RECORD OF THE APPROPRIATE ASSESSMENT UNDERTAKEN UNDER REGULATION 5 OF THE OFFSHORE PETROLEUM ACTIVITES (CONSERVATION OF HABITATS) REGULATIONS 2001 (AS AMENDED)

April 2011

Title of Application:

Seismic Survey Programme, Braemore, Forse, Berriedale and Helmsdale Prospects and Burrigill site survey

1 INTRODUCTION

1.1 This is a record of the Appropriate Assessment undertaken by the Department of Energy and Climate Change (DECC) in respect of the undertaking of a 2D seismic survey as proposed in the PON14a application DECC ref. no. 2217 ("the project"), as required under Regulation 5 of the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (S.I. 2001/1754) (as amended), and in accordance with the Habitats Directive (Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora) and the Wild Birds Directive (Council Directive 2009/147/EC on the conservation of wild birds).

1.2 The project is not directly connected with, or necessary to, the management of a European site. Based on advice received from Scottish Natural Heritage (SNH) the Appropriate Assessment considers the following designated European sites:

- Moray Firth SAC,
- Dornoch Firth and Morrich More SAC,
- Berriedale and Langwell Waters SAC,
- River Oykel SAC,
- River Evelix SAC,
- River Moriston SAC,
- River Spey SAC,
- East Caithness Cliffs SPA.

1.3 The purpose of the Appropriate Assessment is to ascertain whether the project will not adversely affect the integrity of the European sites listed above, in terms of their conservation objectives.

1.4 This record should be read in conjunction with the following documentation:

- Petroleum Operations Notice No. 14A (PON14A) Notification and/or application for consent for oil and gas surveys and shallow drilling operations. Ref. No. 2217. Dated 6 May 2010, updated 16 December 2010.
- Caithness Petroleum (2010) Moray Firth 2D Seismic Survey Environmental Impact Assessment, Braemore, Forse, Berriedale and Helmsdale Seismic Survey Programme.
- Kongsberg (2010[a]). Underwater noise propagation modelling and estimate of impact zones for seismic operations in the Moray Firth. Final report 37399 – FR1 (c).
- Kongsberg (2010[b]). 2D Seismic Survey in the Moray Firth: Review of noise impact studies and re-assessment of acoustic impacts.
- Thompson *et al*. (2010). Assessing the potential impact of oil and gas exploration operations on cetaceans in the Moray Firth. University of Aberdeen.
- SNH (2010). Caithness Petroleum 2D Seismic Survey. Letter to DECC dated 11 June 2010. Ref No. B623544.

1.5 The assessment has been undertaken using the best scientific knowledge available and, based on this knowledge, used a precautionary approach when assessing potential effects.

2 PROJECT LOCATION

2.1 The proposed 2D seismic survey will be undertaken across five separate locations within the Moray Firth: the Braemore, Forse, Berriedale, and Helmsdale Prospects, plus the Burrigill site, covering a total area of 308.5 km^2 (Figure 1). Four of the proposed survey areas, Braemore, Forse Berriedale and Burrigill, are outwith any area subject to a local, national or international environmental designation. The Helmsdale survey area is 160 km^2, of which 115 km^2 is within the Moray Firth SAC.

2.2 Seismic surveys have been undertaken in the Moray Firth area since the 1970's. There are primarily two types of seismic survey: 2D and 3D, with 3D being less frequent but typically on a larger scale and a greater source level sound. The majority of surveys undertaken in the Moray Firth have been 2D (Figure 2).

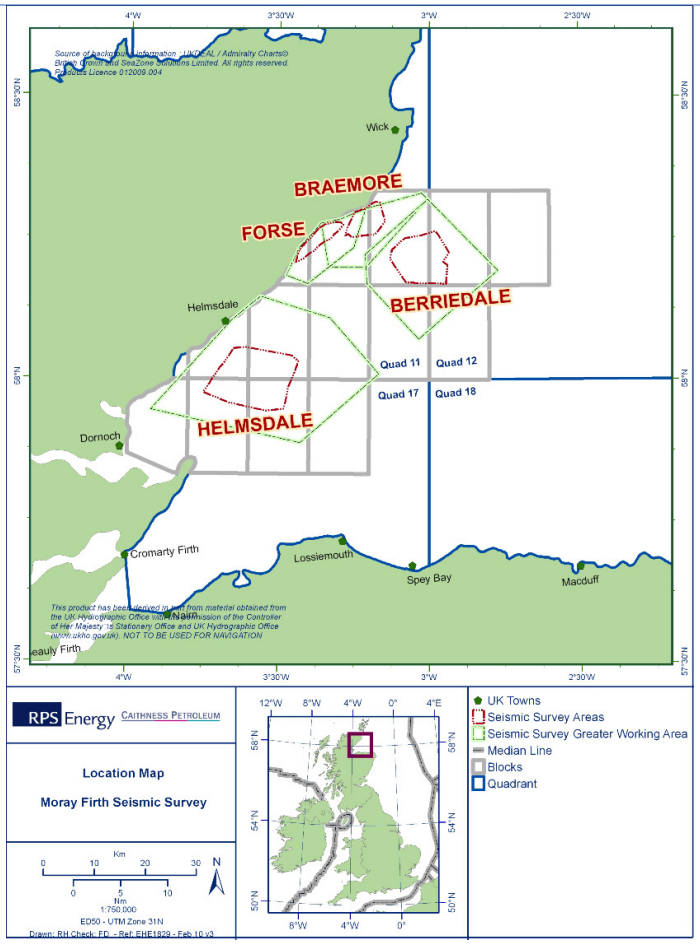

Figure 1: Map showing areas of proposed Caithness Petroleum seismic surveys in the Moray Firth (Burrigill at 11/24 & 11/25- not shown here)

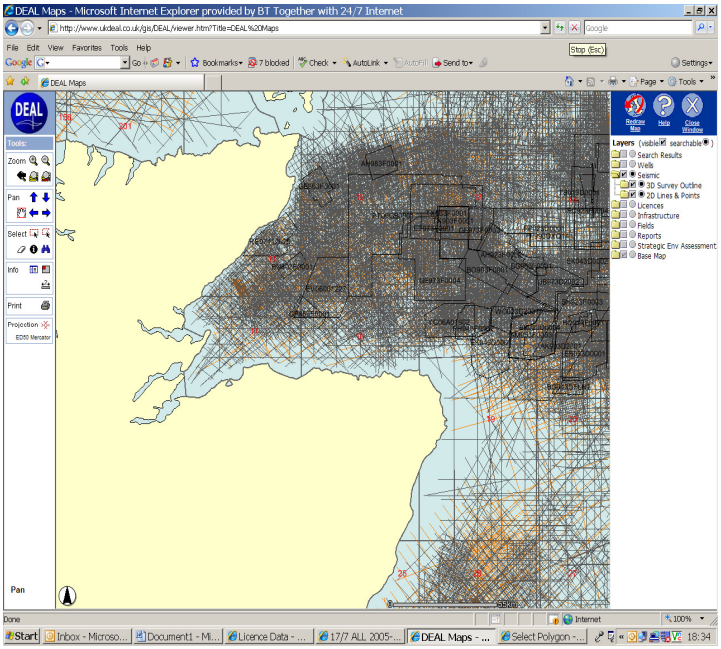

Figure 2: Historical seismic survey coverage in the Moray Firth

Source: DEAL database

3 PROJECT DURATION

3.1 It is proposed that the Caithness Petroleum surveys will start no earlier than 1 August 2011 and finish no later than 31 October 2011. The total duration of all those surveys is expected to be no longer than 14 days (Table 1).

3.2 PA Resources has submitted a proposal to undertake a separate seismic survey in Blocks 17/4b[1], 17/3, 11/28, &11/29 starting no earlier than 01 August 2011 and finishing no later than 31 October 2011, which in total is expected to last between approximately five and seven days. The survey has a proposed contingency duration of fifteen days, but this does not mean there will be an increase in the length of time that the airguns will be used as the contingency is included to cover periods when it is not possible to use the airguns, primarily due to weather downtime.

Table 1. Specifications for proposed seismic surveys in the Moray Firth September 2010

Site	Block	Area (km^2)	No. of lines	Length of Lines (km)	Duration (days)
Helmsdale	11/27, 11/28, 17/02, 17/03	160	14	191	3
Berriedale	11/25, 12/21	89.8	10	100	2
Forse	11/23, 11/24	24	27	140	4
Braemore	11/24, 11/25	34.7	11	72	2
Burrigill	11/24 11/25	9	18	54	3
Block 17/4B [1]	17/4, 17/3, 11/28, 11/29	90		493	5-7 (contingency of 15)

[1] – Block 17/4B is the proposed seismic survey by PA resources

[1] For the purposes of this assessment, where Block 17/4B is referred to within the document it is also including Blocks 11/28, 11/29, 17/3.

4 PROJECT DESCRIPTION

4.1 The Braemore, Forse, Berriedale, and Helmsdale Prospect surveys and Burrigill site survey will involve a single survey vessel undertaking 2D seismic along a pre-determined pattern of transect lines, with the lines spaced at approximately 25 m – 50 m intervals (Figure 3). The total length of the survey transects, during which the airguns will be operating, will be 463 km, spread over the five survey locations. Between 2 km and 4 km will also be required at the end of each survey line to allow the vessel to turn, during which time the airguns could be operating (depending upon operational requirements).

4.2 The proposed seismic survey system consists of a G Gun array, comprising two airguns with a total capacity of 470 cubic inch at 2,000psi. Each airgun may be fired approximately every 4.5 seconds emitting sound levels no greater than 243 dB re 1µPa @ 1m. The applicant has undertaken an impact assessment based on a peak sound source level of 228 dB at 100 Hz. Additional sound propagation modelling has been used in this assessment, based on different sound levels:

- Kongsberg noise model based on a 470 cu. inch gun with a peak sound source level of 243 dB re1. µPa @ 1m.
- PA Resources noise modelling is based on sound source level of no greater than 220 dB re. 1µPa @ 1m and 183 dB re 1µPa @ 500m.

This assessment is primarily based on the study undertaken by Kongsberg, supported by the other studies (Kongsberg 2010[b], Caithness Petroleum 2010, PA Resources 2010). The assessment is therefore based on the most precautionary sound source level of 243 dB re 1µPa @ 1m.

4.3 A single streamer containing the hydrophones will be towed behind the survey vessel. The length of the streamer will vary between 600 metres for the two proposed inshore survey areas to 3,000 metres for the three proposed offshore survey areas.

4.4 In addition to the seismic survey vessel, a safety vessel will also be present for the duration of the proposed survey.

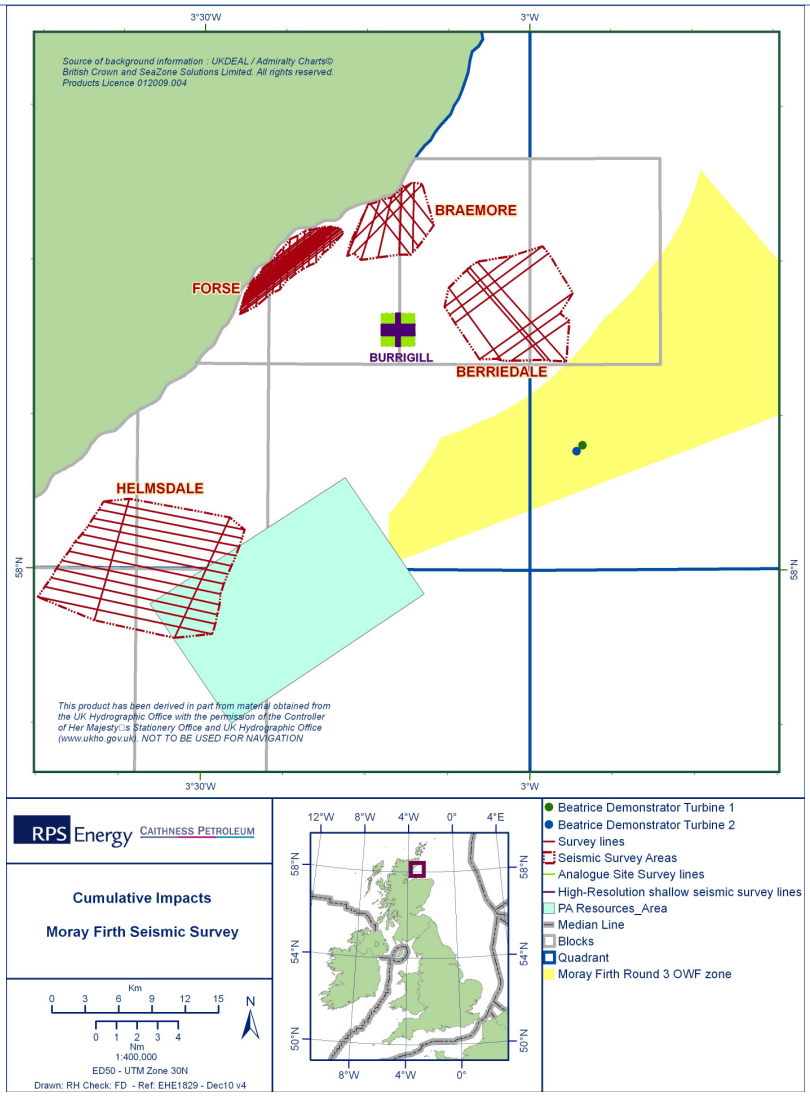

Figure 3: Map showing areas of proposed Caithness Petroleum and PA Resources seismic surveys and the area of the Moray Firth R3 OWF zone in the Moray Firth

5 SCOPE OF THIS ASSESSMENT

5.1 Detailed analysis, consultation and discussion of the environmental sensitivities related to the conservation features in the vicinity of the project have taken place prior to this assessment. DECC has concluded, taking account of the advice received from the Joint Nature Conservation Committee (JNCC)[2] and Scottish Natural Heritage (SNH)[3] that an Appropriate Assessment is required (SNH 2010).

5.2 The scope of the assessment is based on discussions with, and/or advice received from, the Scottish Government, JNCC, SNH, the University of Aberdeen, CEFAS, the Sea Mammal Research Unit and the Whale and Dolphin Conservation Society (WDCS) including the responses received to the consultation on the PON14A application submitted by Caithness Petroleum and the responses to the consultation draft of the Appropriate Assessment which are summarised in Annex 1 to this report.

5.3 Based on the advice received it has been determined that the assessment should consider alone and in-combination the potential direct and indirect impacts on:

- Bottlenose dolphin,
- Harbour seal,
- Atlantic salmon,
- Sea lamprey,
- Freshwater pearl mussel,
- Seabird assemblages.

Bottlenose Dolphin

5.4 The bottlenose dolphin is a qualifying species for the Moray Firth SAC. The area of Moray Firth SAC is 1,513 km^2 and 115 km^2 of the Helmsdale survey will overlap the SAC. Sound arising from the proposed seismic survey has the potential to significantly affect bottlenose dolphins, due to permanent or temporary physical hearing damage and or displacement and disturbance. The proposed survey areas outwith the SAC will also include areas where there is the potential for bottlenose dolphins to occur. The surveys could therefore affect bottlenose dolphins or their prey both within and outwith the Moray Firth SAC.

Harbour Seals

5.5 Harbour seals are an Annex II feature of the Dornoch Firth and Morrich More SAC. JNCC and SNH have advised that seismic airguns may affect harbour seals or their prey. All the surveys

2 JNCC advise on nature conservation effects *at* and *beyond* 12 nautical miles.

3 Scottish Natural Heritage advise on nature conservation effects *within* 12 nautical miles.

are outwith the SAC but occur in areas where harbour seals may occur and therefore there is a potential to effect on harbour seals outwith the Dornoch Firth and Morrich More SAC.

Atlantic Salmon

5.6 SNH have advised that Atlantic salmon are susceptible to loud underwater sound and that proposed survey could have a significant effect on the Atlantic salmon, which is a qualifying species for Berriedale and Langwell Waters SAC, River Oykel SAC, River Moriston SAC and River Spey SAC and have advised that DECC is required to undertake an Appropriate Assessment in view of these sites' Conservation Objectives for Atlantic salmon (SNH 2010).

5.7 Only the Berriedale and Langwell Waters SAC is less than 20 km from the proposed survey areas; and it is concluded that there will be no significant impact on Atlantic salmon within or near the River Oykel, River Moriston and River Spey SACs. The proximity of Berriedale and Langwell Waters SAC to one of the proposed survey areas may indicate that there is the potential for some displacement of Atlantic salmon near to the entrance of the river. However, the proposed survey is planned to last no longer than two days and any displacement, should it occur, would therefore be for a very limited period and unlikely to be significant. Low densities of migrating Atlantic salmon may pass through the ensonified area during seismic operations, but will not remain in the area. Consequently, any potential adverse effect on Atlantic salmon would be localised, of short duration and only likely to affect a small number of individuals. There is also no evidence that any displacement would have any long-term effect on migratory behaviour.

5.8 There is the potential for in-combination effects with the survey being proposed by PA Resource (PA Resources 2010). This survey is over 20 km from the relevant SACs and is also of a relatively short duration of no longer than 15 days, during which period some Atlantic salmon may be displaced.

5.9 SNH have advised the proposal will not adversely affect the integrity of the sites. Therefore, Atlantic salmon are not considered further in this assessment.

Sea Lamprey

5.10 Sea lamprey spend their adult life in the sea or estuaries but spawn and spend the juvenile part of their life cycle in freshwater rivers. SNH have advised that the proposed survey could have a significant effect on the sea lamprey, which is a qualifying species for River Spey SAC. and have advised that DECC is required to undertake an Appropriate Assessment in view of the sites Conservation Objectives for sea lamprey (SNH 2010).

5.11 The River Spey SAC is located on the southern side of the Moray Firth and is approximately 25 km from the nearest survey area and consequently the sound levels from the surveys in the vicinity of the SAC will be relatively low. Although research indicates that sea lamprey respond to sound at frequencies of between 20 Hz and 100 Hz (Lenhardt & Sismour 1995), they do not possess a swim bladder and are therefore less sensitive to sound than fish that do possess a

swim bladder (Maes *et al*. 2004); and potential impacts in the vicinity of the SAC are therefore considered to be low. In addition, sea lamprey leave the River Spey and enter the Moray Firth during October and November and will be largely absent from the Moray Firth during September when the proposed seismic surveys are planned. It is therefore concluded that they will not be adversely impacted by the proposed seismic surveys.

5.12 There is the potential for in-combination effects with the survey being proposed by PA Resource (PA Resources 2010). This survey is over 20 m from the relevant SAC and is also of a relatively short duration of no longer than 15 days. As sea lamprey are largely absent from the Moray Firth during the period of the proposed survey it is concluded that there will be no in-combination impact.

5.13 SNH have advised that the proposal will not adversely affect the integrity of the site. Therefore, sea lamprey are not considered further in this assessment.

Freshwater Pearl Mussel

5.14 SNH have advised that the proposed surveys could have a significant effect on the freshwater pearl mussel, which is a qualifying species for River Oykel SAC, River Evelix SAC, River Moriston SAC and River Spey SAC and have advised that DECC is required to undertake an Appropriate Assessment in view of these sites' Conservation Objectives for freshwater pearl mussel (SNH 2010).

5.15 The freshwater pearl mussel is dependent on salmonid fish during the larval stage of their life cycle, during which time they attach themselves onto the gills of salmon or brown trout until the following summer when they drop off onto the river bed. There is therefore a theoretical possibility that, should there be any significant displacement of salmon from their spawning rivers, there could be an adverse effect on the freshwater pearl mussel. As indicated above (Section 5.7), it is concluded that any potential effect, either alone or in-combination on Atlantic salmon would be localised, of short duration and only likely to affect a small number of individuals, and there is also no evidence that any displacement would have any long-term effect on migratory behaviour. Consequently, it is not anticipated that there will be any impact on the freshwater pearl mussel.

5.16 SNH have advised the proposal will not adversely affect the integrity of the sites. Therefore, freshwater pearl mussels are not considered further in this assessment.

Seabirds

5.17 The East Caithness Cliffs SPA hold internationally important populations of seabirds, particularly: guillemot, herring gull, kittiwake, razorbill and shag. In addition, the site qualifies under Article 4.2 of the Birds Directive as a site hosting a seabird assemblage of greater than 20,000 individuals. Peak seabird activity occurs during June and July with the fewest birds in the area in September and November (Brookes 2010). This supports the evidence from visual

surveys that indicate low densities of seabirds at the East Caithness Cliffs after the breeding season is finished (Mudge *et al*. 1987).

5.18 There is no published evidence of any direct or indirect impacts on seabirds from seismic surveys. The proposed surveys will be undertaken outwith the breeding season when the majority of seabirds that breed in the East Caithness Cliffs SPA have dispersed into the North Sea and the level of foraging activity in nearby waters will be relatively low.

5.19 SNH have advised that an Appropriate Assessment is not required in relation to the seabird populations, as it is unlikely that the proposal will have a significant effect on any qualifying interests of the East Caithness Cliffs SPA, either directly or indirectly. Therefore, seabirds are not considered further.

In-combination effects

5.20 For the purposes of this assessment, the consideration of in-combination effects follows published guidance by including the following plans and projects:

- Approved but as yet uncompleted plans or projects;
- Permitted ongoing activities,
- Plans or projects for which an application has been made and which are currently under consideration but not yet approved by competent authorities
- Plans and projects which are "reasonably foreseeable" (i.e. developments that are being planned and with sufficient information available to inform the assessment).

5.21 SNH have advised that the following projects should be considered as part of the in-combination assessment:

- PA Resources proposed seismic survey, Block 17/4B,
- Geophysical surveys in relation to renewables development,
- Piling operations proposed for the Highland Deephaven Jetty at Evanton,
- MOD activities (that generate underwater noise),
- Other vessel traffic.

In addition, the likely deployment of a power buoy in the Moray Firth, the likely drilling of an appraisal well (Knockinnon appraisal well) in the Moray Firth, the likely installation of a Met Mast (MORL) and the likely deployment of an electricity transmission hub in the outer Moray Firth has been considered as part of the in-combination assessment.

5.22 Marine Scotland Licensing has confirmed that the proposed works at the Highland Deephaven Jetty will not involve pile driving operations and instead gravity base moorings are to be used. It is therefore not included as part of the in-combination assessment.

5.23 Ocean Power Technologies have applied to the Scottish Government for consent to locate a power buoy in the Moray Firth. The location of the deployment has yet to be determined but one of the preferred locations is in Block 17/4. The buoy will be tested for a period of up to

three months before being moved. The exact operational sound will not be known until it has been tested but the maximum sound recorded so far onshore is 86 dB. Although this may vary once deployed and operating, the maximum sound recorded so far is below the background ambient sound levels in the Moray Firth and will not therefore cause an in-combination effect.

5.24 Caithness Petroleum have indicated that they plan to drill an appraisal well in Block 11/24, provisionally planned for July 2011 and would take approximately 90 days to complete. It is anticipated that a jack-up rig similar to the Ensco 92 will be used for the drilling operation. Jack-up drilling rigs generate typical noise levels of around 140 dB (Richardson *et al.* 1995) and assuming a spherical propagation of noise from the source, it can be seen from Figure 4 that background noise levels will be reached within a kilometre of the source. The proposed drilling operations may coincide with the timings of the seismic survey operations.

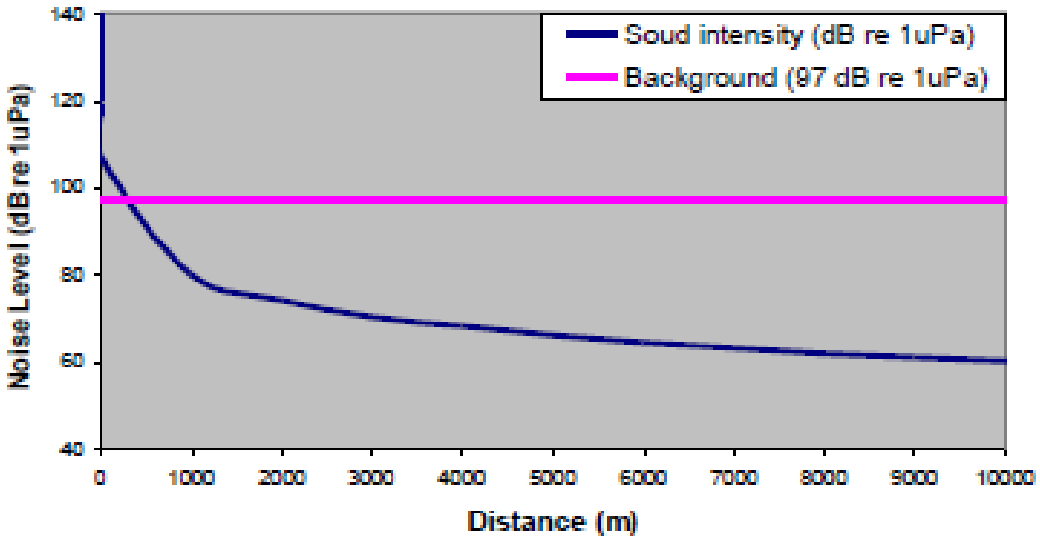

Figure 4: Propagation of Sound in Water (Source: Richardson *et al.* 1995)

5.25 Scottish Hydro-Electric Transmission Ltd (SHETL) is developing proposals to upgrade the electricity transmission infrastructure in the north of Scotland to meet the demand for connection from various renewable energy proposals. The proposals include installation of a hub (switching station) to be located in the outer Moray Firth and it is anticipated that the hub would be installed by piling. The location of the proposed hub has not been finalised nor has the design for the hub. SHETL have confirmed that the offshore construction will take place in 2012. It is therefore not included as part of the in-combination assessment.

5.26 In October 2009 there were military activities in the Moray Firth associated with a bi-annual multi-national exercise called Joint Warrior. The MoD has identified the following areas for proposed Exercise Joint Warrior in 2011 (Figure 5):

- QHM Clyde
- West Coast SXA

- East Coast SXA
- Cape Wrath Range (Source - http://www.rnopsscotland.com/index.htm)

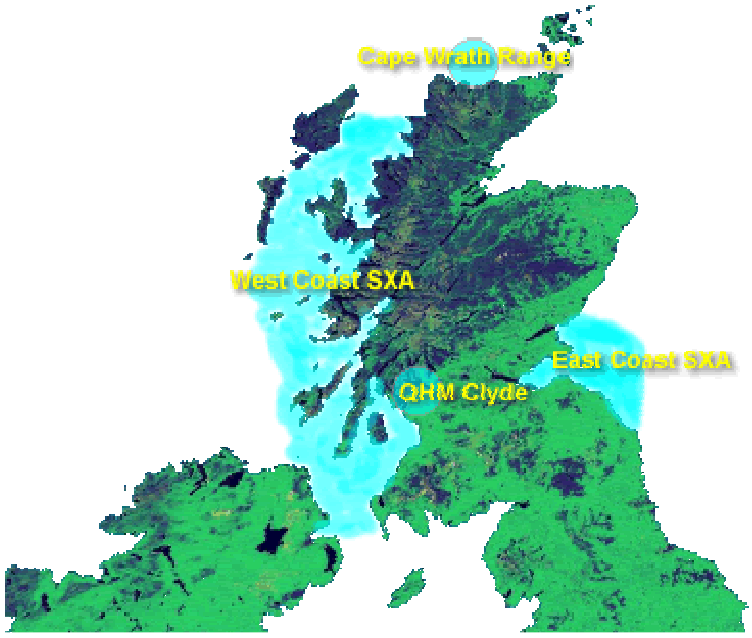

Figure 5: MoD 2011 Exercise Joint Warrior locations (Source: http://www.rnopsscotland.com/index.htm)

Although a military exercise occurred in 2009, the Moray Firth is not a routinely used Scottish Exercise Area and there is currently no information available on any further proposed MoD activities within the Moray Firth during 2011. There are currently no notices to fisherman with respect to any planned naval exercises in the Moray Firth during 2011 (http://www.rnopsscotland.com/aboutSXAs.htm [Accessed 20 April 2011]). It is therefore not possible to include MoD activities as part of the in-combination assessment.

5.27 Since 1913 there has been a military bombing range at Tain on land located next to the inner Moray Firth. It is one of the busiest bombing ranges in the UK with practice bombs of up to 14 kg being used in addition to 1,000 lb inert concrete bombs. No data are available on the extent to which these aerial and terrestrial activities may produce noise within the water column, but the Moray Firth SAC Management Plan has previously considered the consequences of such noise as minimal and noted that any potential impacts have been ongoing since at least WWII. The survey may occur during a period of training activity but any in-combination effects are considered unlikely. An offshore military firing practice area is located in the outer Moray Firth, but noise modelling suggests that this is sufficiently separated from the seismic survey area to avoid in-combination effect (Figure 6).

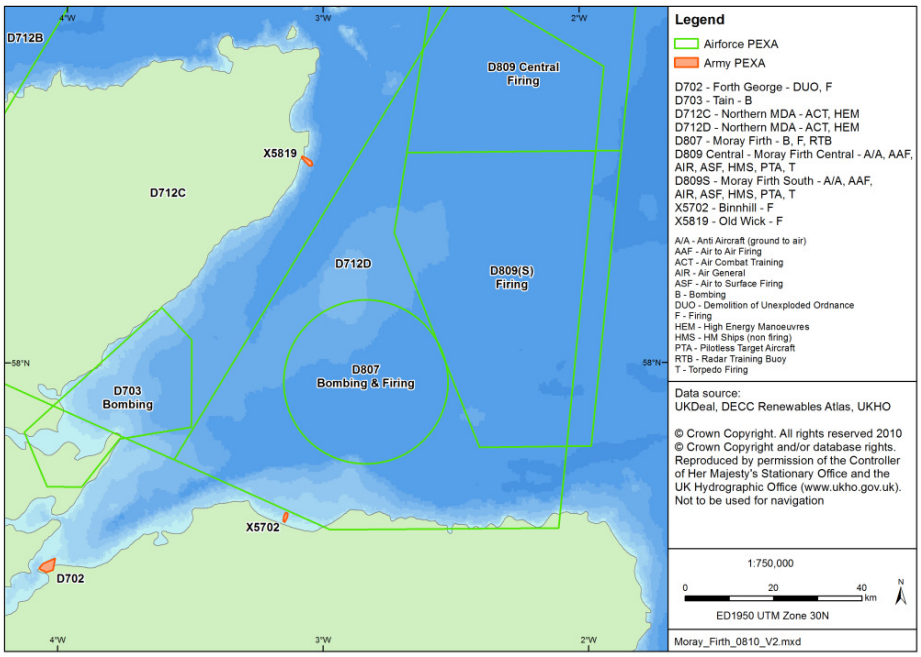

Figure 6: Military exercise areas in the Moray Firth

5.28 Vessel traffic is already part of the baseline environment in the Moray Firth and there is no information that suggests that there will be a significant increase in vessel traffic in the Moray Firth during September. The presence of an additional two further vessels in the Moray Firth over a period of 14 days is not expected to cause an adverse effect. There is therefore no requirement for an in-combination assessment.

5.29 PA Resources propose to undertake a 2D seismic survey in Block 17/4B and surrounding Blocks of the inner Moray Firth between 01 August and 31 October 2011 (Figure 3). The proposed survey will last for 5 to 7 days, with a contingency for up to 15 days. The survey vessel used will be the same as that used for the Braemore, Forse, Berriedale and Helmsdale Prospect and Burrigill site surveys, so there will be no overlap of operations. The equipment used will also be the same as that used for the proposed Braemore, Forse, Berriedale, and Helmsdale Prospect and Burrigill site surveys. PA Resources have undertaken modelling based on a sound source of no greater than 220 dB re 1 µPa @ 1m.

5.30 Moray Offshore Renewables Ltd (MORL) have indicated that geophysical surveys along the cable route are likely to be undertaken during spring 2011. The geophysical surveys would involve side scan sonar, sub-bottom profiler and multi-beam echo sounder. MORL have also confirmed potential to undertake geotechnical surveys in 2011 in their renewable energy zone and cable route. The geotechnical surveys will involve drilling shallow bore-holes.

5.31 In addition MORL have indicated that the installation of a Met Mast is likely to go ahead during Q3/Q4 2011. It is likely that a steel mono tower or steel framed structure will be secured with pin pile, mono pile or suction caissons. Detailed information of the piling operations to install the Met Mast is not likely to be available until Q2 2011. Since the exact nature of the source level

sound is unknown, a typical source level sound propagation model was commissioned from Genesis Oil & Gas Consultants Ltd, and the report is included at Appendix 1. Should the piling operations to install the Met Mast be carried out in Q3 2011, the piling operations may coincide with the timings of the seismic survey operations, however, piling operations to install the Met Mast is unlikely to be carried out at the same time due to technical reasons,

5.32 Beatrice Offshore Wind Limited (BOWL) has applied to Marine Scotland to undertake geotechnical surveys in their renewable energy zone for a week during January 2011. The geotechnical survey will involve drilling a number of shallow bore-holes. BOWL have also indicated that potential geophysical surveys along the cable route might be undertaken during spring 2011 with MORL.

5.33 The use of a single beam echo sounder may produce a sound source up to 160dB. Other, un-quantified but lower, sources of sound will also arise from the sub-bottom profiler and side scan sonar..

5.34 The following proposed projects have therefore been considered for in-combination effects:

- PA Resources proposed seismic survey Block 17/4B,
- Caithness Petroleum proposed Knockinnon appraisal well drilling programme.
- Geophysical surveys and the installation of Met Mast relating to offshore renewables.

Table 2. Likely effects assessed

Interest Feature	***Potential Effect***	***European Site/Habitat***	
		Moray Firth SAC	Dornoch Firth and Morrich More SAC
Bottlenose dolphin	• Physical damage	✓	
	• Displacement and Disturbance	✓	
	• Displacement of prey	✓	
Harbour seals	• Physical damage		✓
	• Displacement and Disturbance		✓
	• Displacement/reduction of prey species		✓

Other considerations

5.35 All cetacean species in UK waters are protected under Annex IV of the Habitats Directive, and this has been taken into consideration in the environmental impact assessment and disturbance assessment relating to the seismic survey application. However, apart from the bottlenose

dolphin, there is no connection between the other cetaceans and a Special Area of Conservation, so the other species present in the area are not included within the scope of this assessment.

Summary of scope

5.36 Based on the advice received and the analysis presented above, the following features will be assessed:

- Moray Firth SAC – Bottlenose dolphin
- Dornoch Firth and Morrich More SAC – Harbour seal

6 CONSERVATION OBJECTIVES

6.1 The Habitats Directive does not define what is meant by conservation objectives, but it is considered that the objectives would be directly related to the desired status of a site in terms of the interest features for which it has been designated. When these interest features are being managed in a way which maintains their nature conservation value, then they are said to be in 'favourable condition'. An adverse effect on integrity is therefore likely to be one which prevents the site from making the same contribution to favourable conservation status for the relevant feature as it did at the time of its designation (English Nature 1997).

6.2 Favourable Conservation Status is defined in Article 1(i) of the Habitats Directive as:

> *(i) conservation status of a species means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the territory referred to in Article 2;*
>
> *The conservation status will be taken as "favourable" when:*
>
> *- population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and*
>
> *- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and*
>
> *- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis;*

6.3 The published qualifying features and conservation objectives for the Moray Firth SAC and the Dornoch Firth and Morrich More SAC are attached in Appendix 2 The following summary of the conservation objectives refer only to the European interest features which are within the scope of this Appropriate Assessment. It is recognised that other qualifying features and species are present within the designated areas, but there is no evidence that the proposals will have any likely significant or adverse effect on those features or species and they are therefore not considered further in this assessment.

6.4 ***Moray Firth SAC - Bottlenose dolphin* – (SNH 2006[a])**

Conservation Objective*:* To avoid deterioration of the habitats of the qualifying species (Bottlenose dolphin *Tursiops truncatus*) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interest.

To ensure for the qualifying species that the following are established then maintained in the long term.

- Population of the species as a viable component of the site,
- Distribution of the species within the site,
- Distribution and extent of habitats supporting the species,
- Structure, function and supporting processes of habitats supporting the species,

- No significant disturbance of the species.

6.5 ***Dornoch Firth and Morrich More SAC – harbour seal* – (SNH 2006[b])**

Conservation Objective: To avoid deterioration of the habitats of the qualifying species (Harbour seal *Phoca vitulina*) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interest.

To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site,
- Distribution of the species within the site,
- Distribution and extent of habitats supporting the species,
- Structure, function and supporting processes of habitats supporting the species,
- No significant disturbance of the species.

7 SOUND MODELLING

7.1 Both Caithness Petroleum and PA Resources have commissioned sound modelling studies to assist in determining likely impacts on the qualifying species, bottlenose dolphin and harbour seal. It is recognised that both applicants have used slightly differing approaches and that neither model may, on its own, provide a robust assessment of the potential area of effect. Consequently, DECC, through Genesis Oil and Gas Consultants Ltd, commissioned Kongsberg to undertake an independent modelling study to provide the robust evidence required to assess potential zones of effect (Kongsberg 2010[b]). This study has been reviewed by a number of independent experts. Nevertheless, to ensure that all relevant and appropriate evidence is considered, the most significant results from the sound modelling undertaken by both applicants and those from the study undertaken by Kongsberg are presented in this assessment. Conclusions are drawn from findings from all three modelling studies and are based on the best scientific knowledge on the hearing thresholds of the species concerned.

7.2 Sound modelling commissioned by Caithness Petroleum is based on a predicted peak sound source of 228 dB re.1 µPa @ 1m at 100 Hz.

7.3 Sound modelling undertaken by PA Resources in support of the proposed seismic survey in Block 17/4 is based on a predicted sound source of no greater than 220 dB re.1 µPa @ 1m and 183 dB re.1 µPa @ 500m.

7.4 Based on the sound modelling undertaken by both survey applicants for the bottlenose dolphin, there is predicted to be no physical injury (temporary threshold shift), but strong avoidance may occur at ranges from less than 10 metres to 11 km, depending on the source level sound, the received sound level and the avoidance threshold (Table 3).

7.5 Based on the sound modelling undertaken by both survey applicants for pinnipeds, there is predicted to be no physical injury (temporary threshold shift) but potential strong avoidance out to 5.1 km (Table 3).

Table 3. Modelled responses to seismic sound source.

	Source	Source level at source (dB re.1 µPa @ 1m)	Received sound level at source (dB_{ht})	Distance for strong avoidance (metres)
Pinniped	Caithness Petroleum	188	104	<10
	PA Resources	<220	90	900
	PA Resources	<220	75	5,100
Bottlenose dolphin	Caithness Petroleum	228	97	<10
	Caithness Petroleum	188	92	<10
	PA Resources	<220	90	1,800
	PA Resources	<220	75	11,000

7.6 PA resources have assessed avoidance distances using two levels of hearing threshold: 90 dB_{ht} and 75 dB_{ht}. The 75 dB_{ht} is more precautionary and consequently indicates avoidance rates may occur at greater distances. Caithness Petroleum have undertaken modelling using two different source level noises depending on the frequency of either 100 Hz or 1 KHz.

7.7 Ambient noise data for both the inner and outer Moray Firth were collected in 2006. The results of the studies indicated a variation in the level of background sea noise depending on the location. For the Inner Moray Firth levels of noise ranged from between 104 dB re 1µPa and 119 dB re 1µPa. Background noise levels for outer Moray Firth were recorded as being approximately 20 dB higher than in the inner Moray Firth, with a maximum of 138 dB re. 1µPa. Shipping activities were thought to be responsible for the difference in the background noise levels.

7.8 Sound from airguns has been measured as being between 222 dB re.1µPa @ 1m and 265 dB re.1µPa @ 1m. For the purposes of the sound modelling study undertaken by Kongsberg the peak to peak source level used was 243 dB re.1µPa @ 1m which is based on an airgun with a capacity of 470 cubic inches. Sound modelling suggests that the airgun sound will remain above background noise levels at distances beyond 20 km at a frequency of 1 kHz and less than 10 km at a frequency of 20 kHz.

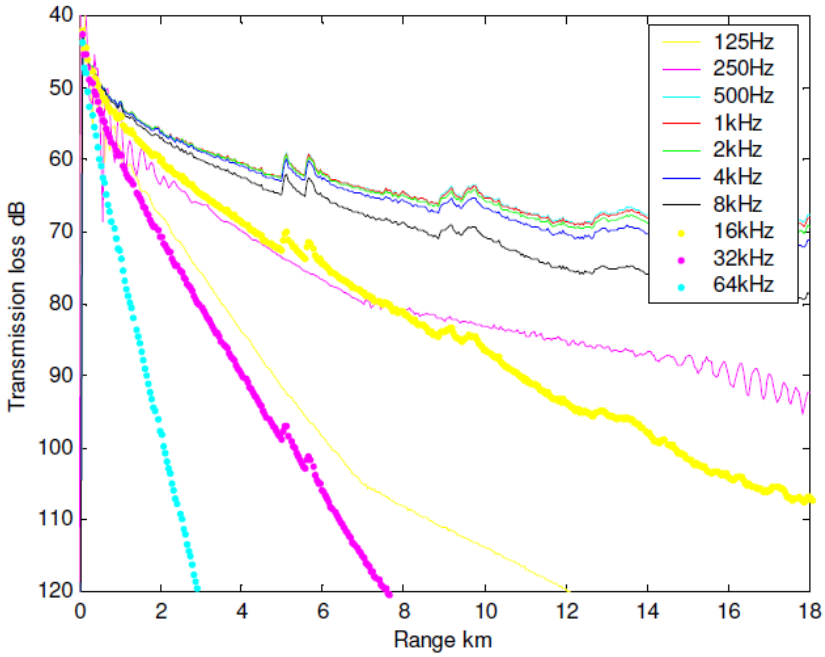

Figure 7: Predicted propagation loss to the south-west of the proposed survey areas in typical summer conditions.

7.9 Sound propagation varies in the marine environment depending on the water depth and seabed characteristics. Modelling undertaken by Kongsberg for four different transects across the Moray Firth indicated that there were some differences in sound propagation loss depending on the season and seabed profiles, with rapid attenuation of high and low level frequencies in shallower waters compared to mid-frequencies of between 500 Hz and 2 kHz. Predicted sound propagation losses for a transect towards the Moray Firth SAC are presented in Figure 7.

7.10 The Kongsberg model considered both un-weighted sound exposure level (SEL) and M -weighted SEL as supported in relevant scientific literature (e.g. Southall *et al.* 2007). The use of M-weighted SEL takes into account the species-specific audiograms; with the hearing of some species being adapted for high frequencies and others low frequencies. Bottlenose dolphins are mid-frequency hearing specialists and using the appropriate filter (Mmf) provides a more appropriate prediction as to likely zones of potential impact. Similar filters (Mpf) have been used for assessing potential impacts on pinnipeds (Southall *et al.* 2007, Kongsberg 2010[b]).

7.11 The results of the modelling using single pulse M -weighted SEL indicates that, for bottlenose dolphin, the greatest distance at which a permanent threshold shift may occur is 2 metres and, for pinnipeds, up to 11 metres (Table 4).

7.12 The results of the modelling using M-weighted SEL indicates that, for bottlenose dolphin, the maximum distance at which a temporary threshold shift is predicted to occur is 55 metres in a north-easterly direction, away from the SAC. For pinnipeds the distance, in the same direction, is 75 metres (Table 4).

Table 4. Single shot M-weighted SEL. Maximum potential auditory injury range for mid-frequency range bottlenose dolphin and pinnipeds

Marine Mammal Species	Criteria	Maximum Distance (metres)	Transect
Cetaceans (Mmf) Mid Frequency	PTS Auditory injury 198 dB re 1 $\mu Pa^2.s$	2	All
Pinnipeds (Mpf)	PTS Auditory injury 186 dB re 1 $\mu Pa^2.s$	11	NE (away from SAC)
Cetaceans (Mmf) Mid Frequency	TTS onset cetaceans 183 dB re 1 $\mu Pa^2.s$	55	NE (away from SAC)
Pinnipeds (Mpf)	TTS onset pinnipeds 171 dB re 1 $\mu Pa^2.s$	75	NE (away from SAC)

Source Kongsberg 2010[b]

7.13 Sound propagation towards the Moray Firth SAC indicated that, for a temporary threshold shift to commence in bottlenose dolphin, it must be no greater than 12 metres from the sound source, and for pinnipeds no greater than 60 metres (Kongsberg 2010).

7.14 Cumulative impacts arising from repeated firing of an airgun every seven seconds have been modelled, assuming that the vessel will move away from a stationary mammal. The results of the modelling indicate that, if the airguns are fired every seven seconds, a bottlenose dolphin that does not exhibit avoidance behaviour will be at risk of a permanent threshold shift at a range of less than 5 metres and temporary threshold shift at a range of 20 metres. For pinnipeds, the permanent threshold shift range is the same, but the temporary threshold shift range increases to 200 metres (Table 5). However, it is reasonable to expect, that, if a marine mammal is affected by the sound source it will exhibit some avoidance behaviour and move away. Previous modelling undertaken by Kongsberg has indicated that when there is avoidance behaviour the distance at which a potential impact could occur is reduced (Kongsberg 2010[a]). If consent is issued the JNCC Guidelines on Minimising the Risk of Injury

and Disturbance to Marine Mammals from Seismic Surveys would be included in the consent (Appendix 3). These guidelines require observations and, where appropriate, passive acoustic monitoring for marine mammals to be made to determine that there are no marine mammals in the immediate vicinity prior to commencement of the seismic surveys. If any marine mammal is detected within 500 metres of the airgun, the seismic survey cannot start until no detections have been made within 500 metres of the airgun for at least 20 minutes (JNCC 2010). Therefore the imposition of a consent condition requiring Marine Mammal Observers (MMOs) and Passive Acoustic Monitoring (PAM) should ensure that the possibility that any marine mammals are present at a distance at which either permanent or temporary threshold shift could occur is extremely remote.

Table 5. Multi shot M-weighted SEL PTS and TTS auditory injury range for mid-frequency range bottlenose dolphin and pinnipeds

Behaviour	Marine Mammal Species	Criteria	Maximum Distance (metres)
Without avoidance behaviour, i.e. moving vessel and stationary mammal	Cetaceans (Mmf) Mid Frequency	PTS Auditory injury 198 dB re 1 $\mu Pa^2.s$	<5
	Pinnipeds (Mpf)	PTS Auditory injury 186 dB re 1 $\mu Pa^2.s$	<5
	Cetaceans (Mmf) Mid Frequency	TTS onset cetaceans 183 dB re 1 $\mu Pa^2.s$	20
	Pinnipeds (Mpf)	TTS onset pinnipeds 171 dB re 1 $\mu Pa^2.s$	200

Source Kongsberg 2010[b]

7.15 The sound modelling undertaken by Kongsberg also assessed the potential distance at which sound from airguns could be detected by marine mammals. The distance at which the airgun sound may be detected varies depending on the sensitivity of the species to low, mid or high frequencies. For those of mid-frequency sensitivity, e.g. the bottlenose dolphin, the study predicts that sound from airguns may be detectable above background sea noise up to a range of 20 km. However, this does not necessarily correlate with potential disturbance that could result in displacement nor indicate that any disturbance at that range would be significant.

8 BOTTLENOSE DOLPHIN – Assessment of potential effects resulting from the proposed project, alone and in-combination with other projects

8.1 Bottlenose dolphin is a qualifying species for the Moray Firth SAC.

8.2 Potential impacts, alone and in-combination, to bottlenose dolphin from seismic exploration are:

- Physical impacts on bottlenose dolphin due to sound levels from seismic airguns,
- Displacement effects due to sound levels from seismic airguns,
- Displacement effects due to potential impacts from seismic airguns on prey species.

8.3 The population of bottlenose dolphins within the Inner Moray Firth has previously been estimated to be between 71 and 111 individuals; with 95% confidence limits of between 66 and 161 individuals. Recent estimates suggest that the population could be greater than previously thought, with median estimates of a bottlenose population for the whole of the east coast of Scotland from Moray Firth to St Andrews of between 193 and 237 individuals (Thompson *et al. in prep*). Since the early 1990s the bottlenose dolphins appear to have expanded their range from being largely within the inner Moray Firth to a wider area extending around the east coast of Scotland to St Andrews Bay in Fife. Abundance estimates for St Andrews Bay suggest that between 89 and 112 bottlenose dolphin use that area during the summer months. Consequently, a large proportion of the bottlenose dolphins that may be associated with the Moray Firth SAC are not present in the area at any one time. The exact proportion will vary but the above figures suggest that between 40% and 58% of the population will not be in the Moray Firth at any one time. Bottlenose dolphins from the Moray Firth have also been recorded on the west coast of Scotland and evidence from photo identification suggests that the dolphins observed in the Moray Firth are highly mobile and that a significant proportion of the population moves between the Moray Firth and Fife (Thompson *et al. in prep*).

8.4 The SCANS II survey undertaken in the summer of 2005 estimated 412 individuals over a wider area of the east coast of Scotland and estimated an overall density of 0.01 dolphins per km^2 (SCANS-II 2008).

8.5 Based on an area of the Moray Firth of approximately 5,200 km^2 and recognising that at least 40% of the Moray Firth population of bottlenose dolphins of between 193 and 237 individuals may not be present in the Moray Firth at the time of the proposed surveys; the density of bottlenose dolphins across the Moray Firth is approximately 0.02 dolphins per km^2. Although this figure is extrapolated from two different population estimates it does support the density estimates obtained from the SCANS II surveys used in this assessment. Available data also indicate that densities of bottlenose dolphin will be higher in the inner Moray Firth and in the inshore waters on the southern side of the Moray Firth and inshore waters around the coast south to St Andrews Bay, and that this is where most bottlenose dolphins will occur. These areas of higher estimated densities are outwith the predicted zone of disturbance from the

proposed seismic survey. Furthermore, the higher numbers of animals expected in these areas means that likely densities in other parts of their range will be considerably lower than the 0.02 dolphins per km^2 that would be expected if they were uniformly distributed across their range

8.6 A study undertaken in 2009 reviewed all existing cetacean survey data for the Moray Firth, including the areas of the proposed surveys. All suitable data collected since 1980 were used, including data from the Joint Cetacean Database, University of Aberdeen inshore photo-identification surveys, visual and acoustic surveys within the SAC, Cetacean Research and Rescue Unit surveys and Whale and Dolphin Conservation Society line transect surveys of the outer Moray Firth (Thompson *et al.* 2010). Although the surveys used differing techniques and differing effort, the combined results presented within the report provide a comprehensive overview of the distribution of bottlenose dolphins in the Moray Firth. Data from each of the surveys are presented within the report and a summary of all data collected from within the Moray Firth is presented in Figure 8. There are fewer sightings of all cetaceans along the north coast of the Moray Firth. The results from all surveys that have obtained data across the Moray Firth are consistent in their findings, in that they indicate that bottlenose dolphins are frequent in the coastal near-shore waters in the southern Moray Firth but are not frequent in the central Moray Firth and the more northerly coastal waters, including the areas of the proposed seismic survey. This is further supported by the evidence that (less detectable) harbour porpoises have, by contrast, been recorded throughout the Moray Firth including the waters to the north. Sea Watch Foundation, a national marine conservation research charity records area specific sightings of all cetaceans and maintains a database. Reports of recent sightings (between 31 August 2010 – 16 November 2010) in Northeast Scotland (http://www.seawatchfoundation.org.uk/region.php) indicate bottlenose dolphins are not recorded in the more northerly waters. In addition, Figure 9 shows spatial variation in the occurrence of different dolphin species encountered during aerial line-transect surveys carried out by University of Aberdeen during August – September 2010. These additional data further support previous studies that indicate that bottlenose dolphins occur primarily in the inner Moray Firth and along the coastal near-shore waters in the southern Moray Firth.

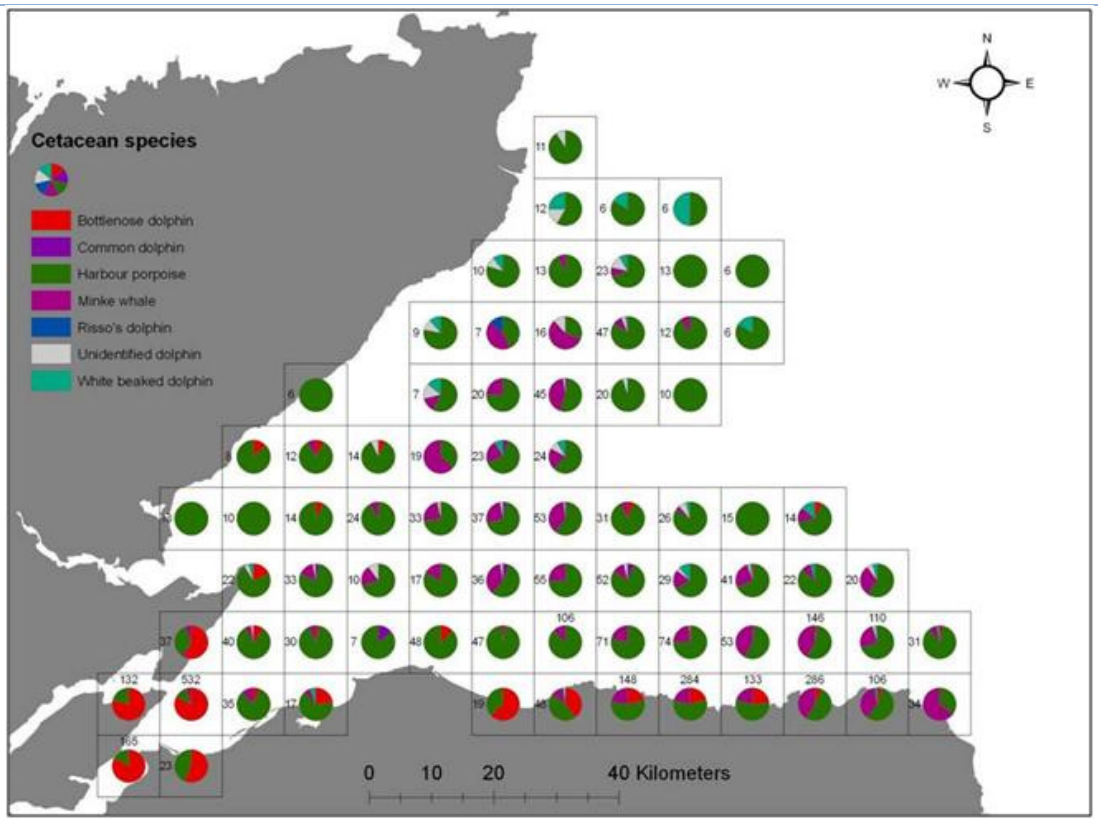

Figure 8: Summary of the number and species composition of cetacean sightings in different parts of the Moray Firth. The number in each cell refers to the number of sightings, whilst the pie chart shows the species composition of sightings in each cell. Data sources include all those reviewed in the Thompson et al. 2010 report.

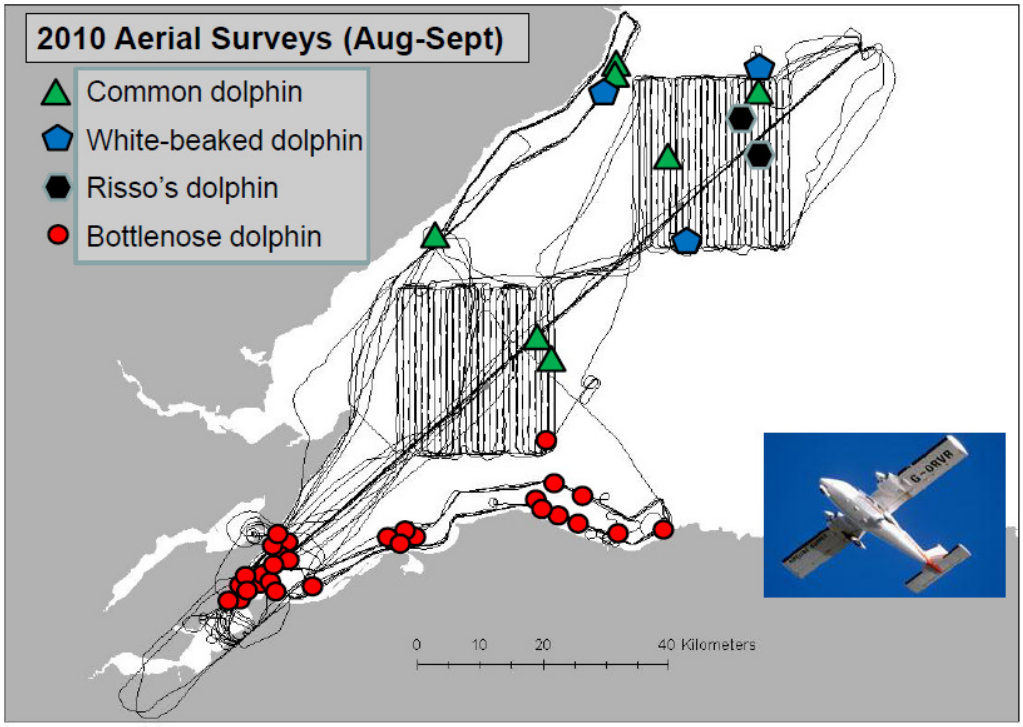

Figure 9: Dolphin sightings during aerial survey in summer 2010 (Thompson et al. 2011 report in-preparation)

8.7 In 2009 a total of sixty-two passive acoustic monitoring devices designed to detect (bottlenose) dolphins over a distance of up to 1 km were deployed within the central and southern Moray Firth between May and October 2009 (Figure 10). Data from the 51 devices recovered to date were analysed to determine the relative use of the central and southern areas of the Moray Firth by dolphins. The results from the passive acoustic monitoring supported the previous findings that bottlenose dolphin occur largely along the southern coastal areas with relatively few recordings along the central offshore areas (Figure 11). The difference between the dolphin usage of coastal waters and the waters further offshore, presented in Figure 11, was statistically highly significant (Thompson *et al*. 2010).

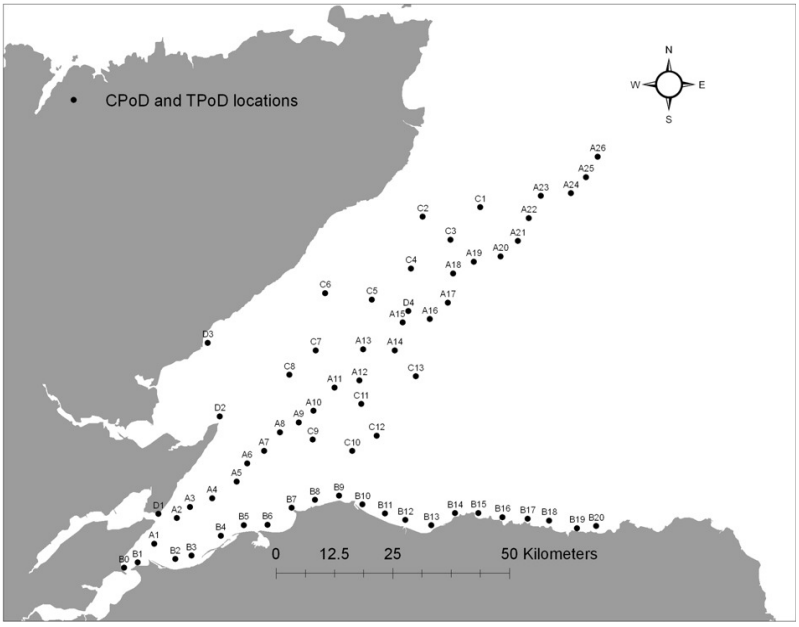

Figure 10: A map showing the location of all acoustic monitoring devices deployed during 2009.

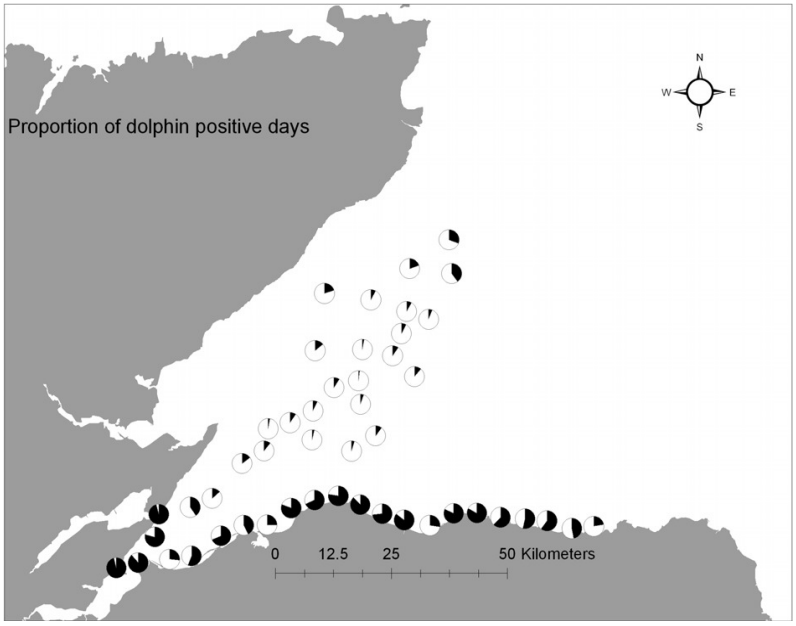

Figure 11: Proportion of days that dolphins were detected at each of the sample sites

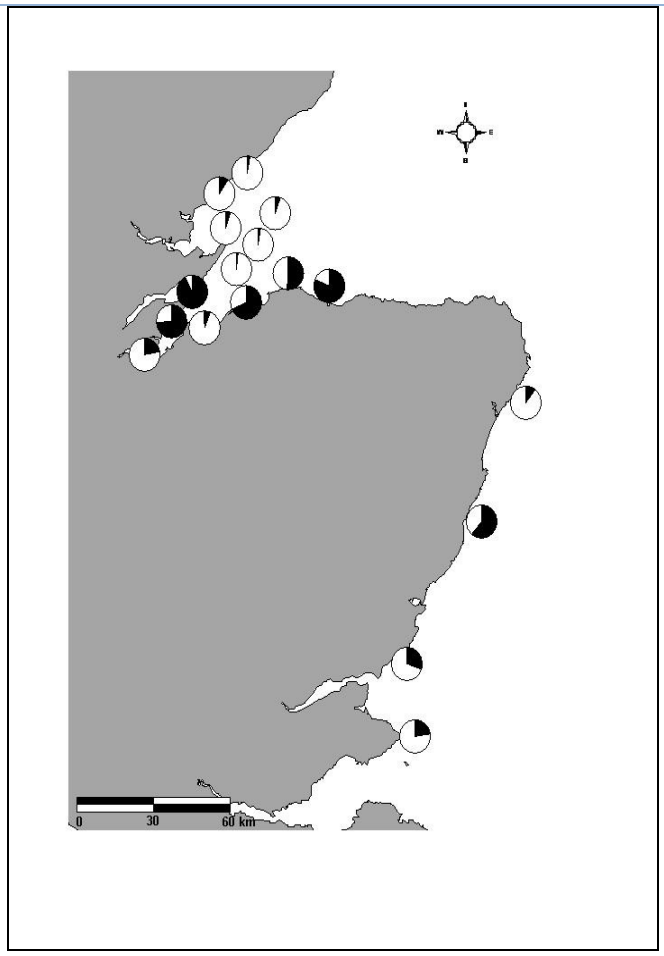

Figure 12: Variations in the proportion of days in which dolphins were detected by T-PODS at different sites around the east coast of Scotland in the summer of 2008.

Evidence of possible effects on bottlenose dolphin

8.8 **Physical damage** – Physical effects on the hearing of bottlenose dolphin resulting from airgun sound can, in theory, be either permanent (permanent threshold shift (PTS)) or temporary (temporary threshold shift (TTS)). Studies assessing the hearing ability of bottlenose dolphin indicate that they have nominal hearing in the mid-frequency range of between 150 Hz and 160 kHz and have poor ability to detect sound frequencies above or below this threshold (Southall *et al*. 2007). Experiments to determine the onset of TTS on bottlenose dolphin indicate that TTS can occur from between 182 dB re.1μ^2-1 and 204 dB re.1μ^2-1 and recovery has been recorded to occur within minutes or can take up to 40 minutes depending on the intensity or duration of the sound source (Southall *et al.* 2007; Mooney *et al.* 2009[a]; Mooney *et al.* 2009[b]).

8.9 **Displacement and Disturbance** – Behavioural disturbance may cause disruption in social and foraging activities including for example: changes in vocal behaviour, breathing rates and signs of agitation. When such effects arising from disturbance have been recorded, i.e. from some tourist boats, the evidence suggests that impacted bottlenose dolphins may react by avoiding the area of disturbance. Consequently, displacement is a visual cue of other potential behavioural disturbance effects on bottlenose dolphin and can occur over a greater range than

TTS. Data obtained from seismic surveys around the UK have indicated that there are fewer sightings of marine mammals during seismic surveys than at other times, and those that are recorded are frequently further from the sound source when the airguns are firing than when they are not firing (Stone & Tasker 2006). There is therefore the potential for some disturbance in the vicinity of the proposed seismic survey. Modelling undertaken by BMT for the applicant suggests that bottlenose dolphin may demonstrate strong avoidance behaviour within 10 metres of the sound source. Additional modelling undertaken by Subacoustech for PA Resources using different source level sound and avoidance threshold, suggests a potential behavioural avoidance by bottlenose dolphins from between 1.8 km and 11 km (Table 3). Estimated zones of disturbance based on both sets of modelling data are presented in Figure 13.

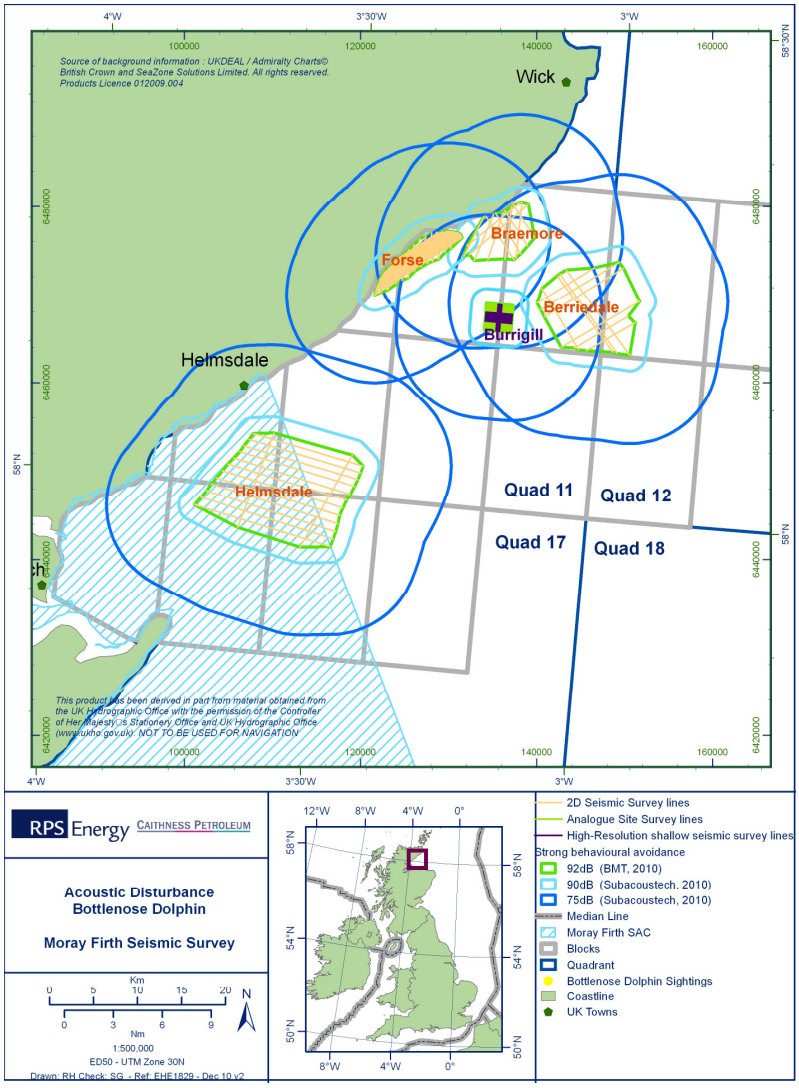

Figure 13. Estimated zones within which bottlenose dolphin may exhibit behavioural responses during the proposed Caithness seismic survey programme

8.10 Based on the data obtained from the SCANS II survey there is a potential bottlenose dolphin density of 0.01 per square kilometre. It is recognised that population densities will vary and that this figure is derived from a single survey and over a larger area. However, data from many other surveys also indicate that only low densities of bottlenose dolphin occur within the proposed survey area (Thompson *et al.* 2010) and there is no data to contradict the assumption and observations (Figure 8 & Figure 11). Based on a bottlenose dolphin density of 0.01 per square kilometre and assessing this against the predicted area of strong avoidance described in the modelling undertaken by BMT and Subacoustech it is predicted that between 1 and 10 bottlenose dolphins may be disturbed at any one time (Table 6). This figure may be higher if the density is 0.02 dolphins/km^2, in which case between 2 and 20 may be displaced at any one time.

Table 6. Numbers of bottlenose dolphin which could be potentially disturbed by the proposed seismic survey

Survey area	BMT Modelling Scenario		Subacoustech modelling scenario (90 dB_{ht})		Subacoustech modelling scenario (75 dB_{ht})	
	Predicted area of strong avoidance (km^2)	Number of bottlenose dolphins disturbed	Predicted area of strong avoidance (km^2)	Number of bottlenose dolphins disturbed	Predicted area of significant avoidance (km^2)	Number of bottlenose dolphins disturbed
Helmsdale	161.12	1.6	206.85	2.6	974.81	9.8
Forse	24.46	0.24	80.68	0.80	594.64	5.9
Braemore	34.97	0.35	87.4	0.87	583.49	5.8
Berriedale	90.19	0.9	165.80	1.7	765.99	7.7

8.11 **Impacts on prey** – Bottlenose dolphins in the Moray Firth feed on a variety of fish species that may be sensitive to sound and vibration and potentially physically impacted or displaced from the area during seismic survey activity. Published studies on the impacts of seismic surveys on fish indicate that there is the potential for physical damage to fish within 5 metres of the sound source with the most significant impact within 1.5 metres of the airgun. Displacement effects have been reported to be up to a few kilometres and can last up to five days after the cessation of activities (OSPAR 2009). Studies using G-guns with a peak pressure level of 218 dB re 1µPa @ 5 metres reported 'startle responses' but no significant displacement of any fish (Wardle *et al*. 2001).

8.12 **In-combination** – PA Resources propose to undertake a seismic survey within Block 17/4b and adjacent blocks within the Moray Firth between 01 August and 31 October 2011 (Figure 3). The proposed seismic survey will be undertaken using the same vessel and equipment, and will be undertaken sequentially with the Caithness proposed surveys. None of the proposed surveys will overlap and there will therefore be no in-combination impacts other than the overall duration of the survey activity and consequently the duration of any potential displacement.

8.13 The proposed survey in Block 17/4b and adjacent blocks is predicted to last for approximately five to seven days, with a contingency of 15 days to allow for weather downtime that would not increase the length of time that the airguns will be operating. Therefore, the total in-

combination duration of all surveys will be no longer than 29 days and this assumes that the airguns are fired every day of the contingency period allowed for delays and weather down-time, which is extremely unlikely.

8.14 Sound modelling commissioned by PA Resources for the survey in Block 17/4b suggests that there is the potential for disturbance of bottlenose dolphin at a range of between 1.8 km and 11 km, depending on the hearing threshold limit used (Figure 14).

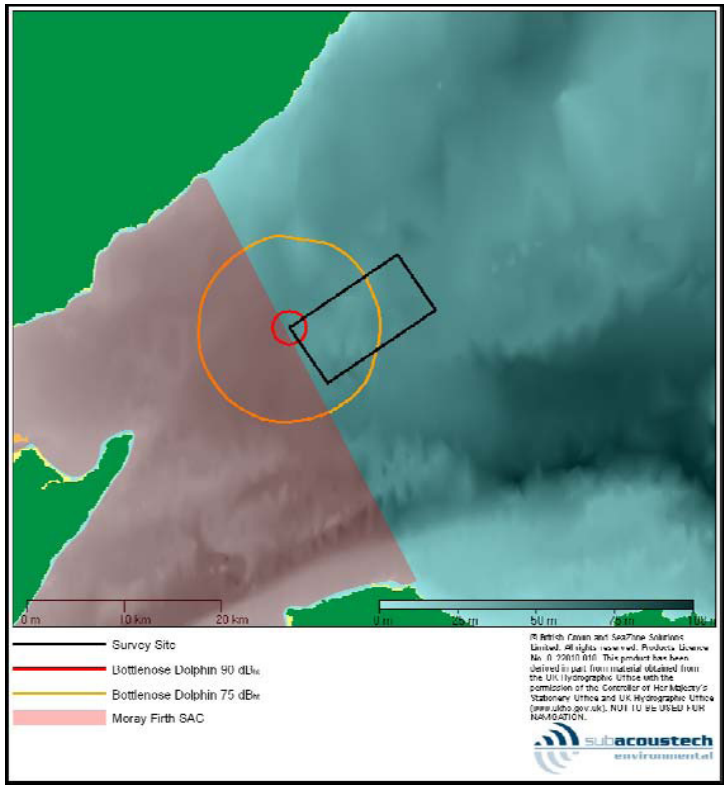

Figure 14: Zones of potential disturbance from Block 17/4B surveys at different criteria thresholds for bottlenose dolphin based on modelling commissioned by PA Resources.

8.15 Caithness Petroleum have indicated that they plan to drill an appraisal well in Block 11/24. The appraisal well is provisionally planned for July 2011 and would take approximately 90 days to complete. It is anticipated that a jack-up rig similar to the Ensco 92 will be used for the drilling operation. Jack-up drilling rigs generate typical noise levels of around 140 dB (Richardson *et al.* 1995) and assuming a spherical propagation of noise from the source, it can be seen from Figure 4 that background noise levels will be reached within a kilometre of the source. It is likely that the proposed drilling operations may coincide with the timings of the seismic survey operations. The proposed exploration well is 5 km from nearest seismic survey location (Burrigill & Forse). Based on a bottlenose dolphin density of 0.01 per square kilometre and assessing this against the predicted area of strong avoidance described in the modelling undertaken by BMT and Subacoustech it is predicted that less than one bottlenose dolphin may be impacted at any one time. This figure will still be less than one if the density of 0.02 per

square kilometre is applied and it is unlikely that it will cause an in-combination effect. Based on the above it is concluded that the drilling programme will not have any adverse affect on the qualifying interest or species relating to the European site, either alone or in combination with the PA Resources or Caithness Petroleum seismic surveys.

8.16 A cable route geophysical survey is likely to be undertaken during spring 2011 in the Moray Firth (MORL & BOWL) R3 zone in the outer Moray Firth (Figure 3). The survey will not be undertaken at the same time as the proposed Caithness Petroleum or PA Resources seismic and site surveys; consequently, there will be no overlap in operational activities. The source level sound is reported to be 160 dB and although the exact nature of the sound is unknown this source level is substantially lower than the proposed Caithness Petroleum and PA Resource surveys and consequently, the zone of potential effect would be less than the zone of potential effect of those seismic and site surveys. A similar geophysical survey in the outer Moray Firth has been approved by the relevant authority during 2010, and DECC is not aware of any requirement for an Appropriate Assessment to be undertaken for that operation. Based on the above, it is concluded that the geophysical survey programme will not have any adverse affect on the qualifying interest or species relating to a European site, either alone or in combination with the Caithness Petroleum or PA Resources surveys.

8.17 In addition MORL have indicated that the installation of a Met Mast is likely to go ahead during Q3/Q4 2011 in the Moray Firth (MORL & BOWL) R3 zone. The piling operation to secure the Met Mast is expected to take between 3-7 days. Since the exact nature of the source level sound is unknown, a typical source level sound of 192 dB re.1µPa @ 1m from pile driving operations for monopile has been assumed. This source level sound is lower than that proposed in PA Resources and Caithness Petroleum surveys and consequently the zone of potential effect would be less than the zone of potential effect of those seismic surveys. Genesis Oil & Gas Consultants Ltd have undertaken predictive modelling of sound pressure levels for the installation of a Met Mast. The report is included at Appendix 1. The report indicates that any impacts from piling operations will be limited to 20km. However, the piling operations and the seismic survey are unlikely to take place at the same time due to the potential for interference with seismic signals compromising the survey effort and MORL have consulted with Caithness Petroleum and PA Resources Ltd and agreed that piling will not take place at the same time as seismic activity. Consequently, there will be no overlap in operational activities. Based on the above it is concluded that the piling operations will not have any adverse affect on the qualifying interest or species relating to the European site, either alone or in combination with the Caithness Petroleum or PA Resources surveys.

Potential adverse effects on bottlenose dolphins

8.18 **Physical Impact** – Evidence from three different sound modelling studies indicates that permanent injury to hearing is extremely unlikely and temporary auditory impacts would only be likely to occur if a bottlenose dolphin is within 55 metres or less of the airgun (Table 4). Assessment of the available data on the distribution of bottlenose dolphins within the Moray

Firth suggests that they are unlikely to frequent the proposed seismic survey areas and therefore suggest that .significant numbers of bottlenose dolphin will not occur within the vicinity of the survey areas during the proposed activities. However, in order to ensure that there are no marine mammals within the range that could result in auditory physical impact, all proposed surveys would be required to follow the JNCC's Guidelines for Minimising the Risk of Injury and Disturbance to Marine Mammals from Seismic Surveys (Appendix 3). The guidelines require that visual and/or passive acoustic monitoring must be undertaken prior to the airgun firing to determine if marine mammals are in the vicinity, and also require that a soft start is undertaken (which requires the volume of airguns to be increased slowly at the start of any survey) to allow any marine mammals in the vicinity to swim away (JNCC 2010).

8.19 **Physical Impact** – *in-combination.* It is concluded that the risk of physical impacts from in-combination effects relating to the proposed seismic survey in Block 17/4b and surrounding Blocks will be no greater than the risk relating to the individual surveys, and insignificant if there is strict adherence to the JNCC guidelines (Appendix 3). All the proposed seismic surveys will be using the same sound source and produce the same sound levels, and consequently the level of effect would be similar and the sound source for the Burrigill site survey (160 dB0) will be less than the seismic survey sound source. The proposed surveys will be undertaken sequentially and therefore, apart from an increase in the duration of any disturbance (see below), there will be no in-combination effects. Though the drilling of the proposed appraisal well may coincide with the seismic surveys, the impact area due to the drilling operations is likely to be restricted to 1 km from the well location and unlikely to have adverse in-combination effects. There is also no potential for an adverse in-combination effect resulting from the likely Moray Firth (MORL & BOWL) R3 zone cable route geophysical survey and the piling operations related to Met Mast installation as there will be no overlap with the seismic survey activities. Consequently, there will be no adverse effects arising from potential in-combination physical impacts and disturbance is the only significant effect that could be expected.

8.20 **Displacement and Disturbance** – The proposed surveys are not the first surveys to be undertaken in the Moray Firth. Historically there have been extensive seismic surveys undertaken in the area (Figure 2). The area of potential displacement and disturbance has been modelled using two different approaches. The results of the modelling suggest that, based on an average density rate of between 0.01 and 0.02 animals per square kilometre (as supported by the observed distribution data), a maximum of between ten and twenty bottlenose dolphins may be displaced at any one time (see Table 6). For those individuals that may be disturbed, there is no data to suggest that the zone of displacement would be outwith the preferred areas of the Moray Firth, or that due to the level and duration of possible impact that the displaced individuals would die or be otherwise adversely impacted.

8.21 It is concluded that, based on the best scientific knowledge available and because there have been no observed cumulative effects from previous seismic surveys, any disturbance or displacement will not affect the long-term distribution and abundance of the bottlenose dolphin population nor will it affect the integrity of the site. There will be no significant disturbance of

the species and there is a sufficiently large habitat to maintain the population on a long-term basis.

8.22 **Displacement and disturbance -** *In-combination*. Using a density of 0.01 – 0.02 per square kilometre it can be predicted that approximately five to ten bottlenose dolphins could be disturbed and displaced at any one time from the proposed PA Resources seismic survey. If all the proposed surveys proceed, there is a potential maximum of 29 days when airguns will be in operation, but the surveys will be undertaken sequentially in different areas across the Moray Firth, and none will be undertaken in the areas where there is relatively high bottlenose dolphin density (Figure 8 & Figure 11). Therefore, any disturbance and potential displacement will only affect localised areas where there are very low densities of animals and for relatively short periods of time and any displaced dolphins would be able to return to the area once each survey is completed. Although the drilling of the proposed appraisal well may coincide with the seismic surveys, the disturbance and potential displacement of bottlenose dolphins is likely to be very limited. Using a density of 0.01 – 0.02 per square kilometre it is predicted that less than one bottlenose dolphin may be displaced at any one time due to the drilling operation and is unlikely to have adverse in-combination effects. The Moray Firth (MORL & BOWL) R3 zone cable route geophysical survey likely to be undertaken during spring 2011 in the outer Moray Firth will not be carried out at the same time as the proposed seismic surveys. It is therefore considered that there is no potential for in-combination effect relating to that geophysical survey, which will not occur at the same time as the proposed seismic surveys. Though the installation of the Met Mast is planned for during Q3/Q4, MORL have confirmed that the piling operations to install the Met Mast is unlikely to be carried out at the same time. The piling operations to secure the Met Mast is expected to take between 3-7 days and will not be undertaken in an area where there is relatively high bottlenose dolphin density. Therefore, any disturbance and potential displacement will only affect localised areas where there are very low densities of animals and for relatively short periods of time and any displaced dolphins would be able to return to the area once each survey is completed. It is therefore considered that there is no potential for a in-combination effect relating to piling operations to install the Met Mast, as this will not occur at the same time as the proposed seismic surveys..

8.23 It is concluded based on the best scientific knowledge available that any cumulative disturbance or displacement will not affect the long-term distribution and abundance of the bottlenose dolphin population nor will it affect the integrity of the site. There will be no significant disturbance of the species and there is a sufficiently large habitat to maintain the population for the short duration that the proposed surveys will be undertaken.

8.24 **Displacement of prey species** – There is a potential for an adverse affect on bottlenose dolphin due to the displacement of prey. However, available data from previous studies suggest that impacts on fish vary, with some species being displaced and others not, and that, once the sound source causing the displacement ceases, fish quickly return to the area (Wardle *et al.* 2001). The longest proposed survey is four days and if all the proposed surveys proceed there is a potential maximum of 29 days when airguns may be in operation. Should any

displacement occur, it would therefore be for a relatively short period of time, with fish returning to the area once the seismic activity is completed (it would also be likely to coincide with any displacement of the bottlenose dolphin).

8.25 **Mitigation measures** – Adherence to the JNCC Guidelines for Minimising the Risk of Injury and Disturbance to Marine Mammals from Seismic Surveys will be a condition of any potential consent (https://www.og.decc.gov.uk/environment/jncc_seismic_guide.pdf; Appendix 3). The Guidelines will further reduce the risk of any potential impact on bottlenose dolphins.

Conclusion

8.26 Based on the best scientific knowledge available, it is concluded that the proposed Braemore, Forse, Berriedale and Helmsdale Prospects and Burrigill site seismic survey programme, both alone and in-combination with other surveys, would not have an adverse effect on the integrity of the bottlenose dolphin population or the Moray Firth SAC.

9 HARBOUR SEAL – Assessment of effects resulting from the proposed project, alone and in-combination with other projects

9.1 Harbour seal is a qualifying species for Dornoch Firth and Morrich More SAC.

9.2 Potential impacts alone and in-combination, on harbour seals from seismic exploration are:

- Physical impacts on harbour seals due to sound levels from seismic airguns;
- Displacement effects at haul-out sites or foraging areas due to sound levels from seismic airguns;
- Displacement effects due to potential impacts from seismic airguns on prey species.

9.3 The harbour seal is one of only two seal species that occur regularly within UK waters. In 2009 the total population of harbour seals in the UK was estimated to be approximately 24,250 individuals, of which 20,000 occurred in Scotland. The Moray Firth population is estimated to be between 1,050 and 1,230 individuals, with a peak count within the Dornoch Firth and Morrich More SAC (since 2005) of 264 individuals during the month of August (SCOS 2009).

9.4 There has been a widespread decline in the UK harbour seal population over the last ten years, with a 20% decrease in the Scottish population and a corresponding decrease in the Moray Firth population (Figure 15).

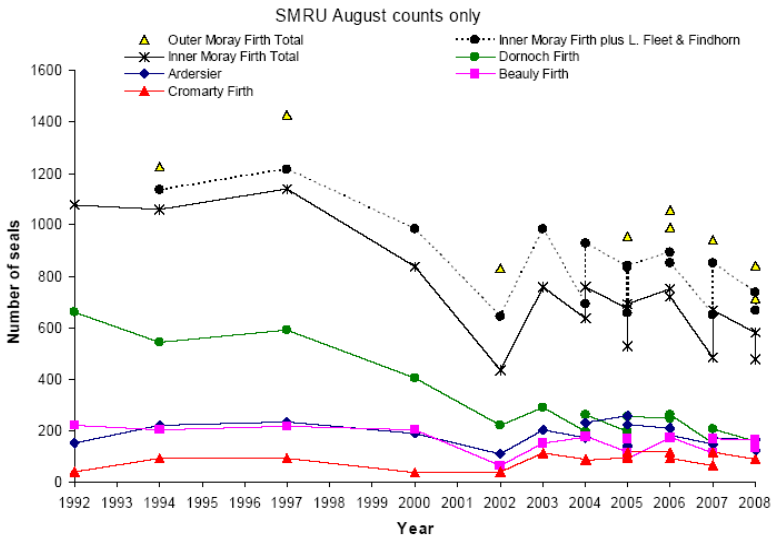

Figure 15. August counts of harbour seal in the Moray Firth since 1992.

9.5 Harbour seals pup during June and July and the females move with their pups into the water prior to the first high tide. The need for pups to rest appears to restrict nursing seals to nearshore waters, with female seals restricting their range markedly during the early (and most intense) part of lactation, with their range restricted to waters within a few kilometres of the shore (Bekkby & Bjorge 2001, Thompson 1990). The lactation period in a harbour seal lasts approximately 25 days, so weaning is normally complete by late July. After weaning, pups may

not be able to catch enough prey to balance their energy consumption for several weeks and may rely on body fat reserves (Muelbert & Bowen 1993). As pups mature, they haul-out less frequently as their endurance and thus their potential range increases. By September most pups will have matured and be hauling-out less frequently than during the previous two months, but may still be within the vicinity of their haul-out sites.

9.6 Peak counts occur at haul-out sites during August, when the seals moult, with adults generally being faithful to specific haul-out sites.

9.7 Harbour seals occur widely within the Moray Firth. Foraging ranges vary between individuals and there are known to be seasonal variations, with more frequent and relatively longer foraging trips away from the haul-out sites during the summer than during the winter months, when harbour seals may remain closer to the inner Moray Firth area (Thompson *et al.* 1991). Data on the distribution of tagged females during June and July show seals foraging widely within the inner Moray Firth (Parijs *et al.* 1997) (Figure 16). The period when the proposed seismic surveys may be taking place could be during the moulting season and seals may spend more time on land. Shortly after the moulting season the seals may be foraging relatively widely and spending less time on land.

9.8 The use of haul-out sites varies during the year, with peak usage from June through to August, during pupping, lactation and, in particular during the moult. Post-moult, the usage of haul out sites decreases, with much lower numbers during the winter. Daily variations in the use of haul-out sites also occur, with greatest numbers ashore two hours of either side of low tide, and there are also decreases in usage during periods of heavy rain (Duck 2003).

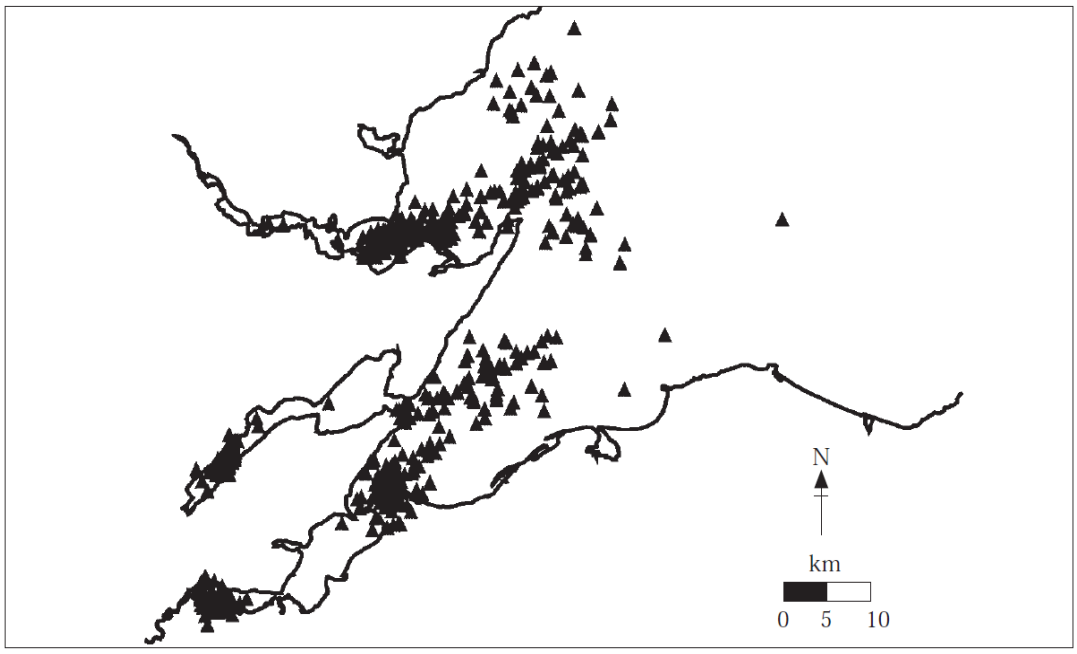

Figure 16: Daily locations of fourteen adult female harbour seals in the inner Moray Firth during June and July of 1988 – 1994

9.9 The Dornoch Firth and Morrich More SAC is 13 km from the closest survey area, the Helmsdale Prospect, but it is likely that foraging harbour seals from the SAC will occur within the proposed survey area. In addition, there are other haul-out sites outwith the SAC which are closer to some of the proposed survey areas that may be used by harbour seals associated with the SAC. The closest site is approximately 400 metres from the nearest point of the two day survey at the Braemore Prospect.

Evidence of possible effects on harbour seals

9.10 **Physical damage** – Experiments on pinnipeds to determine the onset of temporary threshold shift indicate that, for harbour seals, this occurs at SEL 184 dB.re: 1 µ Pa^2-s (Koschinski *et al.* 2003). Southall *et al.* (2007) suggest that injury to all pinnipeds may occur from multiple pulse sources at sound exposure levels of 186 dB.re: 1 µ Pa^2-s (M_{pw}), but that this was considered to be a precautionary figure.

9.11 **Displacement and Disturbance** – Displacement and disturbance may occur at greater distances and at lower sound thresholds than those that can potentially cause physical damage. Data from ringed seals obtained during seismic surveys suggest that there may be some avoidance during periods when airguns are operating, with seals recorded at 210 metres from the sound source compared to 150 metres when the airguns were not operating (Harris *et al.* 2001). Studies on harbour seals during pile driving activities at two sites in Denmark have shown some evidence of displacement, but with no overall change in abundance during construction (Teilmann *et al.* 2006).

9.12 The applicant has undertaken an assessment based on the perceived sound levels detected by harbour seals from sound emitted by a seismic survey (Figure 17). The sound modelling is based on a peak sound level of 228dB re.1 µPa @ 1m at 100Hz. The results indicate that the proposed activity will not cause a temporary threshold shift but may cause strong avoidance behaviour at a distance of up to 10 metres from the sound source (Table 3). Variation in perceived sound level is presented in Figure 17.

9.13 Additional modelling undertaken by Subacoustech for PA Resources suggests a potential behavioural avoidance by harbour seals from between 0.9 km to 5.1 km depending on the hearing threshold used. Estimated zones of disturbance are presented in Figure 18.

9.14 Modelling undertaken by Kongsberg suggests that if there is no avoidance behaviour there is the potential for auditory impact (temporary threshold shift) at a distance of up to 200 metres (Table 5).

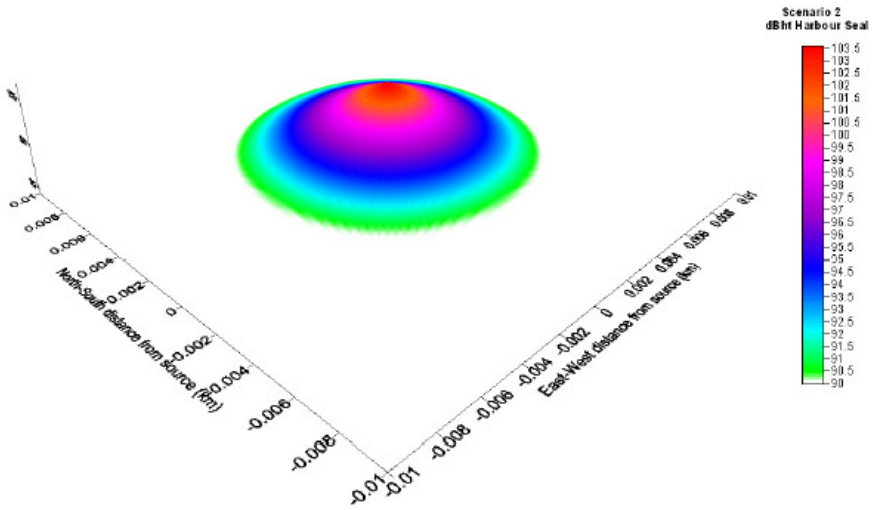

Figure 17: Variation in perceived sound level with distance from source for harbour seal

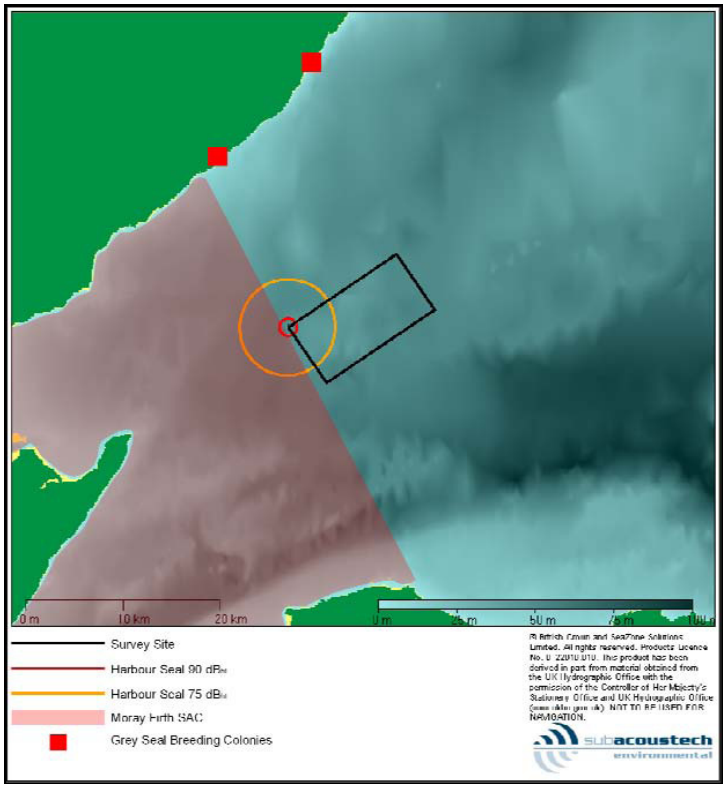

Figure 18. Disturbance area for harbour seals for proposed seismic survey in Block 17/4b

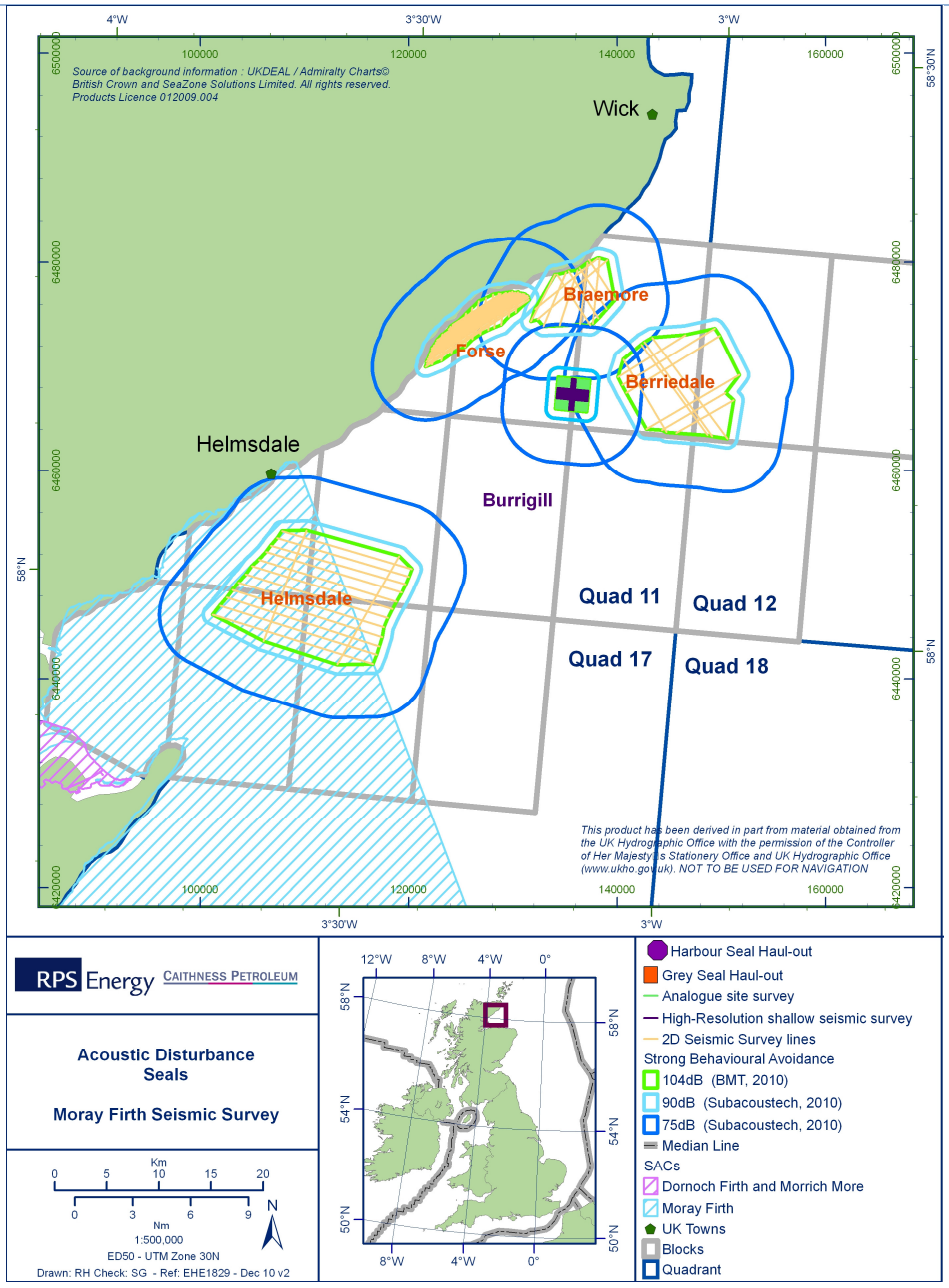

Figure 19: Estimated zones within which harbour seal may exhibit behavioural responses during the proposed Caithness seismic survey programme

9.15 **Sensitivity of key prey species to seismic sound –** Harbour seals take a wide variety of prey, particularly sandeels but also flatfish, Gadoids, Salmonids and Clupeids. Harbour seal diet varies seasonally and from region to region, but within the Moray Firth sandeels are the main prey item during the summer months with Clupeids being more important during the winter (SCOS 2008; Sharples & Hammond 2007; Thompson *et al.* 1991). Impacts on fish from seismic surveys are variable with available information indicating that fish, such as herring, swim away from a seismic source for the duration of the survey (Slotte *et al.* 2004). Other studies have identified little or no impact on fish from seismic sound sources of up to 206 dB re 1µPa (Wardle *et al.* 2001), whilst others have shown some physical impact (Lovell 2008). Studies on sandeels suggest that they are not physically impacted by seismic surveys but may

show startle responses and potentially some displacement from the vicinity of the surveys (Hassel *et al*. 2004).

9.16 **In-combination** – There is a proposal to undertake a seismic survey within Block 17/4b and adjacent blocks in the Moray Firth (Figure 3). The proposed seismic survey will use the same equipment and vessel, and will be undertaken sequentially with the Caithness surveys. None of the proposed surveys will overlap and there will therefore be no in-combination impacts, apart from the overall duration of the proposed surveys and consequently the potential length of any displacement. Caithness Petroleum have indicated that they plan to drill an appraisal well in Block 11/24. The well is provisionally planned for July 2011 and would take approximately 90 days to complete. This coincides with the pupping and moulting season when seals may spend more time on land. Shortly after the moulting season the seals may be foraging relatively widely and spending less time on land. In addition, there is a Moray Firth (MORL & BOWL) R3 zone cable route geophysical survey likely to be undertaken during spring 2011 and a proposed piling operations to install the Met Mast during Q3/Q4 in the outer Moray Firth, in an area where there are likely to be relatively few harbour seals as most will be nearshore during pupping and moulting. The R3 zone geophysical survey and the piling operations will not overlap with the proposed seismic surveys.

Potential adverse effects on harbour seals

9.17 **Physical Impact** – The Dornoch Firth and Morrich More SAC is 13 km away from the closest proposed seismic survey. The distribution of harbour seals within the Moray Firth suggests that harbour seals from the SAC may occur within the proposed survey areas; consequently, there is a potential for physical impact on harbour seals from the SAC resulting from the seismic surveys. Results from three separate sound modelling studies indicate that, should there be no avoidance behaviour, the worst-case assessment is that there could be the potential for a temporary auditory impact of up to 200 metres away, but permanent effects would only occur with a range of 11 metres (Table 4). The results of all the models suggest that there will not be any physical impact on harbour seals present within the Dornoch Firth and Morrich More SAC and that disturbance is the only potential significant effect.

9.18 In order to ensure that there are no marine mammals within range of a potential zone of auditory impact, all proposed surveys would be required to follow the JNCC's Guidelines for Minimising the Risk of Injury and Disturbance to Marine Mammals from Seismic Surveys (Appendix 3). The guidelines require that visual monitoring must be undertaken prior to the airgun firing to determine if marine mammals are in the vicinity and also a soft start which requires the volume of airguns to be increased slowly at the start of any survey to allow any marine mammals in the vicinity to swim away. Specific requirements relating to that guidance are provided by the relevant Statutory Nature Conservation Bodies and included in any consents issued for seismic surveys.

9.19 **Displacement and Disturbance** – It is recognised that there is the potential for mid-frequency sound at 1 KHz to be audible to harbour seals up to 20 km away. However, the most precautionary results from the modelling indicate that the potential for disturbance may extend up to 5,100 metres from the airguns (Table 3). The Dornoch Firth and Morrich More SAC is 13 km from the proposed survey activities and although there is a theoretical possibility that the mid-frequency sound would be audible to seals within the SAC, it is sufficiently far away and of such relatively short duration that there would be no adverse disturbance of harbour seals within the SAC (Figure 19). Harbour seals associated with the SAC will occur in the wider area and may therefore be displaced from around the area of the proposed seismic survey. Each of the proposed seismic surveys is of short duration, with the longest being up to four days. Consequently, any displacement or disturbance that may occur will be outwith the SAC and for a relatively short duration. There is no data to suggest that any displaced seals will not be able to forage elsewhere within the Moray Firth and there is no data to suggest that any displaced seals would not survive or be otherwise adversely affected.

9.20 In-combination effects causing potential displacement may arise from the proposal to undertake a seismic survey activity within Block 17/4b and adjacent blocks (Figure 18). The proposed survey area partially overlaps the Helmsdale survey area, but will be undertaken sequentially with the other proposed surveys.

9.21 The total duration of all proposed surveys is a maximum of 29 days, but a shorter period is likely (Table 1). As the surveys will be undertaken sequentially, there will be no in-combination sound impacts apart from the overall duration of the proposed surveys and consequently the potential length of any displacement. Given the highly mobile nature of marine mammals and the wide distribution of potential prey, it is concluded that any displaced seals would not encounter difficulties in finding alternative prey sources; particularly given the predicted relatively minor spatial impact and the duration of the surveys. Although the drilling of the proposed appraisal well may coincide with the seismic surveys, the disturbance and potential displacement of harbour seals is likely to be very limited as the majority of the period coincides with the pupping and moulting season when seals are at the haul out areas, therefore, any displacement due to the drilling operations is likely to be limited, and it is concluded that any displaced seals would not encounter difficulties in finding alternative prey sources. The Moray Firth (MORL & BOWL) R3 zone cable route geophysical survey likely to be undertaken during spring 2011 and the piling operation to install the Met Mast during Q3/Q4 in the outer Moray Firth will be outwith the main areas of usage by harbour seal. The zone of potential displacement will also be smaller than that of the proposed seismic surveys, and there will be no overlap with those surveys. Consequently, there will be no in-combination impacts arising from the proposed drilling, geophysical survey and piling operations.

9.22 **Displacement of prey species** – There is a potential for an adverse effect on harbour seal due to the displacement of prey. However, available information from previous studies suggest that impacts on fish vary with some species being displaced and others not. Sandeels are the main prey for harbour seal in the Moray Firth and studies indicate that, although they are not

physically impacted by seismic surveys there may be some displacement (Hassel *et al*. 2004). However, should any displacement occur it will be for a relatively short period of time and fish will return to the area once the seismic survey is completed.

9.23 The potential in-combination effects on harbour seal prey species are that fish could be displaced from a relatively localised area, or areas, for up to a maximum 29 days (Table 1). The majority of studies concerning the effects of seismic surveys on fish have found only localised impacts, with fish behaviour returning to pre-survey levels within five days of survey completion. The likely consequences of the proposed surveys are that harbour seal will potentially have to forage outwith the area or areas of displacement for relatively short periods.

9.24 **Mitigation measures** – Adherence to the JNCC Guidelines for Minimising the Risk of Injury and Disturbance to Marine Mammals from Seismic Surveys will be a condition of any potential consent (https://www.og.decc.gov.uk/environment/jncc_seismic_guide.pdf; Appendix 3). The Guidelines will further reduce the risk of any potential impact on harbour seal.

Conclusion

9.25 Taking into account the temporal and spatial extent of the proposed surveys, the predicted levels of sound and the results of the sound propagation modelling, it is concluded that the proposed Braemore, Forse, Berriedale, Burrigill and Helmsdale seismic survey programme, both alone and in-combination with other proposed surveys, will not cause an adverse effect on the integrity of the harbour seal population within the Dornoch Firth and Morrich More SAC.

10 CONCLUSION IN RELATION TO EFFECTS ON THE INTEGRITY OF EUROPEAN SITES

10.1 Based on the information summarised in this report, it is possible to draw conclusions with respect to the assessment of the effects of the proposed seismic surveys alone, and in-combination with other plans and projects.

Bottlenose dolphins – The Moray Firth SAC

10.2 It is not considered that the proposed seismic surveys will have an adverse effect on the integrity of the population of bottlenose dolphin in the Moray Firth SAC or the wider area for the following reasons:

- The locations of the proposed surveys, alone and in-combination, are outwith the main areas used by bottlenose dolphins in the Moray Firth and the number of bottlenose dolphins likely to be present are low. Consequently, the number of bottlenose dolphins that may be affected is also low.
- The attenuation of sound arising from the proposed seismic survey will be such that the zone of any potential permanent threshold shift will be less than five metres from the airgun. The zone of potential temporary threshold shift will be within 20 metres of the source. Therefore, for any physical impact to occur the bottlenose dolphin must be in very close proximity to the survey vessel/sound source.
- Displacement of bottlenose dolphins and/or their prey may, as a worst case, occur out to a range of 11km from the source. Each survey is planned to take only two to four days and the relatively few recordings of bottlenose dolphin in the survey areas suggest that they are infrequently used by this species. Should any displacement occur for the duration of each survey or for the other proposed surveys there are alternative suitable areas that are used by the bottlenose dolphin. Displaced individuals will not die or be otherwise adversely affected.

10.3 It would be a condition of any consent that the surveys are undertaken in accordance with the JNCC 'Guidelines on Minimising Risk of Injury and Disturbance to Marine Mammals from Seismic Surveys'. Thus the risk of any potential impact on bottlenose dolphins would be further reduced.

Harbour seal – Dornoch Firth and Morrich More SAC

10.4 It is not considered that the proposed seismic surveys will have an adverse effect on the integrity of the population of harbour seal in the Dornoch Firth and Morrich More SAC, for the following reasons:

- The locations of the proposed survey areas are, at their closest point, 13 km from the Dornoch Firth and Morrich More SAC. The attenuation of sound arising from the proposed surveys will be such that the zone of any potential permanent threshold shift will be less than 11 metres from the airgun. The zone of potential temporary threshold shift will be within 200 metres of the source. Available data suggests that seals foraging outwith the SAC will avoid the proposed survey areas during seismic operations.
- Displacement of harbour seals and/or their prey may, as a worst case, occur out to a range of 5.1 km from the source. Therefore, there will be no displacement of harbour seals within the Dornoch Firth and Morrich More SAC, which is 13 km away from the nearest survey area. Each survey is planned to take between two and four days, and any displacement of seals outwith the SAC will therefore be of short duration for each survey, and there are other suitable areas used by the harbour seals. Displaced individuals will not die or be otherwise adversely affected.

10.5 It would be a condition of any consent that the surveys are undertaken in accordance with the JNCC 'Guidelines on Minimising Risk of Injury and Disturbance to Marine Mammals from Seismic Surveys'. Thus the risk of any potential impact on harbour seals would be further reduced.

Summary

10.6 Based on the best scientific knowledge available it is concluded that the proposed Braemore, Forse, Berriedale, Burrigill and Helmsdale Seismic Survey programme will not adversely affect the integrity of the relevant European sites, the Moray Firth SAC and the Dornoch Firth and Morrich More SAC, either alone or in combination with other plans or projects.

10.7 Mitigation measures proposed in the application and consent conditions requiring the implementation of JNCC Guidance would further reduce the risk of any potential adverse effects.

10.8 As this Appropriate Assessment has reached a positive conclusion; there is no requirement to include discussion of potential alternatives to the seismic survey proposals or to consider whether there are Imperative Reasons of Overriding Public Interest that would be relevant to consenting the proposal.

ANNEX 1: SUMMARY OF RESPONSES TO DRAFT APPROPRIATE ASSESSMENT ISSUED FOR COMMENT June 2010

Organisation	Summary of response	Amendments
SNH/JNCC 12 August 2010	Joint response with JNCC. Agree with the conclusions of the Appropriate Assessment with respect to Atlantic Salmon, sea lamprey, freshwater pearl mussel and seabird qualifying interests. Do not feel that the appropriate assessment, as it stands, has made sufficient consideration to ascertain that the proposal will not adversely affect the integrity of the sites. The use of mitigation measures would be the most effective way of minimising the risk of adverse affects on site integrity.	Various amendments made throughout the document
Marine Scotland	No Response	
University of Aberdeen	No Response	
CEFAS	No Response	
WDCS	Substantial number of comments and maintain the view that it has not been demonstrated with the required level of scientific certainty that the plan will not have an adverse effect on the integrity of any European Site or potential European Sites.	Comments noted
Caithness Petroleum	No Response	
Care for the Wild International 11 August 2010	The Appropriate Assessment does not provide sufficient justification for DECC to approve the proposals according to the requirements of Article 6.2 of the EU Habitats Directive.	Comments noted

	Numerous comments made	
Brandon Southall 13 August 2010	Highlighted uncertainly over modelling of disturbance effects but agreed that results consistent with current scientific understanding and best practice. Accepted that duration of surveys may be brief but they do have the potential to displace significant portion of the entire population, which is at quite a low level, over fairly large areas of their identified critical habitat. Advises that mitigation measures limit the potential for direct injury to a very low level at start up but that if animals enter the exclusion zone during operations they could experience TTS/PTS. Therefore the exclusion zone should exist during operations.	Additional information provided on current understanding of distribution to highlight that surveys do not impinge on key areas of critical habitat, and that they do not have the potential to displace a significant portion of the entire population.

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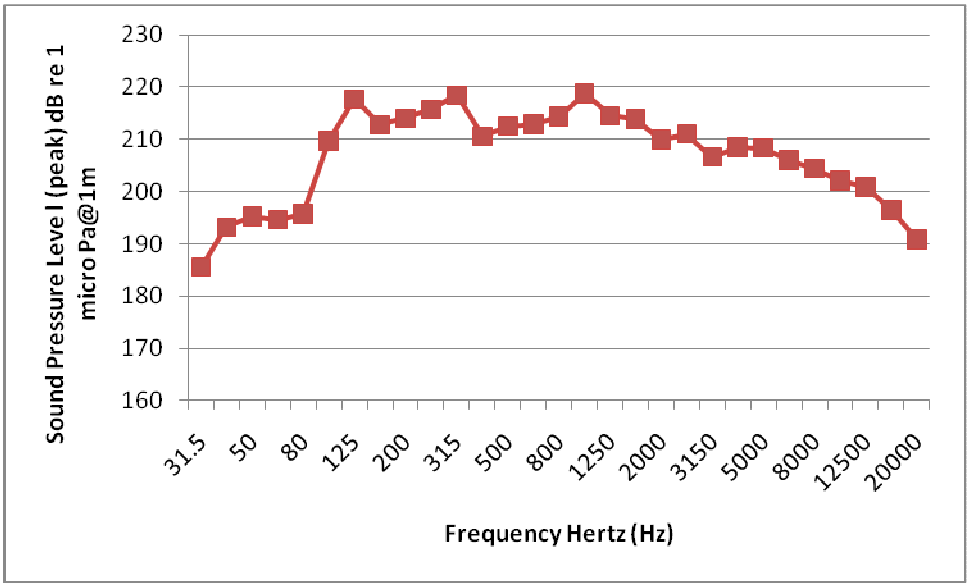
APPENDIX 1

Predicative modelling of sound pressure levels for the installation of a met-mast in the Moray Firth

From the review of suitable source levels and measurements that have been taken on piling, a good surrogate for the smaller diameter piles are sound measurements obtained from the FINO-1 research platform installation. This was a platform which was installed using 1.5 m diameter piles. Unlike many measurements on piling noise this study actually calculated a source level and provided measurements of the frequency spectrum presented as 1/3rd octave levels (See figure 1). From the measurement of the ITAP platform the pile driving was found to generate a broadband peak source level of 228dB (0-peak) re 1µPa @ 1m (ITAP 2005).

Figure 4 Frequency Spectrum (1/3 rd Octave band level) of piling pulses from FINO-1 platform (piles 1.5m)



As can be seen from figure 1 the sound pressure level was highest at the 125Hz centre frequency with additional maxima at 315Hz and 1kHz. It is expected that both MORL piling scenarios would generate comparable frequency spectrums.

These measurements were collected at a distance of 400m but have been back-calculated to calculate the sound pressure level (source level) at a distance of 1 m (using transmission loss calculations).

The frequency output spectrum can be inputted into a modelling programme using the parameters of Smith bank which is a shallow (~20m) sandy sediment environment.

Sound pressure levels in impact pile-driving are dependent on the length and diameter of the pile and the impact energy used to install these. Generally the larger the diameter of the pile, the more force required to install the structure which results in a greater sound pressure level (at source 1m from pile driver). A greater sound pressure level across all frequency bands typically increases the distance that sound can propagate (travel).

The 4.5 m diameter pile which could also be used for the installation of the metmast in a monopole configuration is a comparable size to a windfarm pile. A study measuring 3.5m diameter pile found that the increase in sound level for every 1/3 octave band was in the range of 3-20 dB. If an average of 10 dB is added onto all 1/3rd octave bands frequency bands this can be considered a suitable value to apply for modelling of a larger diameter pile, and should be suitable to cover the size category of pile being considered for the metmast (Thomsen, et al. 2006). It should be appreciated that the metmast pile may produce a sound pressure level in excess of the values below as it is greater than the 3.5m pile which the modelling is based on. There is a discussion further below which highlights some of the uncertainties with the model and choice of source level.

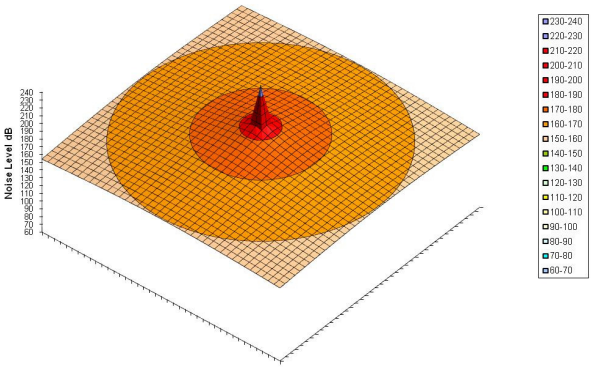
An in-house modelling programme was used to input the 1/3rd octave band levels to calculate a source level for a '3.5m diameter pile' which produced a broadband source level of 236.8 dB (zero-peak) re 1µPa @ 1m.

Other factors which will influence the levels of underwater noise will be related to the choice of pile driver used, the energy of the blow of the driver, seabed type, and whether or not the pile is driven in air or underwater.

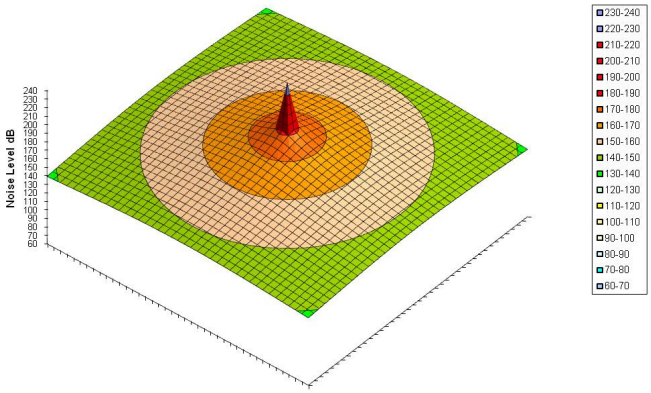
Predictive sound modelling was carried out for a shallow water environment such as the Smith Bank.

Information on the parameters used in the propagation modelling are provided at the end of this document.

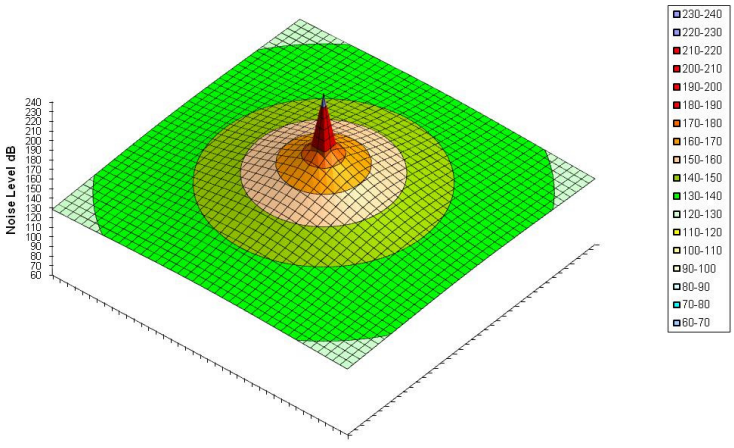
Modelling results Sound Pressure Level at 10km for 1.5m diameter pile



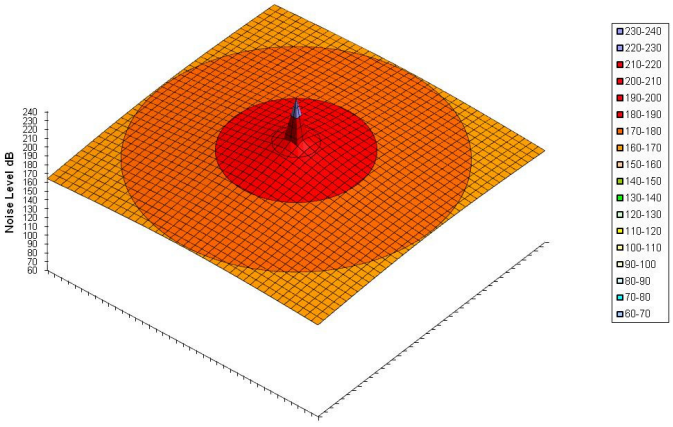
Modelling results Sound Pressure Level at 20km for 1.5m diameter pile



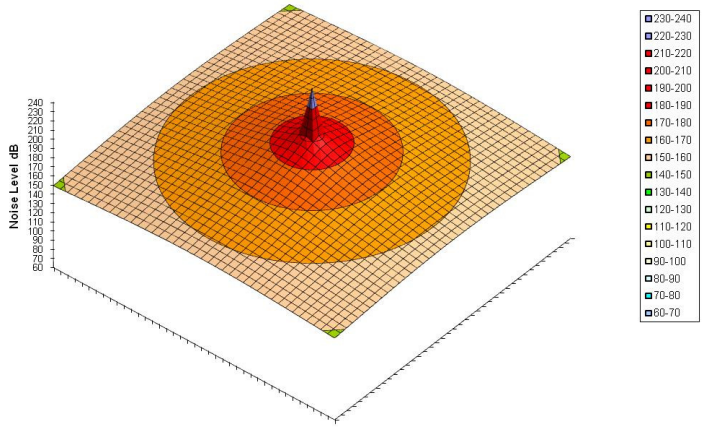
Modelling results Sound Pressure Level at 40km for 1.5m diameter pile



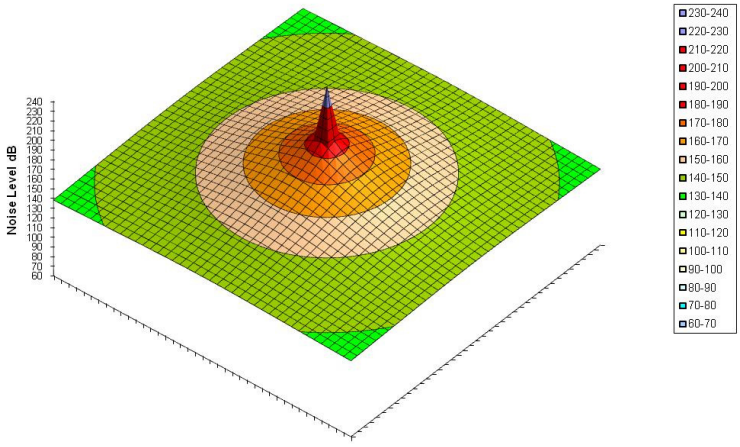
Modelling results Sound Pressure Level at 10km for larger diameter pile ~4.5m



Modelling results Sound Pressure Level at 20km for larger diameter pile ~4.5m



Modelling results Sound Pressure Level at 40km for larger diameter pile ~4.5m



Discussion of modelling results Sound Pressure Level with range

The modelling above is based on no interferences with seabed features such as sandbanks or the coastline, it is of course expected that the topography of the seabed will have an effect on how the sound would propagate.

Larger diameter pile

At very close distances to the pile it is expected that the sound pressure level will be high, but this pressure level is expected to rapidly attenuate with increasing distance from the pile. It is only within the first few metres from the pile that the sound pressure levels are likely to be in excess of 230 dB (zero-peak) (this is currently considered the injury criteria for impulsive sources by Southall et al 2007). Some illustrative sound pressure levels with increasing range are shown below:
1m = 236.8 dB (zero-peak) re 1µPa @ 1m
5m = 229.5 dB (zero-peak) re 1µPa @ 1m
10m = 223.5 (zero-peak) re 1µPa @ 1m
The modelling of sound pressure level for the larger diameter pile suggests that out to a distance of 40km the levels will have fallen to ~140-150 dB, based on no interferences with seabed features such as sandbanks or the coastline. It is, of course, expected that the topography of the seabed will have an effect on how the sound would propagate.

Smaller diameter pile

At very close distances to the pile it is expected that the pressure level will be high, but this high sound pressure level is expected to rapidly attenuate with increasing range from the pile. At a distance of 1m from the pile, the sound pressure level is expected to be approximately 228-230 dB (zero-peak). Some illustrative sound pressure levels with increasing range are shown below.

1m = ~228-230 dB (zero-peak) re 1µPa @ 1m

5m = 220 dB (zero-peak) re 1µPa @ 1m

10m 213 dB (zero-peak) re 1µPa @ 1m

The modelling of sound pressure level for the 1.5m diameter pile suggests that out to a distance of 40km the levels will have fallen to ~130-140 dB.

Frequency spectrum with range

In order to illustrate how the frequency level of sound changes in relation to the distance the sound has travelled, various modelling scenarios with distance were generated, and these frequency specific plots sound pressure levels plots are shown below. This is important when considering how a sound signal (which is made up of difference frequency components) attenuate (decrease in power) with distance travelled. Also included on the plots is a 'typical' ambient noise plot (background levels of sound) for the north sea (discussed in more detail at the end of the report) and also the hearing capabilities of two marine mammals. In the example below two audiograms are provided, one for the common seal and the other from the harbour porpoise. Generally in order for a sound to be audible to a receptor it has to be above its hearing ability (e.g. appear higher on the plot when compared to the audiogram plot for the animal). Therefore, when a sound level falls below either the background noise levels or the hearing threshold level of an animal it can be considered to be inaudible to the animal or indistinguishable from background levels. As piling noise is dominated by the low frequency sounds, which attenuate in power very slowly compared to higher frequencies, it can travel very large distances. It should also be considered that the limited audiogram data which is available for marine mammals does not cover all species and also typically does not have comprehensive data on the lower frequency hearing abilities of marine mammals, but the information that is available can be useful to apply as a reasonable estimate when considering if the sound pressure level at a particular frequency is likely to be audible to an animal.

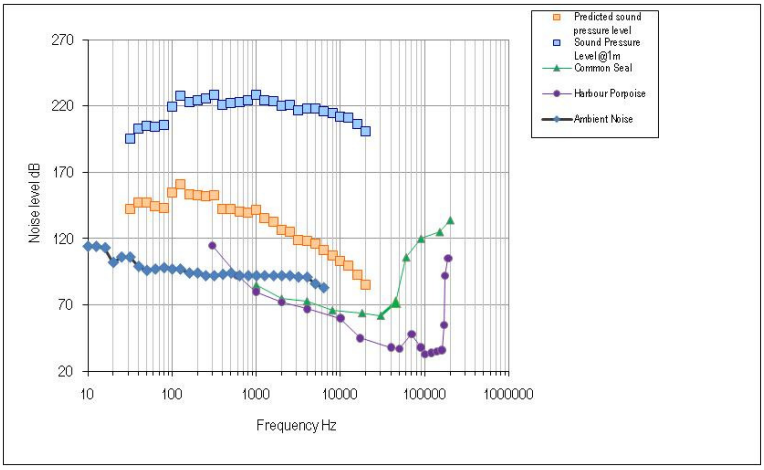
Discussion of the larger diameter piles

From the modelling outputs it suggests that piling noise is likely to be audible to marine mammals (harbour porpoise and seals) beyond at least 20km, and the piling noise, particularly the low frequency components is likely to be detectable above background noise levels in excess of distances of 40km.

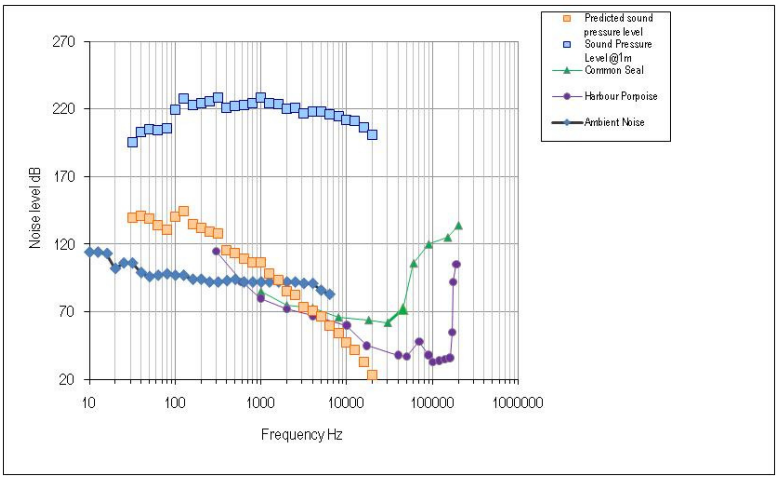
Discussion of the smaller diameter piles

The frequency specific plots from the modelling of the smaller piles, as expected, follow the same pattern as the larger piles. From the modelling outputs it suggests that piling noise for is still likely to be audible to marine mammals (harbour porpoise and seals) beyond at least 20km, and the piling noise, particularly the low frequency components is likely to be detectable above background noise levels in excess of distances of 40km.

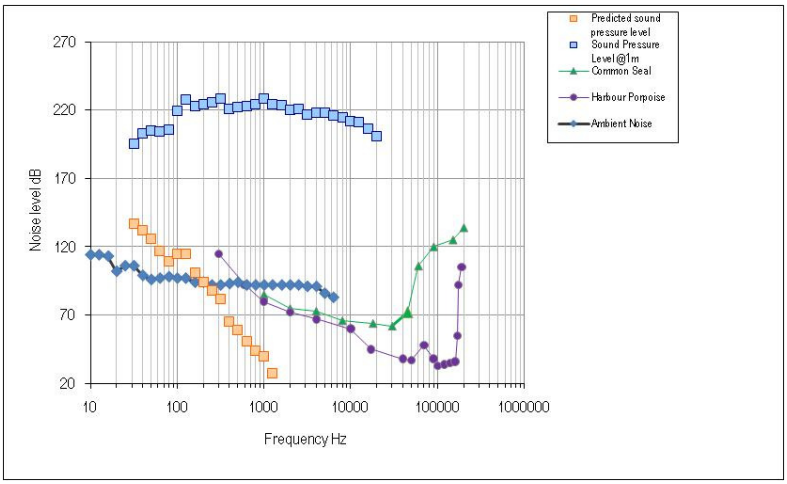
Frequency spectrum with increasing distance from the source at 10km for larger diameter pile



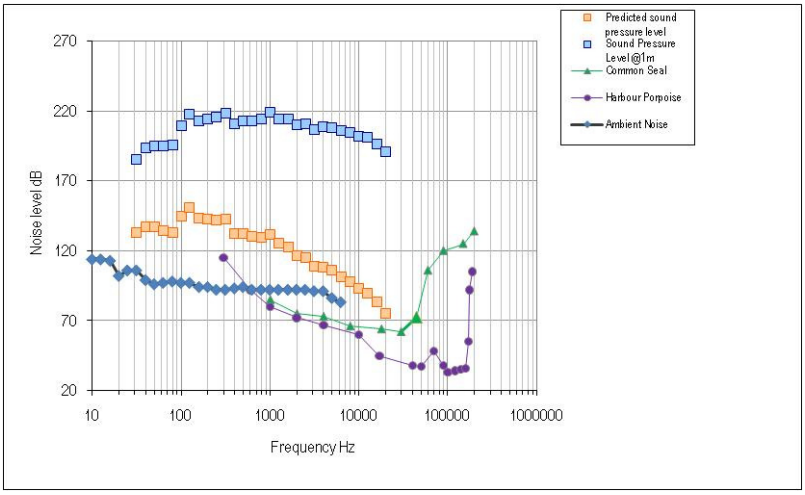
Frequency spectrum with increasing distance from the source at 20km for larger diameter pile



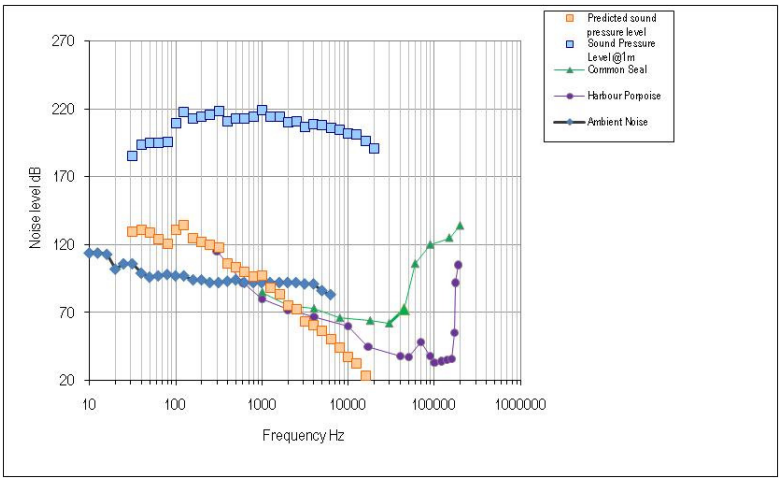
Frequency spectrum with increasing distance from the source at 40km for larger diameter pile



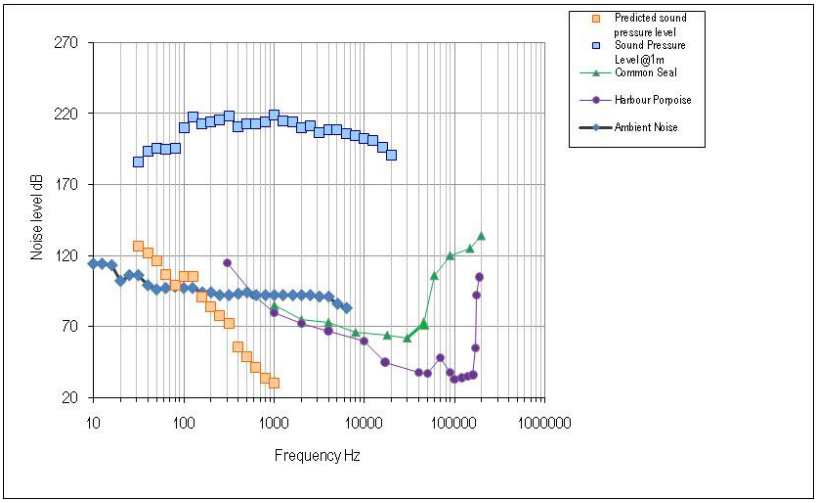
Frequency spectrum with increasing distance from the source at 10km for Smaller diameter piles



Frequency spectrum with increasing distance from the source at 20km for Smaller diameter piles



Frequency spectrum with increasing distance from the source at 40km for Smaller diameter piles



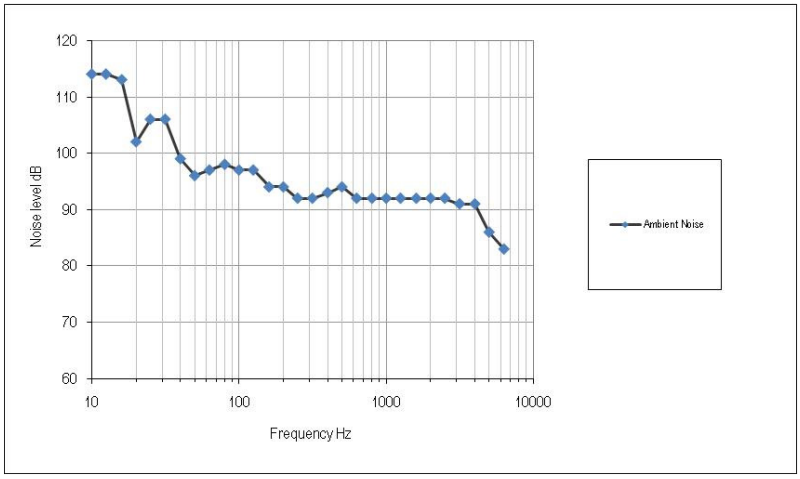
Information on the modelling software used

A calm sea state was used in the modelling. Urick (1983) states that theoretical models have limited application in shallow water, and refers to empirical data by Marsh and Schulkin (1962) that correlate frequency, sea state and noise attenuation. These data are based on approximately 100,000 observations in continental shelf waters and result in a distance attenuation factor based on frequency and sea state plus a 'local anomaly' factor in the form of a constant in the attenuation equation based on the same parameters. For the purposes of the model, the tabulated data is converted into linear form (using power and log regressions) to enable a wider range of frequencies to be calculated. The use of this data is considered to be a more reliable method for shallow coastal waters than a traditional geometric model (Erbe and Farmer 2000). The data applies to frequencies in the range of 100 Hz to 10 kHz, while the model uses third-octaves from 10 Hz to 100 kHz, and the extreme ends of the range are extrapolations. These extrapolated frequency attenuation factors have been checked against other methods to assure their validity (Erbe and Farmer 2000). As the model was developed to take into account variations in the sound speed profile with depth it is able to provide an indication of received sound levels with varying depth, thus the modelling used has been run for a sandy sediment environment and the depth chosen for a mid-water level of 30 m.

Ambient Noise Level Used

The ambient or background noise level is an important component to consider when undertaking noise modelling. The ocean is not a quiet environment, and the ambient noise levels are influenced by physical factors such as the sounds generated by the actions of the wind and the waves, and also to a much lesser degree by biologically produced sounds, for example marine mammal vocalisations. Anthropogenic activities, principally shipping, is a key contributor to ambient noise levels in certain areas.
Although there have been a number of studies that have collected measurements on ambient noise levels in the Moray Firth, the raw data was not available in any useable format to use in this modelling. However, there are a number of studies that have collected ambient noise measurements in the North Sea. Therefore, for the purposes of this assessment, ambient noise levels measured at 5 different locations in the North Sea at wind speeds of 3-8 ms have been considered and the third octave band measurements for ambient noise applied in this study are shown below.

Ambient noise measurements measured in 5 different locations in the North Sea at wind speed of 3-8 ms (Reproduced from DEWI 2004)



References:

DEWI. *Standardverfahren zur Ermittlung und Bewertung der Belastung der Meeresumwelt durch Schallimmissionen von Offshore-Windenergieanlagen,.* Abschlussbericht zum Forschungsvorhaben 0327528a an das BMU, 123pp: Deutsches Windenergie-Institut (DEWI), 2004.

ITAP. *Standardverfahren zur Ermittlung und Bewertung der Belastung der Meeresumwelt durch die Schallimmission von Offshore-Windenergieanlagen.* Project 0327528A: The German Federal Environmental Ministry & ITAP – Institut für technische und angewandte Physik GmbH, 2004.

Southall, B.L, et al. "Marine mammal noise exposure criteria: Initial scientific recommendations." *Aquatic Mammals 33(4)*, 2007: 411-521.

Thomsen, F, K Lüdemann, R Kafemann, and W. Piper. *Effects of offshore wind farm noise on marine mammals and fish,.* Newbury, UK: Biola, Hamburg, Germany on behalf of COWRIE Ltd, , 2006.

APPENDIX 2

Qualifying Features and Conservation Objectives for sites where potential for adverse effects have been identified.

<table>
<tr><td colspan="2">Site Name: Moray Firth SAC

The Moray Firth was designated as a Special Area of Conservation (SAC) on 17th March 2005.</td></tr>
<tr><td>Location</td><td>Grid Ref: NH976821 (central point)
Latitude 57º49’00”N
Longitude 03º43’36”W</td></tr>
<tr><td>Area (ha)</td><td>151341.67</td></tr>
<tr><td>Summary</td><td>The Moray Firth SAC is one of the largest marine SACs in the UK. The designated site lies west of a line between Helmsdale on the Sutherland coast and Lossiemouth on the Moray coast and includes the Beauly/Inverness Firths, and the outer reaches of the Dornoch and Cromarty Firths. The Moray Firth supports the only known resident population of bottlenose dolphin in the North Sea.</td></tr>
<tr><td colspan="2">Qualifying features for which the site is designated [condition]:</td></tr>
<tr><td colspan="2">Annex 1 Habitat
Primary feature: None

Secondary features: Sandbanks which are slightly covered by sea water all the time [favourable maintained]

Annex 2 Species
Primary features: Bottlenose dolphin Tursiops truncatus [unfavourable recovering]
Secondary features: None</td></tr>
<tr><td colspan="2">Conservation objectives:</td></tr>
<tr><td colspan="2">For Annex I Habitats
To avoid deterioration of the qualifying habitat (listed above) thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interest.

To ensure for the qualifying habitat that the following are maintained in the long term:
• Extent of the habitat on site
• Distribution of the habitat within site
• Structure and function of the habitat
• Processes supporting the habitat
• Distribution of typical species of the habitat
• Viability of typical species as components of the habitat
• No significant disturbance of typical species of the habitat</td></tr>
<tr><td colspan="2">For Annex II Species
To avoid deterioration of the habitats of the qualifying species (listed above) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interest. To ensure for the qualifying species that the following are established then maintained in the long term:
• Population of the species as a viable component of the site
• Distribution of the species within the site
• Distribution and extent of habitats supporting the species
• Structure, function and supporting processes of habitats supporting the species
• No significant disturbance of the species</td></tr>
</table>

Site Name: Dornoch Firth and Morrich More SAC	
Location	Grid Ref: NH788863 (central point) Latitude 57º51'00"N Longitude 04º02'30"W
Area (ha)	8700.53
Summary	The Dornoch Firth is the most northerly complex estuary in the UK. Situated on the Scottish east coast, the estuary contains extensive areas of soft coastal features of international importance including saltmarshes, dunes and mudflats and sandflats. The area supports a good population of otters in what is the only east coast estuarine site selected for the species in Scotland. The estuary is also home to a significant proportion of the inner Moray Firth population of the common seal. Their numbers represent almost 2% of the UK population.

Qualifying features for which the site is designated [condition]:

Annex 1 Habitat
Primary features: Estuaries, mudflats and sandflats not covered by seawaters at low tide, *Salicornia* and other annuals colonising mud and sand [favourable maintained], Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [favourable maintained], embryonic shifting dunes [favourable maintained], shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes') [favourable maintained], fixed dunes with herbaceous vegetation ('grey dunes') (*priority feature*) [unfavourable no change], decalcified fixed dunes with *Empetrum nigrum* (*priority feature*) [unfavourable no change], Atlantic decalcified fixed dunes (*Calluno-Ulicetea*) (*priority feature*), humid dune slacks [favourable maintained], coastal dunes with *Juniperus* spp. (*priority feature*) [unfavourable no change]

Secondary features: Sandbanks which are slightly covered by sea water all the time, reefs

Annex 2 Species
Primary features: Otter *Lutra lutra* [favourable maintained], common seal *Phoca vitulina* [unfavourable recovering]

Secondary features: None

Conservation objectives:

For Annex I Habitats
To avoid deterioration of the qualifying habitats (listed above), thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interest. To ensure for the qualifying habitats that the following are maintained in the long term:

- Extent of the habitats on site
- Distribution of the habitats within site
- Structure and function of the habitats
- Processes supporting the habitats
- Distribution of typical species of the habitats
- Viability of typical species as components of the habitats
- No significant disturbance of typical species of the habitats

For Annex II Species
To avoid deterioration of the habitats of the qualifying species (listed above) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for the qualifying interest. To ensure for the qualifying species that the following are established then maintained in the long term:

- Population of the species as a viable component of the site
- Distribution of the species within the site
- Distribution and extent of habitats supporting the species
- Structure, function and supporting processes of habitats supporting the species
- No significant disturbance of the species

APPENDIX 3

JNCC guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys

August 2010

Introduction

The guidelines have been written for activities on the United Kingdom Continental Shelf (UKCS) and are aimed at reducing the risk of injury to negligible levels and can also potentially reduce the risk of disturbance from seismic surveys to marine mammals including seals, whales, dolphins and porpoises. Whilst there are no objections to these guidelines being used elsewhere JNCC would encourage all operators to determine if any special or local circumstances pertain, as we would not wish these guidelines to be used where a local management tool has already been adopted (for instance in the Gulf of Mexico OCS Region). In this context, JNCC notes that other protected fauna, for example turtles, will occur in waters where these guidelines may be used, and would suggest that, whilst the appropriate mitigation may require further investigation, the soft-start procedures for marine mammals would also be appropriate for marine turtles and basking sharks[i].

The guidelines require the use of trained Marine Mammal Observers (MMOs) whose role is to advise on the use of the guidelines and to conduct pre-shooting searches for marine mammals before commencement of any seismic activity. A further duty is to ensure that the JNCC reporting forms are completed for inclusion in the MMO report. In addition to the visual mitigation provided by MMOs, if seismic surveys are planned to start during hours of darkness or low visibility it is considered best practice to deploy Passive Acoustic Monitoring (PAM).

The 2010 version of the JNCC seismic guidelines reflects amendments (2007 and 2009 amendments) to the Conservation (Natural Habitats &c.) Regulations 1994 (Habitat Regulations, HR) for England and Wales[ii] and the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (Offshore Marine Regulations, OMR**,** as amended in 2009 and 2010). Both regulations have revised the definition of deliberate disturbance of 'European Protected Species' (EPS), which now excludes

[i] Basking sharks are protected from intentional capture or disturbance in British waters (up to 12 miles offshore) under a 1998 listing on the Wildlife and Countryside Act (1981), Schedule 5.

[ii] In 2010 a consolidated version of the regulations came into force: The Conservation of Habitats and Species Regulations 2010.

trivial disturbance from the offence. Both regulations now also include the offence of deliberate injury. European Protected Species include cetaceans and turtles.

It has been recognised that sound generated from seismic sources has the potential to cause injury and possibly also disturbance to marine mammals. Seismic surveys have therefore the potential to cause a deliberate injury offence as defined under regulations 41(1)(a) and 39(1)(a) and a deliberate disturbance offence as in 41(1)(b) and 39(1)(b) of the HR and OMR, respectively. The JNCC seismic guidelines reflect best practice for operators to follow during the planning, operational and reporting stages. **It is considered that compliance with the recommendations in these guidelines will reduce the risk of injury to EPS to negligible levels**.

Please note that the mitigation measures recommended in the existing guidelines are more relevant to the prevention of injury rather than disturbance as defined in regulations 41(2) and 39(1A), of the HR and OMR, respectively. The onus should be on the entity responsible for the activity to assess whether a disturbance offence is likely to occur. Guidance on how to carry out such risk assessment is provided in the JNCC, NE and CCW document 'The protection of marine European Protected Species from injury and disturbance'.

In relation to oil and gas seismic surveys in the UKCS, it is a requirement of the consent issued under regulation 4 of the Petroleum Activities (Conservation of Habitats) Regulations 2001 (& 2007 Amendments) by the Department for Energy Climate Change (DECC), that the JNCC Seismic Guidelines must be followed, and the elements of the guidelines that are relevant to a particular survey are incorporated into the legally-binding condition of consent. It should be noted that it is the responsibility of the company issued consent by DECC[iii], referred to in these guidelines as the 'applicant', to ensure that these guidelines are followed, and it is recommended that a copy of the JNCC guidelines are available onboard all vessels undertaking seismic activities in UK waters. Where relevant, when the survey is completed a MMO report must be submitted to the JNCC.

[iii] Department of Energy and Climate Change was formerly known as Department for Business and Regulatory Reform (BERR)

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Terminology

Marine European Protected Species: These are marine species in Annex IV(a) of the Habitats Directive that occur naturally in the waters of the United Kingdom. These consist of several species of cetaceans (whales, dolphins and porpoises), turtles, and the Atlantic Sturgeon.

Marine Mammal Observer (MMO): Individual responsible for conducting visual watches for marine mammals. For some seismic surveys it may be requested that observers are trained, dedicated and / or experienced. The MMO may also be a PAM operative if trained.

- **Trained MMO**: Has been on a JNCC recognised course
- **Dedicated MMO**: Trained observer whose role on board is to conduct visual watches for marine mammals (although it could double up as a PAM operative)
- **Experienced MMO**: Trained observer with 3 years of field experience observing for marine mammals, and practical experience of implementing the JNCC guidelines
- **PAM Operative**: Person experienced in the use of PAM software and hardware and marine mammal acoustics

Mitigation Zone: The area where a Marine Mammal Observer keeps watch for marine mammals (and delays the start of activity should any marine mammals be detected).

Passive Acoustic Monitoring (PAM): Software system that utilises hydrophones to detect the vocalisations of marine mammals.

Seismic Survey: Any survey that uses airguns, including 2D/3D/4D and OBC (On-Bottom Cabling) surveys and any similar techniques that use airguns. Surveys using multibeam systems and sub-bottom profiling equipment such as boomers, pingers etc are not considered in these guidelines. However, the guidelines can be adapted and applied to the operation of such systems if considered appropriate.

Shot Point Interval (SPI): Interval between firing of the airgun or airguns.

Site Survey: Seismic survey of a limited area proposed for drilling, infrastructure emplacement etc (typically with source size of 180 cubic inches or less).

Soft-Start: Turning on the airguns at low power and gradually and systematically increasing the output until full power is achieved (usually over a period of 20 minutes). The appropriate soft-start method is dependant upon the type of seismic survey and is discussed in section 3.

United Kingdom Waters: Parts of the sea in or adjacent to the United Kingdom from the low water mark up to the limits of the United Kingdom Continental Shelf.

Vertical Seismic Profiling (VSP) or Borehole Seismic: Seismic survey undertaken 'down hole' in connection with well operations (typically with a source size of 500 cubic inches).

Section 1 – Assessing and minimising the risk of injury

1.1 The Planning Stage

When a seismic survey is being planned, the applicant should consider the following recommendations and best practice advice:

- Determine what marine mammal species are likely to be present in the survey area and assess if there are any seasonal considerations that need to be taken into account, for example periods of migration, breeding, calving or pupping. For UKCS activities the 'Atlas of cetacean distribution in north-west European waters' (Reid *et al*. 2003) is a useful starting point.
- Consult the latest relevant regulatory guidance notes; in the UK, DECC issues guidance notes for oil and gas seismic activities.
- As part of the environmental impact assessment, assess the likelihood of injuring or disturbing a European Protected Species. In the UK, it will be necessary to assess the likelihood of committing an offence as defined in the HR and in the OMR.
- Consult the JNCC, NE and CCW guidance on 'The protection of marine European Protected Species from injury and disturbance' to assist in the environmental impact assessment. To obtain a copy of the latest draft version of the guidance please contact JNCC.

The operator should whenever possible implement the following best practice measures:

- If marine mammals are likely to be in the area, only commence seismic activities during the hours of daylight when visual mitigation using Marine Mammal Observers (MMOs) is possible.
- Only commence seismic activities during the hours of darkness, or low visibility, or during periods when the sea state is not conducive to visual mitigation, if a Passive Acoustic Monitoring (PAM) system is in use to detect marine mammals likely to be in the area, noting the limitations of available PAM technology (seismic surveys that commence during periods of darkness, or low visibility, or during periods when the observation conditions are not conducive to visual mitigation, could pose a risk of committing an injury offence).
- Plan surveys so that the timing will reduce the likelihood of encounters with marine mammals. For example, this might be an important consideration in certain areas/times, e.g. during seal pupping periods near Special Areas of Conservation for common seals or grey seals.
- Provide trained MMOs to implement the JNCC guidelines.
- Use the lowest practicable power levels to achieve the geophysical objectives of the survey.
- Seek methods to reduce and/or baffle unnecessary high frequency noise produced by the airguns (this would also be relevant for other acoustic energy sources).

Section 2 - Marine Mammal Observers

2.1. Role of an MMO

The primary role of an MMO is to act as an observer for marine mammals and to recommend a delay in the commencement of seismic activity should any marine mammals be detected. In addition, a MMO should be able to advise the crew on the procedures set out in the JNCC guidelines and to provide advice to ensure that the survey programme is undertaken in accordance with the guidelines. Before the survey commences it is important to attend any pre-mobilisation meetings to discuss the working arrangements that will be in place, and to request a copy of the survey consent issued by DECC (if applicable). An MMO may also work closely with Passive Acoustic Monitoring operatives. As the MMO role in relation to the vessel and survey operations is purely advisory, it is important to be aware of the command hierarchy and communication channels that will be in place, and determine who the main MMO / PAM operative contacts should be.

In a typical vessel based seismic survey, the MMO / PAM operative may pass advice to the party chief and client's representative through the navigators or seismic observers, and it is important to establish what the working arrangements are, as this may vary from one survey to the other. The MMOs should consider themselves as part of the crew and respect the chain of command that is in place.

MMOs should make certain that their efforts are concentrated on the pre-shooting search before the soft-start. These guidelines cannot be interpreted to imply that MMOs should keep a watch during all daylight hours, but JNCC would encourage all MMOs to manage their time to ensure that they are available to carry out a watch to the best of their ability during the crucial time - the 30 minutes before commencement of the firing of the seismic source (or 60 minutes if surveying where deep diving marine mammals are likely to be present). Whilst JNCC appreciates the efforts of MMOs to collect data at other times, this should be managed to ensure that those observations are not detrimental to the ability to undertake a watch prior to a soft-start. Where two MMOs are onboard a seismic vessel, JNCC would encourage collaboration to ensure that cetacean monitoring is always undertaken during all daylight hours.

2.2. Training requirements for MMOs

A prerequisite for an MMO to be classified as a 'trained MMO' is that they must have received formal training on a JNCC recognised course. (Further information on MMO course providers is available at: http://www.jncc.gov.uk/page-4703)

2.3. MMO equipment and reporting forms

MMOs should be equipped with binoculars, a copy of the JNCC guidelines and the 'Marine Mammal Recording Form' which is an Excel spreadsheet and has embedded worksheets named: 'Cover Page', 'Operations', 'Effort' and 'Sightings'. A Word document named 'Deckforms' is also available, and MMOs may prefer to use this when observing before transferring the details to the Excel spreadsheets.

The ability to determine range is a key skill for MMOs to have, and a useful tool to perform this function is a range finding stick.

All MMO forms, including a guide to completing the forms, and instructions on how to make and use a range finding stick are available on the JNCC website.

2.4. Reporting requirements – the MMO report

A report, the 'MMO report', should be sent to the JNCC after the survey has been completed. It is the responsibility of the consent holder to ensure that the MMO report is sent to JNCC. Ideally the MMO report should be sent via e-mail to seismic@jncc.gov.uk, or it can be posted to the address on the front page of these guidelines. Reports should include completed JNCC marine mammal recording forms and contain details of the following:

- The seismic survey reference number provided to the applicant by DECC.
- 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. 1µPa or bar metres) and firing interval (seconds), and / or details of any other acoustic energy used.
- Number and types of vessels involved in the survey.
- A record of all occasions when the airguns were used.
- A record of the watches made for marine mammals, including details of any sightings and the seismic activity during the watches.
- Details of any problems encountered during the seismic survey including instances of non-compliance with the JNCC guidelines.

If there are instances of non-compliance with the JNCC guidelines that constitute a breach of the survey consent conditions, JNCC will copy the report, and their comments on the potential breach to DECC. It is therefore essential that MMO reports are completed as soon as possible after the survey has been completed.

Section 3 – Guidance before and during seismic activity

All observations should be undertaken from the source vessel (where the airguns are being deployed from), unless alternative arrangements have been agreed with DECC. The MMO should be positioned on a high platform with a clear unobstructed view of the horizon, and communication channels between the MMO and the crew should be in place before commencement of the pre-shooting search (this may require portable VHF radios). The MMO should be aware of the timings of the proposed operations, so that there is adequate time to conduct the pre-shooting search. Figure 1 illustrates a typical seismic survey with decision making pathways in the event a marine mammal is detected.

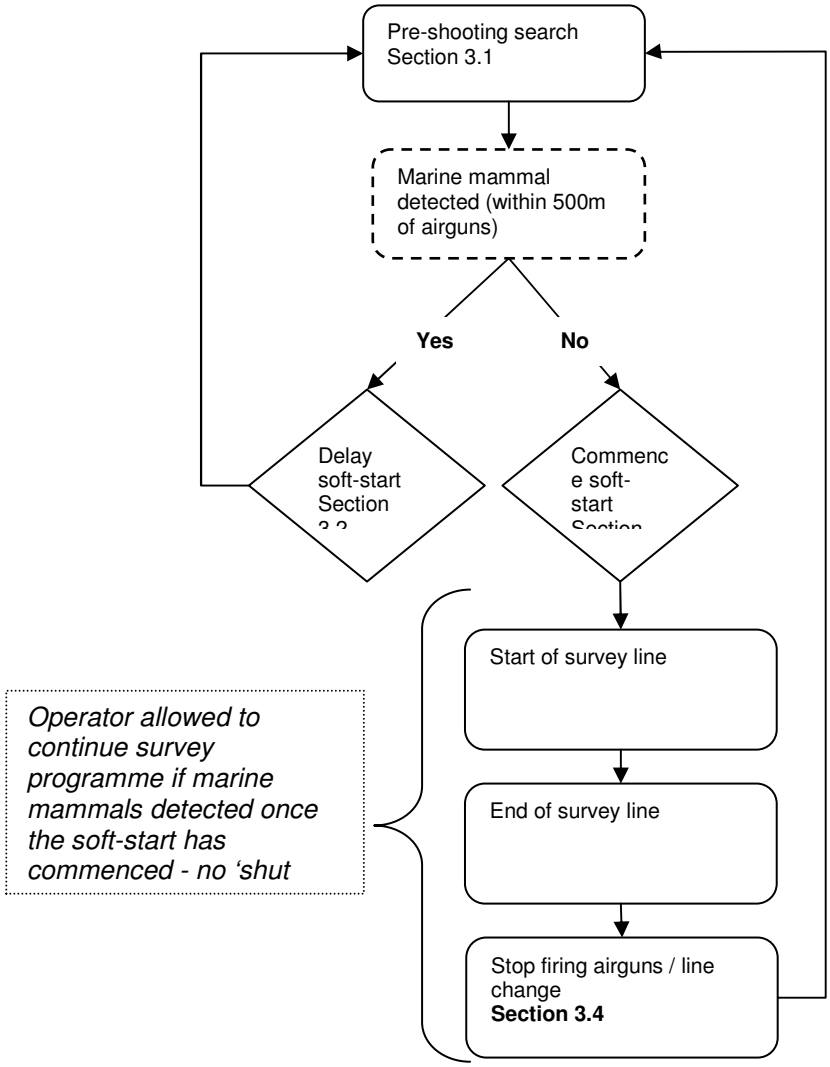

Figure 1. Flowchart illustrating the decision making pathway of a Marine Mammal Observer during a seismic survey.

3.1 Pre-shooting search

The pre-shooting search should normally be conducted over a period of 30 minutes before commencement of any use of the airguns. The MMO should make a visual assessment to determine if any marine mammals are within 500 metres of the centre of the airgun array.

In deep waters (>200m) the pre-shooting search should extend to 60 minutes as deep diving species (e.g. sperm whale and beaked whale) are known to dive for longer than 30 minutes. A longer search time in such areas is likely to lead to a greater detection and tracking of deep diving marine mammals.

To facilitate more effective timing of proposed operations when surveying in deeper waters, the searches for marine mammals can commence before the end of the survey line (whilst the airguns are still firing); this condition may be necessary for surveys which have relatively fast line turn times. If any marine mammals are detected whilst the airguns are still firing, then no action is required other than for the MMO to monitor and track any marine mammals. The commencement of the soft-start for any

subsequent survey lines should be delayed for at least 20 minutes if marine mammals are detected when the airguns have ceased firing.
If PAM is used in conjunction with visual monitoring the PAM operatives should ensure the system is deployed and being monitored for vocalisations during each designated pre-shooting period.

3.2 Delay if marine mammals are detected within the mitigation zone (500 metres)

If marine mammals are detected within 500 metres of the centre of the airgun array during the pre-shooting search, the soft-start of the seismic sources should be delayed until their passage, or the transit of the vessel, results in the marine mammals being more than 500 metres away from the source. In both cases, there should be a 20 minute delay from the time of the last sighting within 500 metres of the source to the commencement of the soft-start, in order to determine whether the animals have left the area. If PAM is used it is the responsibility of the PAM operatives to assess any acoustic detections and determine if there are likely to be marine mammals within 500 metres of the source. If the PAM operatives consider marine mammals are present within that range then the start of the operation should be delayed as outlined above.

If marine mammals are detected within 500 metres of the centre of the airgun array whilst the airguns are firing, either during the soft-start procedure or whilst at full power, there is no requirement to stop firing the airguns.

In situations where seal(s) are congregating around a drilling or production platform that is within the survey area, it is recommended that the soft-start should commence at a location at least 500 metres from the platform.

3.3 The soft-start

The soft-start is defined as the time that airguns commence shooting till the time that full operational power is obtained. Power should be built up slowly from a low energy start-up (e.g. starting with the smallest airgun in the array and gradually adding in others) over at least 20 minutes to give adequate time for marine mammals to leave the area. This build up of power should occur in uniform stages to provide a constant increase in output. There should be a soft-start every time the airguns are used, the only exceptions being for certain types of airgun testing (section 3.3.2), and the use of a 'mini-airgun' (single gun volume less than 10 cubic inches), these are used on site-surveys (section 3.3.1). The duration of the pre-shooting search (at least 30 minutes) and the soft-start procedure (at least 20 minutes) should be factored into the survey design.

General advice to follow for soft-starts:

- To minimise additional noise in the marine environment, a soft-start (from commencement of soft-start to commencement of the line) should not be significantly longer than 20 minutes (for example, soft-starts greater than 40 minutes are considered to be excessive, and an explanation should be provided within the MMO report).
- Where possible, soft-starts should be planned so that they commence within daylight hours.
- Once the soft-start has been performed and the airguns are at full power the survey line should start immediately. Operators should avoid unnecessary firing at full power before commencement of the line.
- If, for any reason, firing of the airguns has stopped and not restarted for at least 10 minutes, then a pre-shooting search and 20 minute soft-start should be carried out (the

requirement for a pre-shooting search only applies if there was no MMO on duty and observing at this time, and if the break in firing occurred during the hours of daylight). After any unplanned break in firing for less than 10 minutes the MMO should make a visual assessment for marine mammals (not a pre-shooting search) within 500 metres of the centre of the airgun array. If a marine mammal is detected whilst the airguns are not firing the MMO should advise to delay commencement, as per the pre-shooting search, delay and soft start instructions above. If no marine mammals are present then they can advise to commence firing the airguns.

- When time-sharing, where two or more vessels are operating in adjacent areas and take turns to shoot to avoid causing seismic interference with each other, the soft-start and delay procedures for each vessel should be communicated to, and applied on, all the vessels involved in the surveying.

3.3.1 Soft-start requirements for site survey or Vertical Seismic Profiling (VSP)

Surveys should be planned so that, whenever possible, the soft-start procedures for site surveys and Vertical Seismic Profiles (VSP's) commence during daylight hours. Whilst it is appreciated that high resolution site surveys / VSP operations may produce lower acoustic output than 2D or 3D surveys it is still considered desirable to undertake a soft-start to allow for marine mammals to move away from the seismic source.

For ultra high resolution site surveys that only use a 'mini-airgun' (single airgun with a volume of less than 10 cubic inches) there is no requirement to perform a soft-start, however, a pre-shooting search should still be conducted before its use.

For site surveys and VSPs, a number of options are available to effect a soft-start.

- The standard method, where power is built up slowly from a low energy start-up (e.g. starting with the smallest airgun in the array and gradually adding in others) over at least 20 minutes to give adequate time for marine mammals to leave the vicinity.
- As the relationship between acoustic output and pressure of the air contained in the airgun is close to linear and most site surveys / VSP operations use only a small number of airguns and a soft-start can be achieved by slowly increasing the air pressure in 500 psi steps. From our understanding, the minimum air pressure which the airgun array can be set to will vary, as this is dependent on the make and model of the airgun being used. The time from initial airgun start up to full power should be at least 20 minutes.
- Over a minimum time period of 20 minutes the airguns should be fired at an increasing frequency (by decreasing the Shot Point Interval (SPI)) until the desired firing frequency is reached.

3.3.2 Soft-starts and airgun testing

Airgun tests may be required before a survey commences, or to test damaged or misfiring guns following repair, or to trial new arrays. Individual airguns, or the whole array may need testing, and the airguns may be tested at varying power levels. The following guidance is provided to clarify when a soft-start is required:

- If the intention is to test all airguns at full power then a 20 minute soft-start is required.
- If the intention is to test a single airgun on low power then a soft-start is not required.
- If the intention is to test a single airgun, or a number of guns on high power, the airgun or airguns should be fired at lower power first, and the power then increased to the level of the required test; this should be carried out over a time period proportional to the number of guns being tested and ideally not exceed 20 minutes in duration.

MMOs should maintain a watch as outlined in the pre-shooting search guidance (section 3.1) before any instances of gun testing.

3.4 Line Change

Seismic data is usually collected along predetermined survey lines. Line change is the term used to describe the activity of turning the vessel at the end of one line prior to commencement of the next line. Depending upon the type of seismic survey being undertaken, the time for a line change can vary. Line changes are not necessary for all types of seismic surveys, for example, in certain regional surveys where there is a significant distance between the lines, and for VSP operations.

The guidance relating to line change depends upon the airgun volume.

3.4.1 Seismic surveys with an airgun volume of 500 cubic inches or more

- If the line change time is expected to be greater than 20 minutes, airgun firing should be terminated at the end of the line and a full 20 minute soft-start undertaken before the next line. A pre-shooting search should also be undertaken during the scheduled line change, and the soft-start delayed if marine mammals are seen within 500 metres of the centre of the airgun array.

3.4.2 Seismic surveys with an airgun volume of 180 cubic inches or less (site surveys)

- If the line change time is expected to be greater than 40 minutes, airgun firing should be terminated at the end of the line and a full 20 minute soft-start undertaken before the next line. The pre-shooting search should also be undertaken during the scheduled line change, and the soft-start delayed if marine mammals are seen within 500 metres of the centre of the airgun array.
- If the line change time is expected to be less than 40 minutes, airgun firing can continue during the turn, but the Shot Point Interval (SPI) should be increased (longer duration between shots). Ideally, the SPI should not exceed 5 minutes during the turn.

Depending upon the duration of the line turns and the nature of seismic survey it may be necessary to vary the soft-start procedures. If an applicant determines that an effective line change can not be achieved using the above methods please contact JNCC at the earliest possible opportunity to discuss the proposed alternative, and include the details of the agreed procedure and the consultation with the JNCC in the application for survey consent.

3.5 Undershoot operations

During an undershoot operation, one vessel is employed to tow the seismic source and a second vessel used to tow the hydrophone array, although the main vessel will still tow the hydrophone array. This procedure is used to facilitate shooting under platforms or other obstructions. The MMO may be too far away from the airguns to effectively monitor the mitigation zone, and it is therefore recommended to place the MMO on the source vessel. If this is not possible, for example for logistical reasons, or the health and safety implications of transferring personnel from one vessel to another, the application should explain that the recommended procedure cannot be followed in the application for the survey consent, or the application for a variation of that consent. Irrespective of the MMO location agreed with DECC, the pre-shooting search and soft-start procedures should still be followed prior to undertaking an undershoot operation.

Section 4 - Acoustic Monitoring

Visual observation is an ineffective mitigation tool during periods of darkness or poor visibility (such as fog), or during periods when the sea state is not conducive to visual mitigation, as it will not be possible to detect marine mammals in the vicinity of airgun sources. Under such conditions, PAM is considered to be the only currently available mitigation technique that can be used to detect marine mammals. Current PAM systems can be particularly helpful in detecting harbour porpoises within the 500 metre mitigation zone, although the systems have their limitations and can only be used to detect vocalising species of marine mammals.

PAM systems consist of hydrophones that are deployed into the water column, and the detected sounds are processed using specialised software. PAM operatives are needed to set up and deploy the equipment and to interpret the detected sounds.

4.1 Use of PAM as a mitigation tool

PAM can provide a useful supplement to visual observations undertaken by MMOs and JNCC may recommend that it is used as a mitigation tool when commenting on applications for survey consents. However, in many cases it is not as accurate as visual observation for determining range, and this will mean that the mitigation zone will reflect the range accuracy of the system. For example, if the range accuracy of a system is estimated at +/-300 metres, animals detected and calculated to be within 500 metres from the source could, in reality, be 500 + 300 = 800 metres, but their detection would still lead to a delay in the soft-start. Although, at present it is not possible to express the range accuracy of most PAM systems in numerical terms, this example serves to illustrate that it is in the operator's best interests to use the most accurate system available, and for the PAM operative to factor in a realistic estimate of the range accuracy.

Some PAM systems do not have a reliable range determination facility or can only calculate the range for some species. In such cases, the detection of a confirmed cetacean vocalisation should still be used to initiate postponement of the soft-start if the PAM operator is able to make a judgement about the range of the animals from the airgun source, because of their experience gained in differentiating between distant and close vocalisations. In the absence of PAM systems capable of range determination, this expert judgement will constitute the basis for deciding whether an area is free from cetaceans prior to the soft-start.

In all cases where PAM is employed, a brief description of the system and an explanation of how the applicant intends to deploy PAM to greatest effect should be included in the application for survey consent.

In the last few years, software that processes and analyses cetacean sounds has been developed. An example of this is PAMGuard, an open source software that has been developed as part of the International Association of Oil and Gas Producers Joint Industry Project (JIP). JNCC recognises that PAMGuard is currently in a transition period between use as a research tool and widespread adoption as a monitoring technique. Moreover, JNCC recognises the need to balance proactive implementation of PAM with the need to further develop its capability, for example to include species recognition and baleen whale detection, and therefore encourages users of these systems to actively contribute to their development and refinement.

Section 5 – Requirements for MMOs and PAM

Any survey application or consultation received by JNCC will be considered on a case-by-case basis, and the mitigation measures advised to DECC will reflect the particulars of the survey and the importance of the survey area for marine mammals. The following

paragraphs are provided as a guide to the advice applicants are likely to receive following submission of an application with JNCC.

For areas that are currently considered particularly important for marine mammals, for example in the UK this includes areas West of Scotland, the Moray Firth and Cardigan Bay, JNCC may recommend that:

- The MMOs should be experienced MMOs, and that PAM should be used.
- The PAM system should be used to supplement visual observations, or as the main mitigation tool if the seismic survey activity commences during periods of darkness or poor visibility, or during periods when the sea state is not conducive to visual mitigation.

JNCC will advise that two marine mammal observers should be used when daylight hours exceed approximately 12 hours per day (between 1st April and 1st October north of 57^{O} latitude), or the survey is in an area considered particularly important for marine mammals.

When a non-dedicated MMO is recommended by JNCC (e.g. for VSPs and certain site-surveys), and the recommendation is incorporated into the conditions of the survey consent, a member of the rig's or vessels crew can perform the duties providing the crew member is a trained MMO.

When a dedicated MMO is recommended and this is a condition of the survey consent, the MMO should be employed solely for the purpose of monitoring the implementation of the guidelines and undertaking visual observations to detect marine mammals during periods of seismic activity.

When two dedicated MMOs are requested and this is a condition of the survey consent, both should be employed solely for the purposes of monitoring the implementation of the guidelines and undertaking visual observations, and the use of a crew member with other responsibilities as the second observer is not considered to be an adequate substitute for a dedicated MMO, or to be in compliance with the conditions of the survey consent.

Section 6 - Background Information

These guidelines were originally prepared by a Working Group convened by the Department of the Environment, and were developed from a draft prepared by the Sea Mammal Research Unit (SMRU). The guidelines have subsequently been reviewed three times by the Joint Nature Conservation Committee, following consultation with interested parties.

6.1. Existing protection to cetaceans

Section 9 of the Wildlife and Countryside Act 1981 (CRoW amended) prohibits the intentional or reckless killing, injuring or disturbance of any cetacean. The UK is also a signatory to the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) and has applied its provisions in all UK waters. Amongst other actions required to conserve and manage populations of small cetaceans, ASCOBANS requires range states to "work towards...the prevention of ...disturbance, especially of an acoustic nature".

Reflecting the requirements of the Convention on the Conservation of European Wildlife and Habitats (the Bern Convention) and Article 12 of the EC Habitats and Species Directive (92/43/EEC), the UK has the following legislation in place:

- The Conservation of Habitats and Species Regulations 2010
- The Conservation (Natural Habitats, &c.) Regulations 1995 (Northern Ireland) (and 2009 amendments)
- The Conservation (Natural Habitats, &c.) Amendment (No. 2) Regulations 2008 (Scotland) (and 2009 amendments)
- The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (and 2007 amendments),
- The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (and 2009 and 2010 amendments) (beyond 12 nautical miles UKCS)

Section 7 – References and contacts

Further information on DECC's survey consent procedure can be found at: http://www.og.decc.gov.uk/.

A copy of these guidelines, the standard forms (electronic and hard copy) and further background information is available from the above address, or can be found on the JNCC website at: http://www.jncc.gov.uk/page-1534

Reid, J.B., Evans, P.G.H., & Northridge, S.P. (2003). *'Atlas of cetacean distribution in north-west European waters'* (Online). http://www.jncc.gov.uk/page-2713

If you have any comments or questions relating to these guidelines, or suggestions on how they may be improved, please email seismic@jncc.gov.uk