NORTH FALLS

Offshore Wind Farm

# ENVIRONMENTAL STATEMENT

## Appendix 12.5 Unexploded Ordnance Clearance Information and Assessment

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|---|---|
| Document Reference: | 3.3.10 |
| Volume: | 3.3 |
| APFP Regulation: | 5(2)(a) |
| Date: | July 2024 |
| Revision: | 0 |

**Project Reference: EN010119**

NORTH FALLS

*Offshore Wind Farm*

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|---|---|
| **Project** | North Falls Offshore Wind Farm |
| **Document Title** | Environmental Statement Appendix 12.5 Unexploded Ordnance Clearance Information and Assessment |
| **Document Reference** | 3.3.10 |
| **APFP Regulation** | 5(2)(a) |
| **Supplier** | Royal HaskoningDHV |
| **Supplier Document ID** | PB9244-RHD-ES-OF-RP-OF-0226 |



| Revision | Date | Status/Reason for Issue | Originator | Checked | Approved |
|---|---|---|---|---|---|
| 0 | July 2024 | Submission | RHDHV | NFOW | NFOW |
| | | | | | |
| | | | | | |
| | | | | | |

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## Glossary of Acronyms

| | |
|---|---|
| ADD | Acoustic Deterrent Device |
| CEA | Cumulative Effect Assessment |
| DCO | Development Consent Order |
| EDR | Effective Deterrent Range |
| EQT | Effective Quiet Threshold |
| EPS | European Protection Species |
| HRA | Habitat Regulation Assessment |
| ML | Marine Licence |
| MMMP | Marine Mammal Mitigation Plan |
| MMO | Marine Management Organisation |
| MMOb | Marine Mammal Observer |
| MTD | Marine Technical Directorate |
| MU | Management Unit |
| NEQ | Net Explosive Quantity |
| PTS | Permanent Threshold Shift |
| SAC | Special Area of Conservation |
| SEL | Sound Exposure Level |
| SIP | Site Integrity Plan |
| SNCB | Statutory Nature Conservation Body |
| SNS | Southern North Sea |
| $SPL_{peak}$ | Sound Pressure Level |
| TTS | Temporary Threshold Shift |
| UXO | Unexploded Ordnance |

## Glossary of Terminology

| | |
|---|---|
| Array area | The offshore wind farm area, within which the wind turbine generators, array cables, platform interconnector cable, offshore substation platform(s) and / or offshore converter platform will be located. |
| Array cables | Cables which link the wind turbine generators with each other, the offshore substation platform(s) and / or the offshore converter platform. |
| Landfall | The location where the offshore cables come ashore at Kirby Brook. |
| Offshore cable corridor | The corridor of seabed from array area to the landfall within which the offshore export cables will be located. |
| Offshore converter platform | Should an offshore connection to an HVDC interconnector cable be selected, an offshore converter platform would be required. This is a fixed structure located within the array area, containing HVAC and HVDC electrical equipment to aggregate the power from the wind turbine generators, increase the voltage to a more suitable level for export and convert the HVAC power generated by the wind turbine generators into HVDC power for export to shore via a third party HVDC cable. |
| Offshore export cables | The cables which bring electricity from the offshore substation platform(s) to the landfall, as well as auxiliary cables. |
| Offshore project area | The overall area of the array area and the offshore cable corridor. |

| | |
|---|---|
| Offshore substation platform(s) | Fixed structure(s) located within the array area, containing HVAC electrical equipment to aggregate the power from the wind turbine generators and increase the voltage to a more suitable level for export to shore via offshore export cables. |
| Platform interconnector cable | Cable connecting the offshore substation platforms (OSP); or the OSP and offshore converter platform (OCP). |
| The Applicant | North Falls Offshore Wind Farm Limited (NFOW). |
| The Project<br>Or<br>'North Falls' | North Falls Offshore Wind Farm, including all onshore and offshore infrastructure. |
| Wind turbine generator | Power generating device that is driven by the kinetic energy of the wind. |

# 1 Unexploded Ordnance Clearance Information and Assessment

## 1.1 Introduction

1. This appendix provides an assessment of potential auditory injury and disturbance effects on marine mammals during Unexploded Ordnance (UXO) clearance for the offshore project area. This assessment is provided within the Environmental Statement (ES) for information purposes only. A separate Marine Licence (ML) application for UXO clearance will be submitted post-consent, once detailed information on the locations and extent of UXO required to be cleared is known.
2. A Cumulative Effect Assessment (CEA) for UXO clearance at other projects is provided in Section 12.8 of ES Chapter 12 Marine Mammals (Document Reference: 3.1.14).

## 1.2 Worst case scenario

3. Table 1.1 sets out the realistic worst-case parameters for the marine mammal UXO assessment.

**Table 1.1 Realistic worst-case parameters for marine mammal UXO assessment**

| Parameters | Notes and Rationale |
|---|---|
| <u>Types and Sizes of UXO:</u><br>Various possible types and sizes of UXO, ranging from 0.5kg to 750kg. | Indicative only.<br>A detailed UXO survey would be completed prior to construction. The exact type, size and number of possible detonations and duration of UXO clearance operations is therefore not known at this stage. |
| <u>Number of UXO requiring clearance:</u><br>Estimated 40 (25 in the array area and 15 in the offshore cable corridor) | |
| <u>Clearance techniques:</u><br>Low-order clearance would be the first and preferred method for UXO that require clearance.<br>As a worst-case, assessments are based on high-order clearance. | High-order clearance would only be undertaken in the event that low-order clearance is not possible, or failed to clear the device completely. This is therefore unlikely to be required, however, it is assessed as the worst-case. |

## 1.3 North Falls mitigation and monitoring measures

4. As part of the separate licencing process, the Applicant would commit to a Marine Mammal Mitigation Plan (MMMP) and underwater noise modelling for UXO Clearance, as outlined in Table 1.2. The Applicant would also commit to a Site Integrity Plan (SIP) for the Southern North Sea (SNS) Special Area of Conservation (SAC) should there be a risk of exceeding disturbance thresholds for the SAC (discussed further in Table 1.2 below).

**Table 1.2 UXO clearance mitigation and monitoring measures**

| Mitigation and Monitoring Measure | Additional Information |
|---|---|
| MMMP for UXO Clearance | A detailed MMMP will be prepared for UXO clearance during the post-consent phase, during the ML application process. The MMMP for UXO clearance will ensure there are adequate mitigation measures to minimise the risk of any physical injury or permanent auditory damage to marine mammals as a result of UXO clearance.<br>The MMMP for UXO clearance will be developed in the pre-construction period, when there is more detailed information on the UXO clearance which could be required and the most suitable mitigation measures, based upon best available information and methodologies at that time. The MMMP for UXO clearance will be prepared in consultation with the Marine Management Organisation (MMO) and relevant Statutory Nature Conservation Bodies (SNCBs).<br>The MMMP for UXO clearance will include details of all the required mitigation measures to minimise the potential risk of permanent threshold shift (PTS) as a result of underwater noise during UXO clearance, for example, this would consider the options, suitability and effectiveness of mitigation measures such as, but not limited to:<br>• Low-order clearance techniques, such as deflagration;<br>• The use of bubble curtains if any high-order detonation is required (taking into consideration the environmental limitations);<br>• All UXO clearance to take place in daylight and in favourable conditions with good visibility (sea state 3 or less);<br>• Establishment of a monitoring area with minimum of 1km radius;<br>• The observation of the monitoring area will be by dedicated and Joint Nature Conservation Committee (JNCC) trained marine mammal observers (MMObs) during daylight hours and suitable visibility and sea state conditions;<br>• The observation of the monitoring area using Passive Acoustic Monitoring (PAM) as an additional monitoring tool;<br>• The activation of Acoustic Deterrent Device (ADDs);<br>• The controlled explosions of the UXO will be undertaken by specialist contractors, using the minimum amount of explosive required in order to achieve safe disposal of the UXO; and<br>• Other UXO clearance techniques, such as avoidance of UXO; or relocation of UXO.<br>If more than one high-order detonation is required, other measures such as multiple detonations, if UXO are located in close proximity, will also be considered in consultation with the MMO and SNCBs.<br>In the event that UXOs are not able to be avoided or removed for onshore disposal, the preferred method for UXO clearance would be a low-order clearance method. However, if high-order detonation is required the following measures are also proposed:<br>• Use of a bubble curtain (if required, and taking into account environmental constraints).<br>UXO is not included in the development consent order (DCO) application, as currently not enough detailed information is available. Therefore, UXO clearance will be in a separate ML post consent. |
| SIP for the SNS SAC | In addition to the MMMP for UXO clearance, a SIP for the SNS SAC will be developed (if required). The SIP will set out the approach to deliver any mitigation or management measures to reduce the potential for any significant disturbance of harbour porpoise in relation to the SNS SAC Conservation Objectives.<br>The SIP is an adaptive management tool, which can be used to ensure that the most adequate, effective and appropriate measures, if required, are put in place to reduce the significant disturbance of harbour porpoise in the SNS SAC.<br>In the event that UXOs are not able to be avoided or removed for onshore disposal, the preferred method for UXO clearance would be a low-order clearance method. However, if high-order detonation is required the following measures are likely to be proposed in order to manage noise within the SAC: |

| Mitigation and Monitoring Measure | Additional Information |
|---|---|
| | • Use of a bubble curtain (if required, and taking into account environmental constraints).<br>• Only one high-order detonation would be detonated per day during UXO clearance operations, during the winter period (October to March).<br>• There would be no UXO high-order detonations on the same day as piling during the winter period (October to March).<br>The SIP will be developed in the pre-construction period, as part of the separate Marine Licencing process (if deemed to be required) and will be based upon best available information and methodologies at that time, in consultation with the relevant SNCBs and the MMO. |
| Underwater noise monitoring for UXO clearances | Underwater noise monitoring will be undertaken for all UXO clearances following the *Protocol for In-Situ Underwater Measurement of Explosive Ordnance Disposal for UXO* (National Physical Laboratory, 2020). |

## 1.4 Assessment of likely significant effects from UXO clearance

5. The following assessments follow the approach set out in Section 12.3 of ES Chapter 12 Marine Mammals (Document Reference: 3.1.14), including the definition of effect magnitudes.
6. The potential for UXO clearance is present during the construction phase only; there will be no potential for UXO clearance during the operation and decommissioning phases.

### 1.4.1 Likely significant effects to marine mammals of UXO clearance

7. It is important to note, the assessments for UXO clearance are for information only and are not secured as part of the DCO application. A separate ML application will be submitted when a detailed UXO survey has been completed prior to construction, and a detailed assessment based on that latest available information (including potential UXO locations, size, type, and number) has been undertaken.
8. Prior to construction, there is the potential for UXO clearance to be required. While any identified UXO will either be avoided or removed and disposed of onshore in a designated place, there is the potential that underwater detonation could be required where it is necessary and unsafe to remove the UXO.
9. A detailed UXO survey will be completed prior to construction. Therefore, the number of possible UXO that may be required to clear, along with the duration of UXO clearance operations is currently unknown.
10. For the assessment, a conservative estimate has been made, based on the best available information from other offshore wind farm UXO clearance operations nearby, and other published information. It is not currently known the size or type of the UXO that could be present, therefore a range of sizes has been assessed, with the maximum charge weight of up to 750kg Net Explosive Quantity (NEQ).
11. When an item of UXO detonates on the seabed underwater, several effects are generated, most of which are localised at the point of detonation, such as crater formation and movement of sediment and dispersal of nutrients and contaminants. After detonation, there is the rapid expansion of gaseous products

known as the "bubble pulse". Once it reaches the surface, the energy of the bubble is dissipated in a plume of water and the detonation shock front rapidly attenuates at the water / air boundary. Fragmentation (that is shrapnel from the weapon casing and surrounding seabed materials) is also ejected but does not pose a significant hazard beyond 10m from source.

12. The likely significant effects of underwater explosions on marine mammals include: (i) physical injury from direct or indirect blast wave effect of the high amplitude shock waves and sound wave produced by underwater detonation, which could result in immediate or eventual mortality; (ii) auditory impairment (from exposure to the acoustic wave), resulting in a temporary or permanent loss in hearing sensitivity such as temporary threshold shift (TTS) or PTS; or (iii) behavioural change, such as disturbance to feeding, mating, breeding, and resting (Richardson *et al.,* 1995; Ketten, 2004; von Benda-Beckmann *et al.,* 2015).

13. The severity of the consequences of UXO detonation will depend on many variables, but principally, on the charge weight and its proximity to the receptor. After detonation, the shock wave will expand spherically outwards and will propagate outwards (i.e. line of sight), unless the wave is reflected, channelled or meets an intervening obstruction.

14. There are limited acoustic measurements for underwater explosions, and there can be large differences in the noise levels, depending on the charge size, as well as water depth, bathymetry and seabed sediments at the site, which can also influence noise propagation. The water depth in which the explosion occurs has a significant influence on the effect range for a given charge mass (von Benda-Beckmann *et al.,* 2015).

15. It is important to note that assessments are based on the worst-case for high-order UXO detonations with no mitigation, which is highly unlikely, as the preferred and first option for any UXO requiring detonation would be a low-order clearance method.

### 1.4.2 Underwater noise modelling for UXO clearance

16. A number of UXOs with a range of charge weights (or quantity of contained explosive) could be located within the offshore project area. There is the potential for there to be a variety of explosive types, which will have been subject to degradation and burying over time. Two otherwise identical explosive devices are therefore likely to produce different blasts if one has been subject to different environmental factors.

17. The Galloper Wind Farm UXO clearance report includes detonation of the UXO devices (and sizes) as shown in Table 1.3.

18. A selection of explosive sizes has been considered in the estimation of the underwater noise levels produced by detonation of UXO (Table 1.3). The assessment assumes the maximum explosive charge (see ES Appendix 12.3 (Document Reference: 3.3.8)).

**Table 1.3 Selection of UXO potentially present at North Falls (data on UXO from Galloper Wind Farm is taken from Innogy Renewables UK Limited, 2019)**

| UXO devices potentially present (based on those found within Galloper Wind Farm) | UXO sizes potentially present (based on those found within Galloper Wind Farm) | NEQ for UXO devices included within the following assessment |
|---|---|---|
| – German E-Series sub-marine land buoyant mine<br>– German LMB ground mine<br>– Air delivered ground mine or explosive bomb<br>– British buoyant mine<br>– Allied (high) explosive device<br>– Naval Projectiles<br>– Torpedo bomb<br>– Mortar Mk10 anti-submarine projectile or squid device | – 50kg<br>– 250lb (113kg)<br>– 500lb (227kg)<br>– 1,000lb (454kg) | – 25kg<br>– 55kg<br>– 120kg<br>– 240kg<br>– 525kg<br>– 750kg |

#### *1.4.2.1 Background to underwater noise*

19. The noise produced by the detonation of explosives is affected by a number of different elements (e.g. its design, composition, age, position, orientation, whether it is covered by sediment) which are unknown and cannot be directly considered in an assessment. This leads to a high degree of uncertainty in the estimation of the source noise level (i.e. the noise level at the position of the UXO). A worst-case estimation has therefore been used for calculations, assuming that the UXO to be detonated is not buried, degraded or subject to any other significant attenuation. The consequence of this is that the noise levels produced, particularly by the larger explosives under consideration, are likely to be over-estimated as they are likely to be covered by sediment and degraded.

20. The assessment also does not take into account the variation in the noise level at different depths. Where animals are swimming near the surface, the acoustics at the surface cause the noise level, and hence the exposure, to be lower at this position compared to deeper waters. The risk to animals near the surface may therefore be lower than indicated by the range estimate and therefore this can be considered conservative in respect of impact at different depths.

21. The potential impact has been assessed based on the latest Southall *et al.* (2019) thresholds and criteria for marine mammals that could be present in the area. The thresholds indicate the point at which there is an increase in risk of permanent hearing damage in an underwater receptor (although not all individuals within the maximum PTS range will have permanent hearing damage; this is assumed as a worst-case scenario).

22. The Sound Exposure Level (SEL) criteria are weighted, which takes into account the sound level based on the sensitivity of the receiver, for example, harbour porpoise *Phocoena phocoena* are less sensitive to low frequency sound than minke whales *Balaenoptera acutorostrata*. Southall *et al.* (2019) also includes criteria based on peak Sound Pressure Level ($SPL_{peak}$), which are unweighted and do not take species hearing sensitivity into account.

23. Both $SPL_{peak}$ and SEL values based on the impulsive and non-impulsive criteria are included in the assessments. However, it is important to note that they are

different criteria and as such they should not be compared directly. All decibel SPL values are referenced to 1 μPa and all SEL values are referenced to 1 $\mu Pa^2 s$.

24. Peak noise levels are difficult to predict accurately in a shallow water environment (von Benda Beckmann *et al.,* 2015) and would tend to be significantly over-estimated by the modelling over increased distances from the source. With increased distance from the source, impulsive noise, such as UXO detonation, noise becomes more of a non-impulsive noise, unfortunately it is currently difficult to determine the distance at which an impulsive noise becomes more like a non-impulsive noise. Therefore, modelling was conducted using both the impulsive and non-impulsive criteria for PTS weighted SEL to give an indication of the difference between maximum potential impact ranges (see ES Appendix 12.3 (Document Reference: 3.3.8)).

25. Impulsive noise sources are described as having a rapid rise time, short duration and high peak pressure. A study into the distance at which underwater noise sources (from offshore wind farm piling and seismic surveys) 'transformed' from an impulsive to a non-impulsive noise revealed that, at a distance of between 2 and 3km the noise sources no longer contained the characteristics (in particular a high enough peak pressure) to be classed as an impulsive noise (Hastie *et al.,* 2019). However, this study was completed in a shallow water environment, with a relatively flat seabed, and the actual range at which a sound source transforms into a non-impulsive noise is likely to be dependent on a number of environmental variables and other sound source characteristics (Hastie *et al.,* 2019).

26. The work by Hastie *et al.* (2019) is preliminary work, and Martin *et al.* (2020) suggest that the change in noise characteristics from impulsive to non-impulsive does not make a difference to assessment of injury because sounds retain impulsive character when SPLs are above effective quiet threshold (EQT). However, as outlined in the Hornsea Project Four Environmental Statement Chapter 4 (Orsted, 2021), some of the results presented by Martin *et al.* (2020) indicate that some of the piling sound loses its impulsiveness with increasing distance from the piling site, therefore the sound loses its harmful impulsive characteristics with increased distance.

#### *1.4.2.2 UXO clearance techniques*

27. All assessments have been based on the worst-case scenario and maximum predicted effect ranges for impulsive thresholds.

28. Low-order clearance techniques, where the ordnance is disposed of or rendered safe without a high-order detonation, is the preferred option for UXO clearance. Examples of low-order clearance techniques include (NPL, 2020):

- Freezing the munition to render it inactive;
- Water abrasive suspension cutting in order to physically disrupt the munition;
- Disposal in a Static Detonation Chamber;
- Photolytic destruction of the munition; and
- Low-order deflagration.

29. Deflagration is a technique whereby the explosive within the UXO is rapidly burned at subsonic speeds using plasma from a small-shaped charge that generates insufficient shock to detonate the UXO (Merchant and Robinson, 2020; NPL, 2020). The explosive material inside the UXO reacts with a rapid burning rather than a chain reaction that would lead to a full explosion (NPL, 2020).

30. Substantial noise reduction for deflagration over high-order ($SPL_{peak}$ and SEL are more than 20 Db lower) and acoustic output for deflagration depends only on the size of the shaped charge (rather than the size of the UXO) (NPL, 2020; Robinson *et al.,* 2020).

31. The technique of low-order clearance appears to present a viable option to avoid high-order explosive detonation. Low-order clearance techniques, such as deflagration, are relatively new to civilian applications but have been used by the UK military since 2005 (Merchant and Robinson, 2020). However, a number of UK offshore wind farms have successfully implemented low-order clearance to date.

32. The Moray West Offshore Wind Farm recently undertook a large scale UXO clearance campaign that utilised only low-order deflagration. This method proved successful for all 82 UXO that required clearing, including the largest device with a NEQ of 700kg (Ocean Winds, 2024).

33. In the unlikely event that low order clearance was unsuccessful or deemed unsuitable for a specific UXO (e.g., due to its condition), high-order clearance may be undertaken. Therefore, as a worst-case, high-order detonations have been considered, alongside low-order clearance.

#### *1.4.2.3 Underwater noise modelling methodology*

34. The range of equivalent charge weights for the potential UXO devices that could be present within the offshore project area boundaries have been estimated as 25kg, 55kg, 120kg, 240kg, 525kg and 750kg for high-order detonation.

35. In addition, low-order clearance (such as deflagration) has been assessed, which assumes that the donor or shaped charge (donor charge weight of 0.5kg) detonates fully but without the follow-up high-order detonation of the UXO.

36. Estimation of the source noise level for each charge weight has been carried out in accordance with the methodology of Soloway and Dahl (2014), which follows Arons (1954) and Marine Technical Directorate (MTD) (1996) (see ES Appendix 12.3 (Document Reference: 3.3.8)).

37. Table 1.4 provides the source level used for the underwater noise modelling (further details on how these were calculated is provided in ES Appendix 12.3 (Document Reference: 3.3.8)).

**Table 1.4 Source levels (unweighted $SPL_{peak}$ and $SEL_{ss}$) used for UXO modelling**

| Charge weight (NEQ) | 0.5kg | 25kg + donor charge | 55kg + donor charge | 120kg + donor charge | 240kg + donor charge | 525kg + donor charge | 750kg + donor charge |
|---|---|---|---|---|---|---|---|
| $SPL_{peak}$ source level (Db re 1 µPa @ 1m) | 272.1 | 284.9 | 287.5 | 290.0 | 292.3 | 294.8 | 296.0 |

| Charge weight (NEQ) | 0.5kg | 25kg + donor charge | 55kg + donor charge | 120kg + donor charge | 240kg + donor charge | 525kg + donor charge | 750kg + donor charge |
|---|---|---|---|---|---|---|---|
| $SEL_{ss}$ source level (Db re 1 $\mu Pa^2 s$ @ 1m) | 217.1 | 228.0 | 230.1 | 232.3 | 234.2 | 236.4 | 237.3 |

38. See ES Appendix 12.3 (Document Reference: 3.3.8) for more detail on the underwater noise modelling methodologies.

#### *1.4.2.4 Assessment methodology*

39. The following assessments are undertaken in line with the methodology as set out in Section 12.3 of ES Chapter 12 Marine Mammals (Document Reference: 3.1.14), including the definition of effect magnitude levels.

40. Assessments are carried out using the density and reference populations for harbour porpoise, minke whale, grey seal *Halichoerus grypus*, and harbour seal *Phoca vitulina* as provided in Section 12.4 of ES Chapter 12 Marine Mammals (Document Reference: 3.1.14).

### 1.4.3 Impact 1: Auditory injury due to underwater noise associated with UXO clearance

#### *1.4.3.1 Sensitivity of marine mammals*

41. In this assessment, all species of marine mammal are considered to have high sensitivity to UXO detonations if they are within the potential impact ranges for physical injury or PTS. Marine mammals within the potential impact area are considered to have very limited capacity to avoid such effects, and unable to recover from physical injury or auditory injury.

42. The sensitivity of marine mammals to TTS and flee response as a result of underwater UXO detonations is considered to be medium in this assessment as a precautionary approach. This is for animals within the potential TTS and flee response range, but beyond the potential impact range for PTS. Marine mammals within the potential impact area are considered to have limited capacity to avoid such effects, although any effects on marine mammals would be temporary and they would be expected to return to the area once the activity had ceased.

#### *1.4.3.2 Potential auditory injury effect ranges*

43. The results of the underwater noise modelling (ES Appendix 12.3 (Document Reference: 3.3.8)) for a range of potential charge weights (NEQ) are presented in Table 1.5 and Table 1.6 for PTS and TTS, respectively. The potential impact ranges have been modelled based on the latest Southall *et al.* (2019) thresholds and criteria. The effect ranges (and areas, based on the area of a circle) are used to inform the assessments in the following sections.

**Table 1.5 Potential maximum impact ranges (and areas) of PTS for marine mammals during UXO clearance (the maximum potential impact range and area for each species used in assessments are shown in bold)**

| Potential maximum charge weight (NEQ) | Maximum predicted impact range (km) (and area (km$^2$)) | | |
|---|---|---|---|
| | PTS $SPL_{peak}$ Unweighted (Impulsive criteria) | PTS $SEL_{ss}$ Weighted (Impulsive criteria) | PTS $SEL_{ss}$ Weighted (Non-impulsive criteria) |
| **Harbour porpoise (Very High Frequency (VHF) cetacean)** | | | |
| **Threshold level** | **202 Db re 1 µPa** | **155 Db re 1 µPa$^2$s** | **173 Db re 1 µPa$^2$s** |
| 0.5kg (low-order clearance) | **1.2km (4.5km$^2$)** | 0.11km (0.04km$^2$) | <0.05km (0.008km$^2$) |
| 25kg + donor charge | 4.6km (66.5km$^2$) | 0.57km (1.02km$^2$) | <0.05km (0.008km$^2$) |
| 55kg + donor charge | 6.0km (113.1km$^2$) | 0.74km (1.7km$^2$) | <0.05km (0.008km$^2$) |
| 120kg + donor charge | 7.8km (191.1km$^2$) | 0.95km (2.8km$^2$) | 0.07km (0.02km$^2$) |
| 240kg + donor charge | 9.8km (301.7km$^2$) | 1.1km (3.8km$^2$) | 0.10km (0.03km$^2$) |
| 525kg + donor charge | 12km (452.4km$^2$) | 1.4km (6.2km$^2$) | 0.13km (0.05km$^2$) |
| 750kg + donor charge | **14km (615.8km$^2$)** | 1.5km (7.07km$^2$) | 0.16km (0.08km$^2$) |
| **Minke whale (Low Frequency (LF) cetacean)** | | | |
| **Threshold level** | **219 Db re 1 µPa** | **183 Db re 1 µPa$^2$s** | **199 Db re 1 µPa$^2$s** |
| 0.5kg (low-order clearance) | 0.22km (0.2km$^2$) | **0.32km (0.3km$^2$)** | <0.05km (0.008km$^2$) |
| 25kg + donor charge | 0.82km (2.1km$^2$) | 2.2km (15.2km$^2$) | 0.13km (0.05km$^2$) |
| 55kg + donor charge | 1.0km (3.1km$^2$) | 3.2km (32.2km$^2$) | 0.19km (0.11km$^2$) |
| 120kg + donor charge | 1.3km (5.3km$^2$) | 4.7km (69.4km$^2$) | 0.28km (0.25km$^2$) |
| 240kg + donor charge | 1.7km (9.1km$^2$) | 6.5km (132.7km$^2$) | 0.39km (0.48km$^2$) |
| 525kg + donor charge | 2.2km (15.2km$^2$) | 9.5km (282.5km$^2$) | 0.57km (1.02km$^2$) |
| 750kg + donor charge | 2.5km (19.6km$^2$) | **11km (380.1km$^2$)** | 0.68km (1.45km$^2$) |
| **Grey seal and harbour seal (Phocid Carnivores in Water (PCW))** | | | |
| **Threshold level** | **218 Db re 1 µPa** | **185 Db re 1 µPa$^2$s** | **201 Db re 1 µPa$^2$s** |
| 0.5kg (low-order clearance) | **0.24km (0.18km$^2$)** | 0.06km (0.01km$^2$) | <0.05km (0.008km$^2$) |
| 25kg + donor charge | 0.91km (2.60km$^2$) | 0.39km (0.48km$^2$) | <0.05km (0.008km$^2$) |

| Potential maximum charge weight (NEQ) | Maximum predicted impact range (km) (and area ($km^2$)) | | |
|---|---|---|---|
| | PTS $SPL_{peak}$ Unweighted (Impulsive criteria) | PTS $SEL_{ss}$ Weighted (Impulsive criteria) | PTS SEL $_{ss}$ Weighted (Non-impulsive criteria) |
| 55kg + donor charge | 1.1km (3.80$km^2$) | 0.57km (1.02$km^2$) | <0.05km (0.008$km^2$) |
| 120kg + donor charge | 1.5km (7.1$km^2$) | 0.83km (2.2$km^2$) | <0.05km (0.008$km^2$) |
| 240kg + donor charge | 1.9km (11.3$km^2$) | 1.1km (3.8$km^2$) | 0.07km (0.02$km^2$) |
| 525kg + donor charge | 2.5km (19.6$km^2$) | 1.6km (8.0$km^2$) | 0.10km (0.03$km^2$) |
| 750kg + donor charge | **2.8km (24.6$km^2$)** | 2.0km (12.6$km^2$) | 0.12km (0.05$km^2$) |

**Table 1.6 Potential maximum impact ranges (and areas) of TTS for marine mammals during UXO clearance (the maximum potential impact range and area for each species used in assessments are shown in bold)**

| Potential maximum charge weight (NEQ) | Maximum predicted impact range (km) (and area ($km^2$)) | | |
|---|---|---|---|
| | TTS $SPL_{peak}$ Unweighted (Impulsive criteria) | TTS $SEL_{ss}$ Weighted (Impulsive criteria) | TTS SEL $_{ss}$ Weighted (Non-impulsive criteria) |
| **Harbour porpoise (VHF)** | | | |
| **Threshold level** | **196 Db re 1 µPa** | **140 Db re 1 µPa²s** | **153 Db re 1 µPa²s** |
| 0.5kg (low-order clearance) | **2.3km (16.6$km^2$)** | 0.93km (2.7$km^2$) | 0.15km (0.07$km^2$) |
| 25kg + donor charge | 8.5km (227.0$km^2$) | 2.4km (18.1$km^2$) | 0.73km (1.7$km^2$) |
| 55kg + donor charge | 11km (380.1$km^2$) | 2.8km (24.6$km^2$) | 0.94km (2.8$km^2$) |
| 120kg + donor charge | 14km (615.8$km^2$) | 3.2km (32.2$km^2$) | 1.1km (3.8$km^2$) |
| 240kg + donor charge | 18km (1,017.9$km^2$) | 3.5km (38.5$km^2$) | 1.4km (6.2$km^2$) |
| 525kg + donor charge | 23km (1,661.9$km^2$) | 4.0km (50.3$km^2$) | 1.7km (9.1$km^2$) |
| 750kg + donor charge | **26km (2,123.7$km^2$)** | 4.2km (55.4$km^2$) | 1.8km (10.2$km^2$) |
| **Minke whale (LF)** | | | |
| **Threshold level** | **213 Db re 1 µPa** | **168 Db re 1 µPa²s** | **179 Db re 1 µPa²s** |
| 0.5kg (low-order clearance) | 0.41km (0.53$km^2$) | **4.5km (63.62$km^2$)** | 0.65km (1.3$km^2$) |
| 25kg + donor charge | 1.5km (7.07$km^2$) | 29km (2,642.1$km^2$) | 4.4km (60.8$km^2$) |

| Potential maximum charge weight (NEQ) | Maximum predicted impact range (km) (and area ($km^2$)) | | |
|---|---|---|---|
| | TTS $SPL_{peak}$ Unweighted (Impulsive criteria) | TTS $SEL_{ss}$ Weighted (Impulsive criteria) | TTS $SEL_{ss}$ Weighted (Non-impulsive criteria) |
| 55kg + donor charge | 1.9km (11.34$km^2$) | 41km (5,281.0$km^2$) | 6.4km (128.7$km^2$) |
| 120kg + donor charge | 2.5km (19.64$km^2$) | 57km (10,207.0$km^2$) | 9.4km (277.6$km^2$) |
| 240kg + donor charge | 3.2km (32.17$km^2$) | 76km (18,145.8$km^2$) | 13km (530.9$km^2$) |
| 525kg + donor charge | 4.1km (52.81$km^2$) | 100km (31,415.9$km^2$) | 18km (1,017.9$km^2$) |
| 750kg + donor charge | 4.6km (66.48$km^2$) | **110km (38,013.3$km^2$)** | 22km (1,520.5$km^2$) |
| **Grey seal and harbour seal (PCW)** | | | |
| **Threshold level** | **212 Db re 1 μPa** | **170 Db re 1 $μPa^2s$** | **181 Db re 1 $μPa^2s$** |
| 0.5kg (low-order clearance) | 0.45km (0.64$km^2$) | **0.8km (2.01$km^2$)** | 0.11km (0.04$km^2$) |
| 25kg + donor charge | 1.6km (8.04$km^2$) | 5.2km (84.95 $km^2$) | 0.79km (2.0$km^2$) |
| 55kg + donor charge | 2.1km (13.85$km^2$) | 7.5km (176.72$km^2$) | 1.1km (3.8$km^2$) |
| 120kg + donor charge | 2.8km (24.63$km^2$) | 10km (314.16$km^2$) | 1.6km (8.0$km^2$) |
| 240kg + donor charge | 3.5km (38.49$km^2$) | 14km (615.75$km^2$) | 2.3km (16.6$km^2$) |
| 525kg + donor charge | 4.6km (66.48$km^2$) | 19km (1,134.12$km^2$) | 3.3km (34.2$km^2$) |
| 750kg + donor charge | 5.1km (81.7$km^2$) | **22km (1,520.53$km^2$)** | 4km (50.3$km^2$) |

#### 1.4.3.3 Magnitude of effect for PTS

44. The number of harbour porpoise, minke whale, grey seal and harbour seal that could potentially be impacted by a high-order UXO detonation (up to 750kg NEQ), and low-order clearance (0.5kg) has been estimated based on the maximum potential PTS impact ranges (Table 1.7).

45. For the high-order detonation of the maximum potential UXO with an NEQ of 750kg plus donor charge, the magnitude for PTS is assessed as a worst-case (Table 1.7) to be:

    - Medium for harbour porpoise and minke whale
    - Low to medium for grey seal
    - Negligible to medium for harbour seal

46. For low-order clearance (0.5kg donor charge for all sizes of UXO) the magnitude for PTS is assessed to be:

    - Low for harbour porpoise
    - Negligible for minke whale, grey seal and harbour seal

**Table 1.7 Maximum number of marine mammals potentially at risk of PTS during UXO clearance**

| Species | Criteria | Maximum effect range (and area) | Maximum number of individuals | % of reference population | Magnitude (permanent effect)* |
|---|---|---|---|---|---|
| Harbour porpoise | PTS $SPL_{peak}$ (unweighted, impulsive) | High-order detonation (750kg (NEQ) + donor charge)<br>14km (615.8km$^2$) | 1,981<br>(based on the worst-case HiDef survey density for the winter period of 3.217/km$^2$) | 0.58% NS Management Unit (MU) | **Medium** |
| | | Low-order clearance (0.5kg (NEQ))<br>1.2km (4.5km$^2$) | 15<br>(based on the worst-case HiDef survey density for the winter period of 3.217/km$^2$) | 0.004% NS MU | **Low** |
| Minke whale | PTS $SEL_{ss}$ (weighted, impulsive) | High-order detonation (750kg (NEQ) + donor charge)<br>11km (380.1km$^2$) | 6<br>(based on the SCANS-IV density of 0.0153/km$^2$) | 0.03% CGNS MU | **Medium** |
| | | Low-order clearance (0.5kg (NEQ))<br>0.32km (0.32km$^2$) | 0.005<br>(based on the SCANS-IV density of 0.0153/km$^2$) | 0.00002% CGNS MU | **Negligible** |
| Grey seal | PTS $SPL_{peak}$ (unweighted, impulsive) | High-order detonation (750kg (NEQ) + donor charge)<br>2.8km (24.6km$^2$) | 5<br>(based on the average offshore cable corridor density of 0.19/km$^2$) | 0.02% SE E MU (0.008% wider population) | **Low to medium** |
| | | | 2<br>(based on the worst-case array area density) of 0.07/km$^2$) | 0.007% SE E MU (0.003% wider population) | **Low** |
| | | Low-order clearance (0.5kg (NEQ))<br>0.24km (0.18km$^2$) | 0.03<br>(based on the average offshore cable corridor density of 0.19/km$^2$) | 0.0001% SE U MU (0.00006% wider population | **Negligible** |
| | | | 0.01<br>(based on the worst-case array area density) of 0.07/km$^2$) | 0.00004% SE U MU (0.00002% wider population | **Negligible** |
| Harbour seal | PTS $SPL_{peak}$ (unweighted, impulsive) | High-order detonation (750kg (NEQ) + donor charge)<br>2.8km (24.6km$^2$) | 3<br>(based on the average offshore cable corridor density of 0.11/km$^2$) | 0.06% SE E MU (wider population) | **Medium** |
| | | | 0.01<br>(based on the worst-case array area density of 0.00048/km$^2$) | 0.0002% SE E MU | **Negligible** |

| Species | Criteria | Maximum effect range (and area) | Maximum number of individuals | % of reference population | Magnitude (permanent effect)* |
|---|---|---|---|---|---|
| | | Low-order clearance (0.5kg (NEQ))<br>0.24km (0.18km$^2$) | 0.02<br>(based on the average offshore cable corridor density of 0.11/km$^2$) | 0.0004% SE E MU | **Negligible** |
| | | | 0.00009<br>(based on the worst-case array area density for array area north) of 0.000048/km$^2$) | 0.000002% SE E MU | **Negligible** |

#### *1.4.3.4 Magnitude of effect for TTS*

47. The number of harbour porpoise, minke whale, grey seal and harbour seal that could potentially be impacted by a high-order UXO detonation (up to 750kg NEQ), and low-order clearance (0.5kg) has been estimated, based on the maximum potential TTS effect ranges (Table 1.8).

48. For the high-order detonation of the maximum potential UXO with an NEQ of 750kg plus donor charge, the magnitude for TTS is assessed, as a worst-case (Table 1.8), to be:

   - Low for harbour porpoise and minke whale
   - Negligible for grey seal
   - Negligible to low for harbour seal

49. For low-order clearance (0.5kg donor charge for all sizes of UXO) the magnitude is assessed to be negligible for all marine mammal species.

**Table 1.8 Maximum number of marine mammals potentially at risk of TTS during UXO clearance**

| Species | Criteria | Maximum effect range (and area) | Maximum number of individuals | % of reference population | Magnitude (temporary effect) |
|---|---|---|---|---|---|
| Harbour porpoise | TTS $SPL_{peak}$ (unweighted, impulsive) | High-order detonation (750kg (NEQ) + donor charge) 26km (2123.7km²) | 6,832 (based on the worst-case HiDef survey density for the winter period of 3.217/km²) | 2.02% NS MU | **Low** |
| | | Low-order clearance (0.5kg (NEQ)) 2.3km (16.6km²) | 54 (based on the worst-case HiDef survey density for the winter period of 3.217/km²) | 0.02% NS MU | **Negligible** |
| Minke whale | TTS $SEL_{ss}$ (weighted, impulsive) | High-order detonation (750kg (NEQ) + donor charge) 110km (38,013.3km²) | 582 (based on the SCANS-IV density of 0.0153/km²) | 2.89% CGNS MU | **Low** |
| | | Low-order clearance (0.5kg (NEQ)) 4.5km (63.6km²) | 1 (based on the SCANS-IV density of 0.0153/km²) | 0.005% CGNS MU | **Negligible** |
| Grey seal | TTS $SEL_{ss}$ (weighted, impulsive) | High-order detonation (750kg (NEQ) + donor charge) 22km (1,520.5km²) | 289 (based on the average offshore cable corridor density of 0.19/km²) | 0.94% SE E MU (0.51% wider population) | **Negligible** |
| | | | 107 (based on the worst-case array area of 0.07/km²) | 0.35% SE E MU (0.19% wider population) | **Negligible** |
| | | Low-order clearance (0.5kg (NEQ)) 0.8km (2.01km²) | 0.38 (based on the average offshore cable corridor density of 0.19/km²) | 0.001% SE E MU (0.0007% wider population) | **Negligible** |
| | | | 0.14 (based on the worst-case array area of 0.07/km²) | 0.0005% SE E MU (0.0002% wider population) | **Negligible** |
| Harbour seal | TTS $SEL_{ss}$ (weighted, impulsive) | High-order detonation (750kg (NEQ) + donor charge) 22km (1,520.5km²) | 168 (based on the average offshore cable corridor density of 0.11/km²) | 3.45% SE E MU (wider population) | **Low** |
| | | | 0.7 (based on the worst-case array area of 0.00048km²) | 0.01% SE E MU | **Negligible** |

| Species | Criteria | Maximum effect range (and area) | Maximum number of individuals | % of reference population | Magnitude (temporary effect) |
|---|---|---|---|---|---|
| | | Low-order clearance (0.5kg (NEQ)) 0.8km (2.01km$^2$) | 0.22 (based on the average offshore cable corridor density of 0.12/km$^2$) | 0.005% SE E MU | **Negligible** |
| | | | 0.001 (based on the worst-case array area of 0.0000048km$^2$) | 0.00002% SE E MU | **Negligible** |

### 1.4.3.5 Effect significance

50. Taking into account the high sensitivity for all species to PTS from UXO clearance, the effect significance, for a high-order detonation without mitigation, has been assessed as major adverse for harbour porpoise and minke whale, moderate to major adverse for grey seal, and minor to major adverse for harbour seal (Table 1.9).

51. For low-order clearance, without mitigation measures, and based on a high sensitivity for all marine mammals to PTS from low-order clearance, the effect significance has been assessed as minor adverse for all species (Table 1.9).

52. With mitigation measures, as laid out below, the residual effect significance would be minor (not significant) for the potential for PTS in all marine mammal species.

53. For TTS, taking into account the medium sensitivity for all species to UXO clearance, the effect significance, for both a high-order detonation and low-order detonation, without mitigation, has been assessed as minor adverse for all species (Table 1.9).

54. It should be noted that the conclusion of moderate or major adverse (significant) without mitigation for PTS is very precautionary, as the assessment is based on the worst-case scenario of the largest possible UXO device as a high-order detonation.

**Table 1.9 Assessment of effect significance for auditory injury from UXO clearance**

| Species | Sensitivity | Magnitude | Effect significance | Mitigation | Residual effect significance |
|---|---|---|---|---|---|
| **PTS during high-order UXO clearance** | | | | | |
| Harbour porpoise and minke whale | High | Medium | Major adverse | MMMP for UXO clearance. | **Minor adverse** |
| Grey seal | High | Low to medium | Moderate to major adverse | | **Minor adverse** |
| Harbour seal | High | Negligible to medium | Minor to major adverse | | **Minor adverse** |
| **PTS during low-order UXO clearance** | | | | | |
| Harbour porpoise | High | Low | Moderate adverse | MMMP for UXO clearance. | **Minor adverse** |
| Minke whale, grey seal and harbour seal | High | Negligible | Minor adverse | | **Minor adverse** |
| **TTS during high-order UXO clearance** | | | | | |
| Harbour porpoise and minke whale | Medium | Low | Minor adverse | None required, but MMMP for UXO clearance would reduce potential for effect. | **Minor adverse** |
| Grey seal | Medium | Negligible | Minor adverse | | **Minor adverse** |
| Harbour seal | Medium | Negligible to low | Minor adverse | | **Minor adverse** |
| **TTS during low-order UXO clearance** | | | | | |
| Harbour porpoise, | Medium | Negligible | Minor adverse | None required, but | **Minor adverse** |

| Species | Sensitivity | Magnitude | Effect significance | Mitigation | Residual effect significance |
|---|---|---|---|---|---|
| minke whale, grey seal and harbour seal | | | | MMMP for UXO clearance would reduce potential for effect. | |

### *1.4.3.6 Mitigation*

55. As outlined in Section 1.3, a MMMP for UXO clearance will be produced post-consent in consultation with the MMO and relevant SNCBs. The final MMMP for UXO clearance will be based on the latest scientific understanding and guidance, pre-construction UXO surveys in the offshore project area, as well as detailed project design.

56. For high-order clearance, an ADD would be activated for a maximum of 80 minutes, during which harbour porpoise, grey seal, and harbour seal would move at least 7.2km away, based on precautionary swimming speed of 1.5m/s (Otani *et al.,* 2000), and minke whale would move 15.6km, based on swimming speed of 3.25m/s (Blix and Folkow, 1995). This is less than the highest PTS effect range of 14km for harbour porpoise (for a device of 750kg NEQ), but higher than the highest PTS effect range for minke whale (of 11km), and 2.8km for grey seal and harbour seal.

57. An ADD activation period of 80 minutes would ensure harbour porpoise are outside the potential PTS effect range for a high-order UXO clearance of up to 55kg. Any high-order clearance for UXO of higher than 55kg would result in potential PTS ranges that exceed the predicted ADD deterrence range for 80 minutes of ADD activation (of 7.2km as noted above). There is therefore the potential for injury to occur for harbour porpoise for a high-order clearance of UXO of higher than 55kg. Alternative mitigation or noise reduction options would therefore be required (e.g. bubble curtains) to avoid injury to harbour porpoise, or, if not possible to wholly mitigate the potential for auditory injury, a European Protection Species (EPS) licence (Marine Wildlife Application) for injury would be applied for, at the time of the ML application.

58. The implementation of the mitigation measures within the MMMP for UXO clearance will reduce the risk of any permanent auditory injury (PTS) during UXO clearance. The mitigation measure would also reduce the risk of TTS.

59. The proposed mitigation measures for consideration in the MMMP for UXO clearance include, the use of low-order clearance techniques, such as deflagration, establishing a monitoring zone and surveying prior to UXO clearance, the use of ADDs if any high-order detonations are required.

60. A marine wildlife licence application, if required, will be submitted post-consent. At this time, pre-construction UXO surveys would have been conducted, and full consideration will have been given to any necessary mitigation measures that may be required following the development of the MMMP for UXO clearance.

### 1.4.4 Impact 2: Disturbance due to underwater noise associated with UXO clearance

#### *1.4.4.1 Sensitivity of marine mammals*

61. The sensitivity of harbour porpoise and minke whale to disturbance as a result of underwater UXO detonations is considered to be medium in this assessment as a precautionary approach, while the sensitivity of grey seal and harbour seal is low. Any effects on marine mammals would be temporary and they would be expected to return to the area once the activity had ceased.

#### *1.4.4.2 Magnitude of effect*

62. There are currently no agreed thresholds or criteria for the behavioural response and disturbance of marine mammals, therefore it is not possible to conduct underwater noise modelling to predict potential impact ranges.

63. For marine mammals, a fleeing response is assumed to occur at the same noise levels as TTS for high-order UXO detonation. As outlined in Southall *et al.* (2007), the onset of behavioural disturbance is proposed to occur at the lowest level of noise exposure that has a measurable transient effect on hearing (i.e. TTS). Although, as Southall *et al.* (2007) recognised that this is not a behavioural effect per se, exposures to lower noise levels from a single pulse are not expected to cause disturbance. However, any compromise, even temporarily, to hearing functions could have the potential to affect behaviour.

64. The use of the TTS threshold is appropriate for UXO disturbance, because the noise from the UXO explosion is only fleetingly in the environment. Therefore, the assumption is that although noise levels lower than TTS threshold may startle the individual, this has no lasting effect. TTS results in a temporary reduction in hearing ability, and therefore may affect the individuals' fitness temporarily (as recommended in Southall *et al.* (2007) for a single pulse).

65. As outlined in Southall *et al*. (2021) thresholds that attempt to relate single noise exposure parameters (e.g. received noise level) and behavioural response across broad taxonomic grouping and sound types can lead to severe errors in predicting effects. Differences between species, individuals, exposure situational context, the temporal and spatial scales over which they occur, and the potential interacting effects of multiple stressors can lead to inherent variability in the probability and severity of behavioural responses.

66. The assessments for TTS / fleeing response have therefore been used for assessing the potential disturbance ranges for UXO high-order detonation for those species where no further information is currently available for potential disturbance ranges due to UXO clearances. Therefore, the potential range and areas for TTS presented in Table 1.8, with the estimated number and percentage of reference populations that could be affected as assessed in Section 1.4.3.4, provides an indication of possible fleeing response.

67. The SNCBs currently recommend that a potential disturbance range based on an Effective Deterrent Radius (EDR) of 26km around UXO high-order detonations is used to assess harbour porpoise disturbance in SACs (JNCC *et al.,* 2020); the offshore project area lies within the SNS SAC. The assessment for the potential disturbance for high-order detonation, therefore, also includes the maximum number of harbour porpoise based on maximum potential impact area for 26km EDR (an area of 2,123.7km$^2$).

68. The potential disturbance for low-order clearance (the first option and preferred method) is currently unknown, however, in the JNCC Marine Noise Registry, the Help and Guidance report details the use of a 5km EDR for harbour porpoise for low order clearance (MNR, 2023). This EDR has also been used in other ML Applications (e.g. at Sofia Offshore Wind Farm[1] and Dogger Bank A and B Wind farms[2]). Therefore, it has been assumed that there could be an estimated worst-case of 5km disturbance range (78.54km$^2$) for low-order clearances, including vessels. As a worst-case assessment, a disturbance impact area of 78.54km$^2$ has been used to assess for temporary disturbance in marine mammals for UXO low-order clearances.

69. In addition, the MMMP for UXO clearance will include ADD activation prior to all UXO clearance, to ensure marine mammals are beyond the maximum potential impact ranges for PTS. The duration for ADD activation will depend on the clearance method, and will vary for low-order clearance, high-order detonation, size of UXO (NEQ) and location (e.g. marine mammal species that could be present in nearshore and offshore areas).

70. The duration of ADD activation required will be determined for the final MMMP for UXO clearance, based on detailed information on the UXO clearance which could be required and the most suitable mitigation measures, based upon best available information and methodologies at that time, in consultation with the MMO and relevant SNCBs. Therefore, assessments provided are for information only and will be reviewed and updated for the ML and marine wildlife licence application prior to UXO clearance.

#### *1.4.4.3 Magnitude of effect for disturbance due to UXO clearance*

71. As assessed in Section 1.4.3.4, for a high-order detonation of the maximum potential UXO with an NEQ of 750kg plus donor charge, the magnitude for TTS / fleeing response is assessed, as a worst-case, to be:

Low for harbour porpoise and minke whale

- Negligible for grey seal
- Negligible to low for harbour seal

72. For low-order clearance (0.5kg donor charge for all sizes of UXO) the magnitude for TTS / fleeing response is assessed to be:

- Negligible for all species

73. The maximum number of harbour porpoise that could potentially be disturbed in a 26km radius of a high-order UXO detonation without mitigation has been estimated. The resulting magnitude is assessed to be low (Table 1.10).

74. There would be only one high-order UXO detonation at any time during UXO clearance operation, i.e., there would be no simultaneous high-order UXO detonations. Although, more than one UXO clearance (low order) could occur in a 24-hour period.

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[1] RWE Renewables Limited (2021)
[2] Dogger Bank Offshore Wind Farm (2021)

**Table 1.10 Estimated number of harbour porpoise that could potentially be disturbed during UXO clearance based on 26km EDR for high-order detonation with no mitigation**

| Species | Maximum effect area | Maximum number of individuals | % of reference population | Magnitude (temporary effect) |
|---|---|---|---|---|
| Harbour porpoise | 2,123.7km$^2$ | 6,832 (based on the worst-case HiDef survey density for the winter period of 3.217/km$^2$) | 2.02% NS MU | Low |

75. Based on an estimated worst-case of 5km disturbance range (78.54km$^2$) including vessels for low-order clearance (such as deflagration), the magnitude of effect has been assessed as negligible for all marine mammal species (Table 1.11).

**Table 1.11 Estimated number of marine mammals that could potentially be disturbed during low-order UXO clearance based on 5km disturbance range**

| Species | Maximum effect area | Maximum number of individuals | % of reference population | Magnitude (temporary effect) |
|---|---|---|---|---|
| Harbour porpoise | 78.54km$^2$ | 253 (based on the worst-case HiDef survey density for the winter period of 3.217/km$^2$) | 0.07% NS MU | Negligible |
| Minke whale | 78.54km$^2$ | 2 (based on the SCANS-III density of 0.0153/km$^2$) | 0.01% CGNS MU | Negligible |
| Grey seal | 78.54km$^2$ | 15 (based on the average offshore cable corridor density of 0.19/km$^2$) | 0.05% SE E MU (0.03% wider population) | Negligible |
| | | 6 (based on the worst-case array area density for array area) of 0.07/km$^2$) | 0.02% SE E MU (0.01% wider population) | Negligible |
| Harbour seal | 78.54km$^2$ | 9 (based on the average offshore cable corridor density of 0.11/km$^2$) | 0.18% SE E MU (same as wider population) | Negligible |
| | | 0.04 (based on the worst-case array area density for array area) of 0.00048km$^2$) | 0.0008% SE E MU | Negligible |

### *1.4.4.4 Magnitude of effect for disturbance from ADD activation*

76. The estimated maximum ADD activation prior to UXO clearance has been determined based on the maximum predicted effect range for low-order clearance of 1.2km for harbour porpoise. For high-order detonation, the maximum ADD activation of 80 minutes has been used to inform potential disturbance ranges (Table 1.5).

77. For low-order clearance, ADD would be activated for 14 minutes, during which harbour porpoise, grey seal, and harbour seal would move at least 1.26km away, based on precautionary swimming speed of 1.5m/s (Otani *et al.,* 2000) and minke

whale would move 2.73km, based on swimming speed of 3.25m/s (Blix and Folkow, 1995).

78. For high-order clearance, an ADD would be activated for a maximum of 80 minutes, during which harbour porpoise, grey seal, and harbour seal would move at least 7.2km away, based on precautionary swimming speed of 1.5m/s (Otani *et al.,* 2000), and minke whale would move 15.6km, based on swimming speed of 3.25m/s (Blix and Folkow, 1995).

79. These maximum deterrence ranges have been assessed as a disturbance range for each species. The area of disturbance is based on these potential disturbance ranges as a radius of a circular area.

80. The magnitude of effect for ADD activation prior to UXO clearance has been assessed as negligible for all marine mammal species (Table 1.12).

81. The ADD would only be activated for the minimum time required to ensure effective mitigation. The disturbance as a result of ADD activation is within the maximum effect range assessed for TTS / disturbance from UXO clearance and is therefore not an additive effect to the overall area of potential disturbance.

**Table 1.12 Estimated number of marine mammals that could potentially be disturbed during ADD activation for UXO clearance**

| Species | Low-order clearance [up to 14 minutes] | | High-order detonation [up to a maximum of 80 minutes] | |
|---|---|---|---|---|
| | Number of individuals potentially disturbed (% of reference population) | Magnitude of effect | Number of individuals potentially disturbed (% of reference population) | Magnitude of effect |
| Harbour porpoise | 17<br>(0.005% NS MU) | Negligible | 524<br>(0.15% NS MU) | Negligible |
| Minke whale | 0.4 (0.002% CGNS) | Negligible | 12<br>(0.06% CGNS) | Negligible |
| Grey seal | 0.4<br>Based on array area density (0.001% SE E MU; 0.0006% wider population) | Negligible | 12<br>Based on array area density (0.04% SE E MU; 0.02% wider population) | Negligible |
| | 1<br>Based on cable corridor density (0.003% SE E MU; 0.002% wider population) | Negligible | 31<br>Based on cable corridor density (0.10% SE E MU; 0.05% wider population) | Negligible |
| Harbour seal | 0.002<br>Based on array area density (0.00005% SE E MU) | Negligible | 0.08<br>Based on array area density (0.002% SE E MU) | Negligible |
| | 0.6<br>Based on cable corridor density (0.01% SE E MU) | Negligible | 18<br>Based on cable corridor density (0.37% SE E MU)) | Negligible |

#### *1.4.4.5 Effect significance*

82. Taking into account the medium sensitivity of harbour porpoise and minke whale to disturbance from UXO clearance, and low for grey seal and harbour seal, and the magnitudes of effect (Table 1.7 & Table 1.8), the temporary disturbance during

UXO clearance has been assessed as negligible to minor adverse for all marine mammals (Table 1.13).

**Table 1.13 Assessment of effect significance for disturbance of marine mammals during UXO clearance**

| Species | Sensitivity | Magnitude | Effect significance | Mitigation | Residual effect significance |
|---|---|---|---|---|---|
| **Disturbance effect based on TTS / fleeing response** | | | | | |
| See **Table 1.8**. | | | | | |
| **Disturbance effect (26km EDR for high-order clearance)** | | | | | |
| Harbour porpoise | Medium | Low | Minor adverse | None required. | **Minor adverse** |
| **Disturbance effect (5km disturbance for low-order clearance)** | | | | | |
| Harbour porpoise and minke whale | Medium | Negligible | Minor adverse | None required. | **Minor adverse** |
| Grey seal and harbour seal | Low | Negligible | Negligible | | **Negligible** |
| **Disturbance from ADD activation** | | | | | |
| Harbour porpoise and minke whale | Medium | Negligible | Minor adverse | None required. | **Minor adverse** |
| Grey seal and harbour seal | Low | Negligible | Negligible | | **Negligible** |

#### *1.4.4.6 Mitigation*

83. No mitigation measures are required to minimise any potential disturbance to marine mammals due to UXO clearance.

### 1.4.5 Impact 3: Changes to prey availability as a result of underwater noise from UXO clearance activities

#### *1.4.5.1 Sensitivity*

84. As outlined in ES Appendix 12.2 (Document Reference: 3.3.7), the diet of harbour porpoise consists of a wide variety of prey species and varies geographically and seasonally, reflecting changes in available food resources. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet daily energy requirements. It has been estimated that, depending on the conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.,* 1997). Harbour porpoise are therefore considered to have low to medium sensitivity to changes in prey resources.

85. Minke whale feed on a variety of prey species, but in some areas, they have been found to prey upon specific species at the population level (see ES Appendix 12.2 (Document Reference: 3.3.7). Therefore, minke whale are considered to have a low to medium sensitivity to changes in prey resource.

86. Grey and harbour seal feed on a variety of prey species, both are considered to be opportunistic feeders, feeding on wide range of prey species and they are able

to forage in other areas and have relatively large foraging ranges (see ES Appendix 12.2 (Document Reference: 3.3.7)). Grey seal and harbour seal are therefore considered to have low sensitivity to changes in prey resources.

#### *1.4.5.2 Magnitude of effect*

87. ES Chapter 11 Fish and Shellfish Ecology (Document Reference: 3.1.13) assessed the potential impact of underwater noise and vibration as a result of UXO clearance activities to fish species. Physical injury / trauma would be expected in close proximity to the detonation (tens to hundreds of meters, depending on charge) with TTS and behavioural impacts potentially occurring at greater distances. In all cases, however, high risks are only anticipated at short distances. Taking this into consideration and the short term and intermittent nature of this activity (limited to instances when detonation of UXO is required), the magnitude of the impact is considered to be negligible for fish species.

88. Therefore, the magnitude of effect for changes to prey resources as a result of UXO clearance activity, has been assessed as negligible for all marine mammal species.

#### *1.4.5.3 Effect of significance*

89. Taking into account the low sensitivity of grey seal and harbour seal and the low to medium sensitivity of harbour porpoise and minke whale, as well as the negligible magnitude of effect for all species. The changes to prey resources as a result of underwater noise from UXO clearance activity has been assessed as negligible for all marine mammal species.

#### *1.4.5.4 Mitigation*

90. No mitigation measures are required for changes to prey availability as a result of underwater noise from UXO clearance activities.

### 1.4.6 Summary

91. The potential impacts on marine mammals from UXO clearance are summarised in Table 1.14.

**Table 1.14 Summary of likely significant effects to marine mammals due to UXO clearance**

| Likely significant effect | Receptor | Sensitivity | Magnitude | Pre-mitigation effect | Mitigation measures | Residual effect |
|---|---|---|---|---|---|---|
| **Impact 1: Auditory injury from underwater noise associated with UXO clearance** | | | | | | |
| PTS for UXO high-order detonation with no mitigation | Harbour porpoise and minke whale | High | Medium | Major adverse | MMMP for UXO clearance. | **Minor adverse** |
| | Grey seal | High | Low to medium | Moderate to major adverse | | **Minor adverse** |
| | Harbour seal | High | Negligible to medium | Minor to major adverse | | **Minor adverse** |
| PTS during low-order UXO clearance | Harbour porpoise | High | Low | Moderate adverse | MMMP for UXO clearance. | **Minor adverse** |
| | Minke whale, grey seal and harbour seal | High | Negligible | Minor adverse | | **Minor adverse** |
| TTS for UXO high-order detonation with no mitigation | Harbour porpoise and minke whale | Medium | Low | Minor adverse | None required, but MMMP for UXO clearance would reduce effect. | **Minor adverse** |
| | Grey seal | Medium | Negligible | Minor adverse | | **Minor adverse** |
| | Harbour seal | Medium | Negligible to low | Minor adverse | | **Minor adverse** |
| TTS during low-order UXO clearance | Harbour porpoise, minke whale, grey seal and harbour seal | Medium | Negligible | Minor adverse | None required, but MMMP for UXO clearance would reduce potential for effect. | **Minor adverse** |
| **Impact 2: Disturbance from underwater noise associated with UXO clearance** | | | | | | |
| Disturbance from high-order UXO clearance | Harbour porpoise and minke whale | Medium | Low | Minor adverse | None required. | **Minor adverse** |
| | Grey seal | Low | Negligible | Negligible | | **Negligible** |
| | Harbour seal | Low | Negligible to low | Negligible | | **Negligible** |
| Disturbance from low-order UXO clearance | Harbour porpoise and minke whale | Medium | Negligible | Minor adverse | | **Minor adverse** |
| | Grey seal and harbour seal | Low | Negligible | Negligible | | **Negligible** |

| Likely significant effect | Receptor | Sensitivity | Magnitude | Pre-mitigation effect | Mitigation measures | Residual effect |
|---|---|---|---|---|---|---|
| Disturbance from ADD activation | Harbour porpoise and minke whale | Medium | Negligible | Minor adverse | | **Minor adverse** |
| | Grey seal and harbour seal | Low | Negligible | Negligible | | **Negligible** |
| **Impact 3: Changes to prey resources** | | | | | | |
| Changes to prey availability as a result of underwater noise from UXO clearance activities | Harbour porpoise and minke whale | Low to medium | Low | Negligible to minor adverse | None required. | **Negligible** |
| | Grey seal and harbour seal | Low | Low | Negligible | | **Negligible** |



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