Marine Mammal Mitigation Protocol

codling wind park

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Abbreviations

Abbreviation	Term in Full
µPa	Micro ascals
ADD	Acoustic Deterrent Device
BEIS	Department for Business, Energy and Industrial Strategy
CPOD	Click Pod Detector
CWP	Codling Wind Park
dB	Decibels
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EMP	Environmental Monitoring Plan
IAC	Inter-array cables
IWDG	Irish Whale & Dolphin Group
JNCC	Joint Nature Conservation Committee
kg	Kilograms
kJ	Kilojoules
km	Kilometres
lb	Pounds
m	Metres
MAP	Maritime Area Planning
MDS	Maximum design scenario
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Mammal Observers
MW	Megawatts
NEQ	Net Explosive Quantity
NPWS	National Parks & Wildlife Service
OfTI	Offshore Transmission Infrastructure
ORJIP	Offshore Renewables Joint Industry Programme
OSS	Offshore substation structures
OTI	Onshore transmission infrastructure
PAM	Passive Acoustic Monitoring
PDA	Planning and Development Act 2000

Abbreviation	Term in Full
PTS	Permanent Threshold Shift
RMS	Root Mean Squared
SEL	Sound Exposure Level
SPL	Sound Pressure Level
TJBs	Transition joint bays
UXO	Unexploded ordnance
WTGs	Wind turbine generators

Definitions

Glossary	Meaning
Permanent Threshold Shift (PTS)	Permanent threshold shift (or PTS) is a permanent increase in the threshold of hearing (minimum intensity needed to hear a sound) at a specific frequency above a previously established reference level.
Sound Exposure Level (SEL)	The decibel level of the time integral (summation) of the squared pressure over the duration of a sound event; units of dB re 1 $\mu Pa^2/s$.
Sound Pressure Level (SPL)	A means of characterising the amplitude of a sound. There are several ways sound pressure can be measured. The most common of these are the root-mean-square (RMS) pressure, the peak pressure and the peak-to-peak pressure.
Temporary Threshold Shift (TTS)	Temporary threshold shift (or TTS) is a temporary increase in the threshold of hearing (minimum intensity needed to hear a sound) at a specific frequency above a previously established reference level.
Passive Acoustic Monitoring (PAM)	Used to measure, monitor and determine the sources of sound in underwater environments. This is a versatile, non-invasive and cost-effective method to detect, classify and track marine mammals over large areas for long periods.
Acoustic Deterrent Devices (ADDs)	A range of devices that either emit sounds, using electrical or mechanical means, or acoustically reflect those emitted by echolocating cetaceans. Often used to discourage marine mammals from an area where anthropogenic activities are occurring.
Noise abatement	A primary mitigation methodology used to reduce the noise emissions at-source.
Marine Mammal Observer (MMO)	A marine mammal observer (MMO) is a professional in environmental consulting who specialises in whales and dolphins and is responsible for spotting and identifying animals through visual or passive acoustic means.
Monitored zone	The zone which is required to remain clear of marine mammals for a specified time-frame, prior to a noisy activity taking place.
PTS-Onset	The distance from the sound source at which the received level decreases to below the level of PTS-onset for a specific marine mammal hearing group.

1 INTRODUCTION

1.1 The CWP Project

1. Codling Wind Park Limited (hereafter 'the Developer') is proposing to develop the Codling Wind Park (CWP) Project, which is located in the Irish Sea approximately 13–22 km off the east coast of Ireland, at County Wicklow.

2. The Developer is applying for permission for all components of the CWP Project under Section 291 of the Planning and Development Act 2000, as amended (PDA) (as inserted by the Maritime Area Planning (MAP) Act 2021). This includes:

   - The generating station, which comprises the wind turbine generators (WTGs), inter array cables (IACs) and interconnector cables;
   - The offshore transmission infrastructure (OfTI), which comprises the offshore substation structures (OSSs) and offshore export cables;
   - The landfall which describes the point at which the offshore export cables are brought onshore; and
   - The onshore transmission infrastructure (OTI) which comprises the onshore export cables, the onshore substation and and network cables to a planned extension to the existing ESB Networks 220 kV substation.

3. A detailed description of the CWP Project is provided in the Environmental Impact Assessment Report (EIAR) **Chapter 4 Project Description**.

1.2 Purpose of the MMMP

4. This Marine Mammal Mitigation Protocol (MMMP) supports the consent application for the CWP Project. The purpose of this MMMP is to provide a framework for the final MMMP, which is anticipated to be required under conditions of the planning consent, to ensure appropriate controls are in place to manage environmental risks associated with the construction and operation of the offshore components of CWP Project as assessed in the EIAR. The MMMP is intended to be a live document which will be updated as project development progresses and will be submitted to the relevant authority (anticipated to be National Parks and Wildlife Service (NPWS)) for approval, prior to the start of construction. A revised document containing the finalised details of the MMMP will also be submitted prior to the commencement of operations. The proposed schedule of submission and scope of the iterations of the MMMP are described in the following 'Scope of the MMMP' section.

1.3 Scope of the MMMP

5. It is anticipated that the development and implementation of a MMMP will form a condition of any planning consent granted. The Developer has also committed to the development of a MMMP within the EIAR and supporting documents for the CWP Project.

6. The MMMP has the following primary objectives:

   1. To outline the potential mitigation measures that could be put in place during **geophysical surveys** to reduce the risk of auditory injury (PTS) to negligible levels;
   2. To outline the potential mitigation measures that could be put in place during **WTG / OSS pile driving activities** to reduce the risk of auditory injury (PTS) to negligible levels;

3. To outline the potential mitigation measures that could be put in place during **onshore substation pile driving activities** in the River Liffey to reduce the risk of auditory injury (PTS) to negligible levels;
4. To outline the potential mitigation measures that could be put in place during **UXO clearance activities** to reduce the risk of auditory injury (PTS) to negligible levels; and
5. To outline the potential mitigation measures that could be put in place during **decommissioning activities** to reduce the risk of auditory injury (PTS) to negligible levels.

7. This MMMP considers the following guidance:

- NPWS (2014): Guidance document for minimising the acoustic impact of man-made sound sources on marine mammals;
- IWDG (2020): IWDG policy on offshore wind farm development;
- JNCC (2017): JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys;
- JNCC (2010b): Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise;
- JNCC (2010a): JNCC guidelines for minimising the risk of injury to marine mammals from using explosives; and
- JNCC (2023): DRAFT guidelines for minimising the risk of injury to marine mammals from unexploded ordnance clearance in the marine environment.

1.4 Revisions of the MMMP

8. As set out above, the MMMP is considered to be a 'live' document and will be reviewed on a regular basis to allow any changes to the construction programme, operations or unforeseen issues to be incorporated at any stage, and as deemed necessary by the Developer, their agents or relevant authorities. The MMMP will be subject to regular review to address, for example:

- Any conditions stipulated in the planning consent;
- Any conditions following an Annex IV risk assessment and Regulation 54 derogation application;
- Any requirements / issues highlighted through consultation prior to construction;
- Any change / updates to guidance, best practice and available technology at the time of construction; and
- To ensure it incorporates the findings of any pre-construction surveys.

9. Beyond the regular review, the MMMP submitted as part of the application will be updated to account for the final design of the proposed project. This is due to certain final aspects being subject to future survey, such as UXO for which a contemporary survey may be required in advance of construction to ensure the risk of UXO is as low as reasonably practicable. Similarly, the final MMMP will confirm which of the two design options for which consent is being sought will form the final option for construction. The proposed approach to updating the MMMP, and submitting to the NPWS, is as follows:

1. MMMP for purposes of consent;
2. Detailed geophysical survey MMMP; timing of submission subject to geophysical survey(s);
3. Detailed UXO MMMP; timing of submission subject to UXO survey;
4. Detailed WTG piling MMMP, timing of submission subject to final construction programme;
5. Detailed onshore substation piling MMMP, timing of submission subject to final construction programme; and
6. Detailed decommissioning MMMP; timing of submission subject to decommissioning plans.

1.5 Structure of the MMMP

10. In line with the requirements set out above, the structure of this MMMP is outlined in **Table 1-1**.

Table 1-1 Structure of the MMMP

Section 1: Introduction	• Overview of the CWP Project • Purpose and scope of the MMMP
Section 2: Geophysical survey MMMP	• Overview of survey equipment; • Overview of auditory impact (PTS) ranges; • Outline of potential primary mitigation measures; and • Conclusion.
Section 3: WTG / OSS Piling MMMP	• Overview of piling parameters; • Overview of auditory impact (PTS) ranges (instantaneous PTS and cumulative PTS); • Outline of potential primary mitigation measures for instantaneous PTS; • Outline of potential additional mitigation measures for cumulative PTS; and • Conclusion.
Section 4: Onshore Substation Piling MMMP	• Overview of piling parameters; • Overview of auditory impact (PTS) ranges (instantaneous and cumulative PTS); • Outline of potential primary mitigation measures for instantaneous PTS; • Outline of potential additional mitigation measures for cumulative PTS; and • Conclusion
Section 5: UXO MMMP	• Overview of auditory impact ranges; • Outline of potential primary mitigation measures; • Outline of potential additional mitigation measures; and • Conclusion.
Section 6: Decommissioning MMMP	• Short summary.

11. A summary of the key aspects identified above is provided within the following sections. While it is anticipated that these will form the key elements of the MMMP, it should be noted that this list may not be exhaustive and will be reviewed and updated within the final MMMP, in line with the final design of the CWP Project and in consultation with relevant stakeholders post consent and therefore closer to the time of construction.

1.6 Implementation of the MMMP

12. Key to the implementation of this MMMP is the delegation of responsibility for the implementation of the MMMP as relevant to the specific contractor's scope, to the relevant appointed person(s) on behalf of the contractor, who will regularly liaise with and update the Developer on all environmental issues relating to the project during the construction phase. As part of the appointment of a contractor and agreement of contracts, the Developer will determine the lines of communication for environmental compliance with the relevant stakeholders.

13. The appointed contractor will be responsible for developing final construction methods and installation procedures for the CWP Project. Contractors and their subcontractors will ensure that all relevant environmental and maritime legislation is complied with, that all necessary licences and permissions are obtained, that all design embedded mitigation measures are applied and that good working practices are adhered to, to minimise risks to the environment.

14. Contractors will be responsible for implementing the MMMP through contractual agreements with the Developer. Contractors will also be required to complete their own Environmental Management Plans (EMPs) that are specific to their works and that are compliant with the MMMP. Requirements of the MMMP will be communicated to contractors (and their subcontractors) as required, to discharge the relevant consent conditions and to communicate project requirements and standards to facilitate incorporation into contractor EMPs.

15. All project personnel are required to ensure compliance with the requirements of this MMMP (and subsequent revisions thereof) and are responsible for ensuring that their actions constitute good environmental practice. All personnel are also encouraged to provide feedback and suggestions for improvements to ensure effective environmental management of all construction activities.

2 GEOPHYSICAL SURVEY MMMP

16. This section of the MMMP details the proposed marine mammal mitigation and monitoring procedures during pre-construction geophysical surveys at the CWP Project. Exposure to loud sounds can lead to a reduction in hearing sensitivity (a shift in the hearing threshold at particular frequencies), which results from physical injury to the auditory system and can result in permanent changes to the hearing sensitivity (PTS). As such, the objective of the geophysical survey MMMP is to minimise the risk of auditory injury (i.e., PTS) to marine mammals as a result of noise generated by geophysical surveys.

2.1 Survey equipment

17. Pre-construction geophysical equipment could include any or all of the following:

- **Multi-Beam Echo Sounder (MBES):** MBES is used to acquire detailed seabed topography and water depth by emitting a fan shaped swath of acoustic energy (sound waves) along a survey transect. The sound waves are reflected from the seabed to enable high resolution seafloor mapping. The MBES can be either hull- or ROV-mounted.
- **Sub-Bottom Imager (SBI):** provides a real-time 3D view of the sub-seabed via multiple 5 m wide data swaths that penetrate the seabed up to 8 m. The SBI uses a frequency modulated signal to identify buried objects, anomalies, geohazards, and stratigraphy to a 10 cm resolution[1]. SBIs are typically deployed on an ROV or towfish, close to the seabed, and operate at a much lower source level than sub-bottom profilers.
- **Side Scan Sonar (SSS):** SSS utilises conical or fan-shaped pulses of sounds directed at the seafloor to provide information on the surface of the seabed through analysis of reflected sound.
- **Sub Bottom Profiler (SBP) – pinger:** The pinger SBP is a type of geophysical survey tool that uses low frequency or high frequency sounds (pings) to identify acoustic impedance of the sub-surface geology and to identify transitions from one stratigraphic sequence to another[2]. Sound sources that produce lower frequency pulses can penetrate through and be reflected by subsurface sediments (low-resolution data), whilst higher frequency pulses achieve higher resolution images but do not penetrate the subsurface sediments[3].
- **Ultra-High Resolution Seismic (UHRS) – sparker:** A small seismic source containing a cluster of electrodes. These systems discharge high voltage impulses which heat the surrounding water within which the device is located through the use of electrode tips. The generation of heat and subsequently, steam, results in the emission of an acoustic impulse (Hartley Anderson Ltd, 2020). While sparkers are less directional than other SBPs, the acoustic energy they emit is still focussed towards the sea floor.
- **Ultra-Short Base Line (USBL) system:** A USBL system is used to obtain accurate equipment positioning during sampling activities. This system consists of a transceiver mounted under the vessel and a transponder on deployed equipment. The transceiver transmits an acoustic pulse which is detected by the transponder, followed by a reply of an acoustic pulse from the transponder. Range and bearing information allow an accurate estimate of the location of the deployed equipment.
- **Magnetometer:** A magnetometer is used to measure the variation in the earth's total magnetic field to detect and map ferromagnetic objects on or near the sea floor along the survey vessel's tracks. Often, two magnetometers are mounted in a gradiometer format to measure the magnetic

[1] https://krakenrobotics.com/our-services/sub-bottom-imager/

[2] https://www.aspectsurveys.com/survey-services/geophysical/sub-bottom-profiling/

[3] https://www.ixblue.com/maritime/subsea-imagery/sub-bottom-profilers/

gradient between the two sensors. The magnetometer is a passive system and, therefore, does not emit any noise.

2.2 PTS-onset impact ranges

18. The impact of PTS from geophysical surveys is expected to be very highly localised. Potential impact ranges are summarised in **Table 2-1**.

Table 2-1 Predicted auditory injury (PTS) impact ranges for geophysical survey equipment.

Equipment	PTS range
MBES SSS	A recent comprehensive assessment of the characteristics of acoustic survey sources proposed that MBES and SSS should be considered de minimis in terms of being unlikely to result in PTS to marine mammals (Ruppel et al., 2022).
USBL	Transmission loss from geometric spreading and frequency-dependent absorption will be such that SPLs within the main beam of the USBL can be expected to drop to below 200 dB re 1 µPa and below the PTS thresholds within a few metres of the source.
SBI	The source levels of SBI equipment are below the PTS-onset thresholds for harbour porpoise, minke whale, dolphins and seals.
SBP URHS	Results for both SBPs and URHS sparkers have indicated that PTS-onset for porpoise is likely to arise between 17–23 m from the use of this equipment at source levels of 267 dB re 1 µPa (SPL_{peak}) (BEIS, 2020). Noise modelling has previously indicated PTS-onset in minke whales within 5 m of the source when SBP pingers operate with a sound source of 220 dB re 1 µPa (SPL_{peak}) (Shell, 2017), and ~10 m for seals (Department for Business Energy & Industrial Strategy, 2019).

2.3 Mitigation of PTS

2.3.1 Primary mitigation

19. Both the Department of Housing, Local Government and Heritage (DAHG) guidance (DAHG (2014)) and the Joint Nature Conservation Committee (JNCC) guidance (JNCC (2017)) advise the use of a pre-shooting MMO watch of the Monitored / Mitigation Zone (hereafter referred to as Monitored Zone). The purpose of a pre-shooting MMO watch is to ensure the Monitored / Mitigation Zone is free of marine mammals prior to the commencement of piling operations. The use of MMOs has been a common form of observational monitoring in the USA and UK since the 1980/90s and is now seen as an industry standard practice. Since the 2000s, PAM has also become part of these standards.

20. DAHG (2014) advises a standard Monitored Zone of 500 m radius for multibeam, single beam, side-scan sonar and sub-bottom profiler surveys and that there should be a 30 minute pre-shooting MMO watch of the Monitored Zone. DAHG (2014) do not recommend the use of PAM and state that where visual observations by an MMO are not possible, the sound-producing activities should be postponed until effective visual monitoring is possible.

21. IWDG (2020) states that seabed surveys should apply standard mitigation practices, and should incorporate the use of PAM in poor visibility or darkness.

22. JNCC (2017) also advises a standard mitigation zone of 500 m radius, and states that for high resolution surveys (small airgun or electromagnetic sources: SBP, i.e., pingers, sparkers, boomers

and CHIRP systems, side-scan sonars and multibeam echosounders), there should be a 30 minute pre-shooting MMO watch of the mitigation zone. JNCC (2017) advises that a pre-shooting PAM watch should be used when visual observations by an MMO are not possible.

23. As such, and in light of more recent JNCC and IWDG guidance, which reflects international best practice, the CWP project proposes to utilise PAM during poor visibility or darkness.

2.3.2 Additional mitigation

24. None required.

2.4 Geophysical survey MMMP conclusion

25. There are primary mitigation measures currently available that could be implemented at the CWP Project, to reduce the risk of auditory injury from pre-construction geophysical surveys to negligible levels. These primary mitigation measures include:

- Establishment of a 500 m monitored / mitigation zone;
- Pre-shooting Marine Mammal Observer (MMO) watches (30 minutes); and
- Pre-shooting Passive Acoustic Monitoring (PAM) (if required to supplement the MMO) during poor visibility or darkness.

3 WTG / OSS PILING MMMP

26. This section of the MMMP details the proposed marine mammal mitigation and monitoring procedures during piling activities at the CWP Project. Exposure to loud sounds can lead to a reduction in hearing sensitivity (a shift in the hearing threshold at particular frequencies), which results from physical injury to the auditory system and can result in permanent changes to the hearing sensitivity (PTS). The assessment of PTS includes both instantaneous PTS using the SPL_{peak} metric (this is the PTS-onset impact range from a single strike), and cumulative PTS using the SEL_{cum} metric (this is the PTS-onset impact range from a cumulation of threshold shift across all pile strikes within a 24-hour period). As such, the objective of the Piling MMMP is to minimise the risk of auditory injury (i.e., PTS) to marine mammals as a result of noise generated by piling activities.

27. For the offshore components of the CWP Project, the representative scenario for assessment is the installation of 75 WTG foundations, in addition to the installation of three offshore substations (OSS). Only monopile foundations are proposed for the CWP Project and thus only monopile foundation types have been assessed in the Environmental Impact Assessment (EIA) undertaken for marine mammals (see **Chapter 11 Marine Mammals**).

28. The foundation installation duration under the representative scenario is expected to be up to 78 days in total over the construction period for the WTGs and the OSS combined (assuming 1 pile installed per day). A summary of the piling parameters assessed are presented in **Section 3.1**.

29. In **Chapter 11** of the EIAR, the assessment provides predicted impacts from the representative scenario. The predicted impacts are outlined in **Section 3.2**.

3.1 Piling parameters

30. Underwater noise modelling of pile driven WTG foundations has been undertaken by Subacoustech Environmental Limited using the INSPIRE model. Full details of the underwater noise modelling methods can be found in **Appendix 9.4 Underwater Noise Assessment**. Four WTG model locations were selected within the array site to represent the range of ground conditions across the site as well as the varying water depth (SE, SW, NE and NW). Three piling scenarios have been assessed:

- **Scenario 1 (SE model location):** Most restrictive – 9.5 m monopile, maximum 4,400 kJ hammer energy, 1 pile per 24 hours, 3.17 hours piling, 5,594 hammer strikes;
- **Scenario 2 (NE and SW modelling locations + OSS):** Less restrictive – 9.5 m monopile, maximum 4,400 kJ hammer energy, 1 pile per 24 hours, 3.17 hours piling, 4,734 hammer strikes;
- **Scenario 3 (NW model location):** Least restrictive – 9.5 m monopile, maximum 4,400 kJ hammer energy, 2 piles per 24 hours, 6.33 hours piling, 9,468 hammer strikes.

31. The WTG piling parameters for each scenario, including soft-start and ramp-up details, are provided in **Table 3-1**. Note, the exact same piling parameters are assumed for the installation of the OSS, adopting scenario 2 which is representative of the OSS locations proposed.

Table 3-1 Piling parameters for WTGs under each piling scenario

Energy (kJ)	440	440	1,100	2,200	3,300	4,400	Total
Scenario 1 (SE piling location): Most restrictive (9.5 m pile diameter / 4,400kJ blow energy / 1 pile per 24 hours)							**1 pile per day**
# strikes per pile	200	1,248	1,151	1,143	899	953	**5,594**
Duration (s)	1,200	2,160	1,980	1,980	1,800	2,280	**3 hours 10 minutes**
Strike rate (blows/min)	10	35	35	35	30	25	**–**
Scenario 2 (SW and NE piling locations): Less restrictive (9.5 m pile diameter / 4,400kJ blow energy / 1 pile per 24 hours)							**1 pile per day**
# strikes per pile	200	277	279	277	240	3,461	**4,734**
Duration (s)	1,200	480	480	480	480	8,280	**3 hours 10 minutes**
Strike rate (blows/min)	10	35	35	35	30	25	**–**
Scenario 3 (NW piling location): Least restrictive (9.5 m pile diameter / 4,400kJ blow energy / 2 piles per 24 hours)							**2 piles per day**
# strikes per pile	200	277	279	277	240	3,461	**4,734 per pile** **9,468 for 2 piles**
Duration (s)	1,200	480	480	480	480	8,280	**3 hours 10 minutes per pile** **6 hours 20 minutes for 2 piles**
Strike rate (blows/min)	10	35	35	35	30	25	**–**

3.2 PTS-onset impact ranges

3.2.1 Instantaneous PTS (SPL_{peak})

32. **Table 3-2** outlines the instantaneous PTS-onset impact ranges (using the SPL_{peak} metric). The maximum instantaneous PTS-onset impact range at full hammer energy is 620 m for harbour porpoise at the SE modelling location under piling scenario 1. For minke whales, dolphins and seals, the instantaneous PTS-onset range is <50 m for all modelling locations.

Table 3-2 Predicted instantaneous auditory injury (PTS) impact ranges (m) from WTG piling

Species	Piling scenario	Instantaneous PTS (SPL_{peak})			
		SE	SW	NE	NW
Harbour porpoise	1	620	–	–	–
	2	–	460	420	–
	3	–	–	–	390
Dolphins	1	<50	–	–	–
	2	–	<50	<50	–
	3	–	–	–	<50
Minke whale	1	<50	–	–	–
	2	–	<50	<50	–
	3	–	–	–	<50
Seals	1	<50	–	–	–
	2	–	<50	<50	–
	3	–	–	–	<50

3.2.2 Cumulative PTS (SEL_{cum})

33. **Table 3-3** outlines the cumulative PTS-onset impact ranges (using the SEL_{cum} metric). The maximum cumulative PTS-onset impact range is 9.5 km for minke whales at the SE modelling location under piling scenario 1 (for scenarios 2 and 3 the maximum range is notably smaller than scenario 1, with a maximum range of 5.8 km for scenario 2 and 2.0 km for scenario 3). For harbour porpoise, the maximum cumulative PTS-onset impact range is 4.7 km at the SE modelling location under piling scenario 1 (for scenarios 2 and 3 the maximum range is notably smaller than scenario 1, with a maximum range of 3.2 km for scenario 2 and 2.2 km for scenario 3). For dolphins and seals, the maximum cumulative PTS-onset range is <100 m at all modelling locations and under all scenarios.

Table 3-3 Predicted cumulative auditory injury (PTS) impact ranges (m) from WTG piling

Species	Piling scenario	Cumulative PTS (SEL_{cum})			
		SE	SW	NE	NW
Harbour porpoise	1	4,700	–	–	–
	2	–	2,500	3,200	–
	3	–	–	–	2,200
Dolphins	1	<100	–	–	–
	2	–	<100	<100	–
	3	–	–	–	<100
Minke whale	1	9,500	–	–	–
	2	–	3,000	5,800	–
	3	–	–	–	2,000
Seals	1	<100	–	–	–
	2	–	<100	<100	–
	3	–	–	–	<100

3.3 Mitigation requirements

34. It is not known at this stage if NPWS require mitigation of the instantaneous PTS-onset impact range only, or the cumulative PTS-onset impact range.

35. In Scotland, NatureScot advise that only the instantaneous PTS-onset range (using the SPL_{peak} metric) requires mitigation. NatureScot consider it to be disproportionate to mitigate the cumulative PTS-onset impact range given the acknowledged uncertainties and over-precaution in the cumulative PTS modelling.

36. Underwater noise modelling conducted for the CWP Project has predicted that the maximum PTS-onset range for cumulative PTS is 4.7 km for harbour porpoise and 9.5 km for minke whales. However, there is much uncertainty associated with the prediction of the cumulative PTS impact ranges. These are described in detail in **Chapter 11 Marine Mammals** and summarised here. The prediction of the onset of PTS is determined with the assumptions that:

- The amount of sound energy an animal is exposed to within 24 hours will have the same effect on its auditory system, regardless of whether it is received all at once (i.e., with a single bout of sound) or in several smaller doses spread over a longer period (called the equal-energy hypothesis); and
- The sound keeps its impulsive character, regardless of the distance to the sound source.

37. However, in practice:

- There is a recovery of a threshold shift caused by the sound energy if the dose is applied in several smaller doses (e.g., between pulses during pile driving or in piling breaks) leading to an onset of PTS at a higher energy level than assumed with the given SEL_{cum} threshold (e.g., Kastak et al., 2005, Mooney et al., 2009, Finneran et al., 2010, Kastelein et al., 2013, Kastelein et al., 2014, Finneran, 2015, Kastelein et al., 2015); and

- Pulsed sound loses its impulsive characteristics while propagating away from the sound source, resulting in a slower shift of an animal's hearing threshold than would be predicted for an impulsive sound (Hastie et al., 2019, Martin et al., 2020, Southall, 2021).

38. Both assumptions, therefore, lead to a conservative determination of the cumulative PTS-onset impact ranges.

39. Given these levels of uncertainty and over-precaution and given that this is an evolving field of research, the Developer does not consider it necessary to commit to mitigating the current predicted cumulative PTS-onset ranges. However, the Developer has provided a suite of appropriate additional mitigation measures that can achieve the required reduction in noise level if ABP and NPWS consider it appropriate.

40. In the event that it is deemed necessary by ABP and NPWS to mitigate the current cumulative PTS onset range, the CWP Project commits to implementing Noise Abatement Systems to ensure an effective reduction of underwater noise of 10 dB SEL_{ss}.

41. The mitigation measures outlined here are divided into those required to mitigate instantaneous PTS (primary mitigation) and those required to mitigate cumulative PTS (additional mitigation).

3.4 Primary mitigation: Instantaneous PTS (SPL_{peak})

42. The instantaneous PTS-onset impact ranges (maximum 620 m) can be mitigated using 'Primary Mitigation Measures'. Primary mitigation measures include those that are considered to be 'industry standard' and are supported by the guidance. These are as follows, and are in addition to the soft-start and energy ramp-up already included in the primary mitigation and modelling:

- Pre-piling MMO watches of the Monitored Zone; and
- Pre-piling PAM.

3.4.1 Pre-piling MMO watches

43. The purpose of a pre-piling MMO watch is to ensure the Monitored Zone is free of marine mammals prior to the commencement of piling operations. The use of MMOs has been a common form of observational monitoring in the USA and UK since the 1980/90s and is now seen as an industry standard practice. Since the 2000s, PAM has also become part of these standards.

44. NPWS (2014) recommends the following approach be adopted, which the proposed project will implement through this MMMP:

- The Monitored Zone will be informed by underwater noise modelling where available;
- The MMO(s) should be qualified and experienced. NPWS (2014) state that a qualified and experienced MMO is defined as *'a visual observer who has undergone formal marine mammal observation and distance estimation training (JNCC MMO training course or equivalent) and also has a minimum of 6 weeks full-time marine mammal survey experience at sea over a 3-year period in European waters'*;
- The MMO should have an unobstructed view of the Monitored Zone;
- The MMO should ideally be located near the centre of the Monitored Zone (i.e., adjacent to the sound source);

- Pre-start up monitoring of the Monitored Zone should be conducted for **at least 30 minutes** before piling commences;
- Piling is not to commence until at least 30 minutes have elapsed with no marine mammals detected within the Monitored Zone by the MMO;
- Once piling has commenced, there is no requirement to cease piling if a marine mammal occurs within the Monitored Zone; however, the MMO should continue monitoring the Monitored Zone during the ramp-up / soft-start procedure; and
- If for any reason there is a break in piling for a period longer than 30 minutes, then pre-start monitoring must be undertaken again, followed by the subsequent ramp-up procedure.

3.4.2 Pre-piling PAM

45. Passive acoustic monitoring (PAM) is the use of acoustic sensors to detect vocalising marine mammals. Since the mid-2000s, PAM has become a part of best practice industry standards in an effort to provide increased marine mammal monitoring capacities during periods of limited visibility, and to prevent delays in the construction and / or operations of offshore industries.

46. In the context of this MMMP, PAM is primarily used as a tool to detect and localise vocalising marine mammals. NPWS (2014) states that PAM '*may be recommended or required as part of the licence / consent conditions in order to optimise marine mammal detection around the site of a plan or project*'. NPWS (2014) highlights that while PAM is encouraged, it was not at the time of publication in 2014 considered by NPWS to be sufficiently developed to be considered the primary or only mitigation measure, as it was not considered to reliably detect all marine mammal species and has a limited detection range for some species.

47. IWDG (2020) recommends that PAM is used in standard mitigation protocols to '*allow detection of cetaceans in poor visibility during the hours of darkness and for detecting animals underwater where source levels are often highest*'.

48. JNCC (2010b) recommends the use of dedicated MMOs and PAM operators. They state that PAM can be a useful supplement to visual observations, though its use is limited by detection range (detecting harbour porpoise in a 500 m mitigation zone), and they also note the limitation that only vocalising animals can be detected. If used, JNCC recommend that the PAM operative should acoustically monitor for marine mammals for a **minimum of 30 minutes** prior to piling commencing, and if a marine mammal is detected, piling should not commence until 20 minutes after the last acoustic detection within the mitigation zone.

49. Given the proposed CWP project will require piling during periods of poor visibility and darkness, it is proposed that pre-piling PAM will be implemented. This will shorten the overall piling programme and the temporal impacts to marine mammals.

3.5 Additional mitigation: Cumulative PTS (SEL_{cum})

50. The inherently conservative maximum predicted cumulative PTS-onset impact ranges (4.7 km for porpoise, 9.5 km for minke whale) are beyond those that can be mitigated by the 'primary' 'industry standard' mitigation measures. As such, additional mitigation measures will be considered ***if NPWS confirm there is a requirement to mitigate cumulative PTS-onset impact ranges***.

51. The piling MMMP provides an outline of the potential additional mitigation measures (in addition to those required to mitigate instantaneous PTS) that could be implemented to reduce the risk of cumulative PTS to negligible levels. The mitigation measures provided reflect current best practice through reference to NPWS guidance and the more recent IWDG policy, and from other relevant

regions for the marine mammal population including, for example, Scottish precedent wherein NatureScot and the Marine Directorate accept ADD and PAM.

3.5.1 Pre-piling ADD activation

52. The purpose of pre-piling ADD activation is to deter marine mammals out of the Monitored Zone prior to the start of piling. The use of pre-piling ADDs is endorsed by Natural England, the MMO and NatureScot, and have been extensively accepted and used as a pre-piling mitigation method in England, Wales, Scotland and other European jurisdictions (e.g., German waters) over the last decade.

53. NPWS (2014) guidance does not include the use of pre-piling ADDs.

54. IWDG (2020) recommends that ADDs should be used to '*reduce the threat of auditory injury, where they are known to be effective for the species present'*. The policy recommends that ADD use should '*not exceed the noise levels of the mitigated activity itself and be only used prior to commencing activities'*.

55. JNCC (2010b) states that ADDs should be considered, but only used in conjunction with visual and / or acoustic monitoring.

56. Currently, the most common ADD used in piling mitigation is the Lofitech AS seal scarer[4]. This ADD has been shown to have the most consistent effective deterrent ranges for harbour porpoise and minke whales, as detailed in the sections below: 'Deterrence of harbour porpoise' and 'Deterrence of minke whales'. It is important to note that there may be additional ADD models identified in the pre-construction phase that are available and suitable for use. As such, if an ADD is identified as part of the suite of mitigation measures set out in the final MMMP, the final ADD choice and specification would be confirmed within the final MMMP.

57. The duration of ADD deployment would be calculated using swimming speed assumptions to ensure that marine mammals are beyond the Monitored Zone when piling commences. For example:

- Assuming a harbour porpoise swims at 1.5 m/s, it would require:
  - 11.1 minutes of ADD activation for an animal to flee from the pile out to 1 km; and
  - 52.2 minutes of ADD activation for an animal to flee from the pile out to 4.7 km (*this is within the range at which ADDs result in significant deterrence of porpoise*).
- Assuming a minke whale swims at 3.25 m/s, it would require:
  - 5.1 minutes of ADD activation for an animal to flee from the pile out to 1 km; and
  - 48.7 minutes of ADD activation for an animal to flee from the pile out to 9.5 km (*though it is noted that there is no evidence currently that ADDs are effective at deterring minke whales out to this distance*).

58. It is important that where ADDs are to be used, the duration of their use is balanced against the increased disturbance impact to marine mammals caused by their use. Therefore, where ADDs are used for mitigation purposes, the duration of their activation would need to be discussed and agreed with NPWS to ensure that the additional impact of disturbance is proportional.

[4] https://www.lofitech.no/

Deterrence of harbour porpoise

59. In the German North Sea, an array of CPODs was used to test the effectiveness of Lofitech devices for deterring harbour porpoise (Brandt et al., 2013b). The extent of deterrence was measured by recording porpoise vocalisations up to 7.5 km from the Lofitech deployment site. Ten trials were conducted, where each trial collected four hours of acoustic detections, in conjunction with an active ADD. During the 40 hours of collected data, there was a significant decline in porpoise detections. Within 750 m, detections of porpoise declined by 86% when the ADD was active. Furthermore, declines in porpoise detections were significant up to 7.5 km from the ADD source (**Plate 3-1**).

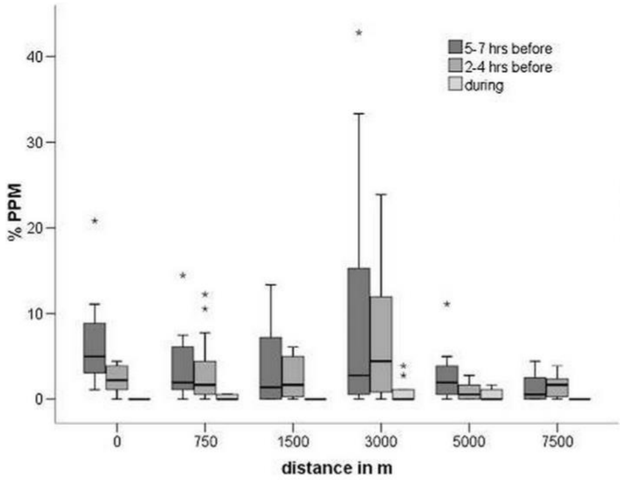


Plate 3-1 Percentage of porpoise positive minutes recorded before and during Lofitech trials at various distances (Brandt et al., 2013b)

60. In addition to acoustic monitoring, visual aerial surveys were conducted to identify changes in harbour porpoise presence during ADD activation. The average density fell to 0.3 porpoise/km^2 when the Lofitech device was activated, where baseline density estimates were 2.4 porpoise/km^2, over the 990 km^2 study area (**Plate 3-2**). To determine the duration of deterrence caused by ADDs, Brandt et al., (2013b) compared harbour porpoise detections before Lofitech activation and after the device was switched off. Porpoise detection rates were significantly lower up to six hours after devices were switched off, and after 7–9 hours, no significant difference was detected.

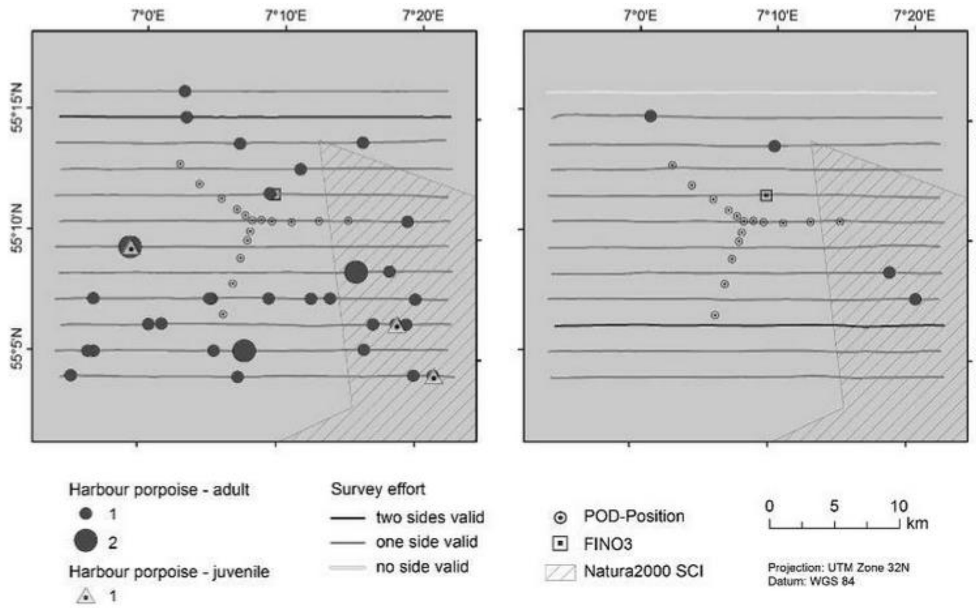


Plate 3-2 Harbour porpoise aerial sightings before (left) and during (right) Lofitech activation (Brandt et al., 2013b)

61. Brandt et al., (2013a) conducted further visual surveys to determine the responses of harbour porpoises to Lofitech ADDs (**Plate 3-3** and **Plate 3-4**). In Danish waters, devices were active for four continuous hours, with seven trials in total, leading to 28 hours of collected data. Sighting rates of harbour porpoise significantly declined up to 1 km from the active Lofitech device, which was associated with a minimum sound level of 129 dB re 1 µPa RMS. Upon activation of the ADD, the mean number of porpoises detected during a scan decreased from 0.86 to 0.01. While Lofitech trials in German waters observed avoidance up to 7.5 km from the device, in Danish waters avoidance was detected at a maximum of 2.4 km from the ADD. However, due to differences in water depth, the sound level at the offshore German site (119 dB re 1 µPa) and the more coastal Danish site were comparable. Porpoise avoidance behaviour occurred immediately upon device activation, with average swim speeds recorded at 1.6 m/s. Visual observations confirmed porpoises within a 1 km radius of the device, on average 51 minutes after the device was deactivated.

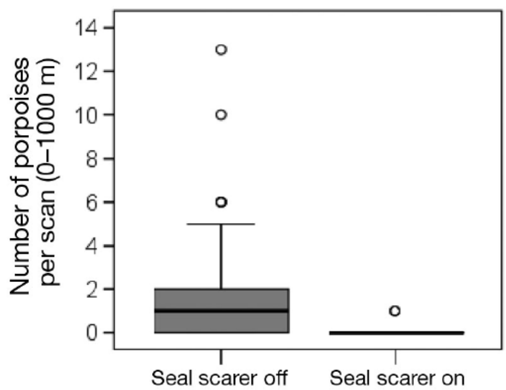


Plate 3-3 Number of harbour porpoises seen during scans when the Lofitech device was active and inactive (Brandt et al., 2013a)

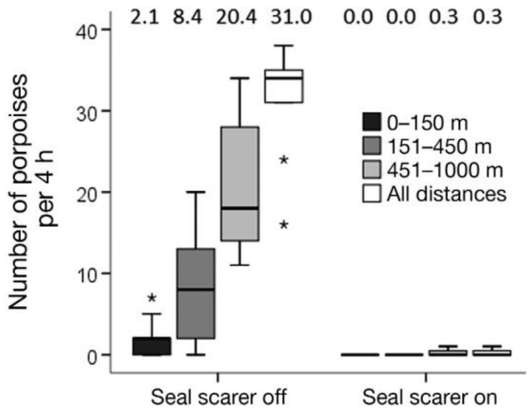
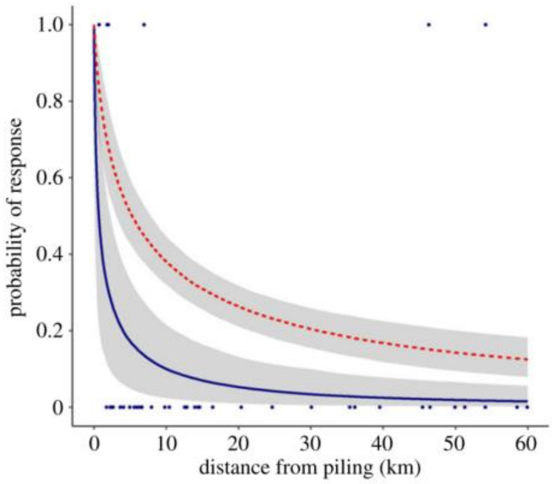


Plate 3-4 Harbour porpoise sighting rates when the Lofitech device was active and inactive over a range of distances (Brandt et al., 2013a)

62. ADDs were deployed (typically for 15 minutes) prior to piling to mitigate potential near-field injury impacts to harbour porpoise at the Beatrice Offshore Wind Farm, and a study of their effectiveness at this site is presented in Graham et al., (2019). They showed that there was a 50% chance of porpoise response out to 5.3 km (95% CI: 3.1–7.8 km) from piling with prior ADD activation. They also note that porpoise responses were higher when ADDs were activated prior to piling compared to when piling occurred without pre-piling ADD activation, though there was only a limited dataset to inform this. They highlight that a balance is needed to mitigate the near-field injury impacts while minimising the wider-field disturbance impacts.



63.

Plate 3-5 The probability of a harbour porpoise response (12 h) in relation to the partial contribution of distance from piling, with (dashed red line) and without (solid navy line) the use of the ADD prior to piling (Graham et al., 2019)

Deterrence of minke whales

64. During a study commissioned by Offshore Renewables Joint Industry Programme (ORJIP) in the UK, the playback of Lofitech ADDs resulted in behavioural modifications of minke whales (McGarry et al., 2017, Boisseau et al., 2021). A significant increase in swim speed and direct movement away from the ADD source implied avoidance of the Lofitech device (**Plate 3-6**). It was therefore suggested that

Lofitech ADDs may be used as a deterrent of minke whales from mitigation zones. One limitation of this study was the ability to follow the focal whale after it had been exposed to the ADD. The ADD was activated 1 km from the focal animal, and remained active for 15 minutes; all animals responded, which demonstrates an effective deterrence zone of at least 1 km. No measurements were made with ADDs activated at initial distances >1 km from the focal animal, and the visual limit of observations limited how far animals could be observed responding, so it is not known what the maximum effective deterrence range is. However, several animals continued to swim further away to a distance of between *c*. 3 km and 4.5 km following exposure.

65. To date, no further studies on the effective deterrence of minke whales from ADDs have been conducted.

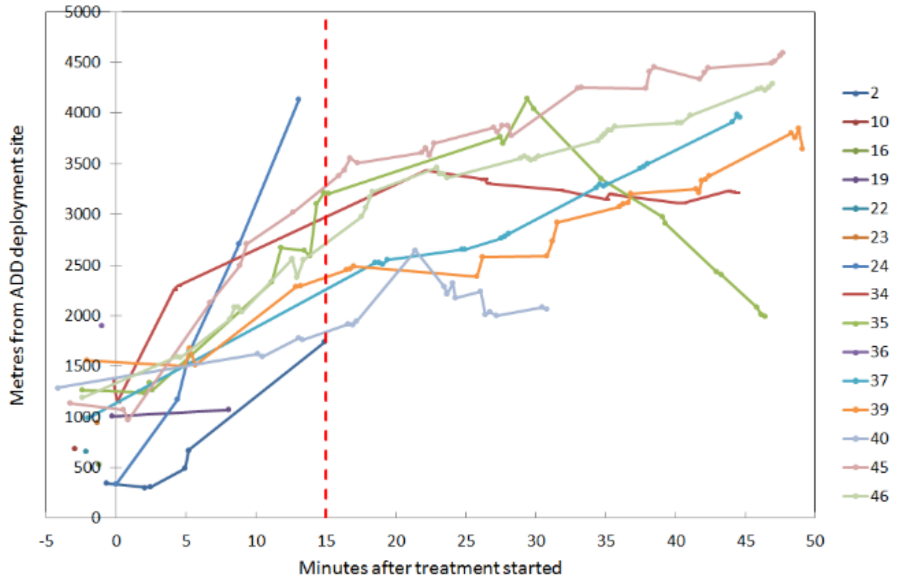


Plate 3-6 Distance of focal whales from the ADD deployment site during treatment and post treatment phases of the experiment (McGarry et al., 2017). The red dashed line indicates the end of the treatment phase.

3.5.2 Potential other additional mitigation measures

66. The predicted cumulative PTS-onset impact range for minke whales (maximum 9.5 km) is beyond those that can be mitigated by the primary 'industry standard' mitigation measures (MMO and PAM). Additionally, whilst there is evidence of affective deterrence out to 3–4 km, there is currently no evidence that ADDs can deter minke whales effectively out to a range of 9.5 km. As such, potential other additional mitigation measures (at-source noise abatement methods and alternative hammer types) will be considered ***if NPWS confirm there is a requirement to mitigate cumulative PTS-onset impact ranges***.

67. There are a number of different at-source noise abatement systems that have been commercially deployed at offshore wind farm projects. The purpose of these noise abatement systems is to reduce the noise propagated through the water column during pile driving, and thus reduce the impact of piling noise on marine life. At this stage it is important to note that the mitigation technology is evolving, and several technologies remain subject to a single supplier. As such, whilst the ability to mitigate to the required level is certain using any one of the technologies, it is prudent to present options in this

MMMP, and to select appropriate options, if required, in consultation with stakeholders closer to the time of construction.

Bubble curtains

68. Bubble curtains are described by Verfuss et al., (2019) as follows: '*Bubble curtains are formed by compressed air that is pumped through one or more nozzle hoses that are laid around the piling position at the seafloor. The air ascends through the nozzles into the water column up to the water surface and thereby builds a curtain of bubbles arising vertically along the tube. Piling sound will be absorbed, reflected and scattered from the ascending air bubbles, and thereby reduced*.'

69. There is increasing information on the effectiveness of bubble curtains to reduce underwater noise, for example:

- Bellmann et al., (2020) report that a single Big Bubble Curtain (BBC) can result in 7 to 11 dB SEL re 1 μPa^{2}s reduction in 40 m water depth, an 8 to 14 dB SEL reduction in 30 m water depth and an 11 to 15 dB reduction in 25 m water depth. Additionally, an optimised double BBC can result in an 8 to 18 dB SEL re 1 μPa^{2}s reduction at 40 m water depth, depending on the air volume used.

Resonators

70. Resonators are described by Verfuss et al., (2019) as follows: '*Resonators consist of an array of (solely or mainly) resonating units that are deployed around the pile to absorb the emitted sound. Unlike with BBCs, which are built of ascending air bubbles from a nozzle hose laid at the seafloor, there are a variety of different ways to build resonators'*. These can include air-filled balloons or foam elements.

71. There is increasing information on the effectiveness of resonators to reduce underwater noise, for example:

- Elzinga et al., (2019) reported on the new noise mitigation system (NMS) developed under the Underwater Noise Abatement System program with a consortium of partners: Van Oord Offshore Wind Projects, AdBm Technologies and TNO (Netherlands Organization for Applied Scientific Research). The NMS consists of a slatted system containing Helmholtz resonators deployed around a monopile. A full-scale test in 2018 showed that a configuration of 0.67 m vertical spacing of slats resulted in a 7 to 8 dB SEL re 1 μPa^{2}s reduction compared to the unmitigated scenario, and when combined with a big bubble curtain resulted in a 14 to 15 dB SEL reduction.
- The Hydro-Sound Damper (HSD) developed by OffNoise Solutions GmbH consists of a net of foam elements of different sizes and materials, and has been shown to result in a 10 to 12 dB SEL re 1 μPa^{2}s reduction alone, or a 15 to 20 dB SEL reduction when used in combination with an optimised BBC (Bellmann et al., 2020).

Casings

72. Casings are described by Verfuss et al., (2019) as follows: '*Casings are hard or soft shells that enclose the pile with reflective material during the piling activity to keep the sound emitted by the pile trapped within the casing. Casings range from flexible pile sleeves made of different fabrics to hollow steel tubes*.'

73. There is increasing information on the effectiveness of casings to reduce underwater noise, for example:

- The IHC-Noise Mitigation Screen developed by IHC IQIP bv consists of a double walled steel tube, with an air-filled interspace. This device has been shown to result in a 13 to 17 dB SEL re 1 μPa²s reduction alone, a 17 to 23 dB SEL reduction when used in combination with an optimised BBC or a 19 to 22 dB SEL reduction when used in conjunction with an optimised double BBC (Bellmann et al., 2020).
- The HydroNAS™ sleeve system developed by W3G Marine Ltd consists of a lightweight inflatable fabric which is used to form a column of air around the pile. The manufacturers website states that this system can result in a 25 dB SEL re 1 μPa²s reduction alone[5].

Environmental limitations

74. The use and effectiveness of each at-source noise abatement method is subject to environmental conditions such as water depth, current speed, wave height and wind speed. These are described further in Verfuss et al., (2019). These system specific environmental limitations need to be taken into consideration when considering which at-source noise abatement method may be suitable for use at the CWP Project.

Alternative hammer types

75. There are a number of different hammer types that have been commercially deployed at offshore wind farm projects for the installation of monopiles. The purpose of these varying hammer types is to reduce the noise propagated through the water column during pile driving, and thus reduce the impact of piling noise on marine life.

76. Whilst CWP have demonstrated that the project can be constructed through traditional percussive piling methods whilst avoiding significant adverse effects (see **Chapter 11 Marine Mammals**), as a responsible developer CWP will continue to review available technology and where new hammer technology is available with a demonstrable reduction in noise at source CWP will review and consider the practical implementation of alternative technology if available. The following sections describe potential or typical technology that may be available, however it is important to note that the technology is nascent, subject to ongoing development, and the specific technology described below cannot be committed to at this stage due to the potential for that technology or manufacturer not being available at the point of construction.

BLUE Piling Technology

77. The BLUE Piling technology is described by Verfuss et al., (2019) as follows: *'The BLUE Hammer from Fistuca BV consists of a steel housing that can be filled with a large water column. The water column is accelerated upwards before dropping onto the pile. High energy levels are achievable which allow a long-lasting blow with high force levels. The cycle of raising and dropping the water column is repeated'.*

78. BLUE Piling technology, produced by Fistuca BV, reduces noise at the source during installation by using the impact of a large water mass to create a pushing force on the pile (Bellmann et al., 2020). This technology reduces vibrations on the pile wall and provides a significant reduction of underwater noise compared to a conventional hammer impact. Underwater noise measurements during a full-

[5] https://www.w3gmarine.com/hydronas.html

scale monopile installation have showed a reduction in underwater noise emissions of more than 20 dB SEL when compared to conventional hammers (Bellmann et al., 2020).

Vibratory Hammers

79. Vibratory hammers are described by Verfuss et al. (2019) as follows: *'The vibratory hammer can be used to vibrate the pile with a certain low vibrating frequency vertically into the seabed. Pairs of counter-rotating eccentric masses generate an upwards and downwards movement, resulting in a vertical amplitude which results in a temporary reduction in soil resistance, which allows the pile to sink into the soil'.*

80. Vibratory piling has been used as an alternative method to impact piling at many wind farms. For example, CAPE Holland's Vibro Lifting Tool (VLT; i.e., vibratory hammer) can support the installation of both monopiles (XXL piles, up to 4 m diameter) and jacket piles and has been commercially deployed in water depths up to 30 m, whilst Dieseko's PVE vibratory hammer has been commercially deployed in water depths up to 40 m (Verfuss et al., 2019).

3.6 WTG / OSS Piling MMMP conclusion

81. A suite of potential mitigation measures are currently available that could be implemented at the CWP Project, to reduce the risk of auditory injury from pile driving to negligible levels. These include:

- For the mitigation of instantaneous PTS (primary mitigation):
    - Pre-piling MMO watches; and
    - Pre-piling PAM (if required to supplement the MMO) during poor visibility or darkness.
- For the mitigation of cumulative PTS (additional mitigation, if required):
    - Pre-piling ADD activation;
    - At-source noise abatement methods; and
    - Alternative hammer types.

82. Both NPWS (2014) and JNCC (2010b) recommend the use of visual observations by an MMO for **at least 30 minutes** prior to piling commencing to ensure the monitored / mitigation zone is free of marine mammals, supplemented with acoustic monitoring by a PAM operator. The use of ADDs prior to piling is not considered in the NPWS (2014) guidance, but the JNCC (2010b) guidance suggests it is considered. The pre-construction MMMP will be agreed with NPWS and the relevant Regulator closer to the time of construction to ensure appropriate technologies are used, and that the most recent guidance and best practice measures are implemented.

4 ONSHORE SUBSTATION PILING MMMP

83. Activities at the onshore substation on the northern shore of the Poolbeg Peninsula may require the installation of a combi-wall and reclamation for the ESB building at landfall on the banks of the River Liffey, Dublin. These activities will occur in the River Liffey, and thus will generate underwater noise that requires consideration in the marine mammal assessment. While it is expected that the combi-wall may be installed using vibro-piling, impact piling using 2.5 m diameter tubular piles was assessed as a proven technology that may also be utilised.

84. The assessment of PTS includes both instantaneous PTS using the SPL_{peak} metric (this is the PTS-onset impact range from a single strike), and cumulative PTS using the SEL_{cum} metric (this is the PTS-onset impact range from a cumulation of threshold shift across all pile strikes within a 24-hour period). As such, the objective of the Piling MMMP is to minimise the risk of auditory injury (i.e., PTS) to marine mammals as a result of noise generated by piling activities.

4.1 Piling parameters

85. Underwater noise modelling for the onshore substation has been undertaken by Subacoustech Environmental Limited using the INSPIRE model. Full details of the underwater noise modelling methods can be found in **Appendix 9.4 Underwater Noise Assessment** and are summarised here in **Table 4-1**. Piling for the onshore substation will be undertaken using a crawler crane with impact hammer attachment, rather than marine vessels.

Table 4-1 Piling parameters for the onshore substation

	1 piling rig	2 piling rigs
Maximum hammer energy (kJ)	400	400
Total number of strikes per piling event	48,000	96,000
Duration of piling event	8 hours	8 hours

4.2 PTS-onset impact ranges

4.2.1 Instantaneous PTS (SPL_{peak})

86. **Table 4-2** outlines the instantaneous PTS-onset impact ranges (using the SPL_{peak} metric). The maximum instantaneous PTS-onset impact range at full hammer energy is <50 m for all marine mammal species.

Table 4-2 Predicted instantaneous auditory injury (PTS) impact ranges (m) from WTG piling at the onshore substation

Species	Instantaneous PTS (SPL_{peak})
Harbour porpoise	<50
Dolphins	<50
Minke whale	<50
Seals	<50

4.2.2 Cumulative PTS (SEL_{cum})

87. **Table 4-3** outlines the cumulative PTS-onset impact ranges (using the SEL_{cum} metric). The maximum cumulative PTS-onset impact range is 3 km for harbour porpoise and 2 km for minke whales when 2 piling onshore rigs are piling simultaneously. For dolphins, the maximum cumulative PTS-onset impact range is <100 m. For seals, this is 300 m.

Table 4-3 Predicted auditory injury (PTS, SEL_{cum}) from piling at the onshore substation

	Minke whale	Dolphins	Harbour porpoise	Seals
Cumulative PTS (SEL_{cum}) 1 rig				
Area (km^2)	0.7	<0.01	1.5	<0.1
Max range (m)	1,100	<50	2,000	130
Cumulative PTS (SEL_{cum}) 2 rig				
Area (km^2)	1.4	<0.1	2.8	<0.1
Max range (m)	2,000	<100	3,000	300

4.3 Primary mitigation: Instantaneous PTS (SPL_{peak})

88. The instantaneous PTS-onset impact ranges (maximum 50 m) can be mitigated using ‘Primary Mitigation Measures’. Primary mitigation measures include those that are considered to be ‘industry standard’ and are supported by the NPWS (2014) guidance. These are as follows:

- Pre-piling MMO watches of the Monitored Zone; and
- Pre-piling PAM (if required).

4.3.1 Pre-piling MMO watches

89. As noted previously, the purpose of a pre-piling MMO watch is to ensure the Monitored Zone is free of marine mammals prior to the commencement of piling operations. The use of MMOs has been a common form of observational monitoring in the USA and UK since the 1980/90s and is now seen as an industry standard practice. Since the 2000s, PAM has also become part of these standards.

90. NPWS (2014) recommends the following approach be adopted, which the proposed project will implement through this MMMP:

- The Monitored Zone should be informed by underwater noise modelling where available (modelling has shown <50 m);
- The MMO(s) should be qualified and experienced. NPWS (2014) state that a qualified and experienced MMO is defined as *'a visual observer who has undergone formal marine mammal observation and distance estimation training (JNCC MMO training course or equivalent) and also has a minimum of 6 weeks full-time marine mammal survey experience at sea over a 3-year period in European waters'*;
- The MMO should have an unobstructed view of the Monitored Zone;
- The MMO should be ideally located near the centre of the Monitored Zone (i.e., adjacent to the sound source);
- Pre-start up monitoring of the Monitored Zone should be conducted for **at least 30 minutes** before piling commences;
- Piling is not to commence until at least 30 minutes have elapsed with no marine mammals detected within the Monitored Zone by the MMO;
- Once piling has commenced, there is no requirement to cease piling if a marine mammal occurs within the Monitored Zone; however, the MMO should continue monitoring the Monitored Zone during the ramp-up / soft-start procedure; and
- If for any reason there is a break in piling for a period longer than 30 minutes, then pre-start monitoring must be undertaken again, followed by the subsequent ramp-up procedure.

4.3.2 Pre-piling PAM

91. As noted previously, PAM is the use of acoustic sensors to detect vocalising marine mammals. Since the mid-2000s, PAM has become a part of best practice industry standards in an effort to provide increased marine mammal monitoring capacities during periods of limited visibility, and to prevent delays in the construction and / or operations of offshore industries.

92. In the context of this MMMP, PAM is primarily used as a tool to detect and localise vocalising marine mammals. NPWS (2014) states that PAM '*may be recommended or required as part of the licence / consent conditions in order to optimise marine mammal detection around the site of a plan or project*'. NPWS (2014) highlights that while PAM is encouraged, it was not at the time of publication in 2014 considered by NPWS to be sufficiently developed to be considered the primary or only mitigation measure, as it was not considered to reliably detect all marine mammal species and has a limited detection range for some species.

93. IWDG (2020) recommends that PAM is used in standard mitigation protocols to '*allow detection of cetaceans in poor visibility during the hours of darkness and for detecting animals underwater where source levels are often highest'*.

94. JNCC (2010b) recommends the use of dedicated MMOs and PAM operators. They state that PAM can be a useful supplement to visual observations, though its use is limited by detection range (detecting harbour porpoise in a 500 m mitigation zone), and they also note the limitation that only vocalising animals can be detected. If used, JNCC recommend that the PAM operative should acoustically monitor for marine mammals for a **minimum of 30 minutes** prior to piling commencing, and if a marine mammal is detected, piling should not commence until 20 minutes after the last acoustic detection within the mitigation zone.

95. Given the proposed CWP project will require piling during periods of poor visibility and darkness, it is proposed that pre-piling PAM will be implemented. This will shorten the overall piling programme and the temporal impacts to marine mammals.

4.4 Additional mitigation: Cumulative PTS (SEL_{cum})

96. The maximum predicted cumulative PTS-onset impact ranges (3 km for porpoise, 2 km for minke whale) are beyond those that can be mitigated by the 'primary' 'industry standard' mitigation measures. As such, additional mitigation measures will be considered ***if NPWS confirm there is a requirement to mitigate cumulative PTS-onset impact ranges***.

97. The piling MMMP provides an outline of the primary and potential additional mitigation measures that could be implemented to reduce the risk of cumulative PTS to negligible levels for piling at the onshore substation. The additional options may be available to reduce the noise impact, but are not required to deliver the project.

4.4.1 Potential additional mitigation measures – ADD Activation

98. The purpose of pre-piling ADD activation is deter marine mammals out of the Monitored Zone prior to the start of piling. The use of pre-piling ADDs is endorsed by Natural England, the MMO and NatureScot, and have been extensively accepted and used as a pre-piling mitigation method in England, Wales, Scotland and other European jurisdictions (e.g., German waters) over the last decade.

99. NPWS (2014) guidance does not include the use of pre-piling ADDs.

100. IWDG (2020) recommends that ADDs should be used to '*reduce the threat of auditory injury, where they are known to be effective for the species present*'. The policy recommends that ADD use should '*not exceed the noise levels of the mitigated activity itself and be only used prior to commencing activities*'.

101. JNCC (2010b) states that ADDs should be considered, but only used in conjunction with visual and / or acoustic monitoring.

102. Currently, the most common ADD used in piling mitigation is the Lofitech AS seal scarer[6]. This ADD has been shown to have the most consistent effective deterrent ranges for harbour porpoise and minke whales, as detailed in the sections above: 'Deterrence of harbour porpoise' and 'Deterrence of minke whales'. It is important to note that there may be additional ADD models identified in the pre-construction phase that are available and suitable for use. As such, if an ADD is identified as part of the suite of mitigation measures set out in the final MMMP, the final ADD choice and specification would be confirmed within the final MMMP.

103. The duration of ADD deployment would be calculated using swimming speed assumptions to ensure that marine mammals are beyond the Monitored Zone when piling commences. For example:

- Assuming a harbour porpoise swims at 1.5 m/s, it would require:
  - 11.1 minutes of ADD activation for an animal to flee from the pile out to 1 km; and
  - 33.3 minutes of ADD activation for an animal to flee from the pile out to 3 km (*this is within the range at which ADDs result in significant deterrence of porpoise*).
- Assuming a minke whale swims at 3.25 m/s, it would require:
  - 5.1 minutes of ADD activation for an animal to flee from the pile out to 1 km; and
  - 10.3 minutes of ADD activation for an animal to flee from the pile out to 2 km (*though it is noted that there is no evidence currently that ADDs are effective at deterring minke whales out to this distance*).

[6] https://www.lofitech.no/

104. It is important that where ADDs are to be used, the duration of their use is balanced against the increased disturbance impact to marine mammals caused by their use. Therefore, where ADDs are used for mitigation purposes, the duration of their activation would need to be discussed and agreed with NPWS to ensure that the additional impact of disturbance is proportional.

4.5 Onshore substation piling MMMP conclusion

105. A suite of potential mitigation measures are currently available that could be implemented at the CWP Project, to reduce the risk of auditory injury from pile driving to negligible levels. These include:

- For the mitigation of instantaneous PTS (primary mitigation):
    - Pre-piling MMO watches; and
    - Pre-piling PAM (if required to supplement the MMO) during poor visibility or darkness.
- For the mitigation of cumulative PTS (additional mitigation, if required):
    - Pre-piling ADD activation.

106. Both NPWS (2014) and JNCC (2010b) recommend the use of visual observations by an MMO for **at least 30 minutes** prior to piling commencing to ensure the monitored / mitigation zone is free of marine mammals, supplemented with acoustic monitoring by a PAM operator. The use of ADDs prior to piling is not considered in the NPWS (2014) guidance, but the JNCC (2010b) guidance suggests it is considered. The pre-construction MMMP will be agreed with NPWS and the relevant Regulator closer to the time of construction to ensure appropriate technologies are used, and that the most recent guidance and best practice measures are implemented.

5 UXO MMMP

107. In line with MARA's Guidance for Consent Holders on the identification of Unexploded Ordnance (UXO) in the Maritime Area, in the event that an UXO is identified, CWPL will notify MARA and the Gardai. It is noted that An Garda Síochána will, in such circumstances, request military assistance be provided to deal with the UXO and that the Naval Service Dive Section are responsible for dealing with any UXO within Irish Territorial waters. In those circumstances, CWPL will engage with An Garda Síochána and the Naval Service Dive Section to ensure that they are aware of the requirements to carry UXO disposal activities in accordance with the mitigation measures in this MMMP and the conditions of the permission.

108. If UXO are identified across the array site or OECC, a risk assessment will be undertaken and items of UXO will be either avoided by equipment micro-siting, moved or detonated in situ. Recent advancements in the commercial availability of methods for UXO clearance mean that high-order detonation may be largely or completely avoided. The methods of UXO clearance considered for CWP Project may include:

- Removal / relocation;
- Low-order detonation (deflagration); and
- High-order detonation.

109. This section of the MMMP details the possible marine mammal mitigation and monitoring procedures during UXO clearance activities at the CWP Project. The objective of the UXO MMMP is to minimise the risk of auditory injury to marine mammals as a result of noise generated by UXO clearance. The metrics presented for PTS for UXO clearance are slightly different to those presented for piling, since UXO clearance is a single blast, rather the multiple pulses from pile driving activities. The assessment of PTS for UXO includes PTS using the SPL_{peak} metric (single strike) and PTS using the SEL_{ss} metric (single strike).

110. The final UXO MMMP will incorporate the most appropriate mitigation measures based upon best available information and proven methodologies at that time to mitigate the impacts of UXO clearance at CWP.

111. Whilst the risk of UXO is considered to be very low, for the purposes of the assessment it is assumed that within the Offshore Development Area of the CWP Project, up to ten UXO may require clearance. For the assessment it is assumed that a maximum charge weight of up to 525 kg Net Explosive Quantity (NEQ) may be required for 2,000 lb (907.2 kg) UXO. Detailed pre-construction surveys have not yet been completed; it is not possible at this time to determine exactly how many items of UXO will require clearance, however these assumptions are based on industry risk assessment and the very low likelihood of encountering UXO in the western Irish Sea. UXO clearance requirements will be the same regardless of the WTG option selected.

112. An overview of the auditory injury impact ranges assessed in the environmental impact assessment undertaken for marine mammals (see **Chapter 11 Marine Mammals**) and the potential mitigation measures for UXO clearance are outlined in the following sections of this MMMP.

5.1 PTS-onset impact ranges

113. The maximum charge weight for the potential UXO devices that could theoretically be present within the offshore development area has been estimated as 525 kg (TNT equivalent). The potential auditory injury (PTS) impact ranges have been modelled for the high-order clearance of a 525 kg UXO alongside a range of smaller devices, at charge weights of 25, 55, 120 and 240 kg. In each case, an

additional donor weight of 0.5 kg has been included to initiate detonation. Additionally, a low-order deflagration scenario has been modelled, assuming a donor charge of 0.25 kg.

114. Estimated auditory injury (PTS-onset) impact ranges are presented in **Table 5-1**. The maximum low order deflagration PTS-onset impact range is 990 m for harbour porpoise. For the high-order clearance of the largest expected UXO, the maximum PTS impact ranges are 12 km for harbour porpoise, 9.5 km for minke whales, 2.5 km for seals and 730 m for dolphins.

Table 5-1 Summary of the auditory injury (PTS-onset) impact ranges for UXO detonation using the impulsive, weighted SEL_{ss} and unweighted SPL_{peak} noise criteria from Southall et al. (2019) for marine mammals

Southall et al. (2019)	PTS (weighted SEL_{ss})				PTS (unweighted SPL_{peak})			
	Minke whale 183 dB	Dolphin 185 dB	Porpoise 155 dB	Seal 185 dB	Minke whale 219 dB	Dolphin 230 dB	Porpoise 202 dB	Seal 218 dB
Low order (0.25 kg)	230 m	<50 m	80 m	40 m	170 m	60 m	990 m	190 m
25 kg + donor	2.2 km	<50 m	570 m	390 m	820 m	260 m	4.6 km	910 m
55 kg + donor	3.2 km	<50 m	740 m	570 m	1.0 km	340 m	6.0 km	1.1 km
120 kg + donor	4.7 km	<50 m	950 m	830 m	1.3 km	450 m	7.8 km	1.5 km
240 kg + donor	6.5 km	<50 m	1.1 km	1.1 km	1.7 km	560 m	9.8 km	1.9 km
525 kg + donor	9.5 km	50 m	1.4 km	1.6 km	2.2 km	730 m	12 km	2.5 km

5.2 Mitigation measures

115. There are a number of potential mitigation measures that could be implemented at the CWP Project in order to reduce the risk of auditory injury from UXO clearance to negligible levels. These measures include pre-clearance soft start, the use of ADDs and monitoring measures, as well as at source noise reduction techniques and consideration of alternative clearance techniques (such as low-order deflagration). As with piling, mitigation measures outlined in this document and relating to UXO have been broken down into primary, additional and potentially required measures to reflect what is known about UXO removal during this stage in the consenting process, and what will be provided post consent once a UXO removal contractor is in place and final requirement for removal methods is known.

116. The different approaches are set out below and described further in the following sections:

- The implementation of an MMO protocol; this includes establishing a protocol in line with NPWS (NPWS, 2014) and JNCC guidelines, including PAM (JNCC, 2010a, 2023);
- The use of pre-clearance deployment of ADDs (JNCC, 2010a, 2023);
- The implementation of a soft-start approach (i.e., use of scare charges) and / or the sequencing of detonations;
- Consideration of any clearance techniques other than high-order detonation (i.e., removal / relocation and deflagration); and
- The use of noise abatement methods (i.e., bubble curtains) (JNCC, 2023).

5.2.1 Primary mitigation measures

Mitigation zone

117. Both the NPWS (2014) and JNCC (2010a) recommend a mitigation zone with a 1 km radius for UXO detonation. However, the estimated maximum ranges within which PTS could occur as a result of the detonation of a maximum 525 kg charge is up to 12 km for porpoise. These ranges are thus greater than the default 1 km mitigation zone recommended by both the NPWS (2014) and JNCC (2010a). A distance modification can be agreed with the Regulatory Authority under both NPWS (2014) and JNCC (2010a) guidelines, as long as information specific to the location and / or plan / project is available to inform a reduction or increase from the default 1 km mitigation zone. Under JNCC (2010a) guidelines, consultation with the appropriate nature conservation body is required throughout this process.

118. By contrast, more recent draft guidelines produced by the JNCC (2023) for minimising the risk of injury to marine mammals from explosive use in the marine environment state that the mitigation zone must cover the full extent of the area within which an animal may be subject to PTS, with a minimum of 1 km covered by MMOs for both low- and high-order clearance of UXO.

119. As impact ranges for auditory injury increase as the charge size weight increases (**Table 5-1**), the actual mitigation zone for the CWP Project will most likely differ from the default / minimum 1 km mitigation zone proposed by the NPWS and JNCC. As such, the mitigation zone used for UXO-detonation at CWP will be determined within the final MMMP once the final charge sizes and detonation methods are confirmed.

120. However, where impact ranges are likely to remain greater than the minimum 1 km mitigation zone (as per JNCC, 2023), it is likely that application of further mitigation measures will be required prior to the commencement of detonations to reduce the likelihood that either:

- Marine mammals are present within the mitigation zone; or
- Auditory injury impacts may occur.

121. This may include the introduction of ADDs and / or noise abatement methods.

Implementation of MMO Protocols (including PAM)

122. Both the NPWS (2014) and JNCC (2010a) recommend the use of an MMO to undertake a pre-detonation search within a defined mitigation zone.

123. Under NPWS (2014) guidelines, which are specific to the Republic of Ireland, it is recommended that *'blasting activities shall only commence in daylight hours where effective visual monitoring, as performed and determined by the MMO, has been achieved'.* Further, it is recommended that a minimum pre-detonation search of **30 minutes** is required in waters up to 200 m deep. Under these guidelines, *'sound-producing activity shall not commence until at least 30 […] minutes have elapsed with no marine mammals detected within the Monitored Zone by the MMO'* (NPWS, 2014).

124. By comparison, the JNCC (2010a) recommend a **60-minute** pre-watch to be conducted irrespective of water depth. In addition, the JNCC also recommend the use of PAM to be used in conjunction with visual monitoring. This allows for an alternative means of monitoring to be carried out pre-detonation for periods of reduced visibility (e.g., night-time hours, the presence of fog and / or high sea states which make marine mammal detection difficult). During the 60-minute visual / PAM pre-watch, if an animal has been visually or acoustically detected, the MMO / PAM operative should determine whether the marine mammal is within the mitigation zone. UXO detonation should not occur until at least 60

minutes have elapsed with no marine mammal detections in the mitigation zone (JNCC, 2010a). 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 vessel will also be recorded as per the JNCC and / or NPWS marine mammal recording forms and guidelines (JNCC, 2010a, NPWS, 2014).

125. Under the draft JNCC (2023) guidelines it is recommended that a minimum **30 minute** pre-detonation search is undertaken for low-order detonations, whilst **60 minute** pre-detonation searches are only required in water depths >200 m. During the pre-watch, a minimum of two MMOs are required for a 1 km mitigation zone, although if PAM is required in conjunction with visual monitoring procedures, then two MMOs and one PAM operator are required. UXO detonation should not occur until at least 60 minutes have elapsed with no marine mammal detections in the mitigation zone (JNCC, 2023).

126. It should be noted that if PAM is unavailable during pre-detonation searches for marine mammals, then UXO detonation would only be able to commence during periods of unrestricted visibility and during daylight hours to prevent the risks of failing to detect marine mammals. During all visual observations, the MMO will undertake visual observations within the 1 km mitigation zone around the UXO location from a suitable elevated platform that allows 360 degree visual observations.

127. The agreed implementation of MMO protocols for UXO detonation will, however, be agreed within the final MMMP once the scope of UXO clearance is known.

5.2.2 Additional mitigation measures

128. The maximum predicted cumulative PTS-onset impact ranges for high-order clearance of a 525 kg UXO (12 km for porpoise and 9.5 km for minke whales) are beyond those that can be mitigated by the 'primary' 'industry standard' mitigation measures. As such, additional mitigation measures will be considered.

Pre-UXO clearance deployment of ADDs

129. Whilst the NPWS (2014) guidelines do not state the use of ADDs as a method for reducing the risk of causing injury to marine mammals pre-UXO clearance, the JNCC guidelines state that *'the use of devices that have the potential to exclude animals from the mitigation zone should be considered'* (JNCC, 2010a); this includes the use of ADDs. Under the new draft JNCC (2023) guidelines, it is stated that ADDs '*can also be deployed'* in circumstances where the mitigation zone is >1 km.

130. It is worth noting, however, that the JNCC (2010a, 2023) guidelines state that *'Acoustic Deterrent Devices (ADDs) should only be used in conjunction with visual and / or acoustic monitoring and for as short period as necessary to minimise the introduction of additional noise'*. As such, the decision to use ADDs as part of the suite of mitigation measures for UXO detonation should be made, based on the effectiveness of ADDs as a mitigative device for reducing underwater noise impacts from UXO detonation on marine mammals.

131. IWDG (2020) do not mention the use of ADDs for UXO clearance in their policy for offshore wind farm development and recommendations document.

Deterrence of marine mammals

132. The effectiveness of ADDs to deter porpoise and minke whales is described above in paragraph 48 et seq. For the high-order clearance of the largest expected UXO, the maximum PTS impact ranges are

12 km for harbour porpoise and 9.5 km for minke whales (**Table 5-1**), which exceeds the distances for which evidence is currently available for the effective use of ADDs (7.5 km for harbour porpoise, ~4 km for minke whale).

133. For the high-order clearance of the largest expected UXO, the maximum PTS impact range is 2.5 km for seals (**Table 5-1**), which exceeds the distances for the effective use of ADDs. In 2015, Marine Scotland funded a project to assess the effectiveness of Lofitech devices as harbour seal deterrents (Gordon et al., 2015). In Kyle Rhea in 2013, 10 seals were tagged, and in the Moray Firth in 2014, 13 tags were deployed. In total, 73 controlled exposure experiments (CEE) were conducted, and responses monitored using a novel telemetry tracking system. All animals within ~1 km of the source exhibited a behavioural response during CEEs (n=38) (**Plate 5-1** and **Plate 5-2**). A lack of response to the CEE was first observed 998 m from the device, with a predicted received sound level of 132 dB re 1 1 µPa RMS (**Plate 5-1**). Conversely, responses were detected up to 3.112 km from the ADD, where the predicted received level was 120 dB re 1 µPa RMS. However, distances further than 1 km from the device were characterised by lower response rates, for example, at 4.1 km from the source, only 20% of seals responded to the CEE (**Plate 5-2**). Overall, it was concluded that the use the Lofitech device would deter seals up to ~1 km from the source.

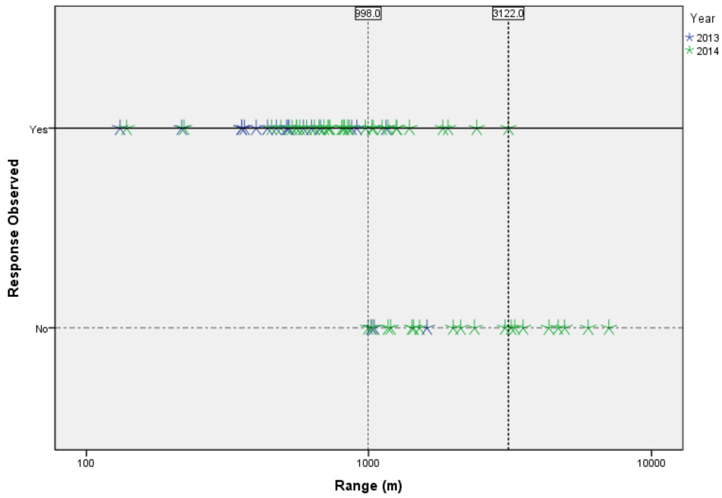


Plate 5-1 Controlled exposure experiments with harbour seals and the Lofitech device which did and did not elicit responses plotted against range (reproduced from Gordon et al., 2015). The range of the first closest non-responsive CEE and the most distant responsive CEEs are indicated by the dotted vertical lines.

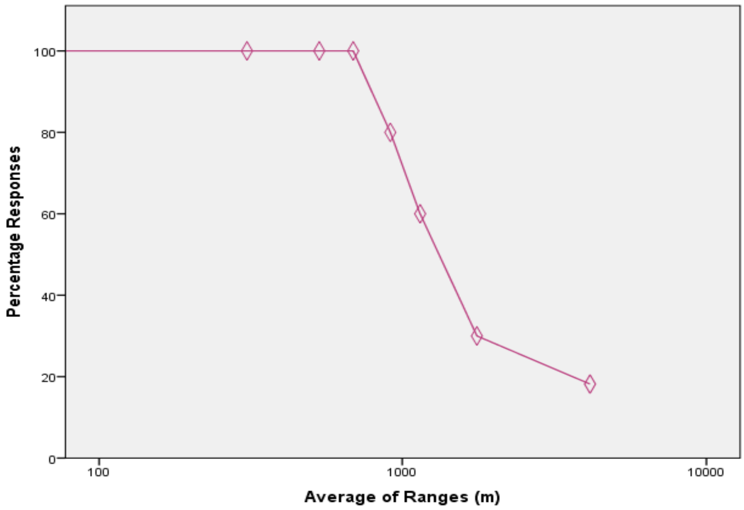


Plate 5-2 Percentage of controlled exposure experiments with harbour seals and the Lofitech device eliciting a response ranked by range (reproduced from Gordon et al., 2015)

Implementation of ADDs for UXO clearance

134. If an ADD is chosen as part of the mitigation measures employed for UXO clearance at the CWP Project, the following measures shall be implemented:

- A suitably trained ADD operator and a dedicated MMO are required to implement the mitigation set out in the final UXO MMMP. The MMO will be required to undertake the pre-detonation watch, which is proposed to be 30 minutes (or 60 minutes depending on water depth), in accordance with recent best practice guidance (JNCC, 2023).
- The duration of ADD deployment would be calculated using swimming speed assumptions to ensure that marine mammals are beyond the mitigation zone when UXO clearance commences.
- The ADD will be switched off immediately prior to UXO detonation.

135. These measures will be reviewed and confirmed within the final MMMP once the scope of UXO clearance is known.

Deflagration

136. The low-order deflagration method which has been through research with Department for Business, Energy & Industrial Strategy (BEIS), Loughborough University and the National Physical Laboratory in the UK, has shown very high efficacy (Robinson et al., 2020). Most recently, low-order deflagration was used at the Moray West wind farm to clear 82 UXOs of various types, with none requiring high-order detonation (Abad Oliva et al., 2024). As such, the JNCC (2023) draft guidelines for minimising the risk of injury to marine mammals from unexploded ordnance clearance state that:

'Low order deflagration is currently the primary alternative available to high order clearance. […]. These guidelines therefore assume the primary method of clearance is one which will result in reduced noise levels compared to high order clearance, for example, low order deflagration.'

137. The JNCC (2023) guidelines also state that *'when deciding what low noise deflagration tool to use, robust evidence to support claims of reduced noise impacts when using that specified tool is key, as is its effectiveness at working as required. It must be clear in the application which tool is to be used*

and evidence presented demonstrating the noise reduction expected to be achieved by the chosen tool.'

138. As final detailed removal methods are unknown at this stage of the consenting process, deflagration tools cannot be provided at this stage. However, in the unlikely event that UXO clearance is required, once a UXO removal contractor is in place and final detailed removal methods are known, if deflagration tools are chosen as a method of UXO removal, low noise methods will be provided along with suitable evidence to support claims of reduced environmental impacts.

Implementation of a soft-start approach and / or sequencing of detonations

139. Under NPWS (2014) guidelines, which are specific to the Republic of Ireland, it is recommended that (bold underline added) *'the use of a clear Ramp-Up Procedure* ***<u>must</u>*** *be considered',* whilst the JNCC (2010a) guidelines state that *'a progressive increase in charge size […]* ***<u>may be</u>*** *effective as a means of reducing the risk of injury, by allowing time for marine mammals to move away from the area'.*

140. Both the NPWS (2014) and JNCC (2010a) guidelines recommend that, whenever possible, the order in which the explosive charges are detonated should be controlled and progressive following the completion of the initial MMO / PAM watch, otherwise known as a 'soft-start' or 'ramp-up' procedure.

141. The soft-start approach, for example, will involve the detonation of smaller mass charge sizes first in a progressive series of blasts. This is intended to allow for animal avoidance, surfacing or other potential safeguarding behaviour of marine mammals to occur. Sequential detonations within an overall blast cycle should employ a short inter-charge time delay (of milliseconds in duration) in order to minimise the cumulative effect of separate individual blast pulses (JNCC, 2010a, NPWS, 2014). These are also known as scarer charges.

142. Whilst the draft JNCC (2023) guidelines note that scarer charges are not recommended '*as a mitigation option for marine mammals and should not be used for this purpose*', it is considered at this stage to rely on extant NPWS (2014) guidelines until such time as they are updated or the draft JNCC guidance finalised. As such, if directed by NPWS, CWP may implement scarer charges if UXO require clearance.

Other potential additional mitigation measures

143. In the event that deflagration fails and the effect cannot be avoided by primary (MMO and PAM) and / or additional mitigation measures (ADDs), and it is safe to do so, CWP commit to implement noise abatement systems.

144. Neither the NPWS (2014) nor the JNCC (2010a) guidelines mention the use of noise abatement systems during UXO clearance; however, the new draft JNCC (2023) guidelines state that noise abatement measures '*should be considered when injury ranges are greater than can be mitigated [against] using MMOs, PAM and / or ADDs (e.g., [impact ranges] >7.5 km [for harbour porpoise])'*. This suggests that noise abatement technologies as a mitigation procedure are not required to be employed unless impact ranges exceed 7.5 km and other methods of mitigation are not successful.

145. Noise abatement technologies are further described in **Section 3.5.2** of this MMMP. Such methods have previously been employed during UXO detonation, such as the use of bubble curtains (Schmidtke, 2010, 2012; Croci et al., 2014; Merchant and Robinson, 2019) and thus, the IWDG (2020) recommend that where UXO removal is not possible, ordnance should be detonated with the use of *'noise abatement to reduce noise impact'.*

146. Croci et al., (2014) presented the results of a study whereby the transmission of a shock wave (one which simulated a shock wave produced by high-order UXO detonation) propagating through a bubble

curtain was investigated. In this study, the attenuation by the use of a bubble curtain was ~48 dB (in terms of peak pressure) (Croci et al., 2014). Another experimental set-up by Cheong et al. (2023) investigated the effectiveness of small bubble curtains around UXO during low-order disposal by conducting controlled experimental trials in a quarry facility. In this study, the results demonstrate that bubble curtains can achieve a reduction in peak sound pressure level of between 13 dB and 17 dB, and in SEL of between 7 dB and 8 dB (Cheong et al., 2023).

147. When comparing the use of ADDs versus noise abatement methods such as bubble curtains during UXO detonation, only high-order detonations of UXO would likely require noise abatement in conjunction with other mitigative measures. In contrast, the use of ADDs only may be sufficient to minimise impacts from low-order (deflagration) clearance.

148. The decision to use noise abatement methods will therefore be made within the final UXO MMMP, when the scope of UXO clearance is known.

5.3 UXO MMMP Conclusion

149. A suite of potential mitigation measures are currently available that could be implemented at the CWP Project, to reduce the risk of auditory injury from UXO detonation to negligible levels. These include:

- Primary mitigation:
  - Pre-detonation MMO watches; and
  - Pre-detonation PAM (if required to supplement the MMO) during poor visibility or darkness.
- Additional mitigation:
  - Pre-detonation ADD activation;
  - The implementation of a soft-start approach (i.e., use of scare charges) and / or the sequencing of detonations; and
  - Consideration of any clearance techniques other than high-order detonation (i.e., removal / relocation and deflagration).
- Potential mitigation (in the event that deflagration fails):
  - At-source noise abatement methods.

150. Both NPWS (2014) and JNCC (2010a, 2023) recommend the use of visual observations by an MMO prior to detonation commencing to ensure the monitored / mitigation zone is free of marine mammals. However, the duration at which pre-detonation watches should last differs between each guidance document. The use of ADDs prior to detonation is not considered in the NPWS (2014) nor IWDG (2020) guidance, but the JNCC (2010a, 2023) guidelines suggest it is considered. There is also disparity in the guidelines on the approach to implementing soft-start procedures or sequencing of detonations. Whilst both the NPWS (2014) and JNCC (2010a) guidelines recommend that, whenever possible, the order in which the explosive charges are detonated should be controlled and progressive following the completion of the initial MMO / PAM watch, the new draft JNCC (2023) guidelines do not recommend the use of scarer charges (i.e., a soft-start or ramp-up procedure).

151. The UXO MMMP will be agreed with NPWS and the relevant Regulator closer to the time of construction to ensure appropriate technologies are used, and that the most recent guidance and best practice measures are implemented.

6 DECOMMISSIONING MMMP

152. Decommissioning activities will include removal of offshore structures above the seabed in reverse order to the construction sequence. The effects of these activities on marine mammals are considered to be similar to, or less than those occurring during construction. The final methods chosen for decommissioning will be dependent on the technologies available at the time, and in accordance with the decommissioning schedule.

153. DAHG (2014) guidance does not cover decommissioning activities.

154. IWDG (2020) acknowledges that at this stage it is not possible to know the decommissioning process, or what impacts it may have on marine mammals. They advise that standard mitigation is used, including 24-hour detection capability and soft-start / ramp-up protocols where applicable.

155. As a minimum, it is expected that an MMO watch and a PAM watch (to supplement the MMO) will likely be required for any underwater noise generating activity that has predicted the potential for auditory injury to marine mammals. Depending on the extent of the predicted auditory injury ranges, other additional mitigation methods can be considered, such as ADDs or noise abatement methods.

156. A full environmental assessment for decommissioning activities will be conducted prior to decommissioning activities taking place. This will outline the potential auditory impact ranges for marine mammals for the decommissioning methods identified for the project. This will also inform a MMMP appropriate for those activities.

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