MARINE LICENCE CML2365

CONDITION 3.26: MARINE MAMMAL MANAGEMENT PLAN (MMMP)

Liverpool Bay CCS Project

Marine and Coastal Access Act 2009

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1. INTRODUCTION

1.1. PURPOSE

1.1.1. This document is the **Marine Mammal Management Plan (MMMP)** for the Liverpool Bay CCS Project and provides information to fulfil the requirements for the discharge of **Condition 3.26** of Marine Licence **CML2365**, which states the following:

- *3.26.1 The Licence Holder must submit a MMMP which shall be in accordance with Outline MMMP (CML2365-LBA CCS Ltd_OFFSHORE ES_Appendix S MMMP_NRW_FINAL) to the Licensing Authority for written approval at least 4 months prior to commencement of the Licensed Activities. No Licensed Activities may be undertaken prior to written approval from the Licensing Authority.*
- *3.26.2 The Licence Holder must ensure that any actions outlined in the documents detailed in condition 3.26.1 are implemented as approved in writing by the Licensing Authority. Any proposed changes to the actions outlined in the documents must be submitted to and approved in writing by the Licensing Authority prior to any changes being enacted.*

1.1.2. This MMMP provides a summary of findings as assessed in the Marine Biodiversity chapter of the Environmental Statement (Volume 2, Chapter 7), on the potentially injurious effects of underwater noise on marine mammals and marine turtles during pre-construction clearance of unexploded ordnance (UXO), geophysical and seismic surveys, and construction piling for the Liverpool Bay CCS Project. This MMMP was informed by the following sections of the Environmental Statement (ES):

- Volume 2, Chapter 7;
- Volume 3, Marine Biodiversity Technical Report (RPS Group, 2024) Appendix I; and
- Volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024 Appendix J.

1.2. STUDY AREA

1.2.1. Marine mammals and turtles are known for being highly mobile and covering large distances within their range of distribution. Therefore, two study areas have been defined:

- **the Liverpool Bay CCS Project marine mammal study area:** this is defined as the area encompassing the Eni Development Area, (including the offshore pipeline, and associated cables in Liverpool Bay) plus a buffer of 10 km (**Figure 1.1**); and
- **the regional marine mammal study area:** this is defined as the area encompassing the wider Irish Sea (**Figure 1.1**). This area has been informed by marine mammal Management Units (MUs) and will provide wider context for characterising the baseline.

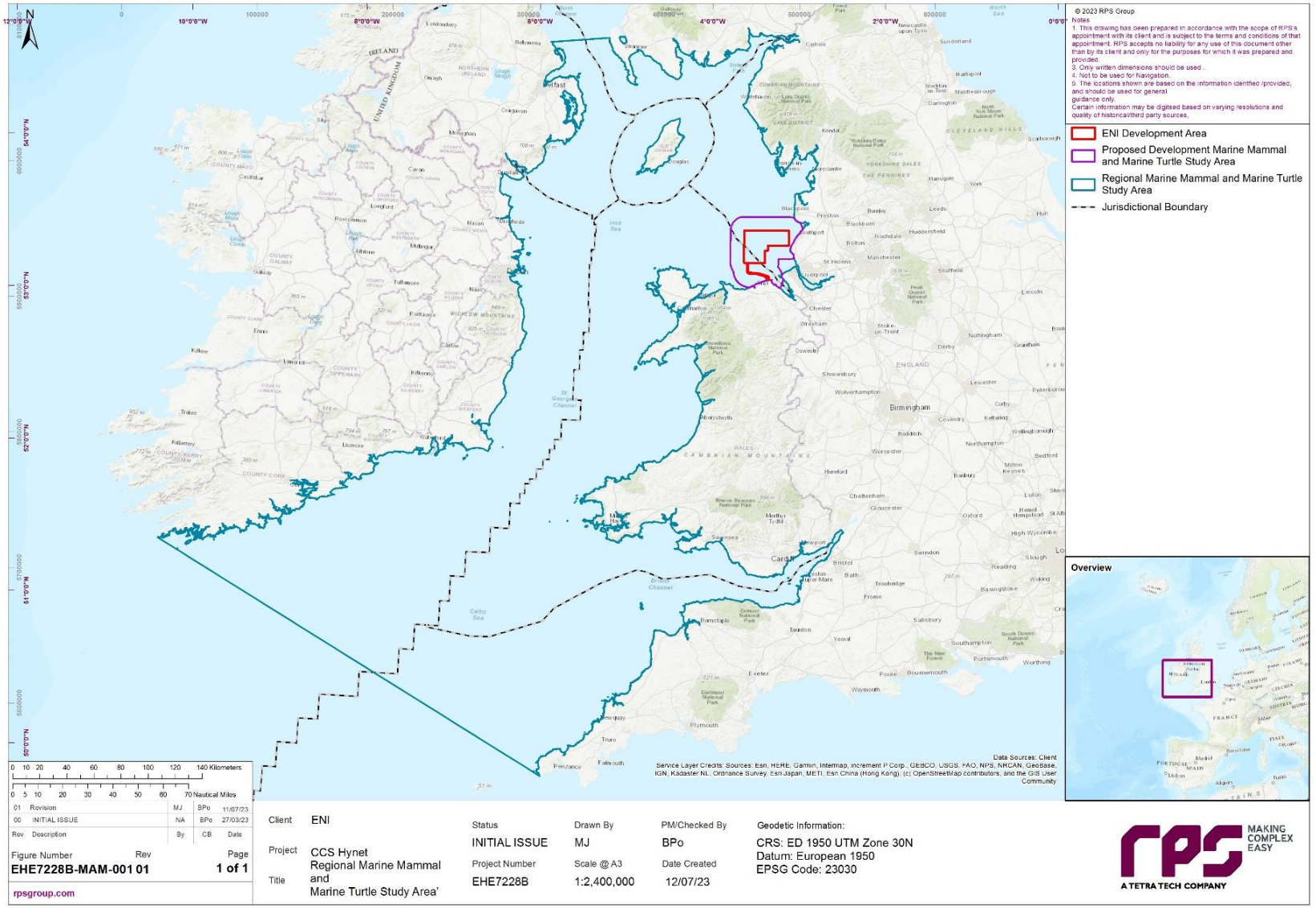

Figure 1.1: Location Of The Liverpool Bay CCS Project And Associated Marine Mammal Study Areas

1.3. SCOPE OF THE MMMP

1.3.1. This MMMP provides practical, contractor-ready procedures to minimise the risk of injury or disturbance to marine mammals during UXO clearance, piling activities, geophysical surveys and vessel operations. It ensures compliance with JNCC guidelines and all relevant marine licence conditions.

1.3.2. This plan applies to the following noise-generating activities:

- UXO clearance operations.
- Impact piling for jacket installation.
- Geophysical and seismic surveys.
- Construction and support vessel operations.

1.3.3. This plan applies mainly to piling operations during installation of the Douglas CCS jacket. It defines roles, mitigation tools, operational procedures and regulatory obligations. At this stage the project is not planning to undertake UXO clearance operations or seismic surveys. All geophysical surveys and supporting vessel activities will continue to be managed under the Marine Licence notification process submitted through the UK Energy Portal.

1.3.4. The purpose of this MMMP is to present how the potentially injurious effects of underwater noise resulting from UXO clearance, geophysical and seismic surveys and piling activity on marine mammals and marine turtles are to be mitigated during the pre-construction, construction and operation and maintenance phases of the Liverpool Bay CCS Project. Information presented in this MMMP is based on Offshore ES volume 2, chapter 7, which considers the potential impacts of the Liverpool Bay CCS Project seaward of MHWS during the construction, operation and maintenance, and decommissioning phases. Only those impacts with the potential to cause auditory injury and for which specific designed in measures have been proposed have been included in this MMMP.

1.3.5. The precautionary injury ranges for marine mammals established in the ES are based on the underwater noise modelling for the most sensitive species (see volume 3, Underwater Noise Technical Report (RPS Group and Seiche, 2024)appendix J), the parameters for which are based on the design parameters for the Liverpool Bay CCS Project. It should be noted that this MMMP will be updated and finalised pre construction following the refinement of the project design and refined marine mammal and marine turtle injury ranges, with mitigation measures updated based on these refined ranges. Any conditions of permission or updated guidelines or changes in industry best practice will also be included. The LBCCS Project design parameters informing the assessment of potential impacts on marine mammals and marine turtles because of underwater noise during UXO clearance, geophysical and seismic surveys and piling is presented in Table 1.1.

Table 1.1: Summary Of Liverpool Bay CCS Project Design Parameters Used For The Assessment Of Potential Impacts On Marine Mammals And Marine Turtles. Full Details Of All Activities Are Presented In Volume 2, Chapter 7

Potential impact	Phase[a]			Liverpool Bay CCS Project design parameters	Justification
	C	O	D		
Injury and disturbance from underwater noise generated from piling	✓	X	X	Construction phase New Douglas platform foundations: • up to 4 piled jacket foundations, with one leg per foundation and up to 2 x 1.524 m diameter piles per leg (8 piles); • maximum hammer energy up to 3,000 kJ; • up to 100 minutes piling per pile; and piling of up to two adjacent piles at the same platform at one time.	Impact piling during construction may result in hearing damage/auditory injury, behavioural disturbance/displacement of marine mammals and marine turtles as well as barrier affects. The largest hammer energy could lead to the largest area of ensonification at any one time. The longest duration of piling at any location results in the greatest number of days when piling could occur.
Injury and disturbance from underwater noise generated from UXO detonation	✓	X	X	Construction phase Clearance of UXOs within the Eni Development Area • maximum UXO size of up to 907 kg; • intention for low order clearance of all UXOs using low order techniques with a single donor charge of up to 80 g NEQ for each clearance event; • up to 500 g NEQ clearance shot for neutralisation of residual explosive material at each location; • risk of potential for unintended consequence of low order techniques to result in high order detonation of UXO (maximum size = 907 kg); • up to 6 detonations within 24 hours; • total duration of clearance activities up to 12 days, assuming a potential for six charges taking two days each; and • clearance during daylight hours only.	Marine mammals and marine turtles are sensitive to increased subsea noise generated during UXO clearance, which can lead to auditory injury, behavioural disturbance as well as barrier effects. UXO Donor charge is maximum required to initiate low order detonation. Assumption of a clearance shot of up to 500 g NEQ at all locations although noting that this may not always be required.
Injury and disturbance from underwater noise generated during geophysical and seismic surveys	✓	✓	X	Construction phase Site investigation surveys will involve the use of up to two survey vessels and take place over a period of up to six months. • MBES (170 to 450 kHz; 220 dB re 1 µPa (Root Mean Squared (rms); pulse rate up to 60 Hz). • SBP (85 to 115 kHz, 247 dB re 1µPa (rms), pulse rate up to 40 Hz). • VSP: - Number of guns= 6; - Total volume= 1,200 cu in; - Source depth = 5 m; - Firing pressure = 2,000 psi; - SEL = 220 dB re 1 µPa2s @1m;	• Geophysical and seismic surveys have the potential to cause direct and/or indirect effects (including injury or disturbance) on marine mammals and marine turtles as well as barrier effects. • Maximum range of geophysical and seismic surveys likely to be undertaken using equipment typically employed for these types of surveys will result in the greatest potential impact.

Potential impact	Phase[a]			Liverpool Bay CCS Project design parameters	Justification
	C	O	D		
				- 0-Peak SPL = 238 dB re. 1 µPa @ 1m; - Pulse interval = 20 s (during operations); and - Total number of pulses per 24 h period = 4,320 (three per minute). **Operation and maintenance phase** Annual geophysical and seismic survey are estimated to occur over a fleet of two vessels.	
Injury and disturbance from vessel activity and other noise producing activities	✓	✓	✓	**Construction phase** There will be a total of 236 round trips of vessels associated with the construction phase. This includes a total of 219 round trips of vessels associated with installation of the new Douglas platform and wells and a total of 17 round trips of vessels associated with installation of the cables. Other activities include: • laying of 126.04 km of the cable (including 815 m within the intertidal zone); • drilling of 11 wells for CO_2 injection; total duration of drilling per well is 15 days; and • use of jack up rigs **Operation and Maintenance Phase** There will be a total of 750 vessel round trips over the entire operation and maintenance phase. This encompasses vessels used during routine inspections, geophysical surveys, removal of marine growth, replacement of corrosion protection anodes, replacement of access ladders and boat landings, modification to/replacement of J tubes at platforms, topsides, inter platform cables/pipelines and PoA terminal to the new Douglas platform cables/pipelines. **Decommissioning Phase** A total of 128 round trips of vessels associated with the decommissioning phase Other activities include removal of infrastructure within the Eni Development Area.	Injury and disturbance of marine mammals and marine turtles may arise during the construction, operation and maintenance and decommissioning phases of the Liverpool Bay CCS Project from vessel use and other noise producing activities (e.g. seabed preparation, drilling, and rock placement over the cable crossings). Underwater noise from vessels and other activities may also result in barrier effects. Maximum numbers of vessels on site at any one time and largest numbers of round trips during each phase of the Liverpool Bay CCS Project and broad range of vessel types, representative of vessels to be used during construction, operation and maintenance and decommissioning will result in the greatest potential impact. Range of other activities including maximum timescales (where available) during which activities are conducted.
Injury to marine mammals from collision risk with marine vessels	✓	✓	✓	**All phases** The MDS for this impact is as described in 'Injury and disturbance from vessel activity and other noise producing activities'.	An increase in vessel activity during construction, operation and maintenance and decommissioning phases of the Liverpool Bay CCS Project, may result in increased vessel collisions with marine mammals and marine turtles.

Potential impact	Phase[a]			Liverpool Bay CCS Project design parameters	Justification
	C	O	D		
					Maximum numbers of vessels on site at any one time and largest numbers of round trips during each phase of the Liverpool Bay CCS Project and broad range of vessel types, representative of vessels to be used during construction, operation and maintenance and decommissioning will result in the greatest potential impact.

1.3.6. In addition to measures included in the Liverpool Bay CCS Project (designed in and management measures (controls) and mitigation proposed to reduce the injurious impacts on marine mammals associated with piling and geophysical surveying, a range of procedures will be applied to reduce other environmental impacts of the Liverpool Bay CCS Project, including development and adherence to a Construction Environmental Management Plan (CEMP), which are summarised in Table 1.2.

Table 1.2: Management Plans Developed To Reduce Environmental Impacts

Consents Management Plan	Relevance to MMMP
Construction Environmental Management Plan (CEMP) CML2365 Condition 3.25	The EMP provides the overarching framework for environmental management during the construction and operation and maintenance phases of the Liverpool Bay CCS Project. The EMP also sets out the monitoring activities to be completed for the Liverpool Bay CCS Project, as proposed in the Environmental Statement, including proposed methodologies.
Cable Specification and Installation Plan (CSIP) CML2365 Condition 3.19	Cable burial minimum of 2.0m will help to reduce the amount of Electromagnetic Field (EMF) which *marine* mammal and megafa*una (and fish and shellfish) receptors* are exposed to during the operations and maintenance phase by increasing the distance between the seabed surface and the surface of the cables. It should be noted, unlike the AC export cables from offshore wind farms, the Applicant's cables for the TCPA Proposed Development are DC, so there will be no detectible electric fields external to the metallic sheath. However, the cable will generate static magnetic fields, which will not be screened by the metallic sheath. At the seabed (i.e. 1.0m above the cable) the magnetic field will be ~0.1uT, and at 0.5 m above the cable (i.e. 0.5m below the seabed) ~1.2uT. These are extremely low values, and these values are much lower than any of those cited from the published literature on the matter where effects may occur on marine life, for example CMACS (2003) and Gill et. al (2009).
Vessel Management Plan (VMP) CML2365 Condition 3.27	Ensures project vessels are suitably managed to minimise the likelihood of involvement in incidents and maximise the ability to assist in the event of a third-party incident.
Decommissioning Plan	Will ensure that the infrastructure associated with the Liverpool Bay CCS Project will result in the minimum amount of long term disturbance to the environment.

1.3.7. This MMMP has been prepared in accordance with the following guidance, and it is considered that compliance with these will reduce the risk of injury to marine mammals to negligible levels:

- Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010a);
- JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (JNCC, 2017); and
- JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC, 2010b)

1.4. TARGET SPECIES

1.4.1. Marine mammals and marine turtle species were characterised based on their abundance and densities at a local scale (Liverpool Bay CCS Project marine mammal study area) and regional scale (regional marine mammal study area), via thorough review of key desktop datasets and reports as detailed in volume 2, chapter 7 and volume 3, appendix I Marine Biodiversity Technical Report (RPS Group, 2024) of the ES. There were no site specific marine mammal surveys conducted for the Eni Development Area, so the results of site specific surveys undertaken for Offshore Wind Farms (OWF) near the Eni Development Area have been utilised. These include Gwynt y Môr OWF and Awel y Môr OWF.

CETACEANS

1.4.2. Five cetacean species likely to be present and/or occur regularly within the regional marine mammal study area:

- Bottlenose dolphin (Tursiops truncatus);
- Harbour porpoise (Phocoena phocoena);
- Minke whale (Balaenoptera acutorostrata);
- Risso's dolphin (Grampus griseus); and
- Short beaked common dolphin (hereafter: 'common dolphin'; Delphinus delphus).

1.4.3. As described in Section 1.2, the regional marine mammal study area was informed by species MUs and the most recent abundance estimates for each cetacean species are provided by the Inter-Agency Marine Mammal Working Group (IAMMWG, 2022), presented in Table 1.3. Further detail on the ecology, abundance, and densities of these five cetacean species is provided in Volume 3, Appendix I Marine Biodiversity Technical Report (RPS Group, 2024).

Table 1.3: Cetacean Abundance Estimates And Measures Of Uncertainty Within Respective MUs (Rogan et al., 2018; Hammond et al., 2021; IAMMWG, 2022)

Species	Management Unit (MU)	Abundance of animals in MU	95% Confidence Interval
Harbour porpoise	Celtic and Irish Sea	62,517 (CV = 0.13)	48,324 – 80,877
Bottlenose dolphin	Irish Sea	293 (CV = 0.54)	108 – 793

Species	Management Unit (MU)	Abundance of animals in MU	95% Confidence Interval
	Offshore Channel, Celtic Sea and South West England	10,947 (CV = 0.25)	6,727 – 17,814
Common dolphin	Celtic and Greater North Seas	102,656 (CV = 0.29)	58,932 – 178,822
Risso's dolphin		12,262 (CV = 0.46)	5,227 – 28,764
Minke whale		20,118 (CV = 0.18)	14,061 – 28,786

PINNIPEDS

1.4.4. Two pinniped species are considered likely to be present and/or occur regularly within the regional marine mammal study area: grey seal (Halichoerus grypus), and harbour seal (Phoca vitulina). As for cetaceans, the regional marine mammal study area has been informed by species MUs, of which five partially or fully coincide with the regional marine mammal study area: the Northern Ireland MU, Southwest (SW) Scotland MU, Northwest (NW) England MU, Wales MU and SW England MU.

1.4.5. The most recent abundance estimates for each pinniped species' respective MU are provided by the Special Committee on Seals (SCOS) and are presented in Table 1.4 Grey seal population estimates are unavailable for the NW England MU, Wales MU and SW England MU, and harbour seal population estimates should be regarded as rough estimates only. Further detail on the ecology, abundance, and densities of grey seal and harbour seal is provided in Volume 3, Appendix I Marine Biodiversity Technical Report (RPS Group, 2024).

Table 1.4: August Haul Out Counts And Population Estimates Of Grey Seal And Harbour Seal In Respective Mus (SCOS, 2020, 2021)

Management Unit (MU)	Grey Seal		Harbour Seal	
	August Haul Out Count	Population Estimate	August Haul Out Count	Population Estimate
Northern Ireland	505	2,113	1,012	1,405
SW Scotland	517	2,163	1,709	2,373
NW England	250	-	5	6
Wales	900	-	10	13
SW England	500	-	0	0

MARINE TURTLES

1.4.6. Six species of marine turtle have been documented within UK and Irish waters (Botterell et al., 2020):

- Green turtle (Chelonia mydas);
- Hawksbill turtle (Eretmochelys imbricata);
- Kemp's ridley turtle (Lepidochelys kempii);
- Leatherback turtle (Dermochelys coriacea);
- Loggerhead turtle (Caretta caretta); and
- Olive ridley turtle (L. Olivacea).

1.4.7. Due to the relative paucity of information surrounding the ecology, distribution, and abundance of these six species within UK and Irish waters in comparison to that available for marine mammals, they have been grouped together as 'marine turtles' for the purposes of this assessment.

1.4.8. There are no MUs available for marine turtles in UK and Irish waters, with most of the information surrounding their abundance, seasonality, and distribution coming from records of sightings and strandings. These data have been recorded since 1748, and are reported annually by Marine Environmental Monitoring, most recently for 2021 (Penrose et al., 2022). Overall, a total of 2,882 marine turtles have been recorded throughout this 273 year dataset, with the majority attributed to leatherback turtle (n = 2,172), followed by unidentified species (n = 394), loggerhead turtle (n = 268), Kemp's ridley turtle (n = 76), green turtle (n = 15), hawksbill turtle (n = 1), and olive ridley turtle (n = 1) (Penrose et al., 2022). Of these 2,882 records, the majority have been recorded in the Republic of Ireland (Table 1.5).

Table 1.5: Number Of Sightings And Strandings Of All Marine Turtles Between 1748 And 2021 By Country (Penrose Et Al., 2022)

Country	Number of Sightings and Strandings of all Marine Turtle Species	
	2021	1748 to 2021
Republic of Ireland	6	1,358
England	7	699
Scotland	11	425
Wales	5	292
Northern Ireland	0	41
Isle of Man	1	37
Channel Islands	0	17
Offshore waters	0	13
Total	30	2,882

1.5. DESIGNED IN MANAGEMENT MEASURES.

1.5.1. In addition to the MMMP the LBCCS project will implement the following mitigation measures presented in Table 1.6.

Table 1.6: Measures Adopted As Part Of The Liverpool Bay CCS Project,

Measures included in the Liverpool Bay CCS Project	Justification
Development of and adherence to Construction Environmental Management Plans (CEMPs) that have and will continue to be prepared covering and implemented during the construction, operation and maintenance, and decommissioning phases of the Liverpool Bay CCS Project. The CEMPs include appendices detailing actions to minimise INNS (the INNSMP), and a Marine Protection Contingency Plan (MPCP) will be developed which include planning for accidental spills, addressing all potential	Measures are being adopted to ensure that the potential for release of pollutants from construction, operation and maintenance, and decommissioning plant is minimised. These include designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes and takes containing hazardous substances, and storage of these substances in impenetrable bunds. All vessels are required to comply with the standards set out in the

Measures included in the Liverpool Bay CCS Project	Justification
contaminant releases and include key emergency contact details.	International Convention for the Prevention of Pollution from Ships (MARPOL).
Implementation of piling initiation, soft start, and ramp up measures within the Marine Mammal Management Plan (MMMP). An initiation stage and soft starts will be used during the installation of pin piles. This involves the implementation of an initial low hammer energy with a low number of strikes, followed by lower hammer energies at a higher strike rate at the beginning of the piling sequence before energy input is 'ramped up' (increased) over time to required higher levels.	This measure will minimise the risk of injury to some fish, marine mammal, and marine turtle species in the immediate vicinity of piling activities, allowing individuals to move away from the area before noise levels reach a level at which injury may occur.
Development and adherence to the Cable Specification and Installation Plan (CSIP) which includes cable burial where possible (in accordance with the specific policies set out in the North West Inshore and North West Offshore Coast Marine Plans (MMO, 2021)) and cable protection, as necessary (Condition 3.19 CML2365)	The CSIP sets out the cable burial depth (min 2.0m) in accordance with industry good practice, minimising the risk of cable exposure. The CSIP ensures that cable crossings are appropriately designed to mitigate environmental effects, these crossings have been agreed with relevant parties in advance of CSIP submission. The CSIP includes detailed Cable Burial Risk Assessments (CBRAs) to enable informed judgements regarding burial depth to maximise the chance of cables remaining buried whilst limiting the amount of sediment disturbance to that which is necessary. Burial measures reduce the amount of EMF which benthic and fish and shellfish receptors are exposed to during the operations and maintenance phase by increasing the distance between the seabed surface and the surface of the cables.
A VMP has been developed which determines vessel routing to and from construction areas and ports to avoid areas of high risk to marine mammals (Condition 3.27 & 3.29 covering Vessel management Plan and navigation safety Plan – CML2365).	The VMP has been issued to all vessel operators, requiring them to: • not deliberately approach marine mammals, marine turtles, and basking sharks; • keep vessel speed to a minimum; and • avoid abrupt changes in course or speed should marine mammals approach the vessel to bow ride.
Inclusion of low order techniques as a UXO clearance option noting, however, that it is not possible to fully commit to this measure at this stage. Low order techniques are not always possible and are dependent upon the individual situations surrounding each UXO. Given that high order detonation may be required, the MMMP will also include mitigation to reduce the risk of injury from UXO clearance.	At this stage the project is **not** planning to undertake UXO clearance operations. However, low order techniques generate less underwater noise than high order techniques and therefore present a lower risk to sound sensitive receptors such as fish, marine mammals, and marine turtles during UXO clearance.
Geophysical surveys undertaken during the operational and maintenance phase will adopt similar measures as for piling operations, including the implementation of an approved MMMP and Vessel Code of Conduct. Measures include the use of a mitigation zone around operations, within which Marine Mammal Observer (MMObs) and Passive Acoustic Monitoring (PAM) will ensure that no marine	The implementation of an approved MMMP will mitigate for the risk of physical or permanent auditory injury to marine mammals within a 500 m radial mitigation zone as determined by JNCC guidance (JNCC, 2017). The soft-start will use a lower-energy output, increasing over a 20-minute period to the maximum data-acquisition energy output to provide an audible cue to allow marine

Measures included in the Liverpool Bay CCS Project	Justification
megafauna are present in the vicinity of the geophysical survey vessel, and the use of a soft start to survey operation, where possible	mammals and megafauna to flee the area before geophysical surveying commences. These activities will continue to be managed under the Marine Licence notification process submitted through the UK Energy Portal when they are carried out in the future
Development of, and adherence to, a Decommissioning Plan	The aim of this plan is to adhere to the relevant UK and international legislation and guidance in place at the time, with decommissioning industry practice applied to reduce the amount of long-term disturbance to the environment so far as reasonably practicable.

1.6. SUMMARY OF VOLUME 2, CHAPTER 7 (MARINE MAMMALS AND MARINE TURTLES)

1.6.1. Auditory injury in marine mammals can occur as either a Permanent Threshold Shift (PTS), where there is no hearing recovery, or as a Temporary Threshold Shift (TTS), where recovery from tissue damage is possible. The most likely response of an animal exposed to noise levels that could induce TTS or impairment is, however, to flee the ensonified area. It is therefore considered that the behavioural response (disturbance) can overlap with potential injury ranges, and animals exposed to noise levels with the potential to induce TTS or impairment are likely to simply move away from the area.

1.6.2. Sound propagation models can be constructed to allow the received noise level at different distances from the source to be calculated. To determine the consequence of these received levels on any marine mammals which might experience such noise emissions, it is necessary to relate the levels to known or estimated impact thresholds. The injury criteria proposed by Southall et al. (2019) are based on a combination of linear (i.e. un-weighted) peak pressure levels and mammal hearing weighted sound exposure levels (SEL). The hearing weighting function is designed to represent the bandwidth for each group within which acoustic exposures can have auditory effects. The categories include:

- Low Frequency (LF) cetaceans: marine mammal species such as minke whale;
- High Frequency (HF) cetaceans: marine mammal species such as bottlenose dolphin, common dolphin, Risso's dolphin;
- Very High Frequency (VHF) cetaceans: marine mammal species such as harbour porpoise, generally with auditory centre frequencies above 100 kHz); and
- Phocid Carnivores in Water (PCW): marine mammal species such as grey seal and harbour seal.

1.6.3. In basking sharks and sea turtles, injury is assessed as 'mortality and potential mortal injury' (immediate or delayed death) or 'impairment' (recoverable injury) (Popper et al., 2014). This dual criteria approach was used to assess the potential for PTS and TTS in marine mammals and 'mortality and mortal injury' and 'impairment' in basking shark and sea turtles.

1.6.4. Where insufficient data exist to determine a quantitative guideline value, the risk is categorised in relative terms as "high", "moderate" or "low" at three distances from the

source: “near” (i.e. in the tens of metres), “intermediate” (i.e. in the hundreds of metres) or “far” (i.e. in the thousands of metres). These qualitative criteria cannot differentiate between exposures to different noise levels and therefore all sources of noise would be assumed to elicit the same response (Popper et al., 2014).

1.6.5. Injury criteria were modelled based on two different types of underwater noise:

- Impulsive sound: which are typically transient, brief (less than 1 s), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay ((ANSI, 1986, 2005; NIOSH, 1998). This category includes sound sources such as seismic surveys, impact piling and underwater explosions.
- Non impulsive sound: which can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent and typically do not have a high peak sound pressure with rapid rise/decay time that impulsive sounds do (ANSI 1995; NIOSH 1998). This category includes sound sources such as continuous, drilling, sonar (including that used in geophysical surveying) and vessels.

Table 1.7: Summary Of PTS And TTS Onset Thresholds For Marine Mammals, Based On Southall et el., 2019. Values for SPL_{pk} are expressed as dB re 1 µpa, and those for SEL_{cum} are expressed as dB re 1 µpa2s

Hearing Group	Parameter	PTS Onset Threshold		TTS Onset Threshold	
		Impulsive	Non impulsive	Impulsive	Non impulsive
LF	SPL_{pk}, unweighted	219	-	213	-
	SEL_{cum}, LF weighted	183	199	168	179
HF	SPL_{pk}, unweighted	230	-	224	-
	SEL_{cum}, HF weighted	185	198	170	178
VHF	SPL_{pk}, unweighted	202	-	196	-
	SEL_{cum}, VHF weighted	155	173	140	153
PCW	SPL_{pk}, unweighted	218	-	212	-
	SEL_{cum}, PCW weighted	185	201	170	181

PILING

1.6.6. Piling during the construction phase of the Liverpool Bay CCS Project has the potential to result in elevated levels of underwater noise that are detectable by marine mammals and megafauna above background levels, and which could result in injurious or behavioural effects on Important Ecological Features (IEFs). A detailed underwater noise modelling assessment has been carried out to investigate the potential for injurious and behavioural effects on marine mammal, fish and sea turtle IEFs because of impulsive sounds from piling (Volume 3, Appendix J Underwater Noise Technical Report (RPS Group and Seiche, 2024)). The results of this modelling were drawn upon to inform the impact assessment presented in Volume 2, Chapter 7.

1.6.7. Injury from PTS and disturbance from TTS were investigated with respect to two metrics over the entire piling sequence from hammer initiation to maximum hammer energy (3,000 kJ) based on up to one pile being installed within a 24 hour period (see Liverpool Bay CCS Project design parameters in Table 1.1). Peak Sound Pressure Level (SPL_{pk}) was used to determine ranges for instantaneous injury at the highest point over the piling

sequence whilst cumulative Sound Exposure Level (SEL_{cum}) was modelled to estimate the injury range from cumulative exposure as an animal flees the area. The SEL_{cum} metric can lead to overestimates in effect ranges which means that subsea noise modelling results in a precautionary assessment due to the conservative assumptions adopted, namely:

- maximum hammer energy (3,000 kJ) would be reached at all locations;
- underwater noise would remain impulsive at all distances, and not transition to a non-impulsive character;
- the soft start procedure does not include short pauses in piling which would reduce the noise exposure that fleeing animals experience;
- animals would swim away from the noise source at the onset of activity at a constant rate and in a straight line; and
- time spent at the surface, where sound levels are reduced, was not considered.

1.6.8. Injury ranges from underwater noise modelling for impact piling are summarised in Table 1.8 and Table 1.9. For all species except LF cetaceans, injury (PTS) ranges based on the SPL_{pk} metric were greater (Table 1.8), with the greatest distance being 490 m for VHF cetaceans (e.g. harbour porpoise), compared with 20 m for SEL_{cum}. For LF cetaceans (which includes minke whale), injury ranges based on the SEL_{cum} metric were greater, at distances up to 1,000 m (compared with 180 m for SPL_{pk}). However, this assumes that Acoustic Deterrent Devices (ADD) would not be deployed, and the use of ADD would be expected to deter marine mammals and marine turtles to distances sufficient to avoid injury. Disturbance ranges (TTS) were also greater for SEL_{cum} across species, except for HF cetaceans (such as bottlenose dolphin). For these species disturbance may be experienced out to 69 m at maximum hammer energy (SPL_{pk}) compared to the SEL_{cum} threshold of 170 dB re 1 µPa2s not being exceeded.

Table 1.8: Auditory Injury Ranges Based On The SEL_{cum} Metric For Marine Mammals Due To Impact Piling Of The Platform Jackets, With And Without The Use Of An ADD (N/E = Threshold Not Exceeded)

Hearing Group	Threshold (Weighted SEL)	Range (m)	
		Without ADD	With 30 mins ADD
LF	PTS – 183 dB re 1 µPa²s	1,000	N/E
	TTS – 168 dB re 1 µPa²s	35,300	31,400
HF	PTS – 185 dB re 1 µPa²s	N/E	N/E
	TTS – 170 dB re 1 µPa²s	N/E	N/E
VHF	PTS – 155 dB re 1 µPa²s	20	N/E
	TTS – 140 dB re 1 µPa²s	8,660	5,960
PCW	PTS – 185 dB re 1 µPa²s	N/E	N/E
	TTS – 170 dB re 1 µPa²s	3,710	585
Marine turtles	Mortality – 210 dB re 1 µPa²s	N/E	N/E

Table 1.9: Summary Of Peak Pressure (SPL_{pk}) Injury Ranges For Marine Mammals And Marine Turtles Due To The Phase Of Impact Piling At Maximum Hammer Energy, And At The First Hammer Strike

Hearing Group	Threshold (Unweighted Peak)	Range (m)	
		Max Hammer Energy	First Hammer Strike
LF	PTS – 219 dB re 1 µPa (pk)	180	45
	TTS – 213 dB re 1 µPa (pk)	184	77
HF	PTS – 230 dB re 1 µPa (pk)	41	17
	TTS – 224 dB re 1 µPa (pk)	69	29
VHF	PTS – 202 dB re 1 µPa (pk)	490	204
	TTS – 196 dB re 1 µPa (pk)	836	349
PCW	PTS – 218 dB re 1 µPa (pk)	118	49
	TTS – 212 dB re 1 µPa (pk)	201	84
Marine turtles	Mortality – 207 dB re 1 µPa (pk)	314	131

1.6.9. There is a possibility that multiple pin piles will need to be installed in a single 24 hour period, in which case the potential SEL_{cum} injury ranges may be greater than those for single piles, due to the longer period of piling. The results for the consecutive piling are shown in Table 1.10. The PTS threshold was not exceeded for any marine mammal hearing group after 30 minutes of ADD activation. The highest TTS threshold after 30 minutes of ADD activation was 42,800 m for the LF hearing group (minke whale). For marine turtles, the SEL_{cum} threshold for mortality due to consecutive piling was the same for the single pile scenario described above and was not exceeded.

Table 1.10: Marine Mammal And Marine Turtle Injury Ranges For Consecutive Pin Pile Installation Based On The SEL_{cum} Metric (N/E = Threshold Not Exceeded)

Hearing Group	Threshold (Weighted SEL)	Range (m)	
		Without ADD	With 30 min ADD
LF	PTS – 183 dB re 1 μPa^2s	1,905	N/E
	TTS – 168 dB re 1 μPa^2s	46,900	42,800
HF	PTS – 185 dB re 1 μPa^2s	N/E	N/E
	TTS – 170 dB re 1 μPa^2s	N/E	N/E
VHF	PTS – 155 dB re 1 μPa^2s	22	N/E
	TTS – 140 dB re 1 μPa^2s	11,700	8,960
PCW	PTS – 185 dB re 1 μPa^2s	N/E	N/E
	TTS – 170 dB re 1 μPa^2s	6,280	3,050
Marine turtles	Mortality – 210 dB re 1 μPa^2s	N/E	N/E

1.6.10. Overall, underwater noise modelling indicated that the embedded mitigation measure of 30 minutes of ADD activation would result in no PTS injury thresholds being exceeded.

1.6.11. Although the underwater noise modelling in the Environmental Statement (ES) assessed worst case underwater noise impacts based on a conservative maximum hammer energy

of 3,000 kJ as indicated above, the actual piling works for the Liverpool Bay CCS Project will be undertaken using hydraulic hammers with substantially lower output. The hammers selected for installation, the MHU 2100 and MHU 1700, have rated energies of 2,100 kJ and 1,700 kJ, respectively, and deliver resulting energies in the pile of 1,810 kJ and 1,465 kJ once wave equation efficiency is applied.

1.6.12. As a result, the real underwater noise emissions during construction will be significantly lower than those modelled. This ensures that the ES predicted PTS/TTS injury and disturbance ranges (Tables 1.8–1.10) are precautionary and that actual piling operations remain comfortably within the assessed impact envelope.

1.6.13. This alignment confirms that the embedded mitigation, particularly the 30 minute pre-piling ADD activation, will continue to achieve the outcomes predicted by the modelling and will maintain compliance with the noise impact scenarios authorised in the Marine Licence. The clarification also demonstrates that installation practice is directly linked to, and more conservative than, the ES assumptions.

1.6.14. Prior to commencement of hammer start-up, during piling of the new Douglas CCS jacket, it will be confirmed that no marine mammals are in the vicinity of the piling location. Next to the Marine Mammal Observer (MMO) on board, a Passive Acoustic Monitoring (PAM) system will be deployed from the installation vessel with a coverage extending 500 m from the installation site

1.6.15. An Acoustic Deterrence Device (ADD), like the Lofitech AS Seal Scarer will be mobilised and will be utilised before the start of piledriving as well.

1.6.16. The pile driving will commence with a “soft start”; pile driving will start at minimum energy level and in short single blows. Continuous hammering with increased energy will commence when sufficient resistance has been observed and a minimum duration has passed.

1.6.17. The VMP will be issued to all vessel operators, requiring them to:

- not deliberately approach marine mammals, marine turtles, and basking sharks; and
- keep vessel speed to a minimum; and avoid abrupt changes in course or speed should marine mammals approach the vessel to bow ride

GEOPHYSICAL/SEISMIC SURVEYING

1.6.18. Geophysical and seismic site investigation surveys during the construction and operation and maintenance phases have the potential to cause direct or indirect effects (including injury or disturbance). A detailed underwater noise modelling assessment has been carried out to investigate the potential for injurious and behavioural effects because of these surveys, using the latest criteria (Volume 3, Appendix J Underwater Noise Technical Report (RPS Group and Seiche, 2024)).

1.6.19. Sonar based survey types will be used for the geophysical surveys to be conducted within the Eni Development Area, including multi beam echo sounder (MBES) and sub bottom profiler (SBP) methods. The equipment likely to be used can typically work at a range of signal frequencies, depending on the distance to the sea floor and the required resolution. The signal is highly directional, acting like a beam, and is emitted in pulses. Sonar based sources are considered as continuous (non-impulsive) because they generally

compromise a single (or multiple discrete) frequency as opposed to a broadband signal with high kurtosis, high peak pressures and rapid rise times. Seismic site investigation surveys will be conducted using vertical seismic profile (VSP) methods. The modelling results for MBES and SBP activities are presented in Table 1.11, and modelling results for VSP are presented in Table 1.12. Qualitative estimates of injury thresholds for marine turtles are presented in Table 1.13.

Table 1.11: Potential Impact Ranges For Marine Mammals During The Geophysical Surveys Based On Comparison To Southall Et Al. (2019) SEL_{cum} Thresholds For Non Impulsive Sound

Survey type	Hearing group	Range (m)	
		PTS	TTS
MBES	LF	N/E	40
	HF	105	290
	VHF	345	485
	PCW	5	80
SBP	LF	45	50
	HF	50	260
	VHF	335	655
	PCW	40	50

Table 1.12: Potential Impact Ranges For Marine Mammals During VSP Data Acquisition Based On Comparison To Southall Et Al. (2019) SEL_{cum} And SPL_{pk} Thresholds (N/E = Threshold Not Exceeded)

Species Group	Threshold (Weighted SEL)	Range (m)	
		SEL_{cum}	SPL_{pl}
LF	PTS – 183 dB re 1 μPa^2s	444	13
	TTS – 168 dB re 1 μPa^2s	2,941	38
HF	PTS – 185 dB re 1 μPa^2s	N/E	N/E
	TTS – 170 dB re 1 μPa^2s	4	6
VHF	PTS – 155 dB re 1 μPa^2s	235	124
	TTS – 140 dB re 1 μPa^2s	1,138	225
PCW	PTS – 185 dB re 1 μPa^2s	11	16
	TTS – 170 dB re 1 μPa^2s	38	44

Table 1.13: Thresholds And Relative Risk For Onset Of Injury To Sea Turtles Due To Non Impulsive And Impulsive Sound (Popper Et Al., 2014). Results For Impulsive Sound Are Based Upon Impact Piling, And Have Been Selected As More Precautionary Than Those For UXO Clearance

Sound type	Parameter	Mortality and Potential Mortal Injury	Recoverable Injury	TTS
Non impulsive (e.g. MBES, SBP)	n/a	(Near) Low (Intermediate) Low (Far) Low	(Near) Low (Intermediate) Low (Far) Low	(Near) Moderate (Intermediate) Low (Far) Low
Impulsive (e.g. VSP)	SEL, dB re 1 μPa^2s	>210	(Near) High (Intermediate) Low (Far) Low	(Near) High (Intermediate) Low (Far) Low
	Peak, dB re 1 µPa	>207		

UXO CLEARANCE

1.6.20. UXO clearance prior to the construction of the Liverpool Bay CCS Project may result in detonation (high order) of a UXO. This activity has the potential to generate some of the highest peak sound pressures of all anthropogenic underwater noise sources (von Benda-Beckman et al., 2015), and are considered a high energy, impulsive sound source. The potential effects of UXO clearance will depend on sound source characteristics, the receptor species, distance from the sound source, and sound attenuation within the environment.

1.6.21. For UXO detonation, underwater noise modelling was undertaken following the methodology described in Soloway and Dahl (2014), which provides a simple relationship between distance from an explosion and the weight of the charge but does not account for bottom topography or sediment characteristics. Since the charge is assumed to be freely standing in mid water, unlike a UXO which would be resting on the seabed and could potentially be buried, degraded or subject to other significant attenuation, this estimation of the source level can be considered conservative.

1.6.22. Potential PTS ranges estimated from underwater noise modelling presented in Volume 3, Appendix J Underwater Noise Technical Report (RPS Group and Seiche, 2024) are summarised in Table 1.14, Table 1.15 and Table 1.16, and injury criteria for marine turtles are summarised in Table 1.17.

Table 1.14: Potential PTS and TTS Ranges For Low Order And Low Yield UXO Clearance Activities

Charge Size (kg)	Hearing Group	PTS Range (m)		TTS Range (m)	
		SPL_{pk}	SEL_{cum}	SPL_{pk}	SEL_{cum}
0.08 kg low order donor charge	LF	122	47	224	655
	HF	40	2	73	23
	VHF	685	190	1,265	1,500
	PCW	135	9	247	124
	LF	223	115	411	1,585

Charge Size (kg)	Hearing Group	PTS Range (m)		TTS Range (m)	
		SPL_{pk}	SEL_{cum}	SPL_{pk}	SEL_{cum}
0.5 kg clearance shot	HF	73	4	134	56
	VHF	1,265	421	2,325	2,435
	PCW	247	22	455	301
2 x 0.75 kg low yield charge	LF	322	196	593	2,665
	HF	105	7	194	95
	VHF	1,820	650	3,350	3,120
	PCW	357	38	660	504
4 x 0.75 kg low yield charge	LF	406	275	750	3,670
	HF	133	10	244	131
	VHF	2,290	840	4,220	3,600
	PCW	449	53	830	695

Table 1.15: Potential PTS and TTS Ranges For Donor Charges Used In High-Order UXO Clearance Activities

Charge Size (kg)	Hearing Group	PTS Range (m)		TTS Range (m)	
		SPL_{pk}	SEL_{cum}	SPL_{pk}	SEL_{cum}
1.2 kg donor charge for high order UXO disposal	LF	299	176	551	2,400
	HF	98	6	180	85
	VHF	1,690	596	3,110	2,975
	PCW	331	34	610	454
3.5 kg donor blast fragmentation charge for high order UXO disposal	LF	427	297	790	3,940
	HF	140	10	257	141
	VHF	2,415	885	4,445	3,715
	PCW	473	57	875	745

Table 1.16: Potential PTS And TTS Ranges For High Order Clearance Of UXOs

Charge Size (kg)	Hearing Group	PTS Range (m)		TTS Range (m)	
		SPL_{pk}	SEL_{cum}	SPL_{pk}	SEL_{cum}
25 kg UXO – high order explosion	LF	825	775	1,515	9,325
	HF	268	27	494	343
	VHF	4,645	1,645	8,555	5,290
	PCW	910	147	1,680	1,760
130 kg UXO – high order explosion	LF	1,425	1,705	2,625	17,755
	HF	464	61	855	680
	VHF	8,045	2,520	14,825	6,830
	PCW	1,580	323	2,905	3,360
	LF	2,720	4,215	5,015	34,365

Charge Size (kg)	Hearing Group	PTS Range (m)		TTS Range (m)	
		SPL_{pk}	SEL_{cum}	SPL_{pk}	SEL_{cum}
907 kg UXO – high order explosion	HF	890	151	1,635	1,380
	VHF	15,370	3,820	28,320	8,925
	PCW	3,015	800	5,550	6,470

Table 1.17: Criteria For Injury To Marine Turtles Due To Explosives (Popper Et al., 2014)

Parameter	Mortality and Potential Mortal Injury	Recoverable Injury	TTS
Peak, dB re 1 µPa	229 – 234	(Near) High (Intermediate) High (Far) Low	(Near) High (Intermediate) High (Far) Low

1.6.23. The greatest impact from UXO clearance would be expected from high order detonation of the largest UXO size, anticipated to be up to 907 kg. In this case PTS would be predicted at distances up to 15,370 m for VHF cetaceans such as harbour porpoise. However, the most likely UXO size expected to require clearance would be in the order of 130 kg, in which case PTS may be expected to occur in VHF cetaceans out to approximately 8,045 m.

1.7. ROLES AND RESPONSIBILITIES

MITIGATION TEAM

1.7.1. The mitigation teams for piling, geophysical/seismic survey and UXO clearance will comprise the following roles, although it should be noted that not all roles will be required for all operations. A summary of roles relevant to respective operations is presented in Table 1.18.

Onshore Environmental Manager

1.7.2. The Applicant's Onshore Environmental Manager (OEM) is responsible for ensuring that all compliance documents, including this MMMP, are included in construction contract documents, including those pertaining to piling, geophysical/seismic surveys and UXO clearance. The OEM will also be responsible for providing a pre works introduction session/s, and for ensuring that all activities are conducted in accordance with this MMMP, with other related consent management plans, and with all relevant regulations and legislation. The OEM is responsible for decision making regarding halts to operations in the event of a non-compliance with the MMMP and/or consent conditions and will report marine mammal monitoring and activities related to geophysical/seismic surveying, UXO clearance and piling activities along with all non-compliances, to MMO/JNCC.

Works Supervisor

1.7.3. The 'Works Supervisor' is the individual/s who hold overall responsibility for operations during piling and geophysical/seismic surveying, based on the piling or survey vessel, and is likely to be a different individual for each activity. The Works Supervisor is in control of

initiating, delaying or pausing operations and is the main point of communication between the MMObs, Passive Acoustic Monitoring (PAM) Operator and ADD Operator and the operations teams (i.e. those personnel responsible for carrying out piling and geophysical/seismic survey activities).

Explosive Ordnance Disposal Supervisor

1.7.4. The Explosive Ordnance Disposal (EOD) Supervisor has overall responsibility for the detonations programme and is based on the main UXO clearance operations vessel. The EOD Supervisor is the main point of communication between the MMObs, PAM Operator and ADD Operator and the EOD support teams (i.e. those personnel responsible for carrying out UXO clearance activities). The EOD Technical Advisor will be in control of initiating, delaying or pausing the detonation activities. Additional support to the mitigation team will be provided by members of the EOD Supervisor's team.

Marine Mammal Observers

1.7.5. At least two dedicated and trained Marine Mammal Observers (MMObs) will be used to survey the mitigation zone at any one time and conduct the pre start searches (and post detonation searches in the case of UXO clearance). The MMObs will be JNCC certified and have an appropriate level of field experience (i.e. a minimum of one year's MMObs experience on offshore projects).

1.7.6. The MMObs will be responsible for recording all marine mammal sightings in the appropriate format, along with other environmental data. Together with the PAM Operator, the MMObs will be responsible for compiling all data on marine mammal observations, mitigation activities and instances of noncompliance for reporting to MMO/JNCC and the Marine Noise Registry (see Section 1.9).

1.7.7. The MMObs must be familiar with the regulatory procedures pertaining to managing risk to marine mammals from underwater sound and to ensure compliance must be provided with full details of all licence/consent conditions relevant to the performance of their role in advance of activity commencing. The MMObs, together with the PAM Operator, will provide a detailed introduction during the pre-works introduction session/s to advise the offshore team on the implementation of the procedures set out in this MMMP.

1.7.8. The MMObs will be equipped with reticule binoculars and Marine Mammal Reporting forms and will be capable of determining the extent of the search zone in relation to their viewing platform. A range stick may be used to aid the estimation of distance of the sighting from the survey vessel. The lead MMObs should also be equipped with a two way radio to ensure communication with both the vessel crew and the PAM Operator. This is to allow any visual or acoustic detections of marine mammals in the mitigation zone and any subsequent delay required to the commencement of surveying to be communicated quickly and effectively between all parties.

1.7.9. The MMObs should ensure their efforts are concentrated on the mitigation periods, (i.e. the pre start search and soft start time periods). JNCC guidelines, and this MMMP, should not be interpreted to imply that MMObs should continue a visual search during all available hours, unless specified as a survey consent or licence condition.

1.7.10. The MMObs will have the necessary authority (or support by Works Supervisor) to implement the plan and advise a stop works if necessary.

Passive Acoustic Monitoring Operators

1.7.11. Dedicated PAM Operators will be responsible for deployment, maintenance and operation of the PAM hydrophone, including spares. The PAM Operators will be based on the vessel together with the MMObs and will be responsible for recording all acoustic marine mammal detections in the appropriate format. Together with the MMObs, PAM Operators will be responsible for compiling all the data on marine mammal observations, mitigation activities (including ADDs and soft start) and instances of noncompliance, for reporting to MMO/JNCC and the Marine Noise Registry (see Section 1.9).

1.7.12. The PAM Operator should ensure their efforts are concentrated on the mitigation periods, (i.e. the pre start search and soft start time periods). JNCC guidelines, and this MMMP, should not be interpreted to imply that PAM Operators should continue a visual search during all available hours, unless specified as a survey consent or licence condition.

1.7.13. To ensure compliance they must be provided with full details of all licence/consent conditions relevant to the performance of their role in advance of activity commencing. The PAM Operator, together with the MMObs, will provide a detailed introduction during the pre-works introduction session/s to advise the offshore team on the implementation of the procedures set out in this MMMP.

1.7.14. The PAM Operator will be suitably trained in passive acoustic monitoring and the use of PAMGuard, with training having been provided by an appropriate organisation (e.g. Seiche). The PAM Operators will also have an appropriate level of field experience (i.e. a minimum of one year PAM experience on offshore projects) and must be familiar with the UK regulatory procedures pertaining to managing risk to marine mammals and marine turtles from underwater sound.

1.7.15. PAM Operators will be responsible for confirming the correct functioning of the ADD (via PAMGuard software) and communicating to the ADD Operator if the ADD is not operating properly and will have the necessary authority (and/or support by Works Supervisor) to implement this MMMP and advise a stop works if necessary.

Acoustic Deterrent Device Operators

1.7.16. A trained and dedicated Acoustic Deterrent Device (ADD) Operator will be responsible for ADD maintenance, operation and reporting (see Section 1.9). The ADD Operator will be responsible for deploying the ADD from the installation vessel, verifying the operation of the ADD before deployment, operating the ADD, ensuring that batteries are fully charged, and that spare equipment is available.

1.7.17. The ADD Operator will also record and report to the Works Supervisor/MMObs/PAM Operator on all ADD and piling activity so the details of any ADD used, and any relevant observations on their efficacy, can be reported as a part of the Operations/Marine Mammal Observer/Passive Acoustic Monitoring Report (see Section 1.9).

Table 1.18: Summary Of Roles And Involvement Of Personnel In Respective Operations

Role	Operation		
	Piling	Geophysical/seismic survey	UXO clearance
Onshore Environmental Manager	✓	✓	✓
Works Supervisor	✓	✓	
EOD Supervisor			✓
MMObs	✓	✓	✓
PAM Operator	✓	✓	✓
ADD Operator	✓		✓

COMMUNICATION

1.7.18. At the planning stage the communication channels between MMObs, PAM Operator and ADD Operator, and the vessel crew are to be established. The MMObs and PAM Operator must also ensure there is a workable communication procedure in place so that any visual and acoustic detections can be corroborated by both. In addition, a formal chain of communication from the MMObs or PAM Operator to the person who can start/stop operations must be established. This is important, because contractors working to a tight timetable may not fully appreciate the roles and responsibilities of the MMObs and PAM Operators. To establish the chain of communication and command MMObs and PAM Operators should attend any relevant pre-mobilisation meetings.

1.8. MITIGATION METHODS AND PROCEDURES

1.8.1. The following specific mitigation measures are proposed for the planned implementation of piling operations, geophysical/seismic surveys, and UXO clearance activities. The mitigation measures presented below include designed in management measures and tertiary mitigation measures (IEMA, 2016) to reduce the risk of injury to marine mammals as described in Volume 2, Chapter 7.

MITIGATION ZONE

1.8.2. The mitigation zone is the area within which mitigation measures are implemented to ensure avoidance of injury to marine mammals. The JNCC guidelines for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010a), geophysical surveys (JNCC, 2017) and the use of explosives (i.e. UXO clearance) (JNCC, 2010b) varies according to activity.

1.8.3. The mitigation zone is defined as the area over which pre start monitoring will be undertaken to record the presence of marine mammals. If marine mammals are recorded within the mitigation zone during the pre-start search, the operations will be delayed until such a time as there have been no sightings of marine mammals and/or acoustic recordings of marine mammals within the mitigation zone for a minimum of 20 minutes.

1.8.4. Following JNCC guidelines, the mitigation zone for pre start monitoring has been determined as having a minimum radius of 500 m from the source of piling noise (JNCC, 2010a) and geophysical surveys (JNCC, 2017) and 1 km for UXO clearance (JNCC, 2010b). The extent to which the PAM will be able to acoustically record marine mammals will depend on the equipment used and the species present. For example, typically PAM can detect harbour porpoise over a range of approximately 300 m, but this may extend to more than a kilometre for low frequency cetaceans (e.g. minke whale).

Deterrence zone

1.8.5. Detection probability decreases considerably over distance and with increasing sea state. Therefore, an important caveat is that designed in management measures such as visual and acoustic monitoring are unlikely to negate the risk of injury to marine mammals over ranges of 1 km (i.e. because a marine mammal may be present but undetected). For this reason, this MMMP also defines a 'deterrence zone' as the zone over which marine mammals will be deterred to reduce the risk of injury.

1.8.6. The size of the deterrence zone would ideally be ~16 km (as the zone of potential injury in marine mammals is up to 15.37 km radius from the sound source (for VHF cetaceans such as harbour porpoise: see Table 1.16), noting that this is a conservative estimate). However, deterrence activities will introduce more noise into the marine environment and there must therefore be a careful balance between introducing sufficient acoustic deterrence to move animals to a safer distance, without further compromising their health through additional risk of injury or disturbance (McGarry et al., 2022).

PILING

Mitigation zone

1.8.7. As per the JNCC (2010a) guidance, a constant effort pre piling search will be undertaken by at least two accredited and experienced MMObs to monitor a radial mitigation zone of at least 500 m to minimise the likelihood of marine mammals being present within this range. The Works Supervisor will notify the MMObs, PAM Operator and ADD Operator at least one hour prior to the planned start of the piling initiation to allow sufficient time for the search period and soft start.

Visual monitoring

1.8.8. Piling shall commence during daylight hours only, when visual monitoring of the mitigation zone is possible. At least two dedicated and qualified MMObs will conduct pre start monitoring of the mitigation zone from a vessel, at least 30 minutes prior to the start of piling. Visual monitoring for marine mammals will be conducted from a suitable platform on the vessel (such as the ship's bridge), that allows 360° visualisation, and full coverage of the mitigation zone. MMObs must concentrate their efforts on the appropriate measures to be implemented in advance of and during commencement, breaks in and resumption of piling activity.

1.8.9. The MMObs will be equipped with reticule binoculars and Marine Mammal Reporting forms (see Annex A) and will be capable of determining the extent of the mitigation zone in relation to their viewing platform. A range stick may be used to aid the estimation of distance of the sighting from the observation vessel. The lead MMObs should also be

equipped with a two way radio to ensure communication with both the vessel crew and the PAM Operator. This is to allow any visual or acoustic detections of marine mammals in the mitigation zone and any subsequent delay required to the commencement of piling to be communicated quickly and effectively between all parties. If marine mammals and/or marine turtles are detected within the mitigation zone during the pre-piling search, then piling will not commence.

1.8.10. Along with the PAM Operator, the MMObs will communicate with the EOD Supervisor to confirm that the mitigation zone is clear of marine mammals, and that the detonation operation (including soft start) can commence. The lines of communication and sequencing of events are shown in Figure 1.2.

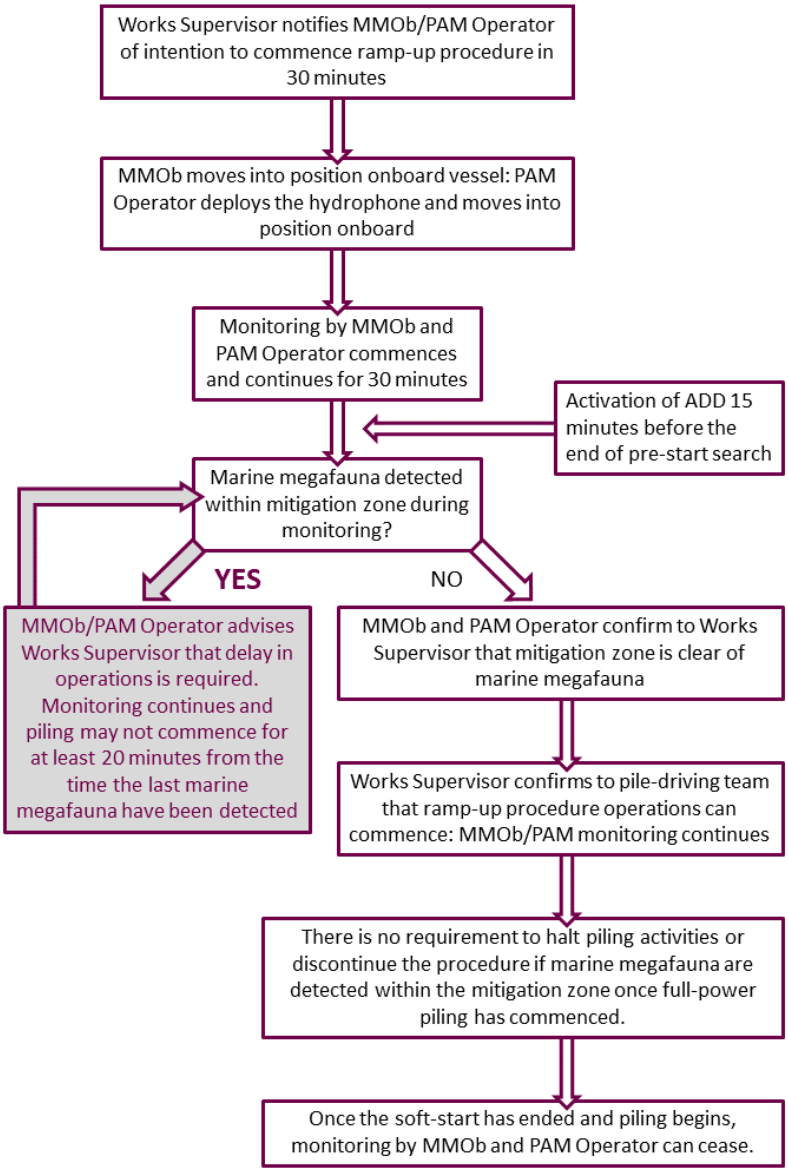

Figure 1.2: Task And Communication Plan For Piling Procedures Start Up

Passive Acoustic Monitoring

1.8.11. PAM will be undertaken during pre-start monitoring, soft start and piling activities. The PAM Operator will acoustically track vocalising marine mammals using a hydrophone,

deployed to a suitable depth from the operation vessel. The hydrophone data will be monitored by the PAM Operator via a computer interface using the software PAMGuard. This allows the Operator to detect vocalisations, and signal strengths give an indication of the position of the animal relative to the hydrophone (i.e. the signal becomes weaker as the animal moves further away). The PAM Operator can communicate with the MMObs to 'ground truth' any detection of marine mammals in order to validate species identification and determine approximate position.

1.8.12. The PAM Operator should also be equipped with a two way radio to ensure communication with both the vessel crew and the lead MMOb. This is to allow any visual or acoustic detections of marine mammals in the mitigation zone and any subsequent delay required to the commencement of piling to be communicated quickly and effectively between all parties.

1.8.13. Along with the MMObs, the PAM Operator will communicate with the Works Supervisor to confirm that the mitigation zone is clear of marine mammals, and that the initiation of piling (including soft start) can commence. The lines of communication and sequencing of events are shown in Figure 1.2.

Acoustic Deterrent Devices

1.8.14. In addition to visual and acoustic monitoring, an ADD will be deployed at the start of the pre piling search near the pile to be installed. ADDs should only be used in conjunction with visual and/or acoustic monitoring, and not as a replacement. It is expected that these devices would always be used in accordance with recommended conditions that would prevent the exposure of animals to disturbance. It should be noted that a wildlife licence under the Wildlife and Countryside Act 1981 (within 12nm) might be required to authorise a potential intentional disturbance.

1.8.15. The PAM Operator will communicate to the ADD Operator when 15 minutes have elapsed since the start of the pre piling search period and at this point the ADD will be deployed and activated for a minimum of 15 minutes to allow animals sufficient time to disperse, while also minimising the additional noise produced by the device and emitted into the marine environment. Visual and acoustic monitoring will continue throughout the ADD deployment to ensure that marine mammals have left the mitigation zone prior to the start of piling. The PAM Operator will communicate to the ADD Operator if there are any problems with the functioning of the ADDs through their role in Passive Acoustic Monitoring.

1.8.16. The ADDs will be deactivated and recovered to the vessel prior to the soft start sequence once it has been confirmed by the MMObs and PAM Operator that the mitigation zone has been clear of marine mammals for at least 20 minutes. The ADDs may remain activated up to the point when this has been confirmed.

Soft start

1.8.17. Piling activities shall only commence in daylight hours where effective visual monitoring, as performed and determined by the MMObs, has been achieved. Where effective visual monitoring, as determined by the MMObs, is not possible (including in circumstances in which poor visibility prevents the 500 m mitigation zone from being visually monitored)

the sound producing activities shall be postponed until effective visual monitoring is possible.

1.8.18. After the 30 minute pre piling search and ADD activation period has elapsed, the piling initiation, soft start and ramp up designed in measures will commence with hammer initiation at the lowest hammer energy and strike rate (600 kJ). The ADD will be turned off immediately after the piling activity has commenced. The soft start is the gradual, incremental increase of piling power over a minimum of 20 minutes. This allows time for marine mammals to move away from the noise source, thereby reducing the risk of exposing animals to noise levels which could cause injury.

1.8.19. The initiation and soft start stages allow for alignment piles and for marine mammals to leave the area and involve a hammer energy of 600 kJ. The ramp up stage is a progressive increase in hammer energy following the soft start and involves an initial hammer energy of 750 kJ which builds up to a maximum of 3,000 kJ over the 9 minute period. The maximum hammer energy proposed for the Liverpool Bay CCS Project is 3,000 kJ. However, the actual energy used when piling will be significantly lower for most of the time and the hammer energy will be raised to 3,000 kJ only when absolutely necessary. A summary of the piling stages and associated strike energies is presented in Table 1.19.

Table 1.19: Impact Piling Schedule Used In The Underwater Noise Modelling

Activity/ stage	Duration, minutes	Hammer Energy (kJ)	Strike Rate (strikes/min)	Number of strikes	Notes/description
Pile self weight penetration	N/A	N/A	N/A	N/A	Pile self weight penetration where the pile will sink into the seabed under its own weight.
Soft start	20	600	3	60	Slow start at low hammer energy
Ramp Up	20	750 – 3,000	30	600	Minimise hammer energies at levels sufficient for pile installation, resulting in energy ramp up throughout the piling operation
Piling	60	3,000	40	2,400	Steady hammer at normal operating mode

1.8.20. These above activities were included in subsea noise modelling (with the inclusion of an ADD for 30 minutes prior to commencement of any piling activity) in Volume 3, Appendix J Underwater Noise Technical Report (RPS Group and Seiche, 2024). The ADD itself was assumed to not contribute towards any injury to marine mammals.

1.8.21. If marine mammals are detected within the mitigation zone during the soft start, then whenever possible piling should cease, or at least the hammer energy should not be further increased until at least 20 minutes after the last visual or acoustic detection of the animal. The MMObs and PAM Operator will track any marine mammals detected and

ensure that they have left the mitigation zone before piling commences or the soft start continues.

During piling operations

1.8.22. It is acknowledged that, for engineering reasons, it may not be possible to stop piling at full power until the pile is in final position. Therefore, if marine mammals are detected in the mitigation zone during full power piling, there will be no requirement to cease piling or to reduce piling energy as the animal would be deemed to have entered the area "voluntarily". Figure 1.2 illustrates the sequence of events and lines of communication required to implement the MMMP.

1.8.23. If for any reason there is a break in piling activity for greater than 10 minutes, then the pre piling search and ADD activation, and a full soft start and ramp up procedure should be repeated before piling recommences. If a watch has been kept during the piling operation, the MMObs or PAM Operator should be able to confirm the presence or absence of marine mammals, and it may be possible to commence the soft start immediately. However, if there has been no watch, the complete pre piling search and soft start procedure should be undertaken.

1.8.24. The designed in and mitigation measures detailed in this MMMP reduce the risk of auditory injury to an acceptable level in terms of PTS. With mitigation in place, the potential effect of piling (auditory injury) on marine mammals is of minor significance, which is not significant in Environmental Impact Assessment (EIA) terms.

GEOPHYSICAL/SEISMIC SURVEYING

1.8.25. As per the JNCC (2017) guidance, a constant effort pre survey search will be undertaken by at least two accredited and experienced MMObs (using binoculars and a range finding stick as required) and a PAM Operator to monitor the specified 500 m radial mitigation zone to minimise the likelihood of marine mammals being present within this range. In waters up to 200 m deep (which includes the Eni Development Area), the MMObs shall conduct pre start up monitoring at least 30 minutes before the survey activity is due to commence. Sound producing activity shall not commence until at least 30 minutes have elapsed with no marine mammals detected by the MMObs within the mitigation zone.

1.8.26. Sound producing activities shall only commence in daylight hours where effective visual monitoring, as performed and determined by the MMObs, has been achieved. Where effective visual monitoring, as determined by the MMObs, is not possible (including in circumstances in which poor visibility prevents the 500 m mitigation zone from being visually monitored) the sound producing activities shall be postponed until effective visual monitoring is possible.

1.8.27. An agreed and clear on site communication signal must be used between the MMObs and the Works Supervisor as to whether the relevant activity may or may not proceed, or resume following a break (see below). It shall only proceed on positive confirmation with the MMObs.

1.8.28. This prescribed pre survey monitoring shall subsequently be followed by a ramp- up procedure (i.e. a soft start) which should include continued monitoring by the MMObs.

1.8.29. If there is a break in sound output for a period greater than 10 minutes (e.g. due to equipment failure, shut down, survey line or station change) then all pre survey monitoring and a subsequent soft start procedure (where appropriate) must be undertaken.

1.8.30. The designed in and mitigation measures detailed in this MMMP reduce the risk of auditory injury to an acceptable level in terms of PTS. With mitigation in place, the potential effect of geophysical acoustic surveys (auditory injury) on marine mammals is of minor significance, which is not significant in EIA terms. Figure 1.3 illustrates the sequence of events and lines of communication required to implement the MMMP.

Mitigation zone

1.8.31. As per the JNCC (2017) guidance, a constant effort pre survey search will be undertaken by at least two accredited and experienced marine mammal observers (MMObs) to monitor a radial search zone of at least 500 m from the sound source to minimise the likelihood of marine mammals being present within this range. The Works Supervisor will notify the MMObs, PAM Operator and ADD Operator at least one hour prior to the planned start of survey operations to allow sufficient time for the search period and soft start.

Visual monitoring

1.8.32. Surveying shall commence during daylight hours only, when visual monitoring of the mitigation zone is possible. At least two dedicated and qualified MMObs will conduct a visual search of the mitigation zone and conduct the pre start searches from a vessel prior to the start of surveying. Visual monitoring for marine mammals will be conducted from a suitable platform on the vessel such as the ship's bridge, that allows 360° visualisation, and full coverage of the mitigation zone. MMObs must concentrate their efforts on the appropriate measures to be implemented in advance of and during commencement, breaks in and resumption of surveying.

1.8.33. The MMO will be equipped with reticule binoculars and Marine Mammal Reporting forms and will be capable of determining the extent of the mitigation zone in relation to their viewing platform. A range stick may be used to aid the estimation of distance of the sighting from the survey vessel. The lead MMObs should also be equipped with a two way radio to ensure communication with both the vessel crew and the PAM Operator. This is to allow any visual or acoustic detections of marine mammals in the mitigation zone and any subsequent delay required to the commencement of surveying to be communicated quickly and effectively between all parties.

1.8.34. Along with the PAM Operator, the MMObs will communicate with the EOD Supervisor to confirm that the mitigation zone is clear of marine mammals, and that the detonation operation (including soft start) can commence. The lines of communication and sequencing of events are shown in Figure 1.3.

Passive Acoustic Monitoring

1.8.35. PAM will be undertaken during pre-start, ramp up/soft start and surveying activities. Two dedicated and qualified PAM Operators will be responsible for deployment, maintenance and operation of the PAM hydrophone, including spares. Both PAM Operators will be

suitably trained in passive acoustic monitoring and the use of PAMGuard, with training having been provided by an appropriate organisation (e.g. Seiche). PAM Operators will also have an appropriate level of field experience (i.e. a minimum of one year PAM experience on offshore projects).

1.8.36. PAM Operators will be based on the vessel together with the MMObs. PAM Operators will be responsible for recording all acoustic marine mammal detections in the appropriate format, and together with the MMObs, will be responsible for compiling all the data on marine mammal observations and mitigation activities for reporting to JNCC. The PAM Operator should also be equipped with a two way radio to ensure communication with both the vessel crew and the lead MMObs. This is to allow any visual or acoustic detections of marine mammals in the mitigation zone and any subsequent delay required to the commencement of surveying to be communicated quickly and effectively between all parties.

1.8.37. PAM Operators must be experienced and familiar with the UK regulatory procedures pertaining to managing risk to marine mammals from underwater sound and to ensure compliance must be provided with full details of all licence/consent conditions relevant to the performance of their role in advance of activity commencement. PAM Operators will have the necessary authority (or support by Works Supervisor) to implement the plan and stop works if necessary.

1.8.38. Along with the MMObs, the PAM Operator will communicate with the EOD Supervisor to confirm that the mitigation zone is clear of marine mammals, and that the detonation operation (including soft start) can commence. The lines of communication and sequencing of events are shown in Figure 1.3.

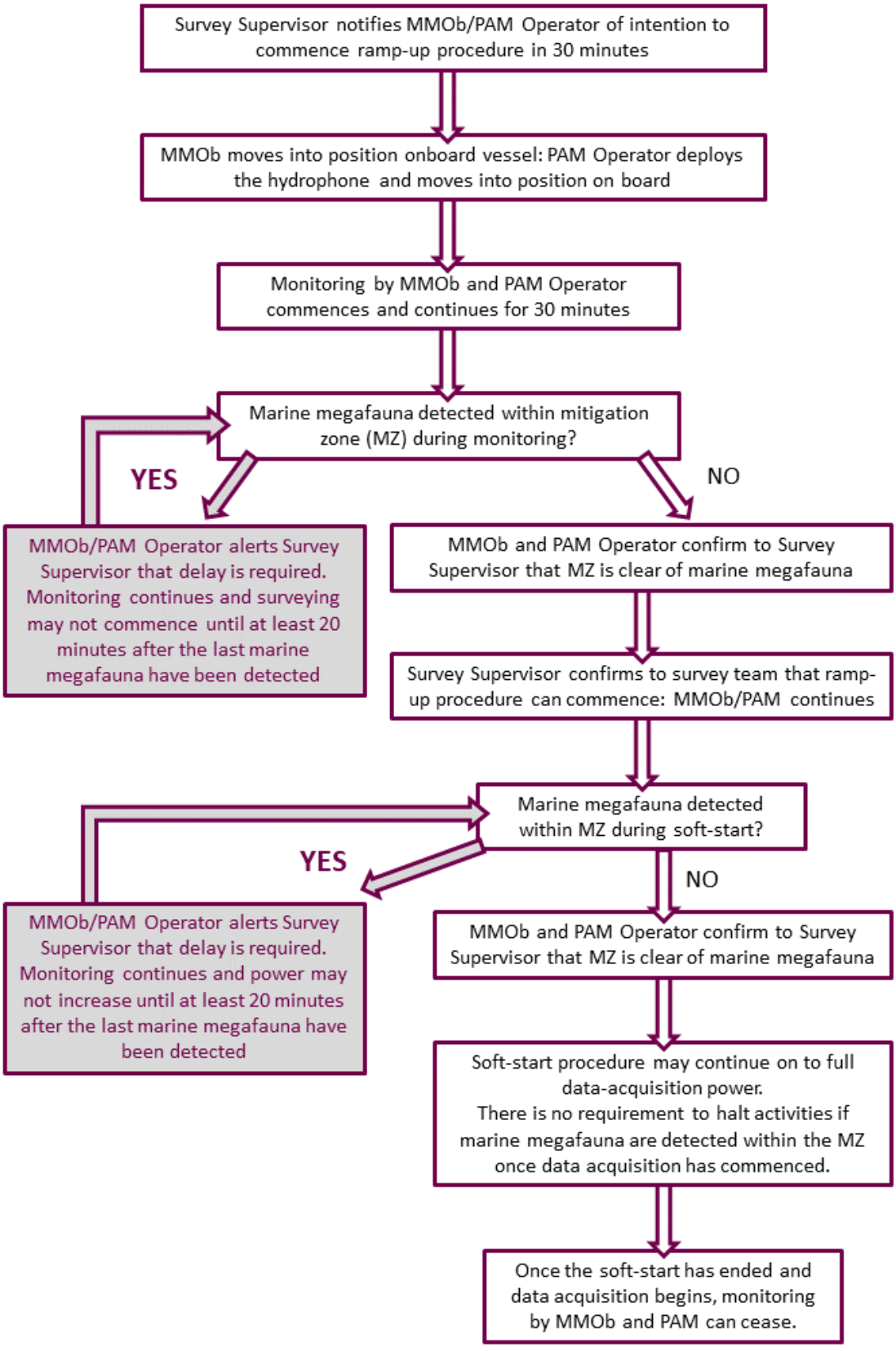

Figure 1.3: Task And Communication Plan For Geophysical Procedures Start Up

Soft start

Electromagnetic sources

1.8.39. In commencing a geophysical survey operation employing electromagnetic equipment (such as sub bottom profiling (SBP, e.g. pingers, sparkers, boomers and CHIRP systems), side scan sonar (SSS) and multi beam echosounders (MBES)), the following soft start procedure must be used, including during any testing of acoustic sources:

- where it is possible according to the operational parameters of the equipment employed, the device's acoustic energy output should start from a lower energy output and be allowed to gradually build up to data acquisition output level over a minimum period of 20 minutes.
- The controlled build-up of acoustic energy output should occur in consistent stages to provide a steady and gradual increase over the ramp up period.
- Where the measures outlined above are not possible according to the operational parameters of the equipment, the device should be switched "on" and "off" in a consistent sequential manner. The duration between shots should begin with a greater interval than is required for data acquisition, reducing over a period of 20 minutes to full necessary output.

1.8.40. In all cases where a soft start is employed the delay between the end of the soft start and the necessary full output must be minimised to prevent unnecessary high level sound introduction into the environment.

1.8.41. Once the soft start commences, there is no requirement to halt or discontinue the procedure if weather or visibility conditions deteriorate, nor if marine mammals occur within the 500 m radial mitigation zone. Marine mammals present at this point are deemed to have entered the ensonified area willingly (although see footnote 2, page 22).

Seismic sources

1.8.42. In commencing a seismic survey operation, the criteria defining the standard duration of a soft start are determined by the maximum airgun volume.

1.8.43. For surveys where the maximum airgun volume is 180 cubic inches or greater:

- from the start of the soft start until full operational power: minimum of 20 minutes; and
- from the start of the soft start until the start of the survey line: maximum of 40 minutes.

1.8.44. For surveys where the maximum airgun volume is less than 180 cubic inches:

- from the start of the soft start until full operational power: minimum of 15 minutes; and
- from the start of the soft start until the start of the survey line: maximum of 25 minutes.

1.8.45. Regardless of duration, power should be built up gradually, in uniform stages from a low energy start up (e.g. increasing the number of airguns, starting with the smallest airgun in the array, or increasing the airgun pressure).

1.8.46. There should be a soft start every time airguns are scheduled to be used, with the exception of mini airguns (i.e. those with a single gun volume of 10 cubic inches or less), which do not require a soft start.

During survey operations

1.8.47. Geophysical data are usually collected along predetermined survey lines. Line change or line turn is the term used to describe the activity of turning the vessel at the end of one survey line prior to commencement of the next.

1.8.48. The following procedures depend on the duration of the line change. If an operator determines that an effective line change cannot be achieved using these procedures, then they should contact the Regulator and appropriate Statutory Nature Conservation Body/Bodies (SNCB/s) at the earliest possible opportunity to discuss a proposed alternative. Details of any agreed alternative procedures should be described during the application process and reiterated, if appropriate, in the survey consent or licence conditions.

1.8.49. If monitoring operations are being undertaken using PAM and difficulties are encountered when deploying the PAM equipment, the line changes should be extended to allow the full pre survey search and soft start to be completed using PAM.

Line changes expected to take longer than 40 minutes.

1.8.50. Most seismic surveys with airgun array volumes of 500 cubic inches or more and extensive hydrophone arrays are not able to complete their line changes within 40 minutes (Stone, 2015) and should therefore adopt the following procedures:

- firing is to be terminated at the end of the survey line (or during geophone repositioning);
- a pre survey search is to be undertaken during the scheduled line change (or geophone repositioning);
- the soft start is to be delayed if marine mammals are detected within the mitigation zone during the pre-survey search (see Figure 1.3); and
- a full 20 minute soft start is to be undertaken before the start of the next line.

Line changes expected to take less than 40 minutes.

1.8.51. If line changes (or geophone repositioning) are expected to be completed within 40 minutes, regardless of airgun volume, airgun firing can continue during the line change only if:

- power is reduced to 180 cubic inches (or as close as is practically feasible) at standard pressure. Airgun volumes of less than 180 cubic inches can continue to fire at operational volume and pressure; and
- the Shot Point Interval (SPI: the duration between shots) is increased to provide a longer duration between shots, with the SPI not to exceed 5 minutes; and
- power is increased while SPI is decreased in uniform stages during the final 10 minutes of the line change (or geophone repositioning), prior to data collection recommencing (a form of mini soft start).

1.8.52. If the above is not practical, and an alternative procedure has not been agreed with the Regulator, then airgun firing should be terminated and a pre survey search and soft start should be implemented prior to the start of the next line.

Breaks in operations.

Planned breaks.

1.8.53. If breaks in data acquisition other than during a line change are required (e.g. to avoid a structure), these should be considered within the application to allow the Regulator and SNCB to fully understand the survey procedure.

1.8.54. The same procedures as below (for unplanned breaks) can be applied. However, if the planned break will be for less than 10 minutes, the MMObs/PAM operatives must begin monitoring 20 minutes prior to the planned break and continue for the duration of the break.

Unplanned breaks

1.8.55. This refers to instances where the survey equipment ceases operation unexpectedly during data acquisition, (e.g. a technical problem or breakdown). In such circumstances, it is imperative the MMObs/PAM operatives begin to monitor the mitigation zone as quickly as possible after an unplanned break has occurred.

Unplanned breaks of less than 10 minutes

1.8.56. If the survey equipment can be restarted and data acquisition resumed in less than 10 minutes, there is no requirement for a soft start and operations can recommence at the same power level as at prior to the break (or lower), provided no marine mammal(s) have been detected in the mitigation zone during the breakdown period.

1.8.57. If a marine mammal is detected in the mitigation zone during the breakdown period, the MMObs/PAM operative will advise to delay recommencement of the airgun firing until their passage, or the transit of the vessel, results in the marine mammals being outside of the mitigation zone. There must be a minimum of a 20 minute delay from the time of the last detection within the mitigation zone, and a soft start must then be undertaken.

Unplanned breaks of longer than 10 minutes

1.8.58. If it takes longer than 10 minutes to restart the survey equipment, a full pre survey search and soft start should be carried out before the survey recommences. If an MMObs/PAM operative has been monitoring during the breakdown period, this time can contribute to the pre survey search time (30 or 60 minutes as appropriate).

1.8.59. If the breakdown occurs at night or during daylight conditions not conducive for a visual search, the mitigation zone should be monitored as described above using PAM. If PAM is not available, the survey must be delayed until conditions are suitable for visual observations.

UXO CLEARANCE

Mitigation zone

1.8.60. As per the JNCC (2010b) guidance, a constant effort pre detonation search will be undertaken by at least two accredited and experienced MMObs to monitor a radial search zone of at least 1 km from the location of the UXO to minimise the likelihood of marine mammals being present within this range. The EOD Supervisor will notify the MMObs, PAM Operator and ADD Operator at least 1.5 hours prior to the planned start of the detonation to allow sufficient time for the search period and soft start.

Visual monitoring

1.8.61. UXO clearance shall commence during daylight hours only, when visual monitoring of the search zone is possible. At least one hour before any type of detonation, at least two dedicated and qualified MMObs will conduct a visual search of the mitigation zone and conduct the pre start searches from a vessel prior to the start of surveying. Visual monitoring for marine mammals will be conducted from a suitable platform on the vessel such as the ship's bridge, that allows 360° visualisation, and full coverage of the mitigation zone. MMObs must concentrate their efforts on the appropriate measures to be implemented in advance of and during commencement, breaks in and resumption of UXO clearance activities (JNCC, 2010b).

1.8.62. The MMObs will be equipped with reticule binoculars and Marine Mammal Reporting forms and will be capable of determining the extent of the search zone in relation to their viewing platform. A range stick may be used to aid the estimation of distance of the sighting from the survey vessel. The lead MMObs should also be equipped with a two way radio to ensure communication with both the vessel crew and the PAM Operator. This is to allow any visual or acoustic detections of marine mammals in the mitigation zone and any subsequent delay required to the commencement of surveying to be communicated quickly and effectively between all parties.

1.8.63. Along with the PAM Operator, the MMObs will communicate with the EOD Supervisor to confirm that the mitigation zone is clear of marine mammals, and that the detonation operation (including soft start) can commence. The lines of communication and sequencing of events are shown in Figure 1.4.

Passive Acoustic Monitoring

1.8.64. The PAM Operator will acoustically track vocalising marine mammals using a hydrophone, deployed to a suitable depth from the operation vessel. The hydrophone data will be monitored by the PAM Operator via a computer interface using the software PAMGuard. This allows the Operator to detect vocalisations, and signal strengths give an indication of the position of the animal relative to the hydrophone (i.e. the signal becomes weaker as the animal moves further away). The PAM Operator can communicate with the MMObs to 'ground truth' any detection of marine mammals to validate species identification and determine approximate position.

1.8.65. Along with the MMObs, the PAM Operator will communicate with the EOD Supervisor to confirm that the mitigation zone is clear of marine mammals, and that the detonation

operation (including soft start) can commence. The lines of communication and sequencing of events are shown in Figure 1.4.

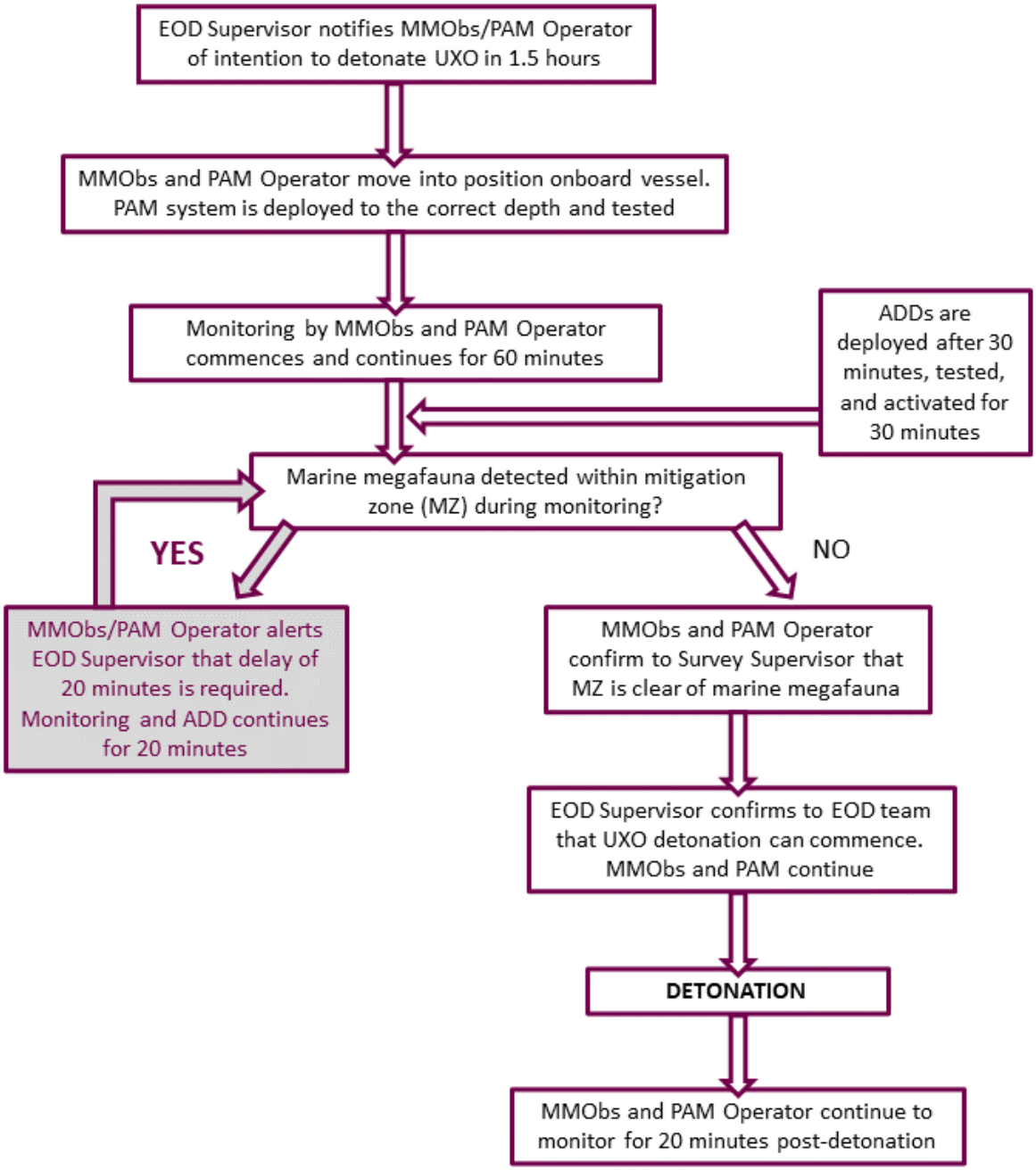

Figure 1.4: Task And Communication Plan For UXO Clearance

Acoustic Deterrent Devices

1.8.66. Active deterrence of marine mammals over the deterrence zone (out to ~16 km) will be undertaken with the use of an ADD. The noise levels emitted by ADDs will not lead to injury of marine mammals (McGarry et al., 2022) but are loud enough to successfully move animals away from the source.

1.8.67. The PAM Operator will communicate to the ADD Operator when 30 minutes have elapsed since the start of the predetonation search period and at this point, the two ADDs will be deployed and activated for the remaining 30 minutes of the predetonation search. The PAM Operator will communicate to the ADD Operator if there are any problems with the functioning of the ADDs through their role in Passive Acoustic Monitoring.

1.8.68. The ADDs will be deactivated and recovered to the vessel prior to the soft start sequence once it has been confirmed by the MMObs and PAM Operator that the Mitigation Zone (MZ) has been clear of marine mammals for at least 20 minutes. The ADDs may remain activated up to the point when this has been confirmed.

Post detonation monitoring

1.8.69. The MMObs and PAM Operator will continue to visually monitor the search zone throughout the soft start and UXO detonation/s (providing it is safe for the equipment to be deployed during the detonations) and for a minimum period of 15 minutes after the last detonation, to look for any evidence of injury to marine life, including fish kills. As described below (Section 1.9) any marine mammals present will be identified, and information recorded using the JNCC Marine Mammal Recording Forms (Annex A).

1.9. REPORTING

1.9.1. The OEM will be responsible for monitoring piling operations, geophysical and seismic surveys and UXO clearance, as well as implementation of this MMMP, and will keep a detailed record of operations, mitigation procedures and any marine mammal sightings.

1.9.2. These records will be prepared and submitted in compliance with consent and/or license conditions to MMO/JNCC and will include completing and submitting Marine Mammal Recording Forms provided by JNCC (Annex A). Marine Mammal Deck Forms are also provided in Annex B.

1.9.3. As well as the above reporting, data on loud, low to medium frequency (10 Hz – 10 kHz) impulsive noise should be submitted to the Defra/JNCC Marine Noise Registry (https://mnr.jncc.gov.uk/). Activities for which data should be submitted include:

- seismic surveys;
- sub bottom profiling;
- impact piling;
- explosive detonation;
- acoustic deterrent devices; and
- MBES devices (≤12kHz).

1.9.4. Data specifics include location, dates and source property data, including (where relevant) source frequency, maximum airgun volume, maximum hammer energy, TNT equivalent, sound pressure level and sound exposure level.

PILING

1.9.5. An MMObs report must be submitted to MMO/JNCC upon completion of piling operations and should include the information detailed below. It should be accompanied by completed JNCC marine mammal recording forms (i.e. the raw data in the excel

spreadsheets) and a copy of the relevant survey consent or licence, as well as the excel spreadsheets in their original format (i.e. do not convert to pdf).

Operator details

1.9.6. Include brief details of the company awarded the consent or licence, relevant contractor details if appropriate, and the survey consent or licence reference number issued by the Regulator. Highlight contact details for whoever is responsible for the piling operations in case JNCC has any follow up questions.

Operational details

Provide a summary of the piling operations, including:

- date and location of piling operations;
- a record of all occasions when piling occurred, including details of the duration of the pre piling search and soft start procedures, and any occasions when piling activity was delayed or stopped due to presence of marine mammals;
- details of watches made for marine mammals, including details of any sightings, details of the PAM equipment and detections, and details of the piling activity during the watches;
- details of any Acoustic Deterrent Devices (ADDs) used, and any relevant observations on their efficacy;
- details of any problems encountered during the piling process including instances of non-compliance with the agreed piling protocol; and
- any recommendations for amendment of the protocol.

MMO/PAM effort and detections

1.9.7. Include details of the number of staff employed, whether they were dedicated or non-dedicated staff and their working location(s) on the vessel. Also, include details of their experience (i.e. level of training, number of previous mitigation assignments or previous experience of observing if new to the role). A brief CV could be added as an appendix if easier. Provide details of the lead operative responsible for the report who can be contacted if JNCC has any follow up questions.

1.9.8. If PAM has been used on the vessel, include details of the equipment and software and a summary of how often if was deployed. Also, detail any technical issues encountered (e.g. equipment failure or deployment issues). Screenshots of spectrograms can also be helpful but are not essential.

1.9.9. Details of all monitoring effort should be included in the recording forms (Annex A) but should also be summarised within the report. Also, summarise details of any marine mammals encountered, either visually or acoustically, distinguishing between those recorded inside and outside the mitigation zone.

Application of mitigation procedures

1.9.10. Include details of any piling specific arrangements agreed with the Regulator as part of the consent conditions prior to the start of piling operations (e.g. changes to the size of the mitigation zone).

1.9.11. Provide a summary of mitigation procedures applied, including details of soft starts implemented and whether delays in piling were required. Again, only a summary is required as further details will be provided in the accompanying recording forms (Annex A).

1.9.12. Details of any issues that have arisen relating to understanding or interpreting the JNCC guidelines should be included in the MMO report, describing the issue and how it was resolved, or including suggestions as to how it could have been resolved, to aid JNCC with future revisions of the guidelines.

1.9.13. Any issues encountered in complying with the consent or licence conditions that relate to marine mammal mitigation should also be summarised in the report.

Submission of data to Marine Noise Registry

1.9.14. Where it has been possible to do so, data collected using the PAM system during piling operations will be submitted to the MNR, and should (where possible) include:

- source properties:
  - SPL, dB re 1 µPa (peak) @ 1 m;
  - SEL, dB re 1 µPa2s (per pulse) @ 1 m;
- maximum hammer energy;
- actual location of activity:
  - latitude/longitude point (decimal degrees);
  - quadrant/Block (UK oil and gas licensing blocks); and
- actual dates on which activity took place in correspondence with the location.

Additional information

1.9.15. Additional information, for example, photographs of marine mammals observed, can be included at the end of the report if available.

GEOPHYSICAL/SEISMIC SURVEYING

1.9.16. An MMObs report must be submitted to MMO/JNCC upon completion of a geophysical or seismic survey and should include the information detailed below. It should be accompanied by completed JNCC marine mammal recording forms (Annex A) (i.e. the raw data in the excel spreadsheets) and a copy of the relevant survey consent or licence, as well as the excel spreadsheets in their original format (i.e. do not convert to PDF).

Operator details

1.9.17. Include brief details of the company awarded the consent or licence, relevant contractor details if appropriate, and the survey consent or licence reference number issued by the Regulator. Highlight contact details for whoever is responsible for the survey in case JNCC has any follow up questions.

Survey details

1.9.18. Provide a summary of the survey including:

- date and location of survey;

- total number and volume of airguns used;
- nature of airgun array discharge frequency (in Hz), intensity (in dB re. 1µPa or bar metres) and firing interval (seconds);
- details of any airgun testing;
- details of any other acoustic energy used (e.g. SBP);
- descriptions of any technical problems encountered and what, if any, actions were taken;
- average duration of all pre survey watches, soft starts and line changes, and the number of occasions when guideline durations were not met (specific times are included in the accompanying MMObs excel recording forms (Annex A));
- any problems encountered and instances of non-compliances with the JNCC guidelines (2017), MMMP, and variations from agreed procedures;
- summary of MMObs/PAM activities for each monitoring period, including specifics of the conducted surveys and any relevant observations on the efficacy of PAM equipment (i.e. full excel recording forms of operations (Annex A) and brief written summary);
- number and types of vessels involved in the survey; and
- presence, location, and activity of other vessels during geophysical surveying.

1.9.19. The geographical coordinates of the survey area and, if appropriate, the greater working area will have been included in the initial application, but a map illustrating the location of the survey (or the licence blocks within which it occurred) can be beneficial, as can be an illustration of the completed survey lines.

1.9.20. It should also be highlighted if the survey has occurred within or close to a protected area which includes marine mammals as a feature. Note, general details of likely marine mammal presence in the survey area will have already been included in the application and does not need repeating here.

MMO/PAM effort and detections

1.9.21. Include details of the number of staff employed, whether they were dedicated or non-dedicated staff and their working location(s) on the vessel. Also, include details of their experience (i.e. level of training, number of previous mitigation assignments or previous experience of observing if new to the role). A brief CV could be added as an appendix if easier. Provide details of the lead operative responsible for the report who can be contacted if JNCC has any follow up questions.

1.9.22. If PAM has been used on the vessel, include details of the equipment and software and a summary of how often if was deployed. Also, detail any technical issues encountered (e.g. equipment failure or deployment issues). Screenshots of spectrograms can also be helpful but are not essential.

1.9.23. Details of all monitoring effort should be included in the recording forms (Annex A) but should also be summarised within the report. Also, summarise details of any marine mammals encountered, either visually or acoustically, distinguishing between those recorded inside and outside the mitigation zone.

Application of mitigation procedures

1.9.24. Include details of any survey specific arrangements agreed with the Regulator as part of the survey consent conditions prior to the start of the survey (e.g. changes to the size of the mitigation zone).

1.9.25. Provide a summary of mitigation procedures applied, including details of soft starts implemented and whether delays in firing were required. Again, only a summary is required as further details will be provided in the accompanying recording forms (Annex A).

1.9.26. Details of any issues that have arisen relating to understanding or interpreting the JNCC guidelines should be included in the MMO report, describing the issue and how it was resolved, or including suggestions as to how it could have been resolved, to aid JNCC with future revisions of the guidelines.

1.9.27. Any issues encountered in complying with the consent or licence conditions that relate to marine mammal mitigation should also be summarised in the report.

Submission of data to Marine Noise Registry

1.9.28. Where it has been possible to do so, data collected using the PAM system during surveying operations from seismic, SBP and MBES sound sources will be submitted to the MNR, and should (where possible) include:

- source properties;
  - SPL, dB re 1 µPa (peak) @ 1 m;
  - SEL, dB re 1 µPa2s (per pulse) @ 1 m;
- maximum airgun volume (where applicable);
- actual location of activity;
  - latitude/longitude point (decimal degrees);
  - quadrant/Block (UK oil and gas licensing blocks); and
- actual dates on which activity took place in correspondence with the location.

Additional information

1.9.29. Additional information, for example, photographs of marine mammals observed, can be included at the end of the report if available.

UXO CLEARANCE

1.9.30. An MMObs report must be submitted to MMO/JNCC upon completion of UXO clearance operations and should include the information detailed below. It should be accompanied by completed JNCC marine mammal recording forms (i.e. the raw data in the excel spreadsheets) and a copy of the relevant survey consent or licence, as well as the excel spreadsheets in their original format (i.e. do not convert to PDF).

Operator details

1.9.31. Include brief details of the company awarded the consent or licence, relevant contractor details if appropriate, and the survey consent or licence reference number issued by the

Regulator. Highlight contact details for whoever is responsible for the survey in case JNCC has any follow up questions.

Operational details

1.9.32. Provide a summary of the UXO clearance operations, including:

- date and location of the activity;
- where relevant, the reference number for the activity provided by the regulatory authority;
- details of the UXO clearance operation, including:
  - information on the size of charges used;
  - the start times of explosive detonations;
  - the start and end times of watches by MMOs;
  - the start and end times of any acoustic monitoring using PAM; and
  - details of all explosive activity during the relevant watches.
- any marine mammal sightings, summarised in completed Marine Mammal Recording Forms (see Annex A);
- details of any ADDs used, and any relevant observations on their efficacy; and
- details of any problems encountered during the activity, including instances of non-compliance with the JNCC guidelines and any variations from the agreed procedure.

MMO/PAM effort and detections

1.9.33. Include details of the number of staff employed, whether they were dedicated or non-dedicated staff and their working location(s) on the vessel. Also, include details of their experience (i.e. level of training, number of previous mitigation assignments or previous experience of observing if new to the role). A brief CV could be added as an appendix if easier. Provide details of the lead operative responsible for the report who can be contacted if JNCC has any follow up questions.

1.9.34. If PAM has been used on the vessel, include details of the equipment and software and a summary of how often if was deployed. Also, detail any technical issues encountered (e.g. equipment failure or deployment issues). Screenshots of spectrograms can also be helpful but are not essential.

1.9.35. Details of all monitoring effort should be included in the recording forms (Annex A) but should also be summarised within the report. Also, summarise details of any marine mammals encountered, either visually or acoustically, distinguishing between those recorded inside and outside the mitigation zone.

Application of mitigation procedures

1.9.36. Include details of any survey specific arrangements agreed with the Regulator as part of the survey consent conditions prior to the start of the survey (e.g. changes to the size of the mitigation zone).

1.9.37. Provide a summary of mitigation procedures applied, including details of soft starts implemented and whether delays in firing were required. Again, only a summary is

required as further details will be provided in the accompanying recording forms (Annex A).

1.9.38. Details of any issues that have arisen relating to understanding or interpreting the JNCC guidelines should be included in the MMO report, describing the issue and how it was resolved, or including suggestions as to how it could have been resolved, to aid JNCC with future revisions of the guidelines.

1.9.39. Any issues encountered in complying with the consent or licence conditions that relate to marine mammal mitigation should also be summarised in the report.

Submission of data to Marine Noise Registry

1.9.40. Where it has been possible to do so, data collected using the PAM system during UXO detonation/s will be submitted to the MNR, and should (where possible) include:

- source properties;
  - SPL, dB re 1 µPa (peak) @ 1 m;
  - SEL, dB re 1 µPa2s (per pulse) @ 1 m;
  - mass of TNT equivalent;
- actual location of activity;
  - latitude/longitude point (decimal degrees);
  - quadrant/Block (UK oil and gas licensing blocks); and
- actual dates on which activity took place in correspondence with the location.

Additional information

1.9.41. Additional information, for example, photographs of marine mammals observed, can be included at the end of the report if available.

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ANNEX A: JNCC MARINE MAMMAL RECORDING FORM

Excel spreadsheet available direct from JNCC, which **should be submitted to MMO/JNCC in original format** (i.e. as a spreadsheet file, and not converted to PDF).

Marine Mammal Recording Form available at: https://hub.jncc.gov.uk/assets/e2a46de5-43d4-43f0-b296-c62134397ce4.

ANNEX B: JNCC MARINE MAMMAL DECK FORMS

MARINE MAMMAL RECORDING FORM - COVER PAGE

Regulatory reference number (e.g. DECC no., BOEM permit no., OCS lease no., etc.)	**Country**	**Location**	**Ship/ platform name**

Client	**Contractor**	**Survey type**
		☐ site ☐ VSP ☐ 2D ☐ WAZ ☐ 3D ☐ piling ☐ 4D ☐ explosives ☐ OBC ☐ other ☐ 4C
Start date	**End date**	

Number of source vessels	**Type of source** (e.g. airguns)	**Number of airguns** (only if airguns used)	**Source volume** (cu. in.)
Source depth (metres)	**Frequency** (range in which peak energy is emitted, in Hz)	**Intensity** (primary peak-to-peak amplitude in dB re. 1µPa or bar metres)	**Shot point interval** (metres)

Method of soft start

☐ increase number of guns ☐ increase frequency (where permitted) ☐ increase pressure (where permitted) ☐ increase number and frequency ☐ increase number and pressure ☐ other

Visual monitoring equipment used (e.g. binoculars, big eyes, etc.)	**Magnification of optical equipment** (e.g. binoculars)	**Height of eye above water surface** (metres)	**How was distance of animals estimated?**
			☐ by eye ☐ with laser rangefinder ☐ with rangefinder stick/callipers ☐ with reticle binoculars ☐ by relating to object at known distance ☐ other

Number of dedicated MMOs	**Training of MMOs**
	☐ JNCC approved MMO training course for UK waters ☐ PSO training course for the Gulf of Mexico ☐ MMO training course for Irish waters ☐ MMO training course for New Zealand waters ☐ other ☐ none

Was PAM used?	**Number of PAM operators**
☐ yes ☐ no	

Description of PAM equipment

Range of PAM hydrophones from airguns (metres)	**Bearing of PAM hydrophones from airguns** (relative to direction of travel)	**Depth of PAM hydrophones** (metres)

MARINE MAMMAL RECORDING FORM - OPERATIONS

Regulatory reference number .....…….. **Ship/ platform name** .....
(e.g. DECC no., BOEM permit no., OCS lease no., etc.)

Complete this form every time the airguns are used, including overnight, whether for shooting a line or for testing or for any purpose.
Times should be in UTC, using the 24 hour clock.

Date	**Reason for firing** l = line t = test x = test followed immediately by line	**Time soft start/ ramp-up began**	**Time of full power**	**Time of start of line**	**Time of end of line**	**Time of reduced output** (if relevant)	**Time airguns/ source stopped**	**Time pre-shooting search began**	**Time search ended**	**Time PAM began**	**Time PAM ended**	**Depth range** (during pre-shooting search) s = <200m d = >200m b = both	**Was it day or night in period prior to firing?** d = day n = night w = dawn k = dusk	**Was any mitigating action required?** (yes/ no)

MARINE MAMMAL RECORDING FORM - EFFORT

Regulatory reference number .....…….. **Ship/platform name** .....
(e.g. DECC no., BOEM permit no., OCS lease no., etc.)

Record the following for all watches, even if no marine mammals are seen.
START A NEW LINE IF SOURCE ACTIVITY OR WEATHER CHANGES. ENTER DATA AT LEAST EVERY HOUR.

Date	**Visual watch or PAM** (v/ p)	**Observer's/ operator's name(s)**	**Time of start of section of watch** (UTC, 24hr clock)	**Time of end of section of watch** (UTC, 24hr clock)	**Source activity** (f/ s/ r/ n/ v)	**Start position** (latitude and longitude)	**Depth at start** (m)	**End position** (latitude and longitude)	**Depth at end** (m)	**Speed of vessel** (knots)	**Wind dir'n**	**Wind force** (B'fort scale)	**Sea state** (g/ s/ c/ r)	**Swell** (o/ m/ l)	**Vis.** (visual watch only) (p/ m/ g)	**Sun glare** (visual watch only) (n/ wf/ sf/ vf/ wb/ sb/ vb)	**Precip.** (n/ l/ m/ h/ s)

Visual watch or PAM: v = visual watch; p = PAM
Source activity: f = full power; s = soft start; r = reduced power (not soft start); n = not active; v = variable (e.g. tests)
Sea state: g = glassy (like mirror); s = slight (no/ few white caps); c = choppy (many white caps); r = rough (big waves, foam, spray)
Swell: o = low (< 2 m); m = medium (2-4 m); l = large (> 4 m)
Visibility: p = poor (< 1 km); m = moderate (1-5 km); g = good (> 5 km)
Sun glare: n = none; wf = weak forward; sf = strong forward; vf = variable forward; wb = weak behind; sb = strong behind; vb = variable behind
Precipitation: n = none; l = light rain; m = moderate rain; h = heavy rain; s = snow

MARINE MAMMAL RECORDING FORM - SIGHTINGS

Regulatory reference number (e.g. DECC no., BOEM permit no., OCS lease no., etc.)	**Ship/ platform name**	**Sighting number** (start at 1 for first sighting of survey)	**Acoustic detection number** (start at 500 for first detection of survey)
Date		**Time at start of encounter** (UTC, 24hr clock)	**Time at end of encounter** (UTC, 24hr clock)

Were animals detected visually and/or acoustically?	**How were the animals first detected?**
□ visual □ acoustic □ both	□ visually detected by observer keeping a continuous watch □ visually spotted incidentally by observer or someone else □ acoustically detected by PAM □ both visually and acoustically before operators/ observers informed each other

Observer's/operator's name	**Position** (latitude and longitude)	**Water depth** (metres)

Species/species group	**Description** (include features such as overall size; shape of head; colour and pattern; size, shape and position of dorsal fin; height, direction and shape of blow; characteristics of whistles/ clicks)
Bearing to animal (when first seen or heard) (bearing from true north)	**Range to animal** (when first seen or heard) (metres)

Total number	**Number of adults** (visual sightings only)	**Number of juveniles** (visual sightings only)	**Number of calves** (visual sightings only)	**Photograph taken**
				□ yes □ no

Behaviour (visual sightings only)

Direction of travel (relative to ship)	**Direction of travel** (compass points)
□ towards ship □ variable □ away from ship □ milling □ parallel to ship in same direction as ship □ stationary □ parallel to opposite direction to ship □ other □ crossing perpendicular ahead of ship □ unknown	□ N □ W □ NE □ NW □ E □ variable □ SE □ stationary □ S □ unknown □ SW

Airgun (or other source) activity when animals first detected	**Airgun (or other source) activity when animals last detected**	**Time animals entered mitigation/ exclusion zone** (UTC, 24hr clock)	**Time animals left mitigation/ exclusion zone** (UTC, 24hr clock)
□ full power □ not firing □ soft start □ reduced power (other than soft start)	□ full power □ not firing □ soft start □ reduced power (other than soft start)	**Closest distance of animals from airguns (or other source)** (metres)	**Time of closest approach** (UTC, 24hr clock)

If seen during soft start give: **First distance** **Closest distance** **Last distance** during soft start (metres)	**What action was taken?** (according to requirements of guidelines/ regulations in country concerned) ☐ none required ☐ delay start of firing ☐ shut-down of active source ☐ power-down of active source ☐ power-down then shut-down of active source	**Length of power-down and/ or shut-down** (if relevant) (length of time until subsequent soft start, in minutes)	**Estimated loss of production (if relevant) due to mitigating actions** (km)