

Norfolk Vanguard Offshore Wind Farm Draft Marine Mammal Mitigation Protocol

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Glossary

ADD	Acoustic Deterrent Device
cSAC	candidate Special Area of Conservation
DCO	Development Consent Order
EIA	Environmental Impact Assessment
ELO	Environmental Liaison Officer
EPS	European Protected Species
ES	Environmental Statement
JNCC	Joint Nature and Conservation Committee
kJ	Kilojoules
km	Kilometre
Km ²	Kilometre squared
m	Metre
m/s	Metres per second
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MMOs	Marine Mammal Observers
NS	North Sea
NV East	Norfolk Vanguard East
NV West	Norfolk Vanguard West
OEP	Offshore electoral platforms
OWF	Offshore Wind Farm
PAM	Passive Acoustic Monitoring
PTS	Permanent Threshold Shift
SEL	Sound Exposure Level
SEL _{cum}	Cumulative Sound Exposure Level
SIP	Site Integrity Plan
SNCB	Statutory Nature Conservation Body
SNS	Southern North Sea
UK	United Kingdom
VWPL	Vattenfall Wind Power Limited

Terminology

Array cables	Cables which link the wind turbine generators and the offshore electrical platform.
Interconnector cables	Buried offshore cables which link offshore electrical platforms.
Landfall	Where the offshore cables come ashore.
Offshore accommodation platform	A fixed structure (if required) providing accommodation for offshore personnel. An accommodation vessel may be used instead.
Offshore cable corridor	The area where 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 turbine generators and convert it into a more suitable form for export to shore.
Offshore export cables	The cables which transmit electricity from the offshore electrical platform to the landfall.
Offshore project area	The overall area of Norfolk Vanguard East, Norfolk Vanguard West and the provisional 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 Purpose of this document

1. The purpose of this draft Marine Mammal Mitigation Protocol (MMMP) for piling is to demonstrate the principles of the final MMMP to be submitted for approval as required under DCO Schedules 9 and 10 Condition [14(1)(f)] and Schedules 11 and 12 Condition [9(1)(f)] of the Deemed Marine Licences for Norfolk Vanguard, and to detail contingency arrangements to respond to and minimise the impacts of piling associated with the construction of Norfolk Vanguard.
2. It should be noted that this draft MMMP is in relation to potential impacts of piling only. A MMMP for Unexploded Ordnance (UXO) would be developed in the pre-construction period prior to any UXO clearance activities, when there is more detailed information on the UXO clearance which could be required for Norfolk Vanguard. The UXO MMMP will take account of the most suitable mitigation measures, based upon best available information and methodologies at that time, in consultation with the relevant Statutory Nature Conservation Bodies (SNCBs) and the Marine Management Organisation (MMO).
3. DCO Schedules 9 and 10 Condition [14(1)(f)] and Schedules 11 and 12 Condition [9(1)(f)] states:

The licensed activities or any part of those activities must not commence until the following (as relevant to that part) have been submitted to and approved in writing by the MMO—

(f) In the event that piled foundations are proposed to be used, a marine mammal mitigation protocol, in accordance with the draft marine mammal mitigation protocol, the intention of which is to prevent injury to marine mammals and following current best practice as advised by the relevant statutory nature conservation bodies
4. This draft MMMP for piling sets out the protocol of how Norfolk Vanguard Limited would:
 - Mitigate impacts assessed in the Environmental Impact Assessment (EIA) to reduce the likelihood of injury to marine mammals as a result of underwater noise during underwater piling operations; and
 - Meet the relevant licence condition ([14(1)(f)] and [9(1)(f)], as stated above).
5. The DMLs set out certain timescales in advance of commencement of the licensed activities, by when the MMMP must be submitted to the MMO for their approval. Norfolk Vanguard Limited will follow the relevant guidelines at the time in relation to

a strategic approach to construction and monitoring and the development of the final MMMP for piling as detailed in the In Principle Monitoring Plan (see document 8.12).

2 DESCRIPTION OF PROJECT

6. Norfolk Vanguard Limited (an affiliate company of Vattenfall Wind Power Ltd (VWPL), 'the Applicant') is proposing to develop Norfolk Vanguard, an offshore wind farm (OWF) in the southern North Sea.
7. 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.
8. Once built, Norfolk Vanguard would have a 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.
9. The key onshore components of the project are as follows:
 - Landfall;
 - Onshore cable route, accesses, trenchless crossing (e.g. Horizontal Directional Drilling (HDD)) zones and mobilisation areas;
 - Onshore project substation; and
 - Extension to the Necton National Grid substation and overhead line modifications.
10. 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.
11. The detailed design of Norfolk Vanguard (e.g. numbers of wind turbines, layout configuration, foundation type and requirement for scour protection) would not be determined until post-consent. Therefore, realistic worst case scenarios in terms of

potential impacts/effects are adopted to undertake a precautionary and robust impact assessment.

12. Within Norfolk Vanguard, several different sizes of wind turbine are being considered in the range of 10MW and 20MW. In order to achieve the maximum 1,800MW installed capacity, there would be between 90 (20MW) and 180 (10MW) wind turbines.
13. In addition, up to two offshore electrical platforms, two accommodation platforms, two meteorological masts, two LiDAR platforms and two wave buoys, plus a network of up to 600km of offshore cables are considered as part of the worst-case scenario.
14. Norfolk Vanguard Limited is considering constructing the project in either a single phase of up to 1800MW or in two phases (up to a maximum of 1800MW).
15. The full construction window is expected to be up to four years for the full 1,800MW capacity and offshore construction would be anticipated to commence around 2024. Chapter 5 Project Description provides indicative construction programmes for the single phase and two phase options.

2.1 Key relevant project characteristics and worst-case scenarios

Parameter	Characteristic
Capacity	Up to 1,800MW
Lease period	50 years
Indicative construction duration	4 years
Anticipated design life	Approx. 30 years
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
Number of wind turbines	180 (10MW turbines); to 90 (20MW turbines)
Number of other offshore platforms	2 x Offshore electrical platforms (OEP) 2 x Met masts 2 x LiDAR 2 x Accommodation platforms

Parameter	Characteristic
Number of piles per foundation	1 (monopile). 3 (tripod with pin-piles of the same diameter as the quadropod and therefore this will not be the worst-case scenario). 4 (quadropod with pin-piles). 6 legged jacket – OCP and accommodation platforms only.
Maximum number of piles - Wind turbines	180 x 4 (10MW quadropod) = 720
Maximum number of piles - Other offshore platforms	2 x OCP with 6 piles = 12 2 x Met masts quadropod = 8 2 x LiDAR monopile = 2 2 x Accommodation platform with 6 piles = 12 Total = 34
Hammer energies	Maximum hammer energy: <ul style="list-style-type: none"> • 2,700kJ pin-pile • 5,000kJ monopile Starting hammer energies of 10% will be used followed by ramp-up to the maximum hammer energy.
Pile diameter	<ul style="list-style-type: none"> • 10m (10MW monopile) • 3m (10MW pin-pile) • 15m (20MW monopile) • 5m (20MW pin-pile)
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; • Gravity Base; or •
Met mast 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.
Offshore platform (electrical and accommodation) foundation type options	<ul style="list-style-type: none"> • Piled monopile; • Suction caisson monopile; • Piled tripod or quadropod; and • Suction caisson tripod or quadropod.
Buoys	<ul style="list-style-type: none"> • LiDAR, wave and guard buoys may be deployed.
Number of concurrent piling events	2

3 BACKGROUND

16. Norfolk Vanguard Limited has made an assessment of potential impacts to marine mammals as part of the Environmental Impact Assessment which is reported in Chapter 12 (Marine Mammals) of the Environmental Statement (document 6.1).
17. At a project level, the potential impacts from Norfolk Vanguard, based on the worst-case scenarios, are assessed as **minor adverse** (not significant) for any permanent auditory injury (Permanent Threshold Shift (PTS)) in harbour porpoise, grey seal and harbour seal as a result of underwater noise from a single strike of starting hammer energy or a single strike of maximum hammer energy, with or without mitigation. Permanent auditory injury (PTS) as a result of underwater noise during piling from cumulative exposure in harbour porpoise has been assessed as **moderate to minor adverse** without mitigation, and **minor adverse** with the mitigation measures implemented, as outlined below.
18. Piling has the potential to produce underwater noise capable of causing auditory injury and disturbance to marine mammals. This draft MMMP details how Norfolk Vanguard Limited would reduce the risk of underwater noise during piling causing auditory injury to marine mammals that could be present in and around the Norfolk Vanguard offshore wind farm site.
19. In addition to the draft MMMP, the In Principle Norfolk Vanguard Southern North Sea (SNS) candidate Special Area of Conservation (cSAC) Site Integrity Plan (SIP) (document reference 8.17) sets out the approach for Norfolk Vanguard Limited to deliver the required mitigation measures for the Norfolk Vanguard project to ensure the avoidance of significant disturbance of harbour porpoise in relation to the Southern North Sea cSAC site Conservation Objectives.
20. DCO Schedules 9 and 10 Condition [14(1)(m)] and Schedules 11 and 12 Condition [9(1)(l)] of the draft DCO states:

The licensed activities or any part of those activities must not commence until the following (as relevant to that part) have been submitted to and approved in writing by the MMO—

(m) In the event that piled foundations are proposed to be used, the licensed activities, or any phase of those activities must not commence until a site integrity plan which accords with the principles set out in the in principle Norfolk Vanguard Southern North Sea Special Area of Conservation Site Integrity Plan has been submitted to the MMO and the MMO is satisfied that the plan, provides such mitigation as is necessary to avoid adversely affecting the integrity (within the

meaning of the 2017 Regulations) of a relevant site, to the extent that harbour porpoise are a protected feature of that site.

4 DRAFT MARINE MAMMAL MITIGATION PROTOCOL

21. Norfolk Vanguard Limited is committed to using the best practicable means at the time of construction to mitigate the impacts of the project, as required, and their contribution to the cumulative impact.
22. The protocol outlined below is in line with current best practice and would be updated based on any updates to the underwater noise modelling and once the final construction methods for the project have been confirmed. The project will employ the most appropriate project related mitigation measures based on best knowledge, evidence and proven available technology at the time of construction. The DMLs set out certain timescales in advance of commencement of the licensed activities, by when the MMMP must be submitted to the MMO for their approval.
23. The final MMMP for piling will detail the required methodologies. Consideration will be given to the requirements following any breaks in piling as well as prior to piling commencing.

4.1 Mitigation zone

24. The MMMP would involve the establishment of a mitigation zone around the pile location before each pile driving activity based on the maximum predicted distance for permanent auditory injury (PTS).
25. Norfolk Vanguard Limited would ensure that the mitigation measures are adequate to minimise the risk of marine mammals being present within the mitigation zone prior to piling activity commencing, to reduce the risk of any physical or auditory injury.
 - The methods for achieving the mitigation zone would be agreed in consultation with Natural England and secured as commitments within the final MMMP for piling, based on the most suitable techniques and current guidance.

4.2 Soft-start and ramp-up

26. Norfolk Vanguard Limited would ensure that a soft-start and ramp-up procedure for piling is conducted for a minimum of 30 minutes. In the event that piling activity is stopped for more than 10 minutes, Norfolk Vanguard Limited would ensure that the soft-start and ramp-up procedure is conducted prior to piling re-commencing.
27. Each piling event would commence with a minimum of 10 minutes at 10% of the maximum hammer energy, followed by a gradual ramp-up for at least 20 minutes to the maximum hammer energy for all pile driving activities. This 30 minute soft start and ramp-up procedure is more precautionary than the current JNCC (2010)

guidance, which recommends that the soft-start and ramp-up duration should be a period of not less than 20 minutes.

28. During the 30 minutes for the soft-start and ramp-up it is estimated that marine mammals would move at least 2.7km from the piling location. This is based upon a precautionary average marine mammal swimming speed of 1.5m/s. This is very precautionary as based on a swimming speed of 1.8m/s which is more representative of a fleeing marine mammal the distance would be at least 3.2km (for example, Kastelein *et al.* (2018) recorded swimming speeds of 1.97m/s during playbacks of pile driving sounds).
- During the 10 minute soft-start it is estimated that marine mammals would move a minimum of 0.9km from the piling (based upon a precautionary average marine mammal swimming speed of 1.5m/s); and
 - During the 20 minute ramp-up it is estimated that marine mammals would move a minimum of 1.8km from the piling location (based upon a precautionary average marine mammal swimming speed of 1.5m/s).

4.3 Other mitigation measures

29. The MMMP for piling would be developed in the pre-construction period and based upon best available information and methodologies in consultation the MMO and relevant SNCBs. The MMMP for piling would include details of the embedded mitigation, for the soft-start, ramp-up and the mitigation zone in order to minimise potential impacts on physical and auditory injury to marine mammals, as well as details of any additional mitigation that could be required. This could include:
- The activation of acoustic deterrent devices (ADDs) prior to the soft-start; and / or
 - Monitoring of the mitigation zone by marine mammal observers (MMOs) during daylight hours and when conditions allow suitable visibility; and / or
 - Deployment of passive acoustic monitoring (PAM) device, if required, during hours of darkness and poor visibility.
30. The final MMMP for piling will detail all agreed mitigation measures, including provision for any breaks in piling and piling at night or in poor visibility, to ensure that the mitigation measures are successfully undertaken for all piling activity.

4.3.1 Example of mitigation measures

31. Based on the current predictive underwater noise modelling as presented in Chapter 12 (Marine Mammals) of the Environmental Statement (document 6.1):

- The maximum potential range for instantaneous PTS from a single strike of the starting hammer energy of 500kJ would be 0.42km for harbour porpoise and 0.02km for grey and harbour seal.
 - Mitigation, such as the activation of ADDs prior to the first strike of the soft-start would allow marine mammals to move away prior to the soft-start and ramp-up. For example, the activation of ADDs for 10 minutes prior to the soft-start would allow harbour porpoise and other marine mammals to move at least 0.9km from the piling location (based on a precautionary average marine mammal swimming speed of 1.5m/s), which is beyond the maximum PTS predicted impact range of 0.42km for the starting hammer energy of up to 500kJ. Therefore, after the ADD activation there should be no harbour porpoise, grey seal or harbour seal in the potential impact range for PTS from the first strike of the soft-start.
- The estimated maximum ranges (without mitigation) within which cumulative sound exposure level (SEL_{cum}) for PTS could occur in harbour porpoise is estimated to be 0.4km and 1.5km for the maximum hammer energy of the monopile (5,000kJ) and pin-pile (2,700kJ), respectively. The estimated maximum ranges (without mitigation) within which PTS SEL_{cum} could occur in grey and harbour seal is up to 2.4km for the maximum hammer energy of the monopile (5,000kJ) and up to 1.7km for the maximum hammer energy of the pin-pile (2,700kJ).

4.4 Reporting

32. Reports detailing the piling activity and mitigation measures would be prepared for all piling activity. This would include, but not necessary be limited to:
- A record of piling operations detailing date, location, times (including soft-starts and ramp-up) and any technical or other issues for each pile.
 - A record of mitigation measures such as ADD deployment, detailing date, location, times and any operational issues.
 - A record of all occasions when piling occurred, including details of the activities used to ensure the mitigation zone is established and any occasions when piling activity was delayed or stopped due to presence of marine mammals.
 - Any relevant details on the efficiency of the marine mammal exclusion methodology.
 - A record of marine mammal observations, conditions, description of any marine mammal sightings and any actions taken.
 - Details of any problems encountered during the piling process including instances of non-compliance with the agreed piling and / or mitigation protocol.

33. It is proposed that weekly reports will be collated and provided to the MMO on a monthly basis. In addition, a final report will be provided which will be submitted to the MMO. The final report will include any data collected during piling operations, details of ADD deployment and / or other mitigation measures, a detailed description of any technical problems encountered and what, if any, actions were taken. The report will also discuss the protocols followed and put forward any recommendations and lesson learned based on the mitigation measures used that could benefit future construction projects.

4.5 Communication and responsibilities

34. The final MMMP will detail the communication protocol to ensure that all marine mammal mitigation measures, including any delays in commencing piling due to marine mammals being present in the area, are successfully undertaken for all piling activity.
35. The final MMMP will also detail all key personnel and their responsibilities to ensure that all marine mammal mitigation measures are successfully undertaken for all piling activity. This will be developed based on the mitigation measures and personnel required (e.g. ADD operators, MMOs, PAM operators, Environmental Liaison Officer (ELO), Offshore Installation Manager) with the titles and responsibilities being refined depending on the contractual agreement.

5 REFERENCES

JNCC (2010) Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise. August 2010.

Kastelein, R.A., Van de Voorde, S, and Jennings, N. (2018) Swimming Speed of a Harbour Porpoise (*Phocoena phocoena*) During Playbacks of Offshore Pile Driving Sounds. *Aquatic Mammals*: 44(1):92-99.