

# Norfolk Vanguard Offshore Wind Farm Outline Offshore Operations and Maintenance Plan

Applicant: Norfolk Vanguard Limited  
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*Photo: Kentish Flats Offshore Wind Farm*



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## Glossary

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

## Terminology

Array cables	Cables which link the wind turbines and the offshore electrical platform.
Interconnector cables	Buried offshore cables which link the offshore electrical platforms
Landfall	Where the offshore cables come ashore at Happisburgh South
Offshore accommodation platform	A fixed structure (if required) providing accommodation for offshore personnel. An accommodation vessel may be used instead
Offshore cable corridor	The corridor of seabed from the Norfolk Vanguard OWF sites to the landfall site within which the offshore export cables would be located.
Offshore electrical platform	A fixed structure located within the wind farm area, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore.
Offshore export cables	The cables which bring electricity from the offshore electrical platform to the landfall.
Offshore project area	The overall area of Norfolk Vanguard East, Norfolk Vanguard West and the offshore cable corridor
Safety zones	A marine zone outlined for the purposes of safety around a possibly hazardous installation or works / construction area under the Energy Act 2004.
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 Vanguard Limited
The OWF sites	The two distinct offshore wind farm areas, Norfolk Vanguard East and Norfolk Vanguard West
The project	Norfolk Vanguard Offshore Wind Farm, including the onshore and offshore infrastructure

## 1 INTRODUCTION

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### 1.1 Background

1. Norfolk Vanguard Limited ('the Applicant' an affiliate company of Vattenfall Wind Power Limited (VWPL)) is seeking a Development Consent Order for Norfolk Vanguard, an offshore wind farm (OWF) in the southern North Sea.
2. The OWF comprises two distinct areas, Norfolk Vanguard East (NV East) and Norfolk Vanguard West (NV West) ('the OWF sites'), within which wind turbines, associated platforms and array cables will be located. The offshore wind farm will 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 at Necton, Norfolk. A full project description is given in the Environmental Statement, Chapter 5 Project Description.
3. Norfolk Vanguard is located approximately 47km from the closest point the Norfolk Coast. NV East covers an area of approximately 297km<sup>2</sup> and NV West covers an area of around 295km<sup>2</sup>.
4. Once built, Norfolk Vanguard would have a capacity of up to 1800MW, with the offshore components comprising:
  - Up to 180 wind turbines;
  - Up to two offshore electrical platforms;
  - Up to two accommodation platforms;
  - Up to two met masts;
  - Up to two LiDAR;
  - Up to 600km array cables;
  - Up to 150km inter-connector cables; and
  - Up to 400km export cables (in two trenches of approximately 100km length each).
5. Construction of the project would be anticipated to commence between 2020 and 2021 for the onshore works, and around 2024 for the offshore works.

### 1.2 Purpose of this Document

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

7. 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.
8. The final OOMP would be prepared following post-consent detailed design as required under DCO Schedule 9 and 10 condition [14(1)(j)] and Schedule 11 and 12 condition [9(1)(j)]. The DMLs set out certain timescales in advance of commencement of the licensed activities, by when the OOMP must be submitted to the MMO for their approval.
9. The OOMP will include details of the:
  - 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
10. Norfolk Vanguard 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.
11. Appendix 1 of this document outlines the estimated frequency and seabed footprints of the maintenance activities. This has been updated and resubmitted at Deadline 7 (02 May 2019) and at Deadline 9 (06 June 2019) of the Examination. The final Deadline 9 submission reflects updates in response to comments received from stakeholders at Deadline 8.

12. 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.
  
13. 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.



## 2 DISCHARGING THE CONSENT CONDITION

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### 2.1 Activity list during the Operations and Maintenance Phase

14. 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 Marine Management Organisation (MMO) as required.
15. 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.
16. 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	Include 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 documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
<b>Wind turbines (topside)</b>						
Annual wind turbine maintenance	Generation	Assessed in the ES	<p>Assessed in the ES within the assumed maintenance activities per annum for scheduled and unscheduled maintenance.</p> <p>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.</p> <p>The wind farm could be maintained from shore using a number of varying Operation and Maintenance (O&amp;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 accommodation platform), with transfer vessels or helicopters also used to transfer personnel to or from turbines and platforms.</p>	<p>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 13 Offshore Ornithology; ES Chapter 14 Commercial Fisheries; ES Chapter 15 Shipping and Navigation.</p>	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		

Potential offshore maintenance activity	Relevant DML/DCO	Include 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 documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Generator replacement	Generation	Assessed in the ES	<p>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 operational phase, the failure of one 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.</p> <p>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 to the Norfolk Vanguard site per day during operation. Jack up vessel with a footprint of 792m<sup>2</sup> which would lead to a total area of up to 0.58km<sup>2</sup> per year</p>		No	No
Paint and repair		Assessed in the ES			No	No
J-Tube and ladder cleaning	Generation	Assessed in the ES			No	No

Potential offshore maintenance activity	Relevant DML/DCO	Include 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 documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
			<p>(assumes large jack up with up to six legs).</p> <p>Indicative quantities of oils and fluids per turbine:</p> <ul style="list-style-type: none"> <li>• Gearbox oil: 1000 litres</li> <li>• Hydraulic oil: 1000 litres</li> <li>• Coolant systems: 1000 litres</li> <li>• Yaw/pitch motor oil: 20 litres</li> <li>• Transformer oil: 1500 litres</li> <li>• Yaw and motors: not determined</li> </ul>			
<b>Cables outside the Haisborough Hammond and Winterson SAC</b>						
Cable inspection	Generation and Transmission	Assessed in the ES	<p>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.</p>	<p>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.</p>	No	Yes
New cable protection	Generation and Transmission	N/A			No	No
Replacement or addition to cable protection in the same area as cable protection installed during construction	Generation and Transmission	Parameters in the DML not to be exceeded	<p>In most cases a failure would lead to the following operations:</p> <ul style="list-style-type: none"> <li>• Vessel anchor placement (150m<sup>2</sup> footprint)</li> <li>• Exposing/unburying the damaged part of the cable, assumed to be approximately 300m length subject to the nature of the repair;</li> <li>• Cutting the cable;</li> </ul>		Yes	Yes
Cable re-burial	Generation and Transmission	Assessed in the ES			No	Yes

Potential offshore maintenance activity	Relevant DML/DCO	Include 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 documents	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	<ul style="list-style-type: none"> <li>For array cables it may be preferable to lift a whole length of a cable between two turbines, of up to approximately 2km length;</li> <li>Lifting the cable ends to the repair vessel;</li> <li>Joining a new segment of cable to the old cable;</li> <li>Lowering the cable (and joints) back to the seabed; and</li> <li>Cable burial, where possible.</li> </ul> <p>Worst case assumes:</p> <ul style="list-style-type: none"> <li>Maximum of 4 failures per year: <ul style="list-style-type: none"> <li>2 x array cables (assume the whole length of an array cable is replaced – max length 6km based on turbine spacing)</li> <li>1 x Interconnector cables (assume 300 metres subject to repair)</li> <li>1 x Export cables (assume 300 metres subject to repair)</li> </ul> </li> </ul> <p>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</p>		No	Yes

Potential offshore maintenance activity	Relevant DML/DCO	Include 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 documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
			<p>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.</p> <p>The worst case scenario for array cable re-burial is based on an estimate of 25% of the array cable every 5 years.</p> <p>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.</p>			
<b>Cables within the Haisborough Hammond and Winterson SAC (addressed in the Haisborough Hammond and Winterson SAC SIP, document 8.20)</b>						
Cable inspection	Generation and Transmission	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	Information to Support HRA Report (document 5.3)	No	Yes

Potential offshore maintenance activity	Relevant DML/DCO	Include 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 documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
			<p>become exposed, re-burial works would be undertaken.</p> <p>In most cases a failure would lead to the following operation:</p> <ul style="list-style-type: none"> <li>• Vessel anchor placement (150m<sup>2</sup> footprint)</li> </ul>		No	Yes
Cable burial using surface protection	Generation and Transmission	Parameters in the DML not to be exceeded	<ul style="list-style-type: none"> <li>• Exposing/unburying the damaged part of the cable, assumed to be approximately 300m length subject to the nature of the repair;</li> <li>• Cutting the cable;</li> <li>• Lifting the cable ends to the repair vessel;</li> </ul>		No	Yes
New cable protection	Transmission	N/A	<ul style="list-style-type: none"> <li>• Jointing a new segment of cable to the old cable;</li> <li>• Lowering the cable (and joints) back to the seabed; and</li> <li>• Cable burial.</li> </ul>		Yes	Yes
Replacement or addition to cable protection in the same area as cable protection installed during construction	Generation and Transmission	Parameters in the DML not to be exceeded	<p>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 repairs 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</p>		No	Yes

Potential offshore maintenance activity	Relevant DML/DCO	Include 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 documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
Cable re-burial	Generation and Transmission	Assessed in the ES	<p>cable repair per year is estimated for the whole corridor and every 10 years, on average, this repair may occur in the SAC).</p> <p>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.</p>		No	Yes
Cable repairs including laying of replaced sections of cable	Generation and Transmission	Assessed in the ES	<p>The aim would be to avoid requirement for any re-burial by using pre-sweeping at the installation stage to bury cables below the mobile sandwave. However 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 the worst case scenario that no pre-sweeping is undertaken during installation.</p>		No	Yes
<b>Wind Turbine, Metmast and Accommodation Platform Foundations</b>						
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;	No	No
Foundation repair	Generation	Assessed in the ES			No	No



Potential offshore maintenance activity	Relevant DML/DCO	Include 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 documents	Additional licence likely to be required	Consultation Required with the MMO and relevant SNCB
				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.		
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	Include 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 documents	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.		
<b>Offshore Electrical Platforms</b>						
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
<b>Other</b>						
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 Commercial Fisheries; ES Chapter 15 Shipping and Navigation.	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