



Aberdeen Harbour Expansion Project

Construction Environmental Management Document

11th May 2017

DRAGADOS

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Chapter 11

Marine Mammal Mitigation Plan

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11 Marine Mammal Protection Plan

11.1 Introduction

A Marine Mammal Mitigation Plan (MMMP) has been prepared to ensure construction risks to marine mammals associated with the proposed Aberdeen Harbour Expansion Project (AHEP) are appropriately managed.

The MMMP includes all mitigation measures that have been identified for marine mammals as outlined in Chapter 15 and Chapter 26 of the AHEP Environmental Statement (ES)¹ as well as measures agreed between Aberdeen Harbour Board (AHB) and Scottish Natural Heritage (SNH), Marine Scotland (MS) and Transport Scotland (TS) during the consultation on the Environmental Statement (ES).

The need to minimise the production of underwater noise is paramount in the harbour design and construction. Dragados have removed all marine impact piling operations included within the ES Design Envelope and will work with our sub-contractor Jan de Nul to minimise blasting and drilling use.

The MMMP describes the monitoring programme associated with Marine Mammal Observers. All MMMP associated monitoring data will be supplied to Marine Scotland and SNH.

All marine operations will adhere to the MMPP. For ease of reference, the commitments and timescales in relation to marine mammal monitoring and reports issued are included in Appendix D of this plan.

11.2 Roles and Responsibilities

The following individuals are responsible for ensuring that the requirements of this Marine Mammal Mitigation Plan are implemented at the AHEP site.

Table 11.1: Roles and Responsibilities Table

Job Title	Name	Responsibilities
Environmental Clerk of Works (ECOW)	Emma Bias	Delivery of toolbox talks to staff regarding watching for marine mammals, work with an experienced MMO to train staff to undertake Marine Mammal watches, audit watches a
Environmental Manager	TBC	Update Marine Noise Registry and undertake marine watches as required.
Marine Mammal Observer	Multiple individuals	Carry out dedicated watches prior to drilling, blasting and disposal

¹ Aberdeen Harbour Expansion Project (November 2015). Volume 2: Environmental Statement, Chapter 15: Marine Mammals.

Job Title	Name	Responsibilities
		activities. Complete watch logs and reports based on observations.
Jan de Nul Environmental Manager	TBC	Work with Dragados EM and ECoW to ensure all aspects of MMMP are adhered to. Relevant reports submitted.

11.3 Legislation

Under the terms of the Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations, in Scottish inshore waters (within 12 nm of the coast), European Protected Species are afforded extra protection. For dolphins, porpoises and whales it is an offence to deliberately or recklessly:

- capture, injure or kill such an animal
- harass an animal or group of animals
- disturb an animal while it is occupying a structure or place used for shelter or protection
- disturb an animal while it is rearing or otherwise caring for its young
- obstruct access to a breeding site or resting place, or otherwise deny the animal use of the breeding site or resting place
- disturb an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs
- disturb an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young
- disturb an animal while it is migrating or hibernating
- disturb any dolphin, porpoise or whale (cetacean)

A licence to disturb marine mammals (known as a European Protected Species or EPS Licence) will be applied for by Dragados prior to any activities producing underwater noise commencing on site.

11.4 Seal Injury Avoidance Scheme

Within this document, the broad term marine mammal is to include all seals and as such, a separate Seal Injury Avoidance Scheme is not required. The risk of ‘corkscrew’ seal injuries from dynamic positioning on vessels is not thought to exist due to the discovery of seals predated on other seals and causing the ‘corkscrew’ type injuries.

11.5 Key Sensitivities

The ES identified bottlenose dolphin, harbour porpoise and grey seal as the key marine mammal species requiring the use of mitigation measures during construction work. In general, the ES found that impacts relating to construction of the AHEP are anticipated to be localised and temporary on very high value receptors and significance of effect is largely considered to be minor or moderate adverse.

Potential impacts from anthropogenic noise due to construction of the harbour upon marine mammals is a key environmental risk. Anthropogenic noise is a generic term that refers to any man-made sound or vibration which intrudes into the natural environment and which can mask a biologically useful sound (a 'signal'), disturb the natural behaviour of the animals, impair hearing or cause injury. Such anthropogenic noise sources include piling, shipping, blasting, and drilling.

Other potential impacts on marine mammals are those caused by collisions with marine vehicles or impacts from accidental releases of pollutants.

11.5.1 Moray Firth Special Area of Conservation

The Moray Firth Special Area of Conservation (SAC) in north-east Scotland supports the only known resident population of bottlenose dolphin *Tursiops truncatus* in the North Sea. As a coastal and wide-ranging species, this population is distributed along the east coast, with a number of hotspots existing within this.

The bottlenose dolphins present around Aberdeen are known to be part of the resident population associated with the Moray Firth SAC, and use Aberdeen Harbour as key foraging habitat.

Disturbance to this species is identified as a key risk for the AHEP project which Dragados will seek to address and mitigate.

11.6 Marine Mammal Mitigation Measures

When reading and implementing the Marine Mammal Protect Plan, cross reference should be made to a number of other plans where mitigation measures are described including:

- Dredging and Dredge Spoil Disposal Monitoring Plan – Information on the dredging works and procedures to be followed during dredging operations
- Vessel Management Plan – Information on the handling of vessels in Nigg Bay including communicate and exclusion areas.
- Piling Management Plan – Information on the planned rotary pile driving operations. No impact piling is currently planned in the marine environment.

11.6.1 Guidelines

Relevant guidelines include:

- The protection of Marine European Protected Species from injury and disturbance – Guidance for Scottish Inshore Waters (Marine Scotland, 2014)
- Adherence to relevant Joint Nature Conservation Committee (JNCC) guidelines (except where amendments have been approved by the licensing authority) and other best practice are a condition of the construction Marine Licence. This includes:
 - JNCC guidelines for minimising the risk of injury to marine mammals from using piling (JNCC, 2010b);
 - JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC, 2010c); and
 - JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (JNCC, April 2017)²

11.6.2 Collision with Vessels

All vessels must adhere to the Aberdeen Harbour Dolphin Code. This will help to mitigate against any potential disturbance and collision effects as a result of vessel traffic.

The Code states that:

- When dolphins are nearby, maintain a steady course and the slowest safe speed you can
- When entering or leaving the harbour stay well away from the breakwaters to avoid startling or boxing-in animals behind them
- If it is safe and practicable to do so, avoid directly approaching the animals.
- Avoid turning engines on and off if dolphins are present
- Never allow anyone to swim with, touch or feed dolphins

Adherence to the Aberdeen Harbour Dolphin Code is also a condition of the Vessel Management Plan and the Environmental Clerk of Works (ECoW) will ensure regular toolbox talks and checks are made to ensure all skippers are aware and adhering to the Code.

11.6.3 Accidental Release of Pollutants

As part of the Pollution Prevention Plan and Vessel Management Plan measures have been developed to control the storage, movement and treatment of fuel and oil on and around the site, which will reduce the risk of accidental spills to the marine environment and potential harm to marine mammals. All vessels will be expecting to carry spill kits and competent staff members to deploy these should the need arise.

² JNCC (April 2017) JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys. http://jncc.defra.gov.uk/pdf/jncc_guidelines_seismicsurvey_apr2017.pdf. Accessed 07/05/2017.

11.6.4 Marine Impact Piling

Marine Impact Piling will not be used in the AHEP Construction. If used, a revised MMMP will be submitted to Transport Scotland/Marine Scotland and consulted upon with Scottish Natural Heritage, Whale and Dolphin Conservation and the Royal Society for the Protection of Birds. Details of rotary piling are included in the Piling Management Plan.

11.6.5 Blasting

Details on the working principles and method statement of the blasting works is provided in the Dredging and Dredge Spoil Disposal Management and Monitoring Plan.

Explosives will be used below the seabed to fracture rock to allow the backhoe dredger to remove it for reuse. When blasting occurs the following conditions will be adhered to:

- a) Blasting is restricted to daylight hours unless during exceptional circumstances.
- b) A process to record and report, in writing to the licensing authority, within 48 hours, instances where blasting has occurred, out with daylight hours, due to exceptional circumstances.
- c) The minimum amount of blasting will be undertaken using the smallest practicable charges.
- d) Where possible, blasting in the northern area will be scheduled so that it is undertaken behind a partially constructed breakwater, so that there is no 'direct line of site' between the blasting and open water. Where this is not possible, blasting will occur behind a bubble curtain (Section 11.10). This complies with the Construction Marine Licence condition 3.2.5.
- e) The northern breakwater construction is to commence mid/end of May 2017, with blasting in the north commencing mid July 2017. Dependent on the speed of works, which is reliant on weather conditions, approximately 180m of the northern breakwater will be partially constructed prior to blasting commencing.
- f) Marine Mammal Observers and Passive Acoustic Monitoring will be used to ensure that operations do not start while marine mammals are within the 1 kilometre mitigation zone.
- g) A watch of at least 30 minutes duration, will be undertaken prior to blasting commencing. Blasting operations may only start after marine mammals have been outside the exclusion zone for 30 minutes. (i.e. no animal has been since for at least 30 minutes).

11.6.6 Drilling and Marine Rotary Piling

Further details of the drilling operation are available in the Dredging and Dredge Spoil Disposal Management Plan (as drilling is associated with blasting). Further details on rotary piling are provided in the Piling Management Plan.

Marine drilling activities are predominantly the drilling of 10 to 15 cm diameter holes to allow the charges to be set for explosives placed below the seabed. These will be drilled to variable depth depending on the thickness of the rock to be fractured.

In order to construct part of the North Quay and the West Quay, Marine Rotary Piling will also be carried out (see Piling Management Plan for further details) and will adhere to the same conditions as drilling activities.

- a) Marine Mammal Observers and Passive Acoustic Monitoring will be used to ensure that operations do not start while marine mammals are within the 500m mitigation zone.
- b) A watch, of at least 30 minutes duration, will be undertaken prior to drilling commencing. Drilling operations may only start after marine mammals have been outside the exclusion zone for 30 minutes. (i.e. no animal has been since for at least 30 minutes).

11.6.7 At Sea Disposal

Further details of the at sea disposal are available within the Dredging and Dredge Spoil Disposal Management Plan. Whilst disposal operations are taking place, the vessels will adhere to the following conditions in relation to marine mammals.

- a) Marine Mammal Observers will be used to ensure that at sea disposal operations do not start while marine mammals are within the 500m mitigation zone.
- b) A 20 minute watch must be kept prior to operations commencing.
- c) A continuous watch must be kept during operations and if marine mammals are observed within 500m then disposal operations must be ceased until the area has been clear of marine mammals for at least 20 minutes.

11.6.8 Breakwater Construction

Further details of the breakwater construction process are available in the Construction Method Statement.

Breakwater construction will, at times be a 24 hour a day operation. There are several different activities which include placing rock and other material from land onto the seabed as well as installation of accropodes. Material will be delivered to site by HGV and placed directly on the seabed either from the HGV or through the use of bulldozers in a 24 hour a day, continuous process.

There is a risk that some marine mammal species may come close to the breakwater operations during construction, particularly seals, due to their inquisitive nature and desire to haul out.

An experienced MMO will train the ECoW, EM and those working on breakwater construction to complete a watch for marine mammals prior to depositing rock on the seabed or installation of accropodes or other activities where there is a risk seals may be struck by material. This will involve undertaking a simple timed watch over 1 or 2 minutes (depending on the area to be surveyed) out to a distance

of 50m from the breakwater, to ensure the area is free of marine mammals. If animals are in the area (most likely to be seals) deposits should be halted until the marine mammal has voluntarily left the area.

A fully trained and experienced MMO, will ensure all those working on the breakwater are appropriately trained to carry out this watch and also train the ECoW to assist in undertaking watches when available. The ECoW will also undertake audits on a weekly basis during breakwater construction to ensure the watch is being correctly undertaken.

11.7 Reporting

For each of the activities listed above, a record of activity including watches prior to activities commencing, marine mammals observed, delays to operations commencing and any post operation sightings will be completed. The forms included in Appendix B will be used as templates and standardised across operations.

As per the Dredging Marine Licence, Marine Mammal Observer logs will be submitted to MS, JNCC, SNH and WDC as required.

Whilst activities are ongoing on site with the potential to create underwater noise likely to disturb marine mammals, the Dragados Environment Team will produce a monthly report on the mitigation measures deployed, marine mammal monitoring undertaken and noise measurements collected, as well as a forward look to activities planned in the next month and any specific mitigations proposed. This report will include an Action Log to detail any problems encountered or issues to be raised with the regulator and provided to Marine Scotland, SNH and other interested parties.

The report will also detail any exceptional circumstances where blasting has occurred, out with daylight hours, although any specific incidences will be reported within 48 hours.

Reports will include:

- Completed Marine Mammal Reporting Forms
- Date and location of the operations
- A record of all operation, including details of the duration of the MMO/PAM search and any occasions when activity was delayed or stopped due to presence of marine mammals
- Details of watches made for marine mammals, including details of any sightings, details of the PAM equipment and detections, and details of the activity during the watches
- Details of any problems encountered including instances of non-compliance with the agreed MMMP
- Any recommendations for amendment of the MMMP.

If desired, Marine Scotland and SNH and other interested parties will also be able to visit site and operations to fully understand the ongoing activities and

mitigation measures deployed and input suggested amendments/best practice ideas.

11.7.1 UK Noise Registry

The UK Marine Noise Registry (MNR) is a database that records the spatial and temporal distribution of impulsive noise generating activities in UK seas in order that they can be analysed to determine whether they may potentially compromise the achievement of Good Environmental Status (GES) under the Marine Strategy Framework Directive. The MNR was developed, and is maintained, JNCC on behalf of Defra and the Devolved Administrations (DAs).

Dragados will submit data to the UK Noise Registry on planned activities and once activities are undertaken records of the actual activity. Dragados must complete and submit a Close-out Report for the licensable marine activities that produced loud, low to medium frequency (10Hz-10kHz) impulsive noise in the online MNR at 6 month intervals during the validity of the licence and no later than 12 weeks from the completion of the licensable marine activity.

In line with the MNR guidance ‘noisy’ underwater activities recorded in the MNR are likely to be explosive use and any impact piling (although this is not planned).

Information required to be recorded in the MNR when explosive are used is listed in Table 11.2

Table 11.2: Information required in the Marine Noise Registry

Proposed activity form	Close-out report
<ul style="list-style-type: none"> • Earliest start date (DD/MM/YYYY) • Latest end date (DD/MM/YYYY) • Expected duration of activity <ul style="list-style-type: none"> ○ Location ○ Latitude/longitude point (decimal degrees) ○ Latitude/longitude polygon (decimal degrees) ○ Quadrant/block • Source properties: <ul style="list-style-type: none"> ○ SPL, dB re 1µPa (peak) @ 1m SEL, dB re 1µPa² s (per pulse) @ 1m ○ Piling: maximum hammer energy (KJ) ○ Explosives: mass of TNT equivalent (kg) 	<ul style="list-style-type: none"> • Source properties: <ul style="list-style-type: none"> ○ SPL, dB re 1µPa (peak) @ 1m ○ SEL, dB re 1µPa² s (per pulse) @ 1m ○ Piling: maximum hammer energy (KJ) ○ Explosives: mass of TNT equivalent (kg) • Actual location of activity <ul style="list-style-type: none"> ○ Latitude/longitude point (decimal degrees) ○ Quadrant/Block • Actual dates on which activity took place in correspondence with the location

Dragados ECoW/EM will input data in the MNR, working with sub-contractors to collate information as and when required.

11.8 Marine Mammal Observers

11.8.1 General Requirements and Experience

It is key that well trained and experienced MMOs are used at the AHEP project to ensure maximum likelihood of any animals being spotted. The MMO's will have attended the JNCC course and be able to identify the marine mammal species likely to be in the area at a distance of 1km. Ideally MMOS will have at least 2 years of experience and have worked on similar projects or in the North Sea. In general MMOs should:

- Concentrate their efforts before, during and after a 'noisy' activity
- Be suitably equipped and trained with binoculars capable of allowing viewing over a 1km mitigation zone and Marine Mammal Reporting forms
- Be capable of determining the extent of the mitigation zone in relation to their viewing platform
- Have direct access to whoever is controlling the construction operation (i.e. an individual who can stop or amend activities if necessary)
- **MMO Experience**
- The 'April 2017 JNCC guidelines for minimising the risk of injury to marine mammals from geophysical survey'² defines experienced, dedicated and non-dedicated MMOs as:
 - **Experienced MMO:** Should have a minimum of 20 weeks' experience of implementing JNCC guidelines in UK waters obtained within the previous ten years, 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.
 - **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.
 - **Non-dedicated:** A trained MMO who may undertake other roles on the vessel when not conducting a mitigation role. This person can be a member of the rig's or vessel's crew providing they do not undertake other roles during mitigation periods.
- JNCC also state that '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.' For AHEP, we have interpreted this as the PAM operator must be experienced and dedicated to the task of operating the PAM equipment. JDN are working with a local, UK based PAM operator for PAM operations (See section 11.9).
- Any deviation in the experience of MMO's/PAM operator from the above will be agreed with MS and SNH, by providing CV's for individuals for review and comment.

- For blasting and marine rotary piling operations, a dedicated, experienced MMO will be positioned on either the North or South Headland.
- The MMOs on the dredgers will be non-dedicated MMO's who are experienced in undertaking the role of the MMO during dredging operations.

11.8.2 Drilling and Blasting

Prior to and during the start-up of the drilling and blasting, one experienced, dedicated MMO will be situated on land at a location with good view over a radius of 1km around the works. The MMO will be a member of the dredging contractor Jan de Nul (JDN) environmental team and will be JNCC certified. He/She will have several years of experience with working as an MMO and will be supported by a local MMO. Another JDN MMO will be positioned on the drill rig to deploy the hydrophone for the PAM system. This MMO will be in direct contact with the blast master.

Depending on the working area within Nigg Bay, the MMO will be positioned on the North or the South headland, as shown on Figure 11.1. When operations are ongoing in the northern part of the bay, the MMO will be in position on the northern (Girdle Ness) headland overlooking the marine environment. Similarly, the MMO will be positioned in the South during drilling and blasting operations in the Southern part of Nigg Bay.

The 1km exclusion zone from the site of operations will be scanned for at least 30 minutes before drilling and blasting operations start. Blasting may only take place in daylight hours. The MMO team will be in direct communication with the blast master to inform him/her if an animal is spotted and whether or not blasting may go ahead. The MMO will continue to watch for 15 minutes after blasting has occurred to record any information on behaviour of animals that enter into the mitigation zone after blasting.

The MMO team will record all relevant events on standard forms. As an example, such a form is included in Appendix B. Recorded information will include:

- Marine mammal identification
- Details concerning the behaviour of the animal
- Date and location of the operations
- Start and end time of the observation
- Weather conditions and visibility

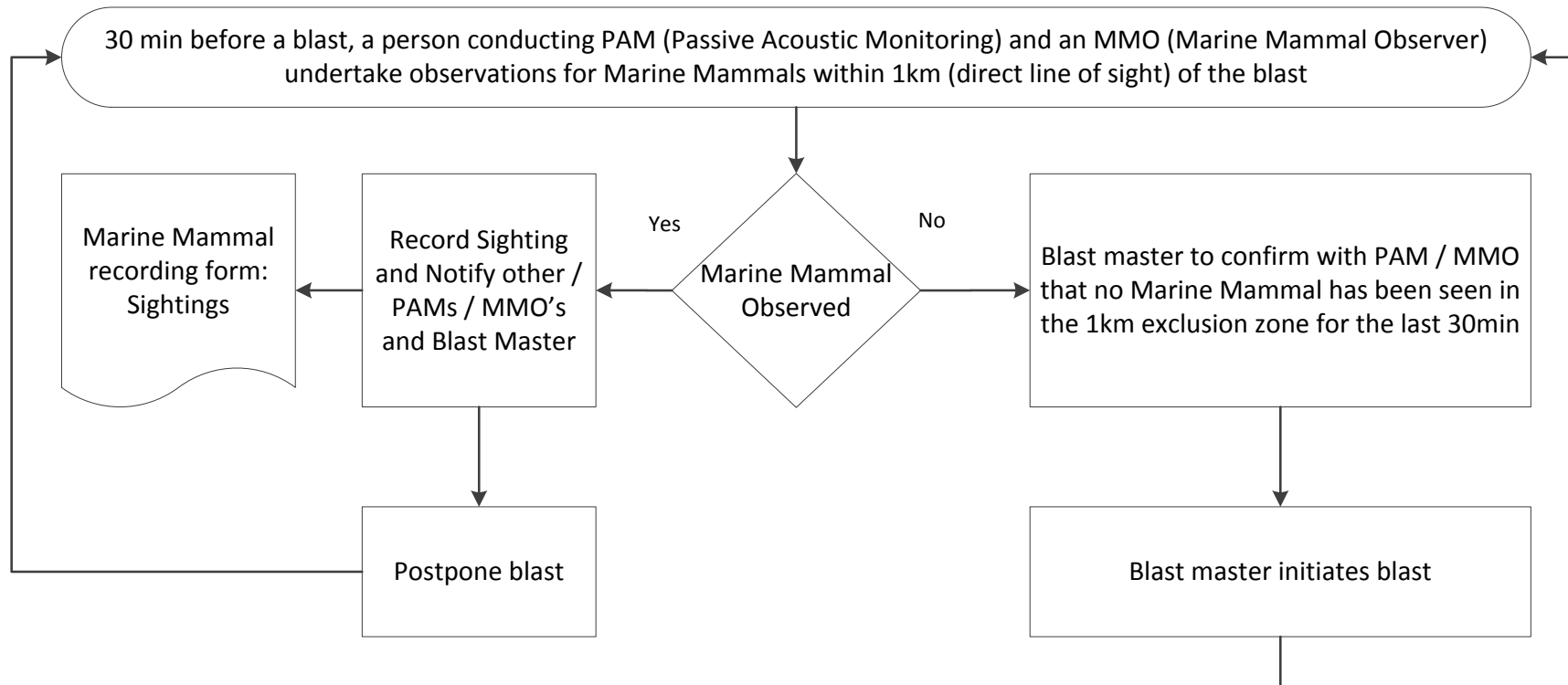
Record sheets will be collated and provided to Dragados on a weekly basis.



Figure 11.1: Different MMO positions - depending on working area

At times, due to sea state and weather conditions, visual observations out to a 1km distance may be more challenging. Passive Acoustic Monitoring will also be undertaken to augment the visual observations (see Section 11.9).

The MMO procedure can be summarised as:



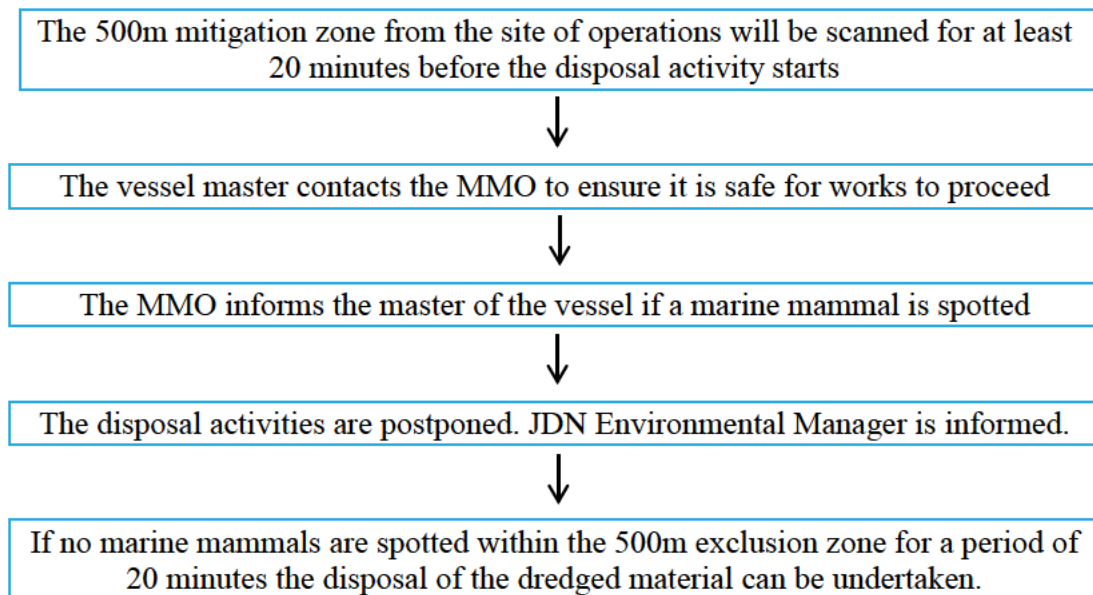
11.8.3 At Sea Disposal of Dredged Material

Members of the crew of the Trailer Suction Hopper Dredger (TSHD) and Split Hopper Barges (SHBs) are trained as non-dedicated MMOs (JNCC certified MMO course) and will be coached by an experienced MMO's. Dragados will perform audits of the MMOs to encourage continuous improvement and to check mitigation measures are being properly implemented.

All crew will be inducted on the topic of marine mammal management by the JDN Environmental team as part of the general induction to the project and regular progress meetings.

The MMO will be dedicated to this activity during the watch, prior to the start of the disposal activity to ensure that the disposal does not start while marine mammals are within the 500m mitigation zone.

The following the communication flow is adhered to if a marine mammal is spotted:



11.8.4 Marine Rotary Piling

Prior to and during the start-up of marine rotary piling, one experienced, dedicated MMO will be situated on land at a location with good view over a radius of 1km around the marine rotary piling works.

Depending on the working area within Nigg Bay, the MMO will be positioned on the North or the South headland. Figure 11.2 shows a 1km exclusion zone from an indicative noise source. The 1km exclusion zone from the site of operations will be scanned for at least 30 minutes before operations start. The MMO team will be in direct communication with the marine rotary piling coordinator to inform them if a mammal is spotted and whether rotary piling may commence. The drill master will not allow rotary piling to start without first checking with the MMO that the 1km zone is free of mammals. The MMO will continue to watch for 15 minutes

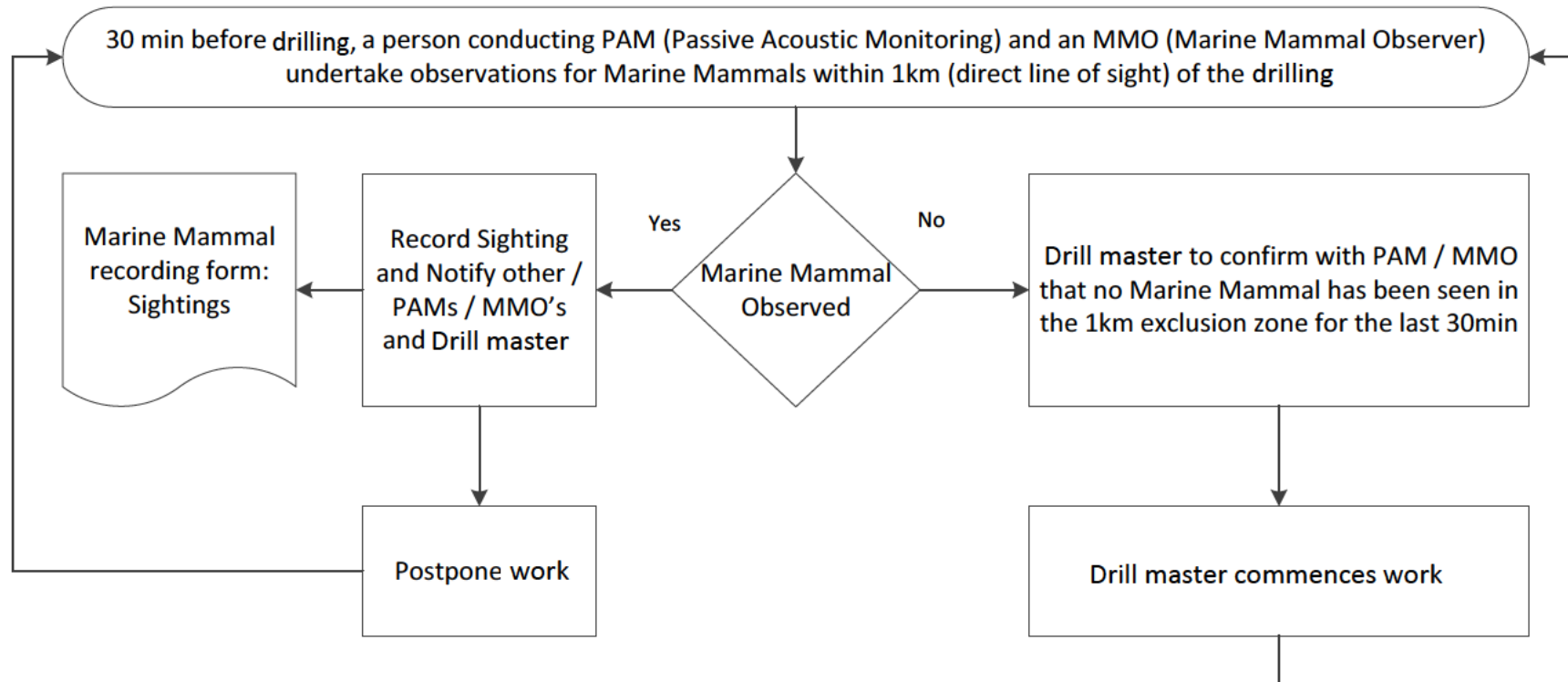
after operations are completed to record any information on behaviour of animals that enter into the mitigation zone after rotary piling has occurred.

The MMO team will record all relevant events on standard forms. As an example, such a form is included in Appendix B.



Figure 11.2: MMO Observation Radius

The following the communication flow is adhered to if a marine mammal is spotted:



11.8.5 MMO Communications

Some activities requiring MMO's/PAM operations may be ongoing at the same time. At the start of each working week, the Dragados EM or ECoW will review the work plan for the week and identify which activities may occur simultaneously or close in timing. They will then ensure that the nominated MMO for each activity is aware of the other MMOs that may be on duty and what activities may run concurrently.

During drilling/blasting activities, the MMO on-board the drill rig will act as the lead MMO and be the final point of communication with the drill/blast master before drilling/blasting commences. They will communicate with the Marine Mammal Mitigation Team Leader /PAM operator as described in Section 11.9.1.

Depending on the activity, the MMOs will be instructed to contact each other using the dedicated radio channel to highlight sightings of marine mammals. When carrying out the watch for mammals, prior to activities happening, the MMO nominated for that activity will be responsible for contacting other MMO's at the AHEP construction site to ensure no marine mammal sightings have been missed.

Whilst this plans provides an overview of procedures, these will be refined and practiced during the period prior to blasting occurring in July 2017 and described in more detail within the planned meetings and reports described in 11.10.1.

11.9 Passive Acoustic Monitoring

Passive Acoustic Monitoring (PAM) system will be used as well as MMOs for drilling, blasting and marine rotary piling operations to ensure the exclusion zone is clear of harbour porpoise, dolphins and other marine mammals, prior to start-up of the operations.

PAM will provide information on marine mammals within the exclusion zone that are not visible to MMOs. In Appendix A, specification sheets are given of the equipment that will be used.

Hydrophone calibration and certification will be carried out by the National Physics Laboratory (NPL), under controlled testing. All hydrophones will be calibrated to low and high frequencies, this will ensure that detections are captured for whole range of species located within the area, within and beyond the mitigation zone. The frequency range of the hydrophones will be as follows: low frequency from 5 Hz to 22 kHz; mid frequency 50 Hz to 160 kHz and high frequency range 200 Hz to 170 kHz. This low frequency to high frequency range will ensure that all species of cetaceans in the vicinity of the AHEP construction will be monitored; this includes harbour porpoises and bottlenose dolphins.

The PAM strategy is to deploy two fixed hydrophones on the seabed and one mobile hydrophone deployed mid-water. The whole system will be deployed prior to start-up to allow for thorough testing to ensure optimal functioning. The operation of the PAM system will be demonstrated and reported to MS, SNH and WDC prior to the blasting operations commencing (see Section 11.10.1)

11.9.1 PAM-Base

The PAM signals will be monitored by a single operator so the signals from all three hydrophones need to be available at a single site (PAM-base). The PAM-base will be located on Greg Ness, the southern point of the Bay.

At the PAM-base three operator displays will be needed to fulfil the mitigation requirement corresponding to the three hydrophones. Each provides a rolling spectrogram window to display the tonal calls and a second window to display echolocation click information. Initially this will be achieved using the ISHMAEL software package but once the characteristics of the site are understood it should be possible to optimise the displays by using MATLAB or LABVIEW processing.

All communications will be directed through the Marine Mammal Mitigation Team (MMMT) Leader/PAM operator, located at PAM-base who will be responsible for coordination and management of the MMMT, and will provide the construction operational teams with “Green Light” (no marine mammals spotted) and “Red Light” (marine mammals spotted) instructions. The Lead MMO/PAM is experienced and followed specialist training. Communications between members of the MMMT and construction operational teams will be carried out by radio with a designated channel. During periods of limited and poor visibility, when no visual monitoring is possible and PAM is the main detection and mitigation tool, Green and Red Light instructions will be given by the Lead MMO/PAM.

Green lights will be given by the Lead MMO/PAM after MMOs report Green light from a visual vantage point. The Lead MMO/PAM will instruct construction team to proceed with operations. All start and stop times will be recorded, as well as operational and technical down time.

Red light instructions will be based on a defined reporting and communication procedure and in adherence to mitigation protocol defined by the statutory authority requirements. Red light instructions will be given by the Lead MMO/PAM after receiving reports/communications from MMOs located at a visual vantage point. The Lead MMO/PAM will instruct the construction team to delay operations until MMO and PAM team are satisfied that all mammals are out of the mitigation zone and that mitigation protocols have been adhered to. All start and stop times will be recorded as well as operational and technical down time.

The data that will be received includes Sound Pressure Levels (SPL) calculated from zero to peak, Sound Exposure Levels (SEL) and third octave analysis that can be interpreted later and used for reporting. The software calculates and stores information on the following parameters in real time:

- SEL values
- Maximum SEL value (and SPL value if required)
- Percentile levels of SEL (i.e. SEL5, SEL90 and SEL50) noise levels
- SPL values
- Third octave band analysis
- Leq every 30 seconds

Whilst the processed results are displayed in real time in the software interface, the raw data are stored on the recorder and therefore there is no risk of data being lost.

The recorders will be fitted with the appropriate hydrophones with sensitivity appropriate for the task to ensure the data recorded are of high quality and no signal distortion occurs.

Monitoring trials will be produced with an overview of all monitoring events, data, possible detections of mammals, etc.

Weekly reports will be produced with an overview of all monitoring events, data, possible detections of mammals, etc.

11.9.2 Fixed Hydrophones

The two fixed hydrophones will be deployed to detect animals approaching the bay as shown in Figure 11.3.

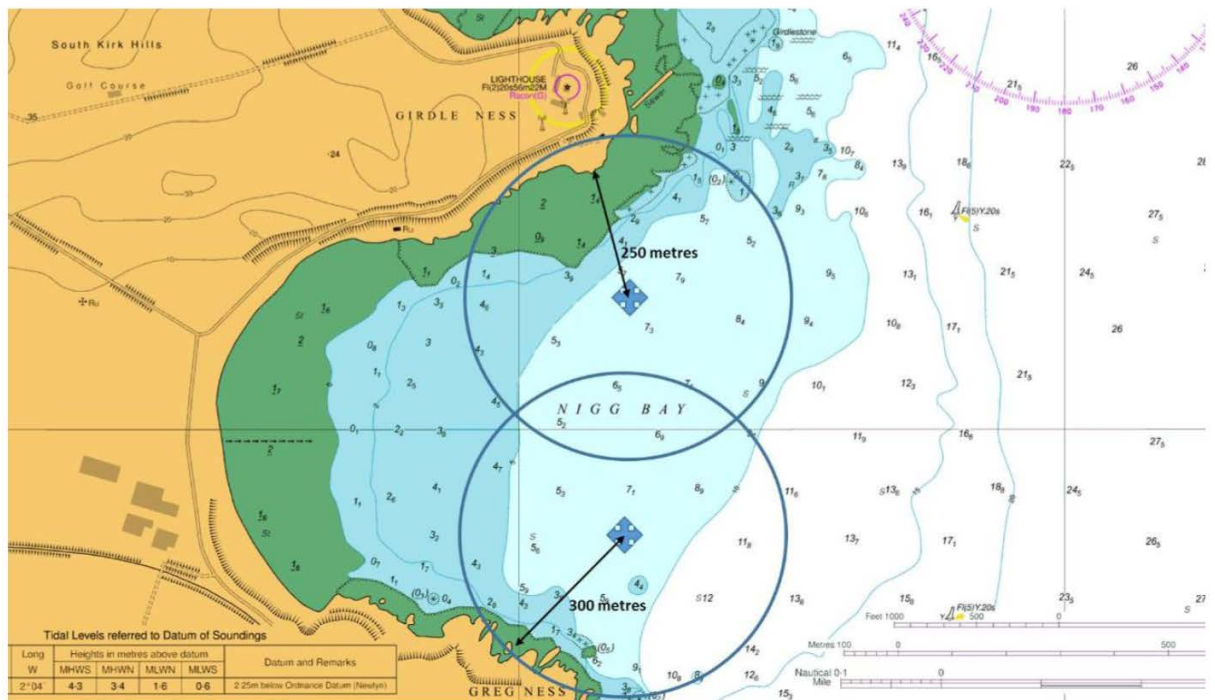


Figure 11.3: Indicative location of the two fixed hydrophones

The signals will be cabled ashore to the nearest shoreline, the exact point of landfall being chosen by inspection of the shoreline and optimised to minimise cable damage by wave action. The location will also need to be chosen in conjunction with the construction and dredging operations in order avoid any changes as the project progresses.

The main run of cable can be lightly armoured with weights added to ensure it stays in place on the seabed. However, the run from leaving the sandy seabed through the shoreline to a point above the storm wave line must be fully armoured to ensure survival over the life of the project.

The signals from the southern hydrophone would be cabled directly to PAM-base. The signals from the northern hydrophone and the mobile hydrophone will then need to be radio-linked to PAM-base. The northern hydrophone will be powered using a solar panel and storage battery. The shore side electronics for the northern hydrophone will be housed in a secure cabinet located above the reach of storm waves.

The radio links have a bandwidth from 50 Hz to 16 kHz. There will be some loss of information from tonal calls which can go up to 25 kHz but this represents a small percentage of the total calls. There will also be a dynamic range loss due to the multiplexing of analogue and click-detected audio signals and a limitation imposed by the use of analogue radio links. At best such a system will achieve around 50 dB of dynamic range.

11.9.3 Mobile Hydrophones

The two fixed hydrophones will give warning of approaching animals and give coverage of the outer bay. In order to provide full protection a third hydrophone is required and this needs to be located close to the sound source. The MMO on the drill rig will be in direct communication with the blast master which will avoid any miscommunication should a mammal be detected prior to the blast.

This hydrophone will be deployed from the anchored drill rig. Harbour porpoises will be detected up to around 300m from measuring location. The measuring hydrophone will be positioned in the lower half of the water column, between $\frac{1}{2}$ and $\frac{3}{4}$ of the total depth on the side away from the site of the explosion in order to minimise the chance of damage to the hydrophone from the explosion shock-wave.

The signals are digitised at source and the data is then transmitted over microwave links carrying Ethernet. The digitisers can provide bandwidths from 20 Hz to 150 kHz without any need to compress the data and will provide a high dynamic range (typically better than 75 dB). This system does carry high power consumption, so can only be used for the mobile hydrophone, where main power is available.

11.10 Bubble Curtain

Taking all of the above mitigation measures into account, it is assumed that no marine mammals will be within the 1km exclusion zone during the time of blasting. However, in order to further reduce the sound exposure to marine mammals during blasting a bubble curtain will be deployed. The bubble curtain will be installed so that there is no 'direct line of site' between the blasting area and open water.

A bubble curtain (BBC) consists of walls of bubbles rising from a nozzle or porous pipe that is secured to the seabed and connected to an air compressor. The compressors will be installed on shore. Bubble curtains can consist of one or two hoses lined up parallel to each other. At AHEP a double bubble curtain will be used in the first instance.

11.10.1 Trials, Testing and Reporting

Dragados and JDN understand that the use of bubble curtains is a novel technique and the effectiveness of the system is key to minimising disturbance to marine mammals. The use of multiple hoses may increase the sound reduction however little experience exists in regard to the actual efficiency of the use of bubble curtains to reduce the sound from confined blasts.

The efficiency of different setups (single vs double) will be tested by measuring the sound at certain distances from a source noise and later during the blasting itself. As bubble curtains use a number of compressors which generate noise and consume fuel, it will be a benefit to the local community and wider environment in minimising their use. Therefore, if it can be demonstrated that a single BBC is effective enough in reducing the sound exposure to marine mammals, a single BBC will be deployed in order to reduce the impact on (open air) noise and air quality.

Other measures that can be taken to increase the sound reduction will also be tested e.g. increasing the air flow to the system or adjusting the amount or spacing of holes in the hoses. Trials will also be undertaken with the positioning of the BBC to capture more of the noise propagating through the seabed and it may also be possible to adapt the detonation sequence during the blast.

Prior to blasting commencing, a series of trials will be undertaken by playback of a suitable sound source underwater and measuring the noise at different frequencies and distances from the source to identify the most suitable deployment regime for the bubble curtain. This testing will continue during the blasting period, with frequency decreasing as all interested parties become confident in the operation of the system.

Once the testing of the bubble curtain is underway in June 2017, prior to blasting commencing in mid-July 2017, a site visit will be held for MS, SNH and WDC to demonstrate the marine mammal mitigation and measuring systems deployed at AHEP (PAM, Bubble curtain, MMO's etc.) and a report submitted to MS, SNH and WDC describing the results achieved to date. Then, once blasting commences, a further report illustrating the attenuation in noise achieved by the bubble curtain will be submitted 2 working days after 5 days of blasting has occurred.

11.10.2 Methodology

The hose is stored on large reels, which will be placed on deck of a multicat. The hose will then be deployed by veering the reel, and pulling it into the water with a tug boat and positioning it in its intended location. As illustration, a possible location for deployment of the bubble curtain is shown below however, the final position will depend upon the results of testing, practicalities of deployment etc. The area in red is the location of the compressors; the line in blue is the feeder hose running from the compressors to the nozzle hose; and the line in green is the nozzle hose.

This setup is considered the best option for deployment due to the below reasons:

- It allows for blasting operations both in the north and south side of the future harbour, without relocating the compressors. One needs to take into account that the air provided to the nozzle hoses will be originating from a number of compressors (each $\pm 2.5 \times 4.5\text{m}$ in dimension), meaning that relocating these compressors will be a time consuming activity which will have a major impact on the blasting operations. Having the flexibility for the blasting operations to move from the south to the north (and vice versa) subject to weather conditions is a critical aspect of the works.
- Additionally during the blasting operations, dredging operations will be undertaken by the Cutter Suction Dredger (CSD) in the Inner Basin. This means that the CSD will be deploying her anchors, split hopper barges will be manoeuvring in the basin, etc. Also the positioning system of the drill and blast pontoon (i.e. spuds and anchors) will inhibit the positioning of the bubble curtain.
- A bubble curtain is designed as a far field mitigation measure, allowing the attenuation of impact sound waves that travel through the water column and through the seabed. In this case, the sound source is located in the seabed and therefore the positioning of the bubble curtain further away from the source will result in better sound mitigation. Positioning the bubble curtain too close to the blasting area would thus reduce its effectiveness.
- Ultimately, after thorough site inspections it is clear that there is no other suitable area to locate the compressors, since they require a relatively large area ($20 \times 20\text{m}$) with sufficient protection from wave action, and without interference of other operations taking place.
- The bubble curtain will be installed so that there is no direct line of sight between the blasting area and the open water (i.e. where breakwaters are not constructed yet). As construction of the north breakwater evolves, this breakwater will be used as a barrier as well (reducing the length of the bubble curtain needed).



Figure 11.4: Indicative bubble screen position during blasting, connected to the partially constructed breakwater



Figure 11.5 : Hose stored on winch



Figure 11.6: Bubble screen during the installation of offshore foundations

11.10.3 Deployment Procedure

During the project, there will be a JDN environmental site engineer on site who will supervise all actions with the bubble curtain. The environmental engineer will be fully trained to work with the equipment and will be on site supervising the whole process.

Before deployment, the bubble curtain will be transferred from the transport reels to the more robust offshore deployment reel with power pack. Depending on the planned positioning of the bubble curtain, the reel will be placed on board a multicat vessel or the hose will be unrolled from shore with a tug boat. A detailed bathymetric survey will be used to decide on the positioning of the nozzle hose. The distance to the blasting site is determined by the number of planned loads, the amount of used explosives and the covered area. This is an assessment that needs to be done on site in consultation with the blasting crew.

During deployment, the installation vessel will be equipped with software that enables the captain to maintain a course corresponding to predetermined nozzle hose positions. After installation of the nozzle hose, its position will be checked by a side scan survey.

Fifteen minutes before the blasting can start, the compressors will be turned on and the functioning of the bubble curtain will be checked. During this pre-blasting period, noise measurements will be made in order to assess the background sound levels. Visual and acoustic watches for marine mammals will be ongoing for 30 mins before blasting occurs. There will be close communication with the MMOs and PAM operators to get updates on the possible sightings of mammals in the exclusion zone. Once the whole exclusion zone has been clear of mammals for 30 minutes, the go-ahead can be given to the blasting crew. The sound monitoring will continue during the blast in order to check the achieved noise levels.

After the blasting is finished, the compressors will continue to run to allow the site engineer to check the functioning of the bubble curtain.

There will be record keeping of all operations, works or adjustments to the bubble curtain.

11.11 Marine Mammal Monitoring

11.11.1 Every Day Observations

As well as the use of Marine Mammal Observers during noisy activities, the use of Nigg Bay and surrounding areas by marine mammals during construction will be monitored by trained MMO ECoW and the EM on site and, where appropriate, dedicated MMOs who are not deployed on mitigation activities (bearing in mind that MMOs need to focus effort on the pre-activity time period and should be at 'peak' performance then). This will take the form of sighting records, recorded using the same forms as those used during noisy activities.

The ECoW and EM will dedicate at least 20 hours per month to carrying out watches for marine mammals and recording observed behaviour, equivalent to one hour for each working day (Monday to Friday). The ECoW/EM will set a time for completing watches at the start of each week/month, depending on other activities ongoing, to provide a range of observations over a number of different times, days and tidal conditions.

11.11.2 During Blasting Operations

As previously detailed, during drilling and blasting operations, as a mitigation, JDN will keep a watch/listen over the required mitigation zone – 1km from the blast site. See Section 11.7.3 for more details on the marine mammal observations during blasting. During Marine Rotary Piling, Dragados will keep a watch over the required mitigation zone (see Section 11.8.2).

As part of the requirement to undertake wider marine mammals monitoring and in discussions with SNH and Marine Scotland, the use of the existing Harbour area by marine mammals (bottlenose dolphins are frequent visitors to this area, presumably to feed), and how they could be impacted by noisy activities including blasting operations, has been raised as a key issue which requires monitoring.

In order to provide information on this, Dragados and JDN will work collaboratively to ensure a MMO is at the Harbour Mouth entrance prior to the start-up of a number of the drilling and blasting activities. If marine mammals are present, the MMO will record the behaviour of the animals and any changes to this behaviour following the blasting activity. The MMO will either be the Dragados ECoW/EM or a dedicated MMO.

11.11.3 C-POD Deployment

Dragados have committed to the deployment of C-PODS to monitor the presence and absence of bottlenose dolphins and harbour porpoise in the AHEP

construction site. A full specification and scope for this survey will be agreed with MS, SNH and WDC on sign off of the CEMD.

11.11.4 Wider Marine Mammal Monitoring

Dragados will also work with organisations such as WDC and RSPB Dolphinwatch to see how data collected in the wider area may be used to augment the data collected within Nigg Bay and the existing Aberdeen Harbour Mouth. The existing data sets managed by these organisations may prove useful during analysis and looking for changes in marine mammal behaviour.

11.11.5 Data Analysis

Whilst collecting marine mammal observations is useful, it is the analysis of the data that provides information for use in future development. Dragados will work with a wildlife statistician to consider the design of surveys and data collection so that the information can be usefully analysed and conclusions drawn.

Dragados and Arup are currently discussing the possibility of the marine mammals observation data (both visual and PAM) alongside the noise measurement data being analysed by an academic through post-doctoral research and collaboration with the local WDC/RSPB groups for use of wider data sets. This will evolve during the course of construction and is seen by Dragados as an iterative process with continual feedback from WDC, MS and SNH taken on-board as the construction commences, continues and monitoring results are delivered.

11.12 Underwater Noise Measurements

Separate to listening for marine mammals as a mitigation measure, known as Passive Acoustic Monitoring and described in Section 11.8 there is also a requirement to undertake underwater noise measurements at AHEP for a range of activities including:

- Drilling of holes into the seabed to set explosive charges
- Blasting
- Marine rotary piling
- Breakwater construction

Noise measurements during the blasting and drilling associated with the dredging operation will be undertaken at AHEP following a separate Noise Measuring Procedure which will be agreed with MS, SNH and WDC and appended to this plan. Methods will be consistent and aligned across the suite of construction operations to ensure data is useful and comparable. Dragados will manage the measurements with input from JDN.

11.12.1 Noise Monitoring Standards

Underwater noise measurements will be undertaken following the ‘Good Practice Guide for Underwater Noise Measurement³’ including following best practice for in-situ measurement of underwater sound, for processing the data, and for reporting the measurements using appropriate metrics.

Prior to noisy activities commencing a detailed Noise Measuring Procedure will be produced. The procedure(s) will include but not be limited to:

- How the measuring system performance will be checked to ensure it is fit for purpose prior to use including the sensitivity, frequency response, directivity, system self-noise and dynamic range;
- Calibration procedures (both in the lab and in-situ) and how validation of ‘off-the-shelf’ systems will be completed;
- For deployments, the procedure will ensure deployment configuration is appropriate for measurement requirements with hydrophones deployed at appropriate depths;
- How ambient noise measurements will be taken alongside with measurements of anthropogenic noise;
- Steps that will be taken to protect recorders and data from loss; and
- Assessment that the objectives of the measurements are clear and that the measurement configuration is appropriate for those objectives.

11.12.1.1 Reporting

The Noise Measuring Procedure document will include reporting of the following information, and will be adapted as the process continues:

- Frequency representation in third octave bands (frequency domain – PSD distribution with variability);
- Temporal variance in frequency content (time domain – spectrogram);
- Received levels at recording location;
- Estimated source level of activity (detail method of calculation);
- Log of recordings together with ancillary data (including weather); and
- Any detail of the analysis that is needed for replication/comparison purpose.
- These reports will be provided to SNH, Marine Scotland and the WDC

Appendix C provides a copy of Annex C of the National Physical Laboratory Guidelines summarising the requirements to ensure best practices are followed during noise measurements.

³ National Measurement Office, Marine Scotland, The Crown Estate, Robinson, S.P., Lepper, P. A. and Hazelwood, R.A., NPL Good Practice Guide No. 133, ISSN: 1368-6550, 2014.

Crucial to being able to usefully use the noise measurement data, including assessing if mitigation such as a bubble curtain is effective, will be the collection of ancillary data such as sediment type, bathymetry and other activities ongoing on site.

11.12.2 Blasting

JDN will take sound measurements from a vessel. The noise measurements will be taken inside the bubble curtain and outside the bubble curtain at 750m from the source in order to assess the effectiveness of the BBC. However, depending on safety precautions and the results, these distances might be varied in order to verify the efficiency of the BBC.

These measurements will be undertaken on a daily basis during the initial week of blasting and frequency will be reduced to weekly thereafter. A detailed plan for the noise monitoring regime will be shared with MS/SNH.

Appendix A

Hydrophone Recorder Specifications

A1 Hydrophone Recorder Specifications



Description

EA-SDA14 is a compact embedded recorder able to acquire up to four broadband hydrophones simultaneously.

The acoustic recorder accepts both passive and pre-amplified active hydrophones. Its broadband analog input allows over 500 kHz with a dynamic range greater than 100 dB guaranteeing efficient signal to noise ratio.

The embedded digital signal processor allows high speed acquisition, filtering and storage.

In autonomous mode, data is stored whether on SD Card or hard drive.
In towed mode, data is stored then transferred via Ethernet.

Its power consumption is between 600 mW to 2 W in active mode and less than 1 mW in sleep mode.

EA-SDA14 can be programmed with a mission schedule including date of beginning, sleep and record periods in order to improve battery life.

The configuration and monitoring are facilitated through web browser interface.

Applications

- Noise impact studies
- Environmental monitoring
- Marine renewable energies
- Cetacean research
- Seismic / Shipping / Construction

Options

- Interchangeable hydrophones
- GPS
- Temperature, Pressure, Conductivity
- Up to 2 TB memory on HDD
- **Low power mode - NEW**
- **Rechargeable batteries - NEW**
- **Low frequency module - NEW**
- **Embedded processing - NEW**

<p>Characteristics Powered by SDA</p> <ul style="list-style-type: none"> • Multichannel: up to 4 hydrophones inputs • Broadband: from 3 Hz to over 500 kHz • Wide dynamic: 24 bits recording • Versatile: towed and autonomous modes • Easy to use: intuitive embedded web interface 	<p>Dim.: 32 cm long, 12 cm in diameter</p> <p>Weight: 5 kg in air, 2 kg in water</p> <p>Depth: 200 to 700 meters</p> <p>Power: 6 or 18 Alkaline or Li-SOCI2 D Cells + optional extension packs</p> <p>Storage: 128 or 256 GB SD Card, 1 TB SSD, 2 TB HDD</p>
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RTsys products comply with noise Good Environmental Status objectives defined by the Marine Strategy Framework Directive (MSFD)





EA-SDA14



- **4 synchronized recording channels**

Channels are electronically synchronized and calibrated at +/- 0.1 dB. Gains are electronically configurable on each channel between -10 dB and +24 dB. High pass filters are also configurable. Hydrophones are easily plugged in and out from the EA-SDA14 recorder.

- **Broadband high data quality**

Eight recording frequencies going from 39 kHz to 1000 kHz are selectable. The EA-SDA14 can thus monitor noises and a frequency bandwidth going from 3 Hz to more than 500 kHz guaranteeing great dynamic and Signal to Noise Ratio (>100 dB). This high SNR allows recording to strong and low level noise simultaneously.

Raw data are collected in 24 bits and stored in .wav standard format, directly compatible with processing software such as ©Matlab, ©LabVIEW and ©PAMguard.

EA-SDA14 recorders are equipped with DSP running Linux allowing integration of real-time data processing.

- **Towed and autonomous modes**

Light and compact, EA-SDA14 can be easily deployed by a single person.

In autonomous mode the recorder is programmed via a software application and then left into the water. After the mission the EA-SDA14 is recovered and data is downloaded by Ethernet. (downloading speed: 7 MB/S)

In towed mode EA-SDA14 is directly connected to a computer through Ethernet connection. The user can thus monitor the missions and access the data in real-time.

- **Easy to Use**

The web browser interface gives intuitive access to configuration of the recorder and to the recorded files.

Contact

- www.rtsys.eu
- info@rtsys.eu
- +33 (0)297 898 580



25 rue Michel Marion 56850 Caudan – France

RTsys activities

- Marine acoustics
- Embedded electronics
- Marine robotics
- Systems integration
- Customized R&D

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A2 Hydrophone – Colmar GP0190

www.hydrophones.net

Hydrophone GP0190



Preamplified omnidirectional hydrophone, for application up to 170 kHz. An high class measurement tool suitable for a wide range of applications:



- High sensitivity
- Low noise
- Working band up to 170 kHz
- Double output: single/differential
- Calibration input
- High materials quality
- Metal shell connector

Working band:	5 - 170.000 Hz
High pass on preamplifier:	Customizable (on demand)
Sensitivity balanced output :	-172dB re 1V/uPa@5kHz
Sensitivity unbalanced output:	-178dB re 1V/uPa@5kHz
Directivity :	Spherical - Omnidirectional
Max working depth :	1000 m (3500m optional)
Gain @5kHz:	26dB (unbalanced output), 32dB (balanced output)
Input acoustic equivalent noise @5kHz:	38dB re 1uPa/sqrtHz
Input impedance:	10 Mega Ohm
Power requirement:	11.5 - 30VDC
Current consumption:	9mA@12VDC
Max voltage output:	4 Vpp (single output), 8Vpp (differential output)
Weight in air:	500 gr
Body:	Stainless steel AISI 316





CO.LMAR. S.r.l. via delle Pianazze, 74 - 19136 La Spezia (Italy)
 Tel +39 0187 982590 Fax 943461 P.I.00742150113
 e-mail colmar@colmaritalia.it www.colmaritalia.it

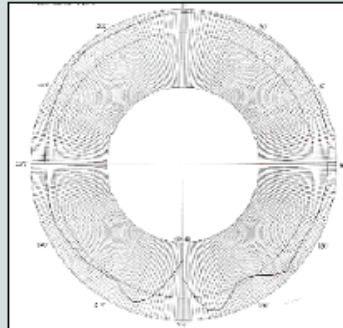
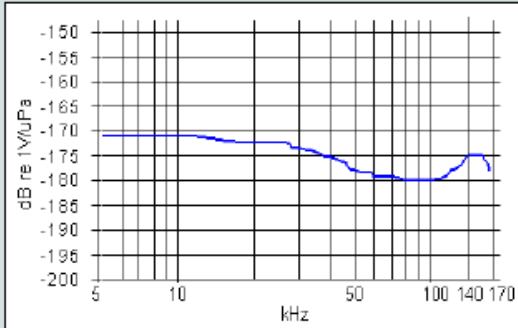


www.hydrophones.net



Receiving sensitivity (unbalanced output)

Vertical directivity pattern @ 35kHz



Optional items

- Protective frame
- Protective frame with suspension system for vibration damping
- Receiving rugged portable unit complete of variable gain, rechargeable battery, audio output, headphones, adjustable output, calibrator
- Terminated cable (optional length)




Also available

- GP0190M version (without connector)

COLMAR. S.r.l. via delle Pianazze, 74 - 19136 La Spezia (Italy)
Tel +39 0187 982590 Fax 943461 P.I.00742150113
e-mail colmar@colmaritalia.it www.colmaritalia.it


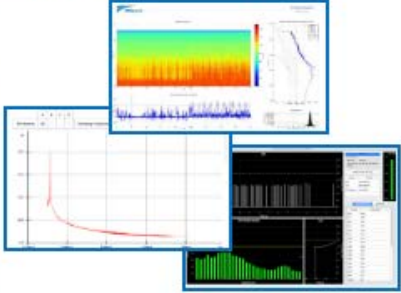


A3 Software Specification



RT-LISTENING SOFTWARE SUITE

Configure – Manage – Analyze - Report

Description

RTsys offers a full software and tools suite for acousticians and non-acousticians to carry underwater noise analysis. It is compatible with all RTsys underwater listening systems.

Based on ANSI, ISO and other international standards, this RT-Suite provides tools for trained and non-trained acousticians. For non-acousticians, it provides easy-to-use certified software suite to analyse underwater noise, saving a valuable time in report generation. For advanced users, it offers versatile features such as complex configuration and processing.

This software range is compatible with calibrated .wav data coming out from RTsys SDA product range such as EA-SDA14 versatile recorders, BA-SDA14 and RB-SDA14 remote autonomous buoys or PR-SDA14 portable recorders.

This software suite offers real-time management and programming of the devices, calibration tools, embedded-processing, calculation and display of calibrated sound levels (SEL, SPL, and third octaves), .png and excel report editing software.

Features

- Real-time noise visualization and processing
- Calibrated measurements and certified standard calculation methods
- Noise and frequency level measurement
- Multi-screen display (FFT, spectrograms)
- Specific Alerts and thresholds configuration
- Reports generation and edition

Option

- Integration into carrier (Glider, rofiler, AUV)



Software-suite Powered by SDA

- Embedded interface and calibration
- Real-Time Live Monitor
- Real-Time Manager & Serial Commander
- Post-processing Quick Report

Compatible with Windows and Mac

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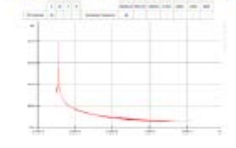
RTsys products respond to noise Good Environmental Status objectives defined by the Marine Strategy Framework Directive



EA-SDA SOFTWARE SUITE

EASDA – calibration check



• Embedded interface mission configuration & data recovery

Embedded interface of RTSys listening systems allows an intuitive and versatile configuration of the device. It gives access to multiple settings and use modes such as sampling size, sampling speed, duty cycle parameters, selection of channels with gain and filters settings.

A range of real-time scripts allows to realize accurate pistonphone calibration and to make real-time recording and data recovery at any time.

EASDA Manager



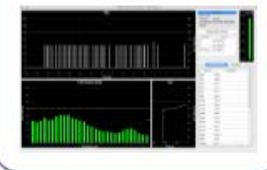
• Real-Time Manager & Serial Commander

Real-time Manager and Serial Commander are additional software tools dedicated to a connected use, whether cabled or wireless.

RT-Manager allows to access different units simultaneously on any connected computer. The use is simplified to allow a non-acoustician to do key actions such as setting time, recovering data, restating missions.

RT-Serial Commander provides direct compatibility of SDA14 devices with external serial command unit such as glider or profiler platform.

Live Monitor



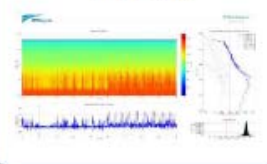
• Real-Time Live Monitor

RT-Live Monitor is an interface compatible with the VHF remote communication option of SDA14 range of RTSys listening systems.

When activated, embedded calculation inside the recording device can be accessible and displayed in real-time with an easy non-acoustician interpretable interface. Live Monitor calculates, steams and displays the Sound Pressure Level (SPL), the Sound Exposure Level (SEL) and the 1/3rd octave band on a 2Hz to 20kHz bandwidth.

RT-Live-Monitor provides a perfect solution for real-time noise monitoring and can be a key help decisional tool.

GraphTools



• Post-processing Quick Report

Quick Report is a post-processing tool providing an easy way to answer basic underwater sound processing and gathering this baseline processing in a redacted report.

Quick-Report is provided with all SDA14 devices. It is used by drag & drop of .wav files, and generates images and excel reports with information such-as third octave bands, event detections, impulse noise levels, etc.

Contact

- www.rtsys.eu
- info@rtsys.eu
- +33 (0)297 898 580



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RTsys activities

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- Systems integration
- Customized R&D

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Appendix B

Marine Mammal Observation Sheet

B1 Appendix B - JNCC Recording Forms adapted for use at AHEP

MARINE MAMMAL RECORDING FORM - COVER PAGE

Regulatory reference number <small>(e.g. DECC no., BOEM permit no., OCS lease no., etc.)</small>	Country	Location	Ship/ platform name
Client Dragados	Contractor		Survey type <input type="checkbox"/> site <input type="checkbox"/> VSP <input type="checkbox"/> 2D <input type="checkbox"/> WAZ <input type="checkbox"/> 3D <input type="checkbox"/> piling <input type="checkbox"/> 4D <input type="checkbox"/> explosives <input type="checkbox"/> OBC <input type="checkbox"/> other <input type="checkbox"/> 4C
Start date	End date		

Number of source vessels	Type of source (e.g. airguns)	Number of airguns (only if airguns used)	Source volume (cu. in.)
Source depth (metres)	Frequency (range in which peak energy is emitted, in Hz)	Intensity (primary peak-to-peak amplitude in dB re. 1µPa or bar metres)	Shot point interval (metres)
Method of soft start <input type="checkbox"/> increase number of guns <input type="checkbox"/> increase frequency (where permitted) <input type="checkbox"/> increase pressure (where permitted) <input type="checkbox"/> increase number and frequency <input type="checkbox"/> increase number and pressure <input type="checkbox"/> other			

Visual monitoring equipment used (e.g. binoculars, big eyes, etc.)	Magnification of optical equipment (e.g. binoculars)	Height of eye above water surface (metres)	How was distance of animals estimated? <input type="checkbox"/> by eye <input type="checkbox"/> with laser rangefinder <input type="checkbox"/> with rangefinder stick/ callipers <input type="checkbox"/> with reticle binoculars <input type="checkbox"/> by relating to object at known distance <input type="checkbox"/> other
Number of dedicated MMOs	Training of MMOs <input type="checkbox"/> JNCC approved MMO training course for UK waters <input type="checkbox"/> PSO training course for the Gulf of Mexico <input type="checkbox"/> MMO training course for Irish waters <input type="checkbox"/> MMO training course for New Zealand waters <input type="checkbox"/> other <input type="checkbox"/> none		

Was PAM used? <input type="checkbox"/> yes <input type="checkbox"/> no	Number of PAM operators	
Description of PAM equipment		
Range of PAM hydrophones from airguns (metres)	Bearing of PAM hydrophones from airguns (relative to direction of travel)	Depth of PAM hydrophones (metres)

MARINE MAMMAL RECORDING FORM - OPERATIONS

Regulatory reference number

(e.g. DECC no., BOEM permit no., OCS lease no., etc.)

Ship/ platform name

Complete this form every time the airguns are used, including overnight, whether for shooting a line or for testing or for any purpose.

Times should be in UTC, using the 24 hour clock.

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

MARINE MAMMAL RECORDING FORM - EFFORT

Regulatory reference number
(e.g. DECC no., BOEM permit no., OCS lease no., etc.)

Ship/ platform name

Record the following for all watches, even if no marine mammals are seen.

START A NEW LINE IF SOURCE ACTIVITY OR WEATHER CHANGES. ENTER DATA AT LEAST EVERY HOUR.

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

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

Appendix C

Annex C Summary of Guidance Notes for Underwater Noise Measurements

C1 Annex C Summary of Guidance Notes for Underwater Noise Measurement

(Reproduced from NPL Good Practice Guide No 133)

C1.1 Summary: Acoustic Metrics

The most appropriate metrics for use with **pulsed sounds** are:

- Single pulse Sound Exposure Level (SEL)
- Cumulative Sound Exposure Level (SEL) (for a series of pulses);
- Peak sound pressure level;
- Peak-to-peak sound pressure level.

It may also be useful to calculate the peak compressional sound pressure level and peak rarefactional sound pressure level, the pulse duration, and the pulse repetition frequency.

The metric most suitable for **continuous sounds** (including ambient noise) is:

- Sound Pressure Level (SPL).

Note that by convention, this is a time-averaged quantity and is most commonly understood as an RMS value. The averaging time used in the calculation of the values of SPL must be stated.

Where continuous sounds also contain transient or pulsed sounds from specific events, the metrics used for pulsed sounds should be used to describe these specific events.

C1.2 Summary: Measuring Instrumentation

Ensure measuring system performance is fit for purpose. Key performance parameters include:

- Sensitivity
- frequency response
- directivity
- system self-noise
- dynamic range

The performance of any commercial off-the-shelf systems should be validated

The measuring system should be calibrated over the full frequency range of interest

Ensure appropriate quality assurance procedures are applied to the measurement

Data storage should ideally be lossless format and include all necessary metadata and calibration information

C1.3 Summary: Deployments

Ensure deployment configuration is appropriate for measurement requirements with hydrophones deployed at appropriate depths

Ensure deployment related parasitic signals are minimised, including those originating from:

- Flow noise
- Cable strum
- Surface heave
- Vessel/platform noise
- Mechanical noise
- Electrical noise

Record all auxiliary data and metadata

Ensure steps are taken to protect recorders and data from loss

C1.4 Summary: Ambient noise measurement

Ensure that the objectives of the measurements are clear and that the monitoring and deployment configuration is appropriate for those objectives

Ensure that the temporal sampling regime is appropriate for the objectives, and that the duration and duty cycle are appropriately chosen

Ensure that the spatial sampling regime is appropriate for the objectives, and that the locations of monitoring stations are appropriately chosen

Ensure that the instrumentation is correctly specified for the application (for example, in terms of frequency range, dynamic range and self-noise)

Ensure the deployment minimises measurement artefacts and parasitic signals

Document and justify choice of data analysis methodology in terms of:

- Metrics – arithmetic mean and median are recommended

- Averaging procedure – choice of snapshot time
- Statistical representation of data – representing dispersion of data by use of analysis such as box-plots, and cumulative distributions.

Record all relevant auxiliary data and metadata including data which may correlate with acoustic data (ship traffic data, weather data, etc.)

C1.5 Summary: Radiated noise measurement

Ensure that the objectives of the measurements are clear and that the measurement configuration is appropriate for those objectives

Ensure that the source output metrics are appropriate for the objectives, and that the measurement configuration enables the chosen metrics to be derived

If a source level is calculated, ensure that an appropriate propagation model is used which accounts for the relevant physical propagation phenomena

Ensure that the measurements satisfy the requirements of the objectives such that:

- the instrumentation is correctly specified for the application in terms of frequency range, dynamic range and self-noise
- spatial sampling is appropriate to ensure far-field conditions and (if required) to provide an empirical check on propagation
- the temporal sampling captures any variation in acoustic output using a fixed (static) recording position
- the deployment minimises measurement artefacts and parasitic signals contaminating noise sources are minimised (or eliminated)

C1.6 Summary: Propagation modelling

Ensure that the choice of model is appropriate for the application

Ensure that the propagation model used accounts for the physical propagation phenomena relevant to the scenario, including the following potential influencing factors

- range-dependent bathymetry including dependence on varying water depth and the frequency cut-off for the channel;
- sound speed including the sound speed profile (especially for deeper water);
- frequency dependence, including absorption in the water;

- seabed properties, including propagation within the seabed;
- interaction with the sea surface, including the effect of surface roughness.

Preferably, use a model that has been benchmarked against historical experimental data or by comparison with other propagation models, or check consistency with range-dependent measured data from current experimental work (for example, when measuring radiated noise).

C1.7 Summary: Uncertainties

1. All measurements require an estimate of uncertainty in order to be useful.
2. Uncertainties may be categorised into two classes
 - Type A: a measure of the repeatability of the measurement (derived from the statistical dispersion of repeated measurements);
 - Type B: a measure of uncertainty due to any the systematic bias.

There are a number of potential sources of uncertainty:

- calibration of instrumentation;
- position of source and receiver;
- spurious signals introduced by the deployment
- validity of any assumptions made;
- environmental parameters (for use in a propagation model).

Ensure that the measurements satisfy the requirements of the objectives such that:

- the instrumentation is correctly specified for the application in terms of frequency range, dynamic range and self-noise
- spatial sampling is appropriate to ensure far-field conditions and (if required) to provide an empirical check on propagation
- the temporal sampling captures any variation in acoustic output using a fixed (static) recording position
- the deployment minimises measurement artefacts and parasitic signals
- contaminating noise sources are minimised (or eliminated)

C1.8 Summary: Propagation modelling

Ensure that the choice of model is appropriate for the application

Ensure that the propagation model used accounts for the physical propagation phenomena relevant to the scenario, including the following potential influencing factors:

- range-dependent bathymetry including dependence on varying water depth and the frequency cut-off for the channel;

- sound speed including the sound speed profile (especially for deeper water);
- frequency dependence, including absorption in the water;
- seabed properties, including propagation within the seabed;
- interaction with the sea surface, including the effect of surface roughness.

Preferably, use a model that has been benchmarked against historical experimental data or by comparison with other propagation models, or check consistency with range-dependent measured data from current experimental work (for example, when measuring radiated noise).

Appendix D

Monitoring and Reporting Commitments

**Summary of monitoring measures within the Marine Mammal Mitigation Plan:
Timescales for reporting to MS-LOT.**

Note: the frequency of all monitoring will be regularly reviewed by Dragados. Any proposed change to the monitoring schedule detailed below will require agreement with MS-LOT.

Relevant section(s) of Marine Mammal Mitigation Plan	Monitoring measure	Timescale for reporting to MS-LOT
Pre-construction		
11.11.3	Deployment of C-PODS: Dragados have committed to the deployment of C-PODS to monitor the presence and absence of bottlenose dolphins and harbour porpoise	C-POD Survey Specification and scope to be submitted within 4 weeks of the approval of the CEMD
11.11.4	Wider analysis of marine mammal data: Dragados and Arup are investigating the possibility of the marine mammal observation data (visual and PAM) alongside the noise measurement data being analysed by an academic through post-doctoral research and collaboration with the local WDC/RSPB groups for use of wider data sets	Report on Wider Data Analysis to be submitted within 6 weeks of the approval of the CEMD
11.9.1	Passive Acoustic Monitoring (PAM): Monitoring trials for the PAM equipment will be carried out prior to the following activities commencing: drilling; blasting; marine rotary piling. A report will be produced of all monitoring events, data and possible detections of mammals.	PAM Monitoring Trial Report to be submitted 2 weeks prior to any of the listed activities commencing.
11.10.1	Bubble curtain monitoring: Prior to blasting commencing, a series of trials will be undertaken by playback of a suitable sound source underwater and measuring the noise at different frequencies and distances from the source to identify the most suitable deployment regime for the bubble curtain. This testing will continue during the blasting period, with	Pre-blasting Monitoring Trial Report to be submitted 2 weeks prior to blasting commencing Once blasting commences, a further report illustrating the attenuation in noise achieved by the bubble curtain to be submitted

	frequency decreasing as all interested parties become confident in the operation of the system	2 working days after 5 days of blasting has occurred and subsequent monitoring reports on a monthly basis
11.12	<p>Underwater noise measurements: Noise measurements will be undertaken during at least the following activities: drilling, blasting, breakwater construction, marine rotary piling and dredging activities. The location and frequency of the measurements will be agreed in a Noise Measuring Procedure prior to these activities commencing</p>	Noise Measuring Procedure to be submitted 2 weeks prior to any of the listed activities commencing
	During construction	
11.6.5	Report of instances where blasting has occurred, outwith daylight hours, due to exceptional circumstances	Report to be submitted within 48 hours of blasting occurring
11.7 11.8.2 11.8.3 11.8.4	<p>Daily Marine Mammal Reporting Form, containing:</p> <ul style="list-style-type: none"> • Marine mammal identification • Details concerning the behaviour of the animal • Date, location and type of the operation(s) • Start and end time of the observation • Action taken if marine mammals are observed in the mitigation zone • Weather conditions and visibility 	Daily Marine Mammal Reporting Forms collated and submitted on a weekly basis during marine construction works
11.9.1	<p>Daily PAM Report</p> <ul style="list-style-type: none"> • Marine mammal detection • Date, type and location of observed operations • Start and end time of detection • Action taken if marine mammals are observed in the mitigation zone 	Daily PAM Reports collated and submitted on a weekly basis during marine construction works
11.6.8 11.7 11.8.2 11.8.3 11.8.4 11.11.1	<p>Monthly Marine Mammal Report, containing:</p> <ul style="list-style-type: none"> • Collated Daily Marine Mammal Reporting Forms • Date, type and location of observed operations • Breakwater observation audits • Details of any operations suspended due to presence of marine mammals • Results of every day marine mammal observations • Results of C-POD monitoring • Result of underwater noise monitoring 	Monthly Marine Mammal Report to be submitted monthly during marine construction works

	<ul style="list-style-type: none"> • Action Log to detail any problems encountered including instances of non-compliance with the agreed MMMP • Forward-look to activities planned in the next month and any specific mitigations proposed • Recommendations for amendment of the MMMP 	
11.12.1	<p>Daily Underwater Noise Monitoring Report, containing:</p> <ul style="list-style-type: none"> • Frequency representation in third octave bands (frequency domain – PSD distribution with variability) • Temporal variance in frequency content (time domain – spectrogram) • Received levels at recording location • Estimated source level of activity (detail method of calculation) • Log of recordings together with ancillary data (including weather) • Any detail of the analysis that is needed for replication/comparison purpose 	Daily Underwater Noise Monitoring Reports collated and submitted on a weekly basis during marine construction works
11.7.1	<p>Noise Registry: Dragados will submit data to the UK Noise Registry on planned and actual activities activity. Dragados must complete and submit a Close-out Report for the licensable marine activities producing loud, low to medium frequency (10Hz-10kHz) impulsive noise, via the online Marine Noise Registry</p>	Close-out Report to be submitted via the online Marine Noise Registry at 6 month intervals during the Construction Marine Licence period and no later than 12 weeks from the completion of the licensable marine activity. Copy will also be submitted to MS-LOT.
Post construction		
	<p>Analysis of data and close out report As the construction of AHEP commences and continues, the analysis of data relating to marine mammals (PAM, C-POD, visual observations, recording of noise measurements) will be analysed and compiled into a final report.</p>	Final Report - Issued within 6 months of construction completion (this will be dependent on whether an academic can be identified to undertake the analysis through a post-doc and their availability). Interim Report – By end of Jan 2018 & end of Jan 2019