



JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys

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Introduction

It is recognised that sound generated from geophysical survey sources has the potential to cause injury (e.g. hearing damage) to marine mammals (cetaceans and seals). Some surveys, seismic surveys in particular, have the potential to result in a deliberate injury offence as defined under UK regulations¹ for the protection of European Protected Species² (EPS). ‘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”³. 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.

The mitigation measures outlined in these guidelines are designed to reduce the risk of deliberate injury to marine mammals and relevant measures are incorporated as part of the consenting regimes for geophysical activities within the United Kingdom Continental Shelf (UKCS). These guidelines were originally written with the oil and gas industry in mind, however since their conception the use of geophysical technologies by other marine industries has grown. Any geophysical survey that has the potential to result in injury to marine mammals should apply the mitigation measures outlined in these guidelines (or an alternative as agreed with the relevant Regulator). 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 injury to marine mammals to negligible levels.

The focus of these guidelines is marine mammals, however they could be adapted to help reduce the risk of deliberate injury to other marine species if deemed appropriate by the relevant Regulator. For example, other potentially sensitive species include marine turtles, also listed as EPS, and several shark species including basking shark which are UK priority marine species⁴.

The Joint Nature Conservation Committee (JNCC) has no objections to these guidelines being used in other territories. However, we would encourage all operators to determine if any special or local circumstances apply, as these guidelines are not intended to be used where local mitigation guidance has been adopted.

The following guidelines have been divided into three sections and supplemented by two appendices:

- **Section 1:** Background information to assist with survey planning;
- **Section 2:** Mitigation; and

¹ Regulation 41(1a) of the Conservation of Habitats and Species Regulations 2012; Regulation 39(1a) of the Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2012; Regulation 34(1a) of the Conservation (Natural Habitats, &c.) (Amendment) Regulations (Northern Ireland) 2015; Regulation 39(1a) of the Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007 (as amended); Regulation 10(a) of the Offshore Petroleum Activities (Conservation of Habitats) Amendment Regulations 2007.

² Species listed on Annex IV of the Habitats Directive² and in UK waters includes all cetacean species

³ Section 1.2.1 in The protection of marine EPS from injury and disturbance (JNCC et al., 2010)

⁴ <http://jncc.defra.gov.uk/page-5167>

- **Section 3: Reporting.**

Appendix 1 includes a glossary of the terminology used within these guidelines and Appendix 2 provides further details on reporting requirements. In addition, a separate JNCC Guidelines Frequently Asked Questions (FAQ) document is available, which should be read alongside the guidelines⁵.

These guidelines were originally prepared by a working group convened by the then Department of the Environment. They have subsequently been reviewed four times by JNCC following consultation with relevant stakeholders. In addition to comments received from stakeholders, the current revision has also considered the 2015 review of marine mammal observer (MMO) data and compliance with the guidelines (Stone, 2015 a and b), new research into potential impacts to marine mammals from anthropogenic noise and new developments in geophysical survey and monitoring technologies.

⁵ http://jncc.defra.gov.uk/marine/seismic_survey

Section 1: Planning

The following information is provided to assist personnel involved with geophysical surveys, however it should not be seen as definitive advice.

Many geophysical surveys are subject to a formal consenting process. When planning a geophysical survey, the applicant should identify and contact the appropriate Regulator and Statutory Nature Conservation Body(s) (SNCB) for specific survey advice as required.

Current UK regulators, to which these guidelines could be relevant, include the Department for Business, Energy and Industrial Strategy (BEIS), the Marine Management Organisation, Marine Scotland, Natural Resources Wales (NRW), Department of Agriculture, Environment and Rural Affairs (DAERA) and the Planning Inspectorate (PINS). The SNCBs are JNCC (offshore⁶ waters), Natural England (English inshore⁶ waters), Scottish Natural Heritage (Scottish inshore⁶ waters), Natural Resources Wales (Welsh inshore⁶ waters) and the Department of Agriculture, Environment and Rural Affairs (Northern Irish inshore⁶ waters).

Not all geophysical surveys across different industry sectors are subject to a formal consenting process i.e. some surveys require notification (to the relevant Regulator) only. However, the survey considerations and mitigation principles outlined in these guidelines should still be considered and applied where appropriate.

1.1 Consenting process

Where a consent is required, the applicant will need to submit an impact assessment in support of the application detailing the potential impacts of the survey, including those on cetaceans and seals. If relevant, the assessment should also consider impacts on the integrity of any Marine Protected Areas (MPAs), such as Special Areas of Conservation (SACs) and if the proposals are likely to impact designated species or habitats (Section 1.3).

These assessments will be reviewed by the Regulator and appropriate SNCB(s) on a case-by-case basis. The Regulator will confirm if a further assessment is required, for example if there is potential for a deliberate injury and/or deliberate disturbance⁷ offence. The Regulator will also confirm whether they are required to undertake a Habitats Regulation Assessment.

Where there is a consent requirement, the Regulator will also advise an applicant if an EPS licence is necessary. Where no consent is required, the organisation undertaking the survey should seek advice directly from the appropriate SNCB. The SNCBs have provided guidance on '*The Protection of Marine European Protected Species from Injury and Disturbance*' which can assist with applications within English and Welsh inshore waters and the UK offshore marine area⁸. Further EPS guidance for Scottish inshore waters has been produced by Marine Scotland⁹.

⁶ All waters outside of 12 nautical miles from the coast are referred to as offshore waters, with all waters inwards of this mark considered to be inshore waters.

⁷ While these guidelines do not deal with disturbance directly, it is considered the mitigation measures contained may assist in reducing potential disturbance.

⁸ To obtain a copy of the latest version, please contact JNCC

⁹ <http://www.gov.scot/Resource/0044/00446679.pdf>

Typically, any survey consent and/or EPS licence issued will include a general condition that relevant sections of these mitigation guidelines are followed. In addition, key elements that must be followed may be incorporated as detailed consent or licence conditions. It is the Regulator who ultimately determines the final consent or licence conditions (taking account of SNCB advice during the consultation).

Variations to the standard procedures outlined in these guidelines may be approved by the Regulator during their consideration of the consent or licence application, or upon request during survey operations if the variation relates to the consent or licence conditions. It is the responsibility of the company issued the consent or licence (the operator) to follow the guidelines and to adhere to any related conditions attached to the consent or licence.

1.2 Survey considerations

The operator is expected to make every possible effort to design a survey that minimises the sound generated and the likely impacts to marine mammals. Early consultation with the appropriate Regulator and SNCB(s) is encouraged, particularly for situations not specifically covered in these guidelines.

When planning a geophysical survey, the following should be considered:

- Use the lowest practicable power levels needed to achieve the survey objectives and seek/consider methods to reduce and/or buffer unnecessary high frequency noise produced.
- Airgun firing (including testing) must not exceed the planned maximum production volumes outlined in the consent or licence application.
- Determine what marine mammal species are likely to be present in the survey area, identify if the survey is to occur within or near an area of importance for marine mammals (Section 1.3), and assess the likelihood of deliberately injuring or disturbing marine mammals and include this assessment as part of the application or notification¹⁰.
- Assess any seasonal considerations, for example, seal pupping, migration periods and routes and seasonal considerations in MPAs. When possible, plan surveys to avoid areas/periods of high abundance and key seasons.

¹⁰ Details of how injury and disturbance as defined in the regulations has been interpreted can be found in the SNCB 2010 EPS guidance and 2014 Marine Scotland EPS guidance (see references). At the time of writing, proposed thresholds for determining injury to marine mammals were under review. Please contact the appropriate statutory advisor for further advice regarding appropriate threshold levels to apply.

- The standard radius of the mitigation zone referred to in these guidelines is 500 metres (m). Any variation to this mitigation zone size can be proposed during the application process, but requires a clear rationale, potentially supported by noise propagation modelling and including consideration of how the standard mitigation measures could be applied to the proposed mitigation zone.
- Consider the direction of survey lines and distance to sensitive areas and coastline to reduce any potential for entrapment (i.e. prevent animals from possibly being trapped between the vessel and shoreline).
- Ensure sufficient MMO and Passive Acoustic Monitoring (PAM) operatives are employed, considering, for example, the size and location of the survey, the number of line changes and soft starts required, the duration of daylight hours and the requirement for night-time operations. It is the operator's responsibility to ensure sufficient personnel are provided to prevent observer fatigue and meet health and safety requirements. SNCB(s) will recommend a minimum number of personnel, not a maximum.
- Reliable lines of communication must be established between the MMO/PAM operatives and the crew. Copies of the consent and/or licence (once available) and any other relevant documentation (electronic or paper) must be provided to the MMO/PAM operatives in sufficient time before any operations begin (Note: this is a condition of any consent issued under the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended)).
- PAM should be used during periods when visual mitigation is not possible (e.g. darkness, low visibility). Depending upon the nature of the survey and the consent or licence conditions, operations may have to be delayed until conditions change or improve, unless an alternative method to visual surveys, such as PAM, is available and can be deployed.
- PAM equipment should be appropriate for the UK marine mammal species most likely to be found within the survey area. Options for PAM deployment should also be considered early in the planning stage to ensure it can be used effectively (i.e. discuss with equipment supplier/PAM operative/vessel operator etc.).
- Incorporate pre-shooting surveys and soft-starts into survey design. Where practical, time operations to commence during daylight hours to ensure that visual mitigation by MMOs can be undertaken. If this is not achievable, the above points on PAM mitigation measures are relevant.
- When vessels are time-sharing, i.e. where two or more vessels are operating in adjacent areas and take turns to shoot to avoid causing seismic interference, the guidelines apply on all vessels involved and clear communication channels are required to ensure effective mitigation.
- If dual source arrays are to be used, particularly if they are to be operated simultaneously rather than in an alternative manner (e.g. flip flop mode), estimate the mitigation zone required to encompass the entire array (e.g. based on the centre point

between the two arrays). Any proposed alteration to the standard mitigation zone should be made clear in the survey application.

- No equipment testing should be undertaken outside the consented or licensed area (including any greater working area as defined in some applications).
- Discussions are welcomed on the emergence of new seismic techniques, the potential for risk to marine species and the development of appropriate monitoring/mitigation measures. Techniques used to collect geophysical data are constantly evolving, for example the acquisition of data using ambient acoustic energy and using automated underwater vehicles (AUVs) as a platform for site surveys. JNCC strive to keep up to date with developments and to ensure their guidelines are relevant to industry practices.

1.3 Areas of importance

Areas of importance can be defined as discrete areas of important habitat for marine mammal species. These have the potential to be delineated and managed for conservation. Ultimately such areas could be designated as MPAs, which in UK waters include:

- Special Areas of Conservation (SAC), designated under the EC Habitats Directive for habitats and species identified in Annexes I and II respectively;
- 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; and
- Nature Conservation Marine Protected Areas (NCMPAs), created in Scottish seas under the Marine (Scotland) Act 2010 (inshore) and the MCAA (offshore) to conserve some of Scotland's most important marine wildlife, habitats and geodiversity.

All MPAs with a marine mammal species as a qualifying feature are considered an area of importance within the context of these guidelines. Consultation with the appropriate Regulator and SNCB(s) at the earliest opportunity is recommended when considering surveys within or near these areas. Additional mitigation requirements for operations in these areas may be recommended (e.g. combined use of MMO and PAM during daylight hours). Any requirement will consider (as a minimum) the size, duration and timing of the survey and the species most likely to be impacted. All proposed, possible and candidate MPAs are a material consideration within the consenting and licensing processes.

West of Shetland

In addition to MPAs, the deep waters to the west of Shetland are considered an area of importance. Although this area does not currently have legal protection, the area is considered important for a variety of species, including some which do not occur elsewhere in UK waters e.g. deep diving species such as beaked whales and sperm whales. As such, there are variations to standard mitigation procedures (i.e. 60-minute pre-shooting searches) in this area (Section 2.1.1). Additional requirements such as the use of PAM to maximise detection potential may also be considered, as deep diving species are difficult to detect by visual mitigation methods alone.

1.4 Visual and Passive Acoustic Monitoring

The primary aim of these guidelines is to reduce the potential for deliberate injury occurring to marine mammals by monitoring a defined area (the mitigation zone) prior to a noise source being activated and delaying operations should a marine mammal be observed. Monitoring can be achieved through a combination of visual and passive acoustic methods. No one method of detecting marine mammals is 100% effective for all species, rather it is considered that these methods seek to complement each other.

Visual monitoring is undertaken by a Marine Mammal Observer (MMO)¹¹. It should be undertaken from the source vessel with the MMO located on a suitable platform enabling the best view of the mitigation zone and ahead of the vessel. It is acknowledged that weather conditions influence an observer's ability to visually detect marine mammals (e.g. Hammond *et al.*, 2013; Northridge *et al.*, 1995), as does available daylight. Consequently, visual monitoring should be restricted to periods of good visibility during daylight hours.

The use of **Passive Acoustic Monitoring** (PAM) was incorporated into the JNCC guidelines as a form of mitigation in 2002 and has been increasingly used as a tool for monitoring marine mammals during night time and poor visibility conditions. Specialist trained PAM operatives are needed to set up and deploy the equipment and to interpret detected sounds. It is acknowledged that current PAM systems are not suitable for detecting seals and some cetaceans (e.g. baleen whales) and have limited range for others (e.g. high frequency cetaceans). However, it is considered a viable monitoring method during periods when effective visual monitoring is not possible (Stone 2015b).

When a PAM system is used, it should achieve as much as possible of the following:

- Detect the range of frequencies of marine mammal vocalisations expected to be present in the survey area;
- Detect and identify vocalising marine mammals and establish bearing and range in a reasonable period of time;
- Immediately communicate relevant information to the PAM operator (real time) so appropriate and timely mitigation measures can be undertaken (e.g. delay soft start);
- Able to be repaired on board or replaced in case of breakdown (e.g. appropriate repair tools and backup equipment).

1.4.1 MMO/PAM Operative role during surveys

The role of an MMO/PAM operative is to detect marine mammals as part of the mitigation procedures and to advise a delay in the commencement of activity should any marine mammals be detected within the mitigation zone. This is to reduce the potential for deliberate injury to occur and ensure the survey complies with relevant consent or licence conditions. Ultimately, however, it is the operator's responsibility to ensure consent and licence conditions are adhered to, noting the advice provided by the MMO/PAM operative(s).

MMO and PAM operatives should be equipped with an up-to-date copy of the JNCC guidelines and recording forms. The recording form is an excel spreadsheet with embedded worksheets.

¹¹ Note the distinction between this mitigation role and that of a marine mammal surveyor (MMS), who undertakes surveys for research or monitoring purposes and may employ different monitoring techniques and survey methods.

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 website¹².

MMOs should be equipped with binoculars and a tool to estimate distance i.e. range finding stick or binoculars with reticles. The ability to determine range is a key skill for MMOs and a proven tool for distance estimation should be used. For these guidelines, the use of the most appropriate method for the survey and observer in question is recommended. Instructions on how to make and use a range finding stick are available on the JNCC website¹².

Both the MMO and PAM operative should ensure their efforts are concentrated on the mitigation periods, i.e. the pre-shooting search and soft-start time periods until the survey line has started and data acquisition has begun. The guidelines should not be interpreted to imply that MMO/PAM operatives should continue a visual/acoustic search during all available hours, unless specified as a survey consent or licence condition. MMO/PAM operatives should manage their time to ensure that they are available to carry out their duties to the best of their ability during the mitigation periods as outlined above. Whilst JNCC appreciates the efforts of MMO/PAM operatives to record valuable data at other times, this should be managed to ensure those observations are not detrimental to their ability to undertake duties during mitigation periods.

In addition to conducting visual/acoustic searches, the MMO/PAM operatives will advise the crew on the procedures set out in the JNCC guidelines and provide advice to ensure the survey programme is undertaken in accordance with the guidelines and any survey consent or licence conditions. It is essential that MMO/PAM operatives are provided with a copy of any consent/licence conditions and any additional information relevant to their activities. In many cases this will be a condition of survey approvals (e.g. consents issued under the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended)). It is also recommended that MMO/PAM operatives attend pre-mobilisation meetings, to discuss working arrangements and their role while on the vessel.

1.4.2 Training

All MMO and PAM operatives are required to be trained.

For a MMO to be classified as trained, the individual must have undertaken formal training on a JNCC recognised course¹³ plus have some experience of visually spotting marine mammals¹⁴. This experience need not be gained while implementing the JNCC guidelines, i.e. it can be from other types of at sea survey work. Key to the MMO role is the ability to spot marine mammals within the mitigation zone. However, as mitigation within UK waters is required for all cetacean species, identification to species level, while preferred, is not essential.

Currently, JNCC do not recognise any PAM courses¹⁵, however, several training courses are available covering both basic hardware and the use of specialist software. As a minimum, a

¹² <http://jncc.defra.gov.uk/page-1534>

¹³ Further information on recognised course providers is available at: <http://www.jncc.gov.uk/page-4703>.

¹⁴ Note: level and form of experience will be considered alongside a general review of training requirements.

¹⁵ Discussions are currently underway to identify minimum standards for the use of PAM as a mitigation tool, including operator training requirements. Further information will be published once available.

PAM operative should be able to assemble and deploy PAM equipment, configure the software, identify acoustic signals and interpret bearing and range information.

1.4.3 Experience

An experienced MMO¹⁵ should have a minimum of 20 weeks' experience of implementing JNCC guidelines in UK waters over the previous ten years, and preferably within the previous five. Furthermore, they will be experienced at identifying UK marine mammal species (visually and/or acoustically depending on the role) and be familiar with their behaviour.

We recommend 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 experienced personnel who can act as mentors while they gain experience of implementing the guidelines.

The use of experienced MMO and PAM operators is essential in areas of importance for marine mammals.

1.4.4 Recommended requirements for MMOs and PAM operatives

JNCC (and other SNCBs) will recommend to the Regulator a minimum number of MMOs and PAM operatives required for each survey. This will take into account, as a minimum, the survey location, duration, time of year, maximum airgun volume and species sensitivities.

In addition, MMOs will be referred to (by JNCC) as either:

- **Dedicated:** A trained MMO who is employed for the sole purpose of undertaking visual observations to detect marine mammals and advising on and monitoring the implementation of the guidelines. They are not normally a member of the vessel crew (i.e. they are sub-contracted professionals).

Dedicated MMOs have higher sighting rates than non-dedicated MMOs and supply higher quality data (Stone, 2015b). They also have the advantage of being available outside of the mitigation periods. For example, they can be called upon to search for marine mammals during operations¹⁶ and advise if any marine mammals are present in the area if operations unexpectedly stop for technical reasons and need to start up promptly after the problem is solved. This can reduce the need for additional pre-shooting searches and soft starts (Section 2:).

- **Non-dedicated:** A trained MMO who may undertake other roles on the vessel when not conducting their mitigation role. This person can be a member of a rig's or vessel's crew providing they do not undertake other roles during mitigation periods.

Non-dedicated MMOs are typically recommended for short surveys using low energy sources e.g. some vertical seismic profiling (VSP), sub-bottom profiling or when using an airgun system with a total volume equal to or less than 180 cubic inches.

Given the specialist nature of the PAM operative role, it is expected they will be a sub-contracted professional whose sole role on the vessel is to operate the PAM system i.e. all PAM operatives will be dedicated.

¹⁶ This should not be done to the detriment of key mitigation periods, unless sufficient personnel are employed to allow continual monitoring.

It is the operators' responsibility to employ sufficient MMO/PAM personnel to cover all mitigation periods, taking account of the specific requirements and logistics of their survey, thus removing the potential for operative fatigue and meeting health and safety requirements. This is particularly important when working at northern latitudes (i.e. above 57°) during summer months (defined here as between 1st April and 1st October) and when planning 24-hour data acquisition. In such cases, the operator must provide sufficient personnel to allow the work to be carried out in shifts.

Where PAM is a condition of the consent or licence, it must be used if soft starts will occur during hours of darkness and during periods when day-time conditions are not conducive to visual surveys (e.g. fog).

Where PAM is not a condition of the consent or licence and day-time conditions are such that visual observations cannot be undertaken and no other form of monitoring is available, best practice would be to delay the initiation of soft starts and seismic shooting until conditions improve.

The use of PAM is particularly important during winter months when hours of darkness are longer. Visual surveys at dusk are not a reliable indicator to inform start-up decisions at night and should not be viewed as an alternative to using PAM. However, it is not recommended that PAM is used as the sole method of mitigation during periods when visual searches are possible (Stone, 2015b).

A minimum of one PAM operative is required when PAM equipment is to be deployed, with consideration of the survey specifics (including potential use during daylight hours) used to determine the total number of operatives. PAM may be required to supplement visual surveys (in addition to use at night and periods of poor visibility) in areas of importance for marine mammals. Under such circumstances, the operator must ensure sufficient personnel are employed to allow for 24-hour PAM coverage (i.e. usually a minimum of two PAM operatives).

It is not uncommon for individuals to conduct both the MMO and PAM roles during the same survey. This is acceptable under these guidelines but it is essential that personnel are trained and competent in both roles.

Regardless of whether the MMO and PAM operatives are conducting sole or dual roles, an operator not providing sufficient personnel for a survey is not a valid reason for conducting surveys without cover during mitigation periods.

Section 2: Mitigation

For surveys that require a consent or licence, any proposed deviation or exception from the provisions of the guidelines must be discussed and agreed with the Regulator during the application process. These guidelines must then be read alongside the specific conditions attached to the approval issued by the Regulator.

2.1 Standard Airgun Mitigation Procedures

The following guidelines apply to all geophysical surveys that use airguns.

2.1.1 Pre-shooting search

Clear communication channels between the MMO/PAM operator and relevant crew must be established prior to the commencement of any operations. The MMO/PAM operator must be aware of the timings of the proposed operations. The crew must inform the MMO/PAM operators (or nominated lead) sufficiently in advance of airgun firing so that a full pre-shooting search can be completed prior to the soft start commencing.

Location of MMO/PAM

All monitoring (visual and PAM) should be undertaken from the source vessel (where the noise source is deployed from), unless alternative arrangements have been agreed with the Regulator.

The MMO should be positioned on a high platform with a clear view of the horizon, mitigation zone and ahead of the vessel. The PAM operator should be positioned in the most appropriate location to allow them to monitor the PAM equipment for acoustic detections and maintain contact with both the MMO and relevant crew, for both mitigation purposes and ensuring the PAM equipment is deployed correctly.

Mitigation zone

The MMO/PAM operative will monitor the agreed mitigation zone and advise if any marine mammals are within it. The standard radius of the mitigation zone is **500m**, estimated from the centre of the airgun array or noise source location (noting comments in 0). If the size of the mitigation zone is adjusted for any reason, this will be stipulated within the survey consent or licence conditions.

Duration of search

The MMO must monitor the mitigation zone for the full duration of the pre-shooting search and soft-start procedure. Where PAM is being used in conjunction with or in place of visual surveys, acoustic monitoring must also occur for the full duration of the pre-shooting search and soft-start procedure. Once the soft start has ended and data acquisition begins, monitoring can cease.

The duration of the pre-shooting search is determined as follows:

- **Waters less than 200m deep:** 30 minutes prior to the use of any airguns.
- **Waters greater than 200m deep:** 60 minutes prior to the use of any airguns.

The longer search period is to allow for deep diving species (e.g. sperm whale and beaked whale) which are known to dive for longer than 30 minutes. PAM may also be required on all pre-shooting searches in deeper waters (i.e. to complement visual surveys) to increase the potential to detect species with long dive times.

Due to the longer pre-shooting search time required in deeper waters, pre-shooting searches can commence before the end of a preceding survey line (whilst the airguns are still firing) **IF** line changes will take less time than the pre-shooting search and soft-start combined (i.e. 80 mins; Section 2.1.4).

2.1.2 If marine mammals are detected within the mitigation zone

If marine mammals are detected within the mitigation zone during the pre-shooting search (visually or acoustically), the soft-start must be delayed until their passage, or the transit of the vessel, results in them being outside of the mitigation zone. There must be a minimum of a 20-minute delay from the time of the last detection within the mitigation zone and the commencement of the soft-start, to allow animals unavailable for detection (i.e. not re-surfacing in that time) to have moved outside of the mitigation zone.

A full soft-start must be undertaken after any delay due to the presence of marine mammals within the mitigation zone.

In situations where seal(s) are congregating around a fixed platform within a survey area, the soft-start should commence at a location at least 500m from the platform.

If marine mammals are detected within the mitigation zone whilst the airguns are firing, either during the soft-start procedure or when at full power, there is no requirement to stop firing.

Figure 1 illustrates a typical seismic survey with decision making pathways in the event a marine mammal is detected.

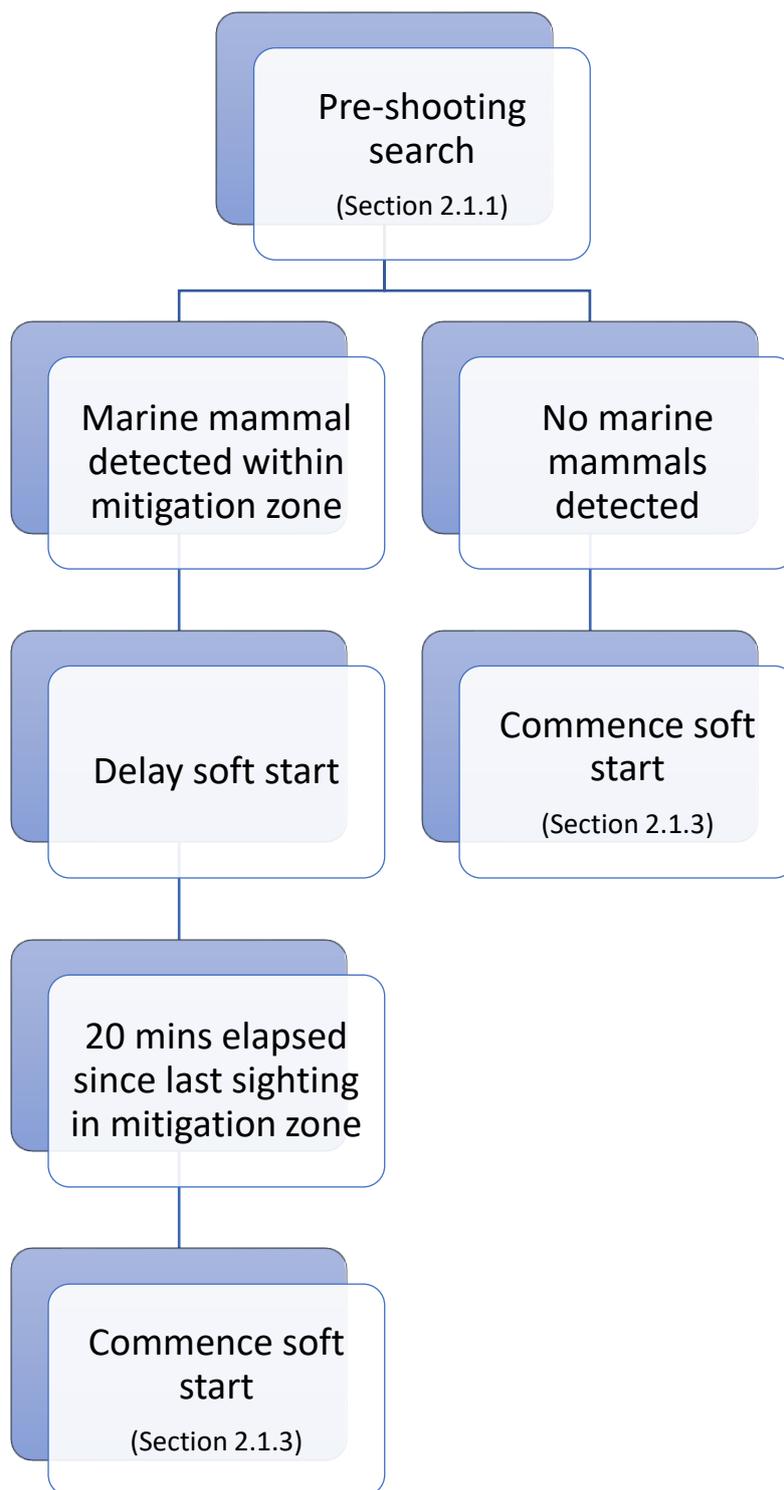


Figure 1. Flowchart illustrating the decision-making pathway of a MMO/PAM operative during a seismic survey.

2.1.3 Soft-start

Two criteria define the standard duration of a soft start:

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

One exception to these criteria is for surveys where the maximum airgun volume is <180 cubic inches, in which case:

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

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

There should be a soft-start every time the airguns are scheduled to be used, the only exceptions being for certain types of airgun testing (Section 2.1.5), and the use of a 'mini-airgun' (single gun volume equal to or less than 10 cubic inches). Mini airguns do not require a soft start.

Surveys operations should be planned to avoid unnecessary firing at operational power before commencement of a survey line and to time operations to commence data collection as soon as possible once full operational power is achieved.

2.1.4 Line changes

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

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

One example of airgun use that does not require a line change is **Vertical Seismic Profiling (VSP)**, a technique where measurements are made at a series of depths in the wellbore using geophones inside the wellbore and an airgun source at the surface near the well. In this instance, the breaks in operations required to reposition geophones are treated in the same manner as line changes.

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

a) If line changes are expected to take longer than 40 minutes:

If line changes (or geophone repositioning) are expected to take longer than 40 minutes, regardless of airgun volume:

- Firing is to be terminated at the end of the survey line (or during geophone repositioning);
- A pre-shooting search is to be undertaken during the scheduled line change (or geophone repositioning);
- The soft-start is to be delayed if marine mammals are seen within the mitigation zone during the pre-shooting search (Section 2.1.2); and
- A full 20-minute soft-start is to be undertaken before the start of the next line or VSP data collection (Section 2.1.3).

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

b) If line changes are expected to take less than 40 minutes:

If line changes (or geophone repositioning) are expected to be completed within 40 minutes, regardless of airgun volume:

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

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

2.1.5 Airgun testing

Airgun tests may be required to trial new equipment or to test damaged or misfiring airguns following repair. Individual airguns or several airguns may need testing and the airguns may also be tested at varying power levels. The following guidance is provided to clarify when a soft-start is required for airgun testing:

- If the intention is to test a single airgun, a soft-start is not required.
- If the intention is to test multiple airguns, a soft-start is required. This should be carried out over a time period proportional to the number and/or volume of guns being tested and should not exceed 20 minutes in duration. Airguns should be tested in order of volume, smallest first.
- A pre-shooting search (Section 2.1.1) must be undertaken before any instances of airgun testing

Where feasible, it is recommended that airgun testing is incorporated into the soft start procedure and conducted before the start of a survey line to reduce the total amount of noise being introduced into the marine environment.

2.1.6 Undershoot operations

The MMO/PAM operatives should be located on the source vessel to ensure they are close enough to the airguns to effectively monitor the mitigation zone. If this is not possible, e.g. for logistical or health and safety reasons, the operator should explain this during the application process and suggest and agree any alternative mitigation arrangements with the Regulator.

A pre-shooting search and soft-start procedure must be followed prior to undertaking all undershoot operations.

2.1.7 Breaks in operations

Unplanned breaks: This refers to instances where the airguns cease firing **unexpectedly** during data acquisition, e.g. a technical problem or breakdown. In such circumstances, it is imperative the MMO/PAM operatives begin to monitor the mitigation zone as quickly as possible after an unplanned break has occurred.

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

If a marine mammal is detected in the mitigation zone during the breakdown period, the MMO/PAM operative will advise to delay recommencement of the airgun firing until their passage, or the transit of the vessel, results in the marine mammals being outside of the mitigation zone. There must be a minimum of a 20-minute delay from the time of the last detection within the mitigation zone and a soft-start must then be undertaken, as described in Section 2.1.3.

- **Unplanned breaks of longer than 10 minutes:** If it takes longer than 10 minutes to restart the airguns, a full pre-shooting search (Sections 2.1.1) and soft-start (Section 2.1.3) should be carried out before the survey re-commences. **If** an MMO/PAM operative has been monitoring during the breakdown period, this time can contribute to the pre-shooting search time (30 or 60 minutes as appropriate).

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

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

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

2.2 High Resolution Surveys (HRS)

High resolution data can be achieved either using airguns or electromagnetic sources. Sub-bottom profiling (SBP, e.g. pingers, sparkers, boomers and CHIRP systems), side-scan sonar and multi-beam echosounders all use electromagnetic sources¹⁷.

JNCC will provide advice on a case-by-case basis based on the following:

- **Airguns:** As a precautionary measure, JNCC advise that any HRS that uses airguns requires mitigation as described in Section 0 above. Note: mini airguns (single gun volume equal to or less than 10 cubic inches) do not require a soft start but do require a pre-shooting search.
- **Electromagnetic sources:**
 - Pre-shooting search of the mitigation zone and a delay in proceeding if a marine mammal is observed as described in Sections 2.1.1 and 2.1.2. Typically, a non-dedicated MMO can be used.
 - Soft start – where practical, ramp up the power in a uniform manner. However, it is acknowledged that this is not possible for some SBP equipment (i.e. it is either on or off). If such equipment is to be used, this should be highlighted during any relevant application process.
 - Line change – as described in Section 2.1.4.

If several types of HRS equipment are to be started sequentially or interchanged during the operation, only one pre-shooting search is required prior to the start of acoustic output, **only** if there are no gaps in data acquisition of greater than 10 minutes (refer to Section 2.1.7 for breaks in operations).

Multi-beam surveys in deep waters

SNCB guidance on the protection of EPS¹⁸ highlights that some multi-beam systems used in deeper waters (>200m) utilise frequencies (<100Khz) at sound levels that may be of concern to cetacean species, both in relation to deliberate injury and disturbance offences (see Section 3.14, page 43 of the EPS guidance). Therefore, an assessment of the risk to EPS from such surveys should be considered. JNCC (or the appropriate SNCB) will provide advice regarding mitigation requirements on a case by case basis as either directly to the operator or as part of any consultation process initiated by the relevant Regulator.

Multi-beam surveys in shallower waters (<200m) are not subject to these requirements as it is thought the higher frequencies typically used fall outside the hearing frequencies of cetaceans and the sounds produced are likely to attenuate more quickly than the lower frequencies used in deeper waters. JNCC do not, therefore, advise that mitigation is required for multi-beam surveys in shallow waters.

¹⁷ It should be noted that airgun and SBP site surveys undertaken in relation to licences issued under the Petroleum (Production) Act 1934, Petroleum Act 1998 or the Energy Act 2008 require consent under the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended), but side-scan sonar and multibeam echosounder surveys only require to be notified to the Regulator.

¹⁸ SNCB Draft Guidance, 2010. To obtain a copy of the latest draft version of the guidance please contact JNCC.

Section 3: Reporting

3.1 MMO report

For all oil and gas geophysical surveys, an MMO report should be sent to the Regulator (via email to emt@beis.gov.uk) and copied to JNCC (via e-mail to seismic@jncc.gov.uk) after the survey has been completed. It is the responsibility of the consent holder to ensure that the MMO report is sent in a timely manner (BEIS consent conditions require submission within six weeks of the date of expiry of the consent). The report should be accompanied by the completed JNCC marine mammal recording forms (i.e. the raw data in the excel spreadsheets) and a copy of the relevant consent. Please include the excel spreadsheets in their original format i.e. do not convert to pdf.

For other industry sectors and respective Regulators, it is recommended that similar procedures regarding MMO reporting should be followed, but this should be agreed with the relevant Regulator and SNCB(s).

Please note that information on marine mammal distribution and general ecology etc. are not required within the MMO report, as such information is provided and reviewed within the survey application. The MMO report should provide a brief summary of the specifics of the conducted survey, mitigation watches (visual and acoustic) and required mitigation action as outlined above (see Appendix 2 for further information to be provided within an MMO report).

3.2 Compliance with JNCC guidelines

In addition to monitoring for the occurrence of marine mammals, the MMO/PAM operatives will advise the crew on the procedures set out in the JNCC guidelines and provide advice to ensure the survey programme is undertaken in accordance with relevant mitigation requirements detailed in any survey consent or licence conditions.

Every effort should be made to resolve any compliance issues during the survey with relevant crew personnel. MMO/PAM operatives and consent/licence holders can contact JNCC to seek advice in relation to any aspect of these guidelines, including any issues that have arisen during the course of a survey that could affect compliance with the guidelines to try to resolve the issues in a timely manner. Any queries can be emailed to JNCC at seismic@jncc.gov.uk. Details of any issues (regardless of whether advice was required) and how they were resolved should also be included in the MMO report (Appendix 2).

Any queries in relation to compliance with specific consent or licence conditions must follow the procedure outlined in Section 3.3.

3.3 Compliance with consent or licence conditions

MMO/PAM operatives and consent or licence holders are encouraged to contact the Regulator during survey operations to seek advice/discuss any mitigation issues that have arisen that could affect compliance with the consent or licence conditions, to try to resolve them in a timely manner. Where necessary, the Regulator will seek advice from JNCC or the relevant inshore nature conservation body. If there is a breach of the consent or licence conditions, the consent or licence holder must advise the Regulator in accordance with the reporting requirements detailed in the relevant consent or licence. The MMO/PAM operatives can also independently

report breaches to the Regulator. Contact details for requesting advice and procedures for the reporting of a non-compliance are normally appended to the relevant consent or licence.

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Appendix 1

Glossary

Areas of importance: Discrete areas of important habitat to marine mammal species.

Airgun: Device into which air is pumped into chambers at high pressure and then released through ports to form an oscillating bubble, thereby producing sound waves. Designed to emit a vertical beam of sound towards the seabed, with some unintentional sound radiating out from other angles.

Applicant: The company or organisation applying for consent or licence to undertake a geophysical survey

Consent holder: The company or organisation holding a consent for a geophysical survey.

Daylight hours: Period between sunrise and sunset when sufficient light is available to effectively conduct visual observations.

Echosounder: Equipment used to provide a water depth estimate by emitting pulses of sound that reflect from the seabed. The typical frequency range is from 10-200 kHz¹⁹.

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

Full power: Firing the airguns at their full operational level, reached at the end of a soft-start.

Geophysical survey: The systematic collection of geophysical data for spatial studies, using a range of equipment including airguns.

Licence holder: The company or organisation holding an EPS licence relating to a geophysical survey.

Line change (or turn): The activity of turning the vessel at the end of one survey or production line prior to commencement of the next period of data acquisition.

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 MMO 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 Mammal Surveyor: Individual responsible for conducting visual watches for marine mammals for monitoring or research purposes.

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

¹⁹ Genesis, 2011

of nature with associated ecosystem services and cultural values²⁰. 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.

Mini-airgun: Airgun of volume less than or equal to 10 cubic inch.

Mitigation zone: The area within which the MMO/PAM operative searches (visually or acoustically) for marine mammals.

Multi-beam echosounder: Similar to an echosounder except it emits a fan of sound beams. They work using a range of sound frequencies, with higher frequencies used in shallower waters that are normally outside the hearing range of cetaceans.

Ocean Bottom Seismic: Sound is released from a conventional source vessel and reflections are recorded by sensors placed on the sea floor. Based on the type of recording sensor used to collect data, these surveys may be referred to as

- **Ocean Bottom Cable (OBC):** An assembly of geophones and hydrophones connected by cables and deployed on the seafloor to record and relay data to a seismic recording vessel.
- **Ocean Bottom Nodes (OBN):** Similar to OBC except autonomous recording nodes are placed on the sea floor using ROVs. Nodes may be connected to each other and to the recording vessel with cables or have inbuilt recording capabilities.

Operator: The company or organisation undertaking a geophysical survey.

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

PAM operative: Individual responsible for conducting acoustic searches for marine mammals and experienced in the use of PAM equipment and marine mammal acoustics.

Pre-shooting search: Search for marine mammals (visually and/or acoustically) prior to commencing firing of airguns.

Production (or survey) line: Transect line during which data is acquired. Can also be expressed in terms of the number of shots or lengths (km or miles) of data acquired in a given time.

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

Seismic survey: Any geophysical survey that uses airguns to generate sound which is directed into the seabed and the reflected energy is recorded and processed to produce images of the geological strata; surveys may be described as:

- **2D seismic:** Survey vessel with a single towed hydrophone streamer. Reflections from the subsurface strata provide an image in two dimensions (horizontal and vertical).
- **3D seismic:** Uses more than one hydrophone streamers towed by the survey vessel to provide a three-dimensional image.

²⁰ Dudley, N. (Editor) (2008). Guidelines for Applying Protected Area Management Categories. Gland, Switzerland: IUCN. x + 86pp.

- **4D seismic:** 3D seismic surveys repeated over a period of time, for example, to observe reservoir depletion during production and identify areas where there are barriers to flow that may not be easily detectable using other seismic techniques.

Shot Point Interval (SPI): Interval between successive shots of the airgun(s), measured in time (seconds) or metres travelled over the ground.

Side-scan sonar: Used in mapping the surface and upper layers of the seabed. Sound pulses are usually centred at frequencies between 100-500 kHz, the higher frequencies provide a greater resolution but reduced seabed penetration¹⁹.

Site survey: Seismic survey of a limited area proposed for drilling, infrastructure emplacement etc., typically to identify seabed and subsurface hazards such as wrecks and the presence of shallow gas. The surveys often use a range of techniques, including multi-beam echosounders and side scan sonar, sub-bottom profiler, magnetometer and small airguns (40-400 cubic inches²¹) with short hydrophone streamers.

Soft-start: Process whereby the power of an acoustic source is built up slowly from a low energy start-up, gradually and systematically increasing the output until full power is achieved (usually over a period of 20 minutes).

Source vessel: The vessel from which the acoustic source (e.g. airguns) is deployed.

Source: A device that provides energy for acquisition of seismic data, such as an airgun, explosive charge or vibrator.

Sub-bottom profiling (SBP): Systems employed to identify and characterise layers of sediment or rock under the sea floor. Low frequency sound sources achieve greater penetration through the seafloor, but produce a lower-resolution picture; higher-frequency pulses achieve a higher resolution but do not penetrate as deeply into the sub-bottom strata. In addition to small airguns (typically less than 180 cubic inches). The following systems may be used:

- **Boomer:** Consist of two plates separated by a coil across which a high voltage impulse is created. The induced magnetic field causes one plate to vibrate directing acoustic energy into the surrounding water. They have a broadband acoustic source ranging between 500 Hz - 5 kHz and are used to map the seabed layers between 30 - 100m depth¹⁹.
- **Pingers:** Equipment that periodically emit a high frequency 'ping', typically operating on a range of single frequencies between 3.5 - 7 kHz¹⁹, used to achieve information from the seabed immediately below the surface layers. They offer very high resolution but limited penetration dependent upon the seabed sediments, for example, a few tens of metres in mud.
- **Chirp systems:** These were designed to replace pingers and boomers and are now frequently used in oil and gas site surveys in place of the older systems. Chirp systems operate around a central frequency, usually sweeping across a range of frequencies between 3 - 40 kHz¹⁹.

²¹ OGP 2011 – An overview of marine seismic operations.

- **Sparkers:** Use an electrical discharge to generate sound similar to boomers but their use is now infrequent¹⁹. A high voltage impulse generates a spark across a pair of electrodes forming a gas bubble whose oscillations generate the sound. Sparkers are powerful devices and can be used to penetrate seabed layers up to 1 km.

Time-sharing: When vessels engaged on adjacent surveys take turns to run survey lines to avoid interference from the noise of each other's airguns.

Undershoot: Procedure used to facilitate shooting under platforms or other obstructions. One vessel is used to tow the seismic source and a second to tow the hydrophone array.

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.

Vertical Seismic Profiling (VSP) (or Borehole Seismic): Measurements made using geophones located inside the wellbore and a seismic source at the surface near the well. The seismic sources are generally smaller than those used for deep geophysical surveys but larger than for site surveys¹⁹. The seismic sources can be deployed in several ways:

- **Zero offset:** source located on the drilling platform;
- **Offset:** source vessel stationed at fixed location some distance from the well; and
- **Walk away:** source vessel traverses one or more lines away from the well.

Appendix 2

MMO report

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

Operator details:

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

Survey details:

Provide a summary of the survey including:

- Date and location of survey;
- Total number and volume of the airguns used;
- Nature of airgun array discharge frequency (in Hz), intensity (in dB re. 1 μ Pa or bar metres) and firing interval (seconds);
- Details of any other acoustic energy used (e.g. SBP);
- Details of any airgun testing;
- Average duration of all pre-watches, soft starts and line changes, and the number of occasions when guideline durations were not met (specific times are included in the accompanying MMO excel recording forms);
- Summary of MMO/PAM activities for each monitoring period i.e. day/night (i.e. full excel recording forms of operations and brief written summary)
- Number and types of vessels involved in the survey;

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

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

MMO/PAM effort and detections:

Include details of the number of staff employed, whether they were dedicated or non-dedicated staff and their working location(s) on the vessel. Also, include details of their experience i.e. level of training, number of previous mitigation assignments or previous experience of observing if new to the role. A brief CV could be added as an appendix if easier.

Provide details of the lead operative responsible for the report who can be contacted if JNCC has any follow up questions.

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

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

Application of mitigation procedures

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

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

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

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

Additional information

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