installation is planned for May/June 2011 Installation will occur on a neap tide; ensuring the most favourable conditions for the installation operation. As the operation is dependent on the correct tidal and weather window coinciding, a slip in the programme due to adverse weather conditions would mean installing at the next most suitable neap tide. Some work may be carried out during the hours of darkness to mitigate major delay. Vessels will move onto location at a speed commensurate with safe navigation and to allow marine mammals time to leave the area	This impact is considered in more detail in Section 5.2
	Atmospheric emissions	NR	Temporary		No mitigation required	

Identified Activity	Prediction of Potential Impact	Routine or Non Routine Event	Continuous, Temporary or Intermittent	Potential Impact Significance	Proposed Management and Mitigation Measures or Comments	Residual Impact Significance
					Atmospheric emissions are rapidly dispersed naturally Winds in Orkney average Force 3-4 in the summer and Force 6 in winter	
	Visual and seascape	NR	Temporary		No mitigation required Duration of substructure installation is one day. Duration of cable installation is three days. Duration of nacelle installation is one day Maintenance vessel present between two and six times for one day at a time in the first year after the first year it is anticipated that the maintenance vessel will be present three times for one day at a time Area already used by vessel traffic Duration of decommissioning is two days	
	Waste disposal from vessel operations	NR	Temporary		No mitigation required All wastes will be disposed of in line with legislative requirement No wastes disposed of overboard	No offshore impact
	Navigational hazard from presence of vessel. Area already used by numerous vessels	NR	Temporary		The controls include (but are not limited to): - Notification of appropriate authorities of the works for consideration for promulgation as Notices to Mariners and Navigational Warnings. - Ensuring marine contractor competency. - Vessels complying with International Regulations for Preventing Collision at Sea (COLREGS) Short installation/decommissioning periods (max. approx. 10 days). Maintenance expected to be a few hours/days once every 6 months	This impact is considered in more detail in Section 5.3

Identified Activity	Prediction of Potential Impact	Routine or Non Routine Event	Continuous, Temporary or Intermittent	Potential Impact Significance	Proposed Management and Mitigation Measures or Comments	Residual Impact Significance
					Short installation and decommissioning periods (combined period of 7 days). Inspection expected 2-6 times in the first year with an estimated 3 inspections in the remaining time period. These inspections will require a DP vessel on site for no more than one day at a time. Nacelle maintenance is expected once in the five year period and will involve a DP vessel on site for one day. The navigational risks for the installation, maintenance and decommissioning phases have been addressed in a Navigational Safety Risk Assessment in accordance with current MCA and DECC guidance. This involved consultation with both local and national stakeholders. The risks associated with installation operations conducted concurrently with other developers (Simultaneous Operations – SIMOPS) will be addressed by additional Hazard Identification and Risk Assessment under the EMEC permit to work system The Fall of Warness will remain navigable to other users	
	Impact on local fisheries (including diving fishermen)	NR	Temporary		Test site boundary / lease area has been reduced based on EMEC consultations undertaken with fishermen representatives since initial site establishment. This has been a significant decrease in test site lease area to accommodate creeling in up to 30 m water depth Consultation with local fisheries representatives with regard to this specific deployment site did not raise any significant issues	
Accidental	Oil spill to water column	NR	Temporary		All marine subcontractors' vessels will have valid	

Identified Activity	Prediction of Potential Impact	Routine or Non Routine Event	Continuous, Temporary or Intermittent	Potential Impact Significance	Proposed Management and Mitigation Measures or Comments	Residual Impact Significance
events	from vessels				Shipboard Marine Pollution Emergency Plan including a Shipboard Oil Pollution Emergency Plan (SOPEP) or equivalent procedures as required The risk of collision (leading to oil spill) has been addressed in the NSRA. In addition, the risk from Simultaneous Operations (SIMOPS) will be addressed in a separate HIRA	
Installation phase						
Installation of substructure and umbilical cable	Smothering of seabed and turbidity in water column	NR	Temporary		No mitigation required. Seabed areas at the test berth are not of any conservation importance, dominated by exposed bedrock and sparse presence of epifauna No significant presence of mobile sediments therefore no turbidity expected The substructure and cable has a 200 m^2 footprint with an area of contact of 37.92 m^2. 200 m^2 represents <1 % of the Fall of Warness seabed area	

Identified Activity	Prediction of Potential Impact	Routine or Non Routine Event	Continuous, Temporary or Intermittent	Potential Impact Significance	Proposed Management and Mitigation Measures or Comments	Residual Impact Significance
Accidental events	Ballast packages or equipment lost during lowering to seabed	NR	Temporary		Lifting operations will be conducted using appropriately rated lifting equipment and lifting gear maintained and examined in accordance with a suitable scheme meeting regulatory requirements. The marine contractor selected will be assessed for competency and use suitably qualified and experienced personnel (SQEP) Installation methodologies and procedures will be subject to an appropriate risk assessment EMEC has a series of Emergency Response Plans (ERPs) and Standard Operating Procedures (SOPs) and all plans drawn up by SPR will be fully integrated with these	
	Ballast buoys dragged under water due to current creating unseen obstacle	NR	Temporary		Device will be installed in conditions where the tidal rate is unlikely for this to occur Ballast will be buoyed for a short time period	
Installation of nacelle	No additional impacts to vessel presence (see above) associated with the installation of the nacelle					
Operational phase						
Presence of device and cable	Seabed and habitat disturbance/loss	R	Continuous		No mitigation required. Footprint of device will be approx 200 m^2 with an area of contact of 32.97 m^2; 200 m^2 represents <1 % of the Fall of Warness seabed area	
	Habitat provision from the presence of the new structure	R	Continuous		Potential colonisation by benthic fauna	
	Visual and seascape impact	R	Continuous		No mitigation required Structure will be fully submerged	No impact
	Impact on local fisheries including diving fishermen.	R	Continuous		Test site boundary / lease area has been reduced based on EMEC consultations undertaken with fishermen representatives since initial site	

Identified Activity	Prediction of Potential Impact	Routine or Non Routine Event	Continuous, Temporary or Intermittent	Potential Impact Significance	Proposed Management and Mitigation Measures or Comments	Residual Impact Significance
					establishment. This has been a significant decrease in test site lease area to accommodate creeling in up to 30 m water depth Consultation with local fisheries representatives with regard to this specific deployment site did not raise any significant issues	
	Hazard to navigation – area used by numerous vessels	R	Continuous		The controls include (but are not limited to): - Notification of appropriate authorities of the works for consideration for promulgation as Notices to Mariners and Navigational Warnings. - Ensuring marine contractor competency. - Vessels complying with International Regulations for Preventing Collision at Sea (COLREGS) Short installation/decommissioning periods (max. approx. 10 days). Maintenance expected to be a few hours/days once every 6 months Short installation and decommissioning periods (combined period of 7 days). Inspection expected 2-6 times in the first year with an estimated 3 inspections in the remaining time period. These inspections will require a DP vessel on site for no more than one day at a time. Nacelle maintenance is expected once in the five year period and will involve a DP vessel on site for one day The navigational risks for the installation, maintenance and decommissioning phases have been addressed in a Navigational Safety Risk Assessment in accordance with current MCA and DECC guidance. This involved consultation with both local and national stakeholders. The risks associated with installation operations conducted concurrently with other developers (Simultaneous Operations – SIMOPS) will be addressed by additional Hazard	This impact is considered in more detail in Section 5.3

Identified Activity	Prediction of Potential Impact	Routine or Non Routine Event	Continuous, Temporary or Intermittent	Potential Impact Significance	Proposed Management and Mitigation Measures or Comments	Residual Impact Significance
					Identification and Risk Assessment under the EMEC permit to work system The Fall of Warness will remain navigable to other users	
Device operation	Wildlife interaction – avoidance / displacement – presence of internationally, nationally and locally important populations of seals, cetaceans and birds.	R	Continuous		An area of avoidance is expected, however no information/data presently available to ascertain if this is a significant issue Ongoing visual wildlife monitoring programme (data collection undertaken by EMEC) to ascertain any changes in wildlife distribution in the Fall of Warness over time (surface observations only) Once these data are available the requirement for additional avoidance/displacement monitoring will be established Although the use of a light to aid monitoring using a device mounted camera may alter the behaviour of species around the turbine, the light will only be used for limited periods	Unknown
	Wildlife interaction – collision risk-presence of internationally, nationally and locally important populations of seals, cetaceans and birds.	R	Continuous		No information/data presently available to ascertain if this is a significant issue HSUK/SPR are committed to operational monitoring to ascertain the collision risks from this specific tidal technology No industry wide accepted method of monitoring collision risk presently exists, but HSUK/SPR are investigating suitable technologies, including the use of an underwater camera. Specific monitoring protocol details will be provided in a subsequent detailed environmental monitoring plan (EMP)	Unknown This impact is considered in more detail in Section 5.2

Identified Activity	Prediction of Potential Impact	Routine or Non Routine Event	Continuous, Temporary or Intermittent	Potential Impact Significance	Proposed Management and Mitigation Measures or Comments	Residual Impact Significance
	Wildlife interaction – acoustic disturbance - presence of internationally, nationally and locally important populations of seals, cetaceans and birds.	R	Continuous		Acoustic testing carried out on the 300 kW in Norway in 2009 found that the main bandwidth where the turbine is giving its most obvious signature is from about 2 kHz and below. At this peak frequency sound intensity reaches about 20 dB above ambient noise The requirement for additional underwater acoustic monitoring will be discussed with SNH once further data is available	Largely unknown This impact is considered in more detail in Section 5.2
Discharges to sea	Leaching of antifoulants into water column	R	Continuous		Use of antifoulant will be kept to a minimum Any nominal leaching will be rapidly dispersed in the turbulent receiving environment	
	Leaching of corrosion protection into water column	R	Continuous		Use of corrosion protection will be kept to a minimum Any nominal leaching will rapidly be dispersed in the turbulent receiving environment.	
	Discharge of oil from gearbox into water column	R	Continuous		No routine operational discharge as gearbox lubrication system is sealed and is contained within the nacelle which is also sealed Previously proven sealed system during testing of a similar tidal turbine prototype for four years.	No impact
	Discharge of oil from auxiliary system into water column	R	Continuous		No routine operational discharge as auxiliary systems are sealed and contained within the nacelle which is also sealed. Previously proven sealed system during testing of a similar tidal turbine prototype for four years.	No impact
	Heat – cooling system	R	Continuous		No mitigation required Heat will be immeasurable and will be rapidly dispersed in the tidal flow The cooling water heat exchanger uses fresh water, not a chemical coolant	
	Heat – loadbank	R	Continuous		No mitigation required	

Identified Activity	Prediction of Potential Impact	Routine or Non Routine Event	Continuous, Temporary or Intermittent	Potential Impact Significance	Proposed Management and Mitigation Measures or Comments	Residual Impact Significance
					Heat from the loadbank is likely to result in an increase of around 0.02 °C within 1 m of the device	
Energy balances and flows	Changes to water column characteristics: - Energy extraction from the tide - Reduced downstream mean velocity - Residual turbulence - Flow acceleration around the device	R	Continuous		Studies undertaken as part of the tidal test site infrastructure EIA indicate that operations of individual test devices will result in insignificant loss of overall current speed for the Fall of Warness area and thus no modification to the marine environment is predicted (HR Wallingford, 2005) The HS1000 device includes a flow meter which will monitor tidal flow	
	Changes to seabed: - Scour of seabed surface - Transport and / or deposition of scoured sediments	R	Continuous		Seabed areas at the test berth are not of any conservation importance, dominated by exposed bedrock, sparse presence of epifauna, devoid of mobile sediments, no scour expected	No impact
Accidental discharges to sea from device	Gearbox – discharge of Gearbox lubricant to water column: Auxiliary systems – discharge of lubricant/grease to water column:	NR	Temporary		Wherever possible environmentally friendly/non toxic fluids have been selected (see MSDS sheets provided in Appendix B) Previously proven sealed system (during testing of a similar tidal turbine prototype, four years continuous operation without incident) In the unlikely event of a leak/spill to sea, the relatively small inventory will be quickly dispersed in turbulent waters Natural degradation of such small inventories is considered the best approach EMEC has a series of Emergency Response Plans (ERPs) and Standard Operating Procedures (SOPs) and all plans drawn up by Hammerfest will be fully	

Identified Activity	Prediction of Potential Impact	Routine or Non Routine Event	Continuous, Temporary or Intermittent	Potential Impact Significance	Proposed Management and Mitigation Measures or Comments	Residual Impact Significance
					integrated with these	
Accidental events	Loss of device/foundation components	NR	Temporary		HIRA undertaken prior to installations will identify suitable mitigation/contingency Unlikely event due to design and testing of GBS. Entire system, device and foundation will undergo third party design verification prior to installation All works undertaken under the EMEC permit to work system EMEC has a series of Emergency Response Plans (ERPs) and Standard Operating Procedures (SOPs) and all plans drawn up by HSUK/SPR will be fully integrated with these	
Decommissioning						
Waste disposal of decommissioned parts	Waste disposal	NR	Temporary		The nacelle will be disassembled and extensively studied following testing to inform future design improvements Once investigations are complete all components will be handled in accordance with waste hierarchy with priority on re use and recycling Any items disposed of will be done so in line with legislative requirements to avoid unnecessary environmental impact	No impact

Identified Activity	Prediction of Potential Impact	Routine or Non Routine Event	Continuous, Temporary or Intermittent	Potential Impact Significance	Proposed Management and Mitigation Measures or Comments	Residual Impact Significance
Accidental events	Equipment/ballast packages lost during lifting from sea bed in a high energy environment.	NR	Temporary		Lifting operations will be conducted used appropriately rated lifting equipment and lifting gear maintained and examined in accordance with a suitable scheme meeting regulatory requirements The marine contractor selected will be assessed for competency and use suitably qualified and experienced personnel (SQEP) Installation methodologies and procedures will be subject to an appropriate risk assessment	

5 ASSESSMENT OF POTENTIAL KEY IMPACTS

5.1 Introduction

This section of the supporting document explores in more detail the potentially significant environmental impacts identified earlier in the document. Following the ranking of all potential impacts (see Section 4) and taking into account scoping opinion the following impacts are deemed to be potentially significant as their impact is unknown or their residual impact is considered minor or above.

- Wildlife interactions (Section 5.2)
- Navigational risk (Section 5.3)

Consideration has also been given to potentially cumulative impacts of the proposed development on wildlife in and around the Fall of Warness, and of simultaneous operations on navigational safety in the area.

During scoping and the assessment, a number of issues of concern were raised by various stakeholders. These issues have been considered by SPR and, where appropriate, are addressed below. A list of the issues raised is detailed in Table 1.1 in Section 1 of this report.

During consultation with SNH, the need for a habitats regulation assessment (HRA) to ascertain the potential impacts from the deployment of the tidal device on the conservation objectives of the Faray Holm of Faray SAC and Sanday SAC was raised. Appendix C of this report provides information to support the habitats regulations assessment process.

5.2 Wildlife interactions

This section provides detail of the known baseline for wildlife in the Fall of Warness from data presently available. Based on comments from the scoping exercise in Section 1 wildlife interactions were identified as an unknown issue and are therefore being considered.

5.2.1 Baseline conditions

Data and information on the species likely to be present in and around the Fall of Warness is taken from ongoing wildlife observations being undertaken by EMEC, species-specific studies and previous work undertaken for the tidal test site EIA.

5.2.1.1 Grey seals

A recent study by SMRU (2008), confirmed by EMEC wildlife observations, has reported that grey seals (*Halichoerus grypus*) are the most frequently observed pinniped species in the vicinity of the Fall of Warness tidal test site. There is a notable significant peak in sightings during their breeding season from September to October. Sightings in the study area for the EMEC wildlife observations were concentrated close to the shore area, particularly near to Muckle and Little Green Holm which is approximately 3 km south west of the proposed test location. It should be noted that these observations record sea surface observations only and whilst grey seals may be observed near land and at haulout sites, they may also be present underwater throughout the tidal test site area.

Two designations in the vicinity of the Fall of Warness exist to help protect grey seals:

Faray and Holm of Faray SAC – these two islands support a well-established grey seal breeding colony which is the second-largest breeding colony in the UK, contributing around 9% of the UK's annual pup production (and approximately 18 % of Orkney's grey seal production)(EMEC, 2005b; SNH, 2009). This SAC is approximately 10 km north from the proposed test berth but it is likely that seals will use the Fall of Warness for foraging or en route to alternative haul out sites.

Muckle Green Holm and Little Green Holm SSSI – these two islands are a SSSI for their nationally important breeding colony of grey seals which have been recorded immediately off the east coast and in the Fall of Warness. This SSSI is approximately 3 km south west of the proposed test berth, and it is likely that these seals will use the Fall of Warness for foraging or en route to haul out sites.

Under the Conservation of Seals Act, 1970, the Natural Environment Research Council (NERC) has a duty to provide scientific advice to government on matters related to the management of seal populations. NERC has appointed the Special Committee on Seals (SCOS) to formulate this advice. SCOS (2008) have calculated the Potential Biological Removal (PBR) figure of grey seals from the Northern Isles of Orkney as 885. This is based on 2007 counts as summarised in the report for SNH on estimates of harbour seal decline and grey seal numbers around Scotland (SMRU, 2008). The PBR is the maximum number of animals, not including natural mortalities that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population.

5.2.1.2 Harbour seals

Harbour seals (*Phoca vitulina*) have been recorded by the EMEC wildlife observations throughout the tidal test site area and similar to grey seals, are mostly recorded close to shore. Sightings have been recorded in all months but most frequently between July and October, although these sightings equate to less than 2 per hour. From December 2006 to February 2007, only 14 sightings of harbour seals were recorded in the tidal test site area (SMRU, 2007). Seal Skerry (approximately 3 km to the north of the proposed test berth) is a known locally important haul out site for harbour seals although it is not designated under any national/international legislation. The Fall of Warness area in general provides several haulout sites for harbour seals and it is believed that from mid-June to late-July, the sea in the area is used as an underwater display setting for male harbour seals to attract females (EMEC, 2005b).

One conservation designation in the north isles of Orkney exists to help protect a meta-population of breeding harbour seals:

> Sanday SAC – situated in the north east of Orkney, approximately 30 km from the proposed test site, Sanday SAC supports the largest group of breeding harbour seals at any discrete site in Scotland. These breeding groups are found on intertidal haulout sites that are unevenly distributed around the Sanday coast and represent over 4 % of the UK population. SMRU (2008) report that the population in Orkney has undergone a dramatic decline from over 8,500 in 1997 to less than 2,900 in 2008.

SCOS (2008) have calculated the PBR figure of harbour seals (based on 2007 counts) to be 23 individuals from the metapopulation. SNH (2009) note that this value is likely to be revised downwards following re-calculation based on 2008/09 harbour seal counts, but as yet there is no published data available to support this.

5.2.1.3 Cetaceans

European Protected Species (EPS) are those which are protected under the Conservation (Natural Habitats) Regulations 1994 (The Habitats Regulations) and the Nature Conservation (Scotland) Act 2004. All species of cetacean are listed as EPS. Those species known regularly to be present in the waters around the Fall of Warness from the ongoing EMEC wildlife monitoring are the harbour porpoise (*Phocoena phocoena*), minke whale (*Balaenoptera acutorostrata*), white-beaked dolphin (*Lagenorhynchus albirostris*), killer whale (*Orcinus orca*) and Risso's dolphin (*Grampus griseus*). These sightings are consistent with existing knowledge of these species behaviour and distribution in Orkney waters. Table 5.1 summarises the sensitivities of each species, including their seasonal activity.

Table 5.1 Cetacean species sensitivity (Reid, 2003; Carwardine, 1995; SMRU, 2007)

Species	Seasonality and habitat	Behaviour and general sensitivities
Harbour porpoise (*Phocoena phocoena*)	Occur regularly around Orkney waters, particularly during the summer months of June, July and August. Often seen in small groups, harbour porpoises usually inhabit inshore waters	- Pollution - Habitat disruption - Human disturbance - Sensitive to moderate - high frequency sounds (e.g. > 1,000 Hz) - May swim in wake of vessel
Minke whale (*Balaenoptera acutorostra*)	Sighted relatively infrequently around Orkney waters, particularly during the summer months of June, July and August	- Pollution - Human disturbance - Sensitive to low and moderate frequency sounds (e.g. 12 – 8,000 Hz)

Species	Seasonality and habitat	Behaviour and general sensitivities
White-beaked dolphin (*Lagenorhynchus albirostris*)	Sighted relatively infrequently around Orkney waters, most likely during mid to late-summer months. Likes to mix inshore and offshore habitat	- Sensitive to moderate - high frequency sounds (e.g. > 1,000 Hz) - Relatively less sensitive to pollution and human disturbance, quite likely to bow-ride or swim alongside vessels
Killer whale (*Orcinus orca*)	Sighted relatively infrequently around Orkney waters, most likely to be seen in inshore waters from April to October	- Habitat disruption - Sensitive to moderate - high frequency sounds (e.g. > 1,000 Hz) - Relatively less sensitive to pollution and human disturbance, quite inquisitive and approachable
Risso's dolphin (Grampus grisseus)	Sighted relatively infrequently around Orkney waters, most likely during mid to late-summer months. Likes to mix inshore and offshore habitat	- Sensitive to moderate - high frequency sounds (e.g. > 1,000 Hz) - Relatively less sensitive to pollution and human disturbance, seldom bow rides but may swim alongside a vessel or in its wake

Of the species listed above, it is believed that the harbour porpoise is the only resident cetacean species off the south west coast of Eday and that sightings of other species occur during transitory periods (SMRU, 2007). EMEC observations show that the harbour porpoise is common throughout the Fall of Warness with sighting rates notably lower during the middle of the day than early morning or late evening with a peak in sighting rates at around 1900 hrs.

5.2.1.4 Fish

Important and protected fish species likely to be found in or around the Fall of Warness include the common skate (*Dipturus batis*) and the basking shark (*Cetorhinus maximus*).

The common skate is classed as critically endangered by the IUCN and features on the red list and Orkney's Local Biodiversity Action Plan (BAP) and is known to use Orkney as one of a few isolated locations in which it survives.

The basking shark is protected under the Convention on International Trade in Endangered Species (1981), the Convention on Migratory Species (1979) and the Wildlife and Countryside Act (1981). This protection means it is an offence to intentionally capture or disturb a basking shark in UK waters (up to 12 miles offshore). Basking sharks have been observed in the tidal site area during EMEC wildlife observations in the months of June, July, September and October. Basking sharks represent the largest fish found in the UK and are most regularly recorded in coastal areas with seasonally persistent tidal fronts.

Several other fish species, of more commercial importance, are known to use the Fall of Warness, notably; herring (*Clupea harengus*), mackerel (*Scomber scombrus*), sprat (*Sprattus sprattus*), sand eel (*Ammodytes* sp.), haddock (*Melanogrammus aeglefinus*), ling (*Molva molva*), saithe (*Pollachius virens*) and cod (*Gadus morhua*) which are all present in seas around Orkney (EMEC, 2005b). As well as the commercially important species, non commercial species including butterfish (*Pholis gunnellus*) and scorpion fish (Scorpaeniformes) have been sighted in the Fall of Warness (Aquatera, 2005). It is known that some fish species are likely to spawn in this region or migrate through the area as larvae and pelagic adults (e.g. salmon, sea trout and herring).

5.2.1.5 Seabirds

The Fall of Warness and its surrounding coastal margin provide important habitats supporting a large variety of bird species. Table 5.2 details the birds observed during wildlife observations at EMEC (2006).

Table 5.2 Bird species observed (EMEC, 2006; JNCC, 2000)

Species	Average number of birds seen per hour	Diving species? (Approximate depth)	Notes on seasonality and habits
Guillemot (*Uria aalge*)	39.2363	✓ (down to 100m)	From May to July, high concentrations are found in near-shore waters during the breeding period. August and September is spent moulting (and flightless) before dispersing further offshore for the winter. Adult birds visit the colonies during the winter, with visits becoming longer by March. Guillemots dive for fish from the surface and swim well underwater using their wings
Black guillemot (*Cepphus grylle*)	13.571	✓ (down to 40m)	Breeding season is March to August during which time black guillemots usually feed within 5 km of their nests. Similarly from September to February, these birds will not venture further than approximately 50 km from their breeding colonies. Guillemots dive for fish from the surface and swim well underwater using their wings
Eider duck (*Somateria mollissima*)	10.8218	✓ (down to 10m)	Normally feeding in waters less than 4 m deep, Orkney is popular for eiders throughout the year who generally disperse only short distances between breeding grounds and wintering areas
Shag (*Phalacrocorax aristotelis*)	10.0819	✓ (down to 40m)	Shags rarely forage more than 10 km from their colonies and are usually found in waters less than 40 m deep. These birds can be seen throughout the year. Shags dive for fish from the surface of the sea and use powerful webbed feet to propel themselves whilst swimming underwater. Maximum recorded diving depth of 116 m
Arctic tern (*Sterna paradisaea*)	3.1503	×	During the breeding season from May to July, Arctic terns are found mainly in inshore waters (Orkney and Shetland hold over 80% of the UK breeding population). From October to April, these birds winter far south
Kittiwake (*Rissa tridactyla*)	2.7326	×	From May to July, kittiwakes are concentrated in coastal waters, close to colonies, although the foraging range varies from 5 km to 160 km (usually observed within 25 km, however)
Gannet (*Morus bassanus*)	1.5907	✓ (down to 20m)	Gannets are likely to be observed between March and August as many move far south during the winter months, however some concentrations remain around colonies between September and February. Dive steeply into the sea from a great height to capture large fish such as herring and

Species	Average number of birds seen per hour	Diving species? (Approximate depth)	Notes on seasonality and habits
			mackerel. Most plunge dives are relatively shallow (<10 m)
Puffin (*Fratercula arctica*)	1.4788	✓ (down to 60m)	April to July sees an increase in density around the breeding colonies. Breeding birds will generally feed near to the colony whilst non-breeding birds will venture further afield. Through the winter, birds from Orkney are likely to disperse widely to the south and to deeper water. These birds are unlikely to dive for food in the immediate vicinity of the tidal test site
Cormorant (*Phalacrocorax carbo*)	0.8249	✓ (down to 10m)	Cormorants usually feed in water less than 10 m deep and are usually rare at sea away from the coast. Cormorants will not generally travel far from colonies to forage. Dives from the surface for fish
Red-throated diver (*Gavia stellata*)	0.5078	✓ (2 – 9m)	Red-throated divers may be observed in all months of the year. In late September they moult for about a month and during this time remain flightless on the sea surface, making them vulnerable to surface pollution
Razorbill (*Alca torda*)	0.3596	✓ (down to 20m)	Breeding occurs from May to July before moulting (during which time they are flightless) and dispersing over the winter. Adult birds visit the colonies during the winter, with visits becoming longer by March. Dives from the surface of the water
Great northen diver (*Gavia immer*)	0.1990	✓ (down to 60m)	Primarily a winter visitor from October to May. These birds moult between late March and early May during which time they are flightless and particularly vulnerable to surface pollution
Long-tailed duck (Clangula hyemalis)	0.0870	✓ (down to 60m)	Generally a winter visitor to the area, with the only notable concentration in the 2000 survey (JNCC) being in Scapa Flow, Orkney. Most birds in Orkney recorded from March to May
Other divers (*Gavia*)	0.0187	✓ (down to 10m)	Divers may be observed in all months of the year. In late September they moult for about a month and during this time remain flightless on the sea surface, making them vulnerable to surface pollution. Generally shallow-water divers
Red breasted merganser (*Mergus serrator*)	0.0031	✓ (down to 10m)	Potentially observed all year round, mostly in inshore waters. Surface diver, generally shallow waters
Little auk (*Alle alle*)	0.0010	✓ (down to 30m)	Likely to be a winter visitor in very variable numbers between September and December. Dive from the sea surface and swim underwater
Slavonian Grebe	0.0010	✓	Very wide-ranging bird, on the IUCN red

Species	Average number of birds seen per hour	Diving species? (Approximate depth)	Notes on seasonality and habits
(*Podiceps auritus*)		(down to 2m)	list and categorised of 'least concern'. Mainly feed in shallow water and perform only shallow dives

During the winter, Greentoft Bay (approximately 2 km east of the proposed test berth) supports numerous large flocks of wading birds including turnstone (*Arenaria interpres*), dunlin (*Calidris alpina*), purple sandpiper (*Calidris maritima*), curlew (*Numenius arquata*), bar-tailed godwit (*Limosa lapponica*), ringed plover (*Charadrius hiaticula*), oystercatcher (*Haematopus ostralegus*) and redshank (*Tringa totanus*) (EMEC, 2005b).

All wild birds have general protection provided by UK legislation which prohibits the killing, injuring, taking or selling of any wild birds or their nest or eggs, but diving species residing in close proximity to the development warrant particular consideration. Little Green Holm (approximately 3.5 km from the proposed test berth) is home to a breeding colony of cormorants. Cormorants are protected under the general provisions of the Wildlife and Countryside Act (1981) and are listed in the Local Biodiversity Action Plan (LBAP) as a local priority species owing to declining numbers (EMEC, 2005b). Cormorants may be easily disturbed and subsequently prone to high losses of chicks and eggs to predators.

5.2.2 Potential impact

Potential impacts associated with the proposed development can be considered in the phases of installation, operation and maintenance and decommissioning. There will be two installation phases associated with this development, the potential impacts for these installation phases are likely to be very similar and are therefore considered together. Decommissioning is proposed to occur as a reverse of installation and is likely to have similar potential impacts to installation; therefore, decommissioning is considered together with installation. The operational phase has potentially a wider and more complex range of impacts for consideration and is considered separately.

5.2.2.1 Installation, maintenance and decommissioning

Vessel activity

Vessel activity may be a source of noise and vibration and may give rise to accidental events such as a fuel spill. Accidental events have the potential to impact all species but are unlikely to occur. Direct contamination and contamination of the food chain may, without mitigation, have a significant impact on all aspects of the receiving environment. It should be noted that the area in and around the Fall of Warness is already well-used by vessels.

Although the installation phases are scheduled in order that the substructure and nacelle can be installed on a neap tide in May/June 2011 respectively, a slip in the schedule might occur if the correct tidal conditions and weather window do not coincide. Installation would then need to take place at the next most suitable neap tide. In order to mitigate delays work will carry on in hours of darkness if necessary.

The DP vessel proposed to be used for installation and decommissioning of the HS-1000 is most likely to be a Class III DP vessel. The vessel contract is not yet in place and therefore specific details of likely noise output from vessel thrusters and engines is not yet available. Once details of likely noise characteristics are available these will be made available.

The DP vessel required for maintenance and the umbilical cable connection will be a smaller vessel and will not move on site until the heavy lift vessel has demobilised from site.

The significance of further potential impacts of vessel activity may differ by species, therefore the potential impact on each species or species class is discussed below.

Grey seals

Grey seals are particularly sensitive to low frequency sounds which they rely on for communication. Vocalisation may be masked by vessel noise which produces low frequency sounds, potentially triggering avoidance behaviour.

Due to the high PBR figure for the metapopulation, and as the installation and decommissioning operations will utilise a DP vessel, over a relatively short time period in an area already routinely used by vessels, vessel activity will not result in any significant effects on population level of the European protected population at Faray and Holm of Faray SAC. The proposed schedule for installation of the substructure and umbilical cable operations is May/June 2011 which will not overlap with grey seal breeding season which begins late September - early October.

Harbour seals

Harbour seals are particularly sensitive to low frequency sounds which they rely on for communication. Vocalisation may therefore be masked by vessel noise which also produces low frequency sounds, potentially triggering avoidance behaviour. Masking of harbour seal low frequency vocalisations may be possible at 15 km.

The installation maintenance and decommissioning operations will utilise a DP vessel, over a relatively short time period in an area already routinely used by vessels. The proposed schedule for installation is May/June 2011; this timing will coincide with pups being born.

Although the installation and maintenance operations have the potential to result in the temporary displacement of seals from the area of installation or nearby haulout sites, vessel disturbance is not likely to result in injury or death or the removal of any individuals from the previously referenced metapopulation. Installation operations are therefore not expected to result in any negative impact on the PBR figure of 23 (or less based on the yet unpublished revised PBR) harbour seal individuals, either from the internationally important metapopulation or specifically from the population of harbour seals protected by Sanday SAC.

Cetaceans

Visits by non-resident cetacean species are sporadic and brief. As such, focus is reserved for the harbour porpoise as it is the only cetacean species thought to be resident in the area. There is potential for lower frequency vessel noise to be detected by harbour porpoises at distances of 1 km, and higher frequency vessel noise to be audible up to 3 km from the installation site/test berth. However, the impact of vessel activity is not clear as both attraction and avoidance behaviours have been observed in cetaceans, including the harbour porpoise. Porpoises will, however, be expected to avoid the immediate vicinity during installation and decommissioning operations.

Fish

The wildlife Trust (2010) state that basking sharks are sensitive to engine noise. This may result in basking sharks temporarily avoiding the immediate vicinity of the development at the time of installation and decommissioning due to the disturbance caused by vessel noise as well as heightened general activity associated with installation and decommissioning. In contrast, EMEC wildlife observations have shown that basking sharks are regularly recorded in the vicinity of construction works. Temporary avoidance behaviour is a possibility for other species of fish. The low frequency nature of vessel noise means it is likely to be detectable by fish over a large range, depending on ambient conditions. In an area already routinely used by vessels, it is not anticipated an additional vessel will have a significant impact on fish populations using the area.

Seabirds

In an area already well-used by vessels it is not anticipated that one additional vessel, is likely to significantly disturb birds using the area.

Removal of habitat

On decommissioning the tidal turbine and umbilical cable, it is a condition that all materials deposited on the seabed within the EMEC tidal test site be removed. The device has the potential to provide a new habitat for some species of fish. When decommissioning, this would result in the removal of this temporary habitat. The new temporary habitat is unlikely to be vastly different to that of the surrounding seabed although it may offer a safe haven for some species normally hunted by those who avoid the area around the turbine. The habitat is also

unlikely to be of any local, national or international importance so it is considered that its removal will not be significant.

No further aspects of the installation or decommissioning phases have been highlighted as having the potential to have a significant impact on wildlife in the area in and around the Fall of Warness.

5.2.2.2 Operation

The physical presence of the turbine has the potential to result in the following impacts on the wildlife in the Fall of Warness; cause avoidance or displacement behaviour, pose a collision risk, and cause acoustic disturbance.

Underwater noise investigations carried out on the 300 kW device in Norway found that the noise frequency range was about 2 kHz and peak frequency lines occurred at 70-326 Hz, the intensity of the sound at these peak frequency lines reaches about 20 dB above ambient noise approximately 30-50 m away from the turbine. It is likely that the EMEC site at Fall of Warness experiences more turbulent conditions than those at the Norwegian site and that therefore ambient noise will be greater indicating that the device noise would be harder to hear.

The significance of potential impacts may differ by species, therefore the potential impact on each species or species class is discussed below.

Grey seals

Collision risk - Grey seals may come into contact with the turbine blades; however the extent of the effect of tidal turbines on marine mammals is poorly understood. SMRU (2005) have suggested that grey seal pups may be most at risk due to their inquisitive nature which can result in them being attracted to moving objects in the water. It is equally possible that instead of attracting inquisitive seals, the presence of the device will result in the creation of an exclusion zone in its immediate vicinity, thereby reducing potential collision risk. Due to the high PBR figure for the metapopulation this tidal turbine will not result in any significant population level effects on the European protected population at Faray and Holm of Faray SAC.

Avoidance/displacement – With respect to avoidance/displacement, it is not known what effect a tidal turbine at this location will have on the grey seal population. No information is currently available to determine if this is a significant risk but is likely to be able to be assessed when the results of the EMEC wildlife monitoring are published.

Acoustic disturbance – Pinnipeds are sensitive to underwater noise, based on the underwater noise studies carried out on the 300 kW device it is possible for pinnipeds to detect the turbine noise, however it may be the ambient noise due to the strong tidal flow, passing vessels and/or existing tidal and wave devices in the area is enough to reduce the relative acoustic impact of the tidal turbine.

Harbour seals

Similar to grey seals, the extent of the effect of tidal turbines is poorly understood. It is not known if a harbour seal is likely to be inquisitive (and increase collision risk) or if the device is likely to deter harbour seals from approaching (and reduce collision risk). However, due to declining numbers of harbour seals there is the potential that the PBR figure of 23 (potentially to be revised downwards based on 2008/2009 counts) harbour seals may be affected due to collisions, avoidance or acoustic disturbance by the turbine.

Cetaceans

The harbour porpoise, considered the only resident cetacean in the area around the Fall of Warness, may react to the tidal turbine in a similar manner to grey and harbour seals in terms of collision risk, avoidance behaviour and acoustic disturbance. Unfortunately, to date, insufficient studies have been carried out on the effect of underwater tidal turbines on harbour porpoise.

It is likely that, the physical presence of the turbine has the potential to generate noise and vibrations which could be detrimental to the species. Harbour porpoises are known to use their sonar mainly for navigation and for catching their prey although little is known about how much free-ranging porpoises use their sonar (Carstensen *et al.*, 2006). Appropriate hydrophone monitoring may increase understanding of the potential effects that the noise generated from the turbine has on the effective use of the animals' sonar.

Fish
As with cetaceans and pinnipeds, there may be a collision risk if species are found not to adopt avoidance behaviours. Pelagic species are thought to be at most risk; however there is a lack of empirical knowledge to be able to quantify the risks.

Fish species may avoid the turbine as a result of increased noise and turbidity. In time, however, the base of the turbine may act as a new habitat for some species of fish; akin to habitat provision witnessed at artificial reefs (Langhamer *et al*., 2009). Based on the underwater noise studies from Norway it is likely that some species will be able to detect the sound of the device. The reaction of the fish to this is harder to predict, behavioural reactions cannot be ruled out; however physiological effects such as hearing loss and or injury are unlikely.

The environmental sensitivities table for the tidal test site, produced by EMEC (in consultation with SNH and the EMEC Monitoring Advisory Group) indicates that fish are not considered particularly sensitive to testing of devices at the EMEC tidal test site and considered to represent only a minor interaction (see Section 3).

Seabirds
The only significant potential impacts on bird populations are likely to be the collision risk posed to species of diving birds, in particular deeper water diving bird species such as guillemot, shag, gannet and puffin. In this respect, RSPB are asking for industry-wide studies on collision risk as there is very little information available on how species might react. The food supply to diving birds might also be affected by the presence of the turbine; although if the device has a fish aggregating effect this may increase the food supply.

In relation to the nearby breeding colony of cormorants, the absence of studies into collision risk makes it hard to anticipate the nature of the interaction between the device and this species. The usual nature of the cormorant's feeding technique is to dive from the sea surface and forage in depths of 2 m to 10 m whilst swimming at slow speeds (Ropert-Coudert *et al.*, 2006; Gremillet *et al.*, 2004). Although the turbine has a minimum depth clearance of 19.5 m, it is expected that this type of diving activity would allow cormorants the opportunity to become aware of the turbine in sufficient time to avoid collision. The HS1000 as opposed to wind turbines, has a relatively slow blade RPM.

Camera (and associated light)

It is intended that a camera be fitted to the device to help monitor its condition and to enable monitoring of a collision should it occur. To ensure suitable visibility, it would be necessary to install a light which would be turned on when natural light too poor for inspection. Inspections will be carried out a few times a month. In the event of a collision an alarm would trigger recording and this would allow an assessment of the collision incident.

The activation of the light may attract marine mammals and fish species to the turbine. However, the light will only be used for limited periods and will enable a much more thorough inspection when natural light is not adequate.

5.2.3 Management and mitigation

SPR has considered a series of mitigation and management techniques related to the potential impacts discussed above in an attempt to reduce the known potential impacts of tidal turbines. However, based on the novel nature of the marine (wave and tidal) renewables industry, there is as yet a lack of understanding of the significance of potential impacts and as such no industry wide consensus on required or suitable mitigation has been reached. In such an instance the most appropriate measure is to implement an appropriate monitoring programme in order to be able to ascertain if any or what mitigation measures might be suitable for future implementation.

5.2.3.1 Vessel activity

Little is known about the potential for disturbance due to shipping and vessel movements (JNCC, 2008) and there are currently no good practice guidelines for minimisation of disturbance by shipping.

One heavy lift DP vessel will be used initially, followed by a smaller DP vessel once the heavy lift vessel has demobilised. This will reduce the time on site for the larger DP vessel. There is potential that to reduce the likelihood of the project schedule slipping to the next neap tide (thereby prolonging the time on site), some installation works will need to be undertaken during the hours of darkness. This is due to the requirement for good tidal conditions and a fine weather window to coincide for the installation procedure. Although some work may be undertaken in the hours of darkness, there are no high noise-generating activities e.g. piling or drilling associated with the installation, testing or decommissioning of the tidal device. Vessels will also move to and from the test berth location slowly to allow wildlife time to leave the area. The area is already routinely used by vessel traffic so it is not thought any further mitigation or management measures are required. SPR is in ongoing discussions with SNH to confirm this. The use of DP vessels significantly shortens the overall works period.

5.2.3.2 Collision risk

The turbine blades have been designed to have a relatively slow rotational speed. But in the absence of an understanding of the significance of impacts from marine wildlife collision, HSUK plans to monitor for marine wildlife collisions during the testing of its device at EMEC.

Verified methods and equipment for carrying out underwater observation and monitoring of wildlife behaviour are still not defined. HSUK will be putting an observational video camera on the device for monitoring however this has technical issues that could cause other environmental impacts, such as lighting aids required and the ecological impacts of introducing artificial lighting to the site. Both HSUK and SPR are committed to operational monitoring and a device-specific monitoring protocol will be developed as part of an Environmental Management Programme (EMP) (see Section 6).

Any detected collision will trigger a controlled shutdown to allow for the inspection of available video footage and other condition monitoring data. The alarm will be cleared by the operator before the device is restarted. It will be built into the EMP that, on detecting collisions, HSUK and SPR will discuss appropriate mitigation measures with SNH and determine the requirement for temporary shutdown of the device.

5.2.3.3 Acoustic disturbance

Acoustic testing carried out on the 300 kW in Norway in 2009 found that the main signature bandwidth is about 2 kHz and below. At this peak frequency sound intensity reaches about 20 dB above ambient noise. The EMEC test site in the Fall of Warness is likely to be considerably more turbulent than the Norwegian test site and therefore will have a greater level of ambient noise.

SPR has commissioned SAMS to undertake further work to examine the propagation of the underwater noise from the device. Ongoing wildlife monitoring being undertaken by EMEC will also be used to ascertain any changes in wildlife distribution in the Fall of Warness over time (surface observation only). The requirement for additional underwater acoustic monitoring will be discussed with SNH once further data is available.

5.2.3.4 Avoidance/displacement

During operation, an area of avoidance might be expected; however there is no information/data presently available to ascertain if this would be a significant issue. Ongoing wildlife monitoring being undertaken by EMEC will also be used to ascertain any changes in wildlife distribution in the Fall of Warness over time (surface observation only). HSUK and SPR are committed to developing an EMP to help monitor and mitigate significant impacts.

5.2.4 Residual impact

5.2.4.1 Installation and maintenance

During installation and maintenance vessels will be on site for longer periods than passing traffic however the activities will not be significantly disproportional to those of typical vessel traffic in the area, and will only have a short term impact (intermittent activities over a one week period). Therefore, it is expected that the residual impact on wildlife during installation will be minor.

5.2.4.2 Operation

The residual impact of day to day operation of the device is unknown and may therefore only be assessed on a deploy-and-monitor strategy (see Section 6). The monitoring carried out to observe bird, seal and cetacean populations and activities using the Fall of Warness, in the context of noise surveys (if deemed necessary), video

footage and wildlife observations will provide valuable insight into the habits of these species in relation to the tidal turbine and related operations.

5.2.4.3 Decommissioning

The decommissioning phase will occur as a reversal of the installation phase and will occur following the submission of a decommissioning plan to DECC in line with the Energy Act 2004. although vessels will be on site for longer periods than passing traffic the vessel activity is not significantly disproportional to existing vessel traffic in the area. If a habitat has been established on the device this will be disturbed as there is a condition in place that HSUK must remove all deposits on the seabed after testing is complete. Such habitat removal is unlikely to have a significant negative impact on local biodiversity.

5.2.5 Cumulative impact

5.2.5.1 Installation and maintenance

The addition of a single vessel at any one time to existing vessel traffic for a limited duration is considered negligible, even alongside any other construction or installation works (which will be carefully managed under the EMEC permit to work system). Therefore the installation phase will have no major cumulative effects on the area.

5.2.5.2 Operation

The operational phase is likely to have the most potential for impacting wildlife in the area as there may be up to seven devices deployed in the Fall of Warness test site during some part of the testing phase. However, as interactions between wildlife and tidal turbines are very much unknown, it is impossible to categorise the significance of any potential cumulative impact. Monitoring is required to ascertain the potential cumulative impact from the presence of a number of devices at the Fall of Warness tidal test site. Developer monitoring of specific devices will provide an important contribution to this.

5.2.5.3 Decommissioning

Similar to installation, the decommissioning phase is limited in duration and is not expected to have any major cumulative effects on the wildlife present in the area.

5.3 Navigational risk

The information provided in this section is derived from the Navigational Safety Risk Assessment (NSRA) produced by Abbot Risk Consulting Ltd (ARC, 2010) for HSUK (ARC, 2010) which is specific to the HS1000 device described in this document. A full copy of the NSRA specific to the device is provided in Appendix E. The NSRA has been undertaken in accordance with Marine General Guidance Notice MGN 275 now replaced by MGN 371 (M+F) – Offshore Renewable Energy Installations (OREI): Guidance on UK Navigational Safety and Emergency Response Issues. This section of the supporting document summarises the main findings of the NSRA.

5.3.1 Baseline conditions

Shipping activity in the Fall of Warness and potential impacts of generic tidal devices were addressed in a site NSRA undertaken alongside the original tidal site EIA in 2005. This study identified the following significant groups of vessel traffic in the Fall of Warness:

- Fishing vessels on passage to/from fishing grounds
- Cruise vessels on passage
- Inter-island ferries
- Local fishing activity (creeling)

Other potential users of the area were identified but were either not using the area on a regular, identifiable basis (such as leisure users), or declared no conflict between their activities and the site (such as the MoD).

The vessels identified in 2005 as using the Fall of Warness and which have significance for the HSUK deployment are, primarily, deep draught vessels such as passenger cruise ships with draughts up to 8.56 m and fully laden pelagic trawlers with reported draughts up to 8.5 m. Monitoring of the test site area has confirmed usage by vessels identified in the 2005 NSRA and that the deepest draught (that of the MV Mona Lisa) is 8.56 m.

Although there is a general, recognisable trend in Orkney for cruise ships to be present during summer months, the limiting factor to the vessels remains port and harbour access. It is noted that modern cruise ships, of greater Gross Tonnage, all exhibit shallower draughts. For this reason, it is not anticipated that any other cruise ships will exceed the draught of the MV Mona Lisa.

5.3.2 Potential impact

It is considered that installation and decommissioning present a potential risk of collision with cruise vessels and transiting fishing vessels which would normally pass down the channel centre line. Inter-island ferries also make use of the Fall of Warness as an adverse weather/tide avoidance route.

The expected level of cruise ship activity, based on traffic survey data from the EMEC tidal site NSRA, would be in the order of 4 transits of the Fall of Warness per month for the May to June period. Given that the installation task is planned to take place over 9 days, it is expected that in the worst case there could be up to two cruise vessel transits concurrent with the installation activity. In addition, an average of 5 deep sea fishing vessels (with draughts not exceeding 8.5 metres) per month are expected to transit the Fall of Warness. Hence, for the period of installation, it may be expected that 2 to 3 fishing vessels may pass the site. If cruise ships and fishing vessels in transit were to suffer a catastrophic propulsion and/or steering gear failure whilst passing the installation vessel an interaction may occur. This interaction is discussed in detail in the NSRA which concludes that, given the traffic levels, the likelihood of occurrence of vessel breakdown, the expectation of weather and tidal combinations in the period under consideration and the physical extent it is considered that the risk posed by the installation is not significant.

During operation in still water conditions, and given the clearance above the device, it would not present a potential hazard to vessels using the Fall of Warness even if they were to pass directly over it. However in exceptional environmental conditions there is a theoretical risk to deep draught vessels if they were to pass over the device. The activities associated with maintenance may also increase the risk to vessels undertaking passage or other activities in the waters. The use of buoys to enable retrieval of the ballast packages presents a hazard to marine traffic and fishing activities in the area, given the tidal rates the buoys are likely to be dragged under the surface at times, creating an unseen hazard to passing traffic. However inclusion of this hazard in the Maritime Safety Information should alert mariners to their presence and it is therefore considered that the risk is tolerable with monitoring.

Potential risks discussed in the NSRA are listed below:

- Collision with device
- Failure of the device
- Maintenance
- Fishing activity around the device
- Effects of tide and tidal stream
- Effects of weather

5.3.3 Management and mitigation

The NSRA presents risk mitigation measures that help to reduce or mitigate any potential hazards to navigation that installation or decommissioning of the development might pose:

- Avoidance of extreme weather/tidal conditions for installation activities means that inter-island ferries would not require to use their adverse weather/tide routes.
- Promulgation of installation activities through UKHO Maritime Safety Information System and local Notices to Mariners.

Operationally:

- The device will be charted appropriately as an underwater installation of known depth;
- The chart currently provides warning of the siting of Energy Devices in the area of the Fall of Warness;
- Still water clearance above the device is likely to be sufficient to avoid collision between all known vessels using the area;
- A study is being commissioned by EMEC as part of an updated site NSRA to establish the theoretical “safe depth” for devices in the Fall of Warness taking into account the characteristics of known and predicted vessels using the Fall of Warness and the wave characteristics that would be likely to be developed in environmental conditions to be expected in the 5, 10, 20, 50 and 100 year events;

- Maintenance activities will only be conducted in low sea states and in minimum tidal stream rates in which inter-island ferries would not normally be required to employ their adverse weather/tidal routing measures and
- Vessels/craft engaged in maintenance activities will comply with the COLREGS.

The NSRA also states a series of recommendations which include precautions to be taken during installation and decommissioning (such as Notices to Mariners), charting of the device and charting of the test site area as a whole.

The construction and decommissioning phases of the project present a potential, but tolerable hazard to navigation. It is considered that normal precautions and controls are adequate to ensure that the risk remains tolerable.

As the device will have a minimum clearance of 17.7 m above it, it is not likely to present a hazard to vessels using these waters in still water conditions even if they were to pass directly over it. However, there remains a potential risk to vessels of deep draught in high sea states if they were to pass over the device. Whilst a general warning notation has been added to the chart indicating that such devices may be encountered in the area, the test site area has not been charted to show the boundaries of the site in which mariners may be expected to encounter test devices. However, UKHO have indicated that individual devices will be marked on charts once installed.

Full detail of the assessment of navigational safety and risk is provided in the complete NSRA specific to the HSUK device at Appendix E.

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6 MITIGATION AND MONITORING STRATEGY

6.1 Introduction

The assessment undertaken for the deployment of the HS1000 device at the EMEC tidal test site has identified mitigation measures that should be implemented for the project. These mitigation measures along with the proposed monitoring strategy are summarised here.

HSUK and SPR recognise that the proposed deployment of the HS1000 is in a sensitive area and requires appropriate management. The evaluation of environmental impacts of the HS1000 device is therefore an important aspect for SPR in assessing the success of the deployment. As responsible developers, HSUK and SPR is keen to cooperate and participate in managing and evaluating their impacts. Based on the consultation undertaken to date it is known that licence conditions will include a requirement for environmental monitoring, in addition HSUK and SPR realise results of such monitoring will provide valuable information to inform the assessment for commercial scale developments.

The environmental monitoring strategy for the project has been developed in consultation with SNH, EMEC and Hammerfest and builds on work already undertaken to understand the potential environmental impacts from the smaller prototype device deployed in Norway. This strategy is outlined below and will be developed further and documented in a detailed environmental monitoring programme (EMP) for the project. The specific detail of the plan is still being developed and therefore will be made available for review at a later date, expected to be August 2010. HSUK and SPR will review the EMP on a regular basis throughout their testing programme at EMEC and update and reissue as necessary. This review process will include consultation with relevant stakeholders.

6.2 Monitoring undertaken to date

The prototype 300 kW device has been tested successfully for four years at Kvalsund, Hammerfest, Norway. After four years it was removed and overhauled for research and development purposes before being re-installed in August 2009. This testing period has been used as an opportunity to collect some environmental data during the operation of the prototype device in the marine environment including:

- Underwater noise measurements and a discussion on the potential impact of the produced noise on fish and marine mammals; and
- Observations of bird and marine mammal use of the area.

This period of testing has informed the development of HS1000 to be deployed at EMEC and, where possible, the data and methodologies from environmental monitoring undertaken to date will be used to inform the detailed EMP for the HS1000 device.

6.3 Deployment monitoring

The installation activities do not involve any significantly noisy activities such as piling or drilling. There will only be one vessel required on site at any point in the installation process. All heavy lifting operations will be undertaken by a large DP vessel, and operations using an ROV will be undertaken from a smaller DP vessel. Consultation is ongoing with SNH to establish if there is a need for any monitoring e.g. use of a marine mammal observer (MMO), during installation.

6.4 Operational monitoring

6.4.1 Collision risk

There is as yet no standard accepted methodology or technology for the monitoring of wildlife collision with tidal energy devices. To this end HSUK and SPR are investigating the options available to it during turbine testing to ascertain their suitability for collecting the data required to assess potential collision impacts. This has included consultation with SNH who have indicated that due to the lack of accepted monitoring technology/methodology the use of a combination of two or more different techniques initially might be appropriate.

The turbine nacelle will be fitted with a video camera, looking almost vertically so that the entirety of each blade can be seen as the turbine rotates. A minimum of two fibre-optic strain gauges will also be built into each blade. The practicalities of making video recordings at a water depth of 52 m, how data from the strain gauges and camera can be interpreted and the details of how data will be collected and analysed are still being developed and will be presented in the EMP.

In addition to the use of the underwater camera and strain gauges HSUK and SPR will make use of the EMEC collected visual observations of marine wildlife at the tidal site. The specific details of how visual observation data will be collected and analysed will be presented in the EMP.

EMEC's Monitoring Advisory Group (MAG) extends and coordinates ongoing monitoring discussions EMEC has with regulators and their consultees. MAG focuses on specific methods of monitoring device-specific and generic issues relating to the devices deployed at the Fall of Warness. EMEC also has a series of ongoing or potential research projects. These include a potential short range active sonar project aimed at investigating the underwater collision issue.. HSUK and SPR would be happy to consider involvement in any associated research once further detail becomes available.

In the event of detecting a collision HSUK will discuss options with SNH including the potential for temporary shutdown of the device. The procedure for this will be set out in the EMP and agreed with SNH prior to installation in 2011.

6.4.2 Underwater noise

In order to be able to ascertain the potential significance of underwater noise generated from the tidal turbine there is a need to establish the underwater acoustic signature of the device. SPR has approached the SAMS with regards examining the propagation of noise against baseline data utilising the noise envelope gathered from the 300 kW prototype device.

The requirement for additional underwater acoustic monitoring will be discussed with SNH once further data is available. Any subsequent methodologies associated with the underwater noise output of HS1000 will be presented in the EMP.

6.4.3 Marine wildlife displacement

EMEC has an ongoing marine wildlife observation programme (since 2005). The data and summary reports produced from this project will be studied by SPR to ascertain if the presence of the HS1000 turbine, and other turbines at the tidal test site, result in wildlife displacement impacts. When further analysis of the EMEC collected data is available HSUK and SPR will consider the need for any further environmental monitoring requirements.

6.5 Mitigation and management commitments

Table 6.1 below lists all commitments made by HSUK and SPR to reduce potential environmental impacts associated with the deployment and testing of HS1000.

Table 6.1 Table of commitments

Issue	Commitment or action	Responsible organisation	Notes
Marine wildlife impacts	SPR will consult further with SNH on the requirement for a MMO during installation	SPR	Specific requirement for an MMO will depend on nature of specific DP vessel to be used for installation
	Wherever possible, periods of greatest vessel activity will be planned to avoid grey and harbour seal breeding seasons, and vessels will move onto location at slow speeds Vessel operations will be planned to minimise duration on site	SPR	Due to the logistical issues of working in such harsh physical environments, this may not always be feasible
	SPR is committed to understanding the noise output of the device and its impact on the receiving environment. The need for further work additional to that already commissioned by SPR will be assessed once results become available	SPR	
	Ongoing visual wildlife monitoring programme (undertaken by EMEC) to establish any changes in wildlife distribution in the Fall of Warness over time (surface observations only) will be used to ascertain the need for further monitoring of displacement/avoidance impacts	SPR	
	SPR is committed to operational monitoring to ascertain the collision risks for this specific tidal technology	SPR	
	If collision events are detected during operation, SNH will be consulted to ascertain the need for mitigation actions e.g. temporary shut down of the device	SPR	
Navigational risks	All works will be broadcasted by appropriate Notices to Mariners and Navigational Warnings	HSUK	
	Compliance with EMEC Notifications procedure	HSUK	
	All vessels undertaking work for HSUK will comply with COLREGS	HSUK	
	A modelling study is to be commissioned by EMEC to determine the extent of motions induced, in a variety of vessels known to use the areas, by sea states appropriate to the area	EMEC	

Issue	Commitment or action	Responsible organisation	Notes
	HIRA meeting/workshop with EMEC	HSUK /SPR / EMEC	Attended by all contractors
	Method statement will be agreed by EMEC, under its Permit to Work system	HSUK	
	Where possible, maintenance activities will be conducted in low sea states and in minimum tidal stream rates in which inter-island ferries would not normally be required to employ their adverse weather/tidal routing measures	HSUK	
Discharges to sea	Where possible, environmentally friendly/non-toxic fluids are to be used	HSUK	Device designed for no routine discharges to sea
Waste management	All wastes will be disposed of in line with legislative requirements and no overboard discharge of wastes	HSUK / marine contractors	
Accidental events	Foundation and device design will undergo third party design verification	HSUK	
	Installation methodologies and procedures will be subject to appropriate risk assessment/HIRA	HSUK / EMEC	
	All activities will be undertaken in accordance with the EMEC permit to work system	HSUK / EMEC	
	SPR will ensure all their procedures dove tail with EMEC Standard Operating Procedures (SOPs) and Emergency Response Plans (ERPs)	HSUK / EMEC	
	All subcontractors will have valid Shipboard Marine Pollution Emergency Plans including a Shipboard Oil Pollution Emergency Plan (SOPEP), or equivalent procedures as required	HSUK	
	Marine contractors selection criteria include competency assessment and use of suitably qualified and experienced personnel	HSUK	
	Lifting operations will be undertaken using appropriately rated lifting equipment	HSUK / marine contractors	

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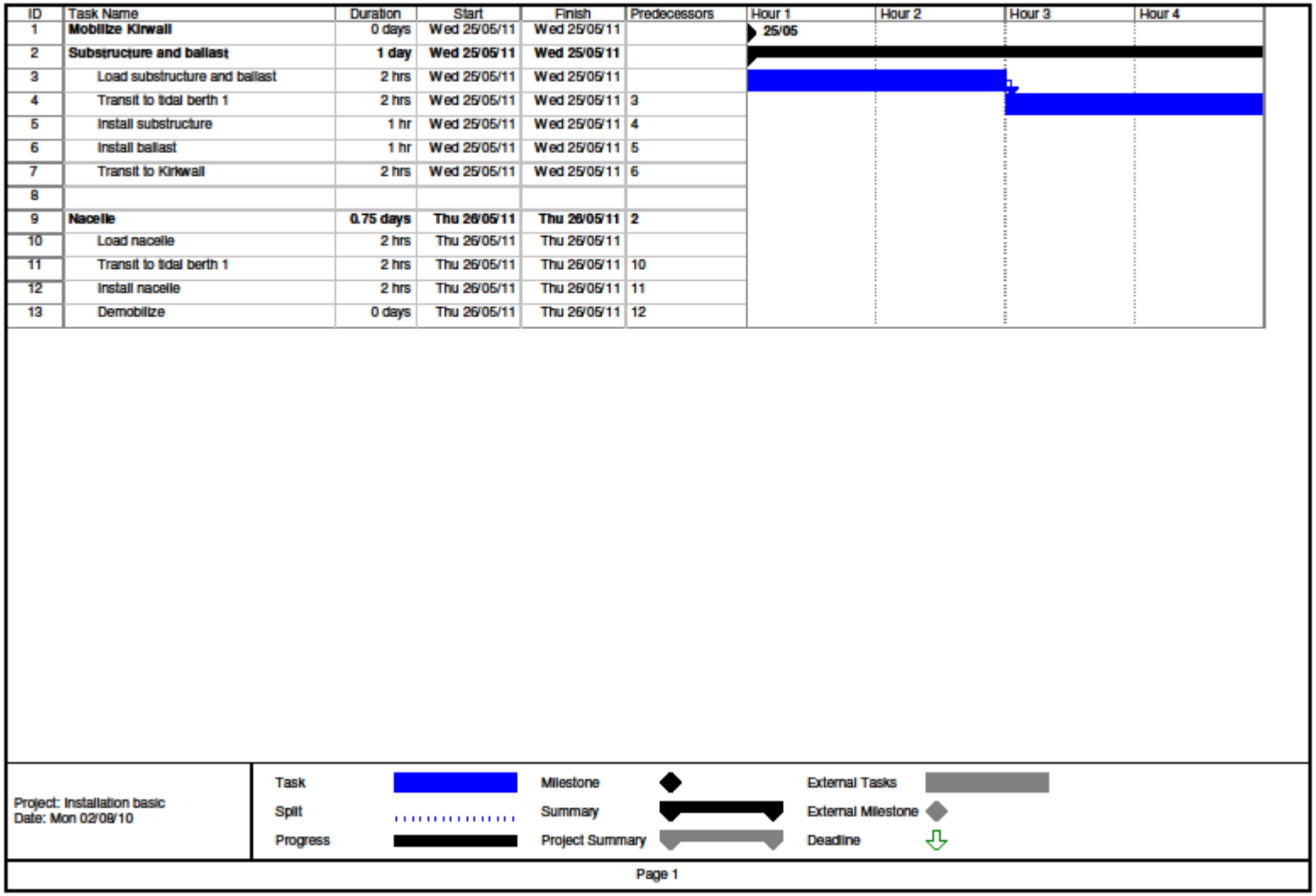
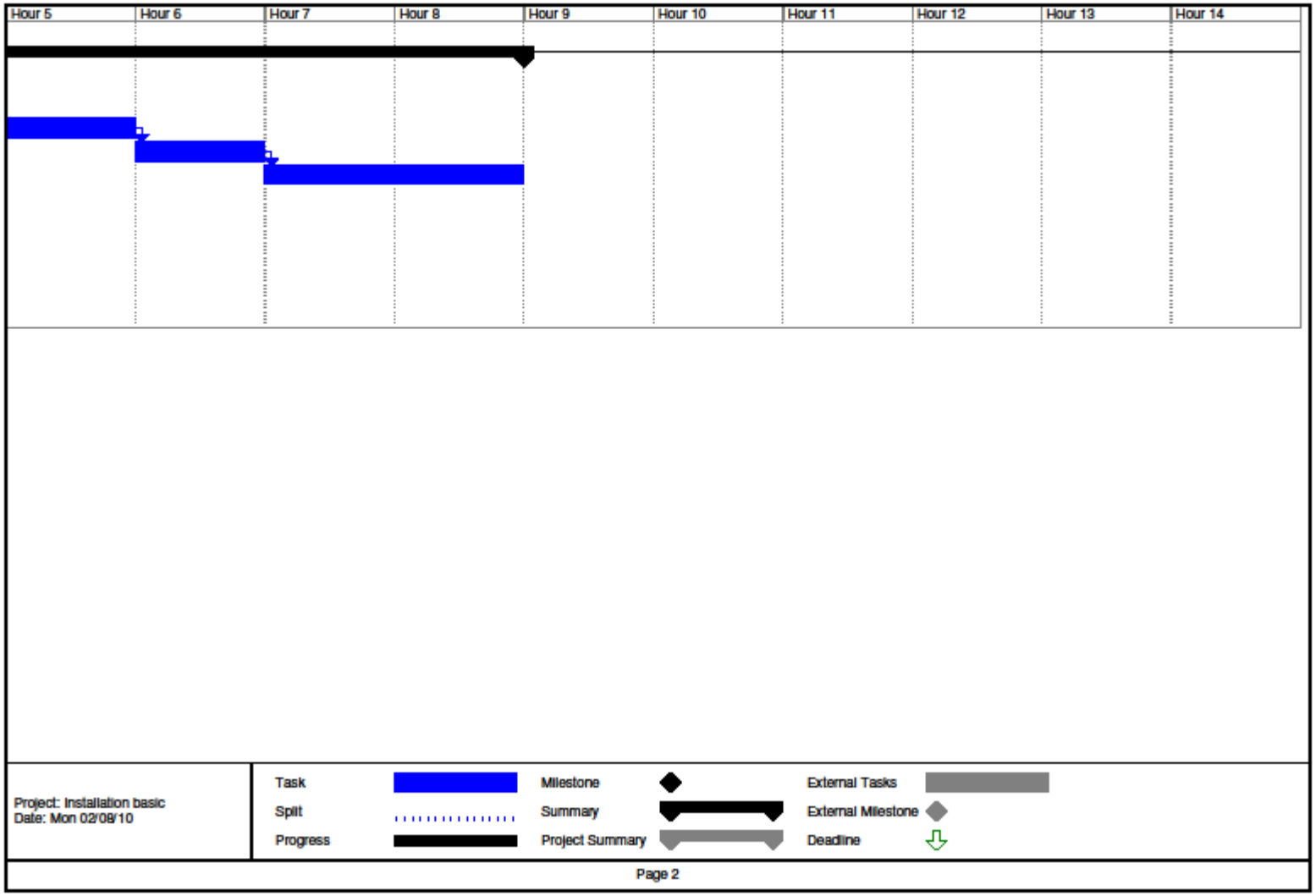
APPENDIX A INSTALLATION PROGRAMME

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Mobilize Kirwall**	0 days	Wed 25/05/11	Wed 25/05/11	
2	**Substructure and ballast**	**1 day**	**Wed 25/05/11**	**Wed 25/05/11**	
3	Load substructure and ballast	2 hrs	Wed 25/05/11	Wed 25/05/11	
4	Transit to tidal berth 1	2 hrs	Wed 25/05/11	Wed 25/05/11	3
5	Install substructure	1 hr	Wed 25/05/11	Wed 25/05/11	4
6	Install ballast	1 hr	Wed 25/05/11	Wed 25/05/11	5
7	Transit to Kirkwall	2 hrs	Wed 25/05/11	Wed 25/05/11	6
8					
9	**Nacelle**	**0.75 days**	**Thu 26/05/11**	**Thu 26/05/11**	**2**
10	Load nacelle	2 hrs	Thu 26/05/11	Thu 26/05/11	
11	Transit to tidal berth 1	2 hrs	Thu 26/05/11	Thu 26/05/11	10
12	Install nacelle	2 hrs	Thu 26/05/11	Thu 26/05/11	11
13	Demobilize	0 days	Thu 26/05/11	Thu 26/05/11	12

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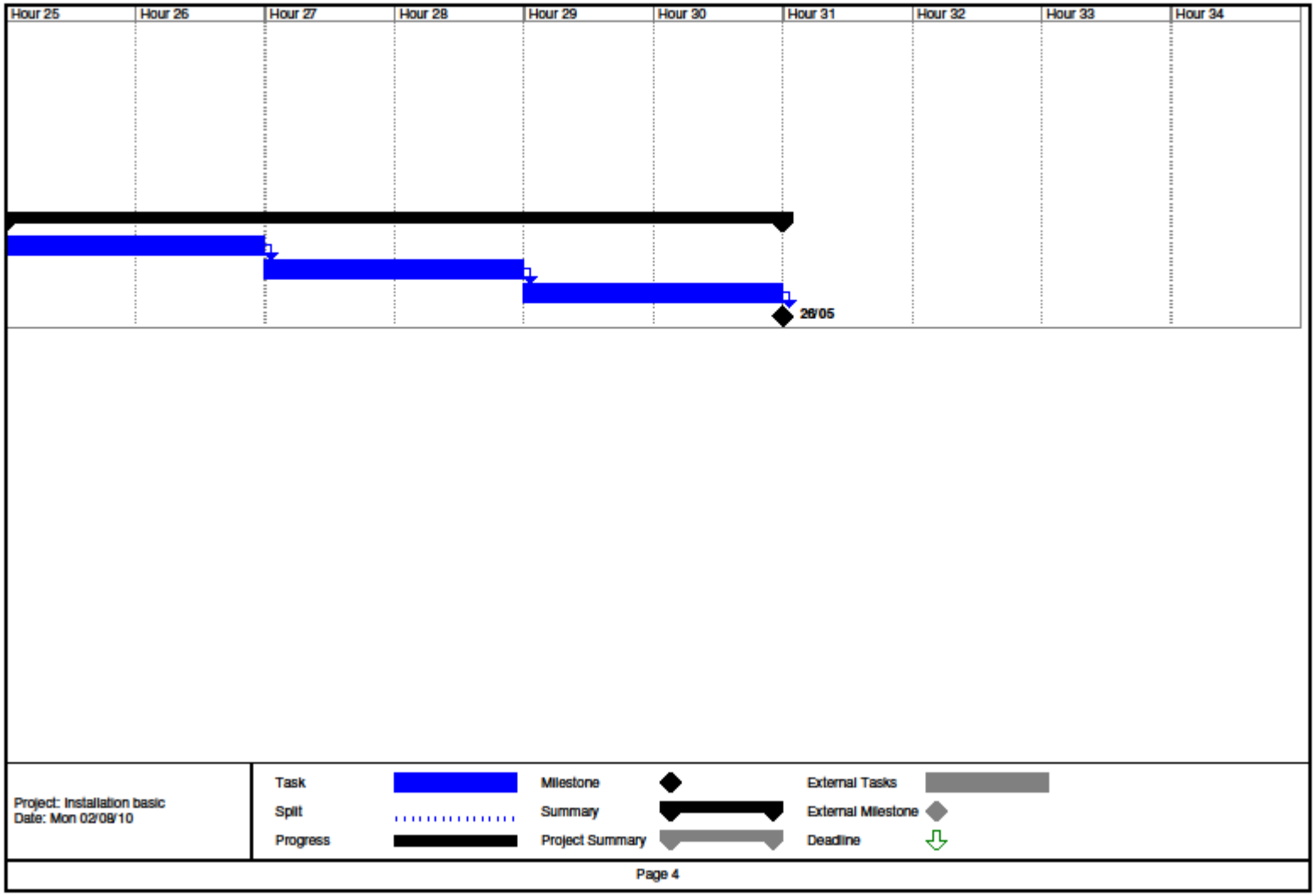
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APPENDIX B MATERIAL SAFETY DATA SHEETS

Appendix H

PRODUCT INFORMATION

FUCHS

RENOLIN UNISYN CLP

Fully-synthetic industrial gear lubricants based on polyalphaolefins

Description

Demulsifying, fully-synthetic industrial gear oils with elevated aging resistance, excellent load-carrying capacity and wear protection. RENOLIN UNISYN CLP oils have good resistance to micropitting. Reliable lubrication of roller bearings is confirmed by the good results of the FE8 testing. The products are preferably used when increased requirements are set for high and low temperature usage limits. In gearboxes and circulating systems with sump temperatures up to 90°C, longer oil change intervals in comparison with previous mineral oils are achieved. Miscibility with gearbox oils based on mineral oil is generally given, which means that simplified conversion is possible.

Application

The oils of the RENOLIN UNISYN CLP series are used for all applications in industry where a synthetic oil of the CLP type according to DIN 51 517-3 is recommended by the manufacturer. Highly stressed bearings, joints, pressure screws, spur gears and worm gears can be reliably, safely and economically supplied even at short-term peak temperatures up to 140°C.

Advantages/Benefits

- Low foaming
- Good air release capacity
- Very good aging resistance
- Excellent corrosion protection
- Excellent viscosity temperature behaviour
- High natural VI (viscosity index)
- Multigrade character
- Excellent wear protection, high EP performance
- Miscible with mineral oil and ester based
- gear oils
- Lifetime lubrication possible
- For high and low operating temperatures

Specifications

The products meet and in many cases exceed the requirements of:

- DIN 51 517-3: CLP
- ISO 6743-6: CKD
- ISO 12925: CKD
- AIST 224
- David Brown S1 53.101
- FAG requirements: FAG-FE 8-Test, stage 1-4 pass (test report is available for ISO VG 320)
- SKF requirements: pass (100°C-test)

The RENOLIN UNISYN CLP series are approved for example by:

A. Friedrich Flender AG, 46395 Bocholt (07/01/07)

September 2008 CDUK Page 1 of 3

FUCHS LUBRICANTS (UK) PLC
New Century Street, Hanley
GB-Stoke-on-Trent, Staffordshire, ST1 5HU

Tel: +44 1782 20 37 00
Fax: +44 1782 20 20 73
Email: contact-uk@fuchs-oil.com

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PRODUCT INFORMATION

CHARACTERISTICS: RENOLIN UNISYN CLP

RENOLIN UNISYN CLP ...		220	320	460	680	
Characteristics	Unit					Test Method
ISO VG		220	320	460	680	DIN 51 519
Kinematic viscosity at 40°C at 100°C	 mm²/s mm²/s	 220 29.7	 320 34.1	 460 46.8	 680 62.2	DIN EN ISO 3104
Viscosity index		148	150	155	160	DIN ISO 2909
Density at 15°C	kg/m³	867	863	866	868	DIN 51 757
Colour index	ASTM	0.5	0.5	0.5	0.5	DIN ISO 2049
Flash point, Cleveland open cup	°C	280	280	300	300	DIN ISO 2592
Pour point	°C	-54	-54	-45	-42	DIN ISO 3016
Neutralisation number	mgKOH/g	0.0	0.0	0.0	0.0	DIN 51 558
Scuffing and scoring test, FZG A/8, 3/90	failure load stage	>14	>14	>14	>14	DIN ISO 14635-1
Scuffing and scoring test, FZG A/16, 8/140	failure load stage	>12	>12	>12	>12	DIN ISO 14635-1
Micropitting test, FZG GFT Test GT C/8.3/90°C Loadstage test / endurance test	GT Class	GT I high	GT I high	GT I high	GT I high	FVA Information Sheet No. 54/1 IV
Micropitting test, FZG GFT Test GT C/8.3/60°C Loadstage test / endurance test	GT Class	GFT high	GFT high	GFT high	GFT high	FVA Information Sheet No. 54/1 IV
FE 8 roller bearing test, //-x80/90 and //-x70/90		pass (excellent)	pass (excellent)	pass (excellent)	pass (excellent)	DIN 51 819-3

SHELL OMALA® OILS

High quality industrial gear and bearing oils

Product Description

Shell Omala® Oils are high quality, extreme-pressure oils designed for the lubrication of heavy-duty industrial gears. Their high load carrying capacity and anti-friction characteristics combine to offer exceptional performance in gears and other industrial applications including some mist applications.

Shell Omala Oils help reduce gear tooth and bearing wear on both steel and bronze components. The load carrying capacity of **Shell Omala Oils**, as determined in laboratory tests, meets Shell's stringent requirements to be offered globally. The additive system helps to reduce gear tooth wear, particularly under conditions of high load. Shell Omala Oils are suitable for spur, helical and bevel gears and are designed to operate under conditions of heavy and shock loads.

Shell Omala Oils withstand elevated temperatures and resist the formation of sludge. The formulation helps provide extended oil life even under higher than normal operating temperatures. **Shell Omala Oils** protect both steel and bronze components, even in the presence of contamination by water and solids. **Shell Omala Oils** also have excellent water separation properties, such that excess water can be drained easily from lubrication systems. Water can greatly accelerate surface fatigue with gears and bearings as well as promoting ferrous corrosion on internal surfaces. Water contamination should therefore be avoided or removed as quickly as possible after the occurrence.

Shell Omala Oils are formulated using high viscosity index base oils, and incorporate a special sulfur-phosphorus additive to provide extreme pressure performance.

They are available in several ISO viscosity grades ranging from 68 to 3220.

Applications

- steel gear transmissions including spur, helical and bevel gears
- industrial gear drives where full extreme pressure performance due to heavy or shock loading is needed
- plain and roller contact bearings
- circulating and splash lubricated systems
- mist systems

Note: For automotive hypoid gears, use the appropriate **Shell Spirax® Heavy-Duty** or **Shell Spirax® S** lubricant.

Performance Features and Benefits

- outstanding oxidation and thermal stability which helps extend oil life
- effective corrosion inhibitors to help protect gearbox components
- effective sulfur-phosphorus extreme pressure system to prevent wear under tough conditions
- wide range of viscosities to meet a wide variety of operating conditions
- excellent water shedding properties which allow the water to separate and be drained protecting components from rust and corrosion
- excellent load carrying capacity helping to extend equipment life

August, 2005

Specifications, OEM Listings and Approvals	
• AGMA 9005 D94EP (150-3200 grades) • Bosch Rexroth (Listing) • Boston Gear (Listing) • David Brown (Approval) • Danieli (Listing) • FAG (Listing) • Falk (Listing) • GM LS-2 verification upon request (ISO grades 150, 220, 320 and 460)	• Lenze AG (Approval) • Minter Machine Company (Approval) • Morgan Construction (Listing) • Moeller Wenguren (Listing) • Rexnord-Stephan (Approval) • Wartsila (Approval) • US Steel 224 (150-3200 grades)

Typical Properties of Shell Omala® Oils

	Test Method	ISO Viscosity Grade									
AGMA EP Gear Oil Grade		68	100	150	220	320	460	680	1000	1500	3200
Old AGMA Grade		2 EP	3 EP	4 EP	5 EP	6 EP	7 EP	8 EP	8A EP	9 EP	10 EP
Product Code		65101	65103	65104	65105	65107	65108	65109	65541	65542	65543
Gravity, °API	D 287	29.2	28.6	27.4	26.6	25.8	25.0	23.6	22.8	22.2	19.5
Viscosity:											
@ 40°C, cSt	D 445	68	100	150	220	320	460	680	1000	1500	3200
@ 100°C, cSt	D 445	8.8	11.4	14.65	18.6	23.7	30.2	36.4	49.8	61.4	98.8
@ 100°F, SUS	(calc)	356	521	788	1143	1657	2356	3307	5441	8252	16001
@ 210°F, SUS	(calc)	58	65	78	96	118	148	190	262	359	653
Viscosity Index	D 2270	101	99	96	96	97	96	91	95	91	89
Flash Point, COC, °F	D 92	425	420	445	450	460	470	470	475	505	480
Pour Point, °F	D 97	15	10	-10	-10	0	10	10	15	20	40
Copper Corrosion @ 212°F	D 130	1a	1a	1a	1a	1a	1a	1a	1b	1b	1b
Foam, tendency/stability	D 892										
Seq I ml/ml		nil/0	nil/0	nil/0	nil/0	nil/0	nil/0	nil/0	—	—	—
Seq II ml/ml		nil/0	nil/0	nil/0	nil/0	nil/0	nil/0	nil/0			
Seq III ml/ml		nil/0	nil/0	nil/0	nil/0	nil/0	nil/0	nil/0	—	—	—
FZG, Scuffing Load Capacity, Fail Stage	D 5182	12+	12+	12+	12+	12+	12	12+		—	
Timken, OK Load, lbs	D 2782	60	60	65	70	75	80	80	60	60	60
Four-Ball EP											
Load Wear Index, kgf	D 2783	45	45	45	45	46	47	47	45	45	45
Weld Point, kgf		250	250	250	250	250	250	250	250	250	250
Demulsibility	D 2711										
Free water, ml		87.1	87.2	85	84.8	84.5	82.5	82.5	-		--
Emulsion, after cmplg ml		0.1	0.2	0.2	0.2	0.2	0.1	0.1	--	--	--
Rust Protection	D 6138	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

Handling & Safety Information

For information on the safe handling and use of this product, refer to its Material Safety Data Sheet at https://www.shell-lubricants.com/msds/. If you are a Shell Distributor, please call 1+800-468-6457 for all of your service needs. All other customers, please call 1+800-840-5737 for all of your service needs. Information is also available on the World Wide Web: https://www.shell-lubricants.com.

Material Safety Data Sheet

according to EC directive 2001/58/EC

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND COMPANY/UNDERTAKING

Material Name	:	**Shell Omala Oil 460**
Uses	:	Gear lubricant
Product Code	:	001A0778
Manufacturer/Supplier	:	**Shell UK Oil Products Limited** PO Box 3 Ellesmere Port CH65 4HB United Kingdom
Telephone	:	+44-(0) 151-350-4000
Fax	:	+44-(0) 151-350-4843
Emergency Telephone Number	:	+44-(0) 151 350 4595

2. COMPOSITION/INFORMATION ON INGREDIENTS

Preparation description	:	Highly refined mineral oils and additives.
Additional Information	:	The highly refined mineral oil contains <3% (w/w) DMSO-extract, according to IP346.

3. HAZARDS IDENTIFICATION

EC Classification	:	Not classified as dangerous under EC criteria.
Health Hazards	:	Not expected to be a health hazard when used under normal conditions. Prolonged or repeated skin contact without proper cleaning can clog the pores of the skin resulting in disorders such as oil acne/folliculitis. Used oil may contain harmful impurities.
Signs and Symptoms	:	Oil acne/folliculitis signs and symptoms may include formation of black pustules and spots on the skin of exposed areas. Ingestion may result in nausea, vomiting and/or diarrhoea.
Safety Hazards	:	Not classified as flammable but will burn.
Environmental Hazards	:	Not classified as dangerous for the environment.

4. FIRST AID MEASURES

General Information	:	Not expected to be a health hazard when used under normal conditions.
Inhalation	:	No treatment necessary under normal conditions of use. If symptoms persist, obtain medical advice.
Skin Contact	:	Remove contaminated clothing. Flush exposed area with water and follow by washing with soap if available. If persistent irritation occurs, obtain medical attention.
Eye Contact		Flush eye with copious quantities of water. If persistent

		Irritation occurs, obtain medical attention.
Ingestion	:	In general no treatment is necessary unless large quantities are swallowed, however, get medical advice.
Advice to Physician		Treat symptomatically.

5. FIRE FIGHTING MEASURES

Clear fire area of all non-emergency personnel.

Specific Hazards	:	Hazardous combustion products may include: A complex mixture of airborne solid and liquid particulates and gases (smoke). Carbon monoxide. Unidentified organic and inorganic compounds.
Extinguishing Media	:	Foam, water spray or fog. Dry chemical powder, carbon dioxide, sand or earth may be used for small fires only.
Unsuitable Extinguishing Media	:	Do not use water in a jet.
Protective Equipment for Firefighters	:	Proper protective equipment including breathing apparatus must be worn when approaching a fire in a confined space.

6. ACCIDENTAL RELEASE MEASURES

Avoid contact with spilled or released material. For guidance on selection of personal protective equipment see Chapter 8 of this Material Safety Data Sheet. See Chapter 13 for information on disposal. Observe all relevant local and international regulations.

Protective measures	:	Avoid contact with skin and eyes. Use appropriate containment to avoid environmental contamination. Prevent from spreading or entering drains, ditches or rivers by using sand, earth, or other appropriate barriers.
Clean Up Methods	:	Slippery when spilt. Avoid accidents, clean up immediately. Prevent from spreading by making a barrier with sand, earth or other containment material. Reclaim liquid directly or in an absorbent. Soak up residue with an absorbent such as clay, sand or other suitable material and dispose of properly.
Additional Advice	:	Local authorities should be advised if significant spillages cannot be contained.

7. HANDLING AND STORAGE

General Precautions	:	Use local exhaust ventilation if there is risk of inhalation of vapours, mists or aerosols. Properly dispose of any contaminated rags or cleaning materials in order to prevent fires. Use the information in this data sheet as input to a risk assessment of local circumstances to help determine appropriate controls for safe handling, storage and disposal of this material.
Handling	:	Avoid prolonged or repeated contact with skin. Avoid inhaling vapour and/or mists. When handling product in drums, safety footwear should be worn and proper handling equipment should be used.
Storage		Keep container tightly closed and in a cool, well-ventilated place. Use properly labelled and closeable containers. Storage

Temperature: 0 - 50°C / 32 - 122°F
The storage of this product may be subject to the Control of Pollution (Oil Storage) (England) Regulations. Further guidance may be obtained from the local environmental agency office.

Recommended Materials : For containers or container linings, use mild steel or high density polyethylene

Unsuitable Materials : PVC

Additional Information : Polyethylene containers should not be exposed to high temperatures because of possible risk of distortion. Exposure to this product should be reduced as low as reasonably practicable. Reference should be made to the Health and Safety Executive's publication "COSHH Essentials".

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Limits

Exposure Controls : The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Select controls based on a risk assessment of local circumstances. Appropriate measures include: Adequate ventilation to control airborne concentrations. Where material is heated, sprayed or mist formed, there is greater potential for airborne concentrations to be generated.

Personal Protective Equipment : Personal protective equipment (PPE) should meet recommended national standards. Check with PPE suppliers.

Respiratory Protection : No respiratory protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid breathing of material. If engineering controls do not maintain airborne concentrations to a level which is adequate to protect worker health, select respiratory protection equipment suitable for the specific conditions of use and meeting relevant legislation. Check with respiratory protective equipment suppliers. Where air-filtering respirators are suitable, select an appropriate combination of mask and filter. Select a filter suitable for combined particulate/organic gases and vapours [boiling point >65 °C (149 °F)] meeting EN371.

Hand Protection : Where hand contact with the product may occur the use of gloves approved to relevant standards (e.g. Europe: EN374, US: F739) made from the following materials may provide suitable chemical protection: PVC, neoprene or nitrile rubber gloves. Suitability and durability of a glove is dependent on usage, e.g. frequency and duration of contact, chemical resistance of glove material, glove thickness, dexterity. Always seek advice from glove suppliers. Contaminated gloves should be replaced. Personal hygiene is a key element of effective hand care. Gloves must only be worn on clean hands. After using gloves, hands should be washed and dried thoroughly. Application of a non-perfumed moisturizer is recommended.

Eye Protection : Wear safety glasses or full face shield if splashes are likely to occur. Approved to EU Standard EN 166.

Protective Clothing	:	Skin protection not ordinarily required beyond standard issue work clothes.
Monitoring Methods	:	Monitoring of the concentration of substances in the breathing zone of workers or in the general workplace may be required to confirm compliance with an OEL and adequacy of exposure controls. For some substances biological monitoring may also be appropriate.
Environmental Exposure Controls	:	Minimise release to the environment. An environmental assessment must be made to ensure compliance with local environmental legislation.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	Brown. Liquid.
Odour	:	Slight hydrocarbon
pH	:	Not applicable.
Boiling point	:	> 280 °C / 536 °F estimated value(s)
Pour point	:	Typical -12 °C / 10 °F
Flash point	:	Typical 265 °C / 401 °F (COC)
Explosion / Flammability limits in air	:	Typical 1 - 10 %(V) (based on mineral oil)
Auto-ignition temperature	:	> 320 °C / 608 °F
Vapour pressure	:	< 0.5 Pa at 20 °C / 68 °F (estimated value(s))
Density	:	Typical 904 kg/m3 at 15 °C / 59 °F
Water solubility	:	Negligible.
n-octanol/water partition coefficient (log Pow)	:	> 6 (based on information on similar products)
Kinematic viscosity	:	Typical 460 mm2/s at 40 °C / 104 °F
Vapour density (air=1)	:	> 1 (estimated value(s))
Evaporation rate (nBuAc=1)	:	Data not available

10. STABILITY AND REACTIVITY

Stability	:	Stable.
Conditions to Avoid	:	Extremes of temperature and direct sunlight.
Materials to Avoid	:	Strong oxidising agents.
Hazardous Decomposition Products	:	Hazardous decomposition products are not expected to form during normal storage.

11. TOXICOLOGICAL INFORMATION

Basis for Assessment	:	Information given is based on data on the components and the toxicology of similar products.
Acute Oral Toxicity	:	Expected to be of low toxicity: LD50 >2000 mg/kg . Rat
Acute Dermal Toxicity	:	Expected to be of low toxicity: LD50 >2000 mg/kg . Rabbit
Acute Inhalation Toxicity	:	This product is not expected to pose an inhalation hazard under conditions of foreseeable use
Skin Irritation	:	Expected to be slightly irritating. Prolonged or repeated skin contact without proper cleaning can clog the pores of the skin resulting in disorders such as oil acne/folliculitis.
Eye Irritation	:	Expected to be slightly irritating.
Respiratory Irritation	:	Inhalation of vapours or mists may cause irritation.
Sensitisation	:	Not expected to be a skin sensitiser.

Repeated Dose Toxicity	:	Not expected to be a hazard.
Mutagenicity	:	Not considered a mutagenic hazard.
Carcinogenicity	:	Product contains mineral oils of types shown to be non-carcinogenic in animal skin-painting studies. Highly refined mineral oils are not classified as carcinogenic by the International Agency for Research on Cancer (IARC). Other components are not known to be associated with carcinogenic effects.
Reproductive and Developmental Toxicity	:	Not expected to be a hazard.
Additional Information	:	Used oils may contain harmful impurities that have accumulated during use. The concentration of such impurities will depend on use and they may present risks to health and the environment on disposal. ALL used oil should be handled with caution and skin contact avoided as far as possible.

12. ECOLOGICAL INFORMATION

Ecotoxicological data have not been determined specifically for this product. Information given is based on a knowledge of the components and the ecotoxicology of similar products.

Acute Toxicity	:	Poorly soluble mixture. May cause physical fouling of aquatic organisms. Expected to be practically non toxic: LL/EL/IL50 > 100 mg/l (to aquatic organisms) (LL/EL50 expressed as the nominal amount of product required to prepare aqueous test extract). Mineral oil is not expected to cause any chronic effects to aquatic organisms at concentrations less than 1 mg/l.
Mobility	:	Liquid under most environmental conditions. Floats on water. If it enters soil, it will adsorb to soil particles and will not be mobile.
Persistence/degradability	:	Expected to be not readily biodegradable. Major constituents are expected to be inherently biodegradable, but the product contains components that may persist in the environment.
Bioaccumulation	:	Contains components with the potential to bioaccumulate.
Other Adverse Effects	:	Product is a mixture of non-volatile components, which are not expected to be released to air in any significant quantities. Not expected to have ozone depletion potential, photochemical ozone creation potential or global warming potential.

13. DISPOSAL CONSIDERATIONS

Material Disposal	:	Recover or recycle if possible. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste classification and disposal methods in compliance with applicable regulations. Do not dispose into the environment, in drains or in water courses.
Container Disposal	:	Dispose in accordance with prevailing regulations, preferably to a recognised collector or contractor. The competence of the collector or contractor should be established beforehand.
Local Legislation	:	Disposal should be in accordance with applicable regional, national, and local laws and regulations.

EU Waste Disposal Code (EWC): 13 02 05 mineral-based non-chlorinated engine, gear and lubricating oils. Classification of waste is always the responsibility of the end user.

14. TRANSPORT INFORMATION

ADR
This material is not classified as dangerous under ADR regulations.

RID
This material is not classified as dangerous under RID regulations.

ADNR
This material is not classified as dangerous under ADNR regulations.

IMDG
This material is not classified as dangerous under IMDG regulations.

IATA (Country variations may apply)
This material is not classified as dangerous under IATA regulations.

15. REGULATORY INFORMATION

The regulatory information is not intended to be comprehensive. Other regulations may apply to this material.

EC Classification	:	Not classified as dangerous under EC criteria.
EC Symbols	:	No Hazard Symbol required
EC Risk Phrases	:	Not classified.
EC Safety Phrases	:	Not classified.
EINECS	:	All components listed or polymer exempt.
TSCA	:	All components listed.
Other Information	:	Environmental Protection Act 1990 (as amended), Health and Safety at Work Act 1974, Consumers Protection Act 1987, Control of Pollution Act 1974, Environmental Act 1995, Factories Act 1961, Carriage of Dangerous Goods by Road and Rail (Classification, Packaging and Labelling) Regulations, Chemicals (Hazard Information and Packaging for Supply) Regulations 2002, Control of Substances Hazardous to Health Regulations 1994 (as amended), Road Traffic (Carriage of Dangerous Substances in Packages) Regulations, Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations, Road Traffic (Carriage of Dangerous Substances in Road Tankers and Tank Containers) Regulations, Road Traffic (Training of Drivers of Vehicles Carrying Dangerous Goods) Regulations, Reporting of Injuries, Diseases and Dangerous

Occurrences Regulations, Health and Safety (First Aid) Regulations 1981, Personal Protective Equipment (EC Directive) Regulations 1992, Personal Protective Equipment at Work Regulations 1992.

16. OTHER INFORMATION

R-phrase(s)

Not classified

MSDS Version Number	:	1.1
MSDS Effective Date	:	05.03.2007
MSDS Revisions	:	A vertical bar (|) in the left margin indicates an amendment from the previous version.
MSDS Regulation	:	The content and format of this safety data sheet is in accordance with Commission Directive 2001/58/EC of 27 July 2001, amending for the second time Commission Directive 91/155/EEC.
MSDS Distribution	:	The information in this document should be made available to all who may handle the product.
Disclaimer		This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product.

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August, 2005

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Old AGMA Grade		2 EP	3 EP	4 EP	5 EP	6 EP	7 EP	8 EP	8A EP	9 EP	10 EP
Product Code		65101	65103	65104	65105	65107	65108	65109	65541	65542	65543
Gravity, °API	D 287	29.2	28.6	27.4	26.6	25.8	25.0	23.6	22.8	22.2	19.5
Viscosity:											
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@ 210°F, SUS	(calc)	58	65	78	96	118	148	190	262	359	453
Viscosity Index	D 2270	101	99	96	96	97	96	91	95	91	89
Flash Point, COC, °F	D 92	425	420	445	450	460	470	470	475	505	480
Pour Point, °F	D 97	-15	-10	-10	-10	0	10	10	15	20	40
Copper Corrosion @ 212°F	D 130	1a	1a	1a	1a	1a	1a	1a	1b	1b	1b
Foam, tendency/stability	D 892										
Seq I ml/ml		nil/0	nil/0	nil/0	nil/0	nil/0	nil/0	nil/0	—	—	—
Seq II ml/ml		nil/0	nil/0	nil/0	nil/0	nil/0	nil/0	nil/0			
Seq III ml/ml		nil/0	nil/0	nil/0	nil/0	nil/0	nil/0	nil/0	—	—	—
FZG, Scuffing Load Capacity, Fail Stage	D 5182	12+	12+	12+	12+	12+	12	12+		—	
Timken, OK Load, lbs	D 2782	60	60	65	70	75	80	80	60	60	60
Four-Ball EP											
Load Wear Index, kgf	D 2783	45	45	45	45	46	47	47	45	45	45
Weld Point, kgf		250	250	250	250	250	250	250	250	250	250
Demulsibility	D 2711										
Free water, ml		87.1	87.2	85	84.8	84.5	82.5	82.5	-		--
Emulsion, after cmplg ml		0.1	0.2	0.2	0.2	0.2	0.1	0.1	--	--	--
Rust Protection	D 6138	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

Handling & Safety Information

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Material Safety Data Sheet

according to EC directive 2001/58/EC

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND COMPANY/UNDERTAKING

Material Name	:	**Shell Omala Oil 460**
Uses	:	Gear lubricant
Product Code	:	001A0778
Manufacturer/Supplier	:	**Shell UK Oil Products Limited** PO Box 3 Ellesmere Port CH65 4HB United Kingdom
Telephone	:	+44-(0) 151-350-4000
Fax	:	+44-(0) 151-350-4843
Emergency Telephone Number	:	+44-(0) 151 350 4595

2. COMPOSITION/INFORMATION ON INGREDIENTS

Preparation description	:	Highly refined mineral oils and additives.
Additional Information	:	The highly refined mineral oil contains <3% (w/w) DMSO-extract, according to IP346.

3. HAZARDS IDENTIFICATION

EC Classification	:	Not classified as dangerous under EC criteria.
Health Hazards	:	Not expected to be a health hazard when used under normal conditions. Prolonged or repeated skin contact without proper cleaning can clog the pores of the skin resulting in disorders such as oil acne/folliculitis. Used oil may contain harmful impurities.
Signs and Symptoms	:	Oil acne/folliculitis signs and symptoms may include formation of black pustules and spots on the skin of exposed areas. Ingestion may result in nausea, vomiting and/or diarrhoea.
Safety Hazards	:	Not classified as flammable but will burn.
Environmental Hazards	:	Not classified as dangerous for the environment.

4. FIRST AID MEASURES

General Information	:	Not expected to be a health hazard when used under normal conditions.
Inhalation	:	No treatment necessary under normal conditions of use. If symptoms persist, obtain medical advice.
Skin Contact	:	Remove contaminated clothing. Flush exposed area with water and follow by washing with soap if available. If persistent irritation occurs, obtain medical attention.
Eye Contact		Flush eye with copious quantities of water. If persistent

		Irritation occurs, obtain medical attention.
Ingestion	:	In general no treatment is necessary unless large quantities are swallowed, however, get medical advice.
Advice to Physician		Treat symptomatically.

5. FIRE FIGHTING MEASURES

Clear fire area of all non-emergency personnel.

Specific Hazards	:	Hazardous combustion products may include: A complex mixture of airborne solid and liquid particulates and gases (smoke). Carbon monoxide. Unidentified organic and inorganic compounds.
Extinguishing Media	:	Foam, water spray or fog. Dry chemical powder, carbon dioxide, sand or earth may be used for small fires only.
Unsuitable Extinguishing Media	:	Do not use water in a jet.
Protective Equipment for Firefighters	:	Proper protective equipment including breathing apparatus must be worn when approaching a fire in a confined space.

6. ACCIDENTAL RELEASE MEASURES

Avoid contact with spilled or released material. For guidance on selection of personal protective equipment see Chapter 8 of this Material Safety Data Sheet. See Chapter 13 for information on disposal. Observe all relevant local and international regulations.

Protective measures	:	Avoid contact with skin and eyes. Use appropriate containment to avoid environmental contamination. Prevent from spreading or entering drains, ditches or rivers by using sand, earth, or other appropriate barriers.
Clean Up Methods	:	Slippery when spill. Avoid accidents, clean up immediately. Prevent from spreading by making a barrier with sand, earth or other containment material. Reclaim liquid directly or in an absorbent. Soak up residue with an absorbent such as clay, sand or other suitable material and dispose of properly.
Additional Advice	:	Local authorities should be advised if significant spillages cannot be contained.

7. HANDLING AND STORAGE

General Precautions	:	Use local exhaust ventilation if there is risk of inhalation of vapours, mists or aerosols. Properly dispose of any contaminated rags or cleaning materials in order to prevent fires. Use the information in this data sheet as input to a risk assessment of local circumstances to help determine appropriate controls for safe handling, storage and disposal of this material.
Handling	:	Avoid prolonged or repeated contact with skin. Avoid inhaling vapour and/or mists. When handling product in drums, safety footwear should be worn and proper handling equipment should be used.
Storage		Keep container tightly closed and in a cool, well-ventilated place. Use properly labelled and closeable containers. Storage

Temperature: 0 - 50°C / 32 - 122°F
The storage of this product may be subject to the Control of Pollution (Oil Storage) (England) Regulations. Further guidance may be obtained from the local environmental agency office.

Recommended Materials : For containers or container linings, use mild steel or high density polyethylene

Unsuitable Materials : PVC

Additional Information : Polyethylene containers should not be exposed to high temperatures because of possible risk of distortion. Exposure to this product should be reduced as low as reasonably practicable. Reference should be made to the Health and Safety Executive's publication "COSHH Essentials".

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Limits

Exposure Controls : The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Select controls based on a risk assessment of local circumstances. Appropriate measures include: Adequate ventilation to control airborne concentrations. Where material is heated, sprayed or mist formed, there is greater potential for airborne concentrations to be generated.

Personal Protective Equipment : Personal protective equipment (PPE) should meet recommended national standards. Check with PPE suppliers.

Respiratory Protection : No respiratory protection is ordinarily required under normal conditions of use. In accordance with good industrial hygiene practices, precautions should be taken to avoid breathing of material. If engineering controls do not maintain airborne concentrations to a level which is adequate to protect worker health, select respiratory protection equipment suitable for the specific conditions of use and meeting relevant legislation. Check with respiratory protective equipment suppliers. Where air-filtering respirators are suitable, select an appropriate combination of mask and filter. Select a filter suitable for combined particulate/organic gases and vapours [boiling point >65 °C (149 °F)] meeting EN371.

Hand Protection : Where hand contact with the product may occur the use of gloves approved to relevant standards (e.g. Europe: EN374, US: F739) made from the following materials may provide suitable chemical protection: PVC, neoprene or nitrile rubber gloves. Suitability and durability of a glove is dependent on usage, e.g. frequency and duration of contact, chemical resistance of glove material, glove thickness, dexterity. Always seek advice from glove suppliers. Contaminated gloves should be replaced. Personal hygiene is a key element of effective hand care. Gloves must only be worn on clean hands. After using gloves, hands should be washed and dried thoroughly. Application of a non-perfumed moisturizer is recommended.

Eye Protection : Wear safety glasses or full face shield if splashes are likely to occur. Approved to EU Standard EN 166.

Protective Clothing	:	Skin protection not ordinarily required beyond standard issue work clothes.
Monitoring Methods	:	Monitoring of the concentration of substances in the breathing zone of workers or in the general workplace may be required to confirm compliance with an OEL and adequacy of exposure controls. For some substances biological monitoring may also be appropriate.
Environmental Exposure Controls	:	Minimise release to the environment. An environmental assessment must be made to ensure compliance with local environmental legislation.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	Brown. Liquid.
Odour	:	Slight hydrocarbon
pH	:	Not applicable.
Boiling point	:	> 280 °C / 536 °F estimated value(s)
Pour point	:	Typical -12 °C / 10 °F
Flash point	:	Typical 265 °C / 401 °F (COC)
Explosion / Flammability limits in air	:	Typical 1 - 10 %(V) (based on mineral oil)
Auto-ignition temperature	:	> 320 °C / 608 °F
Vapour pressure	:	< 0.5 Pa at 20 °C / 68 °F (estimated value(s))
Density	:	Typical 904 kg/m3 at 15 °C / 59 °F
Water solubility	:	Negligible.
n-octanol/water partition coefficient (log Pow)	:	> 6 (based on information on similar products)
Kinematic viscosity	:	Typical 460 mm2/s at 40 °C / 104 °F
Vapour density (air=1)	:	> 1 (estimated value(s))
Evaporation rate (nBuAc=1)	:	Data not available

10. STABILITY AND REACTIVITY

Stability	:	Stable.
Conditions to Avoid	:	Extremes of temperature and direct sunlight.
Materials to Avoid	:	Strong oxidising agents.
Hazardous Decomposition Products	:	Hazardous decomposition products are not expected to form during normal storage.

11. TOXICOLOGICAL INFORMATION

Basis for Assessment	:	Information given is based on data on the components and the toxicology of similar products.
Acute Oral Toxicity	:	Expected to be of low toxicity: LD50 >2000 mg/kg . Rat
Acute Dermal Toxicity	:	Expected to be of low toxicity: LD50 >2000 mg/kg . Rabbit
Acute Inhalation Toxicity	:	This product is not expected to pose an inhalation hazard under conditions of foreseeable use
Skin Irritation	:	Expected to be slightly irritating. Prolonged or repeated skin contact without proper cleaning can clog the pores of the skin resulting in disorders such as oil acne/folliculitis.
Eye Irritation	:	Expected to be slightly irritating.
Respiratory Irritation	:	Inhalation of vapours or mists may cause irritation.
Sensitisation	:	Not expected to be a skin sensitiser.

Repeated Dose Toxicity	:	Not expected to be a hazard.
Mutagenicity	:	Not considered a mutagenic hazard.
Carcinogenicity	:	Product contains mineral oils of types shown to be non-carcinogenic in animal skin-painting studies. Highly refined mineral oils are not classified as carcinogenic by the International Agency for Research on Cancer (IARC). Other components are not known to be associated with carcinogenic effects.
Reproductive and Developmental Toxicity	:	Not expected to be a hazard.
Additional Information	:	Used oils may contain harmful impurities that have accumulated during use. The concentration of such impurities will depend on use and they may present risks to health and the environment on disposal. ALL used oil should be handled with caution and skin contact avoided as far as possible.

12. ECOLOGICAL INFORMATION

Ecotoxicological data have not been determined specifically for this product. Information given is based on a knowledge of the components and the ecotoxicology of similar products.

Acute Toxicity	:	Poorly soluble mixture. May cause physical fouling of aquatic organisms. Expected to be practically non toxic: LL/EL/IL50 > 100 mg/l (to aquatic organisms) (LL/EL50 expressed as the nominal amount of product required to prepare aqueous test extract). Mineral oil is not expected to cause any chronic effects to aquatic organisms at concentrations less than 1 mg/l.
Mobility	:	Liquid under most environmental conditions. Floats on water. If it enters soil, it will adsorb to soil particles and will not be mobile.
Persistence/degradability	:	Expected to be not readily biodegradable. Major constituents are expected to be inherently biodegradable, but the product contains components that may persist in the environment.
Bioaccumulation	:	Contains components with the potential to bioaccumulate.
Other Adverse Effects	:	Product is a mixture of non-volatile components, which are not expected to be released to air in any significant quantities. Not expected to have ozone depletion potential, photochemical ozone creation potential or global warming potential.

13. DISPOSAL CONSIDERATIONS

Material Disposal	:	Recover or recycle if possible. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste classification and disposal methods in compliance with applicable regulations. Do not dispose into the environment, in drains or in water courses.
Container Disposal	:	Dispose in accordance with prevailing regulations, preferably to a recognised collector or contractor. The competence of the collector or contractor should be established beforehand.
Local Legislation	:	Disposal should be in accordance with applicable regional, national, and local laws and regulations.

EU Waste Disposal Code (EWC): 13 02 05 mineral-based non-chlorinated engine, gear and lubricating oils. Classification of waste is always the responsibility of the end user.

14. TRANSPORT INFORMATION

ADR
This material is not classified as dangerous under ADR regulations.

RID
This material is not classified as dangerous under RID regulations.

ADNR
This material is not classified as dangerous under ADNR regulations.

IMDG
This material is not classified as dangerous under IMDG regulations.

IATA (Country variations may apply)
This material is not classified as dangerous under IATA regulations.

15. REGULATORY INFORMATION

The regulatory information is not intended to be comprehensive. Other regulations may apply to this material.

EC Classification	:	Not classified as dangerous under EC criteria.
EC Symbols	:	No Hazard Symbol required
EC Risk Phrases	:	Not classified.
EC Safety Phrases	:	Not classified.
EINECS	:	All components listed or polymer exempt.
TSCA	:	All components listed.
Other Information	:	Environmental Protection Act 1990 (as amended), Health and Safety at Work Act 1974, Consumers Protection Act 1987, Control of Pollution Act 1974, Environmental Act 1995, Factories Act 1961, Carriage of Dangerous Goods by Road and Rail (Classification, Packaging and Labelling) Regulations, Chemicals (Hazard Information and Packaging for Supply) Regulations 2002, Control of Substances Hazardous to Health Regulations 1994 (as amended), Road Traffic (Carriage of Dangerous Substances in Packages) Regulations, Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations, Road Traffic (Carriage of Dangerous Substances in Road Tankers and Tank Containers) Regulations, Road Traffic (Training of Drivers of Vehicles Carrying Dangerous Goods) Regulations, Reporting of Injuries, Diseases and Dangerous

Occurrences Regulations, Health and Safety (First Aid) Regulations 1981, Personal Protective Equipment (EC Directive) Regulations 1992, Personal Protective Equipment at Work Regulations 1992.

16. OTHER INFORMATION

R-phrase(s)

Not classified

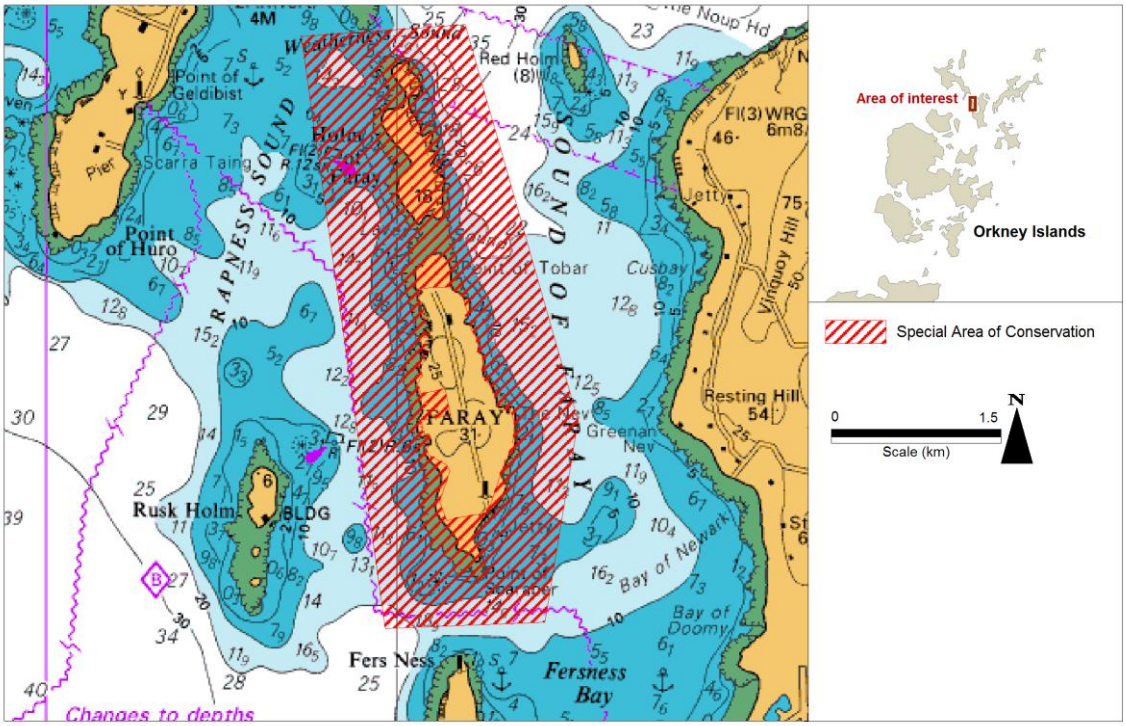
MSDS Version Number	:	1.1
MSDS Effective Date	:	05.03.2007
MSDS Revisions	:	A vertical bar (|) in the left margin indicates an amendment from the previous version.
MSDS Regulation	:	The content and format of this safety data sheet is in accordance with Commission Directive 2001/58/EC of 27 July 2001, amending for the second time Commission Directive 91/155/EEC.
MSDS Distribution	:	The information in this document should be made available to all who may handle the product.
Disclaimer		This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product.

APPENDIX C INFORMATION ON DESIGNATED SITES

Faray and Holm of Faray Special Area of Conservation

Site	Faray and Holm of Faray
Designation	Special Area of Conservation (SAC)
Location and spatial extent	Two uninhabited islands in the north isles of Orkney, at OS ref HY 529 378, covering an area of 785.68 ha. Located approximately 10km away from the SPR site.
Qualifying interest	Support a well established grey seal (*Halichoerus grypus*) breeding colony. The seals tend to be found in areas where there is easy access from the shore, and freshwater pools on the island appear to be particularly important. The islands support the second-largest breeding colony in the UK, contributing around 9% of annual UK pup production.
Conservation objectives	Avoid deterioration of the habitats of the grey seal or significant disturbance to the grey seal, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features and ensure that the following are maintained for the grey seal population in the long term: - Population of the species as a viable component of the site - Distribution of the species within the site - Distribution and extent of habitats supporting the species - Structure, function and supporting processes of habitat - No significant disturbance of the species.
Status	Potential loss of grey seal individuals through collision with operational turbine.

Figure C.1 Faray and Holm of Faray SAC



Description of impact	The proposed activities will not result in any direct impact on the designated site. However indirect impacts may occur as grey seals from the Faray and Holm of Faray SAC are likely to utilise the Falls of Warness (grey seals being the most frequently observed pinniped species in the vicinity, (SMRU 2008)) and there is an unqualified potential for individuals to collide with the turbine blades causing injury or fatality. SMRU (2005) have suggested that grey seal pups may be most at risk due to their inquisitive nature which can result in them being attracted to moving objects in the water; however it is equally possible that instead of attracting inquisitive seals, the presence of the device will result in the creation of an exclusion zone in its immediate vicinity, thereby reducing potential collision risk. Marine mammals have been known to behave apparently illogically when faced with novel circumstances (Wilson *et al.*, 2007).
Mitigation	The turbine blades have been designed to have a relatively slow rotational speed that will never exceed 10.2 RPM. But in the absence of an understanding of the significance of impacts from marine wildlife collision, HSUK and SPR plans to monitor for marine wildlife collisions during the testing of its device at EMEC. The turbine nacelle will be fitted with a video camera which will have a vertical view so that the entirety of each blade can be seen as the turbine rotates. The practicalities of recording at a water depth of 52 m and the details of how data will be collected and analysed are still being worked up and will be presented in the EMP. In addition to the use of the underwater camera HSUK and SPR will make use of visual observations of marine wildlife, including seals, at the

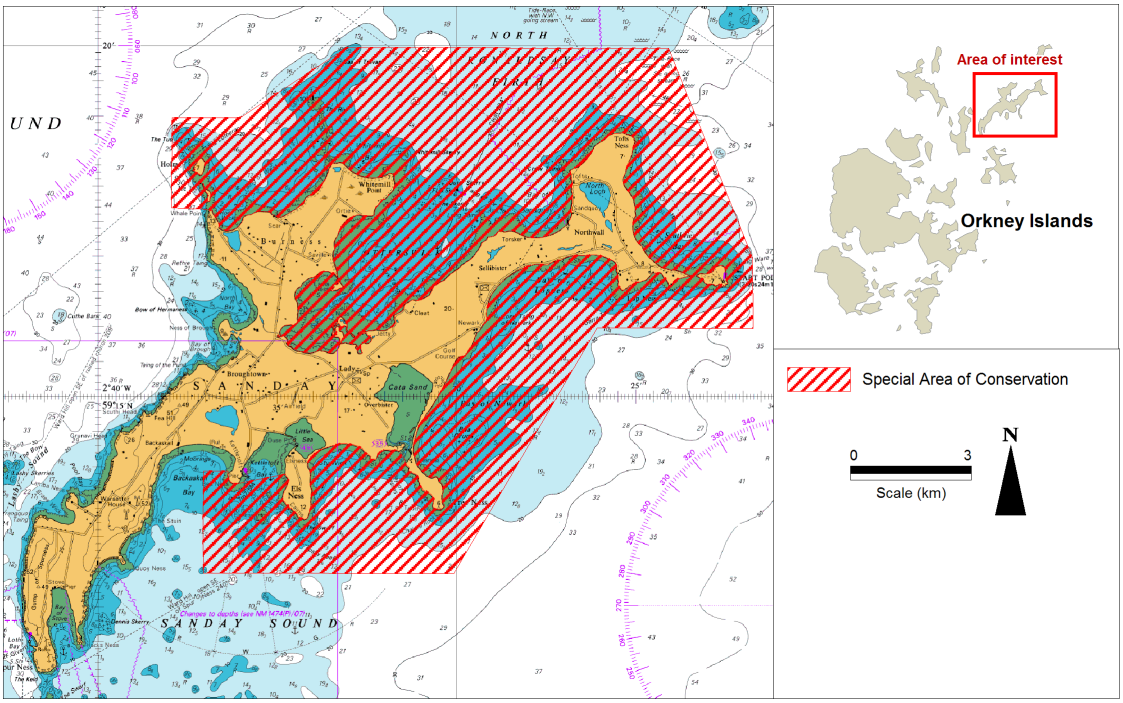
	tidal site. The specific details of how visual observation data will be collected and analysed will be presented in the EMP. SPR is also aware that EMEC is speaking to SNH and the Scottish Government about the potential use of short range active sonar to ascertain collision events. It is understood these discussions are only at an early stage, but SPR would be happy to consider involvement in any associated research once further details become available. In the event of detecting a collision HSUK will discuss options with SNH including the potential for temporary shutdown of the device. The procedure for this will be set out in the EMP and agreed with SNH prior to installation of the nacelle.
Implications to conservation objectives	The key consideration is the need to demonstrate that collisions between seals and the operational turbines, should these occur, will not affect the population viability of grey seals at the SAC site. Grey seal populations on Orkney are stable and increasing slightly (SMRU, 2008). The Potential Biological Removal (PBR) for grey seal numbers in the Northern Isles of Orkney metapopulation (SCOS, 2008) has been calculated from 2007 counts as 885 individuals. In the context of the European protected population of grey seals at Faray and Holm of Faray SAC, it is considered unlikely that the tidal turbine, alone or in combination with other tidal devices at the Fall of Warness, is likely to cause more than 885 individuals to be removed from the Northern Isles of Orkney grey seal population (SNH, 2009). It is therefore considered unlikely that the tidal turbine will adversely affect the integrity of Faray and Holm of Faray SAC.
Remediation	Not applicable.
Recovery	Pinnipeds are long-lived animals with slow reproduction rates. In the event of a population level impact occurring, the rate of population recovery would depend on the proportion and segments of the population killed. Loss of a large proportion of the mature breeding population may lead to longer recovery rates (McLaren, 1990); however given the high PBR for the metapopulation this is unlikely to occur at Faray and Holm of Faray SAC. No population level impacts are expected therefore no discussion of recovery rates is required.
Implications for site integrity	Despite the lack of empirical knowledge of device-seal interactions, taking into account: 1. The stability of the metapopulation and PBR for Northern Isles grey seals of 885; and 2. The highly localised area of potential impact. It may be concluded that an adverse effect on the integrity of Faray and Holm of Faray SAC grey seal population due to collision with the turbine blades is unlikely. This is in agreement with SNH's scoping response for the project (SNH, 2009) which advises that an Appropriate Assessment is likely to ascertain that the proposal will not adversely affect the integrity of the SAC.
References	McLaren IA (1990). Chapter 3: Pinnipeds and oil: ecological perspectives. In: Geraci JR and St Aubin DJ (Eds). Sea mammals and oil: confronting the risks. Academic Press, New York. SCOS (Special Committee on Seals) (2008) Scientific Advice on Matters Related to the Management of Seal Populations: 2008 [online] Available from Sea Mammal Research Unit (SMRU)

	SMRU (Sea Mammal Research Unit) (2005) The numbers and distribution of harbour and grey seals in the North Orkney Islands. SMRU (2008). Surveys of harbour (common) seals around Scotland, August 2007. A report for Scottish Natural Heritage, October 2008. Wilson B, Batty RS, Daunt F and Carter C (2007). Collision risks between marine renewable energy devices and mammals, fish and diving birds. Report to the Scottish Executive. Scottish Association for Marine Science, Oban, Scotland, PA37 1QA.

Sanday Special Area of Conservation

Site	Sanday
Designation	Special Area of Conservation (SAC)
Location and spatial extent	Sanday SAC is situated in the north-east of the Orkney archipelago, at OS ref HY 715 442, and covers an area of 10,971.65 ha. Located approximately 30 km from the HSUK test site.
Qualifying Interest	Supports the largest group of harbour seal *Phoca vitulina* at any discrete site in Scotland. Harbour seals are an Annex II species that are a primary reason for the selection of the site. The breeding groups, found on intertidal haul-out sites that are unevenly distributed around the Sanday coast, represent over 4% of the UK population. Near shore kelp beds that surround Sanday are important foraging areas for the seals, and the colony is linked to a very large surrounding population in the Orkney archipelago. Sanday SAC is also designated for the following habitats: intertidal mudflats and sand flats, reefs and subtidal sandbanks. SNH have advised that it is unlikely that the proposal will have a significant effect on any qualifying habitat interests either directly or indirectly and in SNH's view an appropriate assessment is therefore not required for designated habitat interests (SNH, 2009).
Conservation Objectives	**Regarding qualifying species:** Avoid deterioration of the habitats of the harbour seal or significant disturbance to the harbour seal, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the harbour seals; and ensure that the following are maintained for the harbour seal population in the long term: - Population of the species as a viable component of the site - Distribution of the species within site - Distribution and extent of habitats supporting the species - Structure, function and supporting processes of habitats supporting the species - No significant disturbance of the species
Status	Potential loss of harbour seal individuals through collision with the operational turbine.

Figure C.2 Sanday SAC



Description of impact	The proposed tidal turbine testing activities will not result in any direct impact on the designated site. However indirect impacts may occur as harbour seals from Sanday and the Northern Isles of Orkney metapopulation are likely to utilise the Fall of Warness and there is an unquantified potential for individuals to collide with the turbine blades, causing injury or fatality. Harbour seal sightings have been recorded in all months at the Fall of Warness but most frequently between July and October, although these sightings equate to less than 2 per hour (SMRU, 2007). It is not known if these seals are part of the Sanday SAC population; however it is known that although harbour seals usually stay within 10-20 km of their preferred haulout site (Tollit *et al.*, 1998), they can travel up to 60 km away when foraging. It is therefore possible that a proportion of the harbour seals sighted at the Fall of Warness could have travelled the 30 km from the Sanday SAC. It is also known that harbour seals typically forage in water depths of 10-50 m, i.e. the depth range in which the turbine is proposed to be sited, therefore there is a potential for individuals to come into contact with the blades. It is not known if harbour seals are likely to be inquisitive towards the turbine (therefore increasing collision risk) or if they will be deterred from approaching (therefore reducing collision risk). Marine mammals have been known to behave apparently illogically when faced with novel circumstances (Wilson *et al.*, 2007).
Mitigation	The turbine blades have been designed to have a relatively slow rotational speed that will never exceed 10.2 RPM. But in the absence of an understanding of the significance of impacts from marine wildlife collision, HSUK and SPR plan to monitor for marine wildlife collisions

	during the testing of its device at EMEC. The turbine nacelle will be fitted with a video camera that might be suitable for recording seal collisions. The practicalities of recording at a water depth of 52 m and the details of how data will be collected and analysed are still being worked up and will be presented in the EMP. In addition to the use of the underwater camera HSUK and SPR will make use of visual observations of marine wildlife, including seals, at the tidal site. The specific details of how visual observation data will be collected and analysed will be presented in the EMP. SPR is also aware that EMEC is speaking to SNH and the Scottish Government about the potential use of short range active sonar to ascertain collision events. It is understood these discussions are only at an early stage, but SPR would be happy to consider involvement in any associated research once further details became available. In the event of detecting a collision HSUK and SPR will discuss options with SNH including the potential for temporary shutdown of the device. The procedure for this will be set out in the EMP and agreed with SNH prior to installation of the nacelle.
Implications to conservation objectives	The key consideration is the need to demonstrate that collisions between seals and the operational turbines, should these occur, will not affect the population viability of harbour seals at the SAC site. The harbour seal population in Orkney has recently undergone a considerable decline from over 8,500 in 1997 to less than 2,867 in 2008 (SMRU, 2008). The Potential Biological Removal (PBR) for harbour seal numbers in the Northern Isles of Orkney metapopulation has been calculated from 2007 counts as 23 individuals (SCOS, 2008) and it is likely that this value will be revised downwards following re-calculation of the PBR from 2008/09 counts (SNH, 2009). SNH in consultation with the Sea Mammal Research Unit (SMRU) considers it possible that this device, alone or in combination with other human activity within the Northern Isles of Orkney metapopulation area, has the potential to remove more than 23 individuals from the metapopulation, thus potentially compromising a number of the conservation objectives of the Sanday SAC which is an integral component of the larger Orkney metapopulation.
Remediation	Not applicable
Recovery	Pinnipeds are long-lived animals with slow reproduction rates. In the event of a population level impact occurring, the rate of population recovery would depend on the proportion and segments of the population killed. Loss of a large proportion of the mature breeding population may lead to longer recovery rates (McLaren, 1990), and it is possible that this situation could occur at the Sanday SAC given the relatively low PBR for the metapopulation. As the vulnerability of harbour seals to collision is not known, it is not possible to say what proportion of the breeding population may be lost as a result of collision, therefore recovery rates are unknown.
Implications for site integrity	Despite the highly localised area of potential impact and 30 km distance of the Sanday SAC from the tidal test site, taking into account: 1. The metapopulation's sensitivity to additional mortality; 2. The fact that seals may range up to 60 km from their preferred

	haulout site to forage; 3. The fact that seals typically forage in water depths of 10-50 m (which is the depth range in which the turbine will be sited); and 4. The lack of empirical knowledge of device-seal interactions It is therefore difficult to conclude whether or not there will be any impact on the integrity of the Sanday SAC harbour seal population due to collision with the turbine blades.
References	McLaren IA (1990). Chapter 3: Pinnipeds and oil: ecological perspectives. In: Geraci JR and St Aubin DJ (Eds). Sea mammals and oil: confronting the risks. Academic Press, New York. SCOS (Special Committee on Seals) (2008) Scientific Advice on Matters Related to the Management of Seal Populations: 2008 [online] Available from Sea Mammal Research Unit (SMRU) [Accessed 12/03/2010]. SMRU (2007) The number and distribution of marine mammals in the Fall of Warness, Orkney, July 2006 – July 2007. SMRU (2008). Surveys of harbour (common) seals around Scotland, August 2007. A report for Scottish Natural Heritage, October 2008. SNH (Scottish Natural Heritage) (2009) Scoping Opinion, response to Scoping Report issued by SPR Resources Corporation. Tollit DJ, Black AD, Thompson PM, Mackay A, Corpe HM, Wilson B, Van Parijs SM, Grellier K and Parlane S (1998). Variations in harbour seal *Phoca vitulina* diet and dive-depths in relation to foraging habitat. Journal of the Zoological Society of London, 244: 209-222. Wilson B, Batty RS, Daunt F and Carter C (2007). Collision risks between marine renewable energy devices and mammals, fish and diving birds. Report to the Scottish Executive. Scottish Association for Marine Science, Oban, Scotland, PA37 1QA.

APPENDIX D NAVIGATIONAL SAFETY RISK ASSESSMENT

Navigation Safety Risk Assessment of the Hammerfest Strøm UK and ScottishPower Renewables (UK) Ltd Tidal Turbine Installation at the European Marine Energy Centre, Orkney

Prepared for:	Xodus AURORA 8 Garson Place Stromness Orkney KW16 3EE
Prepared by:	Abbott Risk Consulting Ltd 78 St Vincent Street Glasgow G2 5UB
Report No:	ARC-258-001-R1
Revision:	2
Date:	May 2010

APPROVAL AND REVISION RECORD					
Rev No.	**Date**	**Prepared**	**Reviewed**	**Approval**	**Revision Notes**
0	Nov 08	D Cantello	T Lambert	T Lambert	Initial Issue
1	May 10	D Cantello	T Lambert	T Lambert	Updated
2	May 10	D Cantello	T Lambert	T Lambert	Update with further client data and change of dates

Contents

1.0 Introduction

1.1 Background

Hammerfest Strøm UK (HSUK) are proposing to deploy a demonstration tidal turbine of 1MW capacity at the European Marine Energy Centre (EMEC) Fall of Warness tidal device test site (the "Tidal Test Site") in Orkney from May/Jun 2011. The device being deployed is the Hammerfest Strøm HS-1000 tidal turbine which is described fully in Section 2. ScottishPower Renewables UK Limited (SPR) are working with HSUK on the development of the device, with SPR taking responsibility for consenting issues and acting as agent on HSUK's behalf

The EMEC Tidal Test Site provides facilities for testing and supporting marine renewable technologies. EMEC received consent for the establishment of the Tidal Test Site at the Fall of Warness in 2005. As part of the consenting process for this facility, EMEC undertook an assessment of the navigational safety issues arising from the establishment of the site in accordance with the Maritime and Coastguard Agency's (MCA) Marine General Notice MGN 275(M)[i] - Proposed Offshore Renewable Energy Installations (OREI) – Guidance on Navigational Safety Issues (Reference 1). The EMEC Navigational Safety Risk Assessment (NSRA) (Reference 2) and its Addendum (Reference 3) considered four generic types of device and demonstrated that, given the intended test positions and the assumed characteristics of each device type, the risks to vessels were tolerable with the application of specified controls for both the test site area and the generic devices.

The EMEC NSRA was produced prior to the publication of the Department for Trade and Industry (DtI) (now the Office for Business, Enterprise and Regulatory Reform (BERR)) "Guidance on the Assessment of the Impact of Offshore Wind Farms – Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms" (Reference 4). The EMEC NSRA therefore, whilst addressing the essential requirements of that guidance i.e. the use of a formal risk assessment methodology, the demonstration of tolerability of risk and the compilation of a Hazard and Controls Log, is not structured in accordance with the later guidance. This report, in building on, and drawing from, the EMEC NSRA, follows the structure of the original EMEC report.

Given that the actual device to be deployed could depart from the assumptions made in the enveloping assessment made in the EMEC NSRA, it is a requirement of EMEC that each individual device developer shall demonstrate to the regulatory authorities, by means of a separate NSRA, that their device and its deployment fall within the scope of acceptable operations as described in Reference 2 and 3 or, where devices exceeded the assumptions of that enveloping study, to demonstrate how the risks could be made tolerable.

SPR have, therefore, engaged Abbott Risk Consulting (ARC) Ltd to undertake this assessment of the Navigational Safety Risks arising from the deployment of their specific device, in order to demonstrate how it either complies with the EMEC

[i] Now superseded by MGN 371

NSRA assumptions for generic types of device or, where it does not, to show that the risks are tolerable with appropriate controls.

This report will support the consent application document for this trial deployment (Reference 5).

1.2 Aim

The aim of this report is to demonstrate that the deployment of the HSUK tidal turbine meets the assumptions of the enveloping EMEC NSRA (Reference 2) which has been accepted as demonstrating that the risks from the deployment of such generic devices should, in general, be tolerable or, where the HSUK device deviates from the assumptions used in that report for the generic devices, to demonstrate that the risk remains tolerable with appropriate controls or monitoring. Where additional controls are considered necessary, they are identified in the report.

1.3 Scope

The scope of this NSRA covers the risks to navigation during the construction, operation and decommissioning phases of the Hammerfest Strøm tidal turbine. It draws on the arguments and demonstration of tolerability produced in the EMEC NSRA and its Addendum (References 2 and 3).

1.4 Stakeholders

As part of the consenting process for the EMEC Tidal Test Site, a wide variety of stakeholders were kept informed and consulted on the environmental and navigational impact of the site. Details of these are listed in Appendix A to EMEC Navigational Safety Risk Assessment (Reference 2).

SPR have engaged with particular stakeholders on behalf of HSUK with regard to the issues specific to the deployment of their device in the Eday Test area. This has involved, in particular, the dissemination of a Scoping Document to stakeholders inviting comment and response.

Further to the recommendations made in the EMEC NSRA (Reference 2), EMEC held a meeting 9th August 2007 with MCA, Northern Lighthouse Board (NLB), the UK Hydrographic Office (UKHO) and other marine stakeholders as part of the management of wider issues regarding the marking and charting of Offshore Renewable Energy Installations at the Tidal Test Site. The recommendations of that meeting have been incorporated within this report.

1.5 Glossary

ADCP	Acoustic Doppler Current Profiler
AIS	Automatic Identification System
ATBA	Area To Be Avoided. An area so designated is marked on charts along with details of the area and vessels to which it applies
AtN	Aids to Navigation. Those aids, including visual marks, lights, buoyage, electronic devices etc provided for the mariner to assist in the safe navigation of the vessel
Cable (as a measurement of distance)	1/10th of a sea mile (approx 185 metres/200 yds) and a standard measure of distance at sea
Chart Datum	By international agreement, Chart Datum is a level so low that the tide will not frequently fall below it. In the UK, this is normally approximately the level of LAT
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea, 1972
EMEC	European Marine Energy Test Centre
EMI	Electromagnetic Interference
GLA	General Lighthouse Authority. The general name given to those authorities with responsibilities for Aids to Navigation in specific geographical areas. In the waters around the UK and Republic of Ireland, these authorities are: Trinity House, Northern Lighthouse Board and the Commissioners for Irish Lights
HAT	Highest Astronomical Tide. HAT is the highest level which can be predicted to occur in average meteorological conditions and under any combination of astronomical conditions. This level will not occur every year. HAT is not the extreme level as storm surges may cause higher levels to occur. Determined by inspection over a period of years
HIRA	Hazard Identification and Risk Assessment
HSUK	Hammerfest Strøm UK
IALA	International Association of Lighthouse Authorities
Kn	Knot (nautical mile per hour)
kV	Kilovolt
kW	Kilowatt
LAT	Lowest Astronomical Tide. LAT is the lowest level which can be predicted to occur in average meteorological conditions and under any combination of astronomical conditions. This level will not occur every year. LAT is not the extreme level as storm surges may cause lower levels to occur. Determined by inspection over a period of years
MCA	Maritime and Coastguard Agency
MGN	Marine General Notice
MoD	Ministry of Defence
MHWN	Mean High Water Neaps The height on MHWN is the average, throughout a year, of two successive high waters during those periods of 24hrs (approx. once per fortnight) when the range is the least
MHWS	Mean High Water Springs. The height on MHWS is the average, throughout a year, of two successive high waters during those periods of 24hrs (approx. once per fortnight) when the range is the greatest.
MLWN	Mean Low Water Neaps. The height on MLWN is the average, throughout a year, of two successive low waters during those periods of 24hrs (approx. once per fortnight) when the range is the least
MLWS	Mean Low Water Springs. The height on MLWS is the average, throughout a year, of two successive low waters during those periods of 24hrs (approx. once per fortnight) when the range is the greatest
MSL	Mean Sea Level. The average level of the sea surface over a period (normally 18.6 years)
NavWarns	Navigation Warnings

NLB	Northern Lighthouse Board
NM	Notice to Mariners. A NM is an update or alteration to a chart
nm	(International) Nautical Mile (1,852 metres)
NSRA	Navigational Safety Risk Assessment
OREI	Offshore Renewable Energy Installation
RACON	RAdar beaCON. A transponder system which shows up on a vessel's radar as a coded mark adjacent to the contact
Tidal Stream	A distinction is drawn between tidal streams, which are astronomical in origin, and currents, which are independent of astronomical conditions and which, in the waters around the British Isles, are mainly of meteorological origin
SPR	Scottish Power Renewables (UK) Limited
UKHO	UK Hydrographic Office

2.0 Device Information

2.1 Hammerfest Strøm HS-1000 Tidal Turbine Description

The Hammerfest Strøm HS-1000 Tidal Turbine device is illustrated at Figure 1.

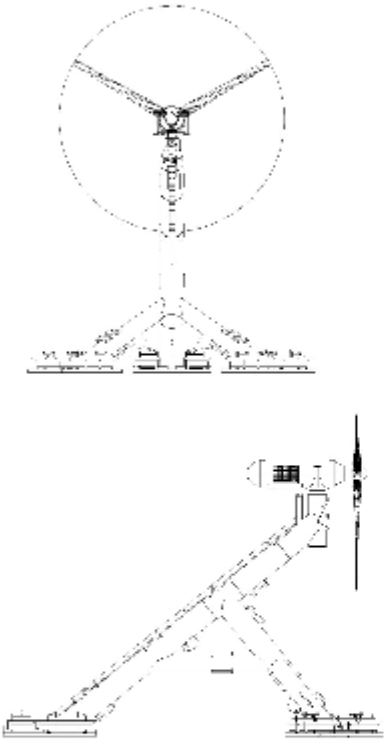


Figure 1 Hammerfest Strøm Tidal Turbine

2.1.1 Structure

The device structure has been designed using data gained from the lengthy testing of the prototype device in Norway. The device structure will undergo third party validation prior to deployment at EMEC. The generating turbine is mounted on a tripod support structure as shown at Figure 1. The structure may incorporate a self-levelling device to ensure that the turbine nacelle and, hence, the rotor would be perpendicular to the flow. The structure itself would be oriented such that the turbine was in alignment with the main tidal stream axis.

The structure would be secured to the seabed by means of ballast weights placed on each foot. There is no requirement for piling or rock anchors.

2.1.2 Nacelle Generator

The Hammerfest Strøm HS-1000 device consists of a single 1MW power train with a three-bladed rotor. The rotor hub, power train and electrical equipment form a single, long cylindrical nacelle structure, which is fixed to the tripod near its centre of gravity. The nacelle contains a shaft, bearings, gearbox, generator, power electrical equipment and auxiliary systems. The auxiliary systems include hydraulic systems for blade pitch control and mechanical brake operation. The pitch of the rotor blades is controllable in order to maximise the energy extracted from the tidal stream.

The rotor diameter chosen for each location is dependent on the tidal stream, required power output, the depth of water and the required clearance above the device. In the case of this device installation, the rotor diameter will be 21m.

A mechanical brake is located on the high speed shaft between the gearbox and generator. This, in conjunction with the pitch control system will allow rotation of the device to be stopped in an emergency or for maintenance and inspection purposes.

The power electrical system outputs at 7kV.

The main parameters of the device and support structure are:

Item	Dimension
Support structure height	22m
Rotor diameter	21m
Hub centreline height above sea bed	22m
Height of device above seabed (to top of rotor swept arc)	32.5m
Estimated mass of nacelle	160te
Estimated mass of support structure	160te
Gravity base ballast	800te

Table 1 Device Dimensions

2.1.3 Subsea Cabling

The existing EMEC Tidal Test Site infrastructure includes the shore substation on the island of Eday and a subsea power and control cable running from there to the vicinity of the test berth at which the device will be sited. The Hammerfest Strøm device will be connected to the EMEC subsea cable by an umbilical fitted to the central member of the tripod which emerges from a J-tube or similar device near seabed level. The umbilical will be armoured cable, with optical fibre bundles embedded for Supervisory Control and Data Acquisition (SCADA).

2.1.4 Installation and Decommissioning

It is currently planned to install the device in May to June 2011. The installation process is expected to take 4 days and commissioning is estimated to take 1

month. The specific installation methodology has yet to be defined but will involve a Dynamic Positioning (DP) (Class II) system equipped heavy lift vessel.

The installation involves the following steps:

1. Lower and place the ballast weights on the seabed.
2. Lower the tripod support structure to the sea bed.
3. Survey the orientation and attitude of the structure using an ROV.
4. Lift ballast weights onto ballast platforms on support structure.
5. Recover the EMEC subsea cable and connect to the device umbilical cable.
6. Using an ROV, connect the umbilical cable to the structure.
7. Inspect / survey installation.

The individual phases above may be conducted during a combined operational periods on site or may require individual site visits to complete. All activities will be subject to environmental limitations (of tidal rate and wind speed) though these have yet to be determined. Hence, it is probable that the entire installation procedure will be conducted over several tidal cycles. Any delays (e.g. from weather) may result in an activity being delayed to the next suitable tidal window. No divers are required during the installation operation.

2.1.4.1. Ballast Weight and Support Structure Installation

It is intended to lower the ballast weights to the seabed in the vicinity of the intended support structure position prior to the installation of the tripod support structure. This is intended to reduce the time that the structure will be un-ballasted as the ballast weights can be recovered and placed quicker having been pre-laid adjacent to the structure. The ballast weights will be buoyed off to facilitate subsequent recovery. The ballast weights will be deployed over one period of slack water.

The tripod base structure will be deployed at the next period of slack water. It will be lowered to its correct position on the seabed and then surveyed in situ by an ROV deployed from the installation vessel to ensure that its orientation and attitude is within tolerance.

Once it is established that the structure is correctly aligned, the ballast weights are lifted onto the ballast platforms located on the feet of the tripod structure.

It is expected that this element of work would take 1 day.

2.1.4.2. Cable Connection

The EMEC subsea cable termination is recovered and connected to the device umbilical on the deck of the installation vessel. The umbilical is then connected to

the device by means of a "wet-mate" connector[ii] using an ROV deployed from the installation vessel. A survey will then be conducted using an ROV.

It is expected that this element of work would take 3 days.

2.1.4.3. Nacelle Installation

The nacelle, complete with rotor, would be lowered onto the structure from a heavy lift DP vessel where it would be located with the help of guidelines and a self locating connections. No divers are required during the operation. An ROV will be used to lock the nacelle in place and for survey and monitoring activities.

The installation process is expected to take a total of 1 day.

2.1.5 Decommissioning

The decommissioning of devices involves a reversal of the installation process but with a reduced timescale. Decommissioning, in outline, comprises:

1. Mobilising a vessel to site with a similar capability to that used for installation for the removal of the tripod structure.
2. Removing the nacelle and rotor from the tripod foundation and lifting it onto the vessel.
3. Recovering the ballast weights from the tripod structure "feet".
4. Recovering the umbilical and seabed cable in order to separate the cables.
5. Lifting the entire tripod structure onto the deck of the vessel.
6. Carrying out an ROV survey of the sea bed condition for record purposes.
7. Demobilising the vessel to a suitable port for offloading and disposal of the tripod structure and nacelle.

The time on site will depend on the weather, the state of the tide, and the maximum current in which the vessel and ROV are capable of operating. Overall, it is envisaged that decommissioning would be achievable within 2 days. A fully detailed decommissioning plan will be provided to EMEC at least 3 months in advance of decommissioning to enable timely submission to regulators.

2.1.6 Device Classification

Given the characteristics of the structure in that it is a fully submerged device sited on the seabed, the device can be classified as a Type 1 Device under the generic

[ii] A "wet-mate connector" is a device capable of being connected or disconnected underwater without first the isolating the electrical supply.

device type classifications as described in the EMEC NSRA (Reference2) i.e. a seabed sited device with no element exposed above Chart Datum.

1.0 Device Site

1.1 Position

Due to the characteristics of this device and the recommended risk controls in the EMEC NSRA (Reference 2) a location was required within the test site where maximum clearance above the device could be obtained whilst providing adequate tidal resource for the purposes of the trial. Therefore, the proposed location of HSUK's device is at Test Berth 1 at the EMEC Tidal Test Site as illustrated by Figure 2 and 3. This location is directly south of Seal Skerry off the west coast of Eday. The nominal position is 59° 08'.5231'N 2° 49'.0530'W and will have a footprint of 200m^2.

The depth of water within a radius of 100m at Test Berth 1 is approximately 50m with a least depth of 50.2m. The least depth within 300m is 41m below CD (See Figure 3). It is assumed that the device will be positioned within this 100m radius at a depth >50m.

During the period that the HSUK device will be at Test Berth 1, a number of the other berths will (or are likely to) be occupied by other developer's devices. Table 2 shows the current occupancy plan.

Berth	Device Type	Clearance at CD	Dates of Occupancy	Comment
2	Type 1 – Seabed sited axial Turbine	17.75m	Installed 2008	TGL - Charted
3	Berth unoccupied			
4	Type 2 – Surface piercing pile mounted axial shrouded turbine	N/A	Installed 2007	OpenHydro Charted
4a	Type 1 – Seabed sited axial shrouded turbine	22m	Installed 2008	
5	Berth unoccupied			
6	Type 1 - Seabed sited axial shrouded turbine	10.8m	Planned 2010	Subject to additional, new subsea cable being laid. No defined location at the moment.
7	Type 1 – non surfacepiercing pile mounted	10m	Planned 2011	Location: 59°09'.2N 002°49'.83W
8	Type 4 – surface sited	N/A	Planned 2011	To be finalise (east of current berths)

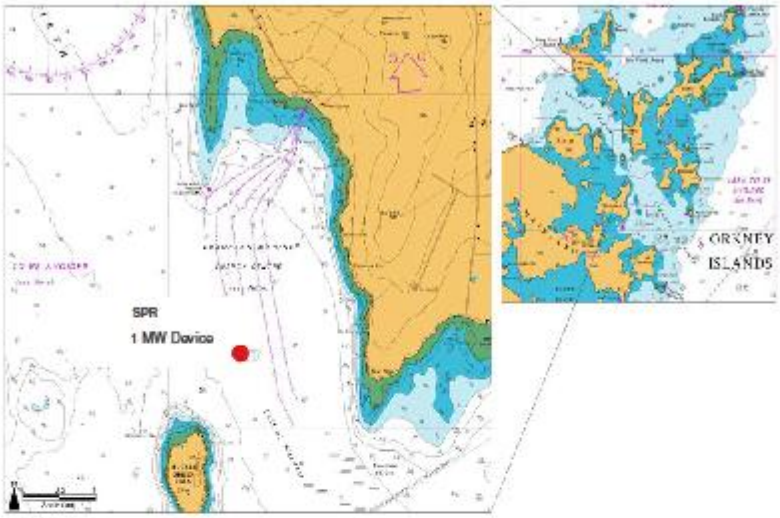


Figure 2 Proposed Device Location

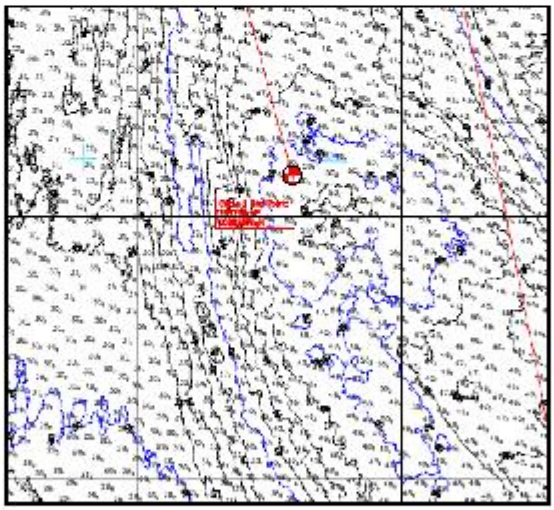


Figure 3 Bathymetry at Proposed Device Location

Note: 1. Depths in this drawing are relative to Chart Datum

3.2 Site Information

3.2.1 Tidal Stream

The dominant factor in this site selection is the strength of the tidal stream through the Fall of Warness. Details of the exact tidal stream rates and direction have been obtained within the Fall of Warness through the deployment of an Acoustic Doppler Current Profiler (ADCP). This has, in general, confirmed the data shown on Admiralty charts of the area which indicates maximum rates of 7.2 kn at Spring Tides and 2.8kn at Neap Tides.

3.2.2 Tidal Height

There are no tidal height data specific to the Fall of Warness channel available. However, that for Rapness (some 6nm north of the channel) would be indicative of the Fall of Warness channel. These indicate a mean tidal range for Neaps of 1.2m and 2.9 for Springs.

	LAT	MLWS	MLWN	MSL	MHWN	MHWS	HAT
Standard Port - Wick	0.0	+0.7	+1.4	+2.0	+2.8	+3.5	+4.0
Rapness (Secondary Port) Differences		0.0	+0.2		0.0	+0.1	
Heights relative to Chart Datum	**0.0**	**+0.7**	**+1.6**		**+2.8**	**+3.6**	**+4.0**
			Mean Range (Neaps) 1.2m				
		Mean Range (Springs) 2.9 metres					

Table 3 Height of Tide - Fall of Warness [iii]

3.2.3 Hydrographic Survey

A detailed hydrographic survey has been undertaken of the Fall of Warness for the installation of the sub-sea cables in 2005 and 2006. This has been augmented by additional surveys conducted by the MCA as illustrated in Figure 4. This survey data has been used as the basis for the positioning of the HSUK device.

[iii] See Glossary for all tidal terms/definitions – Section 1.5

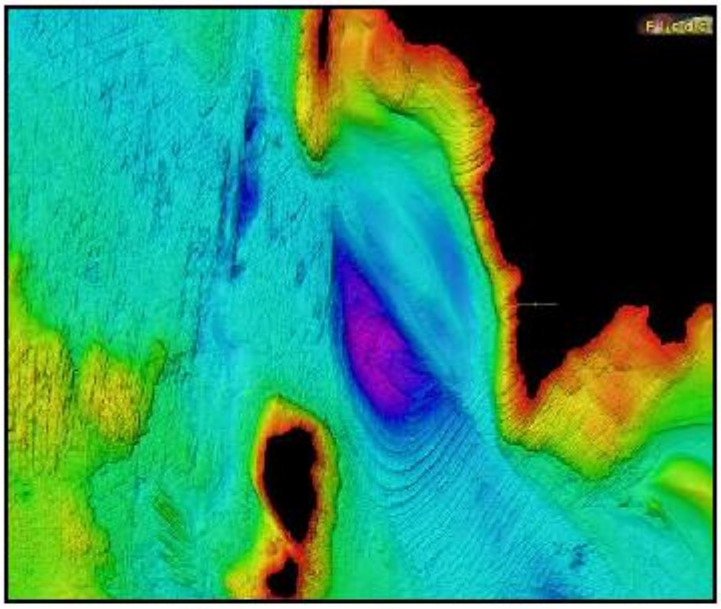


Figure 4 Bathymetric Survey of Fall of Warness

3.2.4 Weather Data

For the original EMEC NSRA report, prevailing wind data was obtained for the general area from HSE Offshore Technology Report 2001/030 – Wind and Wave Frequency Distributions for Sites around the British Isles (Reference 6). This point is some 60 nm from the Fall of Warness and does not take into account the effect of the Island land mass. The wind rose data is at Figure 5.

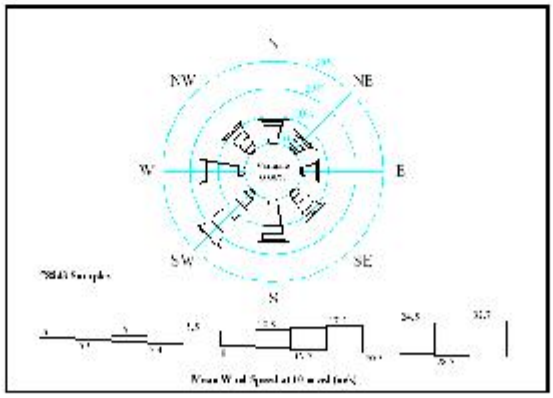


Figure 5 Mean Wind Speed

4.0 Shipping Activity

4.1 Introduction

Shipping activity in the Fall of Warness and the potential impact of the site and generic types of tidal device was addressed in detail in References 2 and 3. The following paragraphs summarise the findings.

4.2 Traffic Survey

The assessment of vessel traffic in the area was conducted by obtaining data from identified users as it was considered that, given the relatively low level of activity and its intermittent nature, a real time survey over short duration periods would not identify the true levels and types of activity. Organisations consulted for information included:

- Orkney Islands Council (Marine Services)
- British Chamber of Shipping
- MCA
- Fishing organisations
- Ferry companies
- Local shipping companies/agents/tour operators
- Local leisure organisations (marinas, sailing clubs, etc)
- ShipRoutes database
- North of Scotland White Fish/Pelagic trawlers (who use the area as a transit route to fishing grounds)
- Cruise Liner companies whose vessels visit the Orkney Isles

4.3 Current Traffic Patterns

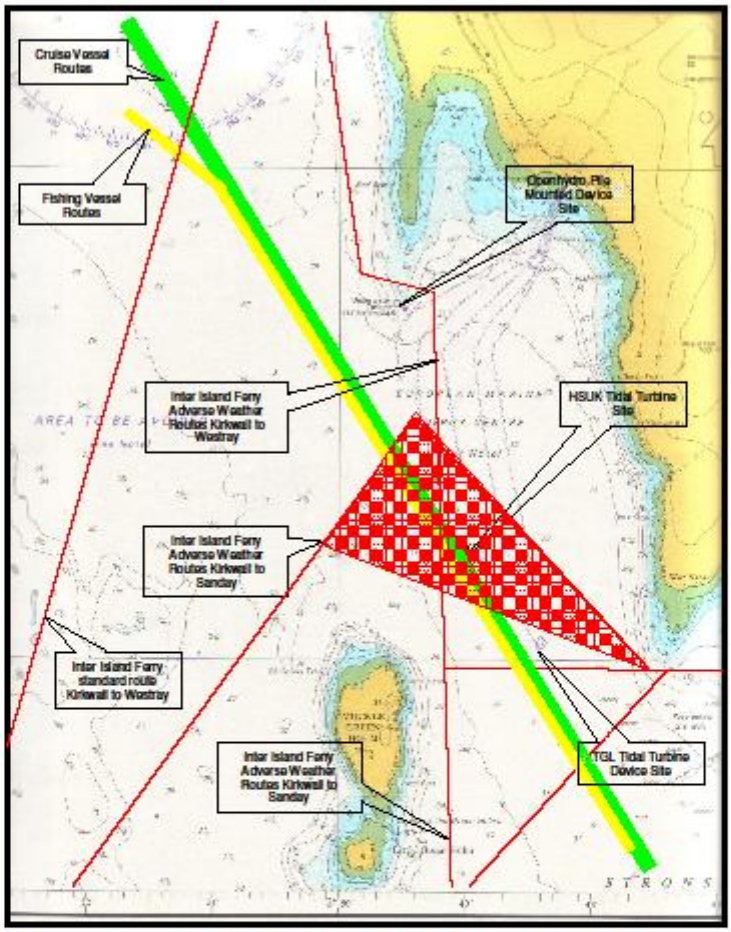
The findings of the EMEC NSRA (Reference 2) demonstrated that the vessel traffic in the Fall of Warness consisted of the following significant groups:

- Fishing vessels on passage to/from fishing grounds
- Cruise vessels on passage
- Inter-island ferries
- Local fishing activity (creeling)

Other potential users were identified but were either not using the area on a regular, identifiable basis, e.g. leisure users, or declared no conflict between their activities and the site, e.g. MoD. The vessels identified in 2005 as using the Fall of Warness and which have significance for the HSUK deployment are, primarily, deep draught vessels such as passenger cruise ships with draughts up to 8.56m and fully laden pelagic trawlers with reported draughts of up to 8.5m. Figure 6 illustrates such vessels reported tracks along with the inter-island ferry routes. A representative of the British Chamber of Shipping stated in 2007 that cruise ships

with draughts of up to 10m have been using the Fall of Warness. There is, however, no evidence to show that this may be the case. Monitoring of the Test Site area has confirmed usage by vessels identified in the 2005 NSRA and provided further information on other vessels such as the MVs Albatross and Ocean Majesty which have been seen to use the area. None of these vessels, however, exceed the draught of the deepest draught vessel identified in the 2005 study – the MV Mona Lisa with a draught of 8.56m. Whilst the trend toward larger vessels of this sort has been notable over the past decade, there is no evidence that there are any plans at present for the use of cruise ships which would exceed the dimensions and characteristics of this vessel as the limiting factor remains port and harbour access. In fact, modern cruise ships, of greater Gross Tonnage, all exhibit shallower draughts for this very reason. The characteristics of Princess Cruise liners, some of which do operate in this area, have been reviewed and none of their vessels have draughts which exceed that of Mona Lisa.

The traffic survey data is summarised in Figure 6.



Not to be Used for Navigation. Reproduced from Admiralty Chart 2562 by permission of Her Majesty's Stationery Office and the UK Hydrographic Office (www.ukho.gov.uk)

Figure 6 HSUK Device Proposed Site and Vessel Traffic Routes.

(Note: The red tracks and shaded area represent a range of Inter-Island ferries routes and operating areas.)

5.0 Hammerfest Strøm Tidal Turbine Device Assessment of Risk

5.1 Hazard Identification and Risk Assessment

A Hazard Identification and Risk Assessment (HIRA) was conducted as part of the EMEC Tidal Test Site NSRA and the results are contained in that report (Reference 2). This identified the hazards and necessary controls associated with the test site infrastructure and the range of devices considered as likely to be deployed at the Tidal Test Site. The types of devices postulated were based on current data available at the time and were grouped into four types. The types were:

- Type 1 – a bottom sited device
- Type 2 - a mid-water, buoyant, moored device
- Type 3 - a pile mounted, surface piercing device
- Type 4 - a surface moored device

The report identified the hazards presented by such devices and examined the risks associated with each type during the installation, operation (including maintenance) and decommissioning phases.

As stated earlier, the HSUK tidal turbine can be considered as a Type 1 device. The EMEC Tidal Test Site NSRA, using device data available at that time, assumed a height above seabed of 25 meters for the generic, Type 1 device postulated in that report. The report recommended that Type 1 devices i.e. bottom sited devices, should be "*sited in the deepest water available but, in any case, in water no shallower than 41m charted depth*". The Hammerfest Strøm device is above this assumed height above seabed (i.e. 33.5m) however will be positioned within water of minimum depth 50.2m.

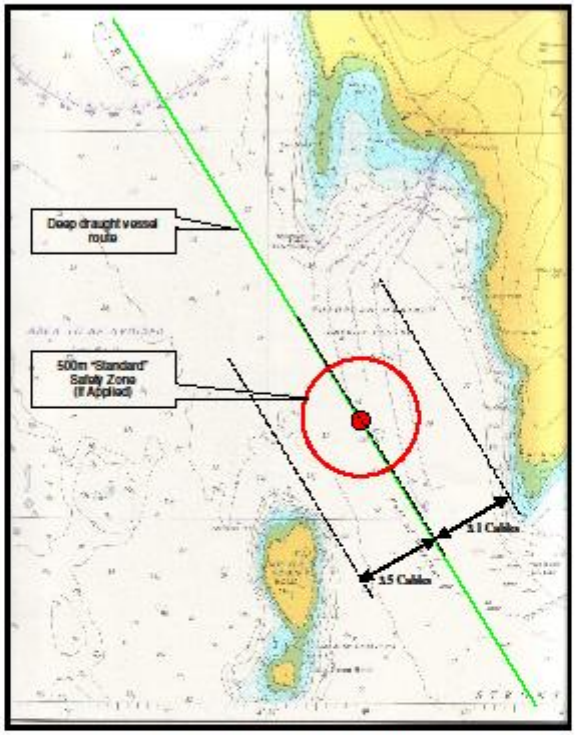
The following section addressed the specific risks associated with the deployment of this particular device to the planned test berth.

A Hazard Identification and Risk Assessment (HIRA) for the HSUK tidal turbine will be completed in conjunction with EMEC prior to deployment. This will review the installation, operation, maintenance and de-commissioning phases of the HSUK device deployment against the HIRA previously conducted for the EMEC Tidal Test Site NSRA. It will also examine the detailed methodology for the activities associated with those phases to ensure that the specific hazards and risks associated with this device are identified and appropriate controls put in place where these are required in addition to those already in place.

5.2 Installation and Decommissioning

Installation and decommissioning can be considered together as the latter will be the reverse of the former. Given the position of the installation, more or less on the centre line of the channel, it is considered that the installation traffic (i.e. DP vessel) would present a hazard to cruise vessels and transiting fishing vessels

which would normally pass down the channel centre line (see Figure 7). It will also present a potential hazard to inter-island ferries which make use of the Fall of Warness for adverse weather/tide avoidance routes.



Not to be Used for Navigation. Reproduced from Admiralty Chart 2562 by permission of Her Majesty's Stationery Office and the UK Hydrographic Office (www.ukho.gov.uk)

Figure 7 HSUK Device Proposed Installation Site.

Cruise vessel activity in the Orkney Islands is seasonal and takes place usually between June and September. This would mean that the expected level of cruise ship activity, based on traffic survey data from the EMEC tidal site NSRA, would be up to 4 transits per month. Given that the installation task is planned to take up to 9 days, it can be estimated that, in the worse case, up to two cruise vessels could be expected to use the Fall of Warness in that time. Deep sea fishing vessels make, approximately, 60 transits of the Fall of Warness per year. This amounts to an average of 5 per month. Hence, for period of installation it may be expected that 2 to 3 fishing vessels may pass the site.

Such vessels would, when faced with the installation vessels require to deviate from their normal planned track. The available options for transiting vessels would be to use the available channels within the Fall of Warness to the east and west of the installation area or to use the waters to the west of Muckle Green Holm. The

easterly channel is some 3.1 cables in width and the westerly channel 3.5 cables in width. There is a greater expanse of navigable water to the west of Muckle Green Holm although several patches of less than 10m exist within 1nm of the western side of Muckle Green Holm and together with the recently discovered rock of 7.1m charted depth in position 59° 06'.85"N 002° 50'29"W present potential hazards to shipping.

If cruise ships and fishing vessels in transit were to suffer a catastrophic propulsion/steering gear failure whilst passing the installation area, the tidal stream would tend to set a vessel along the line of the channel and not to the side. It would take a specific combination of strong westerly winds and tidal stream, allied to the breakdown occurring in a specific position during the short window during which the work would occur, to cause a collision between the vessel and the installation vessel. Given the traffic levels, the likelihood of occurrence of vessel breakdown, the expectation of such a weather and tidal combination in the period under consideration and the physical extent of the installation area, it is considered that the additional risk posed by the installation is not significantly greater than the background risk of a vessel going aground as it would, inevitably, do so in such circumstances.

The proposed device installation position is within an area of ferry adverse weather avoidance routes used during particular combinations of wind and tide to avoid the races generated by such factors. In particular:

- Kirkwall to Westray (and return) in conditions with a Westerly gale and an ebb tide.
- Kirkwall to Sanday, Eday and Stronsay (and return) with a South Easterly Gale and a flood tide.

In addition, fine weather routes in conditions of a strong flood tide cause the ferries proceeding between Kirkwall and Eday, Sanday and Stronsay to use a number of routes close by Warness, north of the "normal" direct route (which passes some 1.5nm to the south) and some 5-6 cables (900m) south of the proposed installation site. The fair weather route between Kirkwall and Westray passes to the west of Muckle Green Holm. These routes are illustrated at Figure 6.

However, given the assumption that the installation activity is planned to be undertaken in periods of favourable tide and weather, it is considered that the use of the adverse weather/tide routes would be considerably reduced such that the risk from any requirement to pass close to the installation vessel would be very low. Also, during periods of forecast adverse weather, operations would either not commence or, if possible, the DP Vessel would be removed from the site leaving only ballast buoy(s) on site.

The use of ballast buoys to enable retrieval of the ballast, would present a hazard to marine traffic and fishing activities in the area. Given the tidal rates, the buoy is likely to be dragged under the surface at times, thereby presenting an unseen hazard to passing traffic, particularly, local ferries. However, the inclusion of such a potential hazard in the Maritime Safety Information submitted for promulgation should alert marine users to their presence on the site. It is, therefore, considered that the risk from the ballast is tolerable with monitoring.

During the installation activities, the installation vessels would comply with the International Rules for Preventing Collision at Sea (COLREGS) (Reference 7) by displaying appropriate international signals/lights indicating that they are involved in under-water operations. The vessel and any anchor buoy positions would be promulgated by Notices to Mariners (NMs) and Navigational Warning (NavWarn) messages broadcast by the appropriate authorities. HSUK will comply with EMEC's procedure for the provision of appropriate marine safety information to the UKHO at appropriate times prior to work starting. Installation support vessels may act as a safety vessel, alerting other vessels passing to the nature of the activities being conducted. The DP vessel would be on site for a limited period of time during the installation phase.

The establishment of a Safety Zone, in accordance with the Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007 (Reference 8), has been considered as a potential control for the reduction of such risks as arise from the installation and de-commissioning phases. However, the use of a "standard" Safety Zone (500m radius)[iv] would encompass a considerably greater area of water than the installation DP vessel and would reduce the width of the navigable channel to 2 cables (365m) between the installation area and the 10m contour off Muckle Green Holm. The channel to the east between the installation area and War Ness would be reduced to approximately 1 cable (180m) (See Figure 7). Whilst it may be possible for a "non standard" zone just encompassing the installation area to be established, it is considered that no particular benefits would be conferred by the application of such an instrument as, during the installation and de-commissioning phases, the site will be attended by manned vessels equipped with radar and appropriate navigational equipment such that they can monitor approaching vessels and provide appropriate advice and warning on the extent of the activities being conducted. It is, therefore, considered that, with the promulgation of Maritime Safety Information through the normal means (i.e. NMs and NavWarns) and the presence on site of manned vessels capable of monitoring and advising the other marine traffic using the Fall of Warness, that the establishment of a Safety Zone in accordance with Reference 8 is not appropriate in that it provides no additional reduction in risk beyond the normal measures that will be employed.

It is concluded that, with the searoom available given the worse case; with an installation support vessel (tug/barge) acting as a safety vessel during the installation and de-commissioning phases; the provision of adequate notice of such activity through the Maritime Safety Information services; appropriate compliance with the COLREGS and by ensuring that installation activities will not proceed during adverse weather, the risks from installation and decommissioning activities are tolerable with monitoring.

[iv] A "standard safety zone" means in the case of the proposed or ongoing construction, extension or decommissioning of a wind turbine, or of major maintenance works in respect of such an installation, a safety zone with a radius of 500 metres measured from the outer edge at sea level of the proposed or existing wind turbine tower – (The Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007)

5.3 Operations and Maintenance

The following paragraphs assess the potential risks to the vessels identified previously as significant users of the area from the operations and maintenance activities associated with the HSUK device.

5.3.1 Collision with Device

The EMEC NSRA (Reference 2) recommended that the Type 1 devices i.e. bottom sited devices, should be "*sited in the deepest water available but, in any case, in water no shallower than 41m charted depth*". This assumed that the dimensions of the generic device being considered had a height above seabed of 25m. This data was derived from devices that were known about at the time. The HSUK device will be sited in waters of approximately 50m charted depth (minimum 50.2m chartered depth assumed siting within 100m radius of Test Berth 1). The overall height of the structure to the rotor tip is 33.5m. Hence, the top of the rotor swept arc would be 16.7m below chart datum. The vessel traffic survey conducted for EMEC NSRA (Reference 2), established that vessels with a draught of up to 8.6m use the Fall of Warness as a transit route. Their routes are shown in Figure 6. Given the assumption, as outlined in the EMEC NSRA (Reference 2), that a negative surge of -0.3m is possible (i.e. reducing the depth to 49.9m), the still-water Under Keel Clearance (UKC) for vessels of that draught would be as shown in Table 4 and illustrated at Figure 8.

However, it should be noted that the figures given assume the simultaneous occurrence of:

- The height of tide being at Lowest Astronomical Tide level AND,
- A negative surge caused by high atmospheric pressure and/or the effects of wind.

Heights of tide at or around LAT are rare occurrences and tidal levels even at Mean Low Water Spring (MLWS) tides are normally around 0.7m above LAT.

Dimension	
Rotor Diameter	21m
Minimum Charted Depth (CD) at Test Berth 1 (within 100m radius)	50.2m
Height above seabed (to top of swept arc)	32.5m
Distance between top of swept arc and CD/LAT (Charted Depth of device)	16.7m
Under Keel Clearance for Vessel of 3.5m Draught (e.g. Inter Island ferry)	12.9m
Under Keel Clearance for Vessel of 8.6m Draught	7.8m

Table 4 Depths and Clearances

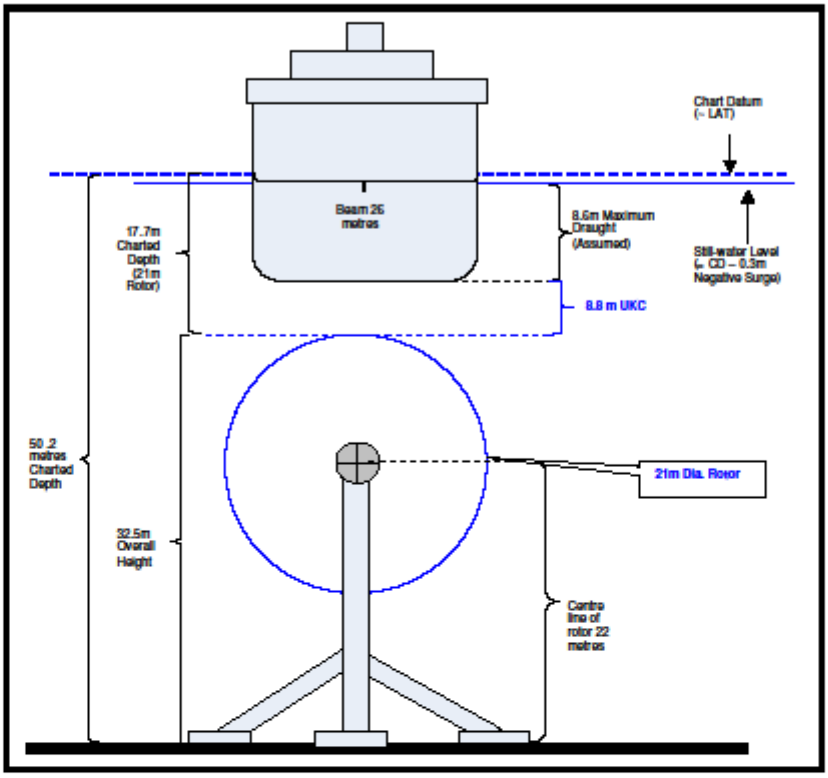


Figure 8 Hammerfest Strøm Tidal Turbine – Depths and Clearances

With a 21m diameter rotor, the device would have a charted depth of 16.7m and the UKC would be 8.8m for the MV MONA LISA (draught 8.56m) and fully laden pelagic trawlers (draught approximately 8.5m). Local ferries would have an UKC of 13.9m.

Whilst the HSUK device, fitted with a 21m rotor would, in general, be considered a tolerable risk to most vessels using the Fall of Warness waters (e.g. ferries, with a draught of 3.5m would have an UKC of over 13.9m), such a figure may still be of concern to deeper draught vessels such as the MV MONA LISA and the deep draught trawlers. Such vessels would therefore, in all probability, avoid passing deliberately over any object which reduced the UKC to a figure less than twice its draught (i.e. in their case, a UKC of less than 19m).

The above figures relate to still water conditions and, therefore, exclude any reductions in the UKC caused by waves and resultant vessel motion. The area encompassing the Fall of Warness is defined in the MCA report, Assessment Of Significant Wave Height In UK Coastal Waters (Reference 9), as an area wherein the probability of exceeding 2.5 m significant wave height (Hs) is smaller than 10% over a one-year. The report does state that "*Clearly the accuracy of the contours is*

constrained by the underlying data and in using the maps, allowance should be made for the possibility that there may be local variations in the wave climatology not represented by the contours. These variations can arise from factors such as tides, currents and the shape of the seabed, all of which can cause local modifications to waves in some coastal areas".

Severe storms may generate long sea waves which can penetrate Westray Firth and pass through the Fall of Warness. Previous work indicates that the 100 year storm may produce waves with significant wave-heights (Hs) up to 4.5m with periods of around 13 – 15 seconds within the Westray Firth and down into the Fall of Warness. This means that there could be individual waves of approximately 7.5m height[v] and with a wave length of 300m in the deeper parts of the Firth. Such extreme wave heights and lengths would cause vessels to pitch, heave and roll considerably, thus effectively increasing their draught by several metres. Hence, it is probable that what would be adequate under-keel clearance in fair weather, could be insufficient in bad.

Deep draught vessels such as cruise ships would, however, only use such a route in fair weather as their main purpose for doing so is coastal sightseeing for the benefit of the passengers. The storm event capable of producing such reductions in underkeel clearances would not generally be conducive to such activities. Also, cruise vessels have, in the past, usually sought the advice of Orkney Harbours before undertaking a passage through Fall of Warness. That recommendation would not be forthcoming in adverse weather. Hence, it is considered extremely unlikely that large cruise vessels or even fishing vessels on passage would use the Fall of Warness in circumstances that could lead to the vessel passing over the charted position of the device. Such vessels would, in all probability, intend to pass a suitable distance clear of an object showing a charted depth of <18m. With the device sited in the relatively narrow channel between Muckle Green Holm and Eday, there is, approximately, 3.1 cables (573m) to the east and 3.5 cables (647m) to the west in which to plan an alternative route. It is considered that the prudent mariner would consider the passage as a narrow channel within the meaning of the COLREGs Rule 9 and keep to the starboard side of the channel thus avoiding head on situations in the unlikely event of meeting vessels using the channel in the opposite direction.

Hence, having planned to avoid passing over the device by keeping to the starboard side of the channel, the vessel should be able to pass some 1.5 cables (277m) clear of the device. In order to pass over the device, the vessel would have to be over 1.5 cables (277m) off track. Given the constraints of these waters, such a cross-track error would generally be intolerable given the proximity of other hazards such as the 10m contours off War Ness and Muckle Green Holm. So, even if the vessel were to be sufficiently off-track to pass over the device, then it would have to do so at a time when the height of tide, the wave height developed under storm conditions and the vessel motion in response to the particular wave spectra all combine to reduce the UKC such that a collision results. It is, therefore,

[v] The height of the highest 1% of waves (H1/100) is approximately equal to 1.67 x Hs and a theoretical maximum wave height (Hmax) are approximately equal to 2 x Hs. Source: US Dept of Commerce, National Oceanographic and Atmospheric Administration

considered that, even if "geographical coincidence" were to occur, the risk of physical contact between the vessel and the device is still remote. Such a risk is a function of a number of variables such as the characteristics of the waves in the Fall of Warness and the vessel passing through them (such as hull form, length, draught, speed through the water etc).

A study is being commissioned by EMEC as part of an updated site NSRA in order to establish the theoretical "safe depth" for devices in the Fall of Warness taking into account:

1. The characteristics of known and predicted vessels using the Fall of Warness;

2. The wave characteristics that would be likely to be developed in environmental conditions to be expected in the 5, 10, 20, 50 and 100 year events.

In summary, given that the device will be charted appropriately, it is considered that the risk presented to transiting deep draught vessels is tolerable with the 21m rotor assuming that the clearances allows for a reduction of the UKC in extreme environmental conditions. It is recognised that a very low probability of navigational safety risk to off-track, deep draught vessels in extreme conditions may remain. Further mitigation will be provided by the EMEC commissioned modelling study to quantify this risk.

It is further considered that the device would not present a hazard to the Orkney Island Ferry Company ferries as, with a draught of 3.5m and a consequent minimum UKC of approximately 13.9m, there is adequate water at all times even if the ferries were to operate in extreme weather conditions.

5.3.2 Failure of the Device

The structural components of the HSUK device are not inherently buoyant. Failure of the support structure would result in the structure remaining on the seabed. As the blades themselves are not buoyant, detachment of the blade, either whole or in part, would not present a hazard to shipping. Blade failure would be detected by the monitoring and lead to the device being shut down automatically by the control system.

5.3.3 Maintenance

The HSUK turbine is expected to be deployed for a period of 5 years at this particular site. The turbine system is designed for five-yearly (minimum) scheduled maintenance. However, during commissioning and early testing, a number of site visits for inspection are expected to be conducted. Whilst there will be no planned interventions requiring removal of the nacelle and rotor, such a requirement may arise during the 5 year deployment life due to defects or a requirement for inspection of components . The removal would require a vessel or barge of a lower lifting capacity than required for the whole installation process as the mass of the nacelle and rotor amounts is less than that of the support structure and gravity masses.

The removal of the nacelle, which is intended to take a matter approximately 30 minutes to one hour, would be undertaken only in suitable environmental

conditions i.e. at slack water and in low sea states. It is considered that the nacelle recovery activity, given the duration and conditions in which it requires to be undertaken, presents an acceptable risk to other potential users of the waters. The inter island ferries would have no reason to be using the adverse/weather tide routes in those conditions and the co-incidental presence of transiting vessels would, given the traffic levels, be unlikely. However, if that were the case, then there would be adequate navigable waters within the channel for passage to be unimpeded.

Once the nacelle and rotor have been removed from the support structure, the clearance above the device increases to approximately 28.2 m (at Chart Datum).

Recovering the whole nacelle back to a suitable onshore facility, would probably involve taking the nacelle to Kirkwall. The distance from Warness to Kirkwall is ~16 nautical miles, assuming the vessel follows the deeper-draught route around the East of Shapinsay avoiding the narrow channel to the west of the Skerry of Vasa.

The vessel undertaking the nacelle recovery activity would comply with the appropriate COLREGS for the nacelle recovery.

5.3.4 Fishing Activity

Creel fishermen operate within the Fall of Warness usually within the 15 metre contour but occasionally out to the 30m contour. The intended site is in 50m of water and is considered to be outwith their normal areas of operation, which are situated to the south of Seal Skerry, as indicated in the discussion with creel fishermen during the stakeholder meetings held for the EMEC NSRA. The creel fishermen's main concern remains the potential for snagging of creel lines on the subsea cable further inshore when hauling in their creels. This risk has been addressed in the EMEC Site NSRA and the cables are appropriately charted. The cables have been in place for two years without any reported incident.

5.3.5 Effects of Tide and Tidal Stream

The inter-island ferry service run by Orkney Ferries utilises the Fall of Warness in circumstances where combinations of tidal stream and wind give rise to areas of water which the ferries wish to avoid. The routes are illustrated in Figure 7. The risks have been discussed above.

5.3.6 Effects of Weather

The risk of collision between vessels and the HSUK device could be increased in situations of high sea state and extreme low tides as previously discussed. Measures to mitigate this potential risk are to be addressed in the EMEC study into vessel dynamics in exceptional weather.

5.3.7 Aids to Navigation (AtN)

The International Association of Lighthouse Authorities (IALA) recommendations on the Marking of Offshore Wave and Tidal Devices are contained in IALA Recommendation O-139 Edition 1 December 2008 (Reference 10). This states that, where a device is within a field (or in this case, a test site) and is not visible

above the surface, the field shall be marked by "Navigational Lighted Buoys". It is implied, but not stated, that, if this is the case, then the individual devices do not need to be marked by buoys etc. Also, the guidance does not stipulate whether marking of the site is dependent on whether the individual devices represent a hazard to shipping or not. In the light of discussions with the Northern Lighthouse Board (NLB)[vi] and others, it was proposed that, given the nature of the area, the test site would require to be charted but not buoyed. Hence, the chart shows the subsea cables overwritten with "European Marine Energy Centre (See Note)". The accompany note states *"Extensive testing of tidal energy devices, both above and below the surface, takes place in this area. Mariners should exercise caution whilst navigating in this area and obtain local knowledge."*

The IALA guidance goes on to state that, "*in the case of a single wave/tidal device which is not visible above the surface but is considered to be a hazard to surface navigation, it should be marked by an IALA Special Mark yellow buoy with a flashing yellow light with a range not less than 5 nautical miles, in accordance with the IALA Buoyage System*". Marking of the device with Special Mark buoys as recommended is not considered a practicable proposition given the tidal stream strength. Such a mark would need to be placed at a suitable distance from the device[vii] to avoid getting entangled with the device. As a Special Mark buoy provides no indication of relative position to the "hazard" it is marking, its use in such waters is of doubtful benefit. If it (or a cardinal mark) were to be placed to the west of the device it would impinge on the routes available for deep draught vessels thus providing a greater potential hazard to mariners than the device it is intended to warn against. Also, given the exceptional tidal rates, the buoy is likely to be dragged under the surface at times, thereby being unavailable as an AtN for periods as well as presenting a significant, hidden hazard to shipping. Therefore, given the conditions at the intended site, it is considered impracticable to provide any physical marking of the device either as part of a field or as an individual device. Hence, it is recommended that the device is charted but not marked. This approach was agreed in principal at the meeting mentioned above and is considered appropriate in this case particularly when the charted depth of the device is considered.

5.3.8 Charting

The HSUK device will be sited within the area charted as the EMEC Tidal Test Area. The UKHO has indicated in discussions that single devices/structures would, if likely to be in situ for more than 6 months, be promulgated as corrections to the appropriate charts. Reference 3 proposed that, in accordance with Admiralty Chart 5011 – Symbols and abbreviations used on Admiralty Charts (Reference 11) a device such as HSUK's should, in the absence of an internationally accepted symbol, be charted as an Underwater Installation, depth known (Symbol L21.2), with an appropriate legend e.g. "Tidal Turbine". This approach has been agreed at

[vi] Meeting EMEC/NLB/MCA/UKHO 9 Aug 2007.

[vii] A buoy in 32m of water would require at least 150m of chain cable not allowing for the exceptional tidal conditions at the site.

the meeting with NLB and has been followed for devices currently installed at the Test Site.

6.0 Other Navigational Issues

Other navigational issues that are required to be addressed by Reference 1 were addressed in EMEC's NSRA (References 2 and 3) and are considered to encompass the hazards and issues presented by HSUK's device. Hence they are not addressed further in this report.

7.0 Conclusions

The main conclusions which arise from the assessment of navigational safety presented by HSUK's device are that;

- The construction and decommissioning phases of the HSUK device present a potential hazard to navigation for which normal precautions and controls are adequate to ensure that the risk is tolerable.
- The device, fitted with a 21m diameter rotor, has a minimum clearance of 17.7m above the rotor swept arc which does not present a hazard to shipping in still water conditions even if they were to pass directly over it. However, the mariner requires to be provided with appropriate information with regard to the reduction in depth and obstruction present.
- There remains a theoretical risk to deep draught vessels in exceptional environmental conditions if they were to pass over the device. Further mitigation will be provided by the EMEC modelling study as part of the revised site NSRA which is intended to quantify the residual navigational safety risk to such vessels.
- The use of buoys to mark the site of the device in accordance with IALA O-139 (Reference 10) is considered impracticable given the tidal characteristics of the area.

8.0 Recommendations

It is therefore recommended that:

- During construction, installation and decommissioning phases of the device that normal precautions and controls for such work need to be enforced i.e.
  - UKHO is to be notified in advance in order that Notice to Mariners and Navigation Warnings (NavWarns) can be issued (this information should include the presence of buoys used to mark ballast blocks).
  - The vessel(s) involved are marked/lit in accordance with COLREGS as appropriate to their activities.
- The device is charted as agreed with UKHO e.g. as an "Obstruction / Underwater Installation– depth known" with an appropriate legend e.g. "Tidal Turbine".
- The modelling study being carried out by EMEC should quantify what, if any, level of navigational safety risk remains to deep draught vessels in extreme environmental conditions. This is an EMEC study and therefore outwith the control of SPR or HSUK.
- The device is not buoyed in accordance with IALA O-139 guidance.

9.0 References

[1] Maritime and Coastguard Agency's (MCA) Marine General Notice MGN 275(M) - Proposed Offshore Renewable Energy Installations (OREI) – Guidance on Navigational Safety Issues.

[2] ARC Report 039-007-R1 - Navigational Risk Assessment of the Proposed Tidal Test Centre at the European Marine Energy Centre, Orkney Issue 1 dated June 2005

[3] Addendum to Navigation Risk Assessment of the Proposed Tidal Test Facility at the European Marine Energy Centre, Orkney Issue 1 dated October 2005

[4] Department for Trade and Industry (now the Office for Business, Enterprise and Regulatory Reform (BERR)) "Guidance on the Assessment of the Impact of Offshore Wind Farms – Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms"

[5] HS-1000 1MW Tidal Turbine at EMEC, Supporting Documentation, ScottishPower Renewables (UK) Limited, A-30127-S03-REPT-01-R01, May 2010.

[6] HSE Offshore Technology Report 2001/030 – Wind and Wave Frequency Distributions for Sites around the British Isles

[7] Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS) (as amended)

[8] Statutory Instrument 2007 No. 1948 The Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007

[9] Assessment Of Significant Wave Height In UK Coastal Waters Meto Ref M/Ci/Bgm/16/5/1/6 dated 06 August 1998

[10] IALA Recommendation O-139 The Marking of Man-Made Offshore Structures December 2008

[11] Admiralty Chart 5011 – Symbols and Abbreviations used on Admiralty Charts (INT 1) Edition 3 – Mar 2005

APPENDIX E VESSEL SPECIFICATIONS

subsea 7

Skandi Seven

PIPELAY AND CONSTRUCTION VESSEL

The Skandi Seven is a pipelay and construction vessel fitted with a Vertical Lay System* for deployment of a range of flexible products, capable of operating in water depths of up to 3,000m with a top-tension capacity of 110t.

- Length 120.7m
- Breadth 23m
- Cargo Deck Area 1,300m²
- Active heave compensated 250t offshore crane
- 2 x Auxiliary cranes
- Single enclosed ROV hanger for side launched and moonpool launched ROV systems
- Provision is also available for five 300t reels on deck
- 3 x 300t reels or a 18m diameter Carousel
- Two main azimuth units with open fixed propellers, two bow tunnel thrusters and two bow azimuth thrusters
- Class III DP System

VSS/Rev.005 - 010610

subsea partner of choice

SPECIFICATION

subsea 7

General Information

Classification	DNV, +1A1, SF, EO, DYNPOS AUTRO DK+, Comf-V(3)C(3), HELDK NAUT-AW, CRANE, ICE-C, CLEAN
Built	Aker Yards Soviknes, Norway 2008
Flag State Authority	Isle of Man
Port of Registry	
Douglas	

Dimensions

Overall Length	120.70m
Breadth	23m
Depth	9m
Draught (summer)	6m
Draught (max)	7m
Deadweight	5,500t

Dynamic Positioning Systems

DP Classification	DYNPOS AUTRO (Class III) ERN
Rating	99.99.99

Tank Capacities (100%)

Fuel Oil	1,930m³
Fresh Water	1,060m³
Ballast Water	3,700m³

Cargo Deck

Deck Area (clear)	1,300m²
Deck Strength	10t/m²

Deck Cranes

The vessel is fitted with an active heave compensated offshore pedestal crane with the following main capacities:

Main Deck Crane	250t at 14m (harbour lift) 250t at 12m (subsea lift) 230t at 13m (ahc subsea lift) 190t at 12m (subsea lift at 2500m)

In addition the vessel is fitted with two auxiliary knuckle boom cranes, each with a capacity of 3t at 15m.

Pipelay System

Provision is also available for five 300t reels on deck. 3 x 300t reels or a 18m diameter carousel. A vertical lay system* (110t capacity) is permanently installed for deployment of a range of flexible products. The carousel can stow products from 100mm to 600mm diameter with the tensioner allowing a minimum of 50mm.

ROV Systems

The vessel has a single enclosed ROV hanger with ROV doors on the port and starboard sides and after end. A moonpool and a side door launch system are provided for ROV operations.

The vessel is fitted with an ROV moonpool (5.6m x 5.5m) with baffle zones in order to provide optimised sea damping capabilities.

ROV Moonpool	5.6m x 5.5m
Work Moonpool	7.2m x 7.2m

Accommodation

120 persons

Helideck

The vessel is fitted with an approved and certified helideck. The helideck has a D-value of 21 and is approved for Sikhorsky S92 helicopters.

Communications

The vessel is fitted with a VSAT communications system.

* Subsea 7's use of the Vertical Lay System (VLS) is under licence from Technip

www.subsea7.com