

Norfolk Boreas Offshore Wind Farm Draft Marine Mammal Mitigation Protocol (Version 2) (Tracked Changes)

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Glossary of Acronyms

ADD	Acoustic Deterrent Device
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
LiDAR	Light Detection and Ranging
M	Metre
m/s	Metres per second
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MMOs	Marine Mammal Observers
MW	Megawatt
NS	North Sea
OEP	Offshore electoral platform
PAM	Passive Acoustic Monitoring
PTS	Permanent Threshold Shift
SAC	Special Area of Conservation
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
UXO	Unexploded Ordnance
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
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.
Norfolk Boreas site	The Norfolk Boreas wind farm boundary. Located offshore, this will contain the wind farm array.
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 refuelling facilities for helicopters. 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 sites.
Project interconnector search area	The area within which the project interconnector cables would be installed.
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 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 the draft Development Consent Order (DCO) Schedules 9 and 10 Condition 14(1)(f) and Schedules 11 and 12 condition 9(1)(f) of the Deemed Marine Licences (DML) for Norfolk Boreas, and to detail contingency arrangements to respond to and minimise the impacts of piling associated with the construction of Norfolk Boreas.
2. Condition 14(1)(f) of Schedules 11 and 12 (Generation DMLs) and Condition 9(1)(f) of Schedules 11 and 12 (Transmission DMLs) of the DCO state that the licensed activities must not commence until certain plans have been approved including:

(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.
3. It should be noted that this draft MMMP covers potential impacts of piling only. A MMMP for Unexploded Ordnance (UXO) clearance would be developed in line with a separate marine licence application in the pre-construction period prior to any UXO clearance activities, once there is more detailed information on the activities required for Norfolk Boreas. The UXO clearance MMMP will take account of the most suitable mitigation measures, based upon best available information and methodologies at that time and in consultation with the relevant Statutory Nature Conservation Bodies (SNCBs) and the Marine Management Organisation (MMO).
4. This draft MMMP for piling sets out the protocol of how Norfolk Boreas 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 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 Boreas 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 (document reference 8.12).

6. This document has been updated for Deadline 5 (26th February 2020) of the Norfolk Boreas examination to take account of a commitment to reduce the maximum number of turbines within the Norfolk Boreas site. This commitment will reduce the maximum number of piling events that could occur as well as reducing the overall duration over which piling could occur.

2 DESCRIPTION OF PROJECT

7. Norfolk Boreas Limited (an affiliate company of Vattenfall Wind Power Ltd (VWPL), ‘the Applicant’) is seeking a DCO for the proposed Norfolk Boreas project (herein ‘the project’ or ‘Norfolk Boreas’), an offshore wind farm in the southern North Sea.
8. The Norfolk Boreas site comprises of a 725km² 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 offshore wind farm 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.
9. Once built, Norfolk Boreas would comprise the following offshore components:
 - Wind turbines;
 - Offshore electrical platforms;
 - An offshore service platform;
 - Met masts;
 - Monitoring equipment including Light Detection and Ranging (LiDAR) and wave buoys;
 - Navigational buoys;
 - Array cables;
 - Interconnector cables project interconnector cables¹; and
 - Export cables.
10. The detailed design of Norfolk Boreas (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.
11. 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

¹ There may 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.

scenarios have no bearing on this document as the worst case for piling would be exactly the same regardless of which ever scenario is taken forward.

12. Within Norfolk Boreas, several different sizes of wind turbine are being considered in the range of 11.55MW and 20MW. In order to achieve the maximum 1,800MW export capacity, there would be between 90 (20MW) and 158 (11.55MW) wind turbines.
13. In addition, up to two offshore electrical platforms, one offshore service platform, two meteorological masts, two LiDAR installations, two wave buoys, a number of navigational buoys plus a network of up to 740km of offshore cables are considered as part of the worst-case scenario within the site.
14. Norfolk Boreas Limited is considering constructing the project in either a single phase of up to 1,800MW or in two phases (up to a maximum of 1,800MW). The layout of the wind turbines will be defined post consent.
15. The full construction window is expected to be up to three years for the full 1,800MW export capacity and offshore construction would be anticipated to commence around 2025. 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
Export capacity	Up to 1,800MW
Lease period	50 years
Indicative construction duration	3 years (preceded by up to 1 year pre-construction work)
Anticipated design life	Approx. 30 years
Norfolk Boreas site	725km ²
Offshore cable corridor area	226km ²
Water depth in the Norfolk Boreas site	20.4m to 42.8m below LAT
Distance from the Norfolk Boreas site to shore (closest point of site to the coast)	73km
Number of wind turbines	<ul style="list-style-type: none"> • 158 (11.55MW turbines); or • 90 (20MW turbines)
Number of other offshore platforms	<ul style="list-style-type: none"> • 2 x Offshore electrical platforms (OEP) • 2 x Met masts • 2 x LiDAR • 1 x Offshore Service platform
Number of piles per foundation	<ul style="list-style-type: none"> • 1 (monopile) or • 3 (TetraBase with pin-piles; or • 4 (quadropod with pin-piles). • 6 jacket foundation – offshore service platform.

Parameter	Characteristic
	<ul style="list-style-type: none"> • 18 Jacket foundation – offshore electrical platform
Maximum number of piles - Wind turbines	158 x 4 pin-piles (11.55MW quadropod) = 632
Maximum number of piles - Other offshore platforms	<ul style="list-style-type: none"> • 2 x OEP with 18 piles = 36 • 2 x Met masts quadropod = 8 • 2 x LiDAR monopile = 2 • 1 x offshore service platform with 6 piles = 6 Total = 52
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"> • 10.775m (11.55MW monopile) • 3m (11.55 MW 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 • TetraBase.
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 offshore service) foundation type options	<ul style="list-style-type: none"> • Six legged jacket - piled; • Six legged Jacket - suction caissons; • Four legged jacket – piled; • Four legged jacket suction caissons; or Gravity base
Buoys	<ul style="list-style-type: none"> • Up to two LiDAR, two wave buoys and a number of navigational buoys may be deployed.
Number of concurrent piling events	Two

3 BACKGROUND

16. Norfolk Boreas Limited has made an assessment of potential impacts to marine mammals as part of the EIA which is reported in Chapter 12 (Marine Mammals) of the Environmental Statement (document reference 6.1.12).
17. At a project level, the potential impacts from Norfolk Boreas, based on the worst-case scenarios of piling, are assessed as **minor adverse** (not significant in EIA terms) 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 **minor adverse** without mitigation, which remains as **minor adverse** with mitigation measures implemented, as outlined below.
18. It should, however, be noted that the commitment to reduce the maximum number of turbines from 180 to 158 was made after the EIA was completed and therefore the magnitude of impact from piling would be lower than that assessed within the EIA. However, the overall significance would remain as assessed (**minor adverse**).
19. Piling has the potential to produce underwater noise capable of causing auditory injury and disturbance to marine mammals. This draft MMMP details how Norfolk Boreas Limited would reduce the risk of underwater noise created during piling causing auditory injury to marine mammals that could be present in and around the Norfolk Boreas site.
20. In addition to the draft MMMP, the In Principle Norfolk Boreas Southern North Sea (SNS) Special Area of Conservation (SAC) Site Integrity Plan (SIP) (document reference 8.17) sets out the approach for Norfolk Boreas Limited to deliver the required mitigation measures for the Norfolk Boreas project to ensure the avoidance of Adverse Effect on Integrity to the designated features of the Southern North Sea SAC.
21. Within the Norfolk Boreas DCO, Condition 14(1)(m) of Schedules 9 and 10 and Condition 9(1)(l) of Schedules 11 and 12 state that the licensed activities must not commence until a number of plans are approved, including:

(m) In the event that piled foundations are proposed to be used, the licenced 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 Boreas Southern North Sea candidate 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

22. Norfolk Boreas 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.
23. 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.
24. 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

25. 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).
26. Norfolk Boreas 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

27. Norfolk Boreas 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 Boreas Limited would ensure that the soft-start and ramp-up procedure is conducted prior to piling re-commencing.
28. 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.

29. 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. An average swimming speed of 1.8m/s is more representative of a fleeing marine mammal which would result in a distance of at least 3.2km (for example, Kastelein *et al.* (2018) recorded swimming speeds of 1.97m/s during playbacks of pile driving sounds) however a level of precaution has been applied.
- 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

30. The MMMP for piling would be developed in the pre-construction period and be based upon best available information and methodologies in consultation with 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.
31. 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 Reduction in piling events and duration

32. Norfolk Boreas Limited have further mitigated underwater noise impacts by reducing the maximum number of turbines from 180 (assessed within the Application) to 158. This measure reduces the number of potential piling events, should monopiles be used, from 180 to 158 and, should pin piles be used, from 720 to 632 (in the event that quadrapod foundations are used).

4.3.2 Example of mitigation measures

33. Based on the current predictive underwater noise modelling as presented in Chapter 12 (Marine Mammals) of the Environmental Statement (document reference 6.1.12):

- The maximum potential range for instantaneous PTS from a single strike of the starting hammer energy of 500kJ would be 0.07km for harbour porpoise and less than 0.05km 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 0.07km 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 less than 0.1km and 0.3km 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 less than 0.1km for the maximum hammer energy of the monopile (5,000kJ) and less than 0.1km for the maximum hammer energy of the pin-pile (2,700kJ).

4.4 Reporting

34. Reports detailing the piling activity and mitigation measures would be prepared for all piling activity. This would include, but not necessarily 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.
35. 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 lessons learned based on the mitigation measures used that could benefit future construction projects.

4.5 Communication and Responsibilities

36. 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.
37. 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.