

Norfolk Vanguard Offshore Wind Farm Offshore In Principle Monitoring Plan

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Glossary

AIS	Automatic Identification System
ALARP	As low as practically possible
SAC	Special Area of Conservation
DCO	Development Consent Order
DMLs	Deemed Marine Licenses
DEPONS	Disturbance Effects on Harbour Porpoise of the North Sea
EAOW	The Consortium Company, East Anglia Offshore Wind Ltd
EIA	Environmental Impact Assessment
ES	Environmental Statement
GBS	Gravity Based Structure
HDD	Horizontal Directional Drilling
IPMP	In Principle Monitoring Plan
LAT	Lowest Astronomical Tide
MCA	Maritime and Coastguard Agency
MHWS	Mean High Water Spring
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MW	Megawatt
NRA	Navigation Risk Assessment
NSIP	Nationally Significant Infrastructure Project
NV East	Norfolk Vanguard East
NV West	Norfolk Vanguard West
O&M	Operation and maintenance
ORJIP	Offshore Renewables Joint Industry Programme
ORPAD	Offshore Renewables Protocol for Archaeological Discoveries
OWF	Offshore Wind Farm
ROV	Remote Operated Vehicle
SAC	Special Area of Conservation
SIP	Site Integrity Plan
SNCBs	Statutory Nature Conservation Bodies
SPR	ScottishPower Renewables
UXO	Unexploded Ordnance
VWPL	Vattenfall Wind Power Ltd
WSI	Written scheme of archaeological investigation
ZDA	Zone Development Agreement

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 will 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
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

1.1 Background

1. Norfolk Vanguard Limited ('the Applicant' an affiliate company of Vattenfall Wind Power Ltd (VWPL)) is seeking a Development Consent Order for Norfolk Vanguard, an offshore wind farm (OWF) in the southern North Sea (herein referred to as 'the project' or 'Norfolk Vanguard').
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, offshore electrical platforms, accommodation 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 will transport power over approximately 60km to the onshore project substation and the National Grid substation at Necton, Norfolk. A full project description is given in the Environmental Statement (ES), Chapter 5 Project Description.
3. Norfolk Vanguard is located approximately 47km from the closest point of the Norfolk Coast. NV East covers an area of approximately 297km² and NV West covers an area of around 295km².
4. Once built, Norfolk Vanguard would have an export capacity of up to 1800MW, with the offshore components comprising:
 - Wind turbines;
 - Offshore electrical platforms;
 - Accommodation platforms;
 - Met masts;
 - LiDAR;
 - Array cables;
 - Inter-connector cables; and
 - Export cables.
5. Norfolk Vanguard Limited is currently considering constructing the project in either a single phase or in two phases (up to a maximum of 1800MW). Construction of the project would be anticipated to commence between 2020 and 2021 for the onshore works, and around 2024 for the offshore works.

Table 1.1 Key offshore project characteristics

Parameter	Characteristic
Capacity	Up to 1,800MW

Parameter	Characteristic
Lease period	50 years
Indicative construction window	Approximately 4 years
Anticipated design life	Approximately 30 years
Number of wind turbines	Range between 90 x 20MW to 180 x 10MW turbines
NV West area	295km ²
NV East area	297km ²
Offshore cable corridor area	236km ²
Water depth NV West	25m to 50m below LAT
Water depth NV East	22m to 42m below LAT
Distance from NV West to shore (closest point of site to the coast)	47km
Distance from NV East to shore (closest point of site to the coast)	70km
Maximum number of export cables	Four cables, installed as pairs in two trenches
Maximum turbine rotor diameter	303m
Maximum hub height above HAT	198.5m
Maximum tip height above HAT	350m
Approximate cable length from offshore electrical platform to land fall	85km from NV West and 100km from NV East
Maximum length of export cables	400km (200km of export cable trenching) Based on a worst case of 1800MW capacity in NV East
Maximum array cable length	600km
Maximum number of interconnectors (between offshore platforms)	2
Maximum length of interconnector cable	150km
Minimum clearance above sea level	22m (Mean High Water Springs)
Indicative minimum and maximum separation between turbines	Between 4 x rotor diameter and 20 x rotor diameter (760m to 6060m)
Wind turbine foundation type options	<ul style="list-style-type: none"> • Piled monopile; • Suction caisson monopile; • Piled tripod or quadropod; • Suction caisson tripod or quadropod; and • Gravity Base System (GBS).
Maximum number of met masts	Up to two
Maximum height of met masts above Highest Astronomical Tide (HAT)	198.5m
Met mast foundation type options	<ul style="list-style-type: none"> • Piled monopile;

Parameter	Characteristic
	<ul style="list-style-type: none"> • Suction caisson monopile; • Piled tripod or quadropod; • Suction caisson tripod or quadropod; and • GBS.
Maximum number of offshore electrical platforms	Two
Maximum number of accommodation platforms	Two
Offshore platform (electrical and accommodation) foundation type options	<ul style="list-style-type: none"> • Piled monopile; • Suction caisson monopile; • Piled tripod or quadropod; • Suction caisson tripod or quadropod; • GBS
Buoys	<ul style="list-style-type: none"> • LiDAR, wave and guard buoys may be deployed.

1.2 Purpose of the In Principle Monitoring Plan

6. This In Principle Monitoring Plan (IPMP) has been produced following consultation with the Marine Management Organisation (MMO) and relevant Statutory Nature Conservation Bodies (SNCBs), in order to provide the basis for delivering the monitoring measures as required by the conditions contained within the Deemed Marine Licences (DMLs). Revision 2 of the IPMP was submitted in May 2019 at Deadline 7 of the Norfolk Vanguard Examination to address comments raised by the MMO in their Relevant Representation.
7. The IPMP provides a key mechanism through which the relevant regulatory authorities can be assured that required offshore monitoring activities associated with the construction and operation of the offshore infrastructure for the project will be formally controlled and mitigated.
8. The IPMP provides a framework to agree the exact detail for monitoring requirements (e.g. timings and methodologies) with the MMO, in consultation with relevant SNCBs post consent . Due to the long lead in time for the development of offshore wind farms it is not desirable or effective to provide final detailed method statements prior to being granted consent. However, agreeing guiding principles reinforces commitments made in the ES and complements other requirements set out in the DMLs and will allow refinements to be made based on the best available knowledge and technology. Final detailed plans for monitoring work will be produced closer to the time that the actual work will be undertaken, and as set out in the DMLs. The DMLs set out certain timescales in advance of commencement of the licensed activities, by when the IPMP must be submitted to the MMO for their approval.

9. The relevant topics and/or receptor groups that will be discussed in this plan are as follows. This is cross referenced against the relevant conditions within the respective DMLs in Appendix 1:

- Marine Geology, Oceanography and Physical Processes;
- Benthic Ecology;
- Fish and Shellfish Ecology;
- Marine Mammal Ecology;
- Underwater Noise;
- Offshore Ornithology;
- Commercial Fishing;
- Shipping and Navigation; and
- Offshore Archaeology and Cultural Heritage.

2 GENERAL GUIDING PRINCIPLES FOR THE PROPOSED MONITORING

10. Throughout the ES and supporting documentation the Applicant has taken steps to avoid or reduce significant impacts either through the iterative process of project design ('embedded mitigation' e.g. the location of project boundaries) or by 'additional' mitigation measures which will be applied during the construction, operation and maintenance (O&M) or decommissioning phases of the Project.
11. The guiding principles for monitoring and which apply in general to the in principle monitoring outlined in this document are as follows:
 - a. All consent conditions, which would include those for monitoring, should be "necessary, relevant to planning, relevant to the permitted development, enforceable, precise and reasonable in all other respects" as set out in Paragraph 206 of the National Planning Policy Framework and referred to as the 'six tests' (Department for Communities and Local Government, 2014).
 - b. In line with good practice, monitoring must have a clear purpose in order to provide answers to specific questions (e.g. Cefas, 2012, Glasson et al., 2011, OSPAR, 2008). As such, monitoring proposals should have an identified end date and confirmed outputs, which provide statistically robust data sets, as applicable to the hypothesis being tested.
 - c. Monitoring should be targeted to address significant evidence gaps or uncertainty, where there is potential for a significant environmental impact.
 - d. Proposals for monitoring should be based, where relevant, on the best practice and outcomes of the latest review of environmental data associated with post-consent monitoring of licence conditions of offshore wind farms (MMO, 2014).
 - e. The scope and design of all monitoring work should be finalised and agreed following review of the results of any preceding survey and/or monitoring work (i.e. an adaptive approach), including those surveys conducted in support of the environmental impact assessment. This includes the potential for survey requirements to be adapted based on the results of the monitoring outlined in this document.

3 NORFOLK VANGUARD RESIDUAL IMPACTS

12. The Environmental Impact Assessment (EIA) predicts the residual impact to a species or features taking into account:
 - Linkages using the source > pathway > receptor model;
 - Embedded / Additional Mitigation;
 - Sensitivity to the effect;
 - Magnitude of the effect; and
 - Ecological / economic importance.
13. For each receptor the residual impacts and key areas of uncertainty as predicted within the Norfolk Vanguard ES are outlined in Section 4.
14. The significance of the residual impact should not in its own right necessarily lead to the requirement for monitoring. Monitoring should be targeted to address significant evidence gaps or uncertainty, where there is potential for a significant environmental impact

4 IN PRINCIPLE PROPOSALS FOR MONITORING

15. The following sections set out the in principle proposals for monitoring in relation to those topics and/or receptor groups assessed in the ES. Appendix 1 provides cross references to the relevant conditions within the respective DMLs.
16. While accepting that this IPMP represents the best approach to monitoring available at the time of writing, it is recognised that the outcomes of the survey work discussed could influence future monitoring requirements, methodologies, focus and effort for the project, as knowledge and understanding develops. For example where appropriate, and in consultation with the MMO and its SNCBs, these scopes may be refined to consider other relevant studies carried out by neighbouring projects such as East Anglia THREE. This is a key principle for an adaptive approach to monitoring and will be the subject of ongoing consultation between the Applicant, the MMO and its SNCBs. It is recognised that the MMO has the ability to vary the DML conditions in this regard.
17. This document will be used as a basis for further discussions post consent.

4.1 Engineering and Design Related Monitoring

18. In addition to the environmental survey and monitoring required as conditions of the DMLs within the Development Consent Order (DCO), additional studies will be undertaken for the project for engineering and design purposes. Some of these will overlap with the conditioned monitoring and wherever possible the Applicant will look to combine surveys for monitoring purposes with those already being carried out for engineering purposes. Examples of these surveys are:
 - Geophysical;
 - Geotechnical;
 - Unexploded ordnance (UXO) survey and clearance; and
 - Cable burial survey.

4.2 Marine Geology Oceanography and Physical Processes

4.2.1 Conclusions of the Environmental Statement

19. The ES concludes no impact would be greater than negligible significance for the project alone or cumulatively.
20. At the landfall, the Horizontal Directional Drills (HDDs) will exit at offshore locations, away from the beach, seaward of the low water mark. Cable protection at each exit point is likely to consist of one mattress (6m long, 3m wide and 0.3m high) and rock protection (up to 5m long, 5m wide and 0.5m high). The cables themselves would be

buried at the landfall throughout the operational life of the project. This design would have limited effect on bedload sediment transport, and hence the magnitude of effect predicted in the ES is negligible, with no impact predicted on the East Anglian coast morphological receptor.

4.2.2 In Principle Monitoring

21. The Applicant would propose to undertake a post construction survey of the offshore and nearshore area(s) within the order limits using appropriate high resolution bathymetric and side-scan equipment (required under Condition 20(2)(b) of the Generation DMLs (DCO Schedules 9 and 10) and Condition 15(2)(b) of the Transmission DMLs (DCO Schedules 11 and 12)). This information would also help inform the interpretation of the benthic monitoring campaign (see section 4.3).
22. Monitoring of the section of the offshore cable corridor which overlaps with the Haisborough, Hammond and Winterton Special Area of Conservation (SAC) will be addressed in the Haisborough, Hammond and Winterton SAC Site Integrity Plan (SIP) required under Condition 9(1)(m) of the Transmission DMLs (Schedules 11 and 12) in accordance with the Outline Haisborough, Hammond and Winterton SAC SIP (document 8.20).
23. The following table provides information on the monitoring requirements for marine physical processes. The proposed monitoring will be discussed and agreed with the MMO in consultation with the relevant Statutory Nature Conservation Body (SNCB).

Table 4.1 In principle monitoring proposed – Marine Geological and Physical Processes

Potential Effect	Receptor/s	Phase	Headline reason/s for monitoring	Monitoring Proposal	Details
Changes in seabed topography, including scour processes	Physical environment and lined receptor groups e.g. marine ecology	Pre-construction	<ul style="list-style-type: none"> Engineering and design purposes Input in to benthic and other related ecological surveys and monitoring requirements as agreed with the MMO in consultation with SNCBs 	A single survey within the agreed array and cable corridor survey areas using full sea floor coverage swath-bathymetric undertaken to IHO S44ed5 Order 1a standard and side-scan surveys of the area(s) within the order limits in which it is proposed to carry out construction works, including a 500m buffer area around the site of each works. (The “site of each works” being the area within the order limits which is actually taken forwards to construction noting that it is possible that certain areas within the order limits may not be developed.)	Scope of surveys and programmes and methodologies for the purposes of monitoring shall be submitted to the MMO for written approval in accordance with the timescales required by the DMLs.
		Post-construction	<ul style="list-style-type: none"> Structural integrity / engineering (scour) Cable burial Monitoring of recovery of Annex 1 Sandbanks at the location of pre-sweeping (if used) within the Haisborough, Hammond and Winterton SAC – details to be addressed in the Haisborough, Hammond and Winterton SAC SIP (document 8.20) 	<p>A single survey within the agreed array and cable corridor survey areas using full sea floor coverage swath-bathymetric surveys undertaken to IHO S44ed5 Order 1a standard and side scan sonar surveys around appropriate samples of adjacent infrastructure to assess any changes in seabed topography. For this purpose the undertaker will, prior to the first such survey, submit a desk based assessment (which takes account of all factors which influence scour) to identify the sample of adjacent turbines with greatest potential for scour. The survey will be used to validate the desk based assessment. Further surveys may be required at a frequency to be agreed with the MMO (e.g. 3 years non-consecutive e.g. 1, 3 and 6 years or 1, 5 and 10 years). If evidence of recovery is recorded and agreed with the MMO, monitoring will cease.</p> <p>The quantity of turbines subject to monitoring will be confirmed following the completion of detailed design studies and in consultation with the MMO and relevant SNCBs.</p>	

4.3 Benthic and Intertidal Ecology

4.3.1 Conclusions of the Environmental Statement

24. The ES concludes no impact would be greater than minor adverse for the project alone or cumulatively. The offshore cable corridor runs through the Haisborough, Hammond and Winterton SAC. Annex I Sandbanks and potential *Sabellaria spinulosa* reef was recorded during the site specific surveys (Fugro, 2016).

4.3.2 In Principle Monitoring

25. The following table provides information on the monitoring requirements for benthic ecology. Pre-construction and post-construction surveys would be targeted to areas where construction activities are planned and where there is deemed to be potential for Annex 1 habitats based on relevant available data. Monitoring of the section of the offshore cable corridor which overlaps with the Haisborough, Hammond and Winterton SAC would be addressed in the Haisborough, Hammond and Winterton SAC SIP required under Condition 9(1)(m) of the Transmission DMLs (Schedules 11 and 12), in accordance with the Outline Haisborough, Hammond and Winterton SAC SIP (document 8.20).
26. The proposed monitoring will be discussed and agreed with the MMO in consultation with the relevant SNCB. Where possible, synergies with monitoring commitments made in sections 4.1 and 4.2 would be explored in interpreting geophysical data.

Table 4.2 In principle monitoring proposed – Benthic Ecology

Potential Effect	Receptor/s	Phase	Headline reason/s for monitoring	Monitoring Proposal	Details
Effects on <i>Sabellaria spinulosa</i> reef	<i>S. spinulosa</i> reef	Pre-construction	Determine the location and extent of any <i>S. spinulosa</i> reef within areas of the order limits in which it is proposed to carry out construction works to inform the appropriate mitigation if found	<ul style="list-style-type: none"> A single geophysical (sidescan or Multi-Beam Echo Sounder) survey of those areas within which it is proposed that seabed works will be carried out at a resolution sufficient to identify potential <i>S. spinulosa</i> reef; and In areas where potential <i>S. spinulosa</i> reef is identified from the review of the geophysical data, further survey e.g. drop down video will be deployed to confirm presence, extent and elevation. 	<ul style="list-style-type: none"> Survey programmes and methodologies for the purposes of monitoring shall be submitted to the MMO for written approval in accordance with the timescales required by the DMLs. at least 6 months prior Surveys may occur up to 12 months prior to the proposed construction works
		Post-construction	The requirement for post-construction monitoring will be dependent on the findings of the pre-construction surveys.	<ul style="list-style-type: none"> A survey to determine any change in the location, extent and composition of any benthic habitats of conservation, ecological and/or economic importance constituting Annex 1 reef habitats identified in the pre-construction survey in the parts of the Order limits in which construction works were carried out. The survey design must be informed by the results of the pre-construction benthic survey. Where no <i>S. spinulosa</i> reef is identified by the pre-construction geophysical survey of the proposed works (and associated buffers), no further post-construction surveys will be undertaken; Where <i>S. spinulosa</i> reef is identified during the baseline survey and cannot be entirely avoided through micro-siting, post-construction survey(s) will be undertaken, at a frequency to be agreed with the MMO (e.g. 3 years non-consecutive e.g. 1, 3 and 6 years 	<ul style="list-style-type: none"> If required, survey programmes and methodologies for the purposes of monitoring shall be submitted to the MMO for written approval in accordance with the timescales required by the DMLs. The survey will be conducted within the first year post commissioning of the proposed wind farm. If significant impacts are observed the potential requirement for further surveys will be agreed with the MMO following review of the post-construction survey.

Potential Effect	Receptor/s	Phase	Headline reason/s for monitoring	Monitoring Proposal	Details
				or 1, 5 and 10 years). If evidence of recovery is available and agreed with the MMO, monitoring will cease. Surveys will specifically target those reefs identified in the baseline survey will be undertaken as a check on their condition using the same methodology set out for pre-construction monitoring, to be agreed with the MMO.	

4.4 Fish and Shellfish Ecology

4.4.1 Conclusions of the Environmental Statement

27. Alone and cumulatively, no moderate or major residual impacts are predicted for Norfolk Vanguard.

4.4.2 In Principle Monitoring

28. The applicant has considered the Guiding Principles set out in section 2 (specifically (b) and (c) and in the case of fish and shellfish ecology it is proposed that no further monitoring or independent surveys are required.
29. Underwater noise monitoring (Section 4.6) is of relevance to Fish Ecology and if, in the opinion of the MMO, the assessment shows significantly greater impacts to those assessed in the ES, further consideration would be given to Monitoring and Mitigation for Fish Ecology, where appropriate.

4.5 Marine Mammals

4.5.1 Conclusions of the Environmental Statement

30. At the project level, impacts from Norfolk Vanguard are assessed as negligible or minor adverse as a result of construction, operation and decommissioning. However, when the assessment took into account other offshore wind farms that could be constructed at the same time, there is potential for significant cumulative impacts prior to mitigation for harbour porpoise and grey seal as a result of all underwater construction noise, including piling. The Norfolk Vanguard contribution to the cumulative impacts from all noise sources is approximately 11% of the total number of harbour porpoise and grey seal predicted to be affected by disturbance impacts and therefore mitigation and monitoring at a project alone level may not be appropriate.
31. An outline Marine Mammal Mitigation Protocol (MMMP) (document 8.13) and In Principle SIP (document 8.17) is provided with the DCO application (required under Conditions 19(5) and 14(1)(m) of the Generation DML and Condition 9(1)(l) and 14(3) of the Transmission DML). These form the framework for developing and agreeing mitigation and monitoring measures, with the SIP focussing on reducing the potential disturbance in relation to the Southern North Sea SAC. In order to address the overall cumulative impact, Norfolk Vanguard Limited is committed to working with SNCBs, the MMO and other developers to establish a possible strategic approach to mitigation and monitoring.

4.5.2 In Principle Monitoring

32. As recognised by the MMO (2014), monitoring should be targeted to address significant risk, evidence gaps or uncertainty, which are relevant to the project and can be realistically filled (section 2 (c)). Given the small contribution that Norfolk Vanguard has to impacts on marine mammals there may be little purpose or advantage in any site specific monitoring and therefore a strategic approach may be more appropriate in providing answers to specific questions where significant environmental impacts have been identified at a cumulative/in-combination level. If a strategic approach is adopted, the methodology and reporting requirements would be agreed with the MMO to ensure the requirements for Norfolk Vanguard are delivered.
33. Vattenfall (the parent company of Norfolk Vanguard Limited) is leading the Disturbance Effects on Harbour Porpoise of the North Sea (DEPONS) project and is supportive of other industry initiatives such as the Offshore Renewables Joint Industry Programme (ORJIP).
34. At the time of finalisation of the monitoring plan prior to construction, consideration would be given to any wider benefits from additional surveys as appropriate within the order limits of Norfolk Vanguard or in the wider Southern North Sea.
35. In addition, underwater noise monitoring (Section 4.6) is of relevance to Marine Mammals and if, in the opinion of the MMO, the assessment shows significantly greater impacts to those assessed in the ES, further consideration will be given to Monitoring and Mitigation for marine mammals.
36. Norfolk Vanguard Limited will follow the latest relevant guidelines and scientific evidence at the time, in relation to a strategic approach to construction and monitoring in development of the MMMP and SIP. A draft MMMP (document 8.13) and In Principle SIP (document 8.17) are provided with the DCO application, which will be finalised prior to construction with input from the contractor and in agreement with the MMO in consultation with the SNCBs.

Table 4.3 In principle monitoring proposed – Marine Mammals

Potential Effect	Receptor/s	Phase	Headline reason/s for monitoring	Monitoring Proposal	Details
Disturbance effects on harbour porpoise	Harbour porpoise	Construction	Ensure best practice is followed to minimise risk of injury or death to marine mammals	<ul style="list-style-type: none"> The Applicant will follow the relevant guidelines at the time in relation to a strategic approach to construction and monitoring in the development the MMMP and SIP. The particulars of deployment will be determined subsequent to appointment of the contractor in the pre-construction stage and with consideration of best available techniques at that time. 	<ul style="list-style-type: none"> The Applicant has submitted and agreed a draft MMMP as part of the ES submission The DMLs set out certain timescales in advance of commencement of the licensed activities, by when the MMP and SIP must be submitted to the MMO for their approval.

4.6 Underwater Noise

4.6.1 Conclusions of the Environmental Statement

37. There is variability and uncertainty in the extent of underwater noise impacts due to the range of threshold criteria used in the assessment (as requested by SNCBs).
38. In addition, varying seabed bathymetry, maximum piling hammer energies and proposed pile sizes provide variability in the impact ranges. Data from previous monitoring of 7m diameter piles, the largest where measured data is available, have been used for the monopile modelling and piles of approximately 4m diameter were used in the pin-pile modelling. The modelling considers the frequency content associated with pile sizes based on available data¹ and assumes the trends would continue to the larger piles of up to 15m diameter under consideration for the monopiles at Norfolk Vanguard.

4.6.2 In Principle Monitoring

39. Construction noise monitoring would be required if piled foundations are used (in accordance with Condition 19(2) of the Generation DMLs (Schedule 9 and 10 of the DCO)). Monitoring would include measurements of noise generated by the installation of the first four piled foundations of each piled foundation type to be installed in order to validate the assumptions made within the ES.
40. Noise measurements will be made in line with Good Practice Guide (2014) – Deployment for noise measurement and full specifications will be provided in the final monitoring plan.
41. Underwater data will be recorded in a format that allows comparison with the EIA underwater noise modelling with analysis using un-weighted metrics, such as peak sound pressure level, sound exposure level and peak to peak pressure level. All conclusions and discussions will be made in relation to the un-weighted metrics.
42. In addition, the requirements of the UK Marine Noise Register will be adhered to. This would cover registering geophysical survey activities (see section 4.1) as well as impact pile driving.

¹ Monopiles contain more low frequency content and the pin piles contain more high frequency content due to the dimensions and acoustics of the pile

Table 4.4 In principle monitoring proposed – Underwater Noise

Potential Effect	Receptor/s	Phase	Headline reason/s for monitoring	Monitoring Proposal	Details
Injury / disturbance to marine ecology	Marine ecology	Construction	Reduce uncertainty in impact assessment	<p>If piled foundations are used during the construction of Norfolk Vanguard:</p> <p>Compare the measured data, from the first four piles of each type (e.g. monopile or pin-pile), with predictions for received levels, source levels that were made in the ES. A Sound Exposure Level plot based on the noise modelling in the ES will be produced and agreed with the MMO prior to construction to allow comparison of the ES predictions and measured data during construction.</p>	<p>Survey programmes and methodologies for the purposes of monitoring shall be submitted to the MMO for written approval in accordance with the timescales required by the DMLs.</p> <p>Information will also be gathered and processed in accordance with UK Noise Registry requirements if appropriate at the time of construction.</p> <p>The results of the initial noise measurements must be provided to the MMO within six weeks of the installation of the first four piled foundations of each piled foundation type. The assessment of this report by the MMO will determine whether any further noise monitoring is required.</p> <p>If, in the opinion of the MMO in consultation with the relevant SNCB, the assessment shows significantly different impacts to those assessed in the ES or failures in mitigation, all piling activity must cease until an update to the MMMP and further monitoring requirements have been agreed.</p>

4.7 Offshore Ornithology

4.7.1 Conclusions of the Environmental Statement

- 43. At the project level, impacts from Norfolk Vanguard are assessed as negligible or minor adverse as a result of construction, operation and decommissioning.
- 44. The cumulative assessment identified that most impacts would be temporary, small scale and localised. Given the distances to other activities in the region (e.g. other offshore wind farms and aggregate extraction) and the highly localised nature of the potential impacts, it is concluded that there is no pathway for interaction between most impacts cumulatively.
- 45. The cumulative collision risk impact and displacement impact assessment determined that the risk to birds is no greater than minor adverse significance for all species.

4.7.2 In Principle Monitoring

- 46. Vattenfall (as the parent company of Norfolk Vanguard Limited) have a proven commitment to ornithological monitoring of offshore wind farms and improving understanding of potential impacts (e.g. through the European Offshore Wind Deployment Centre research projects) and will maintain this in relation to Norfolk Vanguard.
- 47. The aims of monitoring should be to reduce uncertainty for future impact assessment and address knowledge gaps. To this end, Norfolk Vanguard Limited will engage with stakeholders and the methodology would be developed through the Ornithological Monitoring Plan (required under Condition 14(1)(I) of the Generation DMLs (Schedule 9 and 10 of the DCO)). As for marine mammals (section 4.5), there may be little purpose or advantage in any site specific monitoring for offshore ornithology and therefore a strategic approach may be more appropriate in providing answers to specific questions where significant environmental impacts have been identified at a cumulative/in-combination level.
- 48. Aspects for consideration will include collision risks (e.g. improvements to modelling, options for mitigation and reduction), displacement (e.g. understanding the consequences of displacement) and improving reference population estimates and colony connectivity.

4.8 Commercial Fisheries

4.8.1 Conclusions of the Environmental Statement

49. The impacts on commercial fisheries during the construction, operation and decommissioning phases of Norfolk Vanguard would be of negligible or minor adverse residual significance to commercial fisheries.

4.8.2 In Principle Monitoring

50. The DMLs include the requirement for a Fisheries Liaison and Co-existence Plan (Condition 14(1)(d)(v) of the Generation DMLs (Schedule 9 and 10 of the DCO) and Condition 9(1)(d)(v) of the Transmission DMLs (Schedule 11 and 12 of the DCO) to ensure relevant fishing fleets are notified of commencement of licensed activities and to address the interaction of the licensed activities with fishing activities. An outline Fisheries Liaison and Co-existence Plan was submitted as part of the Examination at Deadline 2 (document 8.19). No further monitoring of commercial fisheries is proposed.

4.9 Shipping and Navigation

4.9.1 Conclusions of the Environmental Statement

51. The effects of the project have been assessed in Chapter 15 of the ES and in the Navigation Risk Assessment (Appendix 15.1 of the ES), with impacts ranging from ‘no perceptible effect’ to ‘tolerable with mitigation/as low as reasonably possible (ALARP)’.

4.9.2 In Principle Monitoring

52. Vessel traffic monitoring would be required using Automatic Identification System (AIS) equipment during both construction Condition 19 (4) of the Generation DML and operation Condition 20 (2)(d) of the Generation DML as specified in the Outline Navigation Monitoring Strategy (document 8.18). Table 4.5 provides information on the vessel traffic monitoring requirements for shipping and navigation.

Table 4.5 In principle monitoring proposed – Shipping and Navigation

Potential Effect	Receptor/s	Phase	Headline reason/s for monitoring	Monitoring Proposal	Details
Effects on the levels of marine traffic across the project	Marine traffic	Construction	Validate the predictions made in the Environmental Statement and Navigation Risk Assessment with respect to potential effects on the levels of shipping traffic.	Construction monitoring shall include vessel traffic monitoring by Automatic Identification System (AIS), including the provision of reports on the results of that monitoring periodically as requested by the Maritime and Coastguard Agency (MCA).	Post-construction vessel traffic monitoring using AIS will be undertaken for a maximum of 28 days, although not necessarily consecutive, and will take account of seasonal variation of traffic patterns over a year. This will be done at a suitable time as agreed with the MMO and MCA following the commencement of commercial operation.
		Post-construction		Vessel traffic monitoring by AIS, totalling a maximum of 28 days taking account of seasonal variations in traffic patterns over one year, following the commencement of commercial operation. A report will be submitted to the MMO and the MCA following the end of the monitoring.	

4.10 Offshore Archaeology and Cultural Heritage

4.10.1 Conclusions of the Environmental Statement

53. The construction, operation and decommissioning phases of Norfolk Vanguard would result in a range of effects upon the marine archaeological and cultural heritage environment. For the project alone the effects that have been assessed are anticipated to be minor adverse or negligible on the basis of embedded mitigation. Furthermore, known archaeological receptors are not considered to be subject to significant cumulative impacts on the basis that they would be avoided where possible due to appropriate mitigation.

4.10.2 In Principle Monitoring

54. The following table provides information on the monitoring requirements for marine archaeology and cultural heritage. The principal mechanism for delivery of monitoring is through agreement on the offshore Written Scheme of Investigation (WSI) (as required under Condition 14(h) of the Generation DML and Condition 9 (h) of the Transmission DML) and will be agreed with the MMO in consultation with Historic England. An outline WSI (document 8.6) has been submitted with the DCO application.

Table 4.6 In principle monitoring proposed – Offshore Archaeology and Cultural Heritage

Potential Effect	Receptor/s	Phase	Headline reason/s for monitoring	Monitoring Proposal	Details
All direct and indirect effects on the archaeological resource	All Archaeology receptors	Pre-construction	To inform selection of appropriate mitigation.	<p>An outline offshore WSI has been compiled which makes provision for all archaeological mitigation that might be required in the light of preconstruction investigations, including the archaeological assessment of marine survey data, reporting, archiving and dissemination of results. It is anticipated that the WSI will be updated and finalised post-consent in consultation with Historic England to take account of any specific survey consideration or updates to design.</p> <p>Pre-construction surveys will include swath-bathymetric surveys and side-scan surveys of the area(s) within the order limits in which it is proposed to carry out construction works, including a 500m buffer area around the site of each works. This should include the investigation and identification of seabed features of known (A1) and potential (A2) archaeological interest within the survey areas and which may require the refinement, removal or introduction of archaeological exclusion zones and to confirm project specific micro-siting requirements. Where possible, this will be combined with geophysical surveys required for other receptors (see sections 4.1, 4.2 and 4.3).</p>	Norfolk Vanguard Limited has submitted an outline WSI with the DCO application. This will be submitted to the MMO for written approval in accordance with the timescales required by the DMLs.

Potential Effect	Receptor/s	Phase	Headline reason/s for monitoring	Monitoring Proposal	Details
All direct and indirect effects on the archaeological resource	All Archaeology receptors	Construction	To allow appropriate mitigation.	Specific requirements relating to monitoring during construction (including a conservation programme for finds) as detailed in the WSI. Notably the Offshore Renewables Protocol for Archaeological Discoveries (ORPAD) shall be followed during all intrusive works	The WSI will be submitted to the MMO for written approval in accordance with the timescales required by the DMLs.

5 REFERENCES

Cefas. (2012) Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects. Cefas contract report: ME5403 – Module 15.

Department for Communities and Local Government. (2014) Available at: <http://planningguidance.planningportal.gov.uk/blog/guidance/use-of-planning-conditions/application-of-the-six-tests-in-nppf-policy>

Fugro (2016) Environmental Investigation Report; Norfolk Vanguard Benthic Characterisation Survey. Appendix 10.1 of the Norfolk Vanguard Environmental Statement

Glasson J, Therivel R, Chadwick A. 2011. Introduction to Environmental Impact Assessment. 4th edition. The Natural and Built Environment Series.

MMO. (2014) Review of post-consent offshore wind farm monitoring data associated with licence conditions. A report produced for the Marine Management Organisation, pp 194. MMO Project No: 1031. ISBN: 978-1-909452-24-4.

OSPAR. (2008) Guidance on Environmental Considerations for Offshore Wind Farm Development. Available at: http://www.ospar.org/v_measures/get_page.asp?v0=08-03e_Consolidated%20Guidance%20for%20Offshore%20Windfarms.doc&v1=5

APPENDIX 1: RELEVANT DML CONDITIONS

Subject	Relevant DML Condition			
	Schedule 9 Generation Licence – Phase 1	Schedule 10 Generation Licence – Phase 2	Schedule 11 Transmission Licence – Phase 1	Schedule 12 Transmission Licence – Phase 2
Marine geological and physical processes bathymetric (Pre-construction)	18(2)(b)	18(2)(b)	13(2)(b)	13(2)(b)
marine geological and physical processes bathymetric(Post-construction)	20(2)(b)	20(2)(b)	15(2)(b)	15(2)(b)
Benthic <i>S. spinulosa</i> reef (Pre-construction)	18(2)(a)	18(2)(a)	9(1)(m) 13(2)(a)	9(1)(m) 13(2)(a)
Benthic <i>S. spinulosa</i> reef (Post-construction)	20(2)(a)	20(2)(a)	15(2)(a)	15(2)(a)
Marine mammals/ MMMP (Construction)	14(1)(f) 19(5)	14(1)(f) 19(5)	9(1)(f) 14(3)	9(1)(f) 14(3)
Offshore ornithology/OMP	14(1)(l) 18(c)	14(1)(l) 18(c)	N/A	N/A

(Pre-construction)				
Offshore ornithology/OMP (Post-construction)	14(1)(l) 20(c)	14(1)(l) 20(c)	N/A	N/A
Piling underwater noise (Construction)	19(1)	19(1)	N/A	N/A
Shipping and navigation (Construction)	19(4)	19(4)	N/A	N/A
Shipping and navigation (Post-construction)	20(3)	20(3)	N/A	N/A
Archaeology and cultural heritage (Pre-construction)	14(h)(v)	14(h)(v)	9(h)(v)	9(h)(v)
Archaeology and cultural heritage (Construction)	14(h)(v)	14(h)(v)	9(h)(v)	9(h)(v)