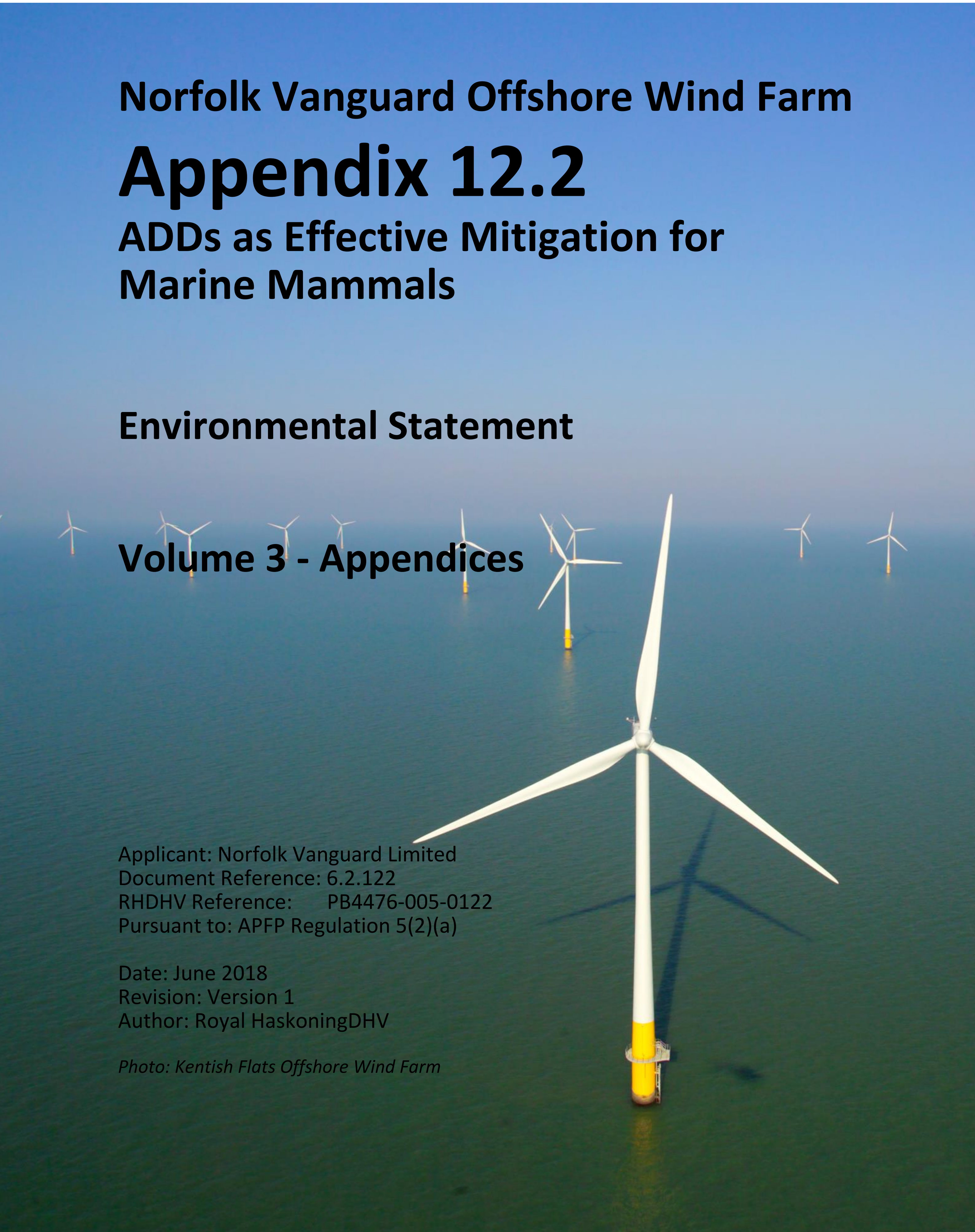

Norfolk Vanguard Offshore Wind Farm

Appendix 12.2

ADDs as Effective Mitigation for Marine Mammals

Environmental Statement

Volume 3 - Appendices

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Environmental Impact Assessment
Environmental Statement

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For and on behalf of Norfolk Vanguard Limited

Approved by: Ruari Lean and Rebecca Sherwood

Signed: [redacted]

Date: 8th June 2018

For and on behalf of Royal HaskoningDHV

Drafted by: Jennifer Learmonth

Approved by: Alisatir Davison

Signed: [redacted]

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Contents

Glossary

ADD	Acoustic Deterrent Devices
CEEs	Controlled Exposure Experiments
dB	Decibel
DCO	Development Consent Order
DOW	Dudgeon Offshore Wind Farm
ES	Environmental Statement
JNCC	Joint Nature Conservation Committee
km	kilometre
km^2	kilometre squared
m	metre
MMMP	Marine Mammal Mitigation Plan
MMO	Marine Mammal Observers
NE	Natural England
NV East	Norfolk Vanguard East
NV OWF sites	Norfolk Vanguard Offshore Wind Farm sites (i.e. NV East and NV West)
NV West	Norfolk Vanguard West
ORJIP	Offshore Renewables Joint Industry Project
OWF	Offshore Wind Farm
PAM	Passive Acoustic Monitoring
RMS	Root Mean Squared
SMRU	Sea Mammal Research Unit
SNCBs	Statutory Nature Conservation Bodies
UXO	Unexploded Ordinance
µPa	Micro pascal

Terminology

Array cables	Cables which link the wind turbines and the offshore electrical platform.
Interconnector cables	Buried offshore cables which link the offshore electrical platforms
Landfall	Where the offshore cables come ashore at Happisburgh South
Offshore accommodation platform	A fixed structure (if required) providing accommodation for offshore personnel. An accommodation vessel may be used instead
Offshore cable corridor	The corridor of seabed from the Norfolk Vanguard OWF sites to the landfall site within which the offshore export cables 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 turbines and convert it into a more suitable form for export to shore.
Offshore export cables	The cables which bring electricity from the offshore electrical platform to the landfall.
Offshore project area	The overall area of Norfolk Vanguard East, Norfolk Vanguard West and the offshore cable corridor
Safety zones	A marine zone outlined for the purposes of safety around a possibly hazardous installation or works / construction area under the Energy Act 2004.

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

12.2 ADDS AS EFFECTIVE MITIGATION FOR MARINE MAMMALS

12.1.1 Introduction

1. A draft Marine Mammal Mitigation Plan (MMMP) for piling (document 8.13) is provided with the DCO application which outlines possible mitigation measures which may include the use of Acoustic Deterrent Device (ADD) to reduce the risk of any auditory injury from the first strike of the soft-start (500kJ hammer energy).

2. This appendix summarises the effectiveness of ADDs as mitigation to prevent auditory injury in marine mammals as a result of underwater noise. The information in this report is from Sparling *et al*. (2016) and DOWL (2016). All current and relevant information has been reviewed, however, the Joint Nature Conservation Committee (JNCC) is currently preparing a report on ADDs which will be taken into account, along with the latest information and guidance, when preparing the final MMMP.

12.2.2 Acoustic Deterrent Devices

3. The Offshore Renewables Joint Industry Project (ORJIP) commissioned a review in 2013 of the potential effectiveness of ADDs. Xodus Group Ltd, in partnership with SMRU Marine (now SMRU Consulting) led the research. The project team conducted a desktop review and produced a set of advisory services regarding ADD use and improvements to standard mitigation measures currently used in the UK (marine mammals observers (MMO), passive acoustic monitoring (PAM) and soft-starts) during piling. This review examined the evidence base for the effectiveness of currently available ADDs to deter UK species of marine mammals to ranges where they would not be at risk of physical or auditory injury. Elements from this review along with more recent information are described and summarised in the subsequent sections of this report.

4. The ORJIP review highlighted that the Lofitech seal scarer was shown to be the most consistent effective deterrence ranges for both harbour seals and harbour porpoise in environments similar to those at offshore wind farm construction sites.

5. The Lofitech seal scarer device was developed in 1988 and is manufactured and sold by the Norwegian company Lofitech AS (http://www.lofitech.no/en/home.html). The seal scarer has been 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) and the Horns Rev II, Nysted and Dan Tysk offshore wind farms in Denmark (Brandt *et al*., 2009; Carstensen *et al*., 2006) and on various German sites. It has also been successfully used as an effective mitigation at a number of UK offshore wind farm sites, including Dudgeon Offshore Wind Farm and Galloper Offshore Wind Farm.

6. The sound characteristics produced by the Lofitech seal scarer device are a source level of approximately 189 re 1 µPa @ 1 m (http://www.lofitech.no/en/seal-scarer.html), while other studies have recorded source levels ranging from 179 dB re 1 µPa (Root Mean Square, RMS) (Fjalling *et al*., 2006) to 194 dB re 1 µPa @ 1m (RMS) (Brandt *et al*., 2012; Yurk and Trites, 2000). The device emits 500ms (0.5s) long pulses in variable length blocks containing a random number of pulses. The minimum pulse interval within blocks is approximately 0.5s and consecutive blocks are separated by 20-60s intervals (Gotz and Janik, 2013). The signal is comprised of a number of very narrow band emissions with a peak at about 15kHz.

7. At Norfolk Vanguard, the ADD device used as mitigation for marine mammals prior to piling and Unexploded Ordinance (UXO) clearance would be devices such as the Lofitech seal scarer or similar devices that have been proven to provide effective mitigation for harbour porpoise and seals, the key species at the site.

12.2.3 Effectiveness of ADDs

8. During the ORJIP Project 4, Stage 1 of Phase 2 (Sparling *et al*., 2015) the expert panel (including UK Statutory Nature Conservation Bodies (SNCBs)) accepted that there is good evidence of effective deterrence of both harbour porpoise and harbour seals for at least one device, which at the time was the Lofitech seal scarer. Therefore, evidence for the effectiveness for this device has been summarised below. However, it should be noted that this information will be reviewed and updated with the latest information for all suitable devices that are available when the MMMP is prepared post-consent and prior to construction. Therefore the information provided below is as an example only.

12.2.3.1 Evidence of effectiveness for harbour porpoise

9. Studies in relation to ADD use in relation to aquaculture have reported significant deterrence of harbour porpoise (e.g. Olesiuk *et al*., 2002). More recently, attention has turned towards their use in the mitigation of impacts of pile driving; Brandt *et al*. (2013a) tested the effectiveness of the Lofitech device on harbour porpoise at a site in the German North Sea. The responses of harbour porpoise were determined using an array of CPODs to record the presence of porpoise vocalisations. The array of CPODs extended to 7.5km from the ADD source. The Lofitech device was active for four continuous hours and a total of ten trials were conducted, resulting in 40 hours of data with an active Lofitech device. A significant decline in porpoise detection was observed even at the furthest CPOD at 7.5km from the source. The number of porpoise detections within 750m declined by 86% compared to baseline recordings.

10. During this study, two visual aerial surveys were conducted over a wider area, one survey before ADD activation and one survey while the ADD was active. There was a marked reduction in harbour porpoise sightings during ADD activation, with an average density across the 990km^2 study area falling from 2.4 harbour porpoise per km^2 before activation to only 0.3 porpoise per km^2 during Lofitech activation. A significant reduction in harbour porpoise activity, as recorded by the CPODs after the sealscarer was switched off, remained up to 6 hours afterwards (in the area closest to ADD activation). After this there was no longer a statistical difference in porpoise activity from pre ADD levels.

11. Brandt *et al*. (2013b) tested the effectiveness of the Lofitech device on harbour porpoise at Fyns Hoved, a coastal site in Danish waters. The responses of harbour porpoise were determined using land based visual observer tracking and using visual observers on the source vessel. The Lofitech device was active for four continuous hours and observations continued as long as weather conditions allowed. A total of seven trials were conducted, resulting in 28 hours of data with an active Lofitech device. The study found that sightings rates of harbour porpoise significantly declined for all distances between 0-1km from the ADD when it was activated. The mean number of porpoise seen during a scan declined from 0.86 per scan during the baseline to only 0.01 per scan when the ADD was active. The authors conclude that there was a clear decline in sightings rates within 1km of the active device, which equated to a minimum sound level of 129 dB re 1 µPa RMS. The maximum distance at which an avoidance reaction was observed was 2.4km. Although this is a lower effective distance than seen at the German site (7.5km), the estimated sound level of the ADDs at this range at the Danish site was similar to that estimated at 7.5km at the German site (119 dB re 1 µPa). This is because of the shadowing effect of the coast and much shallower water there which meant that sound levels were 10-20dB lower than at comparable distances at the more offshore site. They observed that porpoise immediately reacted once the device was activated and swam away at speeds averaging 1.6m/s. Given this swimming speed, the porpoise could swim 500m in approximately 5 minutes which would ensure it was outside of the current standard 500m mitigation zone. Visual observations at Fyns Hoved found the first porpoise to be present within a 1km radius after on average of 51 min (34-67 min) after the sealscarer was switched off.

12. Kastelein *et al*. (2015b) investigated the responses of a single harbour porpoise in captivity to broadcasts of recordings of the Lofitech seal scarer device at a range of different SPLs. The behavioural response sessions were videoed from above and underwater and the animal's distance from the transducer, the number of surfacings and the number of jumps were compared between baseline and test conditions. Playbacks were of 30 minute duration. Results showed that the porpoise swam

significantly faster, showed more leaping behaviour and maintained a greater mean distance from the device at higher broadcast levels (Kastelein *et al*., 2015b). A mean received SPL of 151 ± 6 dB re 1 µPa caused clear displacement in which the animal moved away from the transducers. Based on the source levels and the mean received SPL causing strong deterrence effects, the authors conclude that harbour porpoise are likely to display avoidance behaviour in response to a Lofitech device when the propagation loss is of the order of magnitude of 42dB or less. Therefore, if the local propagation conditions are known at a site, then the deterrence distance at that site can be calculated in advance.

13. There is a growing body of evidence emerging from offshore wind farm sites on the effectiveness of ADDs in deterring harbour porpoises around piling locations prior to piling commencing. Höschle *et al*. (2015) report on ADD use at four offshore wind farms in the German North Sea between 2013 and 2015. All wind farms were situated in an area where harbour porpoises are abundant and occur all year in the area. The ADDs were activated 30 minutes before the commencement of piling. The comparison of porpoise detections between reference periods prior to and during ADD activation demonstrated that the detections were significantly less during ADD activation than during reference periods.

14. Furthermore, data collected as part of the DEPONS project during construction of the Dan Tysk offshore wind farm demonstrate an immediate response of porpoises to ADD activation out to several kilometres prior to piling. In addition, there was no obvious evidence of any reduced effectiveness in the use of ADDs to deter harbour porpoise over the whole construction period.

12.2.3.2 Evidence of effectiveness for harbour seal

15. Gordon *et al*. (2015) conducted field experiments with the Lofitech device as part of a Marine Scotland funded project, specifically designed to assess the effectiveness of aversive sound mitigation by measuring animal movements at appropriate ranges in appropriate habitats. This involved field trials in Kyle Rhea in 2013 and the Moray Firth in 2014 and consisted of 73 controlled exposure experiments (CEEs) with the Lofitech device. During these CEEs, 10 harbour seals were tagged at Kyle Rhea and 13 harbour seals tagged in the Moray Firth. This study used a new telemetry system developed specifically for this application which combines an ability to track seals at sea in near real time with the capability of recovering a complete archived movement dataset for more detailed analysis using shore stations. These trials in the Moray Firth were carried out in conditions up to and including sea state 3 and were carried out against a background of a relatively high degree of ship activity (in close proximity to the ports of Invergordon and Nigg, numerous cargo, tanker and fishing vessels in the area).

16. A behavioural response was observed for all CEEs for which the animal was within approximately 1km from the source (n = 38). The closest range for a CEE that did not elicit a response from a harbour seal was 998m, where the predicted received sound level (based on recordings made in the field) was 132 dB re 1 µPa RMS. Responses were elicited out to a maximum range of 3.122km where the predicted received level was 120 dB re 1 µPa RMS. There was a marked decline in the percentage of harbour seals that responded to the Lofitech device beyond 1km, with the most distant group of seals at 4.1km from the Lofitech device showing a response rate of 20%.

17. Overall increases in distances travelled between surfacing and increases in swim speeds were also noted during playbacks. Seals that were assumed to be foraging at the start of exposure (defined as moving in a non-directed manner) would often return towards their original location and appear to resume foraging soon after the exposure. This study clearly showed that the use of this ADD should result in a low probability of any animals remaining within exclusion zones of approximately 1km.

12.2.3.3 Use of ADDs at Dudgeon Offshore Wind Farm

18. During piling at Dudgeon Offshore Wind Farm (DOW) ADDs were used to deter marine mammals from an area where they could potentially be exposed to noise levels that could result in PTS (DOWL, 2016). A detailed review and assessment of the effectiveness of ADDs at the DOW site to mitigate the risk of physical or auditory injury to harbour porpoise and harbour seal (the two key species of concern at the DOW site) was conducted (Sparling and Plunkett, 2015). Based on the findings of the Sparling and Plunkett (2015) report, the Lofitech seal scarer ADD was used. This ADD has been shown to have the most consistent effective deterrent ranges for both harbour seal and harbour porpoise in environments similar to the DOW site and has been successfully used for marine mammal mitigation purposes at a number of offshore wind farm construction projects in Europe (Sparling and Plunkett, 2015).

19. The ADDs were monitored, as part of the underwater noise monitoring at the first three monopiles. The ADDs were detected at 250m, 500m, 750m and 4,000m from the piling locations for all three monopiles. The ADDs had a centralised frequency of 14.5kHz and were detectable above average background noise level (52-55 dB re 1µPa2.Hz-1 at 14-6kHz (DOWL, 2016).

20. The mean received level of ADDs at 750m from the installation vessel was 99.7, 101.4 and 98.7 dB re 1µPa2.Hz-1 for three monopiles. The estimated source levels, based on back propagation of the received levels, were 196.9, 194.7 and 197.4 dB re 1µPa2.m2 (DOWL, 2016).

21. The noise monitoring of the ADDs supports the ADD mitigation ranges in the Sparling and Plunkett (2015) report. In addition, there were no reports of any marine mammal sightings during the marine mammal observations when the ADDs were activated or during the soft-start.

22. Therefore, it was concluded that the ADDs deployed at DOW were effective mitigation and the ranges were adequate to prevent injury to marine mammals, including auditory injury in the form of PTS, as a result of piling (DOWL, 2016).

12.2.4 Conclusion

23. The studies described above, particularly the field trials with harbour seals in the Moray Firth and with harbour porpoise in the North Sea provide clear evidence that Lofitech acoustic deterrent devices, or similar would provide adequate mitigation when deployed close to the piling location. For harbour seal this will result in the deterrence to at least 1km and the effectives of ADDs for harbour porpoises could be up to 7.5km from the piling location as found at the German field site and at least 4km based on DOW, with both locations having similar site conditions to Norfolk Vanguard.

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