Hornsea 4

Ørsted

Hornsea Project Four: Preliminary Environmental Information Report (PEIR)

F2.5: Outline Marine Mammal Mitigation Protocol

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Glossary

Term	Definition
Commitment	A term used interchangeably with mitigation. Commitments are embedded mitigation measures. Commitments are either primary (design) or tertiary (Inherent) and embedded within the assessment at the relevant point in the Environmental Impact Assessment (EIA) (e.g. at Scoping or Preliminary Environmental Information Report (PEIR)). The purpose of Commitments are to reduce and/or eliminate Likely Significant Effects (LSEs), in EIA terms.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Projects (NSIP).
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Impact Assessment (EIA) Report.
High Voltage Alternating Current (HVAC)	High voltage alternating current is the bulk transmission of electricity by alternating current (AC), whereby the flow of electric charge periodically reverses direction.
Hornsea Four	The proposed Hornsea Project Four offshore wind farm project; the term covers all elements within the Development Consent Order (i.e. both the offshore and onshore components).
Maximum Design Scenario (MDS)	The maximum design parameters of each Hornsea Four asset (both on and offshore) considered to be a worst case for any given assessment.
Mitigation	A term used interchangeably with Commitment(s) by Hornsea Four. Mitigation measures (Commitments) are embedded within the assessment at the relevant point in the EIA (e.g. at Scoping or PEIR).
Most likely piling parameters	The definition of the hammer energy profile and the maximum hammer energy likely to be reached on the majority of pile installations.

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Commitment	A term used interchangeably with mitigation. Commitments are embedded mitigation measures. Commitments are either primary (design) or tertiary (Inherent) and embedded within the assessment at the relevant point in the Environmental Impact Assessment (EIA) (e.g. at Scoping or Preliminary Environmental Information Report (PEIR)). The purpose of Commitments are to reduce and/or eliminate Likely Significant Effects (LSEs), in EIA terms.
Permanent Threshold Shift (PTS)	Following a marine mammal's exposure to high noise levels, if a Threshold shift occurs and does not return to normal after several weeks then a Permanent Threshold Shift (PTS) has occurred. This results in a permanent auditory injury to the marine mammal.
Soft-start	The term 'soft-start' is applied to the gradual, or incremental, increase in hammer blow energy from the initiation of piling activity until required blow energy is reached for installation of each pile. Maximum hammer blow energy may not be required to complete pile installation.

Acronyms

Acronym	Definition
AC	Alternating Current
ADD	Acoustic Deterrent Device
BOWL	Beatrice Offshore Wind Farm
DCO	Development Consent Order
EIA	Environmental Impact Assessment
HF	High Frequency (HF) cetacean
JNCC	Joint Nature Conservation Committee
LF	Low Frequency (LF) cetacean
MDS	Maximum Design Scenario
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Mammal Observer
NSIP	Nationally Significant Infrastructure Project
ORJIP	Offshore Renewables Joint Industry Programme
OSS	Offshore Substation
PCW	Phocid Carnivores In Water
PEIR	Preliminary Environmental Information Report
PTS	Permanent Threshold Shift
SCI	Site of Community Importance
SNCB	Statutory Nature Conservation Bodies
VHF	Very High Frequency (VHF) cetacean
WTG	Wind Turbine Generators

Units

Unit	Definition
dB	Decibel
m	Metre
ms^{-1}	Metres per second
km	Kilometre
kJ	Kilojoules
µPa	Micropascal

1 Introduction

1.1 Project background

1.1.1.1 Ørsted Hornsea Project Four Limited (the Applicant) is proposing to develop Hornsea Project Four offshore wind farm (hereafter Hornsea Four) which will be located approximately 65 km offshore the East Riding of Yorkshire in the Southern North Sea and will be the fourth project to be developed in the former Hornsea Zone.

1.1.1.2 Hornsea Four will include both offshore and onshore infrastructure including an offshore generating station (wind farm) including up to 180 wind turbine generators (WTGs), export cables to landfall, and connection to the electricity transmission network.

1.2 Purpose of the Outline Marine Mammal Mitigation Protocol (MMMP)

1.2.1.1 The primary aim of this outline MMMP is to reduce to negligible the risk of Permanent Threshold Shift (PTS) auditory injury to any marine mammal species in close proximity of the pile driving for the installation of Hornsea Four foundation structures. This Outline MMMP draws on the guidance provided by the Joint Nature Conservation Committee (JNCC) (2010) and recent Statutory Nature Conservation Bodies (SNCB) recommendations with regards to Acoustic Deterrent Device (ADD) use (JNCC *et al.* 2016).

1.2.1.2 Hornsea Four have developed a range of Commitments though the EIA process to eliminate or reduce impacts as far as possible. All Commitments are detailed with **Volume 4, Annex 5.2: Commitments Register.** Of relevance to this MMMP, the Commitments Register includes a Commitment (Co.110) to develop a MMMP (**Table 1**).

Table 1: Marine Mammal Commitments.

Commitment ID	Measure proposed	How the measure will be secured
Co110	Tertiary: A piling Marine Mammal Mitigation Protocol (MMMP), will be implemented during construction and will be developed in accordance with JNCC (2010) guidance. The piling MMMP will include details of soft starts to be used during piling operations with lower hammer energies used at the beginning of the piling sequence before increasing energies to the higher levels.	DCO Schedule 11, Part 2 - Condition 12(1)(g) and; DCO Schedule 12, Part 2 - Condition 14(1)(g) (Marine mammal mitigation protocol)

1.2.1.3 In addition to the Outline MMMP, Hornsea Four will produce a Southern North Sea Site of Community Importance (SCI) (designated for harbour porpoise) Site Integrity Plan at DCO Application. This plan will set out the approach for Hornsea Four to deliver any project mitigation or management measures in relation to the Southern North Sea SCI.

1.3 Implementation of the Outline MMMP

1.3.1.1 The Outline MMMP establishes the principles which will be implemented during construction. Following the granting of consent for Hornsea Four and once the final project design has been confirmed, a detailed MMMP will be prepared following the principles established in

the Outline MMMP. This is supported by the inclusion of Conditions 12(1)(g)and 14(1)(g) of the draft Schedule 11 and 12 which states:

> *"12. — (1) The licensed activities must not commence until the following (insofar as relevant to that activity or phase of activity) has been submitted to and approved in writing by the MMO, in consultation with, where relevant, Trinity House and the MCA*
>
> *(g) in the event that driven or part-driven pile foundations are proposed to be used, a marine mammal mitigation protocol, the intention of which is to prevent injury to marine mammals, including details of the soft start procedures with specified duration periods following current best practice as advised by the relevant statutory nature conservation bodies."*

2 Pile Driving Scenarios

2.1 Scenarios considered

2.1.1.1 Hornsea Four will require the installation of up to 180 WTG foundations and the following other piled infrastructure:

- Up to six small and three large Offshore Substations (OSS);
- Up to one accommodation platform; and
- Up to three High Voltage Alternating Current (HVAC) Booster Stations.

2.1.1.2 There will be a maximum of two piling operations at any one time (maximum of two piling vessels installing monopiles (2) or pin piles (4)) and the maximum foundation installation duration is expected to be 12 working months in total for the WTGs and other piled infrastructure. Both monopiles and pin piles could be installed at Hornsea Four and so both foundation types have been assessed in the Preliminary Environmental Information Report (PEIR)(see **Volume 2, Chapter 4 Marine Mammals**). A summary of the parameters assessed are presented in the sections below, with the outcome of the Marine Mammal PEIR assessment presented in **Section 3**.

2.1.1.3 In **Volume 2, Chapter 4: Marine Mammals**, the main assessment is based upon the most likely scenario as it is more representative of the actual piling activity likely to be used during the majority of piling events (estimated to be applicable for ~70% of foundation installations). The most likely scenario, based on the current engineering design, is a maximum of 4,000 kJ hammer energy for monopiles and 1,750 kJ for pin piles.

2.1.1.4 In addition to this, the maximum design scenario (MDS) has been assessed for each marine mammal species. This scenario is intended to cover the maximum piling parameters that would ever be required to install a foundation (in terms of maximum hammer energies and longest piling durations), and, based on the ground investigation work completed to date, it is expected that this will only be required for ~30% of foundations. The MDS based on engineering predictions is a maximum 5,000 kJ hammer energy for monopiles and 2,500 kJ for pin piles.

2.1.1.5 For the purpose of the PEIR assessment, two different MDS' have been considered: a spatial MDS and a temporal MDS. The spatial MDS equates to the greatest area of effect from subsea noise at any one time during piling. The temporal MDS represents the longest duration

of effects from subsea noise. These two MDS' are presented in the sections below, as well as reference to a most likely scenario.

4.1.1.1 Between PEIR and ES submission, there is likely to be a refinement to both the maximum design and most likely ramp up profiles. It is anticipated that the refinement of the ramp-up procedures will be such that predicted impacts presented in the final ES chapter will be equal to, or potentially less than the MDS presented in Section 3.

2.2 Spatial Maximum Design Scenario

2.2.1.1 Table 2 details the piling parameters that represent the spatial MDS:

Table 2: Spatial MDS parameters.

Parameter	WTG Foundations (180 monopile foundations)		Other Piled Infrastructure (13 monopile foundations)	
	Most likely scenario	Maximum design scenario	Most likely scenario	Maximum design scenario
Maximum hammer driving energy (kJ)	4,000 kJ ~70% of foundation locations (~126 foundations)	5,000 kJ ~30% of foundation locations (~54 foundations)	4,000 kJ ~70% of foundation locations (~9 foundations)	5,000 kJ ~30% of foundation locations (~4 foundations)
Maximum pile diameter	15 m	15 m	15 m	15 m
Ramp up duration (minutes)	52.5 minutes	30 minutes	52.5 minutes	30 minutes
Maximum piling time per foundation	127.5 minutes	240 minutes	127.5 minutes	240 minutes
Maximum piling time[a]	267.75 hours	216 hours	19.13 hours	16 hours
Total piling time[b]	20.17 days over 12 month construction period		1.46 days over 12 month construction period	

[a] = number of foundations multiplied by time per foundation

[b] = sum of maximum piling time for 70% of foundations at most likely hammer energy and maximum piling time for 30% of foundations at MDS hammer energy

2.3 Temporal Maximum Design Scenario

2.3.1.1 Table 3 details the piling parameters that represent the temporal MDS:

Table 3: Temporal MDS parameters.

Parameter	WTG Foundations (180 pin pile foundations – 3 piles per jacket – 540 piles))		Other Piled Infrastructure (13 pin pile foundations – six legs per jacket with four piles per leg = 312 piles))	
	Most likely scenario	Maximum design scenario	Most likely scenario	Maximum design scenario
Maximum hammer driving energy	1,750 kJ ~70% of foundation locations (378 pin piles)	2,500 kJ ~30% of foundation locations (~162 pin piles)	1,750 kJ ~70% of foundation locations (~218 pin piles)	2,500 kJ ~30% of foundation locations (~94 pin piles)
Maximum pile diameter	4 m	4 m	4 m	4 m
Ramp up duration (minutes)	52.5 minutes	30 minutes	52.5 minutes	30 minutes
Maximum piling time per foundation	127.5 minutes	240 minutes	127.5 minutes	240 minutes
Maximum piling time[a]	803.25 hours	648 hours	463.25 hours	376 hours
Total piling time[b]	60.47 days over 12 month construction period		34.97 days over 12 month construction period	

[a] = number of foundations multiplied by time per foundation

[b] = sum of maximum piling time for 70% of foundations at most likely hammer energy and maximum piling time for 30% of foundations at MDS hammer energy

3 Summary of Potential Impacts

3.1 Maximum Design Scenario

3.1.1.1 For the MDS, the maximum instantaneous PTS impact ranges predicted at the commencement of the soft start (20% hammer energy) are shown in Table 5.

Table 4: Estimated instantaneous PTS onset impact ranges at soft-start hammer energy (maximum design scenario).

Species	Threshold	Monopile (1,000 kJ)	Pin pile (500 kJ)
		Maximum range (m)	Maximum range (m)
Harbour porpoise	unweighted SPL_{peak} 202 dB re 1µPa	750	290
Minke whale	unweighted SPL_{peak} 219 dB re 1µPa	<50	<50
White-beaked dolphin	unweighted SPL_{peak} 230 dB re 1µPa	<50	<50
Seal species	unweighted SPL_{peak} 218 dB re 1µPa	<50	<50

3.1.1.2 For the MDS, the maximum instantaneous and cumulative (the potential for PTS as a result of exposure to piling noise over a 24-hour period) PTS impact ranges predicted at full hammer energy are shown in Table 5.

Table 5: Estimated instantaneous and cumulative PTS onset impact ranges at full hammer energy (maximum design scenario).

Species	Threshold	Monopile (5,000 kJ)	Pin pile (2,500 kJ)
		Maximum range (m)	Maximum range (m)
Harbour porpoise Very high frequency (VHF) cetacean	unweighted SPL_{peak} 202 dB re 1µPa	2,900	1,900
	VHF weighted SELcum 155 dB re 1 $\mu Pa^2 s$	1,900	9,700
Minke whale Low frequency (LF) cetacean	unweighted SPL_{peak} 219 dB re 1µPa	140	80
	LF weighted SELcum 183 dB re 1 $\mu Pa^2 s$	11,000	8,900
White-beaked dolphin High frequency (HF) cetacean	unweighted SPL_{peak} 230 dB re 1µPa	<50	<50
	HF weighted SELcum 185 dB re 1 $\mu Pa^2 s$	<100	<100
Seal species Phocid carnivores in water (PCW)	unweighted SPL_{peak} 218 dB re 1µPa	170	100
	PCW weighted SELcum 185 dB re 1 $\mu Pa^2 s$	830	<100

3.2 Most Likely Scenario

3.2.1.1 For the most likely scenario, the maximum instantaneous PTS impact ranges predicted at the commencement of the soft start (20% hammer energy) are shown in Table 6.

Table 6: Estimated instantaneous PTS onset impact ranges at soft-start hammer energy (most likely scenario).

Species	Threshold	Monopile (800 kJ)	Pin pile (350 kJ)
		Maximum range (m)	Maximum range (m)
Harbour porpoise	unweighted SPL_{peak} 202 dB re 1µPa	570	170
Minke whale	unweighted SPL_{peak} 219 dB re 1µPa	<50	<50
White-beaked dolphin	unweighted SPL_{peak} 230 dB re 1µPa	<50	<50
Seal species	unweighted SPL_{peak} 218 dB re 1µPa	<50	<50

3.2.1.2 For the most likely scenario, the maximum instantaneous and cumulative (the potential for PTS as a result of exposure to piling noise over a 24-hour period) PTS impact ranges predicted at full hammer energy are shown in Table 7.

Table 7: Estimated instantaneous and cumulative PTS onset impact ranges at full hammer energy (most likely).

Species	Threshold	Monopile (4,000 kJ) Maximum range (m)	Pin pile (1,750 kJ) Maximum range (m)
Harbour porpoise	unweighted SPL_{peak} 202 dB re 1µPa	2,500	1,300
	VHF weighted SELcum 155 dB re 1 $\mu Pa^2 s$	<100	3,600
Minke whale	unweighted SPL_{peak} 219 dB re 1µPa	120	60
	LF weighted SELcum 183 dB re 1 $\mu Pa^2 s$	4,800	1,200
White-beaked dolphin	unweighted SPL_{peak} 230 dB re 1µPa	<50	<50
	HF weighted SELcum 185 dB re 1 $\mu Pa^2 s$	<100	<100
Seal species	unweighted SPL_{peak} 218 dB re 1µPa	150	70
	PCW weighted SELcum 185 dB re 1 $\mu Pa^2 s$	<100	<100

3.3 Summary of impact assessment for marine mammal in relation to PTS for piling noise

3.3.1.1 **Volume 2, Chapter 4: Marine Mammals** presents the full assessment of the impacts of PTS for piling noise of marine mammals. In summary, the assessment concluded that the impact of PTS from piling noise under both the most likely and the MDS is not considered to have a significant effect on any marine mammal species considered in the assessment.

4 Mitigation Methodology

4.1 Introduction

4.1.1.1 In order to minimise the risk of any auditory injury to marine mammals from underwater noise during pile driving, there are a suite of mitigation measures that the Applicant could implement for Hornsea Four piling. These mitigation measures include (but are not limited to) the following measures:

- Pre-piling deployment of ADDs;
- Concurrent Marine Mammal Observation (MMO);and
- Piling soft-start procedure.

4.1.1.2 The following sections provide a high-level methodology for each of these elements. Further details of the methodology will be provided in an updated version of this document which will be submitted as part of the DCO Application. A final MMMP will be produced prior to construction for approval by the Marine Management Organisation which will ensure compliance with the relevant dML Conditions (see **Section 1.3**).

4.2 Mitigation zone

4.2.1.1 A mitigation zone, based on maximum potential instantaneous PTS impact ranges, will be established. Mitigation measures would aim to remove marine mammals from the mitigation zone prior to the start of piling to reduce the risk of any physical or auditory injury. The mitigation zone for Hornsea Four piling will be confirmed in the pre-construction MMMP

and will be determined based on the confirmed foundation options and hammer energies etc.

4.3 ADD choice and specification

4.3.1.1 The ADD device that is likely to be used is the Lofitech AS seal scarer[1] although this will be confirmed within the final MMMP. This ADD has been shown to have the most consistent effective deterrent ranges for harbour seals (*Phoca vitulina*), grey seals (*Halichoerus grypus*), minke whales (*Balaenoptera acutorostrata*) and harbour porpoise (*Phocoena phocoena*) (the primary species of relevance at Hornsea Four) in environments similar to the offshore wind farm construction site (Sparling *et al.* 2015; McGarry *et al.* 2017). The Lofitech AS seal scarer has been successfully used for marine mammal mitigation purposes at a number of offshore wind farm construction projects in Europe, including the C-Power Thornton Bank offshore wind farm in Belgium (Haelters *et al.* 2012), the Horns Rev II, Nysted and Dan Tysk offshore wind farms in Denmark (Carstensen *et al.* 2006, Brandt *et al.* 2009, Brandt *et al.* 2011, Brandt *et al.* 2013, Brandt *et al.* 2016) and on various German sites (Georg Nehls, pers comm). An Offshore Renewables Joint Industry Programme (ORJIP) study undertook trials of ADD efficacy on minke whale (McGarry *et al.* 2017) The results presented in the ORJIP study demonstrate that the Lofitech ADD modifies the behaviour of free-ranging minke whales at both 500 m and 1000 m. Minke whales demonstrated a significant increase in swim speed, and an increase in the directness of their movement away from the site of the ADD playback. This indicates clear avoidance behaviour, which indicates potential utility as a mitigation tool for the deterrence of minke whales from a standard mitigation zone. The Lofitech device has recently been successfully used for marine mammal mitigation purposes for harbour porpoises, harbour and grey seals, and minke whales during piling construction activities at the several offshore winds farms and is also likely to be used for mitigation at other UK offshore wind farm sites in the near future.

4.3.1.2 There is currently no published evidence of the effectiveness of ADDs on white-beaked dolphins (*Lagenorhynchus albirostris*) but deterrents only have to be effective over a small range for white-beaked dolphins in order to ensure these species are not at risk of instantaneous auditory injury. Further to this, it is also noted that these species are also much less likely to be encountered at the site compared to harbour porpoise due to the lower densities of these species recorded in the area. As such, the likelihood of a white-beaked dolphin being exposed to the risk of auditory injury is considered to be extremely low.

4.3.1.3 It is important to note that there may be additional ADD models identified in the pre-construction phase for Hornsea Four that are available and suitable for use. As such, the final ADD choice and specification will be confirmed within the pre-construction MMMP that will be submitted to discharge the relevant dML condition(s), in consultation with the relevant SNCBs.

4.4 Duration of deployment

4.4.1.1 Herschel *et al.* (2013) recommend that the ADD should be activated for at least as long as it takes for a marine mammal to swim twice the distance of the injury zone at the onset of soft-start piling. The duration of ADD deployment will be calculated using swimming speed

[1] http://www.lofitech.no/en/seal-scarer.html

assumptions to ensure that marine mammals are outwith the maximum instantaneous single strike PTS ranges.

4.4.1.2 In terms of swimming speed assumptions, a swim speed of 1.5 ms^{-1} (Otani *et al.* 2000, Lepper *et al.* 2012) will be assumed for all marine mammals with the exception of minke whales. A swim speed of 3.25 ms^{-1} will be assumed for minke whale.

4.4.1.3 There are data to suggest that these selected swim speeds are precautionary and that animals are likely to flee at much higher speeds, at least initially. Minke whales have been shown to flee from ADDs at a mean swimming speed of 4.2 ms^{-1} (McGarry *et al.* 2017). A recent study by Kastelein *et al.* (2018) showed that a captive harbour porpoise responded to playbacks of pile driving sounds by swimming at speeds significantly higher than baseline mean swimming speeds, with greatest speeds of up to 1.97 ms^{-1} which were sustained for the 30 minute test period. In another study, van Beest *et al.* (2018) showed that a harbour porpoise responded to an airgun noise exposure with a fleeing speed of 2 ms^{-1}.

4.4.1.4 Marine mammals would also be expected to continue moving away during the soft-start at 20% hammer energy. In addition, the presence of novel vessel activity on-site prior to the commencement of piling is also predicted to result in animals moving away from the piling location and out of the injury zone (Brandt *et al.* 2018, Graham *et al.* 2019). Therefore, ADD use before the soft-start commences would ensure that animals are displaced from the mitigation zone before the piling commences.

4.5 ADD deployment procedure

4.5.1.1 It is expected that during monopile or pin pile installation, one ADD will be deployed from the deck of the piling platform/vessel, with the control unit and power supply on board the platform/vessel in suitable, safe positions on deck. The ADD will be verified for operation prior to pre-piling activation. The exact deployment procedure will be agreed once the piling contractor is in place and will follow safe, standard working practices using experienced/trained staff to ensure the ADD equipment is used and deployed correctly within the confines of different vessel layouts.

4.6 ADD operator training and responsibilities

4.6.1.1 A trained and dedicated ADD operator will be responsible for ADD maintenance, operation and reporting. The ADD duties involved would be to deploy the ADD from the installation platform or vessel, to verify the operation of the ADD before deployment, to operate the ADD throughout the pre-piling period (and be available in the case of piling breaks to reactivate), ensure batteries are fully charged and that spare equipment is available in case of any problems, and record and report on all ADD and piling activity. Prior to the start of the MMO pre-piling watch period, the ADD operator will test the equipment to ensure the ADD is working and ensure they are deployed appropriately from the vessel or jacket to an agreed depth. Following the deployment and testing of the ADD equipment, before the commencement of the soft-start procedure (for monopiles/pin piles respectively), the ADD operator will activate the ADD and the MMO will commence the pre-piling watch. When the soft-start commences the ADD operator will deactivate the ADD.

4.7 Marine mammal observers

4.7.1.1 The pre-piling watch for marine mammals will be conducted for a set period of time prior to the commencement of the soft-start procedure. The MMO will undertake visual marine mammal observations within the defined mitigation zone around the piling location from a suitable elevated platform. The MMO will record all periods of marine mammal observations, including start and end times. Details of environmental conditions (sea state, weather, visibility, etc.) and any sightings of marine mammals around the piling vessel will also be recorded as per JNCC marine mammal recording forms and guidelines. In addition, any obvious responses of animals to the ADD activation will be recorded (e.g. a change in behaviour from milling or bottling to directed travel away from the ADD at the onset of ADD activation).

4.7.1.2 If, during the MMO pre-piling watch, a marine mammal is detected within the mitigation zone, ADD activation will continue and soft-start will commence as planned, unless a marine mammal is observed within the instantaneous injury zone. In the unlikely event of an observation within the instantaneous injury zone during the MMO pre-piling watch, the ADD will continue to be activated and soft-start will be delayed until it is assessed by the MMO that the marine mammal has vacated this injury zone. The MMO will continue to note detections and observations on animal behaviour during the soft-start period.

4.8 Soft-start procedure

4.8.1.1 Following the pre-piling deployment of the ADDs (if ADDs selected as a mitigation measure within the final MMMP), a soft-start procedure will commence. This is where the piling hammer energy will gradually increase and it is assumed that any marine mammals still present in the injury zone, despite the pre-piling ADD deployment, will be encouraged to leave by the initial, relatively low levels of underwater noise prior to the noise reaching levels which could cause auditory injury, physical injury or fatality. The installation of each foundation will commence with a soft start of a maximum of 20% of the maximum hammer energy. The hammer energy will then ramp-up in steps until the levels required to install the pile are reached or up to the maximum hammer energy. The hammer energy will not be increased above the hammer energy required to complete each installation – i.e. if ground conditions are such that a lower than maximum hammer energy is sufficient to complete installation, then hammer energy will not be unnecessarily ramped up to full hammer energy.

4.9 Breaks in piling procedure

4.9.1.1 Breaks in the piling process could provide the potential for marine mammals to re-enter the mitigation zone. The guidance provided in JNCC (2010) states that *"If there is a pause in the piling operations for a period of greater than 10 minutes, then the pre-piling search and soft-start procedure should be repeated before piling recommences"*. However, the ability to restart with a soft start may depend on the stage of piling and the pile/soil behaviour. If it is not possible to re-start with a soft-start, the pre-piling ADD deployment and MMO pre-piling watch will be carried out before recommencing piling. The final procedure for breaks in piling will be agreed with input from the piling contractor (once contracted) and SNCBs and set out within the pre-construction MMMP.

4.10 Delays in the commencement of piling

4.10.1.1 Should there be a delay in the commencement of piling, there is a risk of animals moving back into the mitigation zone when ADDs are switched off. However, there is also a risk of habituation as a result of no aversive piling noise commencing after ADD activation. ADDs will therefore be turned off as soon as the delay in the commencement is realised. The ADD will not be switched on again until there is confirmation that piling is ready to commence. The ADD will then be reactivated, as above, for the minimum duration required for animals to move out of the mitigation zone.

4.11 Communications

4.11.1.1 The final MMMP will detail a communications 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 undertaken for all piling activities.

4.11.1.2 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 activities. This will be developed based on the mitigation measures and personnel required with the titles and responsibilities being refined depending on the contractual agreement.

4.12 Reporting

4.12.1.1 Reports detailing the piling activity and mitigation measures will be prepared. Where appropriate these will include, but not necessary be limited to:

- Outline of the marine mammal monitoring methodology and procedures employed;
- Record of piling operations detailing date, soft-start duration, piling duration, hammer energy during soft-start and piling and any operational issues for each pile;
- Record of ADD deployment, including start and end times of all periods of ADD activation, any problems with ADD deployment;
- Record of marine mammal observations including duration of MMO pre-piling watch,
- Environmental conditions during the pre-piling watch, description of any marine mammal sightings and any actions taken and a record of any incidental sightings made during out with the pre-piling watch;
- Details of any problems encountered during the piling process including instances of noncompliance with the agreed piling protocol; and
- Any recommendations for amendment of the protocol.

4.12.1.2 Reports will be collated and provided to the Marine Management Organisation on a weekly basis during the period during which piling operations are being conducted. In addition, a final report will be provided following the completion of the construction activity which will be submitted to the Marine Management Organisation. The final report will include any data collected during piling operations, details of ADD deployment, details of MMO watch periods and observations, 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 recommendations based on project experience and the use of ADDs as mitigation during the construction period that could benefit future construction projects.

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