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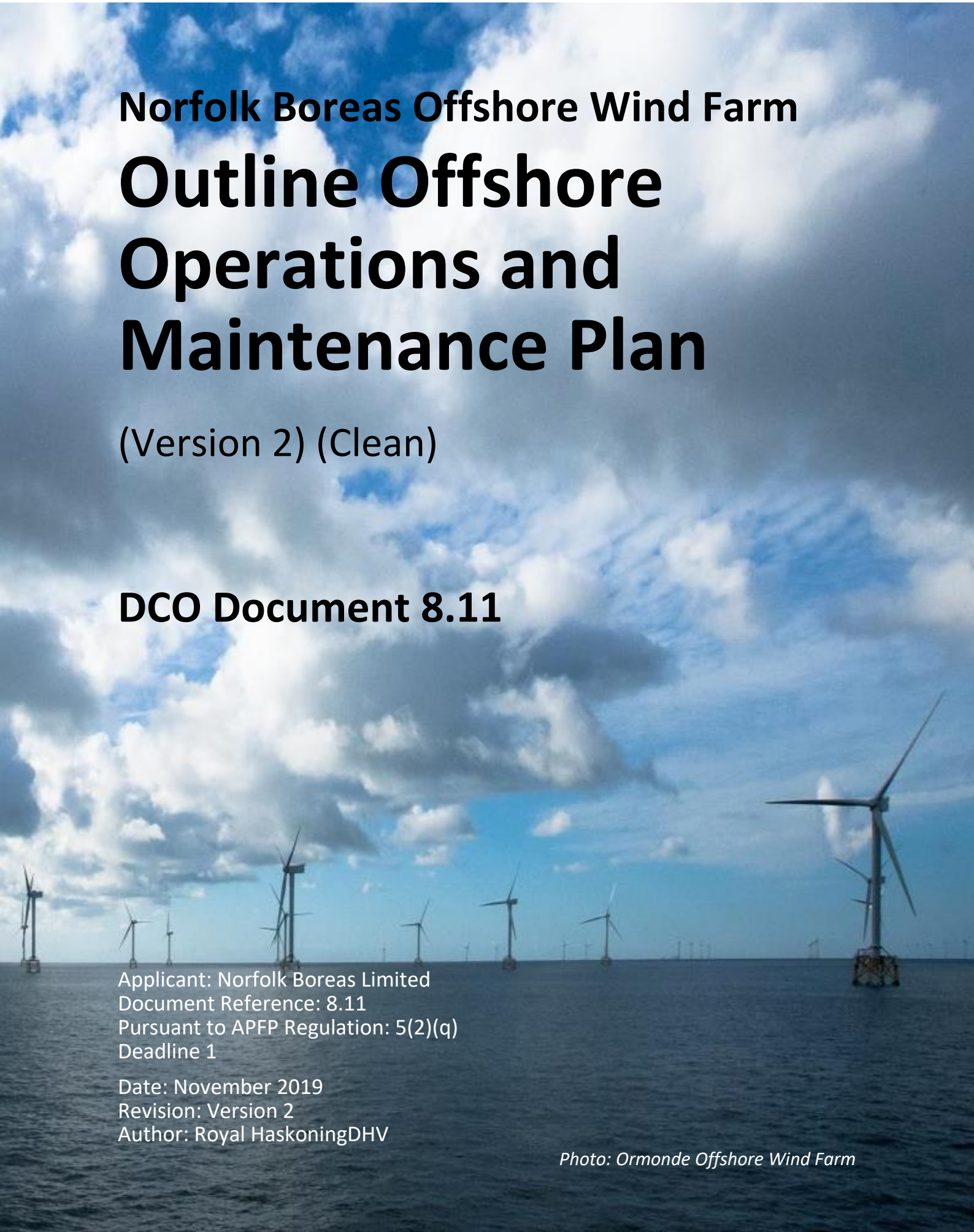

Norfolk Boreas Offshore Wind Farm

Outline Offshore Operations and Maintenance Plan

(Version 2) (Clean)

DCO Document 8.11

Applicant: Norfolk Boreas Limited
Document Reference: 8.11
Pursuant to APFP Regulation: 5(2)(q)
Deadline 1

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Glossary of Acronyms

DCO	Development Consent Order
DML	Deemed Marine Licence
ES	Environmental Statement
MMO	Marine Management Organisation
MW	Megawatt
O&M	Operation and Maintenance
OOMP	Offshore Operation and Maintenance Plan
UPS	Uninterruptible Power Supply
VWPL	Vattenfall Wind Power Limited

Glossary of Terminology

Array cables	Cables which link wind turbine to wind turbine, and wind turbine to offshore electrical platforms.
Interconnector cables	Offshore cables which link offshore electrical platforms within the Norfolk Boreas site
Landfall	Where the offshore cables come ashore at Happisburgh South
Norfolk Boreas site	The Norfolk Boreas wind farm boundary. Located offshore, this will contain all the wind farm array.
Offshore cable corridor	The corridor of seabed from the Norfolk Boreas site to the landfall site within which the offshore export cables will be located.
Offshore electrical platform	A fixed structure located within the Norfolk Boreas site, containing electrical equipment to aggregate the power from the wind turbines and convert it into a suitable form for export to shore.
Offshore export cables	The cables which transmit power from the offshore electrical platform to the landfall.
Offshore project area	The area including the Norfolk Boreas site, project interconnector search area and offshore cable corridor.
Offshore service platform	A platform to house workers offshore and/or provide helicopter refuelling facilities. An accommodation vessel may be used as an alternative for housing workers.
Project interconnector cable	Offshore cables which would link either turbines or an offshore electrical platform in the Norfolk Boreas site with an offshore electrical platform in one of the Norfolk Vanguard OWF sites.
Project interconnector search area	The area within which project interconnector cables would be installed.
Safety zones	An area around a vessel which should be avoided during offshore construction
Scour protection	Protective materials to avoid sediment being eroded away from the base of the foundations as a result of the flow of water.
The Applicant	Norfolk Boreas Limited
The project	Norfolk Boreas Offshore Wind Farm, including the onshore and offshore infrastructure

1 INTRODUCTION

1.1 Purpose of this Document

1. This Outline Offshore Operation and Maintenance Plan (OOMP) has been drafted with specific reference to the interpretation of the definition of "maintain" within the Norfolk Boreas Development Consent Order (DCO).

2. The purpose of this document is to provide an outline of reasonably foreseeable offshore maintenance activities and the broad approach to be taken for each activity.

3. The final OOMP would be prepared following post-consent detailed design as required under DCO Condition 14(1)(j) of Schedule 9 and 10; Condition 9(1)(j) of Schedule 11 and 12 and Condition 7(1)(i) of Schedule 13

4. Operation and Maintenance (O&M) requirements of the project, including all equipment, structures and associated infrastructure, in accordance with design and manufacturer recommendations;

   - Operational health, safety and environment management;
   - Accessibility and constraints;
   - Logistical set up of the O&M base;
   - O&M staff requirement, including numbers and skills;
   - Spare parts and availability; and
   - Planning of scheduled and unscheduled maintenance

5. Norfolk Boreas Limited has assessed the following reasonably foreseeable offshore maintenance activities within the Environmental Statement (ES):

   - Scheduled Maintenance:
     - Each turbine will require regular servicing
     - Scheduled maintenance would be undertaken from vessels (e.g. Service Offshore Vessel, Crew Transfer Vessel etc.) or helicopters.
   - Unscheduled Maintenance:
     - During the operational period it is anticipated that unscheduled maintenance activity may be required to deal with fault finding and repairs of the turbines, cables and associated offshore infrastructure.
     - Unscheduled maintenance would be undertaken from vessels such as jack-up barges, Service Offshore Vessels, Crew Transfer Vessels etc., or helicopters.

6. Norfolk Boreas's parent company, Vattenfall, are also developing a sister project, Norfolk Vanguard. The Norfolk Vanguard Project is being developed by Norfolk

Vanguard Limited who like Norfolk Boreas Limited are an affiliate company of Vattenfall Wind Power Ltd (VWPL). The Norfolk Vanguard project is approximately one year ahead of Norfolk Boreas in its development.

7. This document does take account of developments throughout the Norfolk Vanguard examination and this version has been updated to be consistent with the final version of the Norfolk Vanguard Outline OOMP that was resubmitted at Deadline 9 of that examination (10 June 2019).

8. Maintenance activities relating to the export cables within the section of the offshore cable corridor where it overlaps with the Haisborough, Hammond and Winterton Special Area of Conservation (SAC) are outlined in Appendix 1 for completeness, however these activities are considered separately in the Outline Haisborough, Hammond and Winterton SAC Site Integrity Plan (SIP) (document reference 8.20) and must be agreed with the MMO in consultation with relevant Statutory Nature Conservation Bodies in accordance with Condition 9(1)(m) of DCO Schedules 11 and 12. Maintenance works within the Haisborough, Hammond and Winterton SAC will therefore not be considered in the final Operation and Maintenance Plan.

9. Appendix 1 of this document outlines the estimated frequency and seabed footprints of the maintenance activities. This has been updated and resubmitted at the Deadline 1 (25th November 2019) of the Norfolk Boreas Examination to take into account changes requested by the Marine Management Organisation (MMO) and Natural England and the final Outline OOMP submitted to the Norfolk Vanguard examination.

10. The operational impacts are assessed in each offshore technical chapter of the Environmental Statement; Chapter 8 Marine Geology, Oceanography and Physical Processes; Chapter 9 Marine Water and Sediment Quality; Chapter 10 Benthic Ecology; Chapter 11 Fish and Shellfish Ecology; Chapter 12 Marine Mammal Ecology; Chapter 13 Offshore Ornithology; Chapter 14 Commercial Fisheries; Chapter 15 Shipping and Navigation; and Chapter 18 Infrastructure and Other Users.

1.2 Background

11. Norfolk Boreas Limited (an affiliate company of Vattenfall Wind Power Ltd (VWPL), 'the Applicant') is seeking a Development Consent Order (DCO) for the proposed Norfolk Boreas offshore wind farm which ever scenario arises (herein 'the project' or 'Norfolk Boreas'), an offshore wind farm in the southern North Sea.

12. The Norfolk Boreas site comprises of a 725km^2 area located approximately 73km from the Norfolk coastline within which wind turbines would be located. Norfolk Boreas would have a maximum export capacity of 1,800 megawatts (MW). The OWF

would be connected to the shore by offshore export cables installed within the offshore cable corridor from the wind farm to a landfall point at Happisburgh South, Norfolk. From there, onshore cables would transport power over approximately 60km to the onshore project substation located near to the village of Necton, Norfolk.

13. Norfolk Boreas Limited have included two scenarios within the DCO application; Scenario 1 where Norfolk Vanguard and Norfolk Boreas proceed to construction and Scenario 2 where Norfolk Vanguard does not. These two scenarios are presented in Chapter 5 Project Description of the ES (document reference 6.1.5). The two scenarios have not materially affected the drafting of this document as the operation and maintenance procedures being proposed would be the same regardless of which ever scenario arises. However, it should be noted that If Norfolk Vanguard does not proceed (and if Norfolk Boreas does proceed under Scenario 2) then cables to connect Norfolk Boreas with Norfolk Vanguard (the "project interconnector" cables) would not be required.

14. Once built, Norfolk Boreas would have an export capacity of up to 1,800MW, with the offshore components comprising:

- Wind turbines;
- Offshore electrical platforms;
- Offshore Service platform;
- Met masts;
- Measuring equipment (LiDAR and wave buoys);
- Array cables;
- Interconnector cables or project interconnector cables[1]; and
- Export cables.

15. Norfolk Boreas Limited is currently considering constructing the project using a single phase or a two phased approach (up to a total of 1,800MW).

16. Construction of the project under either approach would be anticipated to commence at the earliest in 2021 for the onshore works, and at the earliest around 2025 for the offshore works.

[1] There may also be a requirement for cables to be placed within the project interconnector search area (Figure 5.1 of the ES) which would link the Norfolk Boreas project to the Norfolk Vanguard project (Section 5.4.12 of ES Chapter 5 Project Description). Either "Interconnector cables", which would link platforms within the Norfolk Boreas site, would be installed or "project interconnector cables" would be installed. Under no scenario would both be required.

2 DISCHARGING THE CONSENT CONDITION

2.1 Activity list during the Operations and Maintenance Phase

17. The list of activities to be undertaken during the O&M phase is provided as Appendix 1. This O&M list is a live document which will be updated and agreed with the MMO as required.

18. For each activity, a 'traffic light system' will be used to provide clarity as to those activities that can be carried out under the existing DMLs.

- **Green** indicates that an additional marine licence is not required, however notification should be provided to the MMO on works being undertaken;
- **Amber** indicates that an additional marine licence may be required if proposed works exceed those assessed within the Environmental Statement or described within the DCO; or
- **Red** indicates that an additional marine licence could be required dependant on the type of works to be undertaken.

19. Additional activities not outlined in this schedule (including Appendix 1) may, if relevant, require future consents such as a Marine Licence under the Marine and Coastal Access Act 2009. Such activities will be discussed with the MMO prior to undertaking if appropriate.

APPENDIX 1: OPERATIONS AND MAINTENANCE LIST

Potential offshore maintenance activity	Relevant DML/DCO	Included in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in the Application Document	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Wind turbines (topside)						
Annual wind turbine maintenance	Generation	Assessed in the ES	Assessed in the ES within the assumed maintenance activities per annum for scheduled and unscheduled maintenance. There are a number of potential maintenance strategies for the wind farm which will be determined by the final design of the wind farm and procurement of the maintenance contractors. The wind farm could be maintained from shore using a number of varying Operation and Maintenance (O&M) vessels (e.g. crew transfer vessels, supply vessels) possibly supported by helicopters. Alternatively, the wind farm could be maintained primarily from an offshore base (e.g. an accommodation vessel (Service Offshore Vessel) or a fixed offshore service platform), with transfer vessels or helicopters also used to transfer personnel to or from turbines and platforms. Typical maintenance activities would include; general wind turbine service; oil sampling / change; UPS (uninterruptible power supply)-battery change; service and inspections of wind turbine safety equipment, nacelle crane, service lift, HV system, blades. Although it is not anticipated that large components (e.g. wind turbine blades or substation transformers) would frequently require replacement during the	ES Chapter 5 Project Description; ES Chapter 8 Marine Geology, Oceanography and Physical Processes; ES Chapter 9 Marine water and sediment quality ES Chapter 10 Benthic Ecology; ES Chapter 11 Fish and Shellfish Ecology; ES Chapter 12 Marine Mammal Ecology; ES Chapter 13 Offshore Ornithology; ES Chapter 14 Commercial Fisheries; ES Chapter 15 Shipping and Navigation.	No	No
Wind turbine troubleshooting	Generation	Assessed in the ES			No	No
Wind turbine repair	Generation	Assessed in the ES			No	No
Blade inspection	Generation	Assessed in the ES			No	No
Blade and hub repair	Generation	Assessed in the ES			No	No
Blade replacement	Generation	Assessed in the ES			No	No
Transition piece repair	Generation	Assessed in the ES			No	No
Transition piece maintenance	Generation	Assessed in the ES			No	No
Transformer replacement	Generation	Assessed in the ES			No	No
Gearbox repair and replacement	Generation	Assessed in the ES			No	No
Generator replacement	Generation	Assessed in the ES			No	No

Potential offshore maintenance activity	Relevant DML/DCO	Included in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in the Application Document	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Paint and repair		Assessed in the ES	operational phase, the failure of these components is possible. Should this be required, large jack-up vessels may need to operate continuously for significant periods to carry out these major maintenance activities. Operational cleaning of offshore infrastructure would consist of jet washing with seawater, no chemicals would be used in this process. The number of estimated operational visits for maintenance activities, including cleaning of infrastructure, are assessed in the ES on the basis of a maximum of two locations visited by one jack-up vessel (counted as a single movement) to the Norfolk Boreas site per day. This would equate to up to 445 vessel movements per year during operation. The Jack up vessel has a footprint of 792m^2 which would lead to a total area of up to 0.58km^2 per year (assumes large jack up with up to six legs). Indicative quantities of oils and fluids per turbine: • Gearbox oil: 1000 litres • Hydraulic oil: 1000 litres • Coolant systems: 1000 litres • Yaw/pitch motor oil: 20 litres • Transformer oil: 1500 litres		No	No
J-Tube and ladder cleaning	Generation	Assessed in the ES			No	No

Potential offshore maintenance activity	Relevant DML/DCO	Included in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in the Application Document	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Cables outside the Haisborough Hamond and Winterton SAC						
Cable inspection	Generation, Transmission and project interconnector	Assessed in the ES	During the life of the project, cable repairs may be required and periodic inspections will be undertaken. Periodic surveys would also be required to ensure the cables remain buried and if they do become exposed, re-burial works would be undertaken. In most cases a failure would lead to the following operations: • Vessel anchor placement (150m^2 footprint) • Exposing/unburying the damaged part of the cable, assumed to be approximately 300m length subject to the nature of the repair; • Cutting the cable; • For array cables it may be preferable to lift a whole length of a cable between two turbines, of up to approximately 2km length; • Lifting the cable ends to the repair vessel; • Jointing a new segment of cable to the old cable; • Lowering the cable (and joints) back to the seabed; and • Cable burial, where possible. Worst case assumes: • Maximum of 4 failures per year:	ES Chapter 5 Project Description; ES Chapter 8 Marine Geology, Oceanography and Physical Processes; ES Chapter 10 Benthic Ecology; ES Chapter 11 Fish and Shellfish Ecology; ES Chapter 12 Marine Mammal Ecology; ES Chapter 14 Commercial Fisheries; ES Chapter 15 Shipping and Navigation.	No	No
New areas of cable protection	Generation, Transmission and project interconnector	N/A			Yes	Yes
Replacement of cable protection in the same area as cable protection installed during construction	Generation and Transmission	Parameters in the DML not to be exceeded			No	Yes

Potential offshore maintenance activity	Relevant DML/DCO	Included in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in the Application Document	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Cable re-burial	Generation, Transmission and project interconnector	Assessed in the ES	○ 2 x array cables (assume the whole length of an array cable is replaced – max length 6km based on turbine spacing); ○ 1 x Interconnector cables or 1 x project interconnector cables (assume maximum of 300m subject to the nature of repair)*; ○ 1 x Export cables (assume 300 metres subject to the nature of repair) Cables can become exposed due to moving sand waves but also sometimes due to erosion of other soft/mobile sediment (not just sand waves). During the life of the project, periodic surveys would be required to ensure the cables remain buried and if they do become exposed, re-burial works would be undertaken. Post construction surveys in the initial 3-5 years are often dictated by the deemed marine license. The worst case scenario for array cable re-burial is based on an estimate of 25% of the array cable every 5 years. For export cables, the aim would be to avoid requirement for re-burial by using pre-sweeping. A worst case scenario of reburial of up to 20km length per export cable pair is assumed. An estimated reburial length of 1 km at a time is assessed.		No	Yes
Cable repairs including laying of replaced sections of cable	Generation, Transmission and project interconnector	Assessed in the ES			No	Yes

Potential offshore maintenance activity	Relevant DML/DCO	Included in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in the Application Document	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Cables within the Haisborough Hammond and Winterson SAC (addressed in the Haisborough Hammond and Winterson SAC SIP, document reference 8.20)						
Cable inspection	Generation and Transmission	Assessed in ES	During the life of the project, cable repairs may be required and periodic inspections will be undertaken. Periodic surveys would also be required to ensure the cables remain buried and if they do become exposed, re-burial works would be undertaken. In most cases a failure would lead to the following operation: • Vessel anchor placement (150m^2 footprint) • Exposing/unburying the damaged part of the cable, assumed to be approximately 300m length subject to the nature of the repair; • Cutting the cable; • Lifting the cable ends to the repair vessel; • Jointing a new segment of cable to the old cable; • Lowering the cable (and joints) back to the seabed; and • Cable burial. While it is not possible to determine the number and location of repair works that may be required during the life of the project, it is estimated that, of the one export cable repair per year discussed above, an average estimate of one export cable repair every 10 years within the SAC is included in the assessment (i.e. one cable repair per year is estimated for the	Information to Support HRA Report (document 5.3)	No	Yes
					No	Yes
Cable burial using surface protection	Generation and Transmission	Parameters in the DML not to be exceeded			No	Yes
Placement of cable protection in new areas	Transmission	N/A			Yes	Yes
Replacement of cable protection in the same area as cable protection installed during construction	Generation and Transmission	Parameters in the DML not to be exceeded			No	Yes
Cable re-burial	Generation and Transmission	Assessed in the ES			No	Yes

Potential offshore maintenance activity	Relevant DML/DCO	Included in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in the Application Document	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Cable repairs including laying of replaced sections of cable	Generation and Transmission	Assessed in the ES	whole corridor and every 10 years, on average this repair may occur in the SAC). Cables can become exposed due to moving sand waves but also sometimes due to erosion of other soft/mobile sediment (not just sand waves). During the life of the project, periodic surveys would be required to ensure the cables remain buried and if they do become exposed, re-burial works would be undertaken. The aim would be to avoid requirement for any re-burial by using pre-sweeping. A worst case scenario for reburial of up to 4km per cable pair within the SAC at approximately 5 year intervals has been assessed based on a worst case scenario that no pre-sweeping is undertaken during installation.		No	Yes
Wind Turbine, Metmast and Service Platform Foundations						
Foundation inspection	Generation	Assessed in the ES	Within the assumed maintenance activities per annum for scheduled and unscheduled maintenance.	ES Chapter 5 Project Description; ES Chapter 8 Marine Geology, Oceanography and Physical Processes; ES Chapter 10 Benthic Ecology; ES Chapter 11 Fish and Shellfish Ecology; ES Chapter 12	No	No
Foundation repair	Generation	Assessed in the ES			No	No

Potential offshore maintenance activity	Relevant DML/DCO	Included in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in the Application Document	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
				Marine Mammal Ecology; ES Chapter 14 Commercial Fisheries; ES Chapter 15 Shipping and Navigation.		
Foundation replacement	Generation	N/A	Replacement of a failed foundation is considered to be a highly unlikely event. Should such an occurrence take place then consent for the replacement of the failed foundation would be obtained from the MMO prior to commencement.	N/A	Yes	Yes
Additional scour protection around foundations	Generation	Parameters in the DML not to be exceeded	Scour protection is included in the worst case scenario of 100% foundations requiring scour protection. The values per foundation presented in the Outline Scour Protection and Cable Protection Plan (document 8.16) must not be exceeded over the life of the project.	Maximum parameters included in construction phase: ES Chapter 5 Project Description; ES Chapter 8 Marine Geology, Oceanography and Physical Processes; ES Chapter 9 Marine Water and Sediment Quality; ES Chapter 10 Benthic Ecology; ES Chapter 11 Fish and Shellfish Ecology;	No	Yes

Potential offshore maintenance activity	Relevant DML/DCO	Included in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in the Application Document	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
				ES Chapter 12 Marine Mammal Ecology; ES Chapter 14 Commercial Fisheries.		
Offshore Electrical Platforms						
Inspections	Transmission	Assessed in the ES	Within the assumed maintenance activities per annum for scheduled and unscheduled maintenance. Offshore electrical platforms would typically require an average of 1 visit / week although this may be more during unscheduled maintenance.		No	No
General maintenance work, eg oil replacement, mechanical works etc	Transmission	Assessed in the ES			No	No
Switchgear replacement	Transmission	Assessed in the ES			No	No
Other						
Davit crane inspection	Generation	Assessed in the ES	Within the assumed maintenance activities per annum for scheduled and unscheduled maintenance. See worst case in terms of 'topside-related replacement, refurbishment and repair activities' for wind turbines.	ES Chapter 5 Project Description; ES Chapter 8 Marine Geology, Oceanography and Physical Processes; ES Chapter 10 Benthic Ecology; ES Chapter 11 Fish and Shellfish Ecology; ES Chapter 12 Marine Mammal Ecology; ES Chapter 14	No	No
Fuel replenishment to crew transfer vessel	Generation	Assessed in the ES			No	No
Re-fuelling of generator on the Sub-station	Generation	Assessed in the ES			No	No
Grout and corrosion works	Generation	Assessed in the ES			No	No
Crane transfers from vessel to either WTG's or to quayside O&M Building or vice-versa	Generation	Assessed in the ES			No	No

Potential offshore maintenance activity	Relevant DML/DCO	Included in the ES and/or DCO	Realistic Worst Case assessed in the Environmental Statement (for any activity outside those listed, the MMO should be alerted)	Location in the Application Document	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
				Commercial Fisheries; ES Chapter 15 Shipping and Navigation.		

*Note that either interconnector cable or project interconnector cable could be required but never both.