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Additional recommendations for the verification of underwater sound fields from the use of explosives in the marine environment

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1. Introduction

Explosives in the marine environment are used for a variety of reasons, including oil and gas infrastructure decommissioning, UXO clearance and military activities. Underwater noise from these explosive operations has the potential to cause injury to noise sensitive species including marine mammals and fish.

Before explosives operations are undertaken in UK waters, a licence or consent is required. Full lists of activities which require a Marine Licence are provided in The Marine and Coastal Access Act 2009 and the Marine (Scotland) Act 2010, including:

- To deposit or use any explosive substance or article within the UK/Scottish marine licensing area either in the sea or on or under the seabed; and
- To incinerate any substance or object on any vehicle, vessel, marine structure or floating container in the UK/Scottish marine licensing area.

Applications for these licences must be supported by a noise risk assessment, which outlines the likely impact of underwater noise from explosive operations on noise-sensitive species. In addition to the noise risk assessment a marine mammal mitigation protocol (MMMP) is often required, summarising the key findings of the noise risk assessment and defining the measures the project will take to mitigate the risks.

As a condition of the licence or consent, there may also be a requirement to undertake underwater noise monitoring. The Joint Position Statement on UXO clearance (UK Government 2025) and accompanying guidance (Defra 2025; Scottish Government 2025) provides some clarity around the expectations and objectives of undertaking underwater noise monitoring of UXO clearance activities. However, there is an absence of similar guidance in relation to noise monitoring of other activities that utilise explosives in the marine environment (such as decommissioning of oil and gas infrastructure or rock breaking).

A common approach to monitoring is required to address the knowledge gaps relating to the risk of underwater noise from explosives as well as inconsistencies that have been identified in how monitoring is undertaken and reported from project to project in the past. The following recommendations have been developed to provide further clarity regarding expectations for underwater noise monitoring required by licence conditions. It assumes the monitoring itself will be undertaken by experienced specialist contractors so aims to support those planning monitoring and procuring specialists. This report should be read in conjunction with the National Physical Laboratory's Protocol for In-Situ Underwater Measurement of Explosive Ordnance Disposal for UXO (NPL 2020).

This report forms the second part of a project undertaken for JNCC called "Recommendations for when assessing injury risk to marine mammals and fish posed by noise when using explosives in UK waters" (hereafter the Project). Development of the following recommendations has been undertaken by a consortium of APEM Ltd, SMRU Consulting and Subacoustech Environmental Ltd., and through consultation with UK Statutory Nature Conservation Bodies and industry stakeholders.

2. Requirements to undertake noise monitoring

As a condition of a licence or consent, there may be a requirement to undertake underwater noise monitoring. For UXO clearance operations, Defra (2025) states:

- Marine licence holders are encouraged to undertake noise monitoring, regardless of whether it is a consent requirement, to:
    - expand the knowledge base on potential impacts and
    - support the use of tools which reduce impacts
- Marine licence holders may be required, as a marine licence condition, to undertake noise monitoring during clearance activities to:
    - verify conclusions drawn in the environmental assessment
    - support claims a particular method or tool will result in lower noise levels compared to high order detonation and
    - the need for noise monitoring will be considered on a case-by-case basis at the application stage.
- Noise monitoring should comply with the protocol provided by the National Physical Laboratory for in-situ underwater measurements. Additional or more detailed requirements may be stipulated by the licensing authority during the application process and included as a consent condition.

At present, no equivalent Position Statement or guidance has been issued by Regulators or Statutory Advisors in respect to the use of explosives for other purposes. In addition, the outputs of Humphrey *et al*. 2026 (Section 1) highlight a data gap regarding underwater noise levels from explosive use in decommissioning.

The encouragement to undertake noise monitoring beyond that required by consent conditions reflects Regulators' desire for a pro-active approach from licence holders to assist with addressing existing knowledge gaps. Although Defra (2025) specifically refers to UXO clearance activities, the intent is equally applicable to all activities requiring the use of explosives in the marine environment.

While the requirement for noise monitoring is considered on a case-by-case basis, the findings from Section 1 (Humphrey *et al*. 2026) highlighted a lack of publicly available data with which to validate noise modelling as well as an uncertainty inherent in all predictive models. Applicants should anticipate that field verification may be required whenever a noise risk assessment indicates that a risk of auditory injury exists.

If a prospective applicant believes that a particular project or operation should not require field verification, it is recommended that they consult the relevant Regulator ahead of submitting the licence application.

3. Existing guidelines and protocols

All underwater noise monitoring of activities using explosives is expected to follow current standards and best practice.

All measurement studies during explosive use in the UK marine environment should be undertaken in accordance with the National Physical Laboratory's Protocol for In-Situ Underwater Measurement of Explosive Ordnance Disposal for UXO (NPL 2020). Although intended to provide recommendations on undertaking in-situ measurements of UXO clearance, this guidance is sufficiently general to be applied to other activities using explosives with only minor adjustments.

NPL (2020) applies the existing international standards for measurement of sound from pile driving (BS EN ISO 18406:2017) and acoustic terminology (BS EN ISO 18405:2017) to the measurement of sound from the use of explosives for UXO clearance. For consistency, this terminology should be applied in marine licence applications and post-monitoring reports.

The scope of NPL (2020) is limited to the technical aspects relevant to acquiring good quality measurement data. Their summary of recommended performance specification is provided in Table 1. The recommendations that follow (Section 4) expands on that to consider the purpose of undertaking field verification in the context of the wider consenting process and existing knowledge gaps. It also considers the practical implementation of the NPL (2020) protocol generally, and for monitoring explosions from other activities.

Key things to note:

- **Terms and definitions:** The terms and definitions given in BS EN ISO 18405:2017 shall apply.

- **General principles:** All measurements should be undertaken in accordance with the general principles outlined in NPL (2020) along with the recommendations in this report. It is acknowledged that the measurement of underwater explosions is highly site specific, and many parameters cannot be known in advance (NPL, 2020).

- **Instrumentation:** The specification of instrumentation for capturing underwater noise from explosions needs careful consideration due to the very high peak pressures required to be monitored. Full details of the performance characteristics that must be considered are detailed in NPL (2020, Section 2) and BS EN ISO 18406:2017, along with the requirements for system calibration in accordance with BS EN IEC 60565 (IEC 60565-1:2020, IEC 60565-2:2019, IEC 60500:2017).

It should be noted that the standards and protocols used to inform this report do not extend to works undertaken in water of depth less than 4 m or greater than 100 m (BS EN ISO 18406:2017; NPL 2020). Where works are to be undertaken out with these parameters, or the site presents specific challenges (such as strong currents), the mooring and deployment examples provided in the existing protocols may not be appropriate. In these circumstances, the specialist contractor should draw on their knowledge and experience to adapt the equipment and methodology to suit the site conditions. They should expect to demonstrate that their proposed equipment and methodology is suitable for the site conditions as well as for achieving the study objectives.

Table 1: Summary of recommended performance specification for when undertaking noise monitoring during UXO clearance (reproduced from NPL 2020).

Performance characteristic	Recommended specifications	
	Explosion	Background noise
Frequency range	20 Hz – 20 kHz	
Sensitivity	Less than -200 re 1V/µPa (for use at a minimum range of 1 km)	Between -185 to -165 dB re 1 V/µPa
Frequency response	Invariant with frequency (flat response) in the range 20 Hz to 20 kHz (to a tolerance of ±1 dB)	
Dynamic range	System dynamic ranges of more than 60 dB are preferred. Analogue to digital converter (ADC) Minimum 16-bit resolution (nominal dynamic range 96 dB), Preferable 24-bit resolution (nominal dynamic range 144 dB)	
Signal to noise ration	Minimum 6 dB level difference	
Directionality	Omnidirectional to within +/- 2 dB up to 20 kHz	
Sampling frequency	44.8 kHz (for one-third octave levels required up to 20 kHz)	Twice the maximum frequency of interest (defined by the maximum hearing response of relevant receptors)
Filtering	Any filter characteristics should be known and corrections applied (low pass and high pass filtering caused by instrumentation). Any low frequency roll-off in recorder performance due to high pass electronic filtering must be measured so that suitable corrections can be applied.	
System self-noise	Ideally 6 dB below the lowest sound level.	
Calibration	Calibrated to traceable standard within the last two years	
Data storage	Raw data ideally stored in lossless format. Any compression used must be reported, and uncompressed data must be recoverable before analysis. Metadata to be stored: instrument calibration and ADC scaling factor, amplifier gains, sampling frequency and resolution	

4. Supplementary recommendations

Monitoring of underwater noise associated with an explosive operation, where required, is an important component of the licensing process and good quality measurement data is essential to ongoing efforts to limit the noise impact on the marine environment. Section 1 of Humphrey *et al*. (2026) found inconsistencies in the way that projects undertake and report noise monitoring studies, which limits both the usefulness of the findings and the information available to Regulators.

The purpose of this section is to supplement guidelines previously discussed (Section 3), by considering the consenting process and the practicalities of working at sea and alongside other activities. It aims to reduce inconsistencies in how monitoring is undertaken and reported between projects. This will enable better comparisons between activities, expanding the available database and reducing evidence gaps.

4.1. Underwater noise monitoring objectives

The objective of all measurement studies is to obtain datasets that are suitable for their intended purpose. A common approach is necessary to facilitate comparison between measurements and aid the understanding of noise from underwater explosions and its impact in the marine environment (NPL 2020).

In the context of marine licencing, Defra (2025) provides four different reasons why underwater noise monitoring may be undertaken for UXO clearance:

- expand the knowledge base on potential impacts,
- support the use of tools which reduce impacts,
- verify conclusions drawn in the environmental assessment,
- support claims a particular method or tool will result in lower noise levels compared to high order detonation (or another method).

These equally apply to other uses of explosives in the marine environment including during decommissioning.

Where a requirement to undertake monitoring is stipulated as a condition of the Marine Licence, then the reason for this is stated, as shown in the following example (MMO 2024):

> “Underwater noise monitoring of a minimum of ten low order (deflagration) UXO clearances and all high order UXO clearances, must be undertaken. Additionally, once the monitoring of the ten low order clearances has taken place, if a new type of UXO which has not yet been surveyed requires low order clearance, then monitoring of this new type should be undertaken.
>
> The monitoring must adhere to Licence Schedule 6 - Protocol for In-Situ Underwater Measurement of Explosive Ordnance
>
> Reason: To provide evidence on the underwater noise impacts of the low order deflagration method.”

The reason given in the licence condition will vary and is necessarily brief but license holders should not infer that the scope of a monitoring study is limited to the stated reason alone and

should also consider the wider context. In all cases, regardless of the reason given in the licence condition, the monitoring must also be appropriate to verify the conclusions drawn in the environmental assessment.

It is recommended that the full requirements for monitoring and reporting of a licence condition be confirmed with the Regulator and methods discussed with the relevant SNCBs.

Note, not having a licence condition requiring noise monitoring does not prohibit it from being undertaken. The collection of data to fill evidence gaps and support the wider industry is encouraged.

4.2. Recommendations for when drafting tenders

When engaging with specialist contractors for undertaking underwater noise monitoring, it is recommended that the tender requirements explicitly reference the requirements of (NPL 2020) and these guidelines.

Unless the tenderer has sufficient knowledge and experience, or specific project constraints, it is recommended that the invitation to tender avoid being overly prescriptive regarding the technical requirements. Doing so may prevent those responding from applying the most appropriate or up to date equipment in their proposal, for example, where equipment has evolved. Instead, tender submissions should be required to demonstrate how their proposal meets the project objectives and prevailing best practice (NPL 2020).

It may also be more appropriate to specify the subsequent contract expectations in terms of outcomes rather than a detailed technical specification (e.g. the contractor is required to successfully monitor detonations up to a particular charge weight and range).

4.3. Supplier engagement

In-situ measurement of underwater noise requires a knowledge of both instrumentation and underwater acoustics. Licence holders will usually need to engage specialists to undertake the measurement study and analyse the results in accordance with current standards. It is for licence holders to determine how to engage specialists in underwater noise monitoring. This may be direct (e.g. the contract is between the specialist and the licence holder) or as a component within a larger agreement (e.g. the contract is between the specialist and a company working on behalf of the licence holder).

Underwater noise monitoring studies undertaken in accordance with this report will require a range of information to inform the monitoring design and methodology. For example, information from noise risk assessments undertaken to support the licence application and other site-specific data. Licence holders are encouraged to ensure that supply chain arrangements do not restrict direct communication between those appointed to undertake the underwater noise monitoring, those who undertook the noise assessment, engineers undertaking the explosive operations and the crew of the vessel from which the monitoring will take place. This will help ensure the planned monitoring will be as effective as possible and help avoid potential problems at sea. This will also help avoid issues of non-compliance where monitoring is required as a licence condition, as it is the licence holder who will be liable regardless of who engages the monitoring specialists.

4.4. System sensitivity and dynamic range

The system sensitivity is required to be an appropriate value for the sound signal being measured and must be chosen to avoid system saturation (clipping) for high amplitude

sounds. This will require knowledge of the estimated peak sound pressure at each location, to ensure the chosen system can measure what is required.

For an unconstrained detonation on the seabed, NPL (2020) provides a recommended system sensitivity value (Section 2.2.1) and describes a simple approach to estimating the peak sound pressure based on the range, weight and type of charge which may be used to choose appropriate sensitivity values (Section 4.3.1). For other explosive activities, it may be necessary to use the findings from the noise impact assessment (in the form of predicted SPL_{pk} ($L_{p,pk}$) with range) to estimate the peak sound pressure at each location. In all cases allowance should be made for actual peak pressure levels to significantly exceed estimates. Note that while NPL (2020) suggests that the system sensitivity should be less than -200 re 1 V/µPa, a sensitivity as low as -240 re 1 V/µPa might be necessary, depending on the overall system specification.

It is good practice to measure background noise levels at each location along with the measurement of the explosive event (NPL 2020; BS EN ISO 18406:2017). It may be necessary to use multiple hydrophones of different sensitivity to simultaneously measure high amplitude sound and low-level background noise without signal clipping, and distortion with an acceptable signal-to-noise ratio (better than 6 dB).

4.5. Frequency range

A minimum sample rate of 43.8 kHz is required for capturing sound from underwater explosions (to measure up the 20 kHz 1/3rd octave band). However, a higher sampling rate may be required depending on the hearing abilities of sensitive receptors (over 300 kHz for harbour porpoise; NPL 2020). Even if 43.8 kHz is considered sufficient to meet the immediate objectives of the study, projects should endeavour to acquire data at the highest practicable sample rate to not limit the analysis that may be undertaken and potential for use in wider industry studies.

4.6. Deployment methodology

Methods for both static and vessel-based deployment of monitoring equipment are described in NPL (2020) (Section 3.1).

It is recommended that static bottom-mounted deployments be preferred over vessel-based deployment wherever possible as these can yield the most useful datasets. Allowing multiple units to be deployed simultaneously will also reduce challenges that can arise with vessel or surface deployments.

It is acknowledged that there may be occasions where static deployments may not be practicable due to environmental or navigational constraints. If vessel-based deployments are the only option for undertaking noise measurements, careful consideration should be given to minimising the sources of platform noise (including vessels) described in NPL (2020) and ensuring that measurements are consistent with the protocol. For example, consideration should be given to:

- Accurate determination of the hydrophone location, which may drift away from the vessel at the moment of detonation.

- Avoiding cable strum (where the movement of the water makes the cable vibrate, creating low frequency signals) - measurements taken with the vessel drifting with the current (out of gear or engines off) should be preferred to minimise this. The hydrophone should be decoupled from the vessel and surface waves using a suitable buoy or compliant mooring line.

- Possible interference from vessel electrical systems and sensors operating at the same time (inverters, depth sounders, etc.).

As described in NPL (2020), the hydrophones are to be positioned in the lower half of the water column but at least 2 m above the seafloor. The depth the hydrophone is positioned in the water column should always be recorded. The minimum requirement at each detonation location is for a single hydrophone but there are benefits to deploying multiple hydrophones of different sensitivity to measure high amplitude explosive sound and low-level background noise (NPL 2020).

It is recommended the licence holders discuss the planned approach with the appropriate regulator. Enabling discussions between the specialist undertaking the monitoring and the vessel operator ahead of deployment can also help prevent issues when at sea.

4.7. Recommended measurement locations

Measurement locations should be selected to facilitate a meaningful comparison between the findings of the noise risk assessment and measurement data. The following summarises recommendations from NPL (2020) for the selection of measurement locations:

- A minimum of three well-separated locations should be used
- To facilitate comparison between studies, a measurement should be made at 1 km, or as close as possible to this distance
- Additional measurements should be made at increasing ranges up to at least 10 km, and ideally 20 km
- Successive ranges should increase by an approximate trebling of distance relative to the 1 km minimum range (for example, say, 1 km, 3 km, 10 km, etc.)
- If possible, a measurement should be made at the range at which biologically relevant thresholds are predicted
- Measurements along a straight line/transect are preferred where practicable, such that all measurement locations are along a single bathymetry profile
- Transects should be chosen along a consistent water depth and sudden changes in bathymetry should be avoided.

It is recognised that the positioning of instrumentation will be subject to environmental and operational constraints that may restrict the number and position of measurement location and options available for deployment. Where significant vessel activity is expected, subsea, bottom mounted deployment with acoustic release for recovery, or ROV deployed mooring, may be the only practicable solutions. Alternative measurement locations may be considered but it will still be necessary to ensure that sufficient measurements are available to be compatible with the study's objectives, such as comparison with an assessment.

4.8. Distance measurement

The location of the noise source and measurement locations must be recorded as accurately as possible, and the distance reported with the results (NPL 2020). Impact assessments and mitigation requirements are based on an estimated reduction in noise level with distance from the explosion, so an accurate knowledge of the measurement position is essential for a

meaningful comparison. Source and receiver locations should be recorded using latitude and longitude coordinates.

GPS accuracy should be sufficient to determine the distance within +/- 5% (NPL 2020; BS ISO 18406:2017). The required accuracy of positioning should be considered when determining the deployment configuration, choice of vessel and methodology.

4.9. Data processing and analysis

Data processing and analysis will be undertaken by the contracted noise monitoring specialist. The processing for converting the measured signal to sound pressure and determining the relevant metrics must follow the procedure prescribed in NPL (2020) and properly account for the calibration of the hydrophone.

In all cases the following acoustic metrics (ISO 18405:2017; ISO 80000-8:2020) are required to be calculated over the whole duration of the pulse from each measurement:

- Peak sound pressure level, $L_{p,pk}$, SPL_{pk} in dB re. 1 µPa
- Unweighted single pulse sound exposure level, $L_{E,p}$ or SEL_{ss}, in dB re. 1 µPa^{2}s
- Weighted single pulse sound exposure level, $L_{E,p,w}$ or $SEL_{ss,w}$, in dB re. 1 µPa^{2}s for all weighted metrics used in the assessment
- One-third octave or decidecade band analysis. The calculation method (i.e. base-2 or base-10) should be stated.

Where a single explosive event gives rise to multiple acoustic pulses, the $L_{E,p}$ should be calculated over the duration of the entire event. However, if individual pulses can be clearly identified and isolated, there is benefit in calculating each as a single pulse. In all cases the time interval used to calculate the $\underline{L_{E,p}}$ should be clearly stated.

Noise levels in the absence of any specific source should be calculated in terms of broadband sound pressure level ($L_{p,rms}$, in dB re. 1 µPa) and one-third octave band levels, and the duration over which the level is calculated must be stated. Typically, this will be presented as a plot of level vs. frequency.

To clearly identify the target events from other possible noise events, the precise timing of events must be available during analysis.

5. Reporting

The primary purpose of reporting is typically to comply with consent/licence conditions. However, it is equally important to improve the consistency of measurement studies and reporting and facilitate comparison between studies. Even where there are no apparent issues with the quality of the measurement data, insufficient analysis or a failure to report auxiliary data will limit the overall usefulness of the report. The monitoring report will be written by the contracted specialist with input from the EOD specialists on the particulars of the explosive activity, however it is the responsibility of the licence holder to submit it to the regulator. Making monitoring reports publicly available (whether produced to meet licence conditions or not) is recommended. When not available via regulatory sources (e.g. the Marine Management Organisation Marine Case Management System), it is recommended those commissioning the monitoring find alternative platforms on which to make them available.

It is essential that whenever a measurement is undertaken, certain auxiliary data must accompany the acoustic measurement to aid the interpretation of the results. It is beneficial to record any auxiliary data that are relevant, as these can be correlated with the measured level during the analysis (NPL 2020; BS EN ISO 18406:2017).

The following outlines Regulators' expectations for reporting and reflects the need for improved consistency between reports produced at different projects or campaigns.

5.1. Measurement details and results

The mandatory and other optional information that is to be provided when reporting noise monitoring to properly describe the measurement of the explosive event, based on NPL (2020), are described in Table 2. Irrespective of whether the information is indicated as mandatory or optional, all relevant information should be provided where readily available.

Note, for UXO clearance campaigns there may be licence requirements for multiple post clearance reports; for example, one detailing the results of the noise monitoring and another detailing the specifics of the clearance activities and post-clearance surveys of the seabed at the location of the detonation. In some instances, it may be possible to combine these reports but in practice, the monitoring report if usually completed later as data analysis can take time. The post clearance report will be completed by the EOD company contracted to undertake the clearance report. It is beneficial for the specialist contractor undertaking the noise monitoring to have sight of this clearance report when analysing the data.

For decommissioning explosive operations, a separate report detailing the specifics of the detonation is rarely needed as these activities tend to be smaller in scale. Subsequently it can be beneficial to include as much information about the explosives operations as possible in the noise monitoring report. Following both types of operation, a report detailing marine mammal mitigation undertaken will also be expected.

Table 2: Mandatory and optional information to be provided in the monitoring report to properly describe the measurement of the explosive event.
Notes:

1. Some of the optional operational measurements (marked with a *) will be recorded as standard by the marine mammal observer undertaking a visual search ahead of the detonation.
2. Folk sediment classification or similar is sufficient; the classification used should be stated.
3. Where a measurement is not taken over a consistent bathymetric profile or if there are significant changes in sediment type, the relevant bathymetry and sediment information is not considered optional.

Measurements	**Mandatory**	**Optional**
Operational	- Date/time of recordings (including time zone) - Hydrophone depths in the water column - Coordinates of detonation location and hydrophone measuring stations - Water depth at detonation and monitoring location - Water depth at the detonation location and measurement locations	- Sound speed profile of the water column - Wind speed* - Significant wave height* - Tidal state during measurement - Precipitation* - Presence of other vessels (within 5 km radius, where data available) [Note 1] - Seabed type at the detonation and measurement locations [Notes 2 and 3] - Bathymetry data covering the transect or area between the measurement location to the detonation [Note 3]

Measurements	**Mandatory**	**Optional**
Explosive characteristic	- Detonation Identifier (ID) and coordinates of detonation. - Explosive type and weight (actual and TNT equivalent). When multiple charges will detonate simultaneously, state the individual and combined charge weight. - For UXOs, description of the munitions (*e.g.* type, approximate age, state of burial, whether shell casing split or corroded, degree of marine growth). - Method of detonation. - Total number of explosives to be detonation over the entire operation.	- For UXOs, photographs of the device before and the area of clearance after. - Event outcome (*e.g.* did the explosion result in the outcome expected/required?)
Deployment and instrumentation configurations	- Measurement system description including: o acquisition system type o bandwidth o system self-noise o dynamic range o sampling frequency o bit depth o gain settings - Data compression routine, if used. - Description/diagram of deployment method and configurations. - Hydrophone specification (type, model, directionality, nominal sensitivity). - Calibration details (calibration standard, dates and certificate).	- Field calibration methods and results.

Measurements	Mandatory	Optional
Analysis	For each measurement: - Broadband peak sound pressure and peak sound pressure level. - Sound exposure level, broadband and one-third octave band levels. - Weighted sound exposure levels. - Time interval for all sound exposure calculations.	- Pulse duration for the associated broadband pulse. - Peak compressional and peak rarefactional sound pressure level. - The signal to noise ratio calculated from background noise level - The waveform of the underwater explosion, including the bubble oscillations, in graphical form.

5.2. Comparison with impact assessments

As discussed in Section 2, there may be multiple reasons for undertaking underwater noise measurements. Additional information may be required when the primary objective of the measurement study is to understand how in-situ measurements compare with the findings of the modelling used to inform the noise risk assessment undertaken in support of the licence application. Licence holders should be prepared to provide the information necessary (e.g. the modelling) to those undertaking the monitoring study to enable a meaningful comparison with the modelling. It is recommended the licence application risk assessment is used as the source of information rather than the MMMP, as the latter will likely contain an abridged version of the results, if anything at all.

The following information from the measured data should be provided for each metric (unweighted and weighted) and explosive event to facilitate a comparison:

- Estimated range to each injury criteria used in the assessment.
- Estimated noise levels at the injury ranges predicted in the assessment.
- Estimated noise levels at the expected range of the marine mammal at the end of the ADD activation period (see Humphrey *et al*. 2026, Section 2).
- Predicted noise levels at 1 km (if available) and measured noise levels at 1 km.

The method used to interpolate between the measurement locations should be described and injury ranges should be calculated using the same assumptions used in the assessment where possible. Where multiple explosive events occur in a day, calculation of ranges should be undertaken and presented for each event individually and estimation of the noise impact of events in combination should be in addition.

5.3. Presentation of results

The results should be presented in a format appropriate for the end readers, noting their individual technical knowledge can vary greatly. A balance is required between presenting all the relevant information with an appropriate level of technical detail while being understandable to those with little acoustic knowledge. This guidance does not specify a particular format except that any information presented for comparison with assessment

findings should be presented in tabular form, in addition to any plots or figures. It is recommended that a description explaining what is being presented in plots and/or figures is also provided, to ensure the reader interprets them as intended.

5.4. Use of metrics

In accordance with BS EN ISO 18405:2017 acoustic metrics may be written using either form provided above ($L_{E,p,w}$ or $SEL_{ss,w}$). Whilst the form $L_{E,p}$ is preferred, it is recognised that it is less familiar to many readers and as such either form is acceptable, provided that it is used consistently throughout.

6. Further recommendations

6.1. UXO clearance: determination of system sensitivity

UK Government (2025) requires that low noise methods should be the default method of clearance, but it is acknowledged that high-order clearance may still be required.

When determining instrumentation performance requirements, allowance should be made for the possibility of a planned low-order clearance accidently becoming a high-order detonation of the target ordinance. Where possible, it is recommended that the number of hydrophones and/or system performance (of differing sensitivity and dynamic range) be appropriately specified to allow for the detonation to be either low or high order.

6.2. Oil and gas decommissioning

Decommissioning of oil and gas infrastructure is undertaken in multiple phases and explosives can be used during multiple activities (see DESNZ 2023). The following sections outline the considerations for underwater noise monitoring at each phase.

6.2.1. Well casing decommissioning

Decommissioning of a well casing uses a range of explosive options to plug and sever the well pipes.

For detonations at depths greater than 100 m below the level of the seabed surface (the mudline), the resultant noise level in the water column is not considered to present a significant risk of injury to marine mammals and monitoring is not required (see Humphrey *et al*. 2026, Section 1). Where explosions are at depths of within 100 m of the mudline the possibility of high noise levels in the water column is significantly increased, especially at close range. If monitoring of such detonations is to be undertaken at a horizontal distance of less than 1 km, it is recommended that multiple hydrophones with different sensitivities are deployed to cover a wide dynamic range.

6.2.2. Wellhead severance

Operations to remove the wellhead may involve the use of explosives, located a few metres below the mudline and charge weights for well severance operations may be in excess of 40 kg (Ainslie *et al*. 2009).

It is recommended that the overall approach to monitoring and specifying instrument sensitivity and dynamic range values should follow NPL (2020) for high-order UXO clearances.

6.2.3. Jacket foundation severance

Where explosive operations are used for removal of jacket foundations, these are unlikely to occur at a depth below the mudline sufficient to adequately attenuate the noise and so should be considered as a detonation in open water.

As such, the monitoring of underwater noise from the use of explosives used to sever the legs of jacket foundations should follow the protocol in NPL (2020) for high-order UXO clearance.

6.3. Comment on availability of reports and data

Regulators are concerned that work to increase the knowledge and understanding of noise from the use of explosives underwater is often frustrated by non-disclosure agreements and confidentially clauses in contracts between developers and the underwater noise specialists. Regulators wish to encourage greater openness and availability of findings wherever commercial considerations allow.

For the avoidance of doubt, where reports have been submitted to Regulators in fulfilment of a licence condition, these should be considered in the public domain, and if not available on the relevant Regulators web page, may be published or released under a Freedom of Information request. Licence holders are encouraged to inform the respective authors of what has been submitted and the extent to which it may be used or shared.

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