7 MITIGATION MEASURES AND MONITORING PROGRAMMES

7.1 INTRODUCTION

The following sections outline the mitigation measures and monitoring programmes that will be incorporated into the Lunskoye seismic survey operations to control the environmental impacts that have been identified in the preceding chapters of this ES. The implementation of these measures is outlined in the Environmental Management Plan presented in *Chapter 8*.

The objective of the mitigation measures and monitoring programmes is to reduce the significant impacts of the Lunskoye seismic survey reported in *Chapter 5,* so that they are acceptable and 'as low as reasonably practicable' (ALARP).

For each of the issues identified in *Chapter 5,* summaries of the potential and residual impacts, taking the agreed mitigation into account, are presented.

7.2 SOURCES OF IMPACT

As reported in *Chapter 5,* the principal impacts and issues associated with the proposed Lunskoye seismic survey have been identified as:

- noise and disturbance impacts to marine mammals, particularly the Critically Endangered western gray whale, which is vulnerable because of its low population size and dependence on the waters off Sakhalin Island's northeastern coast for feeding;
- noise and disturbance impacts to other marine biota;
- conflicts with fishing activities and commercial shipping;
- controlled effluent discharges, wastes and air emissions;
- accidental spills, leaks and dropped objects.

Control measures that are considered necessary for the reduction and maintenance of these potential impacts to within acceptable levels are discussed in the following sections.

In addition to the principal impacts and issues identified above, some potential issues have been assessed in the previous chapters as having *'no impact'* or '*negligible'* impact on the marine environment and associated receptors. Examples of these issues are:

- interference with military use of the area;
- damage to marine archaeology and cultural heritage;
- effects to marine mammal hunting practices;
- effects to the local social environment and economy;
- disturbance or damage to cables and other man-made submarine infrastructure.

As reported in the explanation of impact assessment methodology (included in *Chapter 5, Section 5.2*), these issues do not require the application of specific mitigation measures. However, where related best practice measures have been identified, these will be incorporated into the seismic programme, and summaries have therefore been provided within this chapter.

7.3 MARINE MAMMALS

7.3.1 Introduction

The proposed monitoring programme is designed to provide real-time or near real-time feedback to the operator to allow adjustments to the survey to be made that minimise the potential for impacts on marine mammals, especially western gray whales, and to collect reliable field data to determine if the overall survey may have caused an impact on the whale population.

There are no required or accepted sets of standard mitigation requirements applicable to marine seismic surveys and marine mammals in the Russian Federation. Guidelines of this type have been developed for some other countries or jurisdictions, and these examples have been used to aid in the development of project-specific measures for the Lunskoye seismic survey programme. The most comprehensive sets of guidelines have been developed for the following areas.

- United Kingdom Continental Shelf waters, by the Joint Nature Conservation Committee (JNCC, 1998). The JNCC guidelines apply to both cetaceans and pinnipeds, but emphasise cetaceans.
- Southern California waters, by the High Energy Seismic Survey (HESS) Team; apply to cetaceans, pinnipeds, and (in part) sea otters (HESS, 1999).

- Australian waters, by Environment Australia and the Australian Petroleum Production and Exploration Association (APPEA). Those apply to cetaceans only, not pinnipeds (Environment Australia, 2001).

- US Minerals Management Service (MMS, 2002) mitigation measures for seismic surveys in the Gulf of Mexico. Those measures also apply to deep water (>200 m), sperm whales, and sea turtles.

- Recent seismic surveys in the Beaufort Sea North of Alaska have also been subject to intensive regulatory action, and have included extensive monitoring and mitigation requirements. No specific list of guidelines or requirements has been published for that area, but de facto requirements concerning both cetaceans and pinnipeds have been evolved (National Marine Fisheries Service, 1999, 2000a and Lawson, 2002).

Certain other countries or jurisdictions have also adopted various guidelines and practices, but for the most part these generally represent variations on the five sets of guidelines outlined above.

There have been a number of seismic surveys carried out in the waters off the northeastern coast of Sakhalin Island (see *Chapter 3*). As described in previous chapters, a key issue for surveys carried out farther north around the existing oil and gas fields is the potential for impacts to occur to western gray whales in their known summer feeding areas within the region. The proposed Lunskoye seismic survey is farther away from the main nearshore feeding grounds, however, for a population considered to be Critically Endangered, impacts on only a few individuals may be considered significant. The mitigation measures and monitoring programme discussed in this section focus primarily on reducing potential adverse impacts on western gray whales.

The following sections summarise the major categories of mitigation and monitoring recommendations contained in one or more of the above sets of guidelines. For each category, there is a short description of the corresponding mitigation measure that will be implemented during the Lunskoye seismic survey.

7.3.2 *Seasonal Restrictions*

Background

It is standard practice in many areas to conduct seismic surveys at times of year when marine mammals are absent, present in relatively small numbers, or

present but not engaged in sensitive activities such as breeding or feeding. For example, the JNCC guidelines state that:

"*Operators should plan surveys so that their timing will reduce the likelihood of encounters with marine mammals, although at present there is limited information on their distribution in some areas*."

The HESS guidelines indicate that:

"*The measures recommended are keyed to two major factors: 1) the seasonal occurrence and distribution of marine mammals believed to be most sensitive to the potential effects of seismic sound … , and 2) the projected duration of proposed surveys*."

The Australian guidelines distinguish some periods of the year and locations that are more 'sensitive' than others, based on the occurrence and aggregation of threatened species of cetaceans, especially if engaged in breeding, feeding, or migration.

The MMS guidelines for the Gulf of Mexico do not include any seasonal restrictions on seismic programmes.

In various other areas, seasonal restrictions on seismic operations have sometimes been applied in order to avoid or reduce impacts on whales. For example, in the Alaskan Beaufort Sea, seismic surveys have sometimes (depending on the year) been prohibited when bowhead whales are migrating through the area, or subjected to more stringent geographic limitations and/or monitoring requirements during that period.

Proposed Measures

For the Lunskoye seismic survey, a mitigation measure pertaining to seasonal timing will be implemented in line with the above international practices:

- The seismic survey needs to be conducted during the open-water season, *ie* between May and November. Operations will be conducted between July and September when most western gray whales are feeding to the north, off Chaivo and Piltun Bays.

7.3.3 *Aerial Surveys*

Background

The HESS guidelines indicate that aerial surveys are recommended when a moderate-duration (between 7 and 30 days) seismic programme is planned and 'priority' species are expected to be present. More comprehensive aerial surveys are recommended in the case of a seismic programme 31 or more days in duration.

The HESS guidelines give considerable guidance about recommended aerial survey design and procedures, including the following:

"All aerial surveys should be flown in a two-engine, fixed-wing aircraft. At a minimum, the survey crew should consist of two observers, one data recorder / observer, and a pilot. Surveys should be flown at an altitude of 1000 (feet) ASL and a speed of 100 kts. Standard equipment should include a GPS navigational system tied to an onboard computer and an intercom system connecting all crewmembers. All observers should be certified by NMFS as marine mammal observers…" (see *Section 4.2.5* of *HESS, 1999* for additional details).

The Australian guidelines indicate that aerial surveys may be called for during seismic surveys in Habitat Categories B2, C, and D (1).

The guidelines state that:

"Two types of surveys are envisaged and the requirement for either or both will be assessed on a case-by-case basis.

1. *Surveys to identify where cetaceans are in relation to seismic activity and to identify when seismic vessels should be especially vigilant. These surveys would be run between the areas to be surveyed by the seismic vessel and the likely approach direction of cetaceans, or in the area in advance of the survey vessel.*

2. *Scientific surveys to identify which areas are important to cetaceans eg to identify feeding, breeding and resting areas and times of peak migration. In particular these surveys may be required in areas of potential increased sensitivity where insufficient information currently exists to determine timing and appropriate management arrangements."*

The MMS guidelines for the Gulf of Mexico do not include any suggestions or requirements for aerial surveys to monitor seismic activity.

(1) The Australian guidelines recognise six habitat categories, and require different levels of monitoring and mitigation for different categories. These categories are reported below:

A. Offshore waters outside known migratory paths and periods.

B1. Known humpback whale migration pathways during migration periods but outside peak periods, and all inshore waters.

B2. Known humpback whale migration pathways during peak migration periods; mapped migratory 'paths' of Southern right whales and blue whales during presumed migration periods.

C1. Recognised mapped aggregation areas or feeding areas within inshore or offshore areas.

C2. Inshore waters that overlap known calving areas, or resting areas for females with calves when calving females are present; a 'buffer zone' of 20 km extends around each detailed aggregation area identified.

D. Areas and time within Categories A, B or C identified as Critical Habitat under….. the [Environment Protection and Biodiversity Conservation] Act. (At present, no areas have been identified under this category).

In the Alaskan Beaufort Sea, systematic and intensive aerial survey programmes have been required when seismic surveys have occurred during the migration period of bowhead whales. The purpose has been to document the long-range avoidance responses of migrating animals to seismic operations, not to trigger any real-time mitigation actions. A standard survey grid centred near the seismic vessel and totalling about 1200 km of flight lines is flown daily (weather permitting). By comparing whale distributions at times when the airguns were operating versus shut down, the surveys demonstrated that almost all migrating bowhead whales avoided the area within 20 km of the operating airgun array.

The surveys also showed that there was statistically significant avoidance of the zone 20-30 km away (Miller *et al*., 1999 and Richardson *et al*., 1999).

Proposed Measures

For the Lunskoye seismic survey the following measures are planned:

- periodic aerial surveys of the planned seismic-survey area during the 2002 open water season (the year preceding the planned seismic survey), to characterise seasonal use of the area by western gray whales and other marine mammals.

- aerial surveys of the regional distribution and abundance of the whales in 2003 before the seismic survey starts and periodically during and after the survey. The objectives are to:

    - provide real-time or near real-time information that can be used (if appropriate) to alter the survey's starting point and survey line sequence based on the actual distribution of whales in the area immediately prior to and during surveys (see below);

    - document the numbers of whales exposed to seismic surveys and their responses to the surveys.

- aerial surveys should be conducted only when they can be carried out in a safe manner and during periods of good visibility where there is a greater probability of detecting western gray whales and other marine mammals.

7.3.4 *Airgun Array Size and Configuration*

Background

Increasing attention is being given in some jurisdictions to the desirability of:

- avoiding unnecessarily strong energy sources;
- minimising the proportion of the energy that propagates horizontally;
- minimising the amount of energy at frequencies above those useful for geophysical purposes.

The JNCC guidelines include the following two statements:

"*Operators should seek to reduce and/or baffle unnecessary high frequency noise produced by air-guns or other acoustic energy sources*."

"*KEEP IT LOW: Throughout the survey, the lowest practicable power levels should be used*."

The HESS guidelines do not specifically call for minimising the size of the airgun array or its sound output. However, they do call for the survey proponent to specify the characteristics of the proposed array, its source level, and the distance out to which the sound level could exceed 180 dB re 1 μPa (rms). When marine mammals are seen within that distance, the airguns are to be shut down. Thus, the larger and more powerful the array, the more often the seismic survey will be interrupted.

The Australian guidelines do not include specific wording concerning the size or sound output of the airgun array. However, there is special concern about the zone around the sound source within which the sound level exceeds 150 dB re 1 μPa (rms), or 140 dB in the case of cetacean aggregation areas or critical habitats. Those areas will depend on the size and design of the airgun array.

The MMS guidelines for the Gulf of Mexico do not include any wording concerning airgun array size and configuration.

In the Alaskan Beaufort Sea, where disturbance to bowhead whales is a major issue, seismic surveys conducted since 1996 have been done with relatively small arrays of airguns (560 to 1500 in^3, 9.2 to 24.6 l) in part to minimise impacts on bowheads whales. Two different seismic contractors have also each reduced the size of their standard airgun array after their first year of operations. It should be noted that a small, closely-spaced array of airguns was used for only one season because it was found to emit more sound in horizontal directions than did other larger arrays that were designed to reduce horizontal propagation (Balla-Holden *et al*., 1998 and Lawson, 2000).

Proposed Measures

For the Lunskoye seismic survey:

- the airgun array will be configured to maximise the proportion of the energy that is directed downward and to minimise horizontal sound propagation. In particular, closely spaced airguns whose overall radiation pattern is nearly omnidirectional will be avoided. The size of the airgun arrays, as measured by the source level, will not be any larger than required to meet SEIC's objectives for the seismic survey.

7.3.5 *Ramp-Up or Soft Start*

Background

It has become standard practice in many areas to increase the source level of an airgun array gradually after a period when the airguns have been silent, rather than to commence firing all airguns simultaneously at full power. This practice is intended to allow any marine mammals that are close to the array to move away, if they find the airgun sounds to be aversive, before they are exposed to the sounds at full power. The measure is primarily intended to reduce any potential for hearing damage.

For example, the JNCC guidelines state that:

"*Where equipment allows, power should be built up slowly from a low energy start-up (eg starting with the smallest air-gun in the array and gradually adding in others) over at least 20 minutes to give adequate time for marine mammals to leave the vicinity. There should be a soft start every time the airguns are used, even if no marine mammals have been seen. The soft start may only be waived for surveys where the seismic sources always remain at low power levels eg some site surveys.*"

The HESS guidelines indicate (*Section 4.2.3*) that 'soft start' has become a standard mitigation measure in many areas. The guidelines note that:

"*this has primarily been a common sense measure, since there have been no comprehensive studies of the effectiveness of ramp-up procedures*"

The HESS guidelines recommend the following 'soft start' protocol:

"*At the commencement of operations or anytime that the array has been powered down, the airgun array should be ramped up to full operating levels starting with the smallest airgun and adding power at a rate of approximately 6 dB per minute.*"

The Australian guidelines call for 'soft starts' during all seismic surveys, even in offshore waters outside known migratory paths and periods. Specifically, the guidelines state the following:

- a sequential build-up of warning pulses will be carried out at the commencement of all surveys. The whole array will not be fired without a full soft start. Soft starts will be used even if no whales have been seen;

- visual observation will be maintained continuously during soft starts to establish the presence or absence of whales within 3 km of the vessel;

- if whales are sighted during this soft start procedure within the 3 km zone, the seismic source will be shut down. Re-commencement of soft start procedures will take place after 30 minutes has lapsed since the last whale sighting within the 3 km zone;

- there may be continued discharge of the acoustic source during line turns or changes. Discharge of only a limited number of airguns in the acoustic array would be sufficient in this case.

The soft start procedure involves a gradual increase in the number of airguns fired over a 20 minute period prior to commencement of a survey line, and serves to send out a series of warning pulses to whales and give them adequate time to leave the vicinity.

The MMS guidelines for the Gulf of Mexico require 'soft start' procedures for all seismic surveys in water depths greater than 200 m. Specifically, the guidelines state the following monitoring requirements.

- *"Visually monitor the exclusion zone and adjacent waters for the absence of sperm whales for at least 30 minutes before initiating ramp-up procedures. If no sperm whales are detected, you may initiate ramp-up procedures. You <u>must</u> <u>not</u> <u>initiate</u> ramp-up procedures at night or when you cannot visually monitor the exclusion zone for sperm whales if your minimum source sound level output drops below 160 dB re 1 μPa (see measure 5).*

- *Initiate ramp-up procedures by firing a single airgun. The preferred airgun to begin with should be the smallest airgun, in terms of energy output (dB) and volume (in^3).*

- *Continue ramp-up by activating additional airguns at a rate of 6 dB re 1 μPa per 5 minute interval until the airgun array is operating at the desired survey intensity.*

- *Immediately shut down all airguns ceasing seismic operations at any time a sperm whale is detected entering or within the exclusion zone. You may recommence seismic operations and ramp-up of airguns only when the exclusion zone has been visually inspected for at least 30 minutes for the absence of sperm whales.*

- *You may reduce the energy output of the airgun array to maintain a minimum source sound level output of 160 dB re 1 μPa for routine activities, such as making a turn between line transects, or for maintenance needs. This procedure may be followed during periods of impaired visibility (eg, darkness, fog, high sea states, etc.) and does not require a 30 minute visual clearance of the exclusion zone before the airgun array is again ramped up to full output."*

In the Alaskan Beaufort Sea, all recent seismic programmes (between 1996 and 2001), involving arrays of airguns have required 'soft start' procedures to be followed whenever the airguns have been shut down. Recent practice has been to require a 'soft start' whenever all airguns have been silent for more than 1 minute (or 2 minutes at times when the vessel is moving at less than or equal to 3 knots) (Lawson, 2002). Required practices have varied from year to year, but generally require the 'soft start' to commence with firing of either the smallest airgun or of a single airgun not exceeding 80 in^3 (1.3 litres). To avoid the necessity for full 'soft starts' procedures to be followed after line changes, one or more airguns have often been kept operating during this period.

Proposed Measures

For the Lunskoye seismic survey, one measure pertaining to 'soft start' procedures is planned.

- The seismic operator will ramp-up airguns slowly over a period of 20 minutes each time shooting begins, especially if the shut-down period has been substantial, *ie* over 10 minutes. 'Soft starts' will follow every interruption of the survey, most importantly if the survey is discontinued until marine mammals leave the safety zone. The seismic operator and on-board environmental monitors (see below) will maintain records of the times when ramp-ups start, and when the airgun array reaches full power.

7.3.6 *Safety Distance*

Background

The various guidelines and practices differ substantially with regard to the recommended or required action when marine mammals are seen within designated distances or within zones where the airgun sounds might exceed some specified received level.

The JNCC guidelines call for delaying the start of airgun operations when marine mammals are sighted (or detected acoustically) within 500 m of the vessel or survey equipment, but there is no wording calling for suspension of airgun operations when mammals are seen within any specified distance when the airguns are already operating:

- "*Beginning at least 30 minutes before commencement of any use of the seismic sources, the operator and observers should carefully make a visual check from a suitable high observation platform to see if there are any marine mammals within 500 metres, …*"

- "*DELAY: If marine mammals are present, the start of the seismic sources should be delayed until they have moved away, allowing adequate time after the last sighting (at least 20 minutes) for the animals to move well out of range. Hydrophones may also be useful in determining when cetaceans have moved. In situations where seal(s) are congregating immediately around a platform, it is recommended that commencement of the seismic sources begins at least 500 m from the platform.*"

The Australian guidelines call for the onset of airgun operations to be delayed if a whale is seen within 3 km of the vessel during the 90 minute period before operations are expected to begin. Airgun operations are also to be suspended if a whale is seen within 3 km during airgun operations. Those provisions apply in all habitat categories.

The MMS guidelines for the Gulf of Mexico call for the onset of airgun operations to be delayed if a sperm whale is seen within a 500 m radius surrounding the centre of an airgun array and the area within the immediate vicinity of the survey vessel during the 30-minute period before operations are expected to commence. Airgun operations are also to be suspended if a sperm whale is seen within this exclusion zone during airgun operations. 'Soft start' and seismic survey activities can only be resumed when the observer has:

- determined that the sperm whale(s) has departed the exclusion zone;

- visually monitored the exclusion zone for at least 30 minutes since the last sperm whale sighting within the exclusion zone.

During seismic surveys conducted in the Alaskan Beaufort Sea since 1996, the airguns were to be shut down if a cetacean was detected within the 180 dB re 1 μPa (rms) radius, or if a pinniped was detected within the 190 dB re 1 μPa (rms) radius. The US National Marine Fisheries Service has takes the view that cetaceans and pinnipeds should not be exposed to levels of impulsive sound above 180 and 190 dB re 1 μPa (rms), respectively (*eg* NMFS, 2000b). During six seismic programmes in the Alaskan Beaufort Sea between 1996 and 2001, varying in duration from 3½ to 12 weeks per year, the number of shutdowns for marine mammals was 112 in 1996 (Harris *et al*., 2001) and 104 in the other five seasons combined. All but one of those shutdowns was for seals; bowhead whales almost

always remained far enough away from the operating airguns to avoid the need for shutdowns (Moulton and Lawson, 2002). The purpose of the 180 dB guideline for whales is to avoid potentially harmful exposure, not to avoid disturbance; whales exposed to airgun sounds with received levels well below 180 dB re 1 μPa (rms) are expected to be disturbed. That is allowable in US waters provided that an appropriate incidental 'take' authorisation is obtained from the National Marine Fisheries Service (NMFS, 1996).

The JNCC, MMS, and Australian guidelines are based on fixed distances (500 m, 500 m and 3 km, respectively). Those guidelines do not specifically require measurements of the airgun sounds at those or other distances. However, the Australian guidelines do provide guidance concerning the different ways in which airgun sounds can be measured.

The HESS guidelines specify that the 180, 160, and 140 dB re 1 μPa (rms) distances should be estimated in advance based on the characteristics of the planned airgun array and applicable sound propagation studies for the area. If the latter do not exist, then a conservative (precautionary) approach should be taken in deriving the estimate. At the start of the actual seismic survey, the actual 180 and 160 dB distances should be determined based on field measurements, and a report documenting the results should be submitted within 72 hours. Verification may not be required if acoustic measurements of sound levels from the same airgun array operated in the same location are already available.

The HESS guidelines for Southern California recommend (in *Section 4.2.1*) that the airguns be shut down when a marine mammal is detected within the radius where the received sound level (below the surface) is expected to be 180 dB re 1 μPa (rms) or higher.

The approach has been similar to that developed for the 1996 to 2000 Alaskan Beaufort Sea survey. The 190, 180, and 160 dB distances are estimated in advance based on:

- characteristics of the planned airgun array;
- existing site-specific propagation data;
- measurements of received levels versus distance from airgun arrays operating in the same general area in previous years.

The predictions are checked by direct field measurements during the first 7 to 10 days of the seismic programme, and adjustments to the safety radii are made as necessary. No acoustical measurements have been required in years when the airgun array was the same as (or smaller than) an array used and measured in the same area during a previous year.

As noted above, the purpose of the 180 dB guideline for whales is to avoid potentially harmful exposure. It has been demonstrated that the behaviour of whales can be affected at lower received sound intensities than those causing temporary hearing loss or other physical damage (Richardson *et al*., 1995). Noise associated with seismic exploration may have caused changes in western gray whale behaviour during an earlier seismic survey on the northeast Sakhalin Shelf near the Piltun feeding area in 1997 (Würsig *et al*., 1999). The suspected behavioural changes included alterations in swimming speed and direction, distance travelled, and surface-respiration-dive characteristics (blow interval) during periods when seismic surveys were being conducted, as compared to periods when seismic surveys were not occurring. There was no evidence to suggest that western gray whales were displaced from their feeding grounds.

Behaviour studies conducted in association with earlier seismic experiments (see Malme *et al*., 1983, 1984, 1986, 1988; Malme and Miles, 1985) provide the best information available on the effects of seismic surveys on the eastern population of gray whales. Experiments on feeding gray whales in the Bering Sea indicated that 10% of the whales showed major modifications to behaviour (ceased feeding and moved rapidly away from the vessel) when the received sound levels generated by a seismic ship were greater than 163 dB re 1 μPa rms as measured in the water column (Malme *et al*., 1983, 1984, 1986, 1988; Malme and Miles, 1985). Most displaced whales returned to their original locations and resumed feeding within 1 hour after the seismic source was shut down (Malme *et al*., 1986). A calibration study carried out prior to a seismic survey, conducted by ENL in 2001 near the north end of the Piltun feeding area off northeast Sakhalin Island, determined that the distance at which seismic pulses attenuated to 163 dB re 1μPa rms was about 7 km from the airgun array when the array was operating at full volume (3,090 cu in or 50.6 l) and about 4 km from the array when operating at about half volume (1640 cu in or 26.9 l).

Proposed Measures

For the Lunskoye seismic survey, the following measures are planned.

- Initial safety zones will be established prior to the survey based on available data and modelling concerning sound output and on the assumption that seismic pulses at broadband received levels above 190 dB re 1 μPa (rms over duration of pulse) for pinnipeds, or above 180 dB re 1 μPa rms for cetaceans, should be avoided whenever possible because those levels might affect hearing abilities at least temporarily. The safety radii for pinnipeds and cetaceans at these two respective received levels (190 and 180 dB) are expected to be in the order of 250 m and 1 km, respectively. The sound levels are based on frequencies between 10 Hz and 120 Hz, the typical peak spectrum of sound emitted for seismic surveys.

- If aerial or other surveys of the Lunskoye area in 2002 or 2003 show the seismic survey area to be a regular feeding area for western gray whales during the date range of the proposed seismic operations, then a more precautionary shutdown criterion than the aforementioned 180 dB distance will be adopted for western gray whales, *ie* the 163 dB re 1 μPa rms level described above. With a 47.5 l array, the distance would be approximately 6 to 7 km.

- The safety distances will be verified (and if necessary adjusted) during the first week of the seismic survey, based on direct measurements via calibrated hydrophones of the received levels of underwater sound versus distance and direction from the airgun array. The acoustic data will be analysed quickly in the field and used to adjust safety distance. The same acoustic data will be useful in interpreting observations of marine mammals during analysis of sighting data after the programmes completion (see below).

7.3.7 *Shipboard Marine Mammal Observers*

Background

The JNCC, HESS, Australian, and MMS guidelines all call for one or more personnel dedicated to marine mammal observations to be stationed aboard the seismic vessel to document the occurrence of marine mammals near the seismic vessel, to help implement mitigation requirements, and to record the reactions of marine mammals to the seismic survey.

The JNCC guidelines state that:

- *"In areas which are important for marine mammals (as indicated in consultation with the JNCC) operators should seek to provide the most appropriately qualified and experienced personnel to act as marine mammal observers on board the seismic survey vessel. If possible, such observers should be experienced cetacean biologists. As a minimum, it is recommended that observers should have attended an appropriate training course."*

- *"If advised to do so by the JNCC, discuss the precautions which can be taken to reduce disturbance, and the design of any scientific studies with the Sea Mammal Research Unit… In areas where marine mammals are abundant, properly conducted observation and recordings using qualified observers (see above) carried out before, during and after the seismic survey, can provide valuable information on its effect."*

- *"LOOK AND LISTEN: Beginning at least 30 minutes before commencement of any use of the seismic sources, the operator and observers should carefully make a visual check from a suitable high observation platform to see if there are any marine mammals within 500 metres…"*

The HESS guidelines (*Section 4.2.4*) call for ship-based observers to serve one or both of the following functions:

- monitoring designated safety zones around the airgun array to provide the basis for real-time mitigation (airgun shutdown);
- collecting data on the marine mammals observed, the estimated numbers 'affected' by harassment, and any behavioural responses to the seismic survey activities.

The HESS guidelines include many details concerning the number and qualifications of observers, the types of equipment they should use, and whether operations should continue during the night or periods of poor visibility. Specific requirements depend on the duration of the seismic survey and the types and numbers of marine mammals likely to be encountered. As a minimum, two or three observers with experience as marine mammal observers are required, depending on the duration of the survey. One observer is to be on duty whenever the airgun array is operating, day or night, and beginning at least 30 minutes prior to 'soft start'. Individual watches should not last longer than 4 hours. Observers have the authority to require shutdown of the airguns whenever marine mammals are observed within a designated safety radius.

The Australian guidelines also call for visual observations from the seismic survey vessel during all seismic surveys, even those in offshore waters outside known migratory paths and periods. Trained and dedicated cetacean observers are required during seismic surveys in habitats that are considered more sensitive (Habitat Categories B2, C, and D). The guidelines also state that as a minimum measure the following procedures should be followed adopted.

- *"During daylight hours, visual checks (using binoculars from a suitable, high observation platform on the survey vessel) for the presence of whales will be undertaken before the commencement of operations."*
- *"During night time operations, the use of Infra-Red (IR) or night-vision binoculars will be used to undertake visual checks before the commencement of operations."*
- *"Observations will begin at least 90 minutes prior to use of any high-energy acoustic sources, with particular focus on a 3 kilometres radius around the survey vessel..."*
- *"Visual observations of 10 minute duration per hour will be carried out during seismic operations.*
- *"During night time operations, Infra-Red (IR) or night-vision binoculars will be used for the hourly observations. Night time visual observations will also be of 10 min duration per hour."*
- *"Where a whale of a species included in Attachment 1 is seen as part of the observation procedures, continual observations should occur until 2 hours have passed since the last observation of a cetacean of a species included in Attachment 1."*

- *"All cetacean observations, whether within 3 km or not, should be documented and reported."*

More stringent observational protocols may be required in circumstances where seismic surveys will occur in whale feeding, breeding and resting areas and migratory routes identified in the Australian guidelines.

The MMS guidelines for the Gulf of Mexico require that seismic operators use trained visual observers on all seismic vessels who have successfully completed a NOAA Fisheries approved training programme. The guidelines clearly state that "*seismic operators must shut down the array when instructed by an observer*" but provide few details about observational protocols (*eg*, the use of binoculars, maximum length of observation periods). Observers are not required to monitor when atmospheric conditions reduce visibility to zero or during hours of darkness (*ie* night).

During seismic surveys in the Alaskan Beaufort Sea since 1996, a team of 2 to 4 observers, all with experience in marine mammal observation, has been stationed aboard the seismic vessel. One or (when possible) two observers are on duty at all times when the airguns are operating, and (for comparison) at times when the vessel is underway but the airguns are not operating. Recently, there has been a requirement for two observers to be on duty when the airguns are about to start operating. Watches are limited to 4 hours in duration (NMFS, 1999, 2000a and Lawson, 2000, 2002). When only two dedicated marine-mammal observers are aboard, the seismic contractor's watchkeeping personnel are required to assist in watching for marine mammals, and implementing required mitigation measures, *eg* shutdowns of airguns when mammals are sighted within the safety radius.

Proposed Measures

For the Lunskoye seismic survey the following measures are planned.

- If western gray whales are found to be feeding in the Lunskoye area, boat-based studies of their behaviour will be conducted during the seismic programme to document any changes in normal feeding behaviour by the whales.

- One or more trained marine mammal observers on the seismic ship and, optionally, on an accompanying chase vessel will be on watch for marine mammals during all daylight hours when seismic operations are in progress. This will require at least two and preferably three observers per vessel, given that observer efficiency deteriorates after approximately 4 hours, and that having two observers on watch simultaneously increases the probability of sighting the marine mammals present near the vessel. Observers will be stationed on the chase vessel as well as the seismic ship if aerial surveys in 2002 indicate that the Lunskoye area is used regularly for feeding by western

gray whales or other endangered whales during the time of year when the seismic project is conducted. In selecting seismic and chase vessels for the programme, SEIC will take account of the requirement to accommodate 2 to 3 marine mammal observers on each vessel.

- The purpose of the observers on the seismic vessel, and possibly the chase vessel, will be to document the occurrence and responses of marine mammals visible from the vessel, and to initiate airgun shutdown requirements and any other agreed-upon actions when a marine mammal is observed within certain ranges of the sound source. Furthermore, the observers will attempt to confirm the absence of marine mammals in the safety zones prior to 'soft start'.

- When a marine mammal is sighted within, or approaching, the safety zone around the airgun array, the observers will notify the seismic contractor who will shut down the airguns. After completion of the survey, a technical report and a scientific research paper will be prepared to summarise the observations, results, and conclusions of the marine mammal monitoring programme.

7.3.8 *Operations at Night and in Poor Visibility*

Background

The JNCC, HESS, Australian, Alaskan Beaufort Sea, and MMS Gulf of Mexico guidelines and practices all involve visual observations by observers stationed aboard the seismic vessel and/or support vessels. In all cases, mitigation actions, including delayed start-up and/or airgun shutdown, are to be implemented when marine mammals (in Australia, cetaceans) are sighted within specified distances. Nonetheless, it is recognised that, even on clear nights, visual detection of marine mammals is very difficult and unlikely even when a combination of floodlights, image intensifiers, and thermal infrared detectors is used. The probability of detecting marine mammals visually deteriorates further in fog, heavy rain, or snowfall either by day or especially by night.

The JNCC guidelines do not specify any limitations on seismic surveys during darkness or poor visibility, and say very little about the detection problems at those times. The JNCC guidelines do, however, state that:

"Hydrophones and other listening equipment may provide additional information on the presence of inconspicuous species, such as harbour porpoises, or submerged animals, and should be used whenever possible. This will be particularly appropriate in poor weather, when visual evidence of marine mammal presence cannot be obtained."

The night-time/poor-visibility issue received much attention during development of the HESS guidelines. The HESS Team noted that:

- *"operations at night involve a trade-off regarding the ability to visually detect animals in the study area and the advantages of achieving continuous operation… . Night operation requires a case-by-case evaluation. Factors to consider include seasonality (hours of daylight, weather, migration patterns), priority of animals of concern, air quality, fishing impacts, and economics."*

- *"When operating under conditions of reduced visibility due to adverse weather conditions, operations may continue unless, in the judgement of the shipboard observers, the safety zone cannot be adequately monitored and observed marine mammal densities have been high enough to warrant concern that an animal is likely to enter the safety zone. Observers have the authority to permit operations to resume or continue under reduced visibility conditions, based on periodic re-evaluation that takes into account the densities of observed marine mammals and variations in visibility allowing for intermittent monitoring of the safety zone."*

- *"To strengthen the authority of observers to require shutdown, more specific guidance regarding shutdown criteria to be applied in any specific project should be specified by (NMFS) in the proposed authorization. Such project-specific criteria may include the probabilities that individuals of particular species may enter the safety zone."*

- *"To address the ongoing concerns about the adequacy of existing equipment and its ability to monitor the safety zone at all times (night time and reduced visibility) efforts should be made to test and determine the efficacy of available state-of-the-art equipment…"*

- *"… if information becomes available that demonstrates that marine mammals of concern will avoid the safety zone when the vessel is shooting steadily, or that ramp-up methods are effective in moving marine mammals of concern away from the safety zone, it may be possible to remove the conditional requirements that an array be shut down at times of reduced visibility."*

In the Australian guidelines, no shutdown requirements are specified for night or poor-visibility situations. For all seismic surveys:

- *"During night time operations, the use of Infra-Red (IR) or night-vision binoculars will be used to undertake visual checks before the commencement of operations."*

- *"During night time operations, Infra-Red (IR) or night-vision binoculars will be used for the hourly observations. Night time visual observations will also be of 10 min duration per hour."*

The Australian guidelines also note that:

"Whale observations become increasingly difficult as sea state increase. An upper limit for practical whale observation is sea state 5."

The MMS guidelines for the Gulf of Mexico do not require monitoring when atmospheric conditions reduce visibility to zero or during the night. However, the guidelines prevent initiation of 'soft start' procedures at night or when poor visibility prevents visual monitoring of the exclusion zone for sperm whales if the minimum source sound level output drops below 160 dB re 1 μPa.

Practical experience has shown that night time observations for whales and pinnipeds around a vessel are largely ineffective even when night-vision devices (NVDs), either image intensifiers or commercially available thermal-infrared devices, are used.

Proposed Measures

For the Lunskoye seismic programme, the following measures are planned.

- When operating under conditions of reduced visibility attributable to darkness or to adverse weather conditions, infra-red or night-vision binoculars will be available for use. However, it is recognised that their effectiveness for this application is very limited even in clear night time conditions.

- Seismic activities will not start during darkness or during conditions when visibility is reduced to less than the radius of the safety zone (see *Section 7.3.6*). Seismic operations may continue under conditions of darkness or reduced visibility unless, in the judgement of the senior marine mammal observer, densities of endangered cetaceans in the general area are high enough to warrant concern that an endangered cetacean is likely to enter the safety zone undetected. In that case, observers will advise the Captain to halt airgun operations, or to move to a part of the survey area where visibility is adequate or where the likelihood of encountering an endangered cetacean is low based on aerial and vessel based surveys that would be part of the real-time monitoring programme.

7.3.9 *Real-Time Acoustic Monitoring*

The possibility of using a towed hydrophone array or other passive acoustic technique to detect and perhaps locate marine mammals has been considered for this project, but is not proposed. The species of most concern is the western gray whale. Gray whales are not very vocal when on their summer feeding grounds. When they do call, their calls are typically at low amplitudes and not detectable very far away. Based on discussions with researchers who have recorded and

studied gray whale vocal behaviour during summer, it is concluded that this approach would not be very effective for summering western gray whales.

7.4 CONTROL OF CONFLICTS WITH OTHERS USERS OF THE AREA

7.4.1 *Fishing Operations*

Fishing activity in the Lunskoye field is considered to be very low, however, the following precautionary measures will be adopted.

- Sakhalin Oblast Environmental Protection Committee will be advised of the planned survey activities in advance of the survey at a time recommended by the department. The information provided will include a detailed schedule including the location of activities, timing and the names of all vessels.
- A Notice to Mariners will be issued and local radio broadcasts will be made to inform fishermen of the proposed activities.
- A fisheries liaison officer will broadcast a warning message from the survey vessel on a fixed shipping channel.
- There will be a system of compensation for fishermen to avoid the Lunskoye Field during the survey period.
- A support boat will accompany the seismic survey vessel at all times. The boat's function will include warning fishing vessels ahead of the seismic vessel to clear the area, removing any fishing equipment and preventing the crossing of fishing vessels across the seismic streamer equipment. Any interactions or conflicts with fishing activities will be reported to the Sakhalin Oblast Environmental Protection Committee.
- Removal of fishing equipment by the support boat will be a last resort only; detailed records (including details of the precise location, nature and amount of equipment, identifying marks *etc*) of any equipment or obstructions removed from the path of the survey vessel will be maintained and details communicated to the shore on a daily basis.
- Any compensation claims submitted by fishermen for damaged fishing equipment will be investigated and resolved within a reasonable timeframe (1).
- A radar reflector and flashing light will be provided on the streamer tail buoy for operations at night.

(1) Details to be agreed in due course.

7.4.2 *Shipping and Navigation*

Planned and recommended control measures are as follows.

- The Sakhalin Oblast Environmental Protection Committee will be advised of the planned survey activities and a Notice to Mariners alerting shipping to the survey operations will be issued and any interactions with vessel traffic will be reported to the Sakhalin Oblast authorities.
- Local radio stations will broadcast information about the survey operations.
- Radar and navigational systems on the seismic survey vessel will provide advanced warning of potential conflicts with surface shipping.
- The support boat will guide vessels away from the seismic vessel and its streamer equipment.
- A radar reflector and flashing lights will be provided on the streamer tail buoy.
- Depth controllers or 'birds' will allow the streamer to be rapidly raised or lowered in the event of a potential conflict with a surface or subsea hazard.

7.4.3 *Marine Archaeology and Cultural Heritage*

Previous surveys have not indicated the presence of any wrecks in the survey area, however, a pre-seismic survey side-scan sonar survey will be carried out to identify any potential wrecks and other seabed hazards which could snag the streamers. Any wrecks identified will be marked and a 500 m exclusion zone established around them to prevent potential damage to wreck sites and the survey equipment. All potential wreck sites will be reported to Sakhalin Oblast Environmental Protection Committee on completion of the survey.

7.4.4 *Military Activity*

It is not considered likely that the Lunskoye Field will be used for military purposes, however, as a precautionary measure, the Russian Federation military will be notified of the details and schedule of the operations to avoid any potential conflicts.

7.5 CONTROL OF EFFLUENT DISCHARGE, EMISSIONS AND WASTES

7.5.1 *Effluent Discharges*

Impacts associated with routine effluent discharges from the survey programme vessels are predicted to be negligible providing the following planned and recommended control measures are adhered to:

- the seismic survey vessel will comply with the requirements of *MARPOL 73/78*, *Annex I*, and as such:
    - the vessel will have an International Oil Pollution Prevention (IOPP) Certificate;
    - an Oil Record Book (ORB) will be maintained with details of how, when and where any waste oils or oily effluents were disposed of;
    - an oily slops storage tank will be provided;
    - oily effluents from bilges and machinery spaces will be treated in an oil / water separator to a 15 ppm oil content specification prior to overboard discharge. Bilge will only be pumped if the oil / water separators are functioning correctly;
- the requirements stated above should ensure that overboard discharges comply with the requirements for Russian Federation legislation;
- operational procedures will be in place for the seismic survey vessel for all operations that involve handling fuel, oil and oily effluents/waste during routine and maintenance activities including offshore bunkering/fuelling procedures;
- biodegradable lubricants and rust preventatives will be used on towed equipment such as the streamer;
- sewage generated on the seismic survey vessels will be treated (by aeration, settlement and neutralisation of pathogens) in a packed treatment unit prior to discharge in compliance with Russian Federation legislation.

7.5.2 *Solid & Scheduled Waste Management*

Provided solid and scheduled wastes generated onboard vessels involved in the survey programme are managed and disposed of in accordance with relevant Russian Federation legal requirements and the engaged survey contractors stated waste management procedures, contamination of the marine environment by waste materials would not be expected.

The following planned and recommended measures will be adhered to:

- all wastes generated will be managed (*ie* stored, handled and disposed of) in accordance with the requirements of SEIC, MARPOL 73/78 and the regulations of the receiving port and the flag nationality of the seismic survey vessel. Under no circumstances will solid and scheduled wastes be disposed of to the sea;

- the seismic survey vessel may have onboard incineration facilities. Resultant incineration residues would be returned to shore for disposal at an appropriate facility;

- any scheduled wastes returned to shore will be stored, labelled and disposed of in accordance with local legislation. Prior to entry into port, local authorities will be notified as to the type and quantity of waste to be disposed.

- no scheduled waste will be disposed of to a facility that is not fully equipped to receive and store it;

- material minimisation followed by the reuse and recycling of materials will be considered wherever possible;

- accurate and detailed manifestation and documentation of all wastes generated, disposed of or transferred to shore will be maintained.

7.5.3 *Air Emissions Control*

No impacts relating to emissions from survey operations on air quality are expected to occur provided the following measures are followed:

- all vessel propulsion systems, exhaust systems, power generation equipment and waste incinerators are well maintained and operated efficiently;

- no ozone depleting substances will be used, except in refrigeration equipment where closed recovery systems will be employed;

- newly constructed geophysical vessels should be fitted with exhaust gas monitoring systems as per nationality flag and class requirements and should not use any refrigerants or other substances that have an ozone depletion potential above zero.

7.6 *CONTROL OF ACCIDENTAL SPILLS, LEAKS & DROPPED OBJECTS*

Accidental events including inter-vessel collisions, interactions with the survey equipment, vessel grounding, spills and leaks of hydrocarbon materials or waste products have the potential for adverse environmental consequences unless they can be controlled. Survey activities will be conducted in accordance with the highest standards of safety and industry association guidelines for offshore seismic operations (*eg* the *International Association of Geophysical Contractors Environmental manual for Worldwide Geophysical Operations, 2001*). Detailed written operational, contingency and response procedures including Emergency Response Plans will be in place onboard the vessels to cover all anticipated activities and hazard scenarios. Members of staff will be assigned to these procedures, including an Emergency Response Coordinator and crewmembers who are proficient in the use of clean-up equipment.

The survey contractor will prepare an emergency contingency plan, which will address the recommendation contained in this document. The following planned and recommended measures have been designed to reduce the risks and possible impacts of accidental events to ALARP levels.

- Survey activities will be conducted in accordance with the vessels' operating procedures including:
    - a health, safety and environment (HSE) management system incorporating all the key management components (policy, organisation and responsibilities, planning and implementation, performance monitoring, audits and inspections, review and improvement);
    - an operational plan for the survey operations;
    - an activity catalogue (itemising key personnel tasks and responsibilities);
    - hazard analysis (safety hazards register, safety-critical operational procedures and a manual of permitted operations).
- A support boat will be provided to serve as advanced warning to other users of the marine environment, to protect deployed equipment and to assist / support the seismic survey vessel in the event of power failure, steering failure, crew evacuation *etc*.
- The seismic survey vessel will be installed with radar, navigation and communication systems.
- The minimum operational water depth will be 20 m in order to protect the vessel and survey equipment from grounding and snagging risks.

- A side-scan sonar survey will be conducted in the area prior to the seismic survey to identify any potential grounding or snagging hazards.
- Survey operations will be suspended in severely adverse weather conditions.
- All petroleum products and hazardous substances will be stored according to regulations and manufacturer's directions in approved containers, labelled correctly and stored in bounded areas where spills can be contained and treated.
- All hazardous materials will be identified and handled appropriately and safety regulations and manufacturer's directions will be available to all crew members.
- The valves between manifolded fuel tanks will normally be closed, and all fuel tanks or drums will be labelled with their contents.
- All portable tanks, drums, containers and equipment with capacities of 25 litres or above will be marked with the contractor's name.
- Oily wastes will be handled in accordance with *MARPOL 73/78* requirements.
- All pumping and filling equipment will be kept in good operational condition and will be checked regularly for leaks.
- If oil filled streamers are used they will be filled with cable oil within a dedicated bunded filling area by trained operatives.
- The cable deck, storage and under streamer reel areas will be constructed to collect any oil spills. These areas will drain into a holding tank, and the contents will be recycled or sent ashore for recycling or disposal.
- All deployed equipment will be highly visible and labelled.
- Waste reception facilities on the vessels will be clearly labelled and containers/facilities used to store wastes onboard will be closed or covered to prevent accidental overboard loss.
- The streamers will be fitted with depth controllers to allow the rapid raising/ lowering of the streamers in the event of potential conflict.
- Any waste materials and equipment accidentally lost overboard will be recorded and recovered (whenever possible).
- Regulatory agencies and local traffic will be notified of the loss of equipment.
- Items will be attached securely to equipment *eg* the securing of weights onto streamer cables and the use of tape to secure objects will be minimised.

- Inflatable devices on the streamer sections will prevent sections from being lost. The devices activate when the streamer section sinks to an unacceptable depth.

- Location devices will be in place on the deployed tail buoy and streamer to aid location and recovery in the event of a loss.

- All 'in-sea' equipment will be accounted for.

- Shipboard Oil Pollution Emergency Plans (SOPEP) requires that the vessels carry out an oil spill clean-up drill at intervals to be decided by the vessel owners. Drills should be carried out every three months as a minimum measure.

If a spill occurs, response and contingency plans for accidental events will be in place including a SOPEP, associated equipment and an appropriate spill kit. The safety of personnel will be the primary concern. Any crewmembers involved in clean up or containment will have an adequate level of training and will wear Personal Protective Equipment (PPE) appropriate to the nature and volume of spilled material.

In addition:

- no smoking or open lights will be permitted near to the spill;

- appropriate authorities will be notified immediately after the leak is detected or observed;

- professional assistance will be requested if considered to be required by trained personnel;

- the location of the spill, prevailing winds, currents and sea state will be identified and recorded;

- remedial actions to prevent further leakage will be employed where possible *eg* the plugging of a hole, the transfer of spilling fluids on a breached tank or the listing/trimming of the vessel to bring an area of damage above the water line;

- where possible, the spill will be contained through the downwind assembly of a containment boom, pump preparation and application of absorbent pads;

- no dispersants will be used unless appropriate authorities approve their use;

- action will be taken to prevent recurrence.

7.7 *RESIDUAL IMPACTS*

The potential impacts and the residual impacts from the proposed Lunskoye seismic survey, taking the agreed mitigation measures into account, are presented in *Table 7.1*. All potential impacts identified as being *major* have been reduced to *moderate* or *minor* levels through mitigation. For *moderate* impacts, the agreed mitigation measures are designed to reduce these to ALARP levels. For *minor* impacts and *no impacts*, specific mitigation is not required, however, many of these impacts are controlled by standard vessel operating procedures, best-practice measures and legal compliance measures.

Table 7.1 Summary of Potential and Residual Impacts (Taking Agreed Mitigation Measures into Account)

Issue	Key Impacts	Potential Impact	Residual Impact
Noise and Disturbance Effects on Marine Biota			
The effects of noise and physical presence of survey vessels on marine mammals	• TTS, PTS, and non-auditory physiological effects on all cetaceans and pinnipeds	Moderate	Minor
	• Disturbance and short-range avoidance movements in bowhead and white whales, and ribbon seals	No Impact	No Impact
	• Disturbance and short-range avoidance movements in fin and minke whales	Moderate	Moderate
	• Disturbance and short-range avoidance movements in common dolphins, killer whales and largha, ringed, bearded and Northern fur seal	Moderate	Moderate
	• Disturbance and short-range avoidance movements in the Endangered North Pacific right whale	Moderate	Moderate
	• Disturbance and short-range avoidance movements and temporary displacement from usual migration route of western gray whales if migrating past Lunskoye	Moderate	Moderate
	• Disturbance and short-range movements and reduced feeding opportunities, possible loss of reproductive potential, reduced growth, and reduced ability to survive winter for the Critically Endangered western gray whales if feeding near the survey area (1)	Moderate / Major	Moderate
	• Injury or fatality to marine mammals (including the Critically Endangered western gray whales), from collisions with vessels and deployed equipment	Major	Moderate
The effects of physical presence of survey vessels and seismic sound sources on other marine biota	• Injury and fatality from underwater airgun noise	Minor	Minor
	• Spawning disturbance or damage to eggs	No Impact	No Impact
	• Behavioural disturbance *eg* dispersal of fish shoals	Minor	Minor
	• Disturbance to shellfisheries	Minor	Minor
	• Noise and disturbance impacts to birds (including secondary impacts due to the disturbance of prey species)	No Impact	No Impact

(1) On the basis of present data there are no western gray whales feeding in the Lunskoye area, which would make impacts at most *moderate*. However, if new data would show that whales are feeding, the potential impact would be *major*, to be reduced to *moderate*.

Issue	Key Impacts	Potential Impact	Residual Impact
Impacts on Other Users of the Area			
Vessel and equipment interaction with other users of area	• Potential for collision or other accident with other vessels, equipment and concomitant injury, loss of life, vessel damage, loss of property/cargo	Moderate	Minor
	• Temporary interference with commercial fishing activities / damage to fishing equipment	Minor	Minor
	• Interference with any military use of the area	No Impact	No Impact
	• Direct damage to identified or unidentified wreck or non-wreck sites	No Impact	No Impact
	• Hunting of marine mammals and birds	No Impact	No Impact
	• Impacts on the local social environment and economy	No Impact	No Impact
	• Impacts on cables and other manmade submarine infrastructure	No Impact	No Impact
Pollution Impacts from Effluents, Emissions and Wastes			
Effluent discharges	• Impacts on water quality and marine biota from cooling water and surface drainage discharges (*eg* sea spray and rainwater)	No Impact	No Impact
	• Impacts on water quality and marine biota from controlled drainage and sanitary waste water discharges	Minor	Minor
	• Impacts on marine biota from water intakes	Minor	Minor
Air emissions from survey vessels	• Reduction in local air quality	Minor	Minor
	• Contribution to regional and global atmospheric pollution phenomena *eg* acidic deposition, ozone layer depletion and the greenhouse effect	Minor	Minor

Issue	Key Impacts	Potential Impact	Residual Impact
Solid and scheduled waste	• Impacts on marine organisms from waste management and disposal practices	Moderate	No Impact
Accidental Spills, Leaks and Dropped Objects			
Spills, leaks and dropped objects	• Small release of harmful substances (*eg* wastes, oil, fuel oil) resulting in a decrease in water quality and injury to marine organisms	Minor	Minor
	• Loss of small objects and cargo	No Impact	No Impact
	• Large release of harmful substances (*eg* wastes, oil, fuel oil), and large scale objects and cargo resulting in a decrease in water quality, injury to marine organisms and obstruction to other vessels	Moderate	Minor