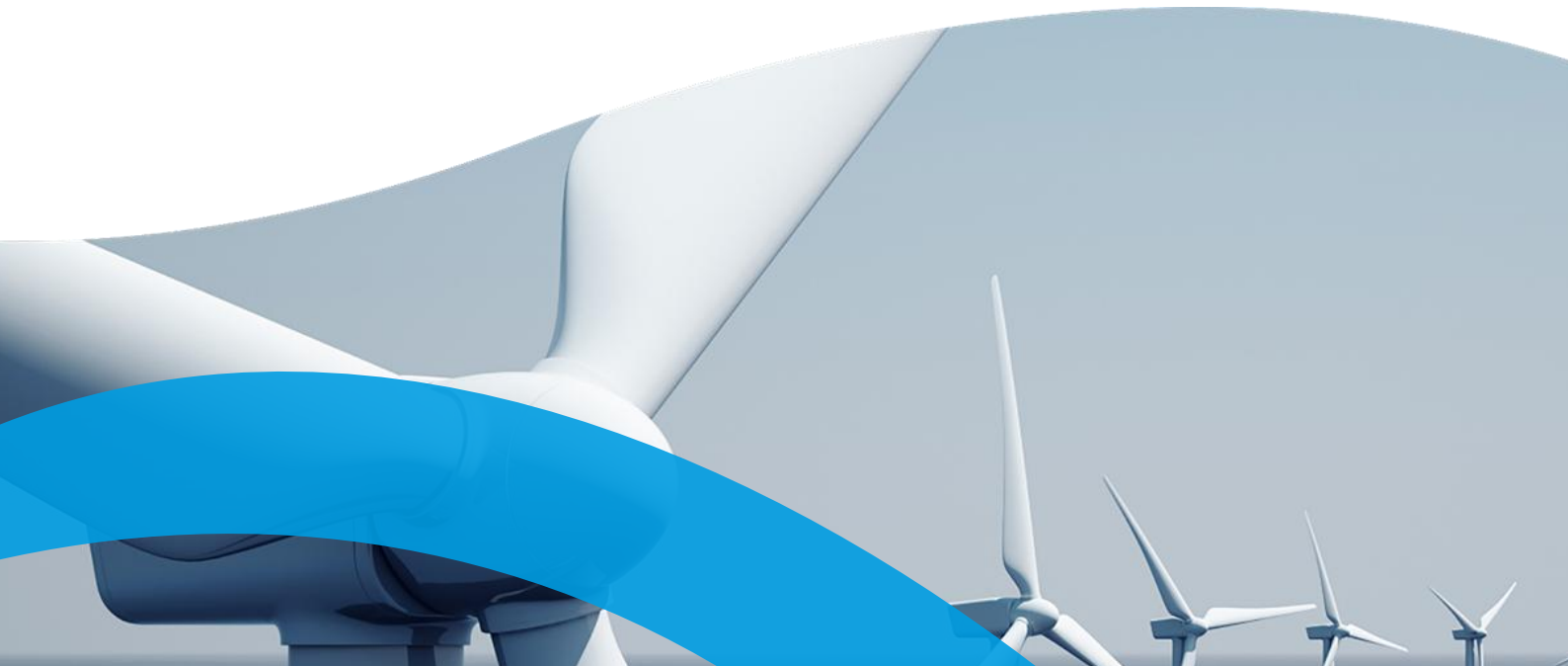
Muir Mhòr Offshore Wind Farm

Environmental Impact Assessment Report

Volume 4, Appendix 3: Outline Marine Mammal Mitigation Protocol



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Contents

1. Introduction 7
2. Project Backround 8
3. Marine Mammal Species 8
4. Embedded Commitments 8
5. Geophysical Survey MMMP 9
5.1. Introduction 9
5.2. Scenarios Considered 9
5.3. Summary of Impacts 9
5.4. Guidance 10
5.5. Mitigation Methods 11
5.6. Reporting 11
6. UXO MMMP 12
6.1. Introduction 12
6.2. Scenarios Considered 12
6.3. Summary of Impacts 13
6.4. Guidance 13
6.5. Mitigation Methods 14
6.6. Reporting 14
7. Piling MMMP 16
7.2. Scenarios Considered 16
7.3. Summary of Impacts 17
7.4. Guidance 17
7.5. Mitigation Methods 18
Mitgation zone 18
MMO and PAM 18
Acoustic deterrent device use 18
Soft-start procedure 19
Breaks in piling 19
Communication 19
7.6. Reporting 20
8. References 21

Tables

Table 4-1Embedded commitment measures of relevance to the outline MMMP 8
Table 5-1 Summary of the auditory injury (PTS) for geophysical survey equipment..... 9
Table 6-1 Summary of the auditory injury (PTS) impact ranges (m) for UXO clearance using the impulsive, unweighted SPL_{peak} and weighted SEL_{ss} noise criteria from Southall et al. (2019)..... 13
Table 7-1 Summary of the soft-start and ramp-up scenario used for the anchor pile foundation modelling..... 16

Table 7-2 Summary of the soft-start and ramp-up scenario used for the multi-leg foundation modelling 16

Table 7-4 Maximum auditory injury instantaneous PTS (SPL_{peak}) impact ranges 17

Glossary

Term	Definition
Array Area	The area in which the generation infrastructure (including Wind Turbine Generators and associated foundations, inter-array cables) and Offshore Electrical Platform(s) and an interconnector cable will be located.
Developer	Muir Mhòr Offshore Wind Farm Limited
EIA Regulations	Collectively the term used to refer to The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, The Marine Works (Environmental Impact Assessment) Regulations 2007, and The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017.
Floating Foundations	The foundations on which the Wind Turbine Generators are installed.
Foundation anchors	The mooring structures which anchor the foundations to the seabed.
Interconnector cable	Cable which links the Offshore Electrical Platforms to one another, allowing for power to be transferred between the platforms
Mitigation Zone	The area within which the Marine Mammal Observer/Passive Acoustic Monitoring operative searches (visually or acoustically) for marine mammals.
Offshore Electrical Platform (OEP)	Offshore platform consisting of High Voltage Alternating Current (HVAC) equipment, details depending on the final electrical set up of the Project.
Offshore Export Cable Corridor (ECC)	The area within which the offshore export cable(s) will be installed.
Permanent Threshold Shift (PTS)	Auditory injury. A shift in the hearing sensitivity at a particular frequency that is not recoverable.
Pre-shooting search	Search for marine mammals (visually and/or acoustically) prior to commencing geophysical survey activities
Project	Muir Mhòr Offshore Wind Farm – comprises the wind farm and all associated offshore and onshore components.
Proposed Development	The offshore Muir Mhòr Offshore Wind Farm project elements to which this Offshore EIA Report relates.
Wind Turbine Generator (WTG)	The wind turbines that generate electricity consisting of tubular towers and blades attached to a nacelle housing mechanical and electrical generating equipment.

Acronyms

Term	Definition
ADD	Acoustic Deterrent Device
BEIS	Department for Business Energy and Industrial Strategy
ECC	Export Cable Corridor
EIAR	Environmental Impact Assessment Report
EOD	Explosive Ordnance Disposal
EPS	European Protected Species
HF	High Frequency
HVAC	High Voltage Alternating Current
JNCC	Joint Nature Conservation Committee
LF	Low Frequency
MAG	Magnetometer
MBES	Multibeam Echo-Sounder
MD-LOT	Marine Directorate – Licensing Operations Team
MHWS	Mean High Water Springs
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Mammal Observer
OEP	Offshore Electrical Platform
PAM	Passive Acoustic Monitoring
PCW	Phocid Carnivores in Water
PS	Piling Strategy
PTS	Permanent Threshold Shift
SBES	Single-Beam Echo-Sounder
SBP	Sub-Bottom Profiler
SEL	Sound Exposure Level
SMWWC	Scottish Marine Wildlife Watching Code
SPL	Sound Pressure Level
SSS	Side Scan Sonar
UHRS	Ultra-High Resolution Seismic (sparker)
USBL	Untra-short Baseline
UXO	Unexploded Ordnance
VHF	Very High Frequency
WTG	Wind Turbine Generator

1. INTRODUCTION

1.1.1. Muir Mhòr Offshore Wind Farm Limited (hereafter referred to as 'the Developer') is proposing to develop the Muir Mhòr Offshore Wind Farm (hereafter 'the Project'). The Project is made up of both offshore and onshore components. The subject of this offshore Environmental Impact Assessment Report (EIAR) is the offshore infrastructure of the Project seaward of Mean High-Water Springs (MHWS) which is hereafter referred to as 'the Proposed Development'.

1.1.2. The Muir Mhòr Array Area covers an area of approximately 200 km^2 and is located approximately 63 km east of Peterhead on the east coast of Scotland. The offshore infrastructure of the Proposed Development includes Wind Turbine Generators (WTGs) and associated floating foundations, the Offshore Electrical Platform (OEP) and associated foundations, the inter-array cables, interconnector cable, and offshore export cables and landfall.

1.1.3. This document presents the outline Marine Mammal Mitigation Protocol (MMMP) prepared by SMRU Consulting to support the EIAR for the Proposed Development. A Piling Strategy (PS) and Marine Licence applications for geophysical surveys and Unexploded Ordnance (UXO) clearance will be prepared and finalised post consent once relevant parameters for the Proposed Development have been refined. These documents will be updated, as necessary, and be supported by updated MMMPs. The final piling MMMP, which is anticipated to be required as a condition of consent for the Section 36 Consent and Marine Licences, will be submitted to the Marine Directorate – Licensing Operations Team (MD-LOT) for approval post-consent.

1.1.4. Ahead of any piling, UXO clearance or geophysical surveys, European Protected Species (EPS) risk assessment need to be conducted and an EPS License potentially needs to be secured where:

1.1.5. Within 12 nautical miles of the coast (territorial sea): An EPS Licence may be required under the Conservation (Natural Habitats, &c) Regulations 1994 (as amended) where there is potential for activities to injure or cause disturbance to an EPS.

1.1.6. Outside 12 nautical miles: An EPS Licence may be required under the Conservation of Offshore Marine Habitats and Species Regulations 2017 where there is potential for the activities to injure or cause significant disturbance to an EPS (population level effect rather than individual animals).

1.1.7. This outline MMMP has been developed to recommend measures for mitigating the potential impact of auditory injury (permanent threshold shift; PTS) on marine mammals from geophysical surveys, UXO clearance and pile driving operations during construction at the Proposed Development. The mitigation measures presented in this outline MMMP are informed by the data presented in following Chapters and technical Appendices:

- Volume 2 Chapter 12 (Marine Mammals);
- Volume 3 Appendix 12.1 (Marine Mammal Baseline Technical Report); and
- Volume 3 Appendix 3.1 (Subsea Noise Technical Report).

1.1.8. The outline MMMP summarises the worst-case scenarios considered in the EIAR together with a summary of impacts and available mitigation measures. These worst-case scenarios

may be subsequently updated post-consent when more detailed and refined parameters for the Proposed Development are available.

2. PROJECT BACKROUND

2.1.1. The key components and infrastructure of the Proposed Development are as follows:

- A maximum of 67 WTGs on floating foundations installed using anchor piles (maximum nine anchors per WTG with one pile per anchor; 603 piled anchors in total);
- A maximum of two OEP(s) (maximum six legs per jacket with two piles per leg; 24 pin piles in total); and
- Up to three offshore export cables within one Offshore Export Cable Corridor (ECC).

3. MARINE MAMMAL SPECIES

3.1.1. Mitigation measures will be applied to any marine mammal species observed during construction activities requiring a MMMP. The marine mammal species expected to be of relevance to the Proposed Development include:

- Harbour porpoise (*Phocoena phocoena*);
- Bottlenose dolphin (*Tursiops truncatus*);
- White-beaked dolphin (*Lagenorhynchus albirostris*);
- Risso's dolphin (*Grampus griseus*);
- Minke whale (*Balaenoptera acutorostrata*);
- Killer whale (*Orcinus orca*);
- Humpback whale (*Megaptera novaeangliae*);
- Harbour seal (*Phoca vitulina*); and
- Grey seal (Halichoerus grypus).

4. EMBEDDED COMMITMENTS

4.1.1. As part of the project design process, several designed-in measures have been proposed to reduce the potential for impacts on environmental receptors. Those relevant to this outline MMMP are summarised in Table 4-1.

Table 4-1 Embedded commitment measures of relevance to the outline MMMP

Code	Commitment	Type (Primary, Secondary or Tertiary)	How Commitment Secured
C-15	Development of and adherence to a MMMP. This will identify appropriate mitigation measures during offshore activities that are likely to produce underwater noise and vibration levels capable of potentially causing injury or disturbance to marine mammals. This will be developed alongside the PS and referred to in EPS	Tertiary	MMMP

Code	Commitment	Type (Primary, Secondary or Tertiary)	How Commitment Secured
	licence applications.		
C-31	UXO hazards will be avoided where practicable and appropriate. If avoidance is not possible, decision making will relate to removal, with detonation considered if avoidance or removal is not possible. If detonation is required, and where practicable and appropriate, low-order deflagration will be the preferred method. Licencing of UXO clearance works will be subject to a standalone Marine Licence (and EPS licence) application. These applications will provide details of measures to minimising impacts on marine mammals where appropriate.	Tertiary	UXO MMMP
C-35	Adherence by vessels to guidelines laid out in the Scottish Marine Wildlife Watching Code (SMWWC)	Tertiary	VMP

5. GEOPHYSICAL SURVEY MMMP

5.1. INTRODUCTION

5.1.1. This outline geophysical survey MMMP has been prepared to support both the future anticipated Marine Licence and future anticipated EPS Licence applications for the mitigation of geophysical survey operations within the Proposed Development.

5.2. SCENARIOS CONSIDERED

5.2.1. Geophysical surveys will be conducted across the Array Area and the offshore ECC over an expected duration of three months. Surveys will comprise the use of Side Scan Sonar (SSS), Sub-bottom Profiler (SBP), Multibeam Echo-Sounder (MBES), Single Beam Echo-Sounder (SBES), high-density magnetometer (MAG) surveys and Ultra High Resolution Seismic (UHRS).

5.3. SUMMARY OF IMPACTS

5.3.1. The auditory injury (PTS-onset) range for all species is expected to be highly localised. Potential impact ranges are summarised in Table 5-1.

Table 5-1 Summary of the auditory injury (PTS) for geophysical survey equipment

Equipment	Estimated source pressure level (dB re 1 µPa)
Multibeam Echo Sounder (MBES) & Side Scan Sonar (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)
Sub-bottom Profiler	High Frequency cetaceans: Dolphins (including bottlenose dolphin, white-

Equipment	Estimated source pressure level (dB re 1 µPa)
(SBP)	beaked dolphin, Risso's dolphin and killer whale): No risk of injury. Very high frequency cetaceans: Harbour porpoise: BEIS (2020) have indicated that PTS onset is likely to occur within 23 m from the use of this equipment at source levels of 267 dB re 1 µPa (SPL_{peak}). Low frequency cetaceans: Minke whale (also proxy for humpback whale): within 5 m of the source when SBP pingers operate with a sound source of 220 dB re 1 µPa (SPL_{peak}) (Shell, 2017). Phocid seals (harbour and grey seals): approximately 10 m (BEIS, 2019b). Albeit with a high degree of uncertainty, BEIS (2019a) suggested that SBPs used in high-resolution geophysical surveys have a very low potential for injury.
Ultra-short Baseline (USBL)	No risk of injury to dolphins, minke or humpback whales or seals. Pace *et al.* (2021) found that at a distance of ~1 km from the source, broadband received levels were ≤140 dB re 1 μPa^2 (SPL_{peak}), ≤130 dB re 1 μPa^2 (SPL_{peak}), and application of VHF cetacean (harbour porpoise) frequency weighting indicated noise levels of <120 dB re 1 μPa^2 (SPL_{rms}, VHF frequency-weighted). These results illustrate no potential for instantaneous PTS-onset from the USBL source tested. Noise levels from the USBL are expected to rapidly attenuate with distance from source to drop below 200 dB within 10 m or less of the source, even when assuming an omnidirectional source.
Ultra-High Resolution Seismic (UHRS; sparkers)	Highly focused beam with limited horizontal transmission of noise.
Magnetometer (MAG)	Not noise producing so no mitigation is required for MAG - scoped out of MMMP.

5.4. GUIDANCE

5.4.1. This outline geophysical survey MMMP follows the guidance provided in JNCC (2017): JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys. The JNCC guidance currently only requires mitigation of MBES during surveys conducted in deep waters (>200 m). Therefore, it is not anticipated that MBES will require mitigation as surveys of the Proposed Development will take place in waters <200 m. NatureScot have also advised that if the USBL is operated above 210 dB re 1 µPa SPL_{peak}, then mitigation will be required to minimise the risk of injury, but that if it is operated below this threshold that mitigation will not be needed (as is expected during surveys of the Proposed Development) (NatureScot, 2024). All other noise producing equipment (SBP, SSS and UHRS sparkers) are currently expected to require mitigation to comply with the Scottish regulations and any potential EPS Licence (if required). The equipment requiring mitigation will be confirmed in the final MMMP, following advice from stakeholders and the issuing of an EPS licence (if required) for geophysical survey activity.

5.5. MITIGATION METHODS

5.5.1. As per the JNCC (2017) guidance, a Marine Mammal Observer (MMO) will conduct a 30 minute pre-shooting search covering a 500 m mitigation zone around the acoustic source prior to the commencement of survey operations. This mitigation zone is considered highly conservative given the anticipated PTS-onset impact ranges for the equipment being used (maximum ≈ 23 m for SBP). If only visual monitoring is used, then survey activity must commence during daylight hours in suitable visibility, but activity can continue during periods of poor visibility and darkness once already commenced. Should it be required that survey activity will commence at night, then Passive Acoustic Monitoring (PAM) will be required to monitor the pre-shooting search period.

5.5.2. If a marine mammal is detected within the mitigation zone during the pre-shooting search, the soft-start will be delayed for 20 minutes after the animals are confirmed to be outside the mitigation zone and the full 30 minute pre-shooting search has been completed. If the animals are not observed leaving the mitigation zone, then the soft start will be delayed by a minimum of 20 minutes after the last detection within the mitigation zone, again making sure the full 30 minute pre-shooting search has also been completed.

5.5.3. Following the completion of the pre-shooting search, where operationally feasible a soft-start will be conducted over at least 15 minutes (and no more than 25 minutes until the start of the survey line) to gradually reach full operational power. If it is not feasible to soft-start any of the survey equipment, this should be highlighted during the geophysical survey licence application.

5.5.4. Additional mitigation measures are also proposed for the purpose of the EPS Risk Assessment. Before the soft-start commences the MMO(s) will make recommendations for survey alterations, should an EPS be seen within a safety zone of 3 km radius from the source. Power will also be reduced to the lowest possible setting if an EPS is seen within a radius of 1-2 km from the acoustic source and power will be shut off completely if an EPS is within 500 m of the acoustic source. Following the survey being stopped, the survey will not be resumed for 30 minutes. This provision adds extra protection for EPS, particularly for coastal bottlenose dolphins.

5.5.5. If a break in operations occurs that lasts less than 10 minutes, equipment can recommence at the required power providing no marine mammals were detected in the mitigation zone during the break. If the break is longer than 10 minutes, then a full pre-shooting search and soft-start procedure will be required before recommencing.

5.5.6. Slow vessel speeds (approximately 4 knots) will be maintained during geophysical survey operations and the vessel will adhere to the Scottish Marine Wildlife Watching Code (SMWWC) provisions {SNH, 2017 #7334}.

5.6. REPORTING

5.6.1. A mitigation report (MMO report) will be sent to JNCC (via e-mail to seismic@jncc.gov.uk) and MD-LOT once surveys have been completed, accompanied by the JNCC marine mammal recording forms and a copy of the corresponding consent. The mitigation report will include the following information:

- Operator details;

- Survey details - including dates, locations, equipment used, discharge frequency, firing interval etc;
- Mitigation requirements- including information on all pre shooting searches, all MMO and PAM activities and duration of soft-starts;
- Application of mitigation procedures- including summaries of all mitigation searches, marine mammal sightings/detections and any deviation from the proposed MMMP/consent conditions; and
- Additional information – e.g. photographs of marine mammals observed.

6. UXO MMMP

6.1. INTRODUCTION

6.1.1. This outline UXO MMMP has been prepared to support both the future anticipated Marine Licence and future anticipated EPS Licence applications for the mitigation of Explosive Ordnance Disposal (EOD) operations within the Proposed Development.

6.1.2. If UXOs are found within the Array Area and/or offshore ECC, a risk assessment will be undertaken and items of UXO will be either avoided by equipment micro-siting, moved, or disposed of in situ. As the detailed pre-construction surveys have not yet been completed, it is not possible at this time to determine how many items of UXO will require clearance. As a result, a separate Marine Licence will be applied for post-consent for the clearance (where required) of any UXO identified.

6.2. SCENARIOS CONSIDERED

6.2.1. Subacoustech Environmental Ltd. conducted underwater noise modelling to inform analysis of the impacts of UXO clearance. For the Proposed Development, both low-order and high-order clearance UXO scenarios have been modelled. The low-order clearance scenario assumed a donor charge of 0.25 kg. The high-order clearance scenario assumed a maximum charge weight of 750 kg. In addition to this, a range of smaller charge weights were estimated at 25, 55, 120, 240, 525, 698 kg. In each case, an additional donor weight of 0.5 kg was included to initiate detonation. It is important to note that, while high-order detonation represents the very worst-case scenario for UXO clearance, it is expected that low-order clearance methods (deflagration) will be a viable and effective method to be applied during UXO clearance (see embedded commitment C-31). For example, the UXOs found within the Moray West Offshore Wind Farm site were cleared using a low-order deflagration technique, with 100% success rate (Ocean Winds, 2024).

6.2.2. UXO detonation is defined as a single pulse and, thus, both the weighted SEL_{ss} criteria and the unweighted SPL_{peak} criteria from Southall *et al.* (2019) have been presented and animal fleeing assumptions do not apply. Full details of the underwater noise modelling and the resulting auditory injury (PTS-onset) impact areas and ranges are detailed in Volume 3, Appendix 3.1 (Subsea Noise Technical Report).

6.3. SUMMARY OF IMPACTS

6.3.1. The auditory injury (PTS-onset) range for low-order clearance is small across all species and both metrics (SPL_{peak} and SEL_{ss}), with a maximum impact range of <1 km (Table 6-1).

6.3.2. The maximum auditory injury (PTS-onset) range for high-order clearance of a 750 kg charge is 14 km for harbour porpoise (Table 6-1).

Table 6-1 Summary of the auditory injury (PTS) impact ranges (km) for UXO clearance using the impulsive, unweighted SPL_{peak} and weighted SEL_{ss} noise criteria from Southall et al. (2019)

Charge weight (TNT equivalent)	PTS (unweighted SPL_{peak})				PTS (weighted SEL_{ss})			
	LF 219 dB	HF 230 dB	VHF 202 dB	PCW 218 dB	LF 183 dB	HF 185 dB	VHF 155 dB	PCW 185 dB
Low order (0.25 kg)	0.17	0.06	0.99	0.19	0.23	<0.05	0.80	<0.05
25 kg (+ donor)	0.82	0.26	4.6	0.91	2.2	<0.05	0.57	0.39
55 kg (+ donor)	1	0.34	6	1.1	3.2	<0.05	0.74	0.57
120 kg (+ donor)	1.3	0.45	7.8	1.5	4.7	<0.05	0.95	0.83
240 kg (+ donor)	1.7	0.56	9.8	1.9	6.5	<0.05	1.1	1.1
525 kg (+ donor)	2.2	0.73	12	2.5	9.5	0.50	1.4	1.6
698 kg (+ donor)	2.4	0.81	13	2.7	10	0.60	1.5	1.9
750 kg (+ donor)	2.5	0.83	14	2.8	11	0.60	1.5	2.0

LF = Low frequency cetaceans: minke whale and humpback whale

HF = High frequency cetaceans: bottlenose, white-beaked, Risso's dolphins and killer whales

VHF = Very high frequency cetaceans: harbour porpoise

PCW = Phocid in water: harbour and grey seals

6.4. GUIDANCE

6.4.1. The latest (draft) guidance for minimising auditory injury to marine mammals from UXO clearance is provided in JNCC (2023a)[1]. The guidance states the following:

- "*The primary method of reducing the potential for deliberate injury […] is to ensure a defined area - the mitigation zone - is clear of marine mammals prior to the explosive source being activated.*"
- *"The mitigation zone must cover the full extent within which auditory injury could occur."*
- *"The minimum mitigation requirement in these guidelines is that the mitigation zone is visually observed for the presence of marine mammals."*
- For low-order deflagration: *"As a minimum, a pre-detonation visual search must be undertaken before any UXO clearance. This must begin at least 30 minutes before the planned low order detonation and cover a 1 km radii around the detonation location."*

[1] JNCC have advised that the draft 2023 guidelines should be finalised in late 2024.

- *"Due to the size of the search area, at least two marine mammal observers (MMOs) should work together to monitor it and they will advise crew if any marine mammals are observed within the area during the pre-detonation search."*
- *"All explosive use should take place during daylight hours to allow visual observation to take place."*

6.5. MITIGATION METHODS

6.5.1. As per the JNCC (2023a) draft guidance, a 30 minute pre-detonation visual search covering a 1 km radius will be conducted by two MMOs if UXO clearance is conducted using low order clearance methods. The maximum PTS impact range predicted from low order UXO clearance was 990 m (see Table 6-1) and, therefore, the minimum required mitigation zone of 1 km is considered sufficient.

6.5.2. However, PTS-onset impact ranges increase as the charge size used increases (Table 6-1). Therefore, should high order clearance methods be required, then the mitigation zone size will differ from the minimum 1 km required by JNCC (2023a) to a maximum of 14 km based on the worst-case scenario impact range using the largest charge weight of 750 kg (+ donor charge; see Table 6-1). As such, the mitigation zone size used for UXO clearance at the Proposed Development will be determined within the final MMMP once the final charge sizes and detonation methods are confirmed. The use of Acoustic Deterrent Devices (ADDs) and noise abatement may be considered necessary to mitigate larger impact ranges. The mitigation methods used will be discussed with the relevant stakeholders and confirmed within the final MMMP once the required charge sizes and detonation methods are determined.

6.5.3. The MMOs will be provided with the JNCC guidelines and the recording forms (deckforms) to record details of all marine mammal detections and mitigation undertaken.

6.5.4. If a marine mammal is detected within the mitigation zone, the clearance activity will be delayed until the animal(s) has moved out of the mitigation zone or delayed by 20 minutes from the time of the last observation/detection if it cannot be confirmed than the animal(s) has left the mitigation zone.

6.5.5. The MMOs will continue visual monitoring of the mitigation zone during the clearance procedure and for at least 15 minutes after the clearance is complete, to record any evidence of injury to marine life, including fish kills.

6.6. REPORTING

6.6.1. A mitigation report (MMO report) will be sent to JNCC (via e-mail to seismic@jncc.gov.uk) and MD-LOT once operations have been completed, accompanied by the JNCC marine mammal recording forms and a copy of the corresponding consent. The mitigation report will include the following information:

- Operator details;
- Operational details- including dates, locations, volume of explosive material, type of explosives and detonation procedures;
- Mitigation requirements- including information on mitigation zone size, pre detonation searches and MMO and PAM requirements,

- Application of mitigation procedures- including summaries of all mitigation searches, marine mammal sightings/detections and any deviation from the proposed MMMP/consent conditions; and
- Additional information – e.g. photographs of marine mammals, screenshots of acoustic detections.

7. PILING MMMP

7.1.1. This outline piling MMMP has been prepared to support both the Marine Licence application and future anticipated EPS Licence application for the mitigation of pile driving operations within the Proposed Development.

7.2. SCENARIOS CONSIDERED

7.2.1. Subacoustech Environmental Ltd conducted underwater noise modelling to inform analysis of the impacts of the worst-case scenario underwater piling noise on marine mammals for two foundation design types:

- An anchor pile foundation scenario for floating WTGs, installing a 4 m diameter pile with a maximum blow energy of 2,400 kJ, with ten anchor piles installed within a 24-hour period (Table 7-1); and
- A multi-leg jacket foundation scenario for fixed OEP(s), installing a 5 m diameter pile with a maximum blow energy of 3,200 kJ, with up to six multi-leg foundations installed within a 24 hour period (Table 7-2).

Table 7-1 Summary of the soft-start and ramp-up scenario used for the anchor pile foundation modelling

Anchor pile foundation	**15% (360 kJ)**	**40% (960 kJ)**	**60% (1,140 kJ)**	**80% (1,920 kJ)**	**100% (2,400 kJ)**
No. of strikes	200	350	350	350	2100
Duration (mins)	20	10	10	10	60
Strike rate (bl/min)	10	35	35	35	35
Single pile: 3,350 strikes/pile, 110 minutes/pile **Ten piles: 33,500 strikes/24 hours, 1,110 minutes/24 hours (18.33 hours/24 hours)**					

Table 7-2 Summary of the soft-start and ramp-up scenario used for the multi-leg foundation modelling

Anchor pile foundation	**15% (480 kJ)**	**40% (1,280 kJ)**	**60% (1,920 kJ)**	**80% (2,560 kJ)**	**100% (3,200 kJ)**
No. of strikes	200	350	350	350	5250
Duration (mins)	20	10	10	10	150
Strike rate (bl/min)	10	35	35	35	35
Single pile: 6,500 strikes/pile, 200 minutes/pile **Ten piles: 39,000 strikes/24 hours, 1,200 minutes/24 hours (20 hours/24 hours)**					

7.3. SUMMARY OF IMPACTS

7.3.1. NatureScot have advised that the modelling of cumulative PTS-onset impact ranges (using the SEL_{cum} metric) is based on highly conservative assumptions that could lead to an over-estimation of impact zones. Cumulative PTS is, therefore, not expected to be mitigated, and thus the following sections outline potential mitigation measures for instantaneous PTS (using the SPL_{peak} metric) only.

7.3.2. The maximum instantaneous PTS-onset range from pile driving was 700 m for harbour porpoise and less than 50 m for all other species groups.

Table 7-3 Maximum auditory injury instantaneous PTS (SPL_{peak}) impact ranges (m)

Hearing group	Species	Instantaneous PTS-onset range (SPL_{peak})	
		Jackets	Anchors
VHF	Harbour porpoise	700 m	620 m
HF	Bottlenose, white-beaked, Risso's dolphins and killer whales	<50 m	<50 m
LF	Minke & humpback whale	<50 m	<50 m
PCW	Seals (harbour and grey seals)	<50 m	<50 m

7.4. GUIDANCE

7.4.1. The current guidance on minimising the risk of injury to marine mammals from piling noise is provided in JNCC (2010). These mitigation guidelines are supplemented by the JNCC guidance for the use of PAM in UK waters (JNCC, 2023b).

7.4.2. Despite the additional guidance on the use of PAM, it is noted that guidance specific to piling has not been updated since 2010 and, therefore, is considered outdated. It does not take into consideration the considerable developments in our understanding of the effects of noise on marine mammals, and increased evidence that ADDs are effective at deterring marine mammals from the instantaneous PTS mitigation zone.

7.4.3. Developers may also follow the guidance in JNCC (2010) by providing the "Best available technique" to be used. Differing methodology has been approved and its efficacy demonstrated at other OWFs within Scottish waters. For example, the use of ADDs as the sole mitigation measure without the need for additional visual and/or acoustic monitoring was used at Beatrice Offshore Wind Farm, Moray East Offshore Wind Farm and Moray West Offshore Wind Farm, all in the Moray Firth. Furthermore, JNCC have advised that an addendum to provided updates to the JNCC (2010) piling guidelines is currently in preparation and, therefore, new advice may be available prior to the finalising of the piling MMMP.

7.4.4. Therefore, various potential options for the mitigation of instantaneous PTS are outlined below. The final piling MMMP will commit to a specific method.

7.5. MITIGATION METHODS

MITGATION ZONE

7.5.1. The mitigation zone that should be monitored for piling is defined as the maximum potential instantaneous PTS-onset impact ranges. The maximum instantaneous PTS-onset range is 700 m for jackets and 620 m for anchors, both of which are greater than the minimum recommended 500 m mitigation zone (JNCC, 2010). Therefore, it is recommended that a 700 m mitigation zone be implemented during piling at jacket locations, and a 620 m mitigation zone at anchor locations, to ensure instantaneous PTS can be mitigated.

MMO AND PAM

7.5.2. If selected as the mitigation method, a pre-piling search of the mitigation zone will be conducted for a minimum of 30 minutes by an MMO. It is expected that one dedicated and/or experienced MMO will would be on watch, unless they do not have access to a location that provides a good all-round view of the mitigation zone (in which case multiple MMOs may be required). PAM will be used to supplement or replace visual observations when visibility is poor (e.g. darkness and sea state >4).

7.5.3. In the event of an observation within the mitigation zone during the pre-piling search, the soft-start will be delayed for a minimum of 20 minutes after the last detection within the mitigation zone and the full 30 minute pre-piling search has been completed to ensure any marine mammals have left the area.

ACOUSTIC DETERRENT DEVICE USE

7.5.4. The use of an ADD may be required in conjunction with visual and/or acoustic monitoring, or instead of visual and/or acoustic monitoring, to deter marine mammals from entering the mitigation zone. The ADD should be located close to the pile and switched on throughout the pre-piling search and switched off once piling activity commenced. Trained ADD personnel should be appointed who will be responsible for operation, monitoring and reporting of the device. Prior to the commencement of piling, the main device and a back-up device should be tested to ensure that they are working, i.e. by using a hydrophone system and computer interface with appropriate software.

7.5.5. The potential effectiveness of the ADD on the key marine mammal species in the area should be considered. For example, the Lofitech seal scarer device has been demonstrated to have consistent effective deterrent ranges for marine mammals and has proven effective in deterring animals beyond the maximum instantaneous PTS-onset impact range of 700 m (Brandt *et al.*, 2013a, Brandt *et al.*, 2013b, Gordon *et al.*, 2015, McGarry *et al.*, 2017, Rose *et al.*, 2019, Boisseau *et al.*, 2021, Graham *et al.*, 2023). The use of this ADD has proven effective for marine mammal mitigation during piling activities at the adjacent Beatrice Offshore Wind Farm (Thompson *et al.*, 2020) and Moray East Offshore Wind Farm (Graham *et al.*, 2023). However, it is acknowledged that ADD development is an active field, and that an alternative device may be selected when the MMMP is finalised. For example, the Lofitech seal scarer has been shown to cause deterrence to harbour porpoise to multiple kilometres (e.g., Brandt *et al.*, 2013b, Thompson *et al.*, 2020) – distances which exceed the maximum instantaneous PTS-onset impact ranges currently predicted for pile-driving at the Proposed Development. For deterrence of up to 1 km, it is possible that alternative devices may be sufficient (e.g. Voß *et al.*, 2023), albeit with careful consideration given to minimising the

potential for excessive disturbance with the need for reliable deterrence within the PTS-onset impact range.

7.5.6. Based on the swimming speed of 1.4 m/s for harbour porpoise (recommended by Scottish Natural Heritage, 2016), it is expected to take 8.3 minutes for a harbour porpoise to exit the 700 m PTS-onset impact range for jacket pile locations, and 7.4 minutes to exit the 620 m PTS-onset impact range for anchor pile locations. For other marine mammal species, the minimum time would be less than 1 minute. Therefore, the minimum ADD activation period is recommended to be set at 9 minutes during jacket piling operations and 8 minutes during anchor piling operations to allow all animals sufficient time to exit the PTS-onset impact range prior to the first blow of the soft-start.

SOFT-START PROCEDURE

7.5.7. Following the completion of the pre-piling search and/or ADD deployment period, a soft-start procedure will commence. This is where the piling hammer energy will gradually increase over a minimum of 20 minutes so that if any marine mammals are still present in the vicinity of the piling location, they are encouraged to leave by the initial low levels of underwater noise prior to the noise reaching levels which could cause PTS-onset.

7.5.8. If a marine mammal enters the mitigation zone during the soft-start, then the piling operation should either stop (if technically feasible), or the hammer energy should not be further increased until it the marine mammal exits the mitigation zone, and there is no further detection for 20 minutes.

7.5.9. Once the soft-start has been completed, there is no requirement under the JNCC (2010) guidelines to stop piling or reduce the hammer energy if a marine mammal is detected in the mitigation zone as the animal is deemed to have entered voluntarily entered. The JNCC (2010) guidelines also acknowledge that it may not be operationally feasible to stop piling at full power until the pile is fully installed.

BREAKS IN PILING

7.5.10. Breaks in the piling process could provide the potential for marine mammals to re-enter the mitigation zone. The guidance provided in JNCC (2010), which piling operations will comply with, states that "*If there is a pause in the piling operations for a period of greater than 10 minutes, then the pre-piling search and soft-start procedure should be repeated before piling recommences*".

COMMUNICATION

7.5.11. Effective lines of communication between mitigation personnel and the crew conducting piling operations are essential. The communications protocol established will include, but not be limited to:

- Procedure to notify the MMO and/or PAMS operative to begin the 30-minute pre piling search prior to soft-start commencing;
- Procedure for the MMO and/or PAMS operative to notify the installation manager that soft-start can commence;
- Procedure for the MMO and/or PAMS operative to notify installation manager that a marine mammal has been detected in the mitigation zone; and

- Procedure to notify MMO and/or PAMS operative that the piling operations have been successfully completed.

7.6. REPORTING

7.6.1. All reporting will be in line with the best practice procedure outlined in the JNCC (2010) guidelines. Reports detailing the piling activity and marine mammal mitigation should be provided to JNCC and MD-LOT. Reports will include:

- Record of piling operations including date and location, duration of pre-piling and soft-start procedures and instances where operations were delayed or stopped due to presence of marine mammals;
- Details of watches made for marine mammals, including details of any sightings, details of the PAM equipment and detections, and details of the piling activity during the watches
- Record of ADD deployment, including deployment locations, evidence of equipment testing, times of activation period, observations of its efficacy, and problems with its deployment;
- Completed Marine Mammal Recording Forms, detailing any incidental marine mammal sightings (i.e. species, distance);
- Details of problems encountered i.e. non-compliance with agreed protocols, and any recommendations for amendments to the protocols; and
- Any recommendations for amendments to the protocol.

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