# JNCC guidelines for minimising the risk of injury to marine mammals from explosive use in the marine environment

**JNCC**

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Supporting information is provided in any accompanying annex, which is also of relevance to *JNCC guidelines for minimising the risk of injury to marine mammals from unexploded ordnance (UXO) clearance in the marine environment*.

# Contents

# 1 Introduction

Explosives may be used in the marine environment in a variety of ways including harbour construction, oil and gas wellhead or platform decommissioning and military activities. It is recognised that underwater sound generated from explosives has the potential to cause death, injury (including permanent hearing damage) and disturbance to marine mammals.

Marine mammals have a long history of legal protection in the UK. Key for the context of these guidelines are the suite of Habitats Regulations, which transposed the EC Habitats Directive into UK law (see Annex, part 1). In these it is an offence to deliberately kill, injure, capture or disturb cetaceans throughout their natural range (referred to as European Protected Species). There is also a requirement to designate protected areas for harbour porpoise, bottlenose dolphin, grey and harbour seal.

Explosive use in the marine environment has the potential to result in a deliberate injury offence as defined under UK Habitats Regulations. 'Deliberate' has been interpreted in European Commission guidance as "actions by a person who knows, in light of the relevant legislation that applies to the species involved, and the general information delivered to the public, that his action will most likely lead to an offence against a species, but intends this offence or, if not, consciously accepts the foreseeable results of his action". Therefore, anyone carrying out an activity which they should reasonably have known could cause injury as defined in the regulations could be committing an offence (JNCC *et al.* 2010). The Scottish Habitats legislation also include an offence of reckless injury. Further guidance can be found on the Scottish Government website.

In addition, The Wildlife and Countryside Act 1981 (as amended) sets out protection for animals listed on Schedule 5 in English and Welsh territorial waters and includes all cetaceans. The Conservation of Seals Act (1970), the Marine Scotland Act (2010), and The Wildlife (Northern Ireland) Order 1985, all set out offences relating to seals, protecting them from capture, killing or injury (see Annex, part 1). Basking sharks are also protected under the Northern Ireland Order from intentional or reckless disturbance.

A marine licence is required before explosives can be detonated in UK waters. Section 66 (1) of The Marine and Coastal Access Act 2009 and Section 21 of the Marine (Scotland) Act 2010 contains a list of activities that can only be undertaken in the marine environment if under a marine licence. This includes:

- 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.

Following the mitigation guidelines contained here or implementing mitigation plans that are based on them, may be a condition of any licence issued.

Regulators have powers in the Habitats Regulations to grant licences for projects that will have impacts on European Protected Species provided certain tests are met. If residual effects are predicted following implementation of mitigation in the impact assessment accompanying a marine licence application, a European Protected Species (EPS) licence may also be required.

The mitigation measures outlined in this document replace those published in 2010. This update has been undertaken through consultation with the Marine Industries Group (MIG mammals), which includes representatives from Natural England, Natural Resource Wales,

NatureScot and the Northern Ireland Department of Agriculture, Environment and Rural Affairs; and relevant stakeholders via a stakeholder engagement exercise (December 2023).

## 1.1 Aim

The aim of these guidelines is to reduce the risk of deliberate or reckless injury to marine mammals to as low as reasonably practical by outlining relevant measures that can be implemented as part of consenting regimes for explosive use/detonation within UK seas.

The following guidelines describe minimum mitigation that should be considered when explosive use has the potential to result in injury to marine mammals, however variations can be proposed by licenced applicants (and may be required as consent conditions are developed on a case-by-case basis) to ensure mitigation plans are appropriate for the planned activity.

It is important that mitigation measures employed are proportionate to potential risk. If evidence is lacking regarding the extent of risk, a precautionary approach should be taken and the maximum mitigation possible applied. Whilst the mitigation measures in these guidelines have some limitations and their effectiveness may not be able to be fully tested, they are based on reasonably conservative assumptions. It is considered that compliance with these guidelines constitutes best practice and will, in most cases, reduce the risk of deliberate/reckless injury to marine mammals.

All mitigation plans should be agreed with the relevant regulator prior to operations commencing and it is the regulator who determines the conditions in any statutory licence issued. This will consider Statutory Nature Conservation Body (SNCB) advice received during the consultation process. If residual impacts will remain after implementing mitigation, a European Protected Species licence may be required.

It is the responsibility of the consent or licence holder to follow these guidelines and to adhere to all licence conditions. It is not intended that following these guidelines should increase the risk of harm to people.

These guidelines are specifically for reducing injury and are not intended to reduce disturbance of marine mammals. However, the measures contained may also assist in reducing a potential disturbance offence. Further guidance on reducing disturbance can be found on the JNCC website.

## 1.2 Scope

These guidelines describe minimum mitigation measures for marine mammals when using explosives in the marine environment. They should be considered for all explosive activities in all UK territorial and offshore waters. Separate guidance is available on the JNCC website for clearance of unexploded ordnance (UXO) from the marine environment.

The primary species group these guidelines aim to protect is marine mammals (i.e. cetaceans and seals). This includes all species of cetacean or seal that may be found in UK seas.

The guidelines can be adapted to reduce the risk of injury to other marine species if deemed appropriate by the relevant regulator and/or SNCB. For example, marine turtles, which are also protected under the Habitats Regulations, and shark species listed as Species of Principal Importance in England, Priority Marine Features in Scotland and as Living organisms of principal importance in Wales (Section 7, The Environment (Wales) Act 2016).

These guidelines are designed for operations in seas around the United Kingdom and considers species that may be found there and the UK regulatory process. They have been adopted in other territories/countries in the past. These guidelines should not be used where local mitigation guidance has been provided.

## 1.3 Areas of importance

These guidelines are applicable to all UK seas however some areas are considered more important for marine mammals than others and may require additional mitigation measures, for example, supplementing visual surveys with acoustic surveys or the use of noise abatement. Areas of importance can be defined as discrete areas of important habitat for marine mammal species. Many of these areas have been designated as Marine Protected Areas (MPAs) but areas of importance under these guidelines are not limited to MPAs (see below).

Note: 'Marine Protected Area' is used here to include all designated protected areas in the marine environment, but it should be noted that the term 'MPA' is also a specific subset of protected area in Scottish waters.

The use of **experienced** mitigation personnel is essential in areas of importance for marine mammals (see below and Annex, part 2 for further detail).

### Marine Protected Areas (MPAs)

All MPAs with a marine mammal species as a qualifying feature are considered an area of importance for those species within the context of these guidelines. Consultation with the appropriate regulator and SNCB(s) at the earliest opportunity is recommended when considering explosive use within or near these areas.

Additional mitigation requirements for operations in or near these areas may be recommended but these will be considered on a case-by-case basis and any requirement will consider (as a minimum) the extent, duration and timing of the proposed activities and the species most likely to be impacted. Note, 'near' refers to a project outside of a site that may cause impacts within a site i.e. the impact assessment identifies a risk of injury within a site from explosive use outside the site.

All proposed, possible and candidate MPAs are a material consideration within the licensing process and all future sites will become areas of importance under these guidelines. MPAs of relevance to these guidelines in UK waters include:

- Special Areas of Conservation (SACs): designated under legislation that transposes the EC Habitats Directive into UK law, with habitats/species that require designation identified in Annexes I and II respectively of the Directive.
- Marine Conservation Zones (MCZs): created under the Marine and Coastal Access Act (MCAA) 2009 with the aim of protecting nationally important marine wildlife, habitats, geology and geomorphology in English and Welsh inshore waters and UK offshore waters adjacent to England and Wales.
- Nature Conservation Marine Protected Areas (NCMPAs): created in Scottish seas under the Marine (Scotland) Act 2010 (inshore) and the MCAA (offshore) to conserve important marine wildlife, habitats, and geodiversity.

- Sites of Special Scientific Interest (SSSIs): legally protected sites under the Wildlife and Countryside Act 1981 (as amended), some of which include marine mammal species as protected features.
- Highly Protected Marine Areas (HPMAs): areas of the sea that allow the protection and full recovery of marine ecosystems; they take a 'whole site approach', therefore the entire marine ecosystem within the HPMA boundary is designated for protection, including marine mammals.
- Ramsar sites: These sites are wetlands of international importance designated under the Ramsar Convention. There are several Ramsar sites in English waters that include marine mammal features, as do several sites in the Channel Islands (a Crown Dependency).

Note: When applying for licences to use explosives within MPAs, the regulator will be required to undertake additional assessments, for example, Habitat Regulation Assessment or Appraisals, to ensure the proposed activity will not be detrimental to the site(s).

### Other important areas

In addition to MPAs, the deep waters to the west of Shetland and areas to the south-west of England are considered areas of importance under these guidelines. Although these areas do not currently have legal protection, they are considered important for a variety of cetacean species, including some which do not usually occur elsewhere in UK waters e.g. deep diving species such as beaked and sperm whales, and common dolphins. Additional requirements to standard mitigation may be required in these areas as, for example, deep diving species are difficult to detect by visual mitigation methods alone. An example of what additional mitigation may be required in this instance could be the use of passive acoustic monitoring to supplement visual searches to maximise detection potential.

In February 2024, 33 new Important Marine Mammal Areas (IMMAs) were approved in the North Atlantic by the IUCN Marine Mammal Protected Areas Task Force, including several in UK waters. While these IMMAs have no legal status in the UK, they do provide information and evidence on the occurrence of cetacean and seal species, why they may be using these areas and any specific sensitivities. As with the areas detailed above, additional requirements to standard mitigation may be required in these areas. Note, a number of these IMMAs overlap with existing MPAs with marine mammal features.

## 1.4 Emerging technologies

JNCC welcomes discussions on the emergence of new techniques which will reduce potential risks to marine species, and the development of new monitoring/mitigation measures. For example, the use of infrared (IR) and other technologies have been subject to trials to determine efficacy for monitoring marine mammals during low visibility conditions. JNCC encourages such research and strive to keep up to date with developments to ensure these guidelines are relevant to industry practices.

# 2 Mitigation requirements when using explosives

Explosives may be required for a variety of activities including harbour construction, oil and gas wellhead or platform decommissioning and military activities. When applying for a marine licence, there should be a clear justification for its use and applicants should always ensure that every effort has been made to plan their operation in such a way to minimise potential injury to marine mammals. The mitigation measures discussed here are the minimum that should be considered to reduce what can't be avoided by project design and planning. If residual impacts remain, an EPS licence to injure can be applied for.

All licence applications will be considered by the regulator on a case-by-case basis. Any proposed deviation or exception from the provisions of these guidelines must be discussed and agreed with the regulator and SNCB during the application process. These guidelines should be read alongside any specific conditions attached to the licence approval issued by the regulator.

Explosive use in the water column and on the surface of the seabed are considered separately in these guidelines from explosive use more than 10 m below the level of the seabed surface.

## 2.1 MMO/PAM Operator experience

All MMO and PAM operatives are required to be trained in applying the JNCC mitigation guidelines, i.e. the individual must have undertaken formal training on a JNCC approved course. These courses focus on how to implement the JNCC mitigation guidelines and record mitigation effort. PAM operators will also require specialised training regarding the use of PAM equipment. Further information on recognised course providers is available on the JNCC website.

JNCC recommends newly qualified MMOs and PAM operatives do not work in isolation for their first few jobs (i.e. they are not the sole MMO/PAM operative on board a vessel). Rather they work alongside personnel who can act as mentors while they gain experience of implementing the guidelines. In addition, the use of experienced MMO and PAM operators (i.e. 20 weeks experience within UK waters over the past 10 years) is essential in areas of importance for marine mammals (see Glossary).

Further details regarding the role to be undertaken by MMO and PAM operators may be found in the Annex, part 2.

## 2.2 Defining the mitigation zone

The primary method of reducing the potential for deliberate injury described in these guidelines is to ensure a defined area – the mitigation zone – is clear of marine mammals prior to the explosive source being activated. The mitigation zone is defined as the full extent within which auditory injury (PTS) could occur or a 1 km radius, whichever is larger. Ensuring the full extent of the mitigation zone is clear of marine mammals before explosive use may require multiple mitigation techniques to be applied. The full extent of the mitigation zone will be agreed during the application process, following review of the impact assessment predicted injury ranges (see Annex, part 3). If the mitigation zone extends to distances which can't be effectively mitigated, an EPS licence for injury may be required.

The minimum mitigation requirement in these guidelines is that the mitigation zone is visually observed prior to clearance for the presence of marine mammals. However, the predicted

injury range from the point of detonation can extend further than can be visually monitored depending on the volume of explosive being used. In these situations, additional measures should be employed alongside the visual search to reduce risks to marine mammals in the wider area (e.g. acoustic deterrents to displace animals) and/or reduce the level of sound propagating through the water column (i.e. noise abatement).

## 2.3 Explosive use in the water column or within 10 m below the seabed surface

The following guidelines apply to all operations where the explosive charge is placed in the water column (open water) or is on or within 10 m below the seabed surface. This is because data is inconclusive regarding how much noise from explosive use within 10 m of the seabed surface propagates into the water column (e.g. Nedwell *et al*. 2001; Nedwell and Edwards, 2004). Separate guidance is provided below for explosive charges placed more than 10 m below the seabed surface. Should further evidence regarding noise levels detectable in the water column from explosive use below the seabed surface become available, these guidelines will be updated.

### Pre-detonation search

All explosive use should take place during daylight hours (see Glossary) and in good weather conditions to allow visual observations to take place. The pre-detonation search (and subsequently the explosive detonation) should not take place or should be delayed if:

- Sea state is Beaufort sea state 4 or JNCC sea state category c (choppy with many white caps) or above. While this sea state is above that which is recommended for sighting harbour porpoises, it provides a compromise for observing other species.
- Visibility drops to a degree that the mitigation zone cannot be clearly seen in its entirety.
- Light levels drop to a point where the mitigation search zone is not clearly visible in its entirety without the aid of artificial light.

As a minimum, a pre-detonation visual search of the mitigation zone must be undertaken before any explosive use. This must begin at least **60 minutes** before the planned detonation and cover the defined mitigation zone, or a minimum **1 km** radii, whichever is greater. Where the mitigation zone is greater than 1 km, the MMOs should endeavour to observe as much of the required area as possible, noting that some species are harder to detect at distance (e.g. harbour porpoise).

For mitigation zones larger than 1 km, additional mitigation measures will be required (e.g. acoustic deterrents). If an ADD is to be used, a visual search is required prior to ADD activation meaning the duration of the pre-detonation search may need to be extended to accommodate this; see below for further details.

Due to the minimum size of the mitigation area, **at least two dedicated marine mammal observers** (MMOs) should work together to monitor it, and they will advise crew if any marine mammals are observed during the pre-detonation search. All monitoring should be undertaken from a platform as close as is safe to be to the detonation location and between them, the MMOs should have a clear view of the entire mitigation zone, noting they may not be on the same platform and a view of the horizon may be needed to estimate distance. Ideally, at least one MMO should be on an elevated platform (e.g. the bridge of a ship). Consideration should always be given to the number of mitigation personnel employed to ensure effective monitoring and reduce observer fatigue.

In some situations, for example if species that are difficult to detect visually may be present in high abundances (e.g. harbour porpoise, beaked whales, etc.), or in areas that are important for marine mammals, passive acoustic monitoring (PAM) should always be considered to supplement visual observations, but it should not be used as an alternative to a visual search.

If used, the PAM system operator should be in a position on the vessel that allows them to monitor the PAM equipment for acoustic detections and maintain contact with both the MMOs and relevant crew. Where practical, the PAM equipment should be deployed such that it can cover as much of the mitigation zone as is possible (noting the detection range for some species is limited), with minimal disturbance from vessel noise. The PAM system deployed should be capable of detecting all the required frequencies of species likely to be in the area. Note, that an individual should not act in a dual MMO/PAM operator role at the same time. When PAM is being used, there should still be two MMOs monitoring the mitigation zone. Like the visual search, PAM monitoring should begin at least 60 minutes before the planned detonation.

Upon completion of the pre-detonation search and confirmation by the MMOs there are no marine mammals within the mitigation zone, the detonation should commence immediately.

Further guidance on pre-detonation searches can be found in the Annex, part 2, and JNCC guidance is available for when using PAM for mitigation.

### If marine mammals are detected during the pre-detonation search

If marine mammals are detected, either visually and/or acoustically, within the mitigation zone during the pre-detonation search, the explosive detonation must be delayed for as long as is necessary to allow the animals passage outside of the mitigation zone. A delay of at least 20 minutes from the time of the last detection within the mitigation zone must be applied (or until the specified pre-detonation search time has elapsed, whichever is longer). This is to allow animals unavailable for detection sufficient opportunity to move outside the mitigation zone.

Note, 20 minutes is the minimum duration of delay, and it should be adjusted to reflect the size of the mitigation zone and how long is needed for an animal to swim outside of it. For example, if assume a swim speed of 1.5 m/s, an animal can swim approximately 1.8 km in 20 minutes and 5.4 km in 60 minutes.

In waters > 200 m deep, the minimum duration of delay should be at least 30 minutes (or until the specified pre-detonation search time has elapsed, whichever is longer) due to the potential for presence of deep-diving species (such as beaked whales) that may remain underwater for longer periods of time.

In the event of a marine mammal being suspected within the mitigation zone, but the MMO is unable to confirm, then a delay should be advised as a precautionary measure.

Note: in practice, for the default 1 km mitigation zone, delays in operations will only occur if a marine mammal is detected during the last 20 minutes of the pre-detonation search, however it is important to be aware of their presence before this hence the pre-detonation search period being longer than the delay. For larger mitigation zones, this principle still applies with the period extended to reflect the time it will take for an animal to leave the mitigation zone.

Care should be taken when working in coastal areas, so animals do not become trapped when moving away and enough time provided to allow them to leave the area of risk.

### During and post detonation search

Visual monitoring should continue during the detonation procedure and for at least 15 minutes after the explosive use is complete, to record any evidence of injury to marine life, including fish kills. All observations should be noted in the mitigation report (see Section 3), and a note included if nothing was sighted.

Note, the vessel(s) on which the mitigation team are located may need to move further away from the pre-detonation search location and detonation point prior to operations commencing for safety reasons. Note this in the mitigation report and whether the new location restricted the ability to undertake the post-clearance search. In such circumstances, monitor the area that can be observed as best as possible.

### Operational delays in operations

Should the detonation be delayed for operational reasons once the pre-detonation search has begun, a decision is needed regarding whether to continue observing during the delay or postpone the search. The vessel crew should discuss the expected duration of the delay with the MMOs to help determine the best course of action. If the search is postponed, a full search (i.e. 60 minutes), must be undertaken prior to the rescheduled detonation.

### Acoustic deterrents

If predicted injury ranges, and consequently the mitigation zone, are greater than 1 km, the use of a proven acoustic deterrent device (ADD) should be considered to encourage marine mammals to leave the required area prior to clearance. The choice of ADD should consider the area of deterrent required and the species of concern in the area of operation. The duration of deployment should be determined in consultation with the appropriate SNCB at the application stage, informed by a review of the impact assessment and consideration of the time required for an animal to leave the mitigation zone.

Proposed durations (by the applicant) should be carefully considered and balance the need to reduce the risk of injury with the need to avoid introducing unnecessary noise into the marine environment. Note, a maximum duration may be imposed regardless of injury range. While the purpose of the ADD is to deter animals outside of the mitigation zone, they should not be so loud they cause an overtly strong behavioural reaction at close distance.

The use of ADDs does not replace the need for visual observations. Depending on the species likely to be present, the deployment of an ADD may mean PAM is not needed. This is because the use of an ADD may mean the PAM is unable to detect any nearby mammals. Alternatively, if species are likely to be present that may be difficult to detect visually, the use of PAM may still be needed. However, as PAM is often used to test the ADDs are functional, an alternative way of doing this should be provided.

The ADD should be placed in a position that is as close as possible to the detonation location without being damaged and the pre-detonation search should continue during ADD deployment. A 30-minute visual search should be undertaken prior to activating the ADD to ensure there are no mammals in the immediate vicinity. Should a mammal be detected within 100 m of the ADD during this search, ADD activation should be delayed until the animal has moved further away (i.e. to more than 100 m from the device) to reduce the possibility of auditory injury from the device if PAM is not on board the vessel.

If a delay in detonation is required due to an animal being present within the mitigation zone while an ADD is active, the ADD should remain switched on for the duration of the delay. The delay should be recorded in the mitigation forms and reported if an animal does not

leave the mitigation zone when an ADD is active. If it appears the delay will be extensive (e.g. the animal is not moving away), the ADD should be switched off as the animal may have become habituated to the sound. Providing the animal does not move to within 100m of the ADD, it can be reactivated after 20 minutes. The aim here is to initiate a new startle response in the animal encouraging it to move away. The ADD should remain active for long enough to allow the animal to swim out of the mitigation zone or as agreed during the application process.

Should detonation be delayed for operational reasons, and the ADD has not been activated, this should be delayed until it is known when the detonation will occur and the ADD activated at the appropriate time prior to that. If the ADD is already active and the operational delay will last more than 20 minutes, the ADD should be switched off and not re-activated until the appropriate time prior to the revised detonation. The ADD should remain active for the time agreed in the mitigation plan.

Upon completion of the activation period and confirmation by the MMO there are no marine mammals within the mitigation zone, the detonation should commence immediately.

To help ensure consistency in decision making in the field, we recommend the mitigation plan includes clear instructions regarding how long the ADD is active for. A review of evidence supporting the effectiveness of ADDs can be found on the JNCC website, and work is underway to develop further guidance on the use of these deterrents for mitigation (refer to JNCC mitigation webpage for updates).

Note: the use of scare charges is not appropriate as a form of acoustic deterrent, and consequently should not be used (see Annex, part 2).

### Noise abatement

In many cases, predicted injury ranges when using explosives in the marine environment, for example during decommissioning, will be sufficiently small they can be effectively mitigated using visual observers, PAM and ADDs. However, this should be confirmed in the impact assessment.

If this is not the case, alternative methods of undertaking the required task should be considered or the use of noise abatement systems (NAS). The potential need for this should be discussed with the appropriate regulator and SNCB at the application stage. Visual searches will still be required if using NAS and details of any NAS to be used must be included in the mitigation plan so the MMOs can plan their searches. The noise abatement should be timed to be activated at the end of the visual search, immediately prior to detonation unless operational delays are required.

If using bubble curtains, these should not be switched on until the end of the pre-clearance search and it is confirmed there are no marine mammals within 1 km of the detonation. This is to ensure they do not become trapped within the curtain.

## 2.4 Explosive operations more than 10 m below the seabed surface

The following guidelines apply to all operations where the explosive charge is placed **more than 10 m** below the seabed surface but are **within 100 m of the seabed surface**. This can include, but is not limited to, salvage/decommissioning activities, harbour development, and pre-dredge detonations; however, the primary use of explosives at these depths in the UK marine environment to date has been for oil and gas decommissioning activities.

Subsequently, the following guidelines have been developed based on experience of these activities but are not limited to them and presume the volume of explosive material used (TNT equivalent) will be relatively small compared to other uses of explosives in the marine environment. The need for explosives and what will be required should be clearly stated in the licence application and potential impacts assessed in the accompanying impact assessment. The following guidelines should be adjusted as required to reflect predicted injury ranges through discussion with the appropriate SNCB.

Explosive charges placed below the seabed surface at depths greater than 100 m do not require marine mammal mitigation as it is considered that noise levels in the water column will not be detectable above background noise.

Should further evidence become available of noise levels detectable in the water column from explosive use below the seabed surface, these guidelines will be updated.

## Pre-detonation search

All explosive use should take place during daylight hours (see Glossary) to allow visual observation to take place. The pre-detonation search (and subsequently the explosive detonation) should not take place or should be delayed if:

- Sea state is above Beaufort sea state 4 or JNCC sea state category c (choppy with many white caps). While this sea state is above that which is recommended for sighting harbour porpoises, it provides a compromise for observing other species.
- Visibility drops to a degree that the mitigation zone cannot be clearly seen in its entirety.
- Light levels drop to a point where the mitigation search zone is not clearly visible in its entirety without the aid of artificial light.

As a minimum, a **30-minute pre-detonation search of a 500 m mitigation zone** must be undertaken before all detonations. Note, use of this smaller mitigation zone and shorter search duration must be backed up by the impact assessment (i.e. the predicted injury ranges must be < 500 m). Under these circumstances, ADDs or noise abatement should not be required however this should be confirmed at the application stage, and supported by the impact assessment.

To reflect the smaller size of the mitigation zone, at least one dedicated MMO should monitor the area however if a larger mitigation zone is identified as being required in the impact assessment, this should be increased to two MMOs.

Consideration should always be given to the number of mitigation personnel employed to ensure effective monitoring and reduce observer fatigue. All monitoring should be undertaken from a platform as close as is safe to be to the detonation location and the MMO must have a clear view of the horizon and full mitigation zone.

## If marine mammals are detected within the mitigation zone

Delays in detonation should a marine mammal be detected within the mitigation zone during the pre-detonation search should be treated as for if the charge is in the water column. That is, the detonation must be delayed allowing an animal's passage outside of the mitigation zone. The delay should be at least 20 minutes from the time of the last detection in the mitigation zone and in waters > 200 m deep, the delay should be at least 30 minutes.

Care should be taken when working in coastal areas, so animals do not become trapped when moving away and enough time provided to allow them to leave the area of risk.

Operational delays should be treated in the same manner as those when the explosive charge is located in the water column.

### During and post detonation search

Monitoring should be continued during the detonation procedure and for at least 15 minutes after the detonation, to record any evidence of injury to marine life, including fish kills. Any observations should be noted in the mitigation report (see Section 3).

# 3 Post mitigation report

When undertaking a mitigation role, MMO and PAM operatives should be equipped with a copy of the agreed mitigation plan, an up-to-date copy of the JNCC mitigation guidelines and relevant recording forms on which to record details of all mitigation undertaken. These will all also be required when completing the post-mitigation report.

The recording form is an Excel spreadsheet with embedded worksheets. Word versions of the spreadsheets named 'Deckforms' are also available which operatives may prefer to use during operations before transferring details to the Excel spreadsheets. All forms, including a guide to completing them, are available on the JNCC website.

A mitigation report (often referred to as the MMO report) should be sent to JNCC (via e-mail to seismic@jncc.gov.uk) once operations have been completed, accompanied by the completed JNCC Excel recording forms, plus a copy of the corresponding consent, and the Marine Mammal Mitigation Plan (if appropriate). Please attach the Excel spreadsheet in its original format i.e. do not convert to pdf or embed in the report. JNCC collates and analyses this data to inform future reviews of the mitigation guidelines. The forms should be thoroughly checked and cross-referenced prior to submission, as errors on the forms can result in the appearance of non-compliance with the guidelines.

There may also be a consent requirement to submit this report to the regulator to verify compliance with licence conditions, usually within a specified time. The report should be written by those undertaking the mitigation role. However, it is the responsibility of the licence holder not the mitigation personnel to ensure that the mitigation report is sent to the regulator in the time specified in the licence. Any changes made to the report before it is submitted to the regulator should be checked with the original author(s) to ensure data is not accidently miss-represented, as errors could result in the appearance of non-compliance with the consent conditions.

Note, information on marine mammal distribution and general ecology etc. are not required within the mitigation report, as such information will have been provided and reviewed at the application stage. Rather, the report should provide a summary of the operations, mitigation searches (visual and acoustic) and other methods employed, with all effort detailed in the spreadsheet. Any required mitigation action (e.g. delays in operations), as well as any sightings/detections recorded should also be summarised in the report.

## 3.1 Outline report

The following outlines the type of information to include in the post-mitigation report.

### I. Operator details

Include details of the company awarded the licence, relevant contractor details if appropriate including who undertook the explosive operations, and the licence reference number issued by the regulator.

### II. Operational details

Provide a summary of the explosives used including the date and location of all detonations geographically (a map can be beneficial). For each detonation specify:

- the type of explosive used,

- whether charges were located in the water column, on the seabed or below the seabed surface,
- the explosive weight and TNT equivalent weight.

In addition, outline the detonation procedure and highlight any activities which influenced when the detonation took place (e.g. was coordination with other noisy activities needed to reduce daily noise levels?).

## III. Mitigation requirements

Specify the agreed mitigation zone radius and the required duration of searches (e.g. one hour before and 15 minutes after). If this varied depending on charge weight, provide details.

Highlight if operations occurred within or close to a protected area which includes marine mammals as a feature, and whether any additional measures were employed to mitigate impacts to the site. Note, general details of likely marine mammal presence in the area will have already been included in the application and does not need repeating here.

Summarise MMO/PAM requirements including:

- Number of personnel with a brief overview of their experience (e.g. level of training, number of previous mitigation assignments or previous experience of observing if new to the role).
- Where personnel were located during pre-detonation searches (e.g. what vessel, where on that vessel (including height above sea surface) and where the vessel was relative to the point of detonation); confirm that the MMOs had a 360° field of view.
- Whether location of the mitigation team changed prior to the detonation (e.g. vessel had to move away for safety reasons which resulted in the post-detonation search being undertaken from a different location).

If PAM was used, include details of the equipment and software. Provide evidence the equipment used was able to detect the species of concern in the area. Further guidance on using PAM for mitigation can be found on the JNCC website.

If an ADD was deployed, provide information on the type of ADD used including detail such as the frequency it operated at and source level. Also explain why that specific model was chosen e.g. effective for the required injury zone or marine mammal species. Describe where it was deployed from, by whom (e.g. MMO or member of crew) and agreed durations of activation, noting multiple options may have been included in the mitigation plan.

If noise abatement was used, specify the type used, including manufacturer and/or supplier. Describe how it was deployed, when and where relative to the detonation location, and how this was coincided to operate alongside search requirements. For example, if a bubble curtain, was it laid before the pre-detonation search began but not switched on till the end of the search? If applicable, highlight caveats to its use specified in the licence, for example, only to be used for certain charge weights or in specific environmental conditions.

In addition, provide an overview of communication channels established between vessel crew and the mitigation team and the procedure identified to communicate if a delay was needed. If communication channels were required with other operators in the locality to reduce the risks of cumulative impacts, provide detail of this also.

A flow diagram outlining the mitigation procedure can also be beneficial.

## IV. Application of mitigation procedures

Provide a summary of all mitigation searches and confirmation of whether the mitigation guidelines and/or relevant licence conditions were met, noting the role of the mitigation team is to provide advice and it is ultimately the responsibility of the licence holder to meet these requirements.

For example, provide the number of occasions when mitigation search was completed satisfactorily with the correct procedures followed for all visual and acoustic searches. Confirm that the correct number of observers were available, and that PAM was deployed correctly (e.g. as described in these guidelines, in consent conditions or a project specific mitigation plan). If appropriate, confirm that the ADD was deployed correctly and the pre-deployment search was conducted. Also confirm that the crew and mitigation team were in good communication with each other and all procedures were discussed prior to operations at start-up meetings. Provide a summary of any marine mammals encountered, either visually or acoustically.

If any delay was needed, confirm that all procedures for that delay and recommencement of the detonation was carried out according to the mitigation agreed on. If applicable, highlight any deviation from the proposed mitigation plan/consent conditions and the circumstance that led to this.

Include detail of any technical issues encountered for example, difficulties undertaking visual observations, technical issues with PAM, ADDs or the deployment of noise abatement systems (e.g. equipment failure or deployment issues). Include actions taken and lessons learned.

If, for some reason, the mitigation requirements could not be complied with, provide details of the circumstances that led to this and how it was rectified for future operations. Note, non-compliance should not occur if there are good communications between the mitigation team and crew. Awareness by the crew of the mitigation team's role can help facilitate this (e.g. through training or toolbox talks/start-up meetings).

Note: specific times for each search/sighting should be provided in the excel recording forms. Please ensure the excel spreadsheets are thoroughly checked before submitting as mistakes in this could make it appear searches did not comply with mitigation requirements.

## V. Additional information

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

## Abbreviations and Glossary

The following have been developed in conjunction with the Institute of Explosive Engineers.

**Applicant:** The company or organisation applying for a licence to undertake explosive operations.

**Acoustic deterrent devices (ADD):** a device that emits a sound used to deliberately deter (or disturb) marine mammals away from a specific area.

**ALARP:** As Low as Reasonably Practicable.

- **Reasonably practicable:** Balancing the level of risk against the measures needed to control the real risk in terms of money, time or trouble. However, you do not need to take action if it would be grossly disproportionate to the level of risk.

**Areas of importance:** Discrete areas of important habitat to marine mammal species including but not limited to marine protected areas.

**Attenuate:** Used to describe the weakening of a shock wave by decreasing its amplitude or duration.

**Black powder:** Gunpowder consisting of charcoal, potassium nitrate and sulphur.

**Blast:** A supersonic longitudinal wave produced in the surrounding atmosphere by an explosion.

**Blast impulse:** The time integral of the overpressure exerted by a blast wave.

**Blasting explosive:** An explosive designed for industrial mining, quarrying, civil engineering, and demolitions.

**Blast wave:** A shock front with an area of high pressure behind it, followed by a rarefied zone.

**Burning:** The propagation of combustion by a surface process (see deflagration).

**Cap:** A small metal container filled with a flame producing explosive composition. (See also detonator).

**Charge:** A bagged, wrapped or cased quantity of explosive without its own integral means of ignition.

**Combustion:** An exothermic oxidation reaction producing flame, sparks or smoke.

**Critical depth:** The depth of bed of explosive at which transition from a burning to a detonative mode of explosion will occur.

**Daylight hours:** Period between sunrise and sunset when sufficient light is available to effectively conduct visual observations (e.g. 1 hour after civil sunrise time and 1.5 hours before civil sunset time).

**Dedicated MMO**: An MMO whose sole role is that of an MMO and is not simultaneously undertaking crew duties.

**Deflagration:** Reaction where materials decompose at a rate much below the sonic velocity of the material without any excess of atmospheric oxygen being required. It is propagated by the liberated heat of reaction. Hazards produced are fireball, thermal radiation and jets of flame.

**Detonating fuze (cord):** Flexible (plastic) tubing filled with a powdered core of secondary high explosive. Used to transmit a detonation wave over any required distance.

**Detonation:** A form of reaction given by an explosive substance in which the exothermic chemical reaction proceeds a shock wave. High temperature and pressure gradients are created in the wave front so that the chemical reaction is initiated instantaneously. Hazards are blast fragments and collapse of buildings.

**Detonation pressure:** The dynamic pressure in the shock front of a detonation wave.

**Detonator:** The component within an explosive train which, when initiated, in turn detonates a less sensitive but larger high explosive (usually the booster), or when containing its own primer initiates the detonation. An instantaneous or delay initiator for explosive materials and containing a charge of high explosive fired by flame, spark or electric current or percussion. A cap is a similar component designed to initiate a deflagration.

**Donor charge:** Bulk charge placed to cause a sympathetic detonation.

**European Protected Species:** Species listed in Annex IV(a) of the Habitats Directive and respective schedules in UK legislation that occur naturally in the United Kingdom. In the marine and coastal environments, this includes all species of cetaceans (whales, dolphins and porpoises), marine turtles, otters, and Atlantic sturgeon.

**EOD:** Explosive Ordnance Disposal.

**Exploder:** A device specially designed for firing electric detonators, from a safe distance.

**Explosion:** Chemical reaction or change of state effected in an exceedingly short period of time with the generation of a high temperature and generally a large quantity of gas. An explosion can produce a shock wave in the surrounding medium. (See also detonation and deflagration).

**Explosive:** A solid or liquid substance that when ignited by heat or shockwave undergoes rapid decomposition. This chemical reaction releases high volumes of energy in the form of heat, light and gasses at such pressure and speed as to cause damage to surrounding structures and objects.

**Explosive operations:** Any activity involving explosives that is subject to the requirements of the regulations. It will include manufacture, storage, disposal, discard and decontamination, on site transport and may include explosives processing that does not constitute manufacture and on certain sites, use.

**Explosive substance:** An explosive substance can be a single substance or mixture of substances. The definition contains two important qualifications:

- the definition of explosive substance excludes gases and mixtures of gasses; and
- the explosive effect must be created by a reaction in the substance or preparation in itself.

This does not include a secondary reaction which involves substances or preparations which were not part of the original explosive substance.

**Explosiveness:** The rate at which a particular explosive, when subjected to a given stimulus, gives up its energy, and/or the degree to which it does so.

**High explosives:** A true explosive is characterised by the fact that in its combustion process, an exothermic (that is heat liberating) reaction wave passes through it, following and supporting a 'shock front'. This phenomenon is described as 'detonation' and the velocity of the wave is the 'velocity of detonation'.

**High order detonation:** Detonation at a velocity approaching the maximum stable velocity of detonation for the system. when a high order explosion is initiated, a very rapid exothermic chemical reaction occurs. High order explosives have a strong supersonic pressure wave, known as the blast wave or shock wave.

**Hollow (shaped) charge:** A charge, usually cylindrical, having a cavity opposite the point of initiation to exploit the Munroe Effect. The cavity may be lined with metal to enhance performance.

**Initiating explosives:** Explosives that can detonate by the action of a relatively weak mechanical shock, heat or by an electric current used to initiate the main explosive charge. Sometimes called primary explosives.

**Initiation:** The act of causing explosive material to ignite, burn, deflagrate, detonate or otherwise explode.

**Injury**: Physical harm to a marine mammal, including hearing damage (e.g. Permanent Threshold Shift)

**Licence holder**: The company or organisation holding a licence to use explosive materials in the marine environment.

**Low explosive/low order explosives:** An explosive which does not detonate under normal conditions of use. Low explosives are mixtures of chemicals that burn very rapidly, meaning that they "deflagrate at sub sonic speeds, they do not produce high shock waves". They consist typically of fuel and an oxidizer. The black powder used in fireworks is one example of a low explosive.

**Low order detonation:** A detonation in which the charge is completely consumed but the velocity of detonation is well below its maximum value, and therefore its effect is lessened.

**Main charge:** The bulk of explosive excluding those items needed to initiate its detonation. In most applications the main charge comprises secondary explosives.

**Marine Mammal Observer (MMO)**: Individual responsible for conducting visual watches for marine mammals for mitigation purposes and providing advice to enable compliance with the JNCC guidelines.

- **Trained MMO**: Individual who has undertaken a JNCC recognised course and has some experience of visually spotting marine mammals.
- **Experienced MMO**: Trained MMO with 20 weeks' field experience of implementing the JNCC guidelines in UK waters obtained during the previous ten years, preferably within the previous five.

**Marine Protected Area (MPA):** A clearly defined geographical space, recognised, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (Dudley 2008). Within the UK, these may be designated under national legislation or international obligations and contribute to an international network of MPAs in the north-east Atlantic.

**Mitigation zone**: The area within which injury is predicted to occur to marine mammals and action is required to reduce the risk to negligible levels; typically defined by injury ranges provided at the application stage.

**Net mass:** The terms 'net explosive content' and 'net explosive quantity' are commonly used in the industry to refer to the weight of the explosive contained within an article (i.e. less packaging, casing etc. but including explosives in fuses and propelling charges, etc.). Although these terms are commonly understood to refer to mass there is scope for different interpretations of 'content' and 'quantity' in that these could be taken to refer to volume. The term 'net mass' is used for the sole reason of avoiding any scope for confusion or misinterpretation.

**Noise abatement:** Reducing the amount of noise that enters the marine environment, usually achieved by creating some kind of barrier around the noise source to prevent propagation of sound through the water column. Systems that do this may be referred to as noise abatement systems (NAS).

**Operator**: The company or organisation undertaking explosive operations, note this may not be the same as the licence holder.

**Partial detonation:** A detonation which fails to propagate right through a charge leaving it partly chemically unchanged.

**Partial ignition:** An ignition in which the burning fails to propagate throughout the sample.

**Passive Acoustic Monitoring (PAM)**: System that utilises hydrophones and specialist software to detect the vocalisations of marine mammals.

**Passive Acoustic Monitoring (PAM) operative**: Individual responsible for conducting acoustic searches for marine mammals and experienced in the use of PAM equipment and marine mammal acoustics.

- **Trained PAM operative**: Individual who has undertaken a JNCC recognised MMO course and has some experience of acoustically detecting marine mammals.
- **Experienced PAM operative**: Trained operative with 20 weeks' field experience of implementing the JNCC guidelines in UK waters obtained during the previous ten years, preferably within the previous five.

**Plastic explosive:** A hand mouldable explosive which includes Semtex and C-4 used in demolition operations.

**Post-detonation search**: Visual search for marine mammals and other marine life (e.g. fish kills) after a detonation has occurred.

**Pre-detonation search:** Search for marine mammals (visually and acoustically (if applicable)) prior to commencing detonation.

**Primary explosive:** An explosive, which is readily initiated or detonated by a small mechanical or electrical stimulus.

**Regulator:** The competent authority appointed by the government to administer regulations controlling a particular activity or industry.

**Secondary explosive:** Explosives in which the detonation is initiated by the detonation impact of an initial (primary) explosive.

**Shock front:** A discontinuous change in the pressure propagating through a medium at supersonic speed.

**Shock wave:** A shock front, together with its associated phenomena, e.g. blast, elevated temperature.

**Statutory licence**: A licence required by law to carry out the intended operations.

**Statutory Nature Conservation Body (SNCB)**: organisation charged by the government with advising on nature conservation issues.

**TNT:** 2,4,6-Trinitrotoluene. $CH_3C6H_2(NO_2)_3$. A secondary explosive.

**United Kingdom waters**: Parts of the sea in or adjacent to the United Kingdom from the low water mark out to the limits of the United Kingdom Continental Shelf.

**UXO:** Unexploded ordnance.

**Velocity of detonation:** The speed at which the detonation wave progresses through an explosive. When it attains a value that it will continue without change, it is called the stable velocity of detonation.

**Water column**: The expanse of water between the surface and floor of the water body (i.e. the sea).

## Weblinks and References

**Table 1**. Full URLS for weblinks used in the text.

| Weblink text | Full URL |
|---|---|
| JNCC: Marine mammals and offshore industries | https://jncc.gov.uk/our-work/marine-mammals-and-offshore-industries/ |
| JNCC: Marine mammals and noise mitigation | https://jncc.gov.uk/our-work/marine-mammals-and-noise-mitigation/ |
| JNCC guidelines for minimising the risk of disturbance and injury to marine mammals whilst using explosives | https://hub.jncc.gov.uk/assets/24cc180d-4030-49dd-8977-a04ebe0d7aca |
| JNCC guidelines for minimising the risk of disturbance and injury to marine mammals whilst clearing unexploded ordnance | https://hub.jncc.gov.uk/assets/cbd480f1-47ea-4d78-b94c-04e0f9389daa |
| JNCC guidance for the use of Passive Acoustic Monitoring in UK waters for minimising the risk of injury to marine mammals from offshore activities. | https://hub.jncc.gov.uk/assets/fb7d345b-ec24-4c60-aba2-894e50375e33 |
| Marine Mammal Observer training course providers | https://jncc.gov.uk/our-work/marine-mammal-observer-training/ |
| JNCC *et al.* 2010: The protection of marine European Protected Species from injury and disturbance | https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/850708/Draft_Guidance_on_the_Protection_of_Marine_European_Protected_Species_from_Injurt_and_Disturbance.pdf |
| Evidence base for application of Acoustic Deterrent Devices (ADDs) as marine mammal mitigation | https://hub.jncc.gov.uk/assets/e2d08d7a-998b-4814-a0ae-4edf5d887a02 |
| Scottish Government guidance – Marine European protected species: protection from injury and disturbance | https://www.gov.scot/publications/marine-european-protected-species-protection-from-injury-and-disturbance/ |
| Marine and Coastal Access Act 2009 | https://www.legislation.gov.uk/ukpga/2009/23/section/66 |
| Marine (Scotland) Act 2010 | https://www.legislation.gov.uk/asp/2010/5/section/21 |
| Marine Mammal Protected Areas Task Force – Important Marine Mammal Areas (IMMAs) in the north east Atlantic Ocean and Baltic Sea | https://www.marinemammalhabitat.org/immas-focus-the-spotlight-on-marine-mammal-species-and-special-habitats-requiring-protection-in-the-north-east-atlantic-ocean-and-baltic-sea/ |
| Habitats and species of principal importance in England | https://www.gov.uk/government/publications/habitats-and-species-of-principal-importance-in-england |
| Scottish Priority Marine Features | https://www.gov.scot/policies/marine-environment/priority-marine-features/ |

**Table 2**. Full references quoted in the guidance.

| | |
|---|---|
| Dudley 2008 | Dudley, N. (Editor) (2008). Guidelines for Applying Protected Area Management Categories. Gland, Switzerland: IUCN. x + 86pp |
| Nedwell *et al.* 2001 | Nedwell, J.R, Needham, K., Gordon, J., Rogers, C. & Gordon, T. The effects of underwater blast during wellhead severance in the North Sea. Subacoustech Ltd, 2001. |
| Nedwell & Edwards 2004 | Nedwell, J.R. & Edwards, B. A review of the measurement of underwater man-made noise carried out by Subacoustech Ltd. Subacoustech Ltd, 2004 |