



Vattenfall Wind Power Ltd

Thanet Extension Offshore Wind Farm

**Draft Marine Mammal Mitigation Protocol
for Piling Activities**

June, 2018, Revision A

Document Reference: 8.11

Pursuant to: APFP Reg. 5(2)(q)

Vattenfall Wind Power Ltd

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Draft Marine Mammals Mitigation Protocol for Piling Activities

June 2018

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Date of Approval	June 2018
Revision	A

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SMRU Consulting

understand ♦ assess ♦ mitigate

Thanet Extension – Draft Marine Mammal Mitigation Protocol for Piling Activities

Report Code:	SMRUC-GOB-2018-008
Date:	Tuesday, 05 June 2018

THIS REPORT IS TO BE CITED AS: SMRU CONSULTING (2018). THANET EXTENSION – DRAFT MARINE MAMMAL MITIGATION PROTOCOL FOR PILING ACTIVITIES. REPORT NUMBER SMRUC-GOB-2018-008 PROVIDED TO THE GOBE, JUNE 2018 (UNPUBLISHED).

Document Control

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Rev.	Date.	Reason for Issue.	Prep.	Chk.	Apr.	Client
1	30/04/2018	Draft 1	RP	CES		SK, DB, JKL
2	23/05/2018	Draft 2	RP	CES		JKL, DB, GoBe
3	04/06/2018	Draft 3	RP			DB

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1 Introduction

1.1 Purpose of the Marine Mammal Mitigation Protocol

The primary aim of this Marine Mammal Mitigation Protocol (MMMP) is to reduce to negligible the risk of PTS auditory injury to any marine mammal species in close proximity of the pile driving for the foundation structures. This MMMP includes the embedded mitigation outlined in the ES chapter and follows the guidance provided by JNCC (2010a) and recent SNCB recommendations with regards to ADD use (JNCC et al. 2016).

While Thanet Extension has not yet received consent, it is expected that the DCO will contain conditions within the dMLs relating to the requirement for marine mammal mitigation and monitoring in relation to pile driving activity. This draft MMMP will be revised to ensure compliance with all conditions in the dMLs once they have been issued with the DCO.

This document has the following structure:

- Section 3: Outline of the different pile driving scenarios considered;
- Section 4: Summary of the estimated PTS impact ranges; and



- Section 5: Detailed description of the mitigation methodology that will be implemented to prevent the risk of PTS. This uses the estimated PTS impact ranges to inform the duration of ADD deployment necessary to move animals out of the injury zone and outlines the mitigation procedure, including a pre-piling ADD deployment and MMO watch, the soft-start procedure, the procedure to be implemented in the case of breaks and delays in piling activity and the duties of the ADD operator and MMO.

1.2 Project background

Vattenfall Wind Power Ltd (VWPL) is proposing the development of Thanet Extension Offshore Wind Farm (Thanet Extension). The project encompasses VWPL's offshore wind strategy in 2017 to be a leader in delivering sustainable production of energy. The proposed project will be located approximately 8 km offshore (at its closest point), adjacent to the operational Thanet Offshore Wind Farm (TOWF). It would have a generating capacity of up to 340 MW.

Thanet Extension will include up to 34 wind turbine generators (WTGs). The Thanet Extension array area (the area in which the WTGs are located) is approximately 70 km², and is located approximately 8 km north-east of the Isle of Thanet. The array area encircles the existing TOWF, which has a similar physical environment.

2 Pile Driving Scenarios

2.1 Wind Turbine Generators

The maximum site capacity at Thanet Extension is 340 MW. There will be a maximum of one piling operation at any one time (single vessel piling only) and a maximum foundation installation expected to be six working months in total, which will be phased at intervals over a 28 month period. Both monopiles and pin piles could be installed at Thanet Extension and so both foundation types were assessed in the Environmental Statement (ES). A summary of the parameters assessed and the outcome of the assessment follows.

2.1.1 Worse case (spatial extent, largest impact footprint)

Pile-driving of 28 monopile foundations (12 MW WTG) with the following piling parameters:

- Max pile diameter 10 m;
- Maximum hammer driving energy 5,000 kJ;
- Soft-start starting hammer energy 250 kJ;



- Soft-start duration 20 mins at 10% then 40 mins ramp-up between 10-100%;
- Soft-start 15 blows per minute;
- Maximum 30 blows per minute;
- Average 20 blows per minute;
- Maximum 8,000 blows per foundation;
- Maximum piling time per foundation (assuming issues such as low blow rate, refusal, etc) six hours; and
- Maximum piling time for WTG foundations = 168 hours.

2.1.2 Worst-case (temporal extent, longest duration of piling)

Pile-driving of 28 quadropod/jacket foundations (12 MW WTG) with the following piling parameters:

- Four piles per foundation;
- Maximum pile diameter four meters;
- Maximum hammer driving energy 2,700 kJ;
- Soft-start starting hammer energy 270 kJ;
- Soft-start duration 20 mins at 10% then 40 mins ramp-up between 10-100%;
- Soft-start 15 blows per minute;
- Maximum 30 blows per minute;
- Average 30 blows per minute;
- Maximum 8,400 blows per foundation;
- Maximum piling time per foundation (assuming issues such as low blow rate, refusal, etc) ten hours; and
- Maximum piling time for WTG foundations = 280 hours.

2.2 Offshore Substation (OSS)

Thanet Extension will require the installation of one OSS with the following piling parameters:

- Monopile, tripod or quadropod foundation;
- Maximum pile diameter ten meters for monopile, three meters for tripod or quadropod;
- Maximum hammer driving energy 2,700 kJ;
- Soft-start starting hammer energy 270 kJ;
- Soft-start duration 0.33 hours;
- Soft-start (assumed) 20 blows per minute;
- Maximum 30 blows per min; and
- Maximum piling time per foundation (assuming issues such as low blow rate, refusal, etc) six hours.



2.3 Met Mast

Thanet Extension will require the installation of one met mast, which will require pile-driving of one monopile foundation (equivalent to 12 MW WTG) with the following piling parameters:

- Max pile diameter 10 m;
- Maximum hammer driving energy 5,000 kJ;
- Soft-start starting hammer energy 250 kJ;
- Soft-start duration 20 mins at 10% then 40 mins ramp-up between 10-100%;
- Soft-start 15 blows per minute;
- Maximum 30 blows per minute;
- Average 20 blows per minute;
- Maximum 8,000 blows per foundation; and
- Maximum piling time per foundation (assuming issues such as low blow rate, refusal, etc) six hours.

3 Summary of Potential Impacts

The maximum instantaneous PTS onset impact range predicted at the commencement of the soft-start (10% hammer energy) is 160 m for porpoise and 18 m for seal species (Table 1). Impact ranges were higher at the east model location compared to the southwest, and higher for monopiles compared to pin piles.

The maximum instantaneous PTS impact range predicted at full hammer energy is 660 m for porpoise and 70 m for seal species (Table 2). As reflected in the soft-start impact ranges, the impact ranges for full hammer energy were higher at the east model location compared to the southwest, and higher for monopiles compared to pin piles.

The maximum cumulative PTS range (the potential for PTS as a result of exposure to piling noise over a 24 hour period) was 960 m for harbour porpoise for the installation of pin piles (and 60 m for monopiles) and 30 m for seal species for the installation of both monopiles and pin piles (Table 2).

Table 1 Estimated instantaneous PTS onset impact areas and ranges for harbour porpoise and seal species at the start of the soft-start (10% of full hammer energy).

Species	Threshold	East		South west	
		Monopile (500 kJ)	Pin Pile (270 kJ)	Monopile (500 kJ)	Pin Pile (270 kJ)
		Mean range (m)			
Harbour porpoise	unweighted SPL _{peak} 202 dB re 1µPa	160	110	150	100
Seal species	unweighted SPL _{peak} 218 dB re 1 µPa	18	12	17	12

Table 2 Estimated instantaneous and cumulative PTS onset impact areas and ranges for harbour porpoise and seal species at full hammer energy.

Species	Threshold	East				South west			
		Monopile (5,000 kJ)		Pin Pile (2,700 kJ)		Monopile (5,000 kJ)		Pin Pile (2,700 kJ)	
		Area (km ²)	Range (km)	Area (km ²)	Range (km)	Area (km ²)	Range (km)	Area (km ²)	Range (km)
Harbour porpoise	unweighted SPL _{peak} 202 dB re 1µPa	1.37	0.660	0.63	0.450	0.993	0.560	0.474	0.390
	NOAA _{HF} weighted SEL _{cum} 155 dB re 1 µPa ² s	0.010	0.060	3.000	0.960	0.004	0.040	0.338	0.330
Seal species	unweighted SPL _{peak} 218 dB re 1 µPa	0.015	0.070	0.007	0.048	0.013	0.065	0.006	0.044
	NOAAPW weighted SEL _{cum} 185 dB re 1 µPa ² s	0.004	0.030	0.002	0.030	0.002	0.030	0.001	0.010

4 Mitigation Methodology

In order to minimise the risk of any auditory injury to marine mammals from underwater noise during pile driving, the following provides an outline of the mitigation that will be implemented:

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

The following sections outline the detailed methodology for each of these elements.

4.1 ADD choice and specification

The ADD device selected for use is the Lofitech AS seal scarer¹. This ADD has been shown to have the most consistent effective deterrent ranges for both harbour seals and grey seals and harbour porpoise (the primary species of concern at Thanet Extension) in environments similar to the offshore wind farm construction site (Sparling *et al.* 2015). 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). The Lofitech device has recently been successfully used for marine mammal mitigation purposes for harbour porpoises, harbour and grey seals during piling construction activities at the Dudgeon Offshore Wind Farm (Statoil, 2015) and Beatrice Offshore Wind Farm (BOWL, 2015), and is also likely to be used for mitigation at other UK offshore wind farm sites in the near future.

4.2 Mitigation zone

The estimated ranges within which instantaneous PTS could occur at the onset of the soft-start is 18 m and 12 m for seals at monopiles and pin piles respectively, and 160 m and 110 m for porpoise at monopiles and pin piles respectively. The risk for PTS from maximum hammer energy single strike is very small as it will always be preceded by a soft-start of 20 mins at 10% hammer energy followed by 40 minutes ramping up between 10-100% hammer energy. However, the estimated ranges within which single strike **instantaneous PTS** could occur at maximum hammer energy is 70 m and 48 m for seals at monopiles and pin piles respectively, and 66 m and 45 m for porpoise at monopiles and pin piles respectively.

The estimated ranges at which **cumulative PTS** could occur is 30 m for seals for both pin piles and monopiles and 60 m and 960 m for harbour porpoise for monopiles and pin piles respectively. ADD

¹ <http://www.lofitech.no/en/seal-scarer.html>



mitigation will be applied prior to the commencement of the soft-start to ensure that no porpoise are present within the injury zone.

4.3 Duration of deployment

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. In this case, assuming a swim speed of 1.5 ms^{-1} (Otani *et al.* 2000, Lepper *et al.* 2012), activation of the ADD would be required for:

- 0.2 minutes to move seals out to the 18 m maximum instantaneous single strike PTS range for monopiles at 10% hammer energy;
- 0.1 minutes to move seals out to the 12 m maximum instantaneous single strike PTS range for pin piles at 10% hammer energy;
- 1.8 minutes to move porpoise out to the maximum 160 m instantaneous single strike PTS impact range for monopiles at 10% hammer energy; and
- 1.2 minutes to move porpoise out to the maximum 110 m instantaneous single strike PTS impact range for pin piles at 10% hammer energy.

The duration of the soft-start period is 20 minutes at 10% hammer energy (followed by a 40 minute ramp-up from 10-100% hammer energy), and it is expected that marine mammals will continue moving away from the piling source as hammer energy ramps up. However, in order to ensure that a marine mammal would be completely clear of an area twice the size of the PTS injury zone for the maximum hammer energy before it is reached, activation of the ADD would be required for:

- 1.6 minutes to move seals out to 140 m ($2 \times 70 \text{ m}$) for monopiles;
- 1.1 minute to move seals out to 96 m ($2 \times 48 \text{ m}$) for pin piles;
- 14.7 minutes to move porpoise out to 1,320 m ($2 \times 660 \text{ m}$) for monopiles; and
- 21.3 minutes to move porpoise out to 1,920 m ($2 \times 960 \text{ m}$) for pin piles.

Therefore, for the installation of **monopiles**, an ADD application for 15 minutes prior to the onset of the soft-start is highly precautionary and will allow marine mammals to be a minimum of 1,350 m from the piling location at the beginning of the piling soft-start, which is well outside of the zone of any potential PTS injury for all species considered.



Therefore, for the installation of **pin piles**, an ADD application for 22 minutes prior to the onset of the soft-start is highly precautionary and will allow marine mammals to be a minimum of 1,980 m from the piling location at the beginning of the piling soft-start, which is well outside of the zone of any potential PTS injury for all species considered.

Marine mammals would be expected to continue moving away during the 20 minute soft-start at 10% hammer energy and therefore would be predicted to be at a total distance of 3,150 m and 3,780 m from the piling location (for monopiles and pin piles respectively) by the time that the soft-start ends and the ramp-up from 10 to 100% hammer energy commences (assuming constant fleeing at a swim speed of 1.5 ms^{-1}). By the time the maximum hammer energy is reached after the 15 min or 22 min pre-piling ADD deployment (for monopiles and pin piles respectively), the 20 min soft-start and the 40 min ramp-up, the animals are expected to be 6.75 km and 7.38 km from the piling location for monopiles and pin piles respectively (assuming constant fleeing at a swim speed of 1.5 ms^{-1}). It is also expected that the vessel activity on-site prior to the commencement of piling will result in animals moving away from the piling location and out of the injury zone.

4.4 ADD deployment procedure

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 ADDs will be verified for operation prior to pre-piling activation. It is expected that a dedicated staff member will be responsible for ADD maintenance, operation, and recording/reporting. 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 kit is used and deployed correctly within the confines of different vessel layouts.

4.5 Soft-start procedure

Following the pre-piling deployment of the ADDs, a soft-start procedure will commence. This is where the piling hammer energy will gradually increase so that if any marine mammals are still present in the injury zone, despite the pre-piling deployment of ADDs, they are encouraged to leave by the initial 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 involve a 20 minute soft-start procedure where a maximum of 10% hammer energy will be used at a strike rate 15 strikes/min. Following this, hammer energy will



ramp-up in a gradual linear step up to full hammer energy over 40 minutes. 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.

4.6 Breaks in piling procedure

Breaks in the piling process could provide the potential for marine mammals to re-enter the mitigation zone. The guidance provided in JNCC (2010b) 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.

4.7 Delays in the commencement of piling

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.

4.8 ADD operator training and responsibilities

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 kit to ensure the ADDs are working and ensure they are deployed appropriately from the vessel or jacket to an agreed depth. Following the deployment and testing of the ADD kit, 15 minutes/22 minutes 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.

4.9 Marine mammal observers

The pre-piling watch for marine mammals will be conducted for 20 minutes prior to the commencement of the soft-start procedure. The MMO will undertake visual marine mammal observations within the 500 m 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).

If, during the MMO pre-piling watch, a marine mammal is detected within the 500 m 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. Figure 1 presents a flow diagram of the processes involved in the MMMP.

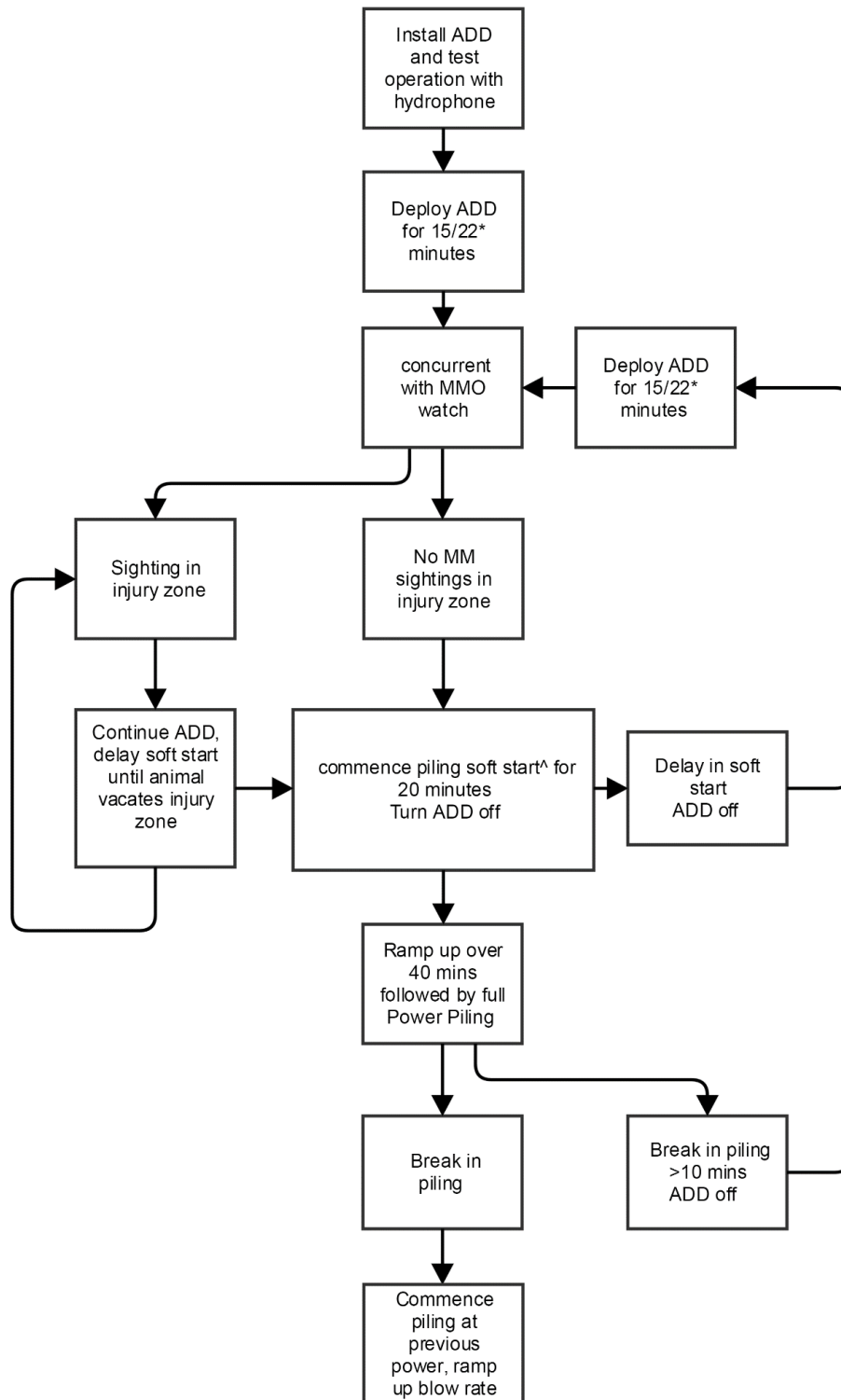


Figure 1 The Marine Mammal Mitigation Protocol.

* 15 minutes for monopiles, 20 minutes for pin piles.



4.10 Communications

This communications protocol will include, but not be limited to:

- Procedure to notify ADD operator to set-up equipment, test and deploy ADDs to allow 15 min/22 min activation (for monopiles and pin piles respectively) and to notify the MMO to begin the 20 minute marine mammal observation prior to soft-start commencing;
- Procedure for the MMO to notify installation manager that deployment of ADDs and activation for the required time has been successful and soft-start can commence, or if deployment of ADDs and activation has not been successful that soft-start will be delayed;
- Procedure to notify that there has been a delay in the onset of the soft-start and that ADD should be turned off;
- Procedure for the MMO to notify installation manager that a marine mammal has been detected in the injury zone and that the soft-start will need to be delayed;
- Procedure to notify ADD operator that soft-start is successfully underway and the ADDs can be deactivated;
- Procedure to notify ADD operator that there is a break in piling and if re-deployment and activation of the ADDs is required; and
- Procedure to notify MMO that the piling operations have been successfully completed.

4.11 Reporting

A record of all piling operations, ADD deployment and marine mammal observations will be maintained. Reports will include:

- 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 non-compliance with the agreed piling protocol; and
- Any recommendations for amendment of the protocol.

Reports will be collated and provided to the Marine Management Organisation on a weekly basis. In addition, a final report will be provided 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.

5 Summary

This document presents the Marine Mammal Mitigation Protocol for the construction of the Thanet Extension Offshore Wind Farm. The primary aim of the MMMP is to prevent instantaneous auditory injury to any marine mammal species in close proximity of the pile driving for the foundation structures (WTGs, OSS and Met Mast). The main features of the MMMP are summarised below:

- Prior to the commencement of the soft-start, a Lofitech ADD will be activated underwater close to the piling location for a period of 15/22 minutes (for monopiles/pin piles respectively). A member of staff, adequately experienced and trained in ADD use will be responsible for the operation and maintenance of the ADD;
- Subject to sighting conditions (daylight, good visibility and sea states of 3 or below), concurrent with the ADD deployment, a pre-soft-start marine mammal observation watch period will be carried out by an appropriately trained Marine Mammal Observer. This role will be combined with the ADD operator as a Marine Mammal Mitigation Officer (MMMO);
- Subsequent to the ADD deployment and pre-piling watch period, the soft-start pile driving will commence at 10% hammer energy for 20 minutes, after which it will ramp-up over 40 minutes to maximum hammer energy;
- Reports of ADD operation, piling activity and marine mammal observation data will be provided to the Marine Management Organisation; and



- The noise emitted by the ADDs will be monitored as part of the Project noise monitoring strategy and the results will be provided to the Marine Management Organisation.

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