MMO/PAM

Recommendation Report

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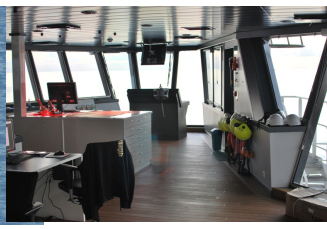

1. Executive Summary

The waters surrounding the Seychelles have long been associated with whales and historically with whaling. Since the mid 1900's Seychelles has become a strong advocate for conservation and was instrumental in the setting up of the Indian Ocean Whale Sanctuary in 1979. Currently 26 species of marine mammal are recorded from Seychelles waters making this the most diverse area within the Indian Ocean.

In efforts to maintain Seychelles developmental progress the Government of Seychelles has pursued a policy of active involvement in the sustainable use of natural resources and is promoting the sustainable development of the 'Blue Economy', the marine resources of the region. As a part of this policy it has granted rights for the exploration and extraction of hydro-carbon products within the Seychelles Exclusive Economic Zone (EEZ) to the long-term benefit of the people of Seychelles.

While some off-shore exploration has been carried out around Seychelles previously, only recently have model petroleum agreements been issued that address environmental concerns. One of the major concerns of such activities are their effects on marine mammals and many areas have developed guidelines or regulations to enable these activities while mitigating possible risk to these endangered species.

The recent seismic reflection surveys carried out around the north and western Seychelles plateau have highlighted the need for appropriate guidelines to be formally adopted and a cadre of suitably qualified local specialists developed. While a team of four persons successfully implemented appropriate mitigation 24 hours per day for a total of 57 days non-stop, this was done at considerable personal and financial cost; this situation will not be accommodated in future surveys nor should it be expected. This report contains recommendations based on these experiences as well as a detailed account of this survey and a draft set of guidelines for consideration in this regard.

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2. Introduction

2.1. Rationale

In an effort to maintain the progress and development of the country, the Government of Seychelles has pursued a policy of active involvement in the sustainable use of natural resources. This policy has included the granting of rights for the exploration and extraction of hydro-carbon products within the Seychelles Exclusive Economic Zone (EEZ) to the long-term benefit of the people of Seychelles. In order for this to be sustainable such activities need to take appropriate steps to ensure that irreparable harm is not done to any part of Seychelles natural environment. With respect to off-shore hydro-carbon exploration this is particularly of concern to marine mammal species that have been shown to be very susceptible to the effects of seismic exploration and associated disturbance (see Gordon *et al.* 2003 for a review). The risk to marine mammal species is such that the International Association of Oil and Gas producers and the International Association of Geophysical Contractors have agreed that such activities should be carried out under risk-based mitigation measures and a number of countries have developed national legislation to protect marine mammals through regulation of exploration and production activities and enforcement of mitigation measures (see Compton *et al.* 2007; Weir & Dolman 2007 for reviews).

The area around the shallow Seychelles plateau has long been associated with whales and historically with whaling. According to Bureau of International Whaling Statistics around 1350 whaling voyages have been conducted in the Indian Ocean. Mahe was an important base for whaling around Seychelles, the highest capture rate being in the mid-19th century with the rate remaining remarkably stable until 1870. The target species was primarily sperm whale (*Physeter macrocephalus*), most captures being made north of Denis and Bird islands or south and west of the plateau.

Seychelles initiated the Indian Ocean Whale Sanctuary under the International Whaling Commission in 1979 and boasts a large and diverse list of marine mammal species, having the greatest biodiversity recorded in the Indian Ocean, 26 species (Balance & Pitman, 1998; Kiszka *et al.*, 2009; REMMOA, 2012; see also Bluemel & Holden 2013). At least three of these species are classified as Endangered (Blue, Fin and Sei whales[1]), one as Vulnerable

(Sperm whale), whilst many remain data deficient according to the IUCN Red List of Threatened Species (IUCN 2013). Recent dedicated aerial surveys for marine mammals have confirmed that the Seychelles remain an important area for populations of marine mammals (REMMOA, 2012).

In view of the large number and diversity of marine mammal species found around Seychelles, it is necessary that suitable protocols are followed to safeguard such species during any activity in the EEZ. As Seychelles has no specific protocols for mitigation of the impacts from hydro-carbon exploration and production activities, it is timely that an appropriate policy is developed and implemented.

This report summarises the current situation, reviews concerns that became apparent during the mitigation activities carried out under the Joint Nature Conservation Committee (JNCC, 2010) guidelines on the recent seismic survey of Area A (North Terez) and makes recommendations for future offshore exploration activities to be undertaken in the Seychelles EEZ.

2.2. History of Oil and Gas Exploration in Seychelles Waters

Oil and gas exploration started in the Seychelles EEZ with the International Indian Ocean Expedition in the 1960's. This continued in the 1970s with the first seismic reflection surveys undertaken in the region by Mobil when they included the Seychelles Plateau and some of the adjacent banks on a regional survey from East Africa to Sri Lanka. Information from this and the seismic survey by Burmah Oil over the plateau in 1973 found potentially oil bearing strata.

[1] Blue whale (*Balaenoptera musculus*), Fin whale (*Balaenoptera physalus*), Sei whale (*Balaenoptera borealis*)

These initial efforts promoted increased interest by petroleum companies including Amoco, Texaco, Lasmo and Enterprise Oil. These companies acquired a large amount of 2D seismic and other geophysical data from exploration activities.

In 1984 the Seychelles Government established the Seychelles National Oil Company, to strengthen its capabilities to deal with exploration and other activities related to the development of the petroleum potential of the State, this has been reformed and is currently PetroSeychelles.

Currently the two companies holding offshore exploration licenses in the Seychelles EEZ are Afren and WHL, both are approaching the drilling phase with Afren completing a 3D seismic program in December 2012 – January 2013 and WHL to undertake one shortly.

2.3. Outline Precepts for Mitigation

Although activities related to oil and gas exploration in the Seychelles have been ongoing for many years and are actively being encouraged with PetroSeychelles accepting proposals for Block Licensing Applications from June 1st 2013, Seychelles has not yet adopted any guidelines for the mitigation of the effects of seismic activities on marine species, especially marine mammals. As such, there is an urgent need to establish marine mammal mitigation measures to ensure effective conservation of protected marine species during future oil and gas explorations.

Several countries have developed legislation or guidelines to protect marine mammals from any adverse effects due to off-shore exploration or production activities. These detail various mitigation measures which are applicable to the marine mammals likely to be encountered in the specific submarine terrain present in their territorial waters; as such these guidelines can be used as a best practise reference but need to be adapted based upon species and the depths and type of bathymetric terrain encountered (see Compton *et al.* 2007; Weir & Dolman 2007 for reviews).

Similarly, almost all reputable offshore seismic exploration companies have a standard environmental management plan for their activities that incorporate some form of mitigation

protocols for turtles and marine mammals. With respect to marine mammals these are often designed to fulfil or surpass the requirements of the Joint Nature Conservation Committee (JNCC) for the UK Continental Shelf and the Bureau of Safety and Environmental Enforcement (BSEE) for the US Gulf of Mexico.

Traditional marine seismic surveys are conducted from specially-equipped vessels that tow a high-energy seismic source (usually an 'air gun' array) to generate a pulse of sound waves and an array of hydrophone receivers to recorded the reflected sound signals (see Figure 1 below).

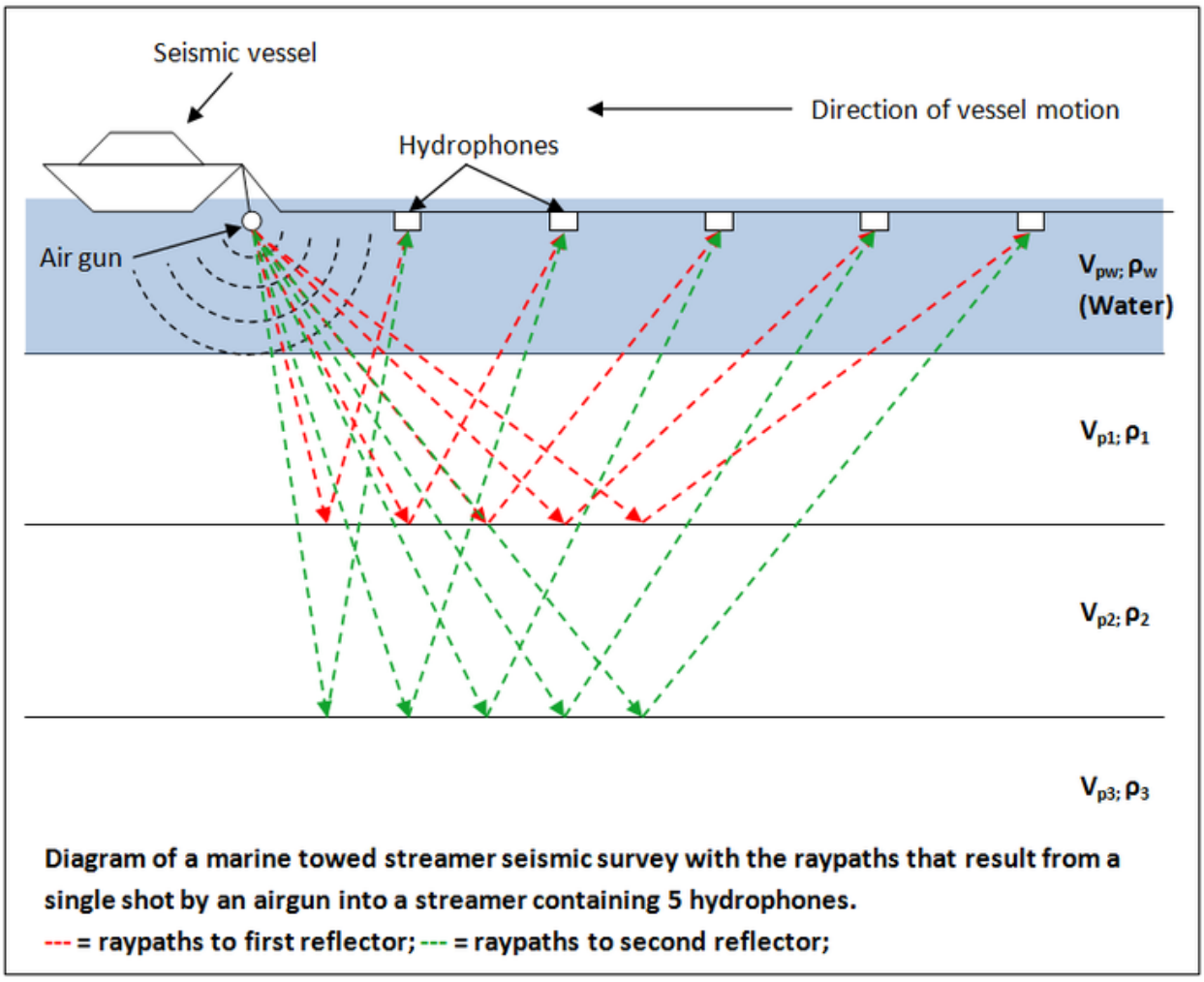

Figure 1. Schematic of a towed seismic array

The hydrophones are positioned at constant intervals along cables which are known as *streamers*; 2D surveys use only one streamer while 3D surveys may use 12 or more. The streamers are deployed just beneath the surface of the water and can be up to 6 - 8 km long and are a concern for the entanglement of marine life, particularly turtles; consequently most streamers are constructed to be 'turtle friendly' for use in areas where this is likely to be a problem. The seismic source is generally an array of up to 48 air guns which generate an air bubble to propagate the seismic sound wave through the water; this is typically fired every 15 or 20 seconds during each survey leg which can be from several hours to several days in length.

The main environmental concerns regarding marine seismic surveys are the effects of high-energy seismic sound waves on marine animal life, especially marine mammals which use sound as their primary method of communication with one another. High-level and long-duration sound can cause physical damage, such as hearing loss, whereas lower-level noise could cause temporary threshold shifts in hearing, obscuring sounds that are vital to marine life (Gordon *et al.* 2003). To mitigate this protocols have been developed to ensure that there are no marine mammals within the immediate vicinity of the seismic array during operations. Generally speaking there are two approaches commonly used:

Visual Observation: A trained Marine Mammal Observer (MMO) watches for marine mammals using suitable binoculars, and other aids.

Passive Acoustic Monitoring: Visual observation is an ineffective mitigation measure during periods of darkness, or during periods when the sea state is not conducive to visual mitigation, or when it will not be possible to detect marine mammals in the vicinity of airgun sources, such as with deep diving species in an area of deep water. Under such conditions, Passive Acoustic Monitoring (PAM) is considered to be the only available mitigation technique that can be used to detect marine mammals. A PAM observer uses passive acoustic hydrophones to detect the vocalisations of marine species. Dependant on the sophistication of the hydrophone and computer system used, PAM systems can provide information ranging from just a simple acoustic detection to a direction and distance to the source of the vocalisation and probable species identification.

The duty of both these observers is to recommend a delay in the commencement of seismic activity should any marine mammals be detected by either method in the 'mitigation zone'. Seismic surveys can last from a few days to several months and due to the costs involved of chartering these specialist vessels and the technical crews, the operations are usually 24 hours a day, 7 days a week. Bearing this in mind, it becomes a logistical problem to ensure that there are adequate MMO and PAM personnel aboard to ensure coverage during the entire period of seismic exploration; dependant on the mitigation protocol adopted, a minimum team would comprise 4 persons all with MMO certification and preferably three with PAM certification to enable adequate 24 hour coverage.

2.4. Summary of Recent Seismic Survey Mitigation Implementation

Possibly due to the novelty of off-shore exploration and production activities and the lack of current regulation, there is a lack of capacity within the country for the implementation of mitigation activities. In the past, despite previous efforts of the Ministry, NGOs and concerned individuals, MMO/PAM observers were not aboard seismic survey vessels when operating in Seychelles waters. Aware of pending seismic surveys by WHL and Afren, the Marine Conservation Society Seychelles (MCSS) had started discussions with the Ministry of Environment and Energy (MEE) and PetroSeychelles to establish a protocol for implementing mitigation activities for future survey activities. In view of the lack of capacity MCSS put forward a proposal for consideration to implement mitigation procedures to JNCC guidelines for the imminent exploration voyages; however, this proposal was not acted upon which resulted in a no-change situation with respect to local capacity.

East African Explorations Seychelles Ltd. undertook a 3D seismic program for Afren Plc. around Seychelles in December 2012 – January 2013 aboard the seismic survey vessel MV Polarcus Adira. The vessel deployed a dual source (3480 cubic inch array), with 12 streamers 6000m long with 100m separation for the 3D acquisition. A schematic of the first shooting plan is shown below (Figure 2).

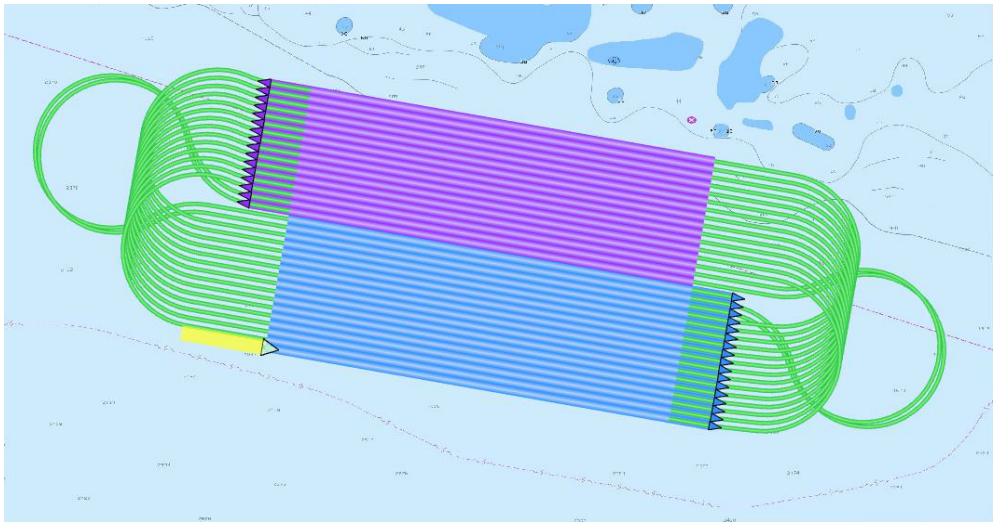

Figure 2. Schematic diagram of the first 3D acquisition shooting plan for the survey of Area A (North Terez), offshore Seychelles (courtesy of Afren).

On confirmation from PetroSeychelles that the MV Polarcus Adira was arriving in Seychelles to conduct this 3D survey, the Ministry of Environment and Energy (MEE) liaised with its partners to enable locally based MMO's and PAM operators to implement appropriate mitigation measures aboard the vessel. Consultations with MEE departments and various NGOs resulted in a total of four personnel, two each from the MEE and MCSS that were available with varied levels of training to undertake the survey.

A detailed assessment of issues that became apparent during the survey is included as **Annex 1**. Briefly, the shortage of personnel and lack of formal training meant that there were some periods when the JNCC guidelines were not followed completely; however, through hard work and very long working hours (14 – 16 hours per day) the surveys were covered and appropriate marine mammal mitigation was provided.

3. Summary of Recommendations

The following is a summary of the recommendations that have surfaced during the build up to and during the survey, and in discussions between the team members and others after the survey.

3.1. Policy Agreement

It was evident from the very short preparation time given for this last survey that there needs to be better communication between Petro Seychelles Ltd, MEE and the MMO/PAM providers. This may have resulted from a combination of circumstances but given the scale of investment that these surveys require a clear policy for the organization of the environmental requirements of exploration and production activities needs to be agreed and implemented.

The majority of developed nations require that appropriate mitigation of environmental impacts be undertaken during any offshore exploration or production activities. The new Model Petroleum Agreement (PetroSeychelles, June 2013) requires that applicable Seychelles environmental legislation be followed, and when none exists that the Industry Best Practices be followed. In view of Seychelles eminent position as a conservation oriented nation and the strong international position in promoting a sustainable Blue Economy, it would be far better for the Country to establish the proper regulations rather than rely on the goodwill of developers to police their own activities.

Similarly, with the agreement of appropriate regulations requiring mitigation activities it must become a requirement of the licensing contract that the developers contract and pay for a team of suitable personnel to carry out the required mitigation. Again this is standard within the offshore industry and is expected, the issue becomes whether this can be accomplished by local specialists rather than foreign contractors (see 3.4 below).

3.2. Legislation

At present the protection of marine mammals in Seychelles waters is assured under the Fisheries Act ED 1991 Section 24 (10) but this Act is being revised and the protection of marine mammals proposed address issues related only to fisheries. If this proposed Fisheries Act is implemented it will mean that that although marine mammals were not fully protected previously, there will be even less protection for these endangered species. The necessary steps should be undertaken for marine fauna especially cetaceans and turtles to gain the appropriate levels of protection that their conservation status requires, particularly in relation to future seismic activities.

3.3. Regulation / Mitigation Guideline Development

There are a number of guidelines and regulations for the different phases of off-shore exploration and production, each having been developed by different countries to cope with the species expected and the depths and type of sea-bed terrain likely to be encountered in their territorial waters. It is recommended that one of these is used as a base and adapted to the Seychelles scenario. The JNCC guidelines are well known and in general use in many areas outside of the UK waters for which they were developed; it is recommended that these be adapted to suit Seychelles. A first draft of such an adaptation to the Guidelines for Minimizing Acoustic Disturbance to Marine Mammals from Seismic Surveys (JNCC, 2010) is provided in **Annex 2**.

3.4. Certification of Personnel

With the adoption of guidelines and regulations it becomes necessary to have suitably qualified personnel available to implement the measures required. Generically, exploration companies have a pool of specialists that they can contract to fulfill such obligations with appropriate qualifications. However, while a team of foreign contractors can be readily acquired it would be in the interests of the development of the country to adopt a local standard and have Seychellois trained to fill these positions. As such it is recommended that

an appropriate standard be adopted and training provided to create a pool of skilled specialists locally to carry out these activities; there is a GEF funded project that aims to provide both MMO and PAM training awaiting confirmation of counterpart funding from the ETF to start activities that could resolve this situation.

It should be noted that in most mitigation protocols crew members (employed as maritime or seismic crew) may not be appointed as a MMO and independent consultants should be sought. It should also be noted that most vessels employed in the offshore exploration and production sector require that all personnel aboard the vessels have appropriate certification in

Basic Offshore Safety Induction Emergency Training (BOSIET). This is an international certification and is valid for four years requiring a refresher course to maintain its validity. This certification is outside the capacity for local implementation and consideration should be given to assist otherwise qualified personnel to attend such courses overseas.

3.4. Provision of Equipment

The provision of equipment for the monitoring of mitigation measures should not be a Governmental or Ministerial responsibility, unless it is felt that a special section should be set up within a particular Ministry or Department. Qualified MMOs should have their own basic visual observation equipment (binoculars), marine mammal identification guides and personal weather equipment (waterproofs) but most vessels will provide appropriate safety gear (Hi-viz jackets, helmets, life-vests, etc). PAM equipment is expensive and requires regular update and maintenance, again most modern vessels will have a full PAM set provided aboard; unless a special section is to be set up to use this equipment regularly it is not recommended that this is purchased. If a vessel does not have appropriate PAM equipment then it would be a requirement that they lease the appropriate equipment to enable proper mitigation in Seychelles waters.

6. Acknowledgments

We would like to thank the Ministry of Environment and Energy and PetroSeychelles for facilitating all the arrangements for us to join the vessel. We would also like to thank Polarcus and EAX (Seychelles) Ltd. for funding the BOSIET training. Special thanks goes to the crew of the MV Polarcus Adira for their professional collaboration throughout the survey, for taking a best practice approach by utilising trained and educated observers to conduct marine mammal visual and acoustic monitoring based on accepted JNCC mitigation protocols. Heartfelt thanks goes to everyone who has helped in one way or another to make this trip a success.

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Annex 1.

Detailed report of MMO and PAM Coverage During the Recent Seismic Survey

Ms. Gilberte Gendron (MEE): marine mammal survey experience, No JNCC experience.
Mr. Ashley Pothin (MEE): marine mammal survey experience, No JNCC experience.
Mr. Peter Holden (MCSS): JNCC MMO and PAM operations (certified).
Dr. Joanna Bluemel (MCSS): substantial marine mammal survey experience and JNCC equivalent experience.

Due to the length of the proposed survey, mid December to mid February, it was agreed that the available personnel would work in two phases of approximately four weeks each.

As the vessel was familiar with operating to JNCC guidelines and one team member had certification in these standards, it was agreed that the JNCC mitigation measures (Guidelines for Minimizing Acoustic Disturbance to Marine Mammals from Seismic Surveys, JNCC, 2010, http://jncc.defra.gov.uk/page-1534) be adopted for the survey. Because the survey was to operate 24 hours a day and the projected survey areas included waters in excess of 1000m in depth it was also agreed that marine mammal observation would need to be by both visual and passive acoustic monitoring. This presented problems as there was only one person trained and certified to use PAM equipment, which necessitated his presence on both survey periods.

Polarcus Adira had a high standard PAM system installed and maintained by a reputable company (MSeis UK) within the oil and gas industry. Most modern seismic vessels have a PAM system installed to ensure that they do not compromise the seismic acoustic equipment; older vessels may not have PAM systems which necessitate that they are provided by agencies which specialise in this field and who often also provide the trained PAM personnel. The PAM system would usually be set up by the trained operator upon boarding the vessel and would need to be calibrated for each vessel and each survey area.

Polarcus Adira also provided computer support with the majority of programs necessary for the MMO/PAM team, except for Microsoft Access that was required to set up a database for the acoustic recordings. Not having access to this software meant that the specific details of cetacean detections could not be logged and to retrieve these details hours of recordings had to be played back. The boat was not due to come to port until the end of the survey so to assure the recovery of all the data MCSS provided a Seagate 1TB external hard drive to store acoustic data.

The first group of observers consisted of one MMO, Ms. Gilberte Gendron (MEE), and one PAM operator, Mr. Peter Holden (MCSS), who boarded the MV Polarcus Adira on 19th December 2012. There was a crew change on the 9th February 2013 whereby the MMO left the boat and was replaced by two other MMO's, Dr. Joanna Bluemel (MCSS) and Mr. Ashley Pothin (MEE). The latter along with Mr. Holden conducted monitoring until the end of the prospection on the 12th February 2013.The 3D seismic survey was conducted at A1 South and A2 North which is within the Area A North known as 'Terez'.

Just prior to joining the vessel the MMO/PAM team were informed that it was a requirement for all Polarcus personnel onboard the vessel to have undertaken the Basic Offshore Safety Induction Emergency Training (BOSIET), which none of the MMO/PAM team members had undertaken. Arrangements were made though the vessel's company (Polarcus) for all four MMO/PAM observers to undertake the required training recognised by the Offshore Petroleum Industry Training Organisation. This was carried out in Dubai (Emirates International Maritime Academy) but resulted in the MMO/PAM team joining the vessel 10 days late, after the set-up of the seismic survey airgun and hydrophone array; this resulted in delays in sorting out the PAM equipment which should ideally have been done prior to the survey commencing.

The MMO and PAM team were decided upon and informed only three days prior to arrival (08/12/2012) of the MV Polarcus Adira leaving insufficient time for preparation (**training and logistics**). (See Section 3 recommendations regarding this respect).

4.1. Equipment

The MEE and MCSS made provisions for some equipment to be available for the length of the survey. The Wildlife Trade and Conservation section provided two Binoculars, one Asahi PENTAX Model No554 and one Mark Scheffel No 21521 with coated optics. Both binoculars were of 10x magnification, however, the specification does not suite the requirements to be used for marine mammal observations due to the lack of a reticule required for range estimation. The Department of Risk and Disaster Management (DRDM) also provided a single pair of reticulated binoculars of 8x magnification which were well suited for this type of survey work. There were several reticulated, waterproof, 7x magnification binoculars on the Polarcus Adira bridge that were available to use when not in use by Polarcus or security personnel.

DRDM also provided a pair of handheld radios with spare batteries and chargers, but they were not functional. Authorisation was given for the vessels radios and internal telecommunications system to be used. MCSS provided a hand held Global Positioning System (GPS) that was not required for this survey as the Polarcus Adira was equipped with its own GPS system. The use of GPS on smaller, less equipped vessels would require the MMO/PAM team to supply their own either in the form of hand held or USB style GPS.

Personal equipment supplied by MMO and PAM included a digital SLR camera (Nikon D60 with a 70-300mm sigma lens) and three marine mammal identification guides (National Audubon Society Guide to Marine Mammals of the World by Brent S. Stewart; Whales Dolphins and Seals – A field guide to marine mammals of the world by Hadoram Shirihai and Brett Jarrett; Whale and Dolphin Guide by MCSS).

4.2. Training, MMO/PAM Personnel and Adherence to JNCC Guidelines

Implementation of the JNCC guidelines and the collaboration of the MMO's and PAM operators with the crew of the MV Polarcus Adira were successful during the survey period. The JNCC guidelines were adhered to by all partners on the majority of occasions, although certain aspects relating to the length of the pre-shooting search and depth of the survey area

were misunderstood on a number of occasions (60 min in waters greater than 200m compared with 30 min in shallower waters), resulting in a number of pre-shooting search times not meeting JNCC standards (less than 60 min).

Due to the short notice given prior to survey commencement adequate JNCC guideline training and preparation for staff with no JNCC experience was not available. During the first survey period the JNCC guidelines were not adhered to effectively on a number of occasions and some data collection and reporting aspects were not carried out (final report and operations forms were not completed by both team members) or were only carried out by a single member of the team (daily reports and data entry mainly carried out by PAM). This was due to an insufficient number of MMO/PAM team personnel (only one MMO and PAM), long working hours, and insufficient training and seismic survey experience. Training in MMO and PAM methodology by the PAM operator whilst on board the vessel was not possible for these reasons.

JNCC guideline compliance and data collection/reporting issues were resolved after the arrival of the second MMO/PAM team which was due to the increased number of personnel (two MMO's and one main PAM operator), although working hours were often 14-16 hours a day to achieve this. To ensure that personnel work no more than 12 hours a day for health and safety reasons and that all MMO/PAM duties are achieved and are contributed to equally by all MMO/PAM personnel (including compulsory reporting duties, as required by seismic survey companies and regulating bodies), adequate numbers of MMO/PAM staff should be present (see Section 2.3 for recommendations).

4.3. Allowances

No established funds or means of paying allowances were in place for MMO and PAM that undertook this survey work, although the vessel could have been charged for the provision of these services. The MEE internally made arrangements for MMO/PAM to be paid a subsistence allowance according to the Public Service Order (PSO, SR 300 per day). However, due to the long working hours (in excess of 12 hours a day, seven days a week), considerable lengths of time spent at sea and the additional offshore health and safety

concerns (particularly in Seychelles with the added piracy threat), MMO and PAM staff should not be paid the equivalent of the standard subsistence allowance nor should it be funded by the Seychelles government. Worldwide, it is the responsibility of the seismic exploration companies to pay allowances and MMO's and PAM consultants on board seismic survey vessels are typically paid between £200-350/day.

Annex 2

Recommendations for Developing Guidelines to Reduce the Effects of Noise from Seismic Activities to Marine Mammals in Seychelles Waters

The Seychelles needs to develop an appropriate guideline structure specific to Seychelles waters to provide adequate protection to threatened marine mammal species, especially now that oil and gas exploration is expanding rapidly in deeper offshore areas such as the Seychelles. This following section aims to provide recommendations to aid decision makers in implementing mitigation guidelines suitable for Seychelles waters.

A recent aerial survey showed that Seychelles has the highest relative density of most species group in the region and that the diversity is relatively important (REMMOA, 2012). Furthermore sightings from this survey trip confirmed that the areas being explored have a relatively high presence of marine mammals and the species most encountered was sperm whale (*Physeter macrocephalus*) follow by several species from the subfamily Globicephalinae (black fish) and to a lesser extent individuals belonging to subfamily Delphininae (Bluemel & Holden, 2013, unpublished data).

Although there is not a substantial amount of data, the few surveys conducted indicate that Seychelles has a high level of diversity of marine mammals. In view of the increased likelihood of further seismic surveys the Government needs to adopt guidelines which will provide adequate safeguards to these protected species (many of which are endangered) from seismic activities.

Seychelles Guidelines for Minimising the Risk of Injury and Disturbance to Marine Mammals During Seismic Survey's

July 2013 (First Draft)

Preface

These draft guidelines were developed directly from the text of the JNCC 2010 guidelines and where the text has been modified in its technical content they contain explanatory footnotes in italics as to the origin of the changes or additions made so that the original sources can be verified if required. These sections should be removed from the published version of the guidelines.

Introduction

These guidelines have been written for activities within the Seychelles Economic Exclusion Zone (EEZ), adapted from the UK Joint Nature Conservation Committee (JNCC, 2010) guidelines and determined based upon the species, depths and type of bathymetric terrain encountered in Seychelles territorial waters. They 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 whales, dolphins, porpoises and dugongs (protected in the Seychelles EEZ under Section 24 (10) of the Fisheries Act 1986, Cap 82, Revised Edition 1991). The Ministry of Environment and Energy (MEE) notes that other protected fauna, for example turtles (protected under the Wild Animals and Bird Protection Act, 1994 ED, CAP 247, Wild Animals (Turtles) Protection Regulations) and whale sharks (protected under the Wild Animals and Bird Protection Act, S.1.1 of 2003, CAP 247, Wild Animal (Whale shark) Protection Regulations, 2003) 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, basking sharks (as advised by JNCC, 2010) and whale sharks.

The guidelines require the use of trained Marine Mammal Observers (MMO's) and Passive Acoustic Monitoring (PAM) operators, whose role is to advise on the use of the guidelines, to conduct pre-shooting searches for marine mammals before commencement of any seismic activity and implement shut-down procedures when marine mammals are identified within the exclusion zone

during firing periods when the sound source is operational. A further duty is to ensure that the reporting forms are completed for inclusion in the MMO/PAM report. Visual mitigation is provided by MMOs during hours of daylight and good visibility while acoustic monitoring during hours of darkness, low visibility during daylight hours and in deeper waters (>200m) is provided by PAM deployment.

The 2013 version of the Seychelles Mitigation Guidelines reflects regulations to meet environmental legislation which may be updated as required; the latest laws and regulations should be reviewed to ensure compliance with guidelines and also to include the offence of **deliberate injury** and **deliberate disturbance** (excluding trivial disturbance) to protected marine species in Seychelles (marine mammals, turtles and whale sharks). The Fisheries Act 1986, Cap 82, Section 24 (10) (revised edition 1991) that marine mammals are currently protected under includes the offence of killing, chasing or taking any marine mammal, alive or dead. The Wild Animals and Bird Protection Act, 1994 ED, CAP 247, Wild Animals (Turtles) Protection Regulations includes the offence of injury or disturbance to turtles and the Wild Animals and Bird Protection Act, S.1.1 of 2003, CAP 247, Wild Animal (Whale shark) Protection Regulations, 2003) only currently includes the offence of killing a whale shark.

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** and a **deliberate disturbance**. These 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 protected marine species within the Seychelles EEZ to negligible levels**.

Please note that the mitigation measures recommended in these guidelines are more relevant to the prevention of injury rather than disturbance. The onus should be on the entity responsible for the activity to assess whether disturbance to marine species is likely to occur and to include this as an output from the Environmental Impact Assessment Studies (EIAs) (a requirement of Section 21 (1), new Model Petroleum Agreement, PetroSeychelles, June 2013). Guidance on how to carry out EIAs on environmental concerns is provided by the MEE and PetroSeychelles issues guidance for oil and gas seismic activities.

In relation to oil and gas seismic surveys in the EEZ, it is a requirement of the consent issued under section 4 (1) (c) of the Seychelles Petroleum Mining Act 1991 ED, by the Government of Seychelles, that no person shall explore, prospect or mine for any petroleum on, in or under any land in Seychelles or do any act preparatory to such exploring, prospecting or mining otherwise than in

accordance with the terms and conditions of an exploration licence or a petroleum agreement (currently the Model Petroleum Agreement, PetroSeychelles, June 2013). The Seychelles Mitigation Guidelines and the elements of the guidelines that are relevant to a particular survey are to be incorporated into the legally-binding condition of consent and must be followed. It should be noted that it is the responsibility of the company issued consent by the Seychelles Government, referred to in these guidelines as the 'applicant', to ensure that these guidelines are followed, and it is recommended that a copy of the Seychelles guidelines are available onboard all vessels undertaking seismic activities in Seychelles waters. It is compulsory, when the survey is completed a MMO/PAM report must be submitted to the MEE, or any other designated organising authority.

Contents

Terminology

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 operator if trained accordingly. The use of a crew member with other responsibilities as the observer is not considered to be an adequate substitute for a MMO, or to be in compliance with the conditions of the survey consent.

Trained MMO: Has attended a Seychelles recognised course and been certified as competent.

Experienced MMO: Trained MMO with 3 years field experience observing for marine mammals, and practical experience of implementing the Seychelles Mitigation Guidelines or similar

Passive Acoustic Monitoring (PAM) Operator: An MMO experienced in the use of PAM software, hardware and marine mammal acoustics. Individual responsible for conducting acoustic monitoring for marine mammals. For some seismic surveys it may be requested that PAM operators are trained, dedicated and / or experienced. The use of a crew member with other responsibilities as the observer is not considered to be an adequate substitute for a PAM operator, or to be in compliance with the conditions of the survey consent.

Trained PAM: Has attended a Seychelles recognised course and been certified as competent.

Experienced PAM: Trained PAM operator with 3 years field experience monitoring for marine mammals, and practical experience of implementing the Seychelles Mitigation Guidelines or similar

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

Passive Acoustic Monitoring (PAM): Software / hardware 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.

Shut-down: Termination of the seismic sound source during production, due to a marine mammal or Species of Concern entering the Mitigation Zone.

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.

Seychelles Waters: Parts of the sea within the Economic Exclusion Zone (EEZ) from the low water mark up to the limits of the Seychelles EEZ.

Species of Concern (SoC): Critically Endangered, Endangered, Vulnerable or Near Threatened marine species according to IUCN Red List of Threatened Species (for example turtles, dugongs, blue, sei, fin and sperm whales etc). Species that are known to utilise specific locations within Seychelles waters for feeding, breeding, migration or use other key habitats (for example humpback migration routes and mother and calf resting habitats).

Time/Area Closed Zone: A zone used by marine mammals for breeding, feeding, migratory or other key life-cycle activities where access for exploratory or production activities is restricted either within specified areas or specified dates.

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 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. Where existing information on species occurrence within a project area is scarce, the establishment of baseline characterisation surveys should be undertaken as part of the EIA study (1.2).
- Consult the latest relevant regulatory guidance notes; currently, the Ministry of Environment and Energy (MEE) issues guidance notes on environmental concerns and Petro Seychelles issues guidance for oil and gas seismic activities.
- As part of the environmental impact assessment, assess the likelihood of injuring or disturbing a protected marine species in the Seychelles EEZ. In the Seychelles, it will be necessary to assess the likelihood of committing an offence as defined in the Fisheries Act 1986 (Cap. 82) regulation number 24 (10), Revised Edition 1991 and the Wild Animals and Bird Protection Act, 1994 ED, CAP 247 (Wild Animals (Turtles) Protection Regulations and S.1.1 of 2003, CAP 247, Wild Animal (Whale shark) Protection Regulations, 2003).

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 when visual and acoustic mitigation is available, using Marine Mammal Observers (MMOs) and Passive Acoustic Monitoring (PAM) operators.
- 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, or in deep waters (>200m) where deep diving species are likely to be present, if a PAM system and operator 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, or in deeper waters (<200m) where deep diving species are likely to be present could pose a risk of committing an offence.
- Plan surveys so that the timing will avoid the likelihood of encounters with marine mammals. For example, this might be an important consideration in certain areas/times, e.g. during humpback migration such as known mother and calf resting areas around the outer

islands. Ensure the use of Time Area Closed Zones, required for species of concern (SoC) breeding, feeding, migratory or other key habitats.

- Provide only trained MMO's and PAM operators to implement the Seychelles Mitigation 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).

The use of Time/Area Closed Zones represents Best Practice methods (Weir & Dolman 2007). The use of such zones is a requirement for breeding, feeding, migratory or other key habitats, a method which is incorporated in guidelines developed for a number of locations (UK, California, Australia, Brazil, New Zealand and Sakhalin).

The use of PAM during seismic surveys in waters greater than 200m is recommended as Best Practice by Weir & Dolman (2007) and Compton et al. (2007).

1.2 Environmental Impact Assessment (EIA)

In the context of this document, the purpose of an EIA study is to identify, predict, evaluate and mitigate the effects of anthropogenic sound on marine mammals and Species of Concern (SoC) prior to, and during, a survey using a sound source. An EIA is a requirement for the granting of an exploration licence or a petroleum agreement in Seychelles. The EIA content with respect to marine mammals and anthropogenic sound should include the following (as a minimum):

- Information (via comprehensive reviews of published and 'grey' literature, and available datasets) on the potential and confirmed occurrence of marine mammals and SoC within the project area. This should include (at least) information on species presence, density, seasonal and spatial distribution, breeding periods and behaviour, where these are available. Any species of particular sensitivity should be identified, for example through assessments of SoC global and regional conservation status (such as IUCN Red List status, IUCN, 2013), local protective legislation to identify locally-important conservation priorities, and compiled information on breeding, feeding or migratory habitat which may indicate the presence of critical habitats for SoC. Where existing information on

species occurrence within a project area is scarce, the establishment of baseline characterisation surveys should be undertaken to provide initial information on marine mammal and SoC occurrence on which a mitigation plan can be based and subsequent impacts identified. Given the marked seasonal variation in occurrence of many marine mammals within particular areas, any baseline characterisation surveys carried out should occur at the same time of year as the planned use of the anthropogenic sound source.

- Details of any environmental legislation pertinent to the protection of marine mammals and SoC in the project area and its implications for the mitigation programme.
- Characteristics of the source being used during the survey. These should include equipment types, amplitude (sound level) and pressure, frequency characteristics, pulse duration and assessment of transmission loss of the sound source (modeled as simple geometric spreading, either spherical (intensity falls off with distance squared) or cylindrical (intensity falls linearly with distance).
- Identification of, and predictions regarding, the potential impacts of the sound source on the marine mammals and SoC that occur in the area (bearing in mind that this will likely require separate evaluation for particular species groups, for example baleen whales, odontocetes, pinnipeds, sea turtles etc.), via a thorough literature review.

With regard to the physical impacts of anthropogenic sound, consideration should be given to:

1. The potential impacts of anthropogenic sound on marine mammals and SoC occurring within the survey area. This should include both direct injury (e.g. tissue damage, hearing loss) and indirect impacts (disturbance, e.g. displacement of marine mammals, SoC, or their prey species).
2. The sound levels documented to cause hearing loss and other impacts to specific marine mammals and SoC found within the survey area.
3. The current 'safe sound levels' (i.e. sound levels below which exposure is unlikely to result in disturbance or injurious impacts) documented for marine mammals and SoC.
4. Calculations of the radius of these safe levels around the proposed sound source (taking into account actual/expected sound transmission properties within the specific survey area and pulse emission rate).
5. Conclusions on the likely impacts on individual animals and at the population level (especially considering feeding, breeding and migratory areas), based on sound exposure and overall duration of the survey.
6. An assessment of cumulative impacts where more than one operation is active simultaneously or activity is over a long period of time (e.g. some piling construction projects may last for 2- 3 years).
7. A review, identification and evaluation of other potential impacts of the survey work on

marine mammals and SoC within the survey area, for example vessel strikes, pollution and entanglement in seismic gear.

8. Information on how the potential impacts on marine mammals and SoC identified during the EIA will be mitigated during the survey. This may take the form of a Mitigation Plan (MP) for specific high-risk impacts (e.g. a MP for sound source mitigation as described below) and additional statements regarding other impacts (e.g. the use of 'turtle guards' on seismic tail buoys to mitigate against sea turtle entrapment).

This EIA section (1.2) is taken from the Marine Mammal Observer Association (MMOA) position statement (MMOA, 2012) and represents Best Practice methods to conduct the assessment having been compiled by the UK's leading marine mammal specialists.

1.3 Mitigation measure planning

The mitigation zone (MZ) is to be established by transmission loss modeling using a threshold of 180 dB re 1 µPa (rms) for a particular source (see section 1.2) in the planning stages and EIA prior to commencing the survey. The MZ should be determined by the site-specific source levels and by in situ measurements of local environmental conditions (e.g. water depth, seabed type, water temperature, salinity), which will affect the resulting sound propagation.

If sound source modeling at the site of the actual project is not possible, the radius of the MZ should be determined by assuming that local conditions are optimal for sound propagation (i.e. the worst case scenario) using idealised modeled source levels and the least favorable (in terms of transmission loss) environmental conditions that are known to occur within the site. The radius of the MZ should be established based on the highest sound levels likely to be emitted by the sound source during the survey (i.e. in the case of seismic surveys, the firing of all guns simultaneously on the array and not including the spare guns – the firing of spare guns should not be carried out unless other guns are dropped out first so that production volume is not exceeded). Notwithstanding the above, the minimum radius of the mitigation zone should be 500 metres.

Where surveys are of long duration (> 1 month), MZ models should be updated regularly according to changes in localised oceanographic conditions within the site. For example, changes in water temperature and salinity are often measured regularly using T-S dips during seismic surveys and can

be incorporated into updated models to calculate site-specific MZs over time.

This section is modeled on the Californian guidelines and recommendations of Weir and dolman (2007) for mitigation measures during seismic surveys. The Seychelles Mitigation Guidelines utilise a Mitigation Zone based on scientific studies of vessels operating 2000 – 3000 in^3 arrays at full power (Weir & Dolman, 2007). The modeling proved a 180 dB re 1 µPa (rms) should dictate the absolute minimum distance from the seismic source at which a marine mammal be allowed to get to the sound source without physical injury.

Section 2 – Marine Mammal Observers (MMOs)

2.1 Role of an MMO

The primary role of an MMO is to act as an observer for marine mammals and SoC, to recommend a delay in the commencement of seismic activity should any be detected within the mitigation zone and to recommend shut-down procedures should marine mammals be identified within the mitigation zone during firing periods when the sound source is operational. In addition, a MMO should be able to advise the crew on the procedures set out in the Seychelles Mitigation 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 they 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 the Ministry of Environment and Energy (MEE) (if applicable). An MMO also works closely with Passive Acoustic Monitoring (PAM) operators (Section 3). 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 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 another. 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 and during firing periods when the sound source is operational. These guidelines must not be interpreted to imply that MMOs should keep a watch during all daylight hours, but MEE 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 waters <200m where deep diving marine mammals are likely to be present) and during firing periods when the sound source is operational to carry out shut-down measures. Whilst MEE 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 or during firing periods when the sound source is operational, to implement appropriate shut-down measures. Where two MMOs are onboard a seismic vessel, MEE would encourage collaboration to ensure that cetacean monitoring is always undertaken during all daylight hours.

Duration of the pre-shoot watch is recognised by JNCC as 30min for waters <200m and 60 min for waters >200m. Although 30 min might be adequate for detecting shallow-diving shelf species, it is not necessarily appropriate in deep water areas where the known dive times of some species (e.g. sperm whale, beaked whales) regularly equal or exceed this duration.

Shut-down measures are a worldwide requirement for the majority of mitigation guidelines with the exception of the UK (JNCC) where production may continue regardless, and Australia where a reduced power zone is used. As best practice the shut-down should be incorporated into the guidelines for all marine mammals and species of concern, as this is apparent in the guidelines for California, Gulf of Mexico, Brazil, Canada, New Zealand and Sakhalin).

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 and a certificate of competence on a MEE recognised course.

It would be encouraged that the MEE provide information on recognised training organisations within the Seychelles.

2.3 MMO equipment and reporting forms

MMOs should be equipped with binoculars, a copy of the Seychelles Mitigation 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 or range-finding reticule binoculars.

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 MEE website.

It would be encouraged that the MEE provide information on and instructions for Marine Mammal Recording Forms and Range Finding Methods and this be available on the MEE website and / or the PetroSeychelles website. These forms are based on the JNCC guideline forms and are currently in the process of amendment for submission in the approval process for these guidelines.

2.4 Reporting requirements – the MMO/PAM report

The 'MMO/PAM report', should be sent to the MEE or other designated organising authority after the survey has been completed. It is the responsibility of the consent holder to ensure that the MMO/PAM report is sent to the MEE or other designated organising authority.

The report should be completed to include visual and acoustic details of the survey and be complied by both MMOs and PAM operators.

The MMO/PAM Report should include the completed Seychelles marine mammal recording forms and contain details of the following:

- The seismic survey reference number provided to the applicant by the seismic operator.
- 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 visual watches and acoustic monitoring for marine mammals, including

details of any sightings or acoustic detections and the seismic activity during the watches.

- Details of the weather conditions and survey depths during the survey.
- Details of any problems encountered during the seismic survey including instances of non-compliance with the Seychelles Mitigation Guidelines.

If there are instances of non-compliance with these guidelines that constitute a breach of the survey consent conditions, the MEE or other designated organising authority will copy the report, and their comments on the potential breach to the relevant Ministerial department. It is therefore essential that the MMO/PAM report is completed as soon as possible after the survey has been finished.

Section 3 – Passive Acoustic Monitoring (PAM)

Visual observation is an ineffective mitigation tool during periods of darkness or poor visibility (such as fog or heavy rain), or during periods when the sea state is not conducive to visual mitigation, or in deeper waters (>200m) where deep diving species are likely to be present 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 and should therefore be utilised during seismic surveys. Current PAM systems can be particularly helpful in detecting odontocetes within the mitigation zone, although the systems have their limitations and can only be used to detect vocalising species of marine mammals. Within the Seychelles EEZ it is a requirement that PAM is used to monitor ALL seismic operations during periods of darkness, poor visibility , or during periods when the sea state is greater than Beaufort 3, or in waters deeper >200m.

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.

3.1 Use of PAM as a mitigation tool

PAM provides a complement to visual observations undertaken by MMOs and is compulsory as a mitigation tool for surveys carried out within the Seychelles.

Some PAM systems do not have a reliable range determination facility or can only calculate the range for some species. As it is a requirement within the Seychelles Mitigation Guidelines to use PAM as a tool for mitigation, PAM systems used for this purpose should be of high enough specification to allow the PAM operator to achieve reliable range estimation of cetacean vocalisations to provide effective mitigation. Below outlines the PAM equipment that is required to provide such effective mitigation:

- An appropriate length of cable to deploy the hydrophone elements at a suitable distance from engine/propellor noise in order to be effective. At least one spare cable is recommended in case damage is incurred during deployments.
- Hydrophone elements with the correct frequency range for the marine mammals and Species of Concern (SoC). This may mean multiple elements with differing frequency sensitivities.

- Sound cards (and back up drivers) with the appropriate sampling rate for the SoC and full instructions on their configuration.
- Pairs of hydrophones elements for each frequency range needed in order to provide bearing information for tracking animals.
- Full details of separation distances of each pair of hydrophone elements for bearing determination.
- GPS for tracking vocalisations (needed for range and bearing determination).
- Calibrated depth sensor and full instructions on configuration.
- Filtering system for unwanted noise and full instructions on configuration.
- Professional noise cancelling headphones (with battery charger and spare batteries).
- Appropriate software for real time monitoring which shows bearing and range to the animals and species classification, where possible.
- Every component of the PAM equipment in duplicate (including the smallest connectors) incase of equipment failures.
- Fully detailed manual of assembly and calibration.
- Full inventory of contents.
- Properly labeled shipping containers and reels.
- 24 hr. support from the PAM equipment provider for technical problems and configuration advice.

Recommendations for the PAM system, set-up and functionality are provided in the MMOA position statement (MMOA, 2012). These recommendations for the PAM system set a standard which allow the PAM operative to achieve reliable range estimation of cetacean vocalisations to provide effective mitigation.

A detailed description of the PAM 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). It is recognised that PAMGuard is currently in a transition period between use as a research tool and widespread adoption as a monitoring technique. Moreover, it is recognised that there is a 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.

3.2 Role of a PAM operator

The primary role of a PAM operator is to act as an acoustic monitor for marine mammals, to recommend a delay in the commencement of seismic activity should any marine mammals be detected within the mitigation zone and to recommend shut-down procedures should marine mammals be detected within the mitigation zone during firing periods when the sound source is operational. In addition, a PAM operator should be able to advise the crew on the procedures set out in the Seychelles Mitigation 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 they 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 the Ministry of Environment and Energy (MEE) (if applicable). A PAM operator also works closely with Marine Mammal Observers (MMOs) (Section 2). As the PAM operators 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 PAM operator contacts should be.

In a typical vessel based seismic survey, the PAM operator 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 another. The PAM operator should consider themselves as part of the crew and respect the chain of command that is in place.

PAM operators should make certain that their efforts are concentrated on the pre-shooting search before the soft-start and during firing periods when the sound source is operational, during periods of darkness or poor visibility, or during periods when the sea state is not conducive to visual mitigation, or in deeper waters (>200m)These guidelines cannot be interpreted to imply that PAM operators should carry out continuous monitoring 24 hours a day, but MEE would encourage all PAM operators to manage their time to ensure that they are available to carry out a pre-shooting 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 waters greater than 200m where deep diving marine mammals are likely to be present) and during firing periods when the sound source is operational to carry out shut-down measures. Whilst MEE appreciates the efforts of PAM operators 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 or implement appropriate shut-down measures during firing periods when the sound source is operational.

Duration of the pre-shoot watch is recognised by JNCC as 30min for waters <200m and 60 min for waters >200m. Although 30 min might be adequate for detecting shallow-diving shelf species, it is not necessarily appropriate in deep water areas where the known dive times of some species (e.g. sperm whale, beaked whales) regularly equal or exceed this duration and where some species, such as beaked whales, vocalize very infrequently.

Shut-down measures are a worldwide requirement for the majority of mitigation guidelines with the exception of the UK (JNCC) where production may continue regardless, and Australia where a reduced power zone is used. As best practice the shut-down should be incorporated into the guidelines for all marine mammals and species of concern, as this is apparent in the guidelines for California, Gulf of Mexico, Brazil, Canada, New Zealand and Sakhalin).

3.3 Training requirements for PAM operatives

A prerequisite for a PAM operator to be classified as a 'trained PAM' is that they must have received formal training and a certificate of competence on a MEE recognised course.

It would be encouraged that the MEE provide information on recognised training organisations within the Seychelles.

3.4 Reporting requirements – the MMO/PAM report

The MMO/PAM report details are outlined in Section 2.4. The report should be completed to include visual observations and acoustic monitoring details of the survey and be complied by both MMOs and PAM operators.

Section 4 – Guidance before and during seismic activity

All MMO observations and PAM should be undertaken from the source vessel (where the airguns are being deployed from), unless alternative arrangements have been agreed with the organising authority. The MMO should be positioned on a high platform with a clear unobstructed view of the horizon. Communication channels between the MMO, PAM operator and the crew should be in place before commencement of the pre-shooting search (this may require portable VHF radios that should be supplied by the vessel). The MMO and PAM operator should be aware of the timings of the proposed operations, so that there is adequate time to conduct the pre-shooting search bearing in mind the time required for equipment readiness and deployment.

4.1 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 and/or PAM should carry out acoustic monitoring to determine if any marine mammals are within the mitigation zone based on 180 dB re 1 µPa (rms) threshold of the centre of the airgun array.

In deep waters (>200m) the MMO and PAM 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 and may vocalise very infrequently. A longer search time in such areas is likely to lead to a greater detection and tracking of deep diving marine mammals.

JNCC state an Exclusion Zone of 500m from the centre of the airgun array, this value has been amended as it is deemed insufficient for vessels operating 2000–3000 in³ arrays at full power which are common today. Several studies indicate that the 180 dB re 1 µPa (rms) threshold correlates well to the minimum distance in most scenarios to avoid physical injury (Weir & Dolman 2007).

To facilitate more effective timing of proposed operations when surveying in deeper waters, the searches for marine mammals and SoC 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 or SoC are detected within the mitigation zone whilst the airguns

are still firing, then shut-down measures should be carried out (Section 4.4). The commencement of the soft-start for any subsequent survey lines should be delayed for at least 30 minutes if marine mammals or SoC are detected within the mitigation zone when the airguns have ceased firing.

Shut-down for the sighting of a marine mammal within the mitigation zone whilst shooting should be mandatory. Based on guidance of best practice recommended by Weir and Dolman (2007).

A 30 minute delay to the soft-start (If any marine mammals or SoC are detected within the mitigation zone) is incorporated in most guidelines worldwide (Australia, Gulf of Mexico, Brazil, Canada and New Zealand), with the exception of UK (JNCC) (20 minutes) California (Not stated), and also Sakhalin where the terms loosely apply to delay activity until the animal(s) depart the Mitigation Zone.

4.2 Delay if marine mammals are detected within the mitigation zone

If marine mammals are detected within the mitigation zone (MZ), based on 180 dB re 1 µPa (rms) threshold 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 outside the MZ. In both cases, there should be a 30 minute delay from the time of the last sighting within the MZ 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 operators to assess any acoustic detections and determine if there are likely to be marine mammals within the MZ. If the PAM operators consider marine mammals are present within the MZ then the start of the operation should be delayed as outlined above.

If marine mammals are detected within the MZ whilst the airguns are firing, either during the soft-start procedure or whilst at full power, a shut-down is required to stop firing the airguns.

The MZ size is modified as described previously while the shut-down and 30 minute pre start-up watch guidance is based on best practice recommended by Weir and Dolman 2007.

4.3 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 4.3.2), and the use of a 'mini-airgun' (single gun volume less than 10 cubic inches), these are used on site-surveys (section 4.3.1). 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/PAM 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. Seismic 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 (however, the requirement for a pre-shooting search can be met if there were MMO and PAM operators on duty and observing prior to and during the shutdown). After any unplanned break in firing for less than 10 minutes the MMO should make a visual assessment or PAM operator should monitor acoustically for marine mammals (not a pre-shooting search) within the mitigation zone. If a marine mammal is detected whilst the airguns are not firing the MMO/PAM operator should advise to delay commencement, as per the pre-shooting search, delay and soft start instructions above. If no marine mammals are present in the mitigation zone 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.

On a minority of vessels the soft start is computer automated (each gun(s) automatically added in at predetermined shot points), providing a more reliable method of increasing sound level than manual operation. Logging of soft starts must be carried out by seismic crew, MMO's and PAM operators, this is required to ensure compliance with the 20 min duration.

4.3.1 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 a period of no longer than 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 period of no longer than 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.

4.3.2 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 and PAM operators should maintain a watch as outlined in the pre-shooting search guidance (section 4.1) before any instances of gun testing.

4.4 Shut-Down

Any qualified MMO or PAM operator on duty has the authority to shut-down an active survey according to the provisions of these guidelines if any marine mammal or species of concern is visually sighted or acoustically detected within the mitigation zone.

Marine mammal detections by any means should initiate a process of dialogue between the qualified observers on duty at the time. This is to ensure that decisions potentially affecting survey operations are made in a robust and mutually supportive manner, based on the skills, experience, capability and professional judgment of the observers. However, mitigation action is not dependent on marine mammals being detected by PAM and confirmed by a MMO—either qualified observer has the authority to act independently in each instance, if necessary.

Due to the limited detection range of current PAM technology for ultra-high frequency vocalising marine mammals (<300 m threshold of detection), any such bioacoustic detections will require an immediate shutdown of an active survey or delay in soft-start operations, regardless of signal strength or whether distance or bearing from the acoustic source has been determined.

Shut-down measures are a worldwide requirement for the majority of mitigation guidelines. As best practice the shut-down should be incorporated into the guidelines for all marine mammals and SoC, as in the guidelines for California, Gulf of Mexico, Brazil, Canada, New Zealand and Sakhalin.

High frequency acoustic vocalisations are only detected at short range (<300m) indicating that the animal concerned must be within the minimum mitigation zone of 500m, so a shut-down is necessitated (HESS, 1999).

4.5 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; the guidance relating to line change depends upon the airgun volume.

4.5.1 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 the mitigation zone.

4.5.2 Seismic surveys with an airgun volume of 500 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 the mitigation zone.
- 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 the MEE or other designated organizing authority at the earliest possible opportunity to discuss the proposed alternative, and include the details of the agreed procedure and the consultation with the MEE in the application for survey consent.

4.6 Undershoot operations

During an undershoot operation, one vessel (master vessel) is employed to tow the seismic source and the primary hydrophone array and a second vessel (slave vessel) is used to tow the secondary

hydrophone array. This procedure is used to facilitate shooting under platforms or other obstructions. The MMO/PAM operator may be too far away from the airguns to effectively monitor the mitigation zone, it is therefore recommended to place the MMO/PAM 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 applicant 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/PAM location agreed with MEE, the pre-shooting search, soft-start and shut-down procedures should still be followed prior to undertaking an undershoot operation.

Section 5 – Requirements to use MMOs and PAM

Any survey application or consultation received by the organising authority will be considered on a case-by-case basis, and the mitigation measures advised 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.

For areas that are currently considered particularly important for marine mammals, the organising authority may recommend that:

> The MMOs and PAM operators should be experienced MMOs and experienced PAM operators.
>
> The PAM system must 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 or in depths >200m.

The organising authority will advise that an increase of marine mammal observers and PAM operators may be required if the survey is in an area considered particularly important for marine mammals.

Section 6 - Background Information

These guidelines were originally adapted from the UK Joint Nature Conservation Committee (JNCC, 2010) guidelines from a draft prepared by the Marine Conservation Society Seychelles. They have subsequently been reviewed through a stakeholder based review process prior to adoption and regulation by the Ministry of Environment and Energy.

It is advised that these guidelines be reviewed through a stakeholder based review process prior to adoption and regulation by the MEE.

6.1. Existing protection to marine mammals

Section 24 offences (10) of the Fisheries Act 1986 (Cap. 82) from the Laws of Seychelles, Chapter 82, revised edition 1991, pp. 1-16.

(10) *(a)* Any person who, in Seychelles waters Kills, chases or takes any marine mammal, alive or dead, shall be guilty of an offence and liable on conviction to a fine of R.50,000;

(b) It shall be a defence to a charge under paragraph (a) that either-

(i) if taken alive, the marine mammal *was* returned to the sea with the least possible injury: or

(ii) if taken dead or so seriously injured as to render its recovery unlikely, the taking of the marine mammal was reported to the Principal Secretary of the Ministry as soon as practical and body disposed of in accordance with his instructions.

Section 7 – References and contacts

Australian Government Department of the Environment, Water, Heritage and the Arts. 2008 (AU) EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales. www.environment.gov.au

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Brazilian Institute of Environment and Renewable Natural Resources (*Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis*). *Guide for monitoring marine biota during seismic data acquisition activities.* IBAMA, Brazil. 2005.

Compton, R., Goodwin, L., Handy, R., & Abbott, V. 2008. *A critical examination of worldwide guidelines for minimising the disturbance to marine mammals during seismic surveys*. *Marine Policy*, *32*(3), 255-262.

DoC. 2005. Guidelines for minimizing acoustic disturbance to marine mammals from seismic survey operations. Wellington, New Zealand: Department of Conservation.

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HESS (High-Energy Seismic Survey Team). 1999. High energy seismic survey review process and interim operational guidelines for marine surveys offshore Southern California. Report for the California State Lands Commission and the United States Minerals Management Service Pacific Outer Continental Shelf Region.

IUCN (2013). The IUCN Red List of Threatened Species. Version 2013.1. [online] Available at: http://www.iucnredlist.org. [Accessed: 15 July 2013].

Joint Nature Conservation Committee (JNCC). 2010 (UK) Guidelines for Minimizing Acoustic Disturbance to Marine Mammals from Seismic Surveys. Jncc.defra.gov.uk *Seismic Survey*. [online] Available at: http://jncc.defra.gov.uk/page-1534 [Accessed: 10 July 2013].

MMS. 2004. Geological and geophysical exploration for mineral resources on the Gulf of Mexico outer continental shelf: final programmatic environmental assessment. New Orleans: US Department of the Interior Minerals Management Service Gulf of Mexico OCS Region.

Weir, C.R. & Dolman, S.J. 2007. Comparative review of the regional marine mammal mitigation guidelines implemented during industrial seismic surveys, and guidance towards a worldwide standard. *Journal of International Wildlife Law and Policy*, 10:1–27.

Laws of Seychelles, Fisheries Act, Chapter 82, revised edition 1991, p. 13.

Further information on MEE's survey consent procedure can be gained through the website http://www.env.gov.sc or contact:

P.O Box 445 Botanical Gardens Mt-Fleuri Victoria, Mahé Seychelles Telephone

Number: +(248) 467 0500

Fax Number: +(248) 461 0648

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 MEE website at: http://www.env.gov.sc

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These forms would need to be accessed in the public domain, for the operating companies, also individual MMO/PAM operators.

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