MORAY EAST
OFFSHORE WINDFARM

UXO Clearance Cetacean Risk Assessment

Moray East Offshore Wind Farm

December 2018

Moray Offshore Windfarm (East) Limited

Produced by Royal HaskoningDHV on behalf of Moray Offshore Wind Farm (East) Limited	
Produced by	[redacted]
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List of Abbreviations

AEZ	Archaeological Exclusion Zones
AC	Alternating Current
ADD	Acoustic Deterrent Devices
AIS	Automatic Identification System
BAP	Biodiversity Action Plan
CD	Chart Datum
CI	Confidence Interval
CIA	Cumulative Impact Assessment
CRRU	Cetacean Research and Rescue Unit
CV	Coefficient of Variation
EC	European Commission
EIA	Environmental Impact Assessment
EOD	Explosive Ordnance Disposal
EPS	European Protected Species
ES	Environmental Statement
FCS	Favourable Conservation Status
FLO	Fisheries Liaison Officer
HE	High Explosive
HF	High Frequency
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council of the Exploration of the Sea
IROPI	Imperative Reasons of Overriding Public Interest
JCP	Joint Cetacean Protocol
LF	Low Frequency
LSE	Likely Significant Effect
MF	Mid Frequency
ML	Marine Licence
MMMP	Marine Mammal Mitigation Plan
MMO	Marine Mammal Observer
MSL	Mean Sea Level
MS-LOT	Marine Scotland – Licensing Operations Team
MU	Management Unit
NEQ	Net Explosive Quantity
nm	Nautical Miles
NMFS	National Marine Fisheries Service
NNR	National Nature Reserve

NtM	Notice to Mariners
OfTI	Offshore Transmission Infrastructure
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PAM-Op	Passive Acoustic Monitoring Observer
PEXA	Practice and Exercise Areas
PMF	Priority Marine Features
pUXO	Potential Unexploded Ordnance
PTS	Permanent Threshold Shift
PW	Pinnipeds in Water
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCI	Site of Conservation Importance
SEL	Sound Exposure Level
SHETL	Scottish Hydro Electric Transmission Limited
SMRU	Sea Mammal Research Unit
SNCB	Statutory Nature Conservation Body
SNH	Scottish Natural Heritage
SPA	Special Protection Area
SPL	Sound Pressure Level
SSC	Suspended Sediment Concentrations
TI	Transmission Infrastructure
TTS	Temporary Threshold Shift
UK	United Kingdom
UXO	Unexploded Ordnance
WCS	Worst Case Scenario

Executive Summary

Moray East is currently undertaking surveys for identification of potential unexploded ordnance (pUXO) prior to commencement of construction of the Moray East Offshore Wind Farm and associated Offshore Transmission Infrastructure (OfTI) (referred to as “the Development"). Selected pUXO identified during the current surveys (that cannot be avoided during the construction and operations and maintenance activities) will be targeted for a detailed inspection by a vehicle (e.g. Remotely Operated Vehicle (ROV)), and potentially divers to confirm whether the targets are an unexploded ordnance (UXO) hazard and therefore a risk to those activities. If identified as a UXO hazard Moray East, in the first instance, will seek to avoid the UXO hazard. If avoidance is not possible, Moray East will undertake physical removal of the UXO using controlled detonation, and UXO debris (fragmentation) will be recovered to the vessel deck according to the terms of the Marine Licence. UXO debris greater than 30 cm in size, or debris which may contain explosive material originating from the UXO target will be recovered by the ROV to the deck of the vessel.

The UXO clearance activities, if required, will also involve the removal of any non-UXO debris. If, after inspection, the target is confirmed as non-UXO debris, and is able to be recovered by the vehicle (or vessel’s crane), it will either be re-positioned on the seabed in a pre-determined lay down area with GPS co-ordinates logged or recovered to the deck of the vessel. If the debris cannot be recovered or moved, the debris shall remain in place and be avoided by re-routeing.

In order to safely undertake any UXO clearance activities at the Moray East site and OfTI Corridor (i.e. the Development area), a Marine Licence and a European Protected Species (EPS) Licence are required from Marine Scotland Licensing Operations Team (MS-LOT). This Cetacean Risk Assessment is submitted in support of the EPS Licence application submitted by Moray East for the UXO detonations and use of acoustic deterrent devices (ADDs). The UXO clearance activities will take place between February and May 2019, with the UXO detonations being carried out over a maximum of 10 non-consecutive days.

An assessment of the potential impacts of the UXO clearance activities has been carried out in relation to EPS in the area, namely harbour porpoise, minke whale, bottlenose dolphin, white-beaked dolphin and common dolphin. The assessment shows there would be no significant impacts due to the proposed UXO clearance activities. This report also assesses the proposed UXO clearance activities against the three EPS tests, of overriding public interest, the satisfactory alternative test and the favorable conservation status test, and concludes that the UXO clearance activities would pass the three EPS tests.

A Marine Mammal Mitigation Plan (MMMP) has been produced in support of the EPS licence application in order to mitigate against potential any potential impacts to cetacean species due to the UXO clearance activities (Appendix A).

Definitions

The following definitions have been used throughout this document with respect to the company, the consented wind farms and how these definitions have changed since submission of the Moray East Environmental Statement (ES) in 2012 and the Moray East Modified Transmission Infrastructure (TI) ES in 2014.

- **Moray Offshore Windfarm (East) Limited (formerly known as Moray Offshore Renewables Limited)** – the legal entity submitting this UXO Clearance Cetacean Risk Assessment;
- **Moray East Offshore Wind Farm** - the wind farm to be developed in the Moray East site (also referred as the Wind Farm);
- **The Moray East site** - the area in which the Moray East Offshore Wind Farm will be located. Section 36 Consents and associated Marine Licences to develop and operate up to three generating stations on the Moray East site were granted in March 2014. At that time the Moray East site was made up of three sites known as the Telford, Stevenson and MacColl offshore wind farm sites. The Section 36 Consents and Marine Licences were subsequently varied in March 2018;
- **Telford, Stevenson and MacColl wind farms** – these names refer to the three consented offshore wind farm sites located within the Moray East site;
- **Transmission Infrastructure (TI)** - includes both offshore and onshore electricity transmission infrastructure for the consented Telford, Stevenson and MacColl wind farms. Includes connection to the national electricity transmission system near New Deer in Aberdeenshire encompassing AC offshore substation platforms (OSPs), AC OSP interconnector cables, AC export cables offshore to landfall point at Inverboyndie continuing onshore to the AC collector station (onshore substation) and the additional regional Transmission Operator substation near New Deer. A Marine Licence for the offshore TI was granted in September 2014 and a further Marine Licence for two additional distributed OSPs was granted in September 2017. The onshore TI was awarded Planning Permission in Principle in September 2014 by Aberdeenshire Council and a Planning Permission in Principle under Section 42 in June 2015;
- **Offshore Transmission Infrastructure (OfTI)** – the offshore elements of the transmission infrastructure, comprising AC OSPs, OSP inter-connector cables and AC export cables offshore to landfall (for the avoidance of doubts some elements of the OfTI will be installed in the Moray East site);
- **Moray East ES 2012** – The ES for the Telford, Stevenson and MacColl wind farms and Associated Transmission Infrastructure, submitted August 2012;
- **Moray East Modified TI ES 2014** – the ES for the TI works in respect to the Telford, Stevenson and MacColl wind farms, submitted June 2014;
- **The Development** – the Moray East Offshore Wind Farm and Offshore Transmission Infrastructure (OfTI);
- **OfTI Corridor** – the export cable route corridor, i.e. the OfTI area as assessed in the Moray East Modified TI ES 2014 excluding the Moray East site;
- **Design Envelope –** the range of design parameters used to inform the assessment of impacts;
- **Development area –** the Moray East site and OfTI Corridor together;

Moray East Offshore Wind Farm Consents – are comprised of the following:

Section 36 Consents:

- Section 36 consent for the Telford Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the Telford Offshore Wind Farm assigned to Moray East on 19 June 2018.
- Section 36 consent for the Stevenson Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the Stevenson Offshore Wind Farm assigned to Moray East on 19 June 2018.
- Section 36 consent for the MacColl Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the MacColl Offshore Wind Farm assigned to Moray East on 19 June 2018.

Marine Licences

- Marine Licence for the Telford Offshore Wind Farm (as varied) – Licence Number: 04629/18/1 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on the 19 July 2018.
- Marine Licence for the Stevenson Offshore Wind Farm (as varied) – Licence Number: 04627/18/1 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on the 19 July 2018.
- Marine Licence for the MacColl Offshore Wind Farm (as varied) – Licence Number: 04628/18/2 - consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on the 19 July 2018.

OfTI Licences – are comprised of the following:

- Marine Licence for the Offshore Transmission infrastructure – Licence Number 05340/14/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area (referred to as the "OfTI Marine Licence").
- Marine Licence for two additional distributed OSPs – Licence Number 06347/17/1 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction, operation and maintenance works and the deposit of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area (referred to as the "OSP Marine Licence").

1 Introduction

1.1 Project Background

In March 2014, Moray Offshore Windfarm (East) Limited (Moray East) received consent from the Scottish Ministers under Section 36 of the Electricity Act 1989, and the associated Marine Licences under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009 for the construction and operation of the Moray East Offshore Wind Farm. At that time was made up of three sites known as "Telford", "Stevenson" and "MacColl" offshore wind farm sites. Moray East plans to develop the three consented wind farms (Telford, Stevenson and MacColl) as a single wind farm (Moray East Offshore Wind Farm) (Figure 1-1 below).

A Marine Licence for the Offshore Transmission Infrastructure (OfTI) was granted in September 2014 and a further Marine Licence for two additional distributed offshore substation platforms (OSPs) was granted in September 2017 (together these are referred to as the OfTI Licences).

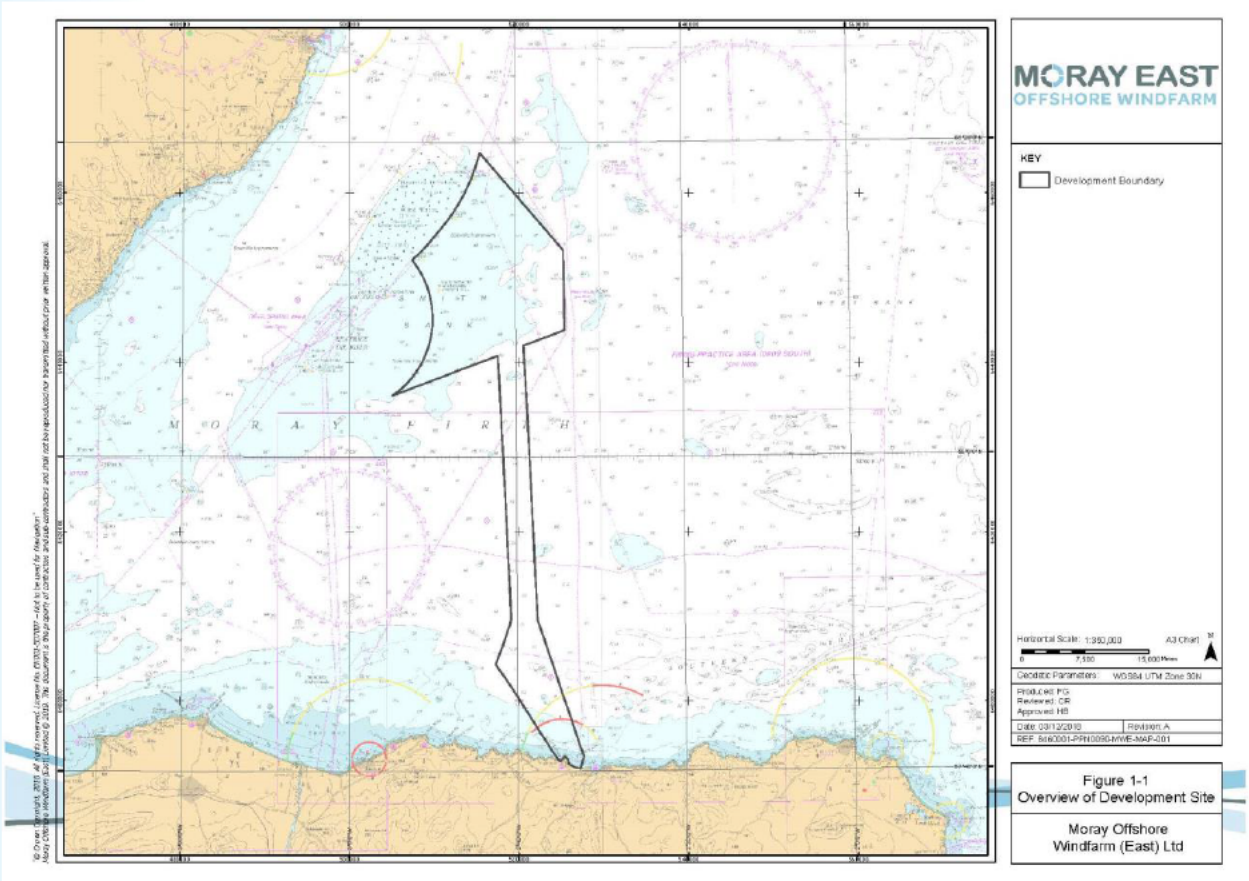

Figure 1-1 Moray East site and OfTI Corridor.

1.2 Purpose of the Cetacean Risk Assessment

In order to safely undertake any UXO clearance at the Moray East site and OfTI Corridor (i.e. the Development area), a Marine Licence and a European Protected Species (EPS) Licence are required from Marine Scotland Licensing Operations Team (MS-LOT). An overview of the overall decision-making process associated with UXO activities is provided in Section 2.1 below. The working methods associated with the licensable activities are detailed in Sections 2.2 and 2.3 below. An EPS Licence is required for cetacean species only. This Cetacean Risk Assessment is submitted in support of the EPS Licence application submitted by Moray East for the UXO detonations and use of acoustic deterrent devices (ADDs).

1.3 Consultation

In October 2018, Moray East submitted a document to MS-LOT detailing the proposed approach to assessment of UXO clearance activity. The proposed approach to assessment was subsequently agreed by Marine Scotland on 6th November 2018; the table below details where specific points raised have been addressed. This Environmental Report follows the assessment approach as agreed with MS-LOT.

Table 1-1 Summary of MS-LOT Consultation

Date and Location of Meeting	Point Raised	Moray East Response
1 November 2018, Edinburgh	MS-LOT requested the EPS Risk Assessment to be provided in a separate document to the Environmental Report.	The Cetacean Risk Assessment forms a separate report, submitted in support of the EPS Licence Application.
8 November 2018, Edinburgh	MS-LOT requested further information on the working methods used during EOD operations.	This information is provided in Section 2 of the Environmental Report, prepared in support of the Marine Licence application.

2 Project Description

The following section provides a description of the UXO clearance activities, including the number, size and location of UXO that may be potentially found within the Development area.

2.1 Potential for UXO

A worst case scenario (WCS) for the total numbers of UXO that may require detonation within the Development area is ten: four within the wind farm site and six within the OfTI Corridor. A study has been conducted on the indicative sizes of charges for UXO that could be present within the Development area (Ordtek, 2018). These are provided in Table 2-1 and Table 2-2 below, the text in red indicates the size of charges that are most likely to be present and that may require detonation. Principal UXO items that are likely to be found within the Development area are German WWI mines and training/High Explosive (HE) bombs, with WWII mines, torpedoes and depth charges a lower residual background threat (Table 2-1).

Table 2-1 UK waters deployed mines (most likely highlighted in red) (Ordtek, 2018)

UXO Type	Maximum UXO Net Explosive Quantity (NEQ) in kg	Likelihood During UXO Investigations
German LMB Ground Mine	700	Highly Unlikely
German UMB Moored Buoyant Mine	41	Highly Unlikely
German RMB Ground Mine	460	Highly Unlikely
German EMC Buoyant Mine	300	Highly Unlikely
German EMA Buoyant Mine	160	Possible
British Mk14 Buoyant Mine	227	Unlikely
British Mk16 Buoyant Mine	145	Unlikely
British Mk20 Buoyant Mine	227	Unlikely

Air-dropped bombs are also a potential hazard across the site, due to the extensive conflict between shipping and aircraft. The air-dropped bombs most likely to be encountered are detailed in Table 2-2 (Ordtek, 2018).

Table 2-2 UK waters deployed HE bombs (most likely highlighted in red) (Ordtek, 2018)

UXO Type	Maximum UXO Net Explosive Quantity (NEQ) in kg	Likelihood During UXO Investigations
Allied 250lb HE Bomb	50	Unlikely
Allied 500lb HE Bomb	126	Possible
Allied 1000lb HE Bomb	260	Possible
German SC-50 HE Bomb	25	Unlikely
German SC-250 HE Bomb	145	Unlikely
German SC-500 HE Bomb	220	Unlikely

2.2 Moray East Approach

A UXO survey campaign is currently being undertaken to identify the potential for UXO within the Moray East site and OfTI Corridor. The results of this campaign are still being analysed to identify potential UXO

(pUXO) within the Development area. Should pUXO be identified, the preference is to avoid the pUXO and re-route. Where practicable, taking into account health and safety, any pUXO targets will be avoided by placing an industry standard 15 m radius avoidance zone around the target for the siting of any infrastructure and other "seabed intrusive" activities (e.g. vessel jack-up). The target locations will be noted and relevant authorities notified, where required. Should re-rerouting not be possible at this stage, the pUXO will be targeted for inspection, and the targets will be confirmed as either UXO or non-UXO debris.

Should the target be confirmed as UXO, the preference is to avoid this target where practicable. If however avoidance is not possible, the target will be subject to EOD operations (see Section 2.3.1 below). There are three options for UXO disposal which could be used as part of EOD operations:

1) UXO detonation in situ – this is the preferred option for health and safety reasons,

2) Relocation of the UXO on the seabed and then detonation – an example of when this would occur are in instances when detonating in situ could potentially compromise the safety of Moray East or third party assets. In the instance where third party assets are situated nearby, Moray East will contact the third party prior to detonation in order to establish a safe distance between the asset and detonation site. Another example of this occurrence is where two UXO are located in close proximity to one another, whereby one UXO is relocated nearer to the other UXO, allowing a single detonation to take place rather than two separate detonations.

3) Recovery of the UXO to the deck of the vessel – this would be undertaken for small items of UXO e.g. hand grenades, or as a last resort for larger items should options 1 or 2 not be possible.

After detonation UXO debris greater than 30 cm in size, or debris which may contain explosive material originating from the UXO target will be recovered to the deck of the vessel and placed in safe storage.

2.3 Activities Assessed Under the Cetacean Risk Assessment

The licensable activities that are the subject of the European Protected Species License application are presented in Section 2.3.1 below. It should be noted that the hierarchy of events during the UXO clearance process is that detonation by controlled explosion will be used as a last resort, should avoidance or removal not be possible.

2.3.1 Clearance of UXO using explosives

The following describes the sequencing of the EOD operations (it should be noted that all EOD operations will be undertaken in accordance of the Marine Mammal Mitigation Plan (MMMP) as included in Appendix A, and the below information is provided as a summary of that procedure only. Please see the full MMMP for all mitigation requirements):

- After all the pUXO targets have been inspected, the confirmed UXO targets will need to be destroyed in a separate EOD campaign. For this campaign, three vessels will be required: an inspection vessel from which the Remotely Operated Vehicle (ROV) will be deployed and where the explosives will be stored; a launch vessel, and a guard vessel to advise other sea users to maintain 1,500 m safe distance, and confirm prior to detonation that the surrounding area is clear. The Acoustic Deterrent Device (ADD) and portable Passive Acoustic Monitoring System (PAM) equipment will be deployed from either the launch or the guard vessel, along with the Marine Mammal Observers (MMOs) and PAM Operator (PAM-Op) as per the mitigation plan provided in Appendix A.

- If a target is confirmed as a UXO by the EOD expert after the UXO inspection, a 250 m radius exclusion zone shall be implemented around the target, the position noted and all relevant authorities notified.
- Once all the target inspections are complete, the vessel will return to the confirmed UXO target, and the geodetic position of the item will be correlated and confirmed with the Client Representative, survey team and EOD Superintendent, at which point the EOD system will be deployed by the ROV and placed in the optimum firing position. There are two main methods used to trigger a detonation: either use of bulk explosives or using a shape charge. The shape charge system would require less than 2 kg of HE, whereas to generate a controlled detonation using bulk charge, the minimum quantity of HE would be between 5 kg and 10 kg per UXO, however after consulting with the EOD Superintendent, a greater quantity may be required.
- Whichever EOD system is used by the EOD contractor, the system shall be safe and reliable, and will have undergone a proven safety and performance testing regime. When a “live firing” run is ordered, the charge will be drawn from the on-board explosives magazine (bomb-proof storage location for explosives), fitted to an anchoring system (typically a concrete block) and secured in the manipulator arm of the ROV. Also attached to the anchoring system is a float with the firing line (typically a shock tube). It is common for safety features like Non-Electric (NONEL) Detonators and Hydrostatic Safety Breaks to be fitted to the EOD system immediately prior to the launching of the ROV to ensure there is no accidental firing of the charge.
- The ROV will be deployed and return to the target at the designated position. When the ROV is 1 m away from the intended target, the anchoring system will be deployed and placed 0.5 m away from the target. In this way, the EOD system will be placed in the optimum firing position without making any physical contact with the target at any time.
- Once in position, the float with the firing line will be released from the ROV manipulator and will ascend to the surface paying out the firing line as it ascends. Afterwards, the ROV will be recovered back to the deck.
- The EOD system will subsequently be in the optimum firing position with the float and firing line at the surface ready to be fitted to the firing mechanism. This is achieved by deploying the launch vessel (Fast Rescue Craft (FRC) or EOD Rigid hull inflatable boat (RhiB)), with the EOD Technicians onboard, back to the float to connect the firing line to the firing mechanism.
- The launch vessel will move to 200-300 m range from the target. Within a safe distance of the target, the ADD and portable PAM will be deployed, and the MMOs will perform a visual survey from the either the launch vessel or the guard vessel to survey a mitigation zone of 1 km for at least one hour prior to any detonation charge (see Appendix A for more information).
- The launch vessel will return to the shot-line float, recover it and connect the firing shot line to the e-clips fitted to the surface initiation float. On completion the surface initiation float will be released and the inspection vessel will advise that the operation has been successfully completed.
- On completion of the ADD procedure and the 1 hour pre-detonation search by the MMOs/PAM-Op, the ADD and PAMs hydrophone will be recovered to the vessel and return to the vicinity of the inspection vessel located at 1,500 m of the UXO detonation (approximately 100 m away on lee side) remaining available to advise other vessels in the vicinity if required.
- The safety management of vessels and other traffic within the UXO mitigation zone (1,500 m), will be managed and coordinated by the EOD Superintendent and the vessel master who will

liaise directly with the authorities for the area in accordance with the embedded mitigation in Section 4.

- A security radio message will be transmitted to state the vessel name, position of firing and planned time 6 hours, 30 minutes and 10 minutes before the UXO detonation.
- Once the 1 hour pre-detonation search has been completed by the MMO and/or PAM-Op, and the ADD activation has been completed, a series of soft-start detonations will take place at 5 minutes intervals to provide further deterrence mitigation for cetaceans. These will comprise of either four or five (depending on the charge size) small charges of 50 g to a maximum of either 200 g or 250 g (depending on UXO charge size). See Appendix A for more information on the soft-start charge procedure. At the agreed firing time, the launch vessel will initiate the firing mechanism and fire the EOD main charge.
- On completion of the successful detonation, the launch vessel will return to the target location, recover the surface initiation float. The MMOs will conduct post-detonation MMO routines (see Appendix A).
- Following the successful detonation, the ROV will be deployed and carry out an as-left survey centred on the target location using the ROV sensors. UXO debris greater than 30 cm in size, or debris which may contain explosive material originating from the UXO target will be recovered by the ROV to the deck of the vessel. This will ensure that the area is cleared of any UXO and that no significant metallic objects remain and will also provide multibeam bathymetry results to quantify the size and shape of any resulting detonation crater, to record any significant environmental impacts and to assist with future engineering plans.

For UXO detonations in shallow waters, (less than 12 m LAT), it is possible the target charge may be set by divers or an ROV (as described above). Initiation and firing procedures remain the same.

2.3.2 Use of Acoustic Disturbance Devices

Moray East Offshore Windfarm will use Acoustic Deterrence Devices (ADDs) to mitigate the risk of physical or auditory injury to cetaceans from the detonation of UXO. Based on a detailed review and assessment as set out below, it is proposed to use the Lofitech seal scarer. The Lofitech seal scarer has successfully been used in a number of projects for a range of industries, including for aquaculture projects and the offshore wind industry. The Lofitech device has been designed to have a source noise level of 189 dB, with numerous field measurements confirming the device to have recorded source levels of 179 to 194 dB (Coram *et al.,* 2014) with a narrow band frequency output between 10 kHz and 20 kHz, with a peak at 15 kHz (McGarry *et al*., 2017).

ADD activation will be for 25 minutes prior to the onset of the soft-start which will allow cetaceans to move to an estimated minimum distance of 2.25 km from the UXO detonation location prior to the onset of the UXO soft-start charges.

3 Existing Environment

The Moray Firth is an important area for cetaceans, with at least 14 species being recorded in and around the Moray Firth. The bottlenose dolphin (*Tursiops truncatus*) population is considered to be nationally and internationally important and is a primary features of the Moray Firth Special Area of Conservation (SAC). Bottlenose dolphin and harbour porpoise (*Phocoena phocoena*) are listed under Annex II of the Habitats Directive as requiring protection through the designation of SACs (Moray East, 2012). Large cetacean species, including minke whale (*Balaenoptera acutorostrata*), humpback whale (*Megaptera novaeangliae*) and less frequently killer whale (*Orcinus orca*) and long-finned pilot whales (*Globicephala melas*) have been recorded within the Moray Firth during the summer months as they migrate.

For more information on the existing environment for harbour porpoise, bottlenose dolphin, minke whale, white-beaked dolphin (*Lagenorhynchus albirostris*) and common dolphin (*Delphinus delphis*), see Section 3 of the Moray East Offshore Windfarm UXO Clearance Environmental Report which accompanies this report.

Table 3-1 outlines the species included in this Cetacean Risk Assessment, and the relevant density estimates and reference populations that each species will be assessed against.

Table 3-1 Summary of species taken forward for assessment, and their density estimates and reference populations

Species	Density estimate	Reference population
Harbour porpoise	1.7/km^2 (*Moray Firth offshore development area*; Paxton *et al*., 2016)	345,373 (North Sea MU; Hammond *et al*., 2017)
Bottlenose dolphin	0.3/km^2 (*Moray Firth offshore development area*; Paxton *et al*., 2016)	195 (Coastal East Scotland MU; Hammond *et al*., 2017)
Minke whale	0.03/km^2 (*Moray Firth offshore development area*; Paxton *et al*., 2016)	23,528 (Celtic and Greater North Sea MU; Hammond *et al*., 2017)
White-beaked dolphin	0.021/km^2 (Survey Block S; Hammond *et al*., 2017)	15,895 (Celtic and Greater North Sea MU; Hammond *et al*., 2017)
Common dolphin	0.025/km^2	56,556 (Celtic and Greater North Sea MU; Hammond *et al*., 2017)

4 Assessment of Effects

4.1 UXO Clearance and the Risk to the Injury and / or Disturbance to Cetaceans

As described in Section 2.1, an estimated WCS of 10 UXO could require detonation across the Development area (a worst-case of four within the Moray East site and six within the OfTI Corridor). The UXO present at the Development are most likely to be German EMA Buoyant mines, with a maximum UXO Net Explosive Quantity (NEQ) of 160 kg, or allied 500 or 1,000 lb HE bomb, with a maximum NEQ of 126 and 260 kg respectively. It has been predicted that these UXO would require a minimum of 5 to 10 kg HE per UXO for a controlled explosion using bulk charges. UXO unlikely to be present have a maximum NEQ of up to 227 kg for ground mines, and up to 220 kg for air-dropped bombs. There are also UXO which are considered highly unlikely to be encountered; of up to 700 kg NEQ for ground mines. The most realistic worst-case is therefore 260 kg NEQ, requiring a charge of 10 kg. Information on the effect of using a larger charge size is provided in Section 5.5.1.1, along with the additional mitigation requirements that would be needed.

4.1.1 The Risk of Injury to Cetaceans

When an item of UXO is detonated on the seabed, a number of impacts to the surrounding area occur, including crater formation and the movement of sediment, both of which are localised impacts. Immediately following detonation, a rapid expansion of gaseous products are formed as a direct result of the detonation. This is known as the "bubble pulse", and once it reaches the surface it will rapidly dissipate. Fragmentation of the UXO will also occur (the ejection of shrapnel from the UXO casing), but is also a localised impact and does not pose a significant risk past 10m from the UXO detonation location.

The impacts from a UXO detonation that have impacts further afield are the high amplitude shock and the attendant sound wave produced. These impacts have the potential to cause injury or death to cetaceans (e.g. Richardson *et al.,* 1995; von Benda-Beckmann *et al.,* 2015). This highest risk to cetaceans are;

- Trauma (direct or indirect blast wave effect injury) such as crushing, fracturing, haemorrhages, and rupture of body tissues caused by the blast wave, resulting in immediate or eventual mortality;
- Auditory impairment (from exposure to the acoustic wave), resulting in a temporary or permanent hearing loss such as temporary threshold shift (TTS) and permanent threshold shift (PTS); or
- Behavioural change, such as disturbance to feeding, mating, breeding, and resting.

Physical injury, or trauma, can result from either direct or indirect effects of the blast wave, potentially causing injury to body tissues; this usually occurs in close proximity to the source. Yelverton *et al.,* (1973) identified that the threshold at which physical injury and/or trauma has the potential to occur on all cetaceans is at a peak to peak SPL of 240 dB re 1µPa (Yelverton *et al*., 1973). Smaller species, such as harbour porpoise, are at greater risk of injury from both the shock wave and blast injuries (Ketten 2004; von Benda-Beckmann *et al.,* 2015). After detonation, the shock wave will expand spherically outwards and in a straight line, unless the wave is reflected, channels or meets an intervening obstruction.

The charge size needed to detonate the UXO, the water depth at the UXO location, bathymetry of the area and seabed sediments all have an impact on how far the noise associated with the UXO detonation will travel. High levels of exposure of underwater noise associated with the attendant sound wave of a UXO detonation can cause instantaneous auditory injury in cetacean species; or PTS. This effect will continue to persist even after the noise has ceased. PTS also has the potential to be occur from lower sound levels if a cetacean is exposed to the sound for a prolonged period of time. TTS can be brought on in cetaceans if they are exposed to lower sound levels. An individual would ordinarily be able to fully

recover from this effect. Fleeing behaviours and disturbance effects can be seen with sound levels of the level that causes TTS.

4.1.1.1 Impact Thresholds

In order to ascertain whether PTS or TTS will occur in cetacean species, a set of thresholds for which the impact becomes a risk have been determined. These are commonly presented as both un-weighted peak SPL and marine mammal hearing weighted (M-weighted) sound exposure levels (Sound Exposure Level (SELs)). Peak Sound Pressure Levels (SPLs) are the maximum sound level a species may be exposed to before there is a risk of the effect occurring. Therefore, at sound levels up to this level, the effect would not occur. SELs allow for the assessment to consider whether the total sound level that the individual receives as it flees the area will cumulatively lead to an effect over the period of time assessed. As dual criteria, the onset of PTS or TTS is considered to have occurred when either one of the two metrics is exceeded (JNCC, 2010b, NMFS, 2016; 2018).

The NMFS (2016; 2018) thresholds group marine mammals into species groups, and applies filters to take into account for the groups specific hearing sensitivities. The NMFS (2016; 2018) criteria include unweighted peak (SPL_{peak}), weighted cumulative (SEL_{cum}) for the underwater noise thresholds at which both PTS and TTS have the potential to occur. **Table 4-1** below outlines these noise impact thresholds for the relevant species groups considered within this assessment; high frequency cetaceans (HF) for harbour porpoise, mid frequency cetaceans (MF) for all dolphin species and low frequency cetaceans (LF) for minke whale.

Table 4-1 NMFS underwater noise thresholds for the onset of PTS for SPL_{peak} and SEL_{cum} criteria (NMFS, 2016; 2018)

Species group	PTS		TTS	
	SPL_{peak} (dB re 1µPa)	SEL_{cum} (dB re 1µPa^{2}s)	SPL_{peak} dB re 1µPa	SEL_{cum} (dB re 1µPa^{2}s)
HF	202	155	196	140
MF	230	185	224	170
LF	219	183	213	168

Von Benda-Beckmann *et al* (2015) identified hearing impact thresholds from single UXO detonations in shallow water (less than 50 m) on harbour porpoise, and the likelihood of both TTS and PTS occurring at different SELs. Table 4-2 below outlines how likely it is for a harbour porpoise to be at risk of either TTS or PTS at different SELs.

Table 4-2 Thresholds related to temporary and permanent hearing loss caused by a single underwater explosion in shallow water (< 50-m depth), "very likely" indicates a probability exceeding 95%, and "unlikely" indicates a probability of less than 5%. "Increasingly likely" is then anything between 5 and 95% probability

SEL (unweighted dB re 1 µPa^{2}s)	Noise induced TTS	Noise induced PTS	Blast wave-induced ear trauma	Permanent hearing loss
> 203	Very Likely	Very likely	Very likely	Very likely
190 – 203			Increasingly likely	
179 – 190		Increasingly likely	Unlikely	Increasingly likely
164 – 179		Unlikely		Unlikely
<164	Unlikely			

4.1.1.2 Impact Ranges Associated with UXO Detonation

There are a number of sources of information available for the impact ranges associated with the detonation of UXO, and the best available literature has been used to inform the assessment. Section 5.5 of the Moray East Offshore Windfarm UXO Clearance Environmental Report accompanying this report, provides more details on the source of information used to determine the impact ranges used in this assessment.

In order to determine the most appropriate to use within the following impact assessment, Table 4-3 summarises the impact ranges with the closest similarities to the potential detonations in the Development area (i.e. with similar charge sizes). The impact ranges taken forward for the impact assessment are shown in bold; these have been used as they represent the most realistic worst case. It must be noted that the impact ranges over longer ranges (associated with the larger charge sizes) should be used with caution. Peak noise levels are difficult to predict over these longer ranges and greater confidence can be expected with the SEL modelled ranges which are considerably shorter in distance (e.g. for harbour porpoise with a charge weight of 250 kg, the impact range using the NFMS (2016; 2018) SEL criteria is modelled at 2.4 km compared to 8.4 km using the NMFS (2016; 2018) SPL criteria (Norfolk Vanguard Ltd, 2018)). The impact ranges modelled using the SPL criteria are used to inform the assessment, but it should be noted that these are considered to an overestimation.

Table 4-3 Summary of identified impact ranges from published literature and reports

Species group	Impact range (m)		
	Injury / trauma (Yelverton *et al.*, 1973)	PTS SPL_{peak} (NMFS, 2016)	TTS SPL_{peak} (NMFS, 2016)
227 kg charge size			
HF	-	8,200 (211.24 km^2)[4]	-
MF		550 (0.95 km^2)[4]	
LF		1.66 (8.66 km^2)[4]	
250 kg charge (source noise level of 292.4 dB SPL_{peak}[3])			
HF	250[1]	8,400[3] - 9,711[1]	13,900[3] - **~16,000[1]**
MF		~500[1] - **570[3]**	~1,000[1] – **1,050[3]**
LF		~1,500[1] – **1,700[3]**	3,100[3] – **~3,500[1]**
263 kg charge size			
HF	-	**8,500 (226.98 km^2)[4]**	-
All cetacean species	**500***	-	-
430 kg charge weight (source noise level of 294.8 dB SPL_{peak}[3])			
HF	-	10,400[3]	16,800[3]
MF		730[3]	3,500[3]
LF		2,200[3]	3,900[3]

*[1] BEIS, 2018; * von Benda-Beckmann et al., 2015; [3] Norfolk Vanguard Limited, 2018; [4] Orsted Power UK Ltd, 2018*

The likelihood of PTS and TTS occurring due to UXO detonation at certain source noise levels (as identified by Von Benda-Beckmann *et al.*, 2015; Table 4-2) indicate that cetacean species would be very likely to be at risk of PTS or TTS with any SEL of more than 203 dB re 1 µPa^{2}s. A charge weight of 270 kg (i.e. similar to the most likely WCS to be assessed for the UXO detonations), would have a source noise level of an

UXO of over 292 dB re 1 µPa as identified within the Norfolk Vanguard noise modelling for the clearance of UXO (see Table 4-3).

4.1.1.3 Impact Assessment for Injury Impact on Marine Mammals

The potential for impact from the detonation of UXO been assessed for each of the species groups, including high, mid and low frequency cetaceans for harbour porpoise, dolphin species and minke whale respectively. The following assessment includes the potential for physical trauma or injury from the initial blast wave, and for auditory injury (either permanent or temporary). This is based on the standard EIA Approach of assigning a magnitude of effect and assessing against the sensitivity of the receptor. Each of the tables below shows the magnitude based on the percentage of reference population impacted, with any significant effects (defined as being either medium or high) shown in bold.

For all species groups, the source noise level of a 270 kg charge, of at least 292 dB re 1 µPa (0-Peak) has the potential to cause physical injury and trauma, and auditory injury (either permanent or temporary) in all marine mammal species.

Physical Injury or Trauma

Von Benda-Beckmann *et al.,* (2015) found that the detonation of a 263 kg charge could lead to a physical injury or trauma to a distance of 500 m. It is therefore considered that the potential for physical injury to occur on any cetacean species will occur within this range. Table 4-4 summarises the potential number of each species that could be at risk of physical injury or trauma within this range based on the relevant density estimate, and the percentage of the management unit population that this represents.

Table 4-4 Risk of cetacean species from physical injury or trauma

Species	Threshold of Impact	Range of Potential Impact*	Number at Risk of Impact (% of Reference Population)	Magnitude of Effect
Harbour porpoise	240 dB re 1µPa SPL_{peak} (Yelverton *et al.*, 1973)	0.79km²	1.3 (0.0004%)	Negligible
Bottlenose dolphin			0.2 (0.12%)	**Medium**
Minke whale			0.02 (0.0001%)	Negligible
White-beaked dolphin			0.02 (0.0001%)	Negligible
Common dolphin			0.02 (0.00003%)	Negligible

** Note that this is based on the area of a circle if the actual impact area is not known*

Permanent Auditory Injury (PTS)

The risk of PTS on cetaceans was assessed using the NMFS (2016; 2018) noise threshold criteria for each species group. The onset of auditory damage has been predicted to occur at 8.5 km for high-frequency cetaceans (harbour porpoise), at 570 m for mid-frequency species (dolphins), and at 1.7 km for low-frequency cetaceans (whales). Table 4-5 below summarises the potential number of each species that could be at risk of PTS within each specific range (as determined within Section 4.1.1) based on the relevant density estimate, and the percentage of the management unit population that this represents. All species are considered to have a high sensitivity to PTS from UXO detonation.

Table 4-5 Risk of marine mammal species of permanent auditory injury (PTS)

Species	Threshold of Impact	Range of Potential Impact*	Number at Risk of Impact (% of Reference Population)	Magnitude of Effect
Harbour porpoise	202 SPL_{peak} (dB re 1µPa)	226.98 km²	385.9 (0.1%)	**Medium**
Minke whale	219 SPL_{peak} (dB re 1µPa)	9.08 km²	0.3 (0.001%)	Low

Species	Threshold of Impact	Range of Potential Impact*	Number at Risk of Impact (% of Reference Population)	Magnitude of Effect
Bottlenose dolphin	230 SPL_{peak} (dB re 1µPa)	1.02 km²	0.3 (0.2%)	**Medium**
White-beaked dolphin			0.02 (0.0001%)	Negligible
Common dolphin			0.03 (0.00005%)	Negligible

** Note that this is based on the area of a circle if the actual impact area is not known*

The most sensitive species assessed is harbour porpoise, with an impact range of 8.5 km for PTS from a UXO of a similar charge size (of 263 kg) to the Development. The most dominant part of the UXO shockwave, and that which has the potential to have the biggest impact, are within the low frequencies, of less than 1kHz. Harbour porpoise are known to vocalise at much higher frequencies than this, of above 100kHz, however, the species do also produce sounds in the range of the UXO detonation (of 1 kHz) that are thought to be for communication (Verboom & Kastelein, 1997).

As can be seen in Table 4-5, a total of 386 harbour porpoise could be at risk of the onset of PTS due to the planned detonation at the Development. The likelihood of harbour porpoise being within the impact range for PTS (i.e. within 8.5 km of the detonation) and the potential for auditory impact (from PTS) without mitigation is considered to be high. Based on the high sensitivity of harbour porpoise and the magnitude of medium, ***harbour porpoise are assessed as being at risk of a major impact due to PTS from UXO detonation without mitigation, which is considered to be significant.***

There is potential for onset of PTS in minke whale up to a distance of 1.7 km, resulting in the potential for 0.3 minke whale to be at risk of the onset of PTS within that area (based on a charge size of 250 kg; Table 4-5). However, the abundance of minke whale in the Moray Firth is known to be much lower in the winter and spring period when the Development UXO detonation has been planned for. The JCP Phase III report states that minke whale abundance in winter and spring would be up to 30 within the *Moray Firth offshore development area*, with an estimated density of 0.004 individuals per km² (Paxton *et al.*, 2016). Using this density estimate, the number of minke whale at potential risk of PTS onset within the 1.7 km impact range is 0.03. The likelihood of minke whale being within the impact range for PTS (i.e. within 1.7 km of the detonation) in the winter and spring period is considered to be low, however the potential for auditory impact (from PTS) without mitigation is considered to be moderate. Based on the high sensitivity of minke whale and the magnitude of low, ***minke whale are assessed as being at risk of a moderate impact due to PTS from UXO detonation without mitigation, which is considered to be significant.***

For the mid-frequency cetaceans species group, including bottlenose dolphin, white-beaked dolphin and common dolphin, the potential auditory injury range is predicted to be 570 m (based on a charge size of 250 kg; Table 4-5). The number of individuals that are at potential risk of the onset of PTS within this impact range is assessed as 0.3, 0.02 and 0.03 of bottlenose dolphin, white-beaked dolphin and common dolphin respectively (Table 4-5). Bottlenose dolphin are a primary reason for the designation for the Moray Firth SAC, and have a relatively small and highly faithful population to the Moray Firth. Consideration of the potential risk to bottlenose dolphin in the SAC is included in Section 5.1 5.12 below (it should be noted that the assessment on the SAC includes potential impacts on the bottlenose dolphins as they commute to the Forth and Inner Tay, as well as the Moray Firth area as the density estimate covers all areas that have the potential to be impact by the UXO clearance activities). The probability of any dolphin being present within the Development area is low as can be noted from the relatively low density estimates (Table 3-1), and the potential for PTS onset as a result of UXO detonation is moderate. Based on the high sensitivity of dolphin species and the magnitude of negligible to medium, ***dolphin species are assessed as being at risk of a minor to major impact due to PTS from UXO detonation without mitigation, which is considered to be significant for bottlenose dolphins (with a major impact) but not significant for other dolphin species (with minor impact).***

Temporary Auditory Injury (TTS)

The risk of TTS on cetaceans was also assessed using the NMFS (2016; 2018) noise threshold criteria for each species group. The onset of temporary auditory injury (TTS) has been predicted to occur at 16 km for high-frequency cetaceans (harbour porpoise), at 1.05 km for mid-frequency species (dolphins), and at 3.5 km for low-frequency cetaceans (whales). Table 4-6 below summarises the potential number of each species that could be at risk of TTS within each specific range (as determined within Section 4.1.1 above) based on the relevant density estimate, and the percentage of the management unit population that this represents. All species are considered to have a medium sensitivity to TTS from UXO detonation.

Table 4-6 Risk of marine mammal species from temporary auditory injury (TTS)

Species	Threshold of Impact	Range of Potential Impact*	Number at Risk of Impact (% of Reference Population)	Magnitude of Effect
Harbour porpoise	196 SPL_{peak} (dB re 1µPa)	804.25 km²	1,367.2 (0.4%)	Negligible
Minke whale	213 SPL_{peak} (dB re 1µPa)	38.48 km²	1.2 (0.005%)	Negligible
Bottlenose dolphin	224 SPL_{peak} (dB re 1µPa)	3.46 km²	1.0 (0.5%)	Negligible
White-beaked dolphin			0.07 (0.0005%)	Negligible
Common dolphin			0.09 (0.0002%)	Negligible

** Note that this is based on the area of a circle if the actual impact area is not known*

The most sensitive species assessed is harbour porpoise, with an impact range of 16 km for TTS. As seen in Table 4-6, a total of 1,367 harbour porpoise could be at risk of the onset of TTS due to the planned UXO detonation at the Development area. The likelihood of harbour porpoise being within the impact range for TTS (i.e. within 16 km of the detonation) and the potential for temporary auditory impact (from TTS) are considered to be high. However, the impact would be temporary only, covering a maximum period of up to 10 non-consecutive days (not including weather downtime), and would occur in a very small percentage of the North Sea MU population. Based on the medium sensitivity of harbour porpoise and the magnitude of negligible***, harbour porpoise are assessed as being at risk of a minor impact due to TTS from UXO detonation without mitigation, which is not considered to be significant.***

There is potential for onset of TTS in minke whale up to a distance of 3.5 km, resulting in the potential for 1.2 minke whale to be at risk of the onset of TTS within that area (Table 4-6). Using the lower density estimate during the winter and spring months of 0.004/km², the number of minke whale at potential risk of TTS onset within the 3.5 km impact range is 0.15. The likelihood of minke whale being within the impact range for TTS is therefore considered to be low, however the potential for auditory impact (from TTS) without mitigation is considered to be moderate. In addition, the impact would be temporary only, covering a maximum period of 10 non-consecutive days, and would occur in a very small percentage of the Celtic and Greater North Sea MU population. Based on the medium sensitivity of minke whale and the magnitude of negligible, ***minke whale are assessed as being at risk of a minor impact due to TTS from UXO detonation without mitigation, which is not considered to be significant.***

For the bottlenose dolphin, white-beaked dolphin and common dolphin, the potential auditory injury range is predicted to be 1.05 km. The number of individuals that are at potential risk of the onset of TTS within this impact range is assessed as 1, 0.07 and 0.09 of bottlenose dolphin, white-beaked dolphin and common dolphin respectively (Table 4-6). Consideration of the potential risk to bottlenose dolphin in the Moray Firth SAC is included in Section 5.1 below. It should be noted that the assessment for the SAC includes potential impacts on the bottlenose dolphins as they commute to the Forth and Inner Tay, as

well as the Moray Firth area as the density estimate covers all areas that have the potential to be impacted by the UXO clearance activities. The probability of any dolphin being present within the Development is low as can be noted from the relatively low density estimates (Table 3-1), and the potential for TTS onset as a result of UXO detonation is moderate. However, the impact would be temporary only, covering a maximum period of 10 non-consecutive days, and would occur in a very small percentage of the relevant MU populations. Based on the medium sensitivity of dolphin species and the magnitude of negligible, ***dolphin species are assessed as being at risk of a minor impact due to TTS from UXO detonation without mitigation, which is not considered to be significant.***

Impact Assessment for Larger UXO Devices

As stated within Section 2.1 above, while considered highly unlikely, it is possible that UXO devices may be present up to 700 kg within the Development area that would require detonation. The following section outlines the impacts and mitigation procedures that should be taken if a UXO device is found with a charge weight of more than 260 kg (and up to 700 kg).

The modelling that was undertaken for Norfolk Vanguard considered devices of up to 700 kg NEQ in charge size. The results of this modelling for the NMFS (2016; 2018) PTS threshold show a potential PTS onset range of up to 11.5 km for HF cetaceans (harbour porpoise), up to 2.5 km for LF cetaceans (minke whale), and up to 820 m for MF cetaceans (dolphin species) (Norfolk Vanguard Ltd, 2018).

For harbour porpoise, this would equate to a total of 706.3 individuals (0.2% of the reference population) at risk of PTS onset, resulting in an ***impact significance for harbour porpoise of major, without mitigation, based on the permanent nature of the impact, the sensitivity of the species and the magnitude of the effect***. For minke whale, a total of 0.6 individuals (0.003% of the reference population) could be at risk of PTS onset, having an ***impact significance for minke whale of moderate, without mitigation***. For dolphin species, the number of individuals that could be at risk of PTS onset are 0.6 (0.3% of the reference population), 0.04 (0.0003% of the reference population) and 0.05 (0.0001% of the reference population) for bottlenose dolphin, white-beaked dolphin and common dolphin respectively. For bottlenose dolphin, the impact significance is assessed as being ***major for bottlenose dolphin, without mitigation, based on the permanent nature of the impact, the sensitivity of the species and the magnitude of the effect***, and for white-beaked dolphin and common dolphin, the impact significance is assessed as ***being minor for both white-beaked dolphin and common dolphin, based on the permanent nature of the impact, the sensitivity of the species and the magnitude of the effect***.

4.1.1.4 Mitigation

A UXO Clearance Marine Mammal Mitigation Plan (MMMP) has been devised, in consultation with SNH, to mitigate the potential for both physical injury and trauma and auditory injury to occur in marine mammals. The UXO MMMP sets out the UXO mitigation procedure, the roles and responsibilities of personnel in the mitigation team, and the reporting requirements (see Appendix A).

The mitigation follows the JNCC (2010) guidelines for minimising the risk of injury to marine mammals from using explosives. The mitigation sets out the need for two Marine Mammal Observers (MMOs) and one Passive Acoustic Monitoring Operator (PAM-Op) (if required and safe to do so) to carry out monitoring over a 1 km pre-detonation search zone for a minimum of one hour period prior to the UXO detonation.

Alongside the monitoring to ensure no marine mammals are within 1 km of the detonation site, there are additional measure to “deter” marine mammals beyond the mitigation zone of 1 km. This uses Acoustic Deterrent Devices (ADDs) and soft-start charges to encourage marine mammals to flee beyond the mitigation zone. In order to ensure that marine mammal species are “deterred” outside of these potential impact ranges, then a further soft-start charge weight of 250 g should be added to the soft-start procedure, totalling five soft-start charges. See Appendix A for more information on these mitigation procedures.

A careful balance must be achieved between ensuring that marine mammals flee the injury zone and minimising the additional noise introduced into the marine environment. The activation of the ADD must

be done 25 minutes prior to the detonation event, and not be activated for any longer than the stated period.

4.1.1.5 Summary

For the planned UXO clearance activities (EOD operations) at the Development, the potential for physical injury or trauma or auditory damage (either permanent or temporary) to occur in cetacean species ranges from moderate to high in the absence of mitigation.

The implementation of the MMMP as summarised above will ensure that the risk of physical injury and trauma and the risk of PTS onset is negated fully, resulting in no risk to cetaceans of physical or permanent auditory injury.

4.1.2 The Risk of Disturbance to Cetaceans

For all cetaceans species, a fleeing response is assumed to occur at the same noise levels as TTS. Southall *et al.* (2007) states that the onset of behavioural disturbance could occur at the lowest level of noise exposure that has an effect on hearing (i.e. at TTS-onset). Although, this is not a specific behavioural effect, exposures to lower noise levels from a single pulse are not expected to cause disturbance.

The Statutory Nature Conservation Bodies (SNCBs) currently recommend that a potential disturbance range of 26 km (with approximate area of 2,124 km^2 based on the area of a circle) around UXO detonations (of any charge size) should be used to assess harbour porpoise disturbance. Disturbance from any UXO detonation would be temporary and for a short-duration (i.e. the detonation period).

For the estimated worst-case it is predicted that there could be up to ten UXO detonations for the Development. As a precautionary worst-case scenario, the maximum number of days of UXO detonations could be undertaken on is up to ten days, excluding weather downtime. This is based on one detonation per day.

The estimated number of harbour porpoise that could potentially be disturbed during underwater UXO detonation, based on a 26 km radius, is 3,611 individuals, equating to 1% of the North Sea MU population. A high number of harbour porpoise are at risk of behavioural disturbance from UXO detonation, however, it represents a small percentage of the population as a whole, and the impact would be temporary only. The magnitude of this impact on harbour porpoise would be low taking into account the temporary nature of the impact, and the sensitivity of the species to disturbance impacts is medium. Therefore, ***the impact of disturbance to harbour porpoise is assessed as minor, which is considered not to be a significant impact***. For other species, the risk of behavioural disturbance from UXO detonation is considered the be same as for TTS, as shown in Table 4-6. Therefore, ***the risk of disturbance to all other cetacean species is low***.

4.1.3 The Risk of Injury and Disturbance to Cetaceans from the use of Acoustic Deterrence Devices

The Lofitech device has been designed to have a source noise level of 189 dB, with numerous field measurements confirming the device to have recorded source levels of 179 to 194 dB (Coram *et al.,* 2014). This source level is below the sound level required for PTS onset in harbour porpoise (202 dB re 1µPa SPL_{peak}) and TTS onset (196 dB re 1µPa SPL_{peak}) under the NMFS criteria (NMFS, 2016; 2018), is below the sound level required for PTS onset in minke whale (219 dB re 1µPa SPL_{peak}) and TTS onset (213 dB re 1µPa SPL_{peak}) under the NMFS criteria (NMFS, 2016; 2018), and is below the sound level required for PTS onset in dolphin species (230 dB re 1µPa SPL_{peak}) and TTS onset (224 dB re 1µPa SPL_{peak}) under the NMFS criteria (NMFS, 2016; 2018).

Herschel *et al*. (2013) presented information on the potential for PTS from various ADD devices, based on an analysis by Gotz and Janik, (2013). This analysis calculated the combination of exposure times and distances that would be required for cetaceans to receive a sound exposure which puts them at risk of hearing damage. For the Lofitech device, individuals would need to remain within 76m for 10 hours or

within 9m for 8 minutes. The likelihood of any individual at sea remaining within this size of area for that time period is extremely low, given the presence of a deterrence signal (Sparling and Plunkett, 2015).

Therefore, there is a negligible risk of cetaceans receiving a dose of sound from the ADD which would reach levels predicted to cause any auditory injury (either PTS or TTS). Taking into account the high sensitivity of cetaceans to PTS, the overall impact is assessed as **minor adverse** for the risk of PTS and TTS onset, and is therefore not significant.

It should be noted that the disturbance to harbour porpoise as a result of the proposed ADD use would be within the 26 km disturbance range for UXO detonation previously assessed, and is therefore not an additive effect to the overall area of potential disturbance. During the implementation of the proposed mitigation, the activation of ADDs for 25 minutes and the maximum 30 minutes time period for the soft-start charges, it is estimated that individuals would be disturbed from at least a 4.95 km range from the UXO detonation location (based on a precautionary marine mammal swimming speed of 1.5 m/s), resulting in a potential disturbance area of 76.98 km^2.

The number of harbour porpoise that could potentially be disturbed as a result of the proposed mitigation would be 136 individuals (0.04% of the North Sea MU reference population). Less than 1% of the reference population would be temporarily exposed to the effect, therefore, the magnitude of the potential temporary impact is assessed as **negligible**. For all other species, the potential for disturbance is considered to be the same as for the potential for the impact of TTS; therefore, all other species are considered to be at risk of a **minor** impact from ADD activation.

4.1.4 Indirect Impacts to Marine Mammals from the Detonation of UXO

4.1.4.1 The Impact of sediment disturbance, increases in SSC and release of sediment contaminants on marine mammals

The UXO clearance activities within the Development area has the potential to result in the disturbance of the seabed and increases in Suspended Sediment Concentrations (SSC) in the water column. This effect would be highly localised and would not result in any significant areas of the seabed being disturbed, or significant levels of sediments being released into the water column. Following disturbance, the levels of suspended sediment are not expected to be significantly higher than background levels, and the sandy and coarse sand sediments present at the site will settle on the seabed again relatively rapidly.

Cetacean species are able to avoid small areas that have been disturbed by the increase in SSC, and the mitigation measures in place to deter individuals from the area mean that any individuals that they are unlikely to be exposed to elevated levels of suspended sediment concentrations during and directly after the detonation event.

Levels of sediment contamination across the Development area did not show any levels above guideline levels. This, and the dispersive and dilutive nature of the environment, mean that any minor elevated levels of contaminants in the water column following UXO clearance activities are unlikely to result in any adverse effects on marine mammals. Therefore, the risk to marine mammals from changes to the sediment processes at the site (including increases in SSC and contaminants) are negligible, and no further mitigation is considered necessary.

4.1.4.2 The Risk of Changes to Prey Availability for Cetaceans due to UXO clearance activities

There are no significant impacts expected to occur in fish species as a result of the UXO clearance activities, due to either behavioural disturbance of the fish species from the area, temporary habitat loss or the release of SSC. Therefore, any potential indirect effects to cetaceans that target these species are expected to be negligible.

4.1.4.3 The Risk of Vessel Collision for Cetaceans due to UXO clearance activities

The number of vessels present in the Development area are 18 in the summer, and 16 in the winter periods. The UXO clearance activities are expected to require three vessels to undertake the works,

increasing the number of vessels present in the area by 15%. A total of 20 vessels within vicinity of the Development area would not pose a risk to cetacean species, and is therefore considered negligible to all species.

4.2 Cumulative Impacts

The following section considers the potential for cumulative impacts from the UXO detonations within the Development area. To be considered within the Cumulative Impact Assessment (CIA), other plans and projects should meet the following criteria. They should:

- Be likely to be constructed or operate over similar time periods (or their environmental consequences have the potential to be realised over the same time period);
- Be spatially linked to the predicted zone of influence of the project;
- Be either consented (but not operational) or the subject of consent applications within the statutory authorities in the study area or part of another statutory procedure; and
- Generate residual impacts of their own, of at least minor significance.

These other projects that have the potential to be within the impact ranges of the UXO detonation at the Development (the largest being for disturbance to harbour porpoise at 26 km) are outlined in Table 4-7 below, along with a conclusion of the potential for cumulative impact.

Table 4-7 Projects and Activities with the Potential for Cumulative Impact

Project (distance from the Development area)	Activity	Description of Potential Impact	Screened In or Out of Further Assessment
Beatrice Offshore Wind Farm (0 km)	Construction of the wind farm impacting on cetacean species through underwater noise and an increase in vessels	This project is currently in construction, with piling works completed in December 2017[1]. There is the potential for there to be an overlap of construction of the Beatrice Wind Farm alongside the UXO detonation of the Development, however, there will be no impulsive underwater noise as all piling (and UXO clearance) will be completed. There will be construction vessels on the site which may be in use at the same time, however, as the number of vessels to be used within the Development area is not expected have more than a negligible impact on the cetaceans of the area, then it is expected that there will be no cumulative impact.	Out
Buckie Disposal site (18.7 km from OfTI Corridor)	Use of the dredging site impacting on cetacean species through the increase in vessel presence	Dredging works considered in the CIA are for operational and consented projects (or dredging lease sites) only. The Buckie disposal site is operational and is therefore considered to be a part of the baseline environment.	Out

Project (distance from the Development area)	Activity	Description of Potential Impact	Screened In or Out of Further Assessment
MacDuff Disposal site (4.8 km from OfTI Corridor)	Use of the dredging site impacting on cetacean species through the increase in vessel presence	Dredging works considered in the CIA are for operational and consented projects (or dredging lease sites) only. The MacDuff disposal site is operational and is therefore considered to be a part of the baseline environment.	Out
Commercial fishing	Commercial fishing impacting on cetacean species through the increase in vessel presence	Commercial fishing activities are included in the CIA if they are for operational or consented only. Commercial fishing activities are considered to be operational, and there is no evidence to suggest that commercial fishing activities are increasing. The activity is therefore considered to be a part of the baseline environment.	Out
Seismic surveys (including Sub-bottom profilers)	None identified within the largest impact range of 26 km.		Out
Commercial shipping and recreational boating	Commercial shipping impacting on cetacean species through the increase in vessel presence	Commercial shipping activities are included in the CIA if they are for operational or consented only. Commercial shipping activities are considered to be operational, and there is no evidence to suggest that commercial shipping activities are increasing. The activity is therefore considered to be a part of the baseline environment.	Out
Wave and Tidal Developments	None identified within the largest impact range of 26 km.		Out
Oil and Gas Developments	None identified within the largest impact range of 26 km.		Out

[1]*As per Beatrice OWF project update provided at the July MFRAG-MM meeting*

4.2.1 Summary of the Cumulative Impact Assessment

No activities with the potential to overlap with the Development's UXO detonations, both temporarily and spatially, as identified within Table 4-7 are expected to have a cumulative impact on cetacean species. Therefore, no other projects are screened in for further assessment.

5 Consideration on Designated Sites

5.1 Moray Firth SAC

The bottlenose dolphins of the Moray Firth SAC are mainly found in the coastal area of the Moray Firth, and most commonly at the entrance to the Moray Firth (see Section 3 for more information). There are therefore relatively lower levels of bottlenose dolphin presence within the Development area. It should be noted that the assessment on the SAC includes potential impacts on the bottlenose dolphins as they commute to the Forth and Inner Tay, as well as the Moray Firth area as the density estimate covers all areas that have the potential to be impact by the UXO clearance activities. Bottlenose dolphin have a relatively low sensitivity to underwater noise from UXO detonations, and the noise assessment predicted that, without mitigation, physical injury or trauma could occur out to a maximum distance of 500 m (based on a UXO charge size of 263 kg) and permanent auditory injury (PTS) could occur out to 570 m from the detonation site, from a UXO with a charge size of 250 kg. This would result in potentially 0.2 individuals being at risk of physical trauma or injury (0.1% of the estimated Moray Firth SAC population, and 0.3 individuals from PTS (0.15% of the Moray Firth SAC population). An additional assessment on the potential for a UXO device of up to 700 kg NEQ has also been undertaken for the onset of PTS in bottlenose dolphin. The assessment showed that a total of 0.6 individuals would be at risk of PTS onset as a result of the detonation of a device of up to 700 kg.

Mitigation for the potential of physical injury or trauma and permanent auditory injury (PTS) will include the monitoring of the detonation site and up to 1 km away (i.e. the mitigation zone) for a period of 1 hour that will ensure there are no bottlenose dolphin present within the physical injury and trauma range and permanent auditory impact ranges prior to detonation. The mitigation has in-built precautionary elements that ensure potential and possible sightings of marine mammals are treated as confirmed and the mitigation carried out as such. As well as this, an ADD device will be deployed for 25 minutes and five soft-start charges will be detonated prior to the UXO detonation to ensure any marine mammals, including bottlenose dolphin, are deterred from the impact area of a detonation up to 700 kg. With this mitigation, the potential for physical or auditory injury to occur is considered to be **negligible**.

Behavioural reactions to underwater noise associated with the detonation of UXO are likely to occur up to a distance of 1.05 km for a device of up to 270 kg, and up to 1.5 km for a device of up to 700kg; this could potentially impacting 1.0 or 2.1 bottlenose dolphin (0.5 or 1% of the Moray Firth SAC population) respectively. The above described mitigation will ensure that there are no bottlenose dolphin within 1.5 km of the detonation site prior to the event.

Based on the above, there is not predicted to be a population-level effect on bottlenose dolphins in the Moray Firth, and therefore, it is considered that ***there would be no potential for Likely Significant Effect (LSE) on the Moray Firth SAC***.

5.2 Southern Trench pMPA

The minke whale in the Southern Trench pMPA are mainly present in the summer months only (see Section 3 for more information). There are therefore relatively lower densities of minke whale present in the winter period compared to the summer. However, as a worst-case scenario, the densities in the summer months have been used in this assessment.

The noise assessment predicted that, without mitigation, physical injury or trauma could occur out to a maximum distance of 500 m and permanent auditory injury (PTS) could occur out to 1.7 km from the detonation site, from a UXO with a charge size of 250 kg. This would result in potentially 0.2 individuals being at risk of physical trauma or injury, and 0.3 individuals from PTS. An additional assessment on the potential for a UXO device of up to 700 kg NEQ has also been undertaken for the onset of PTS in minke whale. The assessment showed that a total of 0.6 individuals would be at risk of PTS onset as a result of the detonation of a device of up to 700 kg.

Mitigation for the potential of physical injury or trauma and permanent auditory injury (PTS) will include the monitoring of the detonation site (and up to 1 km away) for a period of 1 hour that will ensure there are no minke whale present within the physical and permanent auditory impact ranges prior to detonation. The mitigation has in-built precautionary elements that ensure potential and possible sightings of marine mammals are treated as confirmed and the mitigation carried out as such. As well as this, an ADD device will be deployed for 25 minutes and five soft-start charges will be detonated prior to the UXO detonation to ensure any marine mammals, including minke whale, are deterred from the impact area of a detonation up to 700 kg. With this mitigation, the potential for physical or auditory injury to occur is considered to be negligible.

Behavioural reactions to underwater noise associated with the detonation of UXO are likely to occur up to a distance of 4.4 km for a device of up to 700 kg, potentially impacting 1.8 minke whale. The above described mitigation will ensure that there are no minke whale within this impact range of the detonation site prior to the event.

Based on the above, there is not predicted to be a population-level effect on minke whale in the Moray Firth, and therefore, it is considered that ***there would be no potential for significant impact on the minke whale in the Southern Trench pMPA***.

6 EPS Licence Requirements

For an EPS Licence to be granted, an Application must meet the specific purposes as set out within Regulation 44 of the Conservation (Natural Habitats, &c.) 1994 Regulations for licences up to 12 nm, and under Regulation 55 of the Conservation of Offshore Marine Habitats and Species Regulations 2017 beyond 12 nm. The Application should be made for the following purpose: "*imperative reasons of overriding public interest including those of a social or economic nature",* or, IROPI, meeting the terms of Regulation 44(2)(e). In order for the Application to be granted, the Scottish Ministers must be satisfied that (within the terms of Regulation 44(3) of the Habitats Regulations) the following criteria are met:

Test 1 (Overriding Public Interest Test) pertaining to Regulation 44(2) - The Licensable Operations are for a purpose which constitutes "*imperative reasons of overriding public interest including those of a social or economic nature*";

Test 2 (No Satisfactory Alternatives Test) pertaining to Regulation 44(3)(a) - There are no satisfactory alternative methods for the Licensable Operations); and

Test 3 (Favourable Conservation Status Test) pertaining to Regulation 44(3)(b) – The Licensable Operations will not be detrimental to the maintenance of the population of the species concerned at a Favourable Conservation Status (FCS) in their natural range.

As shown above, the potential for injury to cetacean species will be fully negated through the mitigation procedures as outlined in Appendix A. However, there will remain a risk of disturbance to the cetacean species. Therefore, an EPS licence is being applied for the disturbance of cetacean species (namely harbour porpoise, minke whale, bottlenose dolphin, white-beaked dolphin and common dolphin) from the planned UXO clearance activities (specifically the detonation of any UXO device and use of ADDs) for the Moray East Offshore Windfarm.

6.1 Test 1 – Overriding Public Interest Test

Within Europe, the UK and Scotland, there is an overarching policy requiring a sustainable energy supply from renewables; this need is the subject of national planning and energy creation policies. Moray East Offshore Wind Farm and associated OfTI has been consented in line with this policy, and has been subject to a detailed and rigorous EIA in support of the application for consent.

This EPS licence application for UXO clearance is founded on the imperative reasons of overriding public interest (IROPI) identified within the above described policy requirement to achieve (or exceed) the set targets for energy from renewable energy developments. The consented Moray East Offshore Wind Farm and OfTI is of national importance, in relation to delivering the policy requirements, and the delivery of this Development will make a vital contribution to the economic development of the Moray Firth area. There is a clear and direct environmental benefit from the development of the Moray East Offshore Wind Farm, through the reduction in carbon emissions.

Renewable energy developments, such as the Moray East Offshore Wind Farm, are recognised by SNH as a Project that would fulfil the requirements of the IROPI Test. The Moray East Offshore Wind Farm meets the objectives set out in the SNH Guidance in that it will make a significant contribution to the desired reduction in Scotland and the UK's greenhouse gas emissions, and will provide a significant and secure (and sustainable) supply of electricity for the future.

Moray East therefore considers that the UXO clearance operations will facilitate the sustainable and safe construction of the Moray East Wind Farm, and therefore clearly meets the IROPI Test.

6.2 Test 2 – Satisfactory Alternative Test

Regulation 44(3)(a) of the Habitat Regulations 1994 sets out a requirement that Scottish Ministers be satisfied that there is no satisfactory alternative before an EPS Licence can be issued. Potential alternatives to the proposed UXO clearance survey have been considered by the Applicant and the project engineers as outlined in Section2.2, and summarised below.

In deciding how to best deal with UXOs identified within the Moray East Windfarm area, consideration will be given is to whether it is possible to install infrastructure to avoid the UXO locations. Only when it is not possible to avoid the UXO location for engineering or safety reasons, would the last remaining option be implemented; detonation of the UXO device. The proposed methods outlined within this Cetacean Risk Assessment are the only viable way to achieve the required UXO clearance to enable the safe construction of the offshore wind farm.

Moray East therefore considers that, on the basis of health and safety, the no satisfactory alternatives test is clearly met.

6.3 Test 3 – Favorable Conservation Status

Regulation 44(3)(b) of the Habitat Regulations 1994 and Regulation 55(9)(c) of the Marine Habitats and Species Regulations 2017 requires the Scottish Ministers to be satisfied that the Licensed Operations must not be detrimental to the maintenance of the population of species concerned at a FCS in their natural range. The EU Habitats Directive (which is given effect in the UK by, among others, the 1994 Habitats Regulations) includes the definitions for FCS below:

The "conservation status" of a species means, "the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations […]"

The "favourable conservation status" of a species means:

"*population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and*

the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and

there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis."

As outlined in Section 3, there are five cetacean species which have the potential to occur in the vicinity of the Development area, and therefore in the vicinity of the EOD operations for which effects must be assessed on FCS. However, as discussed in Section 4.1, significant behavioural effects are considered likely to occur only in the very short term due to the very short duration of the acoustic event, associated with each UXO clearance, and the small number of discrete events that are likely to occur. Following cessation of each explosion event, it is considered likely that any behavioural effects will be reversible and animals will resume normal behaviour within the short term. In addition, through the mitigation measures outlined within Appendix A of this Cetacean Risk Assessment, physical trauma and injury, and permanent auditory injury will be avoided for all cetacean species. The mitigation procedures are expected to negate all anticipated physical and auditory injurious effects and therefore there will be no long-term impact to the cetacean populations.

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Appendix A: Marine Mammal Mitigation Plan for UXO Clearance

A.1 Introduction

This UXO Marine Mammal Mitigation Plan (MMMP) has been prepared to support both the Marine License (ML) and EPS License application by Moray Offshore Windfarm (East) Ltd (the Development) for the mitigation of Explosive Ordnance Disposal (EOD) operations within the Development area; comprised of the Moray East site and the OfTI Corridor. Further details on the EOD operations planned, including the number and type expected to be found within the Development area, can be found in Section 2 of the Environmental Report. A worst-case of ten UXO devices may require detonation, with up to four in the Moray East site, and up to six in the OfTI Corridor. This is planned to take place over a ten non-consecutive days anytime from February to May 2019, excluding weather conditions.

The methods and procedures required for the effective mitigation of impacts associated with the clearance of any UXO for marine mammal species expected to found in the area. In particular, the MMMP will mitigate against the potential risk of physical injury and / or trauma, and PTS exposure on marine mammals.

The JNCC guidance for "*minimizing the risk of injury to marine mammal from use explosives*" (JNCC, 2010) has been consulted in the process of developing this MMMP to determine the best approach for mitigation, and to ensure best practice measures are followed (JNCC, 2010). In addition, this UXO MMMP has been informed by previous work undertaken for the Moray East and the Beatrice OWF piling protocol included in the Piling Strategy (Moray East, 2016).

The mitigation procedures outlined in this MMMP include;

- Establishment of a mitigation zone of 1 km.
- The monitoring of the mitigation zone by dedicated and trained Marine Mammal Observers (MMOs) during daylight hours and when conditions allow suitable visibility, pre and post-detonation.
- The deployment of Passive Acoustic Monitoring (PAM) devices, if required, and if the equipment can be safely deployed and retrieved.
- The activation of Acoustic Deterrent Devices (ADDs).
- A soft-start procedure using scare charges.
- All detonations to take place in daylight and, when possible, in favourable conditions with good visibility (sea state 3 or less).
- The controlled explosions of the UXO will be undertaken by specialist contractors, using the minimum amount of explosives required in order to achieve safe disposal of the device.
- The fusing of multiple devices; if there are multiple UXO in close proximity (e.g. within 20 m of each other) then one may be moved to be detonated with the other. In this case, the charges should be fused together, allowing for a millisecond of delay between the device detonations in order to reduce the cumulative impact of the shock wave.

A.2 Technical Applicability of Bubble Curtains

In theory, the bubbles change the physical condition of the water and the outward propagation of the acoustic/shock waves. However, there is currently no evidence to show that bubble curtains can successfully mitigate the noise and pressures released during EOD operations. Although commonly used within Europe to mitigate long lasting operations such as percussive piling, the high frequency pulse of noise and pressure released from a UXO detonation has not been shown to sufficiently be reduced by bubble curtain technology (Ordtek, 2018).

Current mitigation methods, for the protection of mammals and fish, are well established and have been shown to be effective in removing mammals and fish from the areas where they would be negatively affected by UXO detonations, providing them with sufficient protection and safeguarding from the noise of EOD operations.

Acoustic and explosive deterrent methods have been seen to disperse mammals to a distance of 1 km from a scheduled detonation site (the mitigation zone), as shown below, as well as numerous reports from live operations where mammal observations are undertaken as standard procedure. In addition, it has been noted within JNCC literature (JNCC, 2010) that the limited exposure of noise and pressure caused by UXO detonations has not been seen to negatively affect marine mammals.

No marine mammal injuries or deaths have been observed or reported by UXO and EOD consultancies or contractors when not using bubble curtains, nor have any been reported within industry press (Ordtek, 2018). In addition, the cost and time associated with bubble curtain use should be considered against any merits to ensure the mitigation is reasonable in relation to the risk presented. The deployment of bubble curtains is costly, due to the requirement of an additional vessel, as well as being highly weather sensitive, which can cause delays to operations preventing additional stages of development progressing (Ordtek, 2018).

In light of the foregoing together with the conclusion that there are no LSE or significant effects predicted where the proposed mitigation without the use of bubble curtains is adopted then it is considered that the proposed mitigation is adequate to reduce the risk to marine mammals.

A.3 UXO Mitigation Procedures

A.3.1 Mitigation Zone

The mitigation zone is the area at which a pre-detonation search is required to be undertaken for by MMOs and/or a PAM-Op. This is based on the minimum required distance as specified within the JNCC guidelines (2010) of 1 km. See below for more information on MMO and PAM operations within the mitigation zone.

The mitigation zone (of 1 km) is measured out from the detonation site with a 360° coverage, with the overall diameter of the mitigation zone being 2 km. Plate A.1 below provides a simple diagram of the mitigation zone in relation to the detonation site.

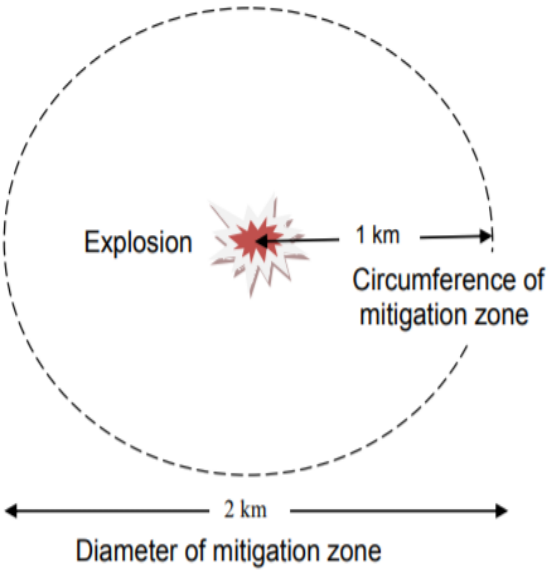


Plate A.1 Representative mitigation zone of 1 km (JNCC, 2010).

A.3.2 Pre-Detonation Search

The pre-detonation search is required to ensure that there are no marine mammals present within the mitigation zone (of 1 km radius) prior to the detonation event, confirming that no marine mammals are within the range at which they would be at risk of injury (permanent auditory or physical).

The pre-detonation search should commence at least 1 hour prior to the detonation event, with at least 2 dedicated and trained MMOs to observe from two different viewing platforms at the closest location possible to the detonation site. This ensures that the entire mitigation zone can be monitored at all times. The MMOs should be in close contact to ensure any sighting of a marine mammal within the mitigation zone is communicated.

During periods of low visibility (due to adverse weather and/or sea states of 4 or higher), the use of PAM will be required as an additional measure to monitor the mitigation zone. The PAM hydrophones should be located as close as possible to the detonation site. It is possible to deploy from the vessels already located at the site, however it should be noted that they may be too far from the detonation site at point of explosion to provide effective monitoring of the entire mitigation zone. For the EOD operations the MMOs and PAM-Op will be either on the launch or the guard vessel, within a maximum distance of 300 m of the detonation location, during the pre-detonation search period.

A PAM system (the software PAM Guard should be used) may not always be able to determine the range of a marine mammal detection, or for all species expected to be present in the area. If this is the case, the PAM-Op will need to use experience and expert judgement to determine the range of the individual/s detected and whether it is within the 1 km mitigation zone. If the PAM-Op is unsure of whether an individual/s is within the mitigation zone or not, the precautionary principle should always be applied and it therefore should be assumed that the marine mammal/s is within the mitigation zone.

A pre-detonation search should commence prior to all detonation events or sequences, or after any break in the detonation event or sequence, and at the end of a detonation event or sequence. The visual (by MMO) and/or acoustic watch (by PAM-Op if required due to poor conditions) will commence at least 1 hour prior to the detonation event, and across the entire mitigation zone using the methods outlined above. This will continue until 1 hour has passed and no marine mammals have been detected within the mitigation zone; the MMO/PAM-Op will then advise that detonation can commence.

If a marine mammal is detected within the mitigation zone during the pre-detonation search, then the commencement of the detonation will need to be delayed. Once a marine mammal has been sighted within the mitigation zone, it should be monitored and tracked until it is clear of the mitigation zone, and the relevant EOD technical advisor notified. It must be clear of the mitigation zone for at least 20 minutes before the soft start procedure can commence.

If the marine mammal/s remains clear of the zone for at least 20 minutes, and the 1 hour pre-search has also been completed, then the soft start procedure can commence. A precautionary approach should always be used, and if the MMO/PAM-Op cannot be sure whether the individual is within the zone or not, or whether there is a confirmed sighting/detection of a marine mammal within the mitigation, then the operation should be delayed accordingly until the MMO/PAM-Op is sure that there are no marine mammals are present within the 1 km mitigation zone.

All MMOs and PAM-Ops present must move clear of the detonation site to a safe distance prior to soft-start detonation.

A.3.3 Deterrence Activities

Deterrence activities are required in order to ensure that marine mammals are not present within the assessed impact ranges when detonation activates commence. The use of a device to deter a marine mammal from the detonation site will therefore be used. Acoustic Deterrence Devices (ADDs) will be used in conjunction with MMOs/PAM-Ops (who can act as the ADD operator) and will be operated for a short

time to deter marine mammals from the detonation area. The effectiveness of the ADDs for each species is provided in Section 3.3.1.1 below, and the ADD operating procedures are outlined in Section A.3.3.1.2.

A.3.3.1 Acoustic Deterrence Activities

A.3.3.1.1 Information on Acoustic Deterrent Device Effectiveness

The Lofitech seal scarer has been shown to be the most consistent and effective at deterring seal species from an area, as well as for harbour porpoise and more recently has been shown to be effective at deterring minke whale. The Lofitech seal scarer has successfully been used in a number of projects for a range of industries, including for aquaculture projects and the offshore wind industry. The Lofitech device has been designed to have a source noise level of 189 dB, with numerous field measurements confirming the device to have recorded source levels of 179 to 194 dB (Coram *et al.,* 2014).

A number of different trials have shown that the Lofitech Seal Scarer device is effective at deterring harbour and grey seals to a distance of 1 km from the device location (Brandt *et* al., 2012; 2013, Harris *et* al., 2014, Gordon *et al.*, 2015; Coram *et al.,* 2014); meeting the 1 km mitigation zone. There was no habituation of harbour seals in field trials that occured over several weeks (Gordon *et al*., 2015).

The noise source level from the Lofitech device (of a maximum 194dB re 1 µPa) is also lower than the injury thresholds for seals in water, with PTS onset at 218 dB re 1µPa SPL_{peak} and TTS onset at 212 dB re 1µPa SPL_{peak} (NMFS, 2016; 2018). Cumulative exposure is not considered for the use of ADDs as the individuals would vacate the area before any risk of cumulative exposure.

Studies have also shown the device to be effective for harbour porpoise up to 7.5 km with an immediate response on activation of the device (Bradnt *et al*., 2012, 2013; Gordon *et al.*, 2015). Harbour porpoise were not habituated to the device over trials of 4-6 months (Brandt *et al*., 2012). The device noise source levels are below the sound level required for PTS onset in harbour porpoise (202 dB re 1µPa SPL_{peak}) and TTS onset (196 dB re 1µPa SPL_{peak}) under the NMFS criteria (NMFS, 2016; 2018).

The Lofitech seal scarer has been proven to effect minke whale behaviour up to 1 km from the source (McGarry *et al*., 2017). Within 15 minutes of ADD activation, minke whale were shown to travel to a minimum distance of 1.7 km from the ADD location, with a maximum deterrence range of 4.5 km detected. The device noise source levels are below the sound level required for PTS onset in minke whale (219 dB re 1µPa SPL_{peak}) and TTS onset (213 dB re 1µPa SPL_{peak}) under the NMFS criteria (NMFS, 2016; 2018). Mean swim speeds of minke whale away from the active device was found to be 15 km/h (± 4.7 km/h), which is significantly higher than the assumed 1.5 m/s used to determine the required ADD activation period (McGarry *et al*., 2017).

There is no information available on the effectiveness of the Lofitech Seal Scarer device on dolphin species. However, studies on the effectiveness of ADDs in captive dolphins has shown startle responses in bottlenose dolphins at ADD source levels of 135 dB re 1µPa RMS (Janik & Götz, 2013). It could therefore be assumed that the deterrence range of bottlenose dolphins from an ADD emitting a sound source level of 190 dB re 1 µPa with a high frequency could be more than 4 km ((McGarry *et al*., 2017). However, it should be noted that this is untested.

In light of the scientific evidence of its effectiveness as shown above, it is proposed that the Lofitech seal scarer will be used for the mitigation of the EOD operations. If a different ADD is chosen to be used at a later date, agreement would be sought from MS-LOT prior to the commencement of any EOD operations.

A.3.3.1.2 Acoustic Deterrent Device Procedure

An ADD should be positioned within the water column in close proximity to the detonation site; the ADD-Op will be either on the launch or guard vessel, within a maximum distance of 300m of the detonation location during the pre-detonation search. The ADD should be switched on for a set number of emissions (identified below) during the pre-detonation search and turned off immediately once the detonations have commenced in order to reduce the level of noise in the area. The MMOs and/or PAM-Op should maintain their pre-detonation search during ADD activation.

Assuming a marine mammal swims at 1.5 ms^{-1}, it would take an individual a total of 11 minutes to leave the 1 km mitigation zone, if it was located at the detonation site at the activation of the ADD. As an additional precautionary approach, ADD activation will be for 25 minutes during the pre-detonation search, immediately prior to the detonation event to allow for any marine mammals that are within the mitigation zone to leave the area and move further away than the worst-case impact ranges for designated site species, including bottlenose dolphin, minke whale and harbour seal.

Two ADDs will be needed, with one on each end or side of the vessel. The best location to deploy the two ADDs, and the method to provide power to the devices, will be decided through a pre-deployment survey of the vessel by the operational manager, the rigger and an electrical supervisor. Once the best location/s for the ADDs have been determined, the control unit and power supply should be temporarily installed. For deployment of the ADDs, the transducer part of the device should be lowered over the side of the deck (they should not be activated at this time) to a water depth that is below the draft of the vessel to ensure the sound can be emitted in all directions and not dampened by the presence of the vessel.

Once the ADDs are in position, they should be tested for operational efficiency. A low sensitivity hydrophone should be lowered over the side of the vessel near the ADDs and the signals tested. The ADD-Op should also ensure that the communications are in place between themselves, the MMOs, the PAM-Op (if present) and the EOD technical advisor.

The ADD will be activated for 25 minutes directly prior to the soft start procedure, during the pre-detonation search. The ADD cannot be used during transit to another detonation event, and must be activated prior to the soft start procedure for any detonation event or sequence. Once the ADD has been activated for a period of 25 minutes, then the ADD-Op will recover the ADDs and undertaken routine checks to ensure all are still working correctly, ready for the next deployment and activation. If the MMO/PAM-Op and ADD-Op are the same person, then the ADD should be deployed and tested prior to the 1 hour pre-detonation search, and activated at the appropriate time.

The pre-detonation search procedures still apply during this time, and if any marine mammals are sighted within the 25 minute ADD activation time, the soft start procedure cannot commence until 20 minutes with no marine mammal presence within the mitigation zone, and until the 1 hour pre-detonation search has been completed (it should be noted that the ADD should not be activated for longer than the stated period of 25 minutes to limit the potential for additional noise impact, unless a marine mammal is detected within the soft-start procedure – see below for more information). The MMO/PAM-Op should maintain their pre-detonation search during the ADD activation time.

A.3.3.2 Soft-Start of UXO

A sequence of small to large charge size in order (very small explosives with charges of 50 g, 100 g, 150 g and 200 g) will be implemented to allow additional time for marine mammals to leave the area of potential impact; this is known as a “soft-start” procedure.

The soft-start charge sequence is based upon the most likely scenario of UXO devices of up to 260 kg requiring detonation. In the unlikely event that charges greater than 260 kg require detonation (and up to 700 kg), an additional small charge will be added of 250 g. The introduction of additional small charges must ensure a balance between the deterrence of marine mammals beyond the potential range of injury, and minimizing the additional noise introduced into the environment.

When the EOD Technical Advisor provides notification that the soft-start is due to commence in 25 minutes, the ADD device will be deployed, five minutes after the ADD deactivation (or as soon as is reasonable considering safety constraints), the four small charge detonations should commence at five minute intervals, with a further interval of five minutes before the detonation of the UXO. This gives a total deterrence time of 50 minutes, and based on a swimming speed of 1.5 m/s (Otani *et al*. 2000), marine mammals should clear a radius of 4.5 km over this duration.

Once the soft-start has commenced, and a marine mammal is detected within the 1 km mitigation zone by the MMO and/or PAM-Op, the soft-start sequence should be paused, the ADD reactivated until the

marine mammal is clear of the mitigation zone for a period of 20 minutes. Once the MMO and/or PAM-Op has confirmed that the marine mammal has been clear for 20 minutes, then the soft-start procedure can recommence with the next charge.

Where charges are to be detonated together, then appropriate fusing should be used wherever practicable to allow for a functional delay (of a few milliseconds only) to reduce the cumulative impact of multiple charges.

Whilst this range (of the cleared range of 4.5 km due to ADD activation) is not beyond the predicted impact range for the 270 kg and 700 kg charge for the risk of PTS onset in harbour porpoise (with ranges of 8.4 and 11.5 km respectively, based on the NMFS (2016; 2018) criteria as reported within Norfolk Vanguard Ltd (2018), it is important to note that this range is sufficient for all other marine mammal species to avoid their respective permanent auditory impact ranges up to a UXO charge size of 700 kg. When considering the predicted impact range for harbour porpoise, it is important to recognise a number of highly precautionary assumptions relating to the predicted impact ranges. No account is made of the different noise propagation profiles throughout the water column (note that the Norfolk Vanguard modelling outputs are based at mid-water depths where ranges are greatest and with no sedimentation of the device; the actual noise levels at the water's surface (where marine mammals are expected to be fleeing) would be much lower than the modelling suggests. The modelling results also take no account of the "bubbling" effect which, as identified in the von Benda-Beckmann *et al.,* (2015) paper, is likely to add further to the over-estimation of impact ranges. Taking all these factors into account, it highly likely that the predicted PTS onset ranges for harbour porpoise are significantly over-estimated. This point is further emphasised in the von Benda-Beckmann *et al.*, (2015) paper where it cites significant uncertainty in the predicted impact ranges beyond 2 km.

In the highly unlikely event that a device of over 260 kg and up to 700 kg is required to be detonated, then an additional soft-start charge would be required, deployed at a five minute interval following the standard soft-start sequence. This additional charge would be 250 g. This allows marine mammals to flee further from the detonation site, ensuring they are beyond the increased potential permeant injury onset range, with a deterrence distance of 4.95 km.

A.3.3.2.1 Duration of Deterrence Activities

Herschel *et al.* (2013) presented an analysis of the potential for the ADD to cause a risk of PTS in marine mammal species. In order for seals to receive sound levels that would provide a risk of PTS (as defined by the NMFS 2016 criteria of 218 dB), they would need to remain within 60 m of the device for a period of 10 hours, or within 7m of the device for 8 minutes. For a harbour porpoise to be at risk of PTS onset (as defined by the NMFS 2016 criteria of 202 dB), an individual would need to remain within 76 m of the device for a period of 10 hours, or remain within 9m of the device for a period of 8 hours. The likelihood of a marine mammal remaining within this area is very low, and, given the presence of an aversive signal, such residence times at these distances from ADDs are considered extremely unlikely.

A.3.5 Post-Detonation Search

The MMOs should maintain a post-detonation search within the mitigation zone for at least 15 minutes after the final detonation, to look for evidence of injury to marine life, including any fish kills (following the JNCC (2010) guidance). Any other unusual observations should be also noted within the report.

A.3.6 Reporting

Reports should be completed detailing the marine mammal mitigation activities and timings, and any detections, and should be submitted to JNCC after the operation has been completed. Reports should be sent directly to seismic@jncc.gov.uk. These reports should include information on the relevant UXO clearance activities, date and location, information on charge sizes, start times of detonations, start and

end of pre and post-detonation watches (MMO) and acoustic monitoring (PAM-Ops), details of explosive activity during the relevant watches. The reports would be reviewed by Moray East and Moray East's ECoW in the first instance prior to their formal issue to JNCC and/or MS-LOT.

Marine Mammal Recording Forms can be found on www.jncc.gov.uk/page-1534 and all parts should be completed (including the cover page, operations sheet, effort sheet, and sightings sheet). Deckforms can be used if preferred with the information transferred to the spreadsheet at the end of the watch. Details of any ADD used and observations of their efficacy, and any problems encountered and instances of non-compliance with the JNCC guidelines and variations form the agreed procedure should also be reported.

In the event of a marine mammal sighting and/or detection, the MMO and/or PAM-Op should report the following information;

- Species, number of individuals, age, sex and size (e.g. juvenile or adult);
- Physical description of individuals features if cannot be identified to species level;
- Behaviour when first sighted (e.g. travelling, foraging, resting);
- Bearing and distance;
- Time, vessel position, vessel speed, vessel activity;
- Water depth (if known), sea state, visibility, glare; and
- Any other vessels in the area.

The ADD-Op should maintain a detailed record of all ADD deployments, including all ADD deployment, activation and recovery times, a record of each verification of ADD activation and a note of any issues encountered with regard to the ADD deployment and activation.

A.4 Roles and Responsibilities

There are a number of people that would be required in the compliance with this MMMP for UXO detonation activities, including;

- Marine Mammal Observers (MMOs);
- Passive Acoustic Monitoring Operator (PAM-Op);
- Acoustic Deterrent Device Operator (ADD-Op);
- Explosive Ordnance Disposal Technician

More information on each of the above's specific responsibilities are outlined below, including information on the experience of each that would be required.

A.4.1 Marine Mammal Observers

Dedicated and JNCC accredited MMOs will need to be present and on-watch for the pre-detonation and for the post-detonation searches (see Section A.3.2). Dedicated means that this should be the persons sole responsibility (however in this case it should be noted that the MMO could also act as the ADD operator, although the ADD procedure would more likely be undertaken by the PAM-Op). Two MMOs will be required to cover the entire mitigation zone, with good viewing platforms to allow for 360° coverage. The MMOs must be able to determine the extent of the 1 km mitigation zone from their location, unless poor visibility does not allow.

The MMOs will need to be equipped with binoculars, a ranging stick and the JNCC reporting forms. The MMOs should scan the mitigation zone with the unaided eye, and use binoculars when needed to

determine detail (such to look in detail at the area where a possible sighting has been made). Binoculars should not be used continually as they restrict peripheral vision and views close to the vessel.

Clear communication channels between the MMOs, the PAM-Op (if present), the ADD-Op and the EOD technical advisor are required, and the communication procedures should be established and agreed prior to any detonation event with regards to the communication of any detection within the mitigation zone, the deployment of ADDs, and when the mitigation zone is clear for detonation to take place. The EOD technical advisor team should assign a person responsible for communication with the mitigation team. The MMOs, PAM-Op (if present) and ADD-Op should be notified of a detonation even 24 hours prior to detonation, and should be on site at minimum 1.5 hours prior to detonation.

The MMOs specific responsibilities are;

- To commence a pre-detonation search at least 1 hour prior to detonation to ensure no marine mammal/s are within the 1 km mitigation zone prior to detonation.
- In the event that marine mammal/s is detected within the 1 km mitigation zone during the pre-detonation search, to communicate to the named member of the EOD technical advisor, and to ensure no detonation commences until at least 20 minutes have passed since the marine mammal/s detection within the 1 km mitigation zone and the 1 hour pre-detonation search has been completed.
- Notify the named member of the EOD technical advisor once the marine mammal/s has left the mitigation zone, and again once the mitigation zone is clear for detonation (i.e. there have been no marine mammals within the mitigation zone for 20 minutes and the 1 hour pre-detonation search has been completed).
- Complete a post-detonation search for at least 15 minutes after the last detonation to look for any evidence of injury to marine life, including fish kills. This will take place in the same location as the pre-detonation search.

A.4.2 Passive Acoustic Monitoring Operator

PAM is able to detect the vocalizations of marine mammals, and works best for echolocating species that are near-continually vocalizing such as harbour porpoise and dolphin species. PAM will be required in periods of low visibility to complement the monitoring by the MMOs. PAM-Ops should be experienced and trained in PAM hardware and software, as they will be required to determine the range of a detected marine mammal to the hydrophone location (note that this will be located between 100 and 300 m from the EOD operation) if the PAM software is unable to, and to interpret the detected sounds.

The PAM-Ops responsibilities will be the same as those for the MMO outlined in Section A.3.2 above. A dedicated PAM-Op will also be responsible for the deployment, maintenance and operation of the PAM hydrophone, including any spares, and notifying the ADD operator of any issues during the testing of the ADD.

A.4.3 Acoustic Deterrent Device Operator

A trained ADD-Op will be responsible for the ADD maintenance, operation and reporting procedures. This could be an existing member of the crew who has been specifically trained in the MMMP procedures and ADD operation who is available to carry out the ADD mitigation procedure in addition to their existing duties, or personnel specifically employed to operate the ADDs only, or this could be undertaken by the MMO and/or PAM-Op. The ADD-Op will need to ensure that the device has fully charged batteries, be available for the deployment and operation of the device, provide communication with all parties and to record all necessary information for the reporting.

The ADD-Op will be responsible for;

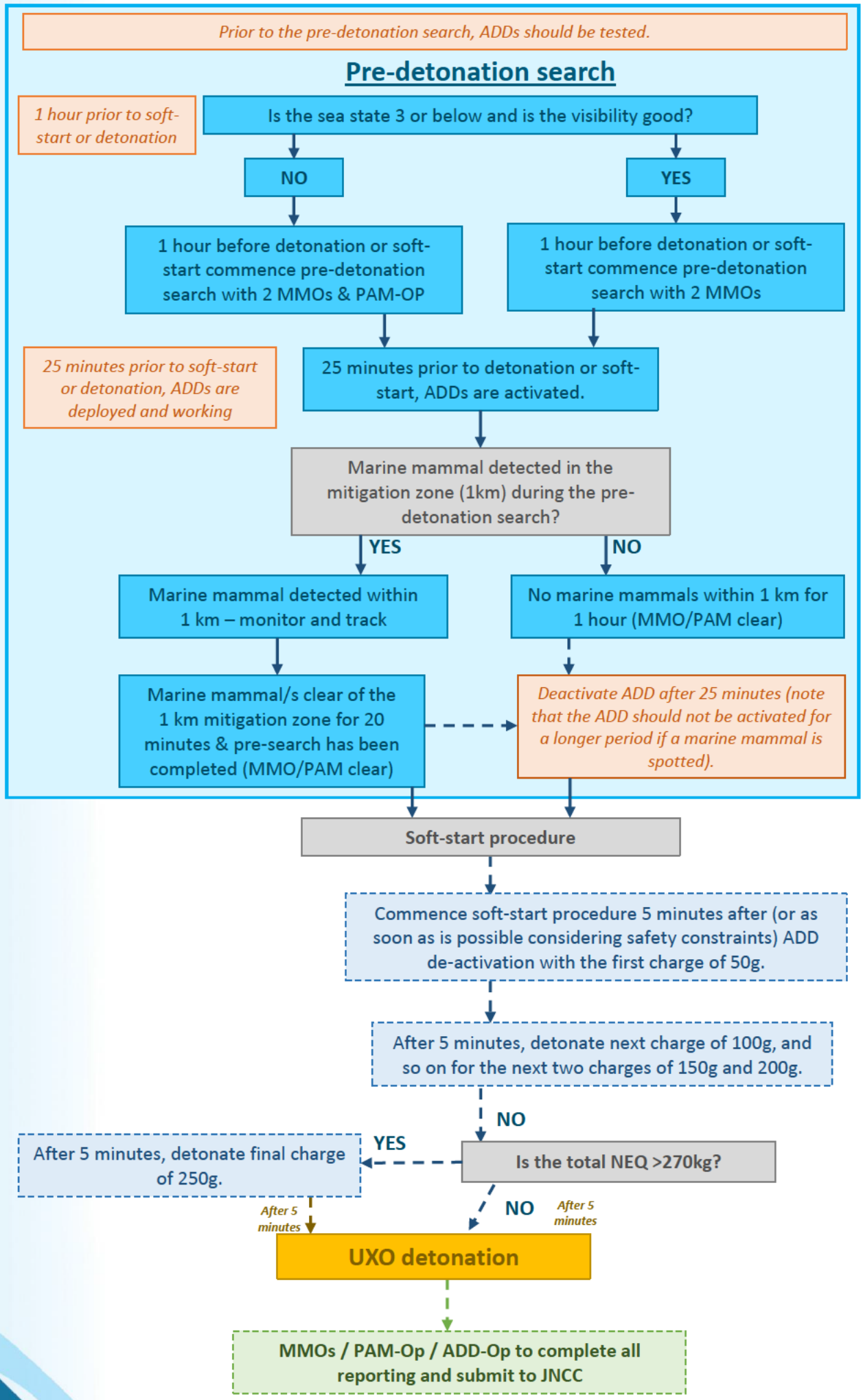
- Determining the best location for ADD deployment along with the operational manager, the rigger and an electrical supervisor, and ensuring the control unit and power supply are temporarily installed ready for deployment.
- Deploying the ADD over the side of the vessel, to a depth lower than the draft of the vessel, and testing the device is working using low sensitivity hydrophones ready for ADD activation 25 minutes prior to detonation. This can be done by the PAM-Op if present.
- Activate the ADD 25 minutes prior to the detonation event, during the pre-detonation search.
- Once the ADD has been activated for a period of 25 minutes, it should be recovered and routine checks on the device undertaken to ensure ready for the next deployment.

A.4.4 Explosive Ordnance Disposal Supervisor

The EOD Supervisor has the overall responsibility for the detonation operation, and to ensure that the soft-start charges are used, and will be based on the inspection vessel. The EOD Supervisor will be the main point of communication between the mitigation team (MMOs, PAM-Op (if present) and the ADD-Op) and the EOD support teams (who are responsible for carrying out the UXO clearance activities). The EOD Supervisor will be in control of initiating, delaying or pausing the detonation activities.

A.5 Outline Mitigation Procedure

The outline mitigation procedure (as outlined above) is summarised below in Plate A.2 below.


Prior to the pre-detonation search, ADDs should be tested.
Pre-detonation search
1 hour prior to soft-start or detonation
Is the sea state 3 or below and is the visibility good?
NO
YES
1 hour before detonation or soft-start commence pre-detonation search with 2 MMOs & PAM-OP
1 hour before detonation or soft-start commence pre-detonation search with 2 MMOs
25 minutes prior to soft-start or detonation, ADDs are deployed and working
25 minutes prior to detonation or soft-start, ADDs are activated.
Marine mammal detected in the mitigation zone (1km) during the pre-detonation search?
YES
NO
Marine mammal detected within 1 km – monitor and track
No marine mammals within 1 km for 1 hour (MMO/PAM clear)
Marine mammal/s clear of the 1 km mitigation zone for 20 minutes & pre-search has been completed (MMO/PAM clear)
Deactivate ADD after 25 minutes (note that the ADD should not be activated for a longer period if a marine mammal is spotted).
Soft-start procedure
Commence soft-start procedure 5 minutes after (or as soon as is possible considering safety constraints) ADD de-activation with the first charge of 50g.
After 5 minutes, detonate next charge of 100g, and so on for the next two charges of 150g and 200g.
NO
YES
After 5 minutes, detonate final charge of 250g.
Is the total NEQ >270kg?
NO
After 5 minutes
After 5 minutes
UXO detonation
MMOs / PAM-Op / ADD-Op to complete all reporting and submit to JNCC

MORAY EAST
OFFSHORE WINDFARM

Contact

Moray Offshore Windfarm (East) Limited
5th Floor, Atria One, 144 Morrison Street,
Edinburgh, EH3 8EX
Tel: +44 (0)131 556 7602